The links between sectoral and regional investment and sectoral, regional, and aggregate productivity in the United Kingdom*

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May 22, 2026

Abstract. We document significant regional and sectoral productivity disparities in the United Kingdom, particularly between London and other regions, with important implications for aggregate productivity and living standards. These differences are driven by sectoral trade imbalances, notably in intermediate services, where London serves as the primary supplier. We explore how productivity shocks propagate through regional and sectoral linkages, using a quantitative spatial model of the U.K. economy to assess their local and aggregate impact. Using data for the 12 ITL1 regions and 9 broad goods and services sectors, we incorporate regional migration, input-output linkages, capital dynamics, and other local factors. We extend the model to a small open economy by including the Rest of the World as an exogenous trading partner, which allows us to study the regional incidence of changes in international trade costs alongside domestic trade reforms. We find that productivity shocks have heterogeneous aggregate impacts depending on the originating regions and sectors. London and the Southern regions exhibit the largest influence on aggregate GDP, while the services sectors yield the highest aggregate total factor productivity (TFP) and GDP elasticities. We identify regions where increases in their capital stock would contribute most to aggregate outcomes, while also emphasising the need for targeted regional and sectoral policies that promote tradability across regions to mitigate disparities and improve national productivity.

Keywords: Regional trade, input-output linkages, labour mobility, regional productivity, sectoral productivity

JEL Codes: O4, O52, R11, R12, R15

*We thank brown bag seminar participants at NIESR, and at the Productivity Institute Productivity Research Conference (2025) for their helpful comments and suggestions. We gratefully acknowledge financial support by The Productivity Institute. All errors are our own.

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1 Introduction

The United Kingdom exhibits large regional differences in productivity, mainly between London and most other regions. This disparity has significant implications for aggregate productivity and welfare, resulting in substantial regional differences in living standards across the country. Trade imbalances between regions differ by sector. Most regions tend to trade a relatively even proportion of intermediate goods; however, there is a large imbalance in intermediate services flows, with London acting as the main supplier to all UK regions. The prominence of specific industries in shaping these differences—such as the financial and business services sectors in London—underscores the importance of incorporating the sectoral composition of regions, particularly in terms of welfare and labour mobility.

Recent literature has examined the uneven role of London in shaping the UK's regional imbalances. For example, Gal and Egeland (2018) point to the capital's higher productivity as driving the North-South divide by attracting labour and capital resources. Although there is a growing literature linking regional productivity to aggregate productivity, the propagation of shocks in UK production networks has not been fully investigated from a regional perspective. In this study, we aim to contribute to this literature by using a quantitative model of the UK economy to measure the local and aggregate impact of changes in regional and sectoral productivity and infrastructure. We develop a static model that accounts for regional migration, input-output linkages between sectors, and local factors such as amenities and capital structures. The interplay of these components translates the disaggregated productivity changes into aggregate outcomes. We consider the large observed regional trade imbalances, including trade in services, and we use this model to propose policy options aimed at improving productivity at the sectoral, regional, and aggregate levels.

Our contribution is twofold. First, we quantify how productivity and infrastructure shocks transmit through the United Kingdom's interregional input-output network when trade in intermediate services inputs is explicitly incorporated, an aspect that is often abstracted from in quantitative sectoral applications, due to measurement constraints. Second, we provide UK-specific evidence by combining International Territorial Level 1 (ITL1) regional data with multi-sector interregional trade flows in a calibrated trade model, and by extending the framework to a small open economy that captures international trade flows between UK regions and the Rest of the World. This allows us to rank regions and sectors by their impact on the national aggregates, to identify which region pairs deliver the largest aggregate gains from reductions in domestic trade costs, and to quantify the regional incidence of changes in UK–RoW trade costs.

We use a rich dataset of 12 regions, covering the ITL1 regions in the United Kingdom. We employ bilateral trade flow data as estimated in the Multi-regional Input-output Dataset (MRIOD) developed by Ouyang et al. (2026).

Our framework builds on conventional specifications of the literature on trade and spatial economics, particularly Caliendo et al. (2018). We assume an open economy, multiple sector model, covering nine tradable goods and services sectors, that combine intermediate inputs from a set of varieties that can be purchased from other regions. Each variety is produced using labour, capital

and intermediate goods, and is subject to idiosyncratic productivity levels, which are region- and sector-specific. As in Moll (2014), final goods are consumed locally by two types of agents: workers and landlords. Workers have free mobility, but landlords are immobile and own the local capital infrastructure. This leads to a distribution of regional endowments that affect local productivity and influence the allocation of the labour input across regions.

Using this framework, we perform several counterfactuals, which allow comparisons with a baseline scenario where the outcomes should therefore be read as short-run under fixed local capital infrastructure and frictionless mobility of workers. In the long run, allowing for capital accumulation, capital adjustment costs, housing constraints, and gradual migration would alter the magnitude of regional and sectoral effects: capital deepening and migration can amplify gains where complementarities are strong, but adjustment frictions can dampen the reallocation mechanisms that drive propagation in the model.

Our preliminary findings suggest that disaggregated productivity changes can have different aggregate implications depending on the regions and sectors affected. These productivity changes are propagated across regions via regional trade linkages, and their sectoral structure determines their ultimate impact. We use elasticities to compare these effects across regional and sectoral shocks. Our quantitative exercises reveal stark heterogeneities in the aggregate impact of productivity shocks. A 1% positive productivity shock to all sectors in London increases national GDP by 1.27%, the largest of any region, compared to an impact of less than 1% for the devolved nations, even with normalised controls[1]. These differential impacts are quantitatively guided by our sectoral trade elasticities, which range from 1.56 in real estate to 8.75 in manufacturing, determining how cost shocks propagate through regional supply chains.

From a sectoral perspective, our results point towards a differential effect depending on the sector experiencing the productivity shock. This arises from costly regional trade on intermediate inputs, leading to the accumulation of production factors and the subsequent regional concentration of sectoral activity. A uniform 1% productivity improvement across all regions in a given sector shows that manufacturing and construction shocks have the smallest aggregate GDP impact (0.74–0.78%), despite their higher tradability. In contrast, shocks to agriculture, mining and energy, and financial intermediation have the largest effects, boosting aggregate GDP by 1.3-1.4%. Conversely, aggregate UK total factor productivity (TFP) is most responsive to positive shocks in services sectors, particularly real estate and business activities, which yield a 0.69% increase for a 1% positive productivity shock.

These results provide a numerical basis for targeted policies. We quantify that a 1% increase in a region's capital stock has a maximum national GDP elasticity of 0.2%, with the highest returns from investment in London and the South. Furthermore, strategically reducing trade costs between specific regional pairs offers highly cost-effective gains: a 1% reduction in trade costs between Lon-

[1]The overall effect of these shocks are reported in terms of elasticities, so to make comparisons across regions and sectors. The aggregate elasticities show the total impact on the UK economy resulting from the shocked sectors or regions. We multiply the size of the variable change (which is 1% in all counterfactuals) by the share of the region or sector where the shock originated. This approach controls for economic size of larger regions and sectors, normalising results so they have a constant national magnitude.

don and the South East, for instance, increases national GDP by 0.37%. Overall, our findings demonstrate that the dual levers of strategic capital investment and infrastructure improvements, and targeted trade cost reduction can significantly mitigate regional disparities, with the precise optimal mix depending on the specific regional and sectoral context.

Our open-economy analysis indicates that a uniform 10% increase in UK–RoW trade costs (the magnitude attributed to the post-Brexit Trade and Cooperation Agreement) reduces aggregate UK GDP by 3.8%, broadly consistent with the 3.9% NIESR estimate in **?**. The full-model autarky loss is roughly 2.75 times larger than the canonical sufficient-statistic prediction of **?**, reflecting the role of general-equilibrium channels (labour mobility, input-output linkages, immobile capital) that the analytical formula abstracts from.

Related literature

Our study relates to different lines of research. In particular, our work engages with the literature on quantitative spatial economics, see Redding and Rossi-Hansberg (2017) for a recent survey. Like many studies in this field, we analyse spatial economic patterns, while focusing on the transmission of shocks across several linkages. On the one hand, at a multisector scale, the transmission of sectoral shocks along production networks can have heterogenous impacts on aggregate economic variables, as explored in Long Jr and Plosser (1983), Horvath (2000), Acemoglu et al. (2012) and De Graeve and Schneider (2023). Given a region's economic structure, these sectoral shocks tend to influence as well the concentration of activity in specific regions through input-output relationships. The allocation of production factors influences as well the intensity of these shocks, as it will result in changes in the flows of migration and capital across regions and sectors, as explored recently in Caliendo et al. (2018), Caliendo et al. (2019), Cai et al. (2022) and Kleinman et al. (2023). We apply a framework based on these studies to determine the channels through which some regions and sectors in the United Kingdom take a more pronounced role in influencing their aggregate economic outcomes.

This strand of the literature considers international trade in static, multi-sector, multi-country quantitative models mostly based on the Ricardian model developed by Eaton and Kortum (2002). We follow mainly Caliendo et al. (2018) to assess the extent to which interregional trade, labour mobility, local fixed factors, and heterogeneous productivities affect national aggregate TFP and GDP. The interaction between internal trade and migration has been explored, among others, in Allen and Arkolakis (2014) and Redding (2016). This literature is dominated by analysis of goods trade. More recently, services trade data has been more available and alongside it, the complexities of measuring them, as well as their different idiosyncrasies when considering quantitative models. Miroudot et al. (2013), Gervais and Jensen (2019) and Nakano and Nishimura (2025) discuss in more detail the tradability of services and their measurement, while the importance of the trade in services in shaping regional production specialization in the United States has been studied by Rossi-Hansberg et al. (2019) and Hsieh and Rossi-Hansberg (2023), and Han et al. (2023) in Canada, based on available data. We contribute to the interregional trade literature by acknowl-

edging the relevance of the trade in services intermediate inputs, incorporating them in our analysis.

Finally, we contribute to the literature on regional disparities in the United Kingdom. Gal and Egeland (2018) note a significant sectoral impact from financial and business services, as manufacturing, construction, government, and distribution services have smaller regional differences. Rice and Venables (2022) indicate that these regional differences stem from the locational persistence of highly tradable sectors, tending to concentrate in specific regions and not develop in less competitive areas. Coyle and Mei (2023) focus on the sectoral composition of the United Kingdom, showing that the aggregate productivity slowdown stems from specific industries (primarily transport equipment and pharmaceuticals), rather than the relocation of factors towards less productive sectors.

In turn, as discussed in Kenny et al. (2023), this spatial inequality is characterised by a concentration of economic activity, migration and capital flows towards the capital of London, a pattern consistent with core-periphery models in spatial economics. In contrast, we employ a Ricardian trade model in order to assess the interactions not just with the periphery and London, but also among regions within the periphery itself. This approach allows us to shed light on why certain peripheral areas experience persistent underdevelopment despite proximity to growth centers, how interregional specialization shapes inequality, and whether policy interventions could rebalance economic opportunities more effectively across the United Kingdom. By moving beyond the simple core-periphery dichotomy, our model provides new insights into the granular dynamics of regional divergence and the potential for more targeted place-based policies. We draw conclusions in the lines mentioned by the above-mentioned studies: Rice and Venables (2022) on the local concentration of tradable sectors, Coyle and Mei (2023) on specific industries dragging down aggregate productivity, and on the prominence of the North-South divide (Gal and Egeland (2018), Gardiner et al. (2020), McCann and Yuan (2022)).

The rest of the paper is structured as follows. Section 2 describes the regional and sectoral composition of economic activity in the United Kingdom. In sections 3 and 4 we develop our static spatial model and we characterize the equilibrium properties of the model. Section 5 describes how we take the model to the data. This section discusses data measurement and the data sources used to take the model to the UK context, as well as our estimation strategy of the relevant trade elasticities. Section 6 presents our quantitative results, while Section 7 concludes. We relegate all proofs, theoretical derivations, and detailed data descriptions to the appendix.

2 Sectoral and regional linkages in the U.K. economy

The regional dimension of this paper is defined by the twelve ITL1 regions of the United Kingdom, with an additional Rest of the World (RoW) region. We consider nine sectoral groups as described in Table 1.

Table 1: Sectoral Groups

Sector Name	**SIC07 code(s)**
Agriculture	A
Mining and Energy Supply	B,D,E
Manufacturing	C
Construction	F
Distribution; Hotels and Restaurants	G,I
Transport and storage; Info and communication	H,J
Financial intermediation	K
Real estate, renting and business activities	L,M,N
Non-market services	O,P,Q,R,S,T

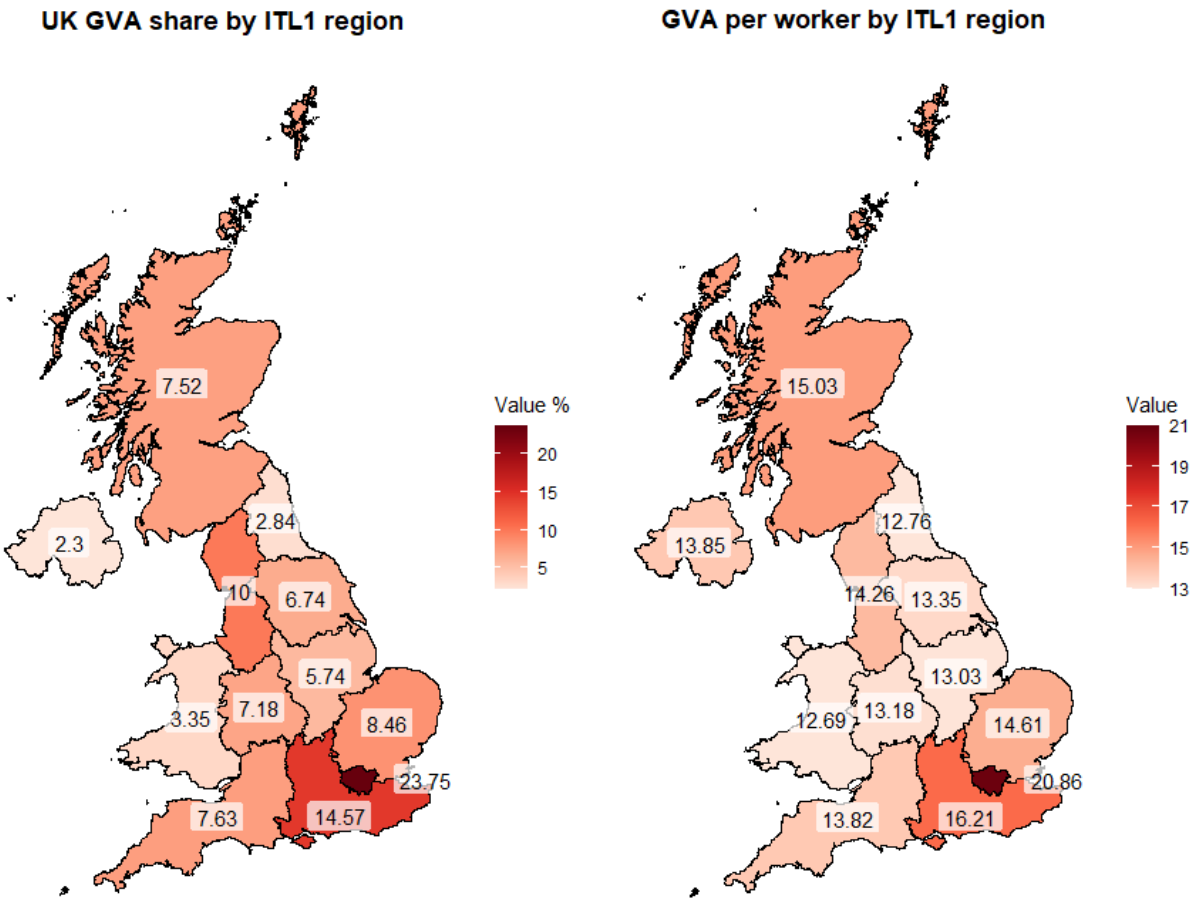
2.1 The Spatial Distribution of Economic Activity

Aggregate data for the UK economy masks considerable heterogeneity in economic circumstances across regions. Understanding regional variation in economic activity is important because it informs the aggregate impact of sector- and region-specific productivity shocks. The transmission of such shocks takes form in different channels, most prominently through migration flows altering employment shares, and trade in goods and services. In this paper we focus exclusively on trade in intermediate inputs, connecting the productive structures of each region and sector in the economy.

Figure 1 illustrates the average share of national GVA produced by each region. There is considerable variation in regional contributions to national GDP. For example, London contributes the most to UK GDP and accounted for 23.7 per cent of national output in 2023. The second-highest contributor to national output is the South East, which generates 14.6 per cent of UK output. Northern Ireland contributes the least, producing 2.30 per cent in 2023. This variation in output volumes across UK regions cannot be explained by geographic size. London has the smallest land area of the UK ITL1 regions; it is almost nine times smaller than Northern Ireland and some fifty times smaller than Scotland. The supply of labour across regions also cannot explain the entirety of the variation in regional output. Figure 1 shows that London exhibits the highest labour productivity of any UK region. Output per job in London is 28.7 per cent higher than in the South East, the second most productive ITL1 region, and 64.4 per cent higher than in Wales, the least productive region.

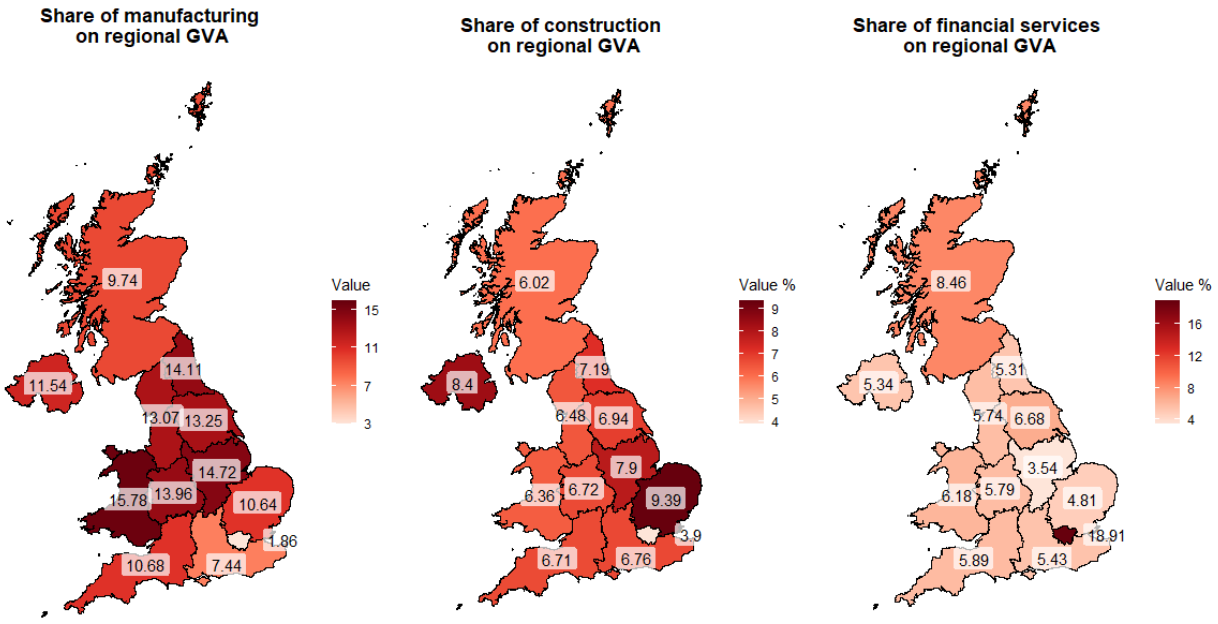
Regional disparities in economic activity are underpinned by substantial variation in the spatial distribution of sectoral activity. Figure 2 shows the GVA share of a selection of sectors for a given region's total output. Wales is the most manufacturing-intensive region, with manufacturing accounting for 15.8 per cent of its GVA, whereas London is 8.5 times less manufacturing-intensive, at only 1.86 per cent. Construction shares exhibit a narrower range: regional GVA shares span from 2.9 per cent in London to 9.4 per cent in the East of England, meaning London is roughly 2.4 times less construction-intensive than the East of England. Financial services shares range from 3.5 per cent of GVA in the East Midlands to 18.9 per cent in London. This implies that the East Midlands is about 5.3 times less finance-intensive than London. More generally, the economic composition of

Figure 1: U.K. Output Shares and Productivity by Region, 2023



London drives much of the spatial variation in sectoral concentration across the United Kingdom.

Figure 2: Spatial distribution of sectoral activity (value added shares, 2023)



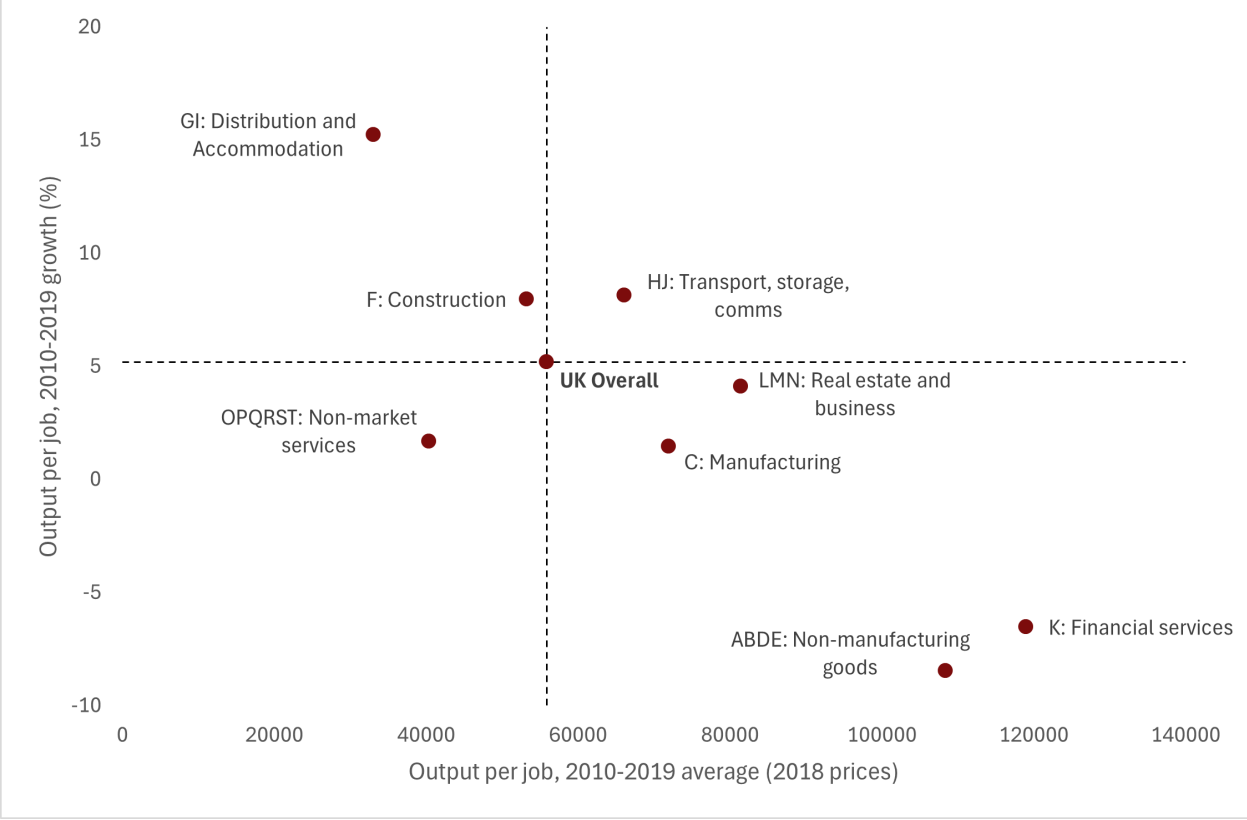
The spatial distribution of sectoral activity is important because sectors are not equally productive. Sectoral productivity differentials therefore directly inform regional differences in productivity levels and productivity growth. Figure 3 plots output per job in levels against output per job growth over the 2010–2019 period. The most productive sectors are non-manufacturing goods and financial services, while the least productive sectors are distribution and accommodation and non-market services. Figure 3 also shows that low productivity sectors tend to realise higher rates of productivity growth, with productivity actually falling for non-manufacturing goods sectors and financial services over the period 2010 to 2019.

2.2 Regional Trade Linkages

Given substantial variation in economic circumstances across regions, interregional trade linkages could play a key role in the propagation and amplification of sectoral and regional productivity shocks.

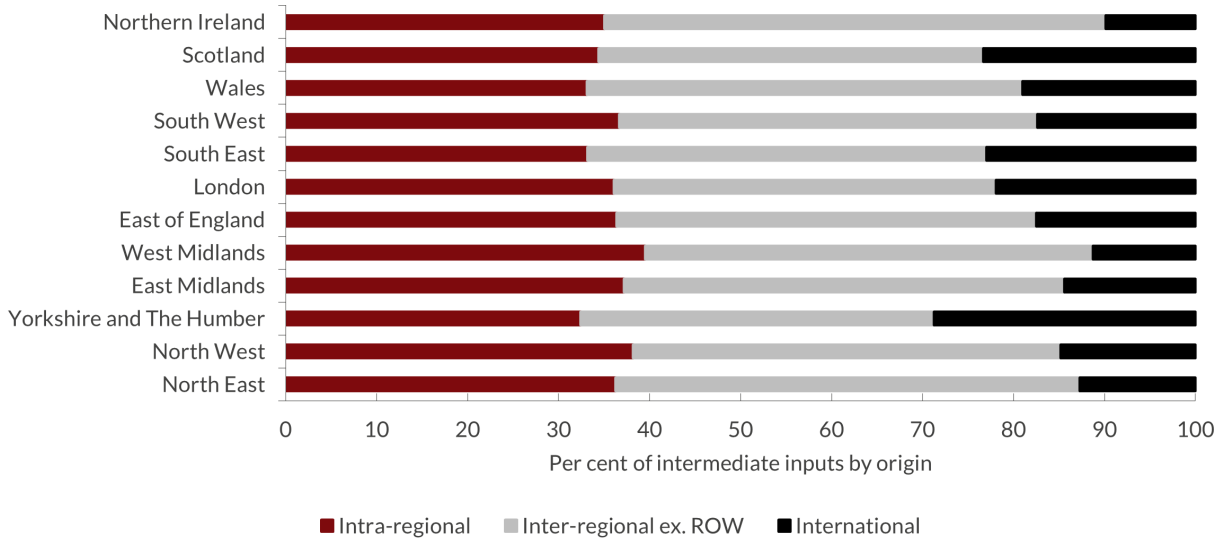
Every UK region relies heavily on the intraregional trade of intermediates (Figure 4) with the most autarkic region being the west Midlands where 39.5 per cent of input trade occurs within the region. The least autarkic region is Yorkshire and The Humber, which exhibits an intraregional input share of 32.4 per cent. Interregional trade within the United Kingdom occupies a particularly large share of trade expenditure for Northern Ireland (55.1 per cent) and the North East (50.9 per cent). As a relatively small open economy, each UK region relies on imports from abroad.

Figure 3: Sectoral productivity performance, output per job, 2010-2019



Imports account for 19.3 per cent of intermediates expenditure in the UK. The imported share of intermediate expenditure is lowest in Northern Ireland (9.9 per cent) and highest in Yorkshire and the Humber (28.8 per cent).

Figure 4: Intermediate expenditure shares by trade partner



Source: MRIOD UK Ouyang et al. (2026), author's calculations.

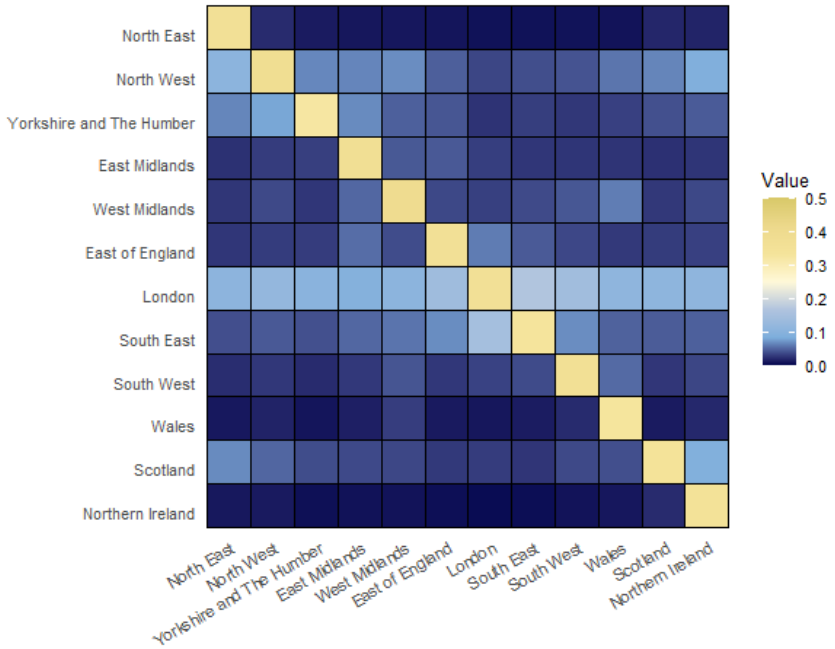
To obtain a more granular picture of trade linkages, Figure 5 presents a heatmap of interregional trade expenditure shares. The UK's input-output network is relatively sparse; for any given region, the majority of intermediates are purchased from a small set of regions. London, the North West, Yorkshire and The Humber, and Scotland are key suppliers of traded intermediates for other UK regions, as indicated by the rows in Figure 5. London occupies a particularly important role for supplying intermediate inputs across all regions.

Figures 6 and 7 display heatmaps of interregional goods and services intermediate expenditure shares, respectively. In line with the consensus on sectoral trade, regions are generally more autarkic with respect to services than goods as indicated by the intensity of the yellow diagonal cells in Figure 7 compared to Figure 6. Expanding on the aforementioned importance of particular regions as domestic suppliers of intermediates, Figures 6 and 7 reveal that other UK regions rely on London as a supplier of intermediates in services sectors while the North West, Yorkshire and The Humber, and Scotland are suppliers of intermediate goods.

3 Model

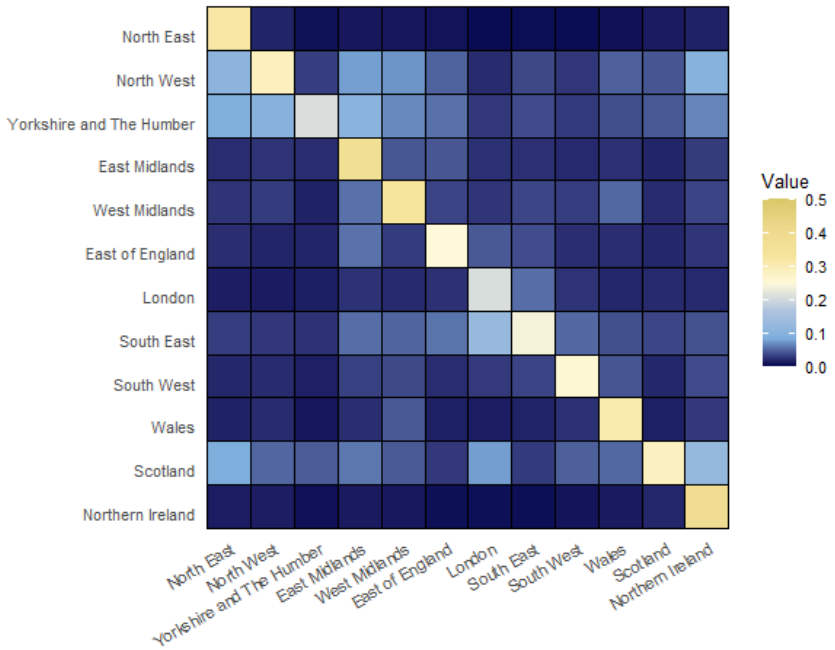
We build on Caliendo et al. (2018) for the overall structure of the sectoral and regional model, introducing international trade and assuming that services are fully tradable. Our objective is to analyse the role of domestic trade in goods and services in shaping the United Kingdom's industrial structure. We consider an open economy in which there is within-country and international trade

Figure 5: Heatmap of regional intermediate expenditure shares



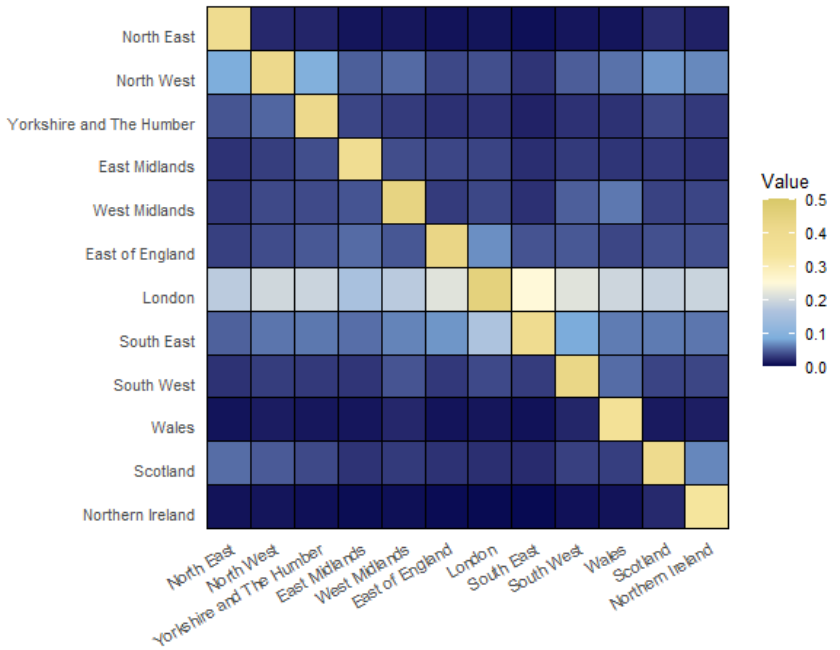
Source: MRIOD UK Ouyang et al. (2026), author's calculations.
Notes: Each (i, j) element in the matrix shows the percentage of total expenditure by region i (columns) coming from producing region j (rows).

Figure 6: Heatmap of regional intermediate expenditure shares (goods sectors)



Source: Ouyang et al. (2026), author's calculations.
Notes: Each (i, j) element in the matrix shows the percentage of total expenditure by region i (columns) coming from producing region j (rows). Figure excludes trade with construction sector.

Figure 7: Heatmap of regional intermediate expenditure shares (services sectors)



Source: Ouyang et al. (2026), author's calculations.
Notes: Each (i, j) element in the matrix shows the percentage of total expenditure by region i (columns) coming from producing region j (rows). Figure excludes trade with construction sector.

between the 12 ITL1 regions. In each region, there are nine goods and services sectors. Firms use labour, capital and intermediate inputs as factors of production.

We assume that the representative firm in each sector and region exports and imports goods and services in the form of intermediate inputs with other regions. We model trade costs through the existence of iceberg costs. Following Eaton and Kortum (2002), producers differ in their productivity and the trade costs associated with different regions. Workers are freely mobile across regions and sectors, while capital stock is fixed locally. Agents consume a composite final good of all local sectors, such that there is no inter-regional trade in final goods.

3.1 Intermediate inputs

In region $i \in \{1, ..., N\}$ and sector j there is a continuum of producers $z \in [0, 1]$, whose production technology is given by

$$q_i^j(z) = Z_i^j(z) \left[T_i^j (L_i^j(z))^{1-\beta^j} (K_i^j(z))^{\beta^j} \right]^{\gamma^j} \left[\prod_{h=1}^{J} \left(M_i^{jh}(z) \right)^{\lambda_n^{jh}} \right]^{1-\gamma^j} \tag{1}$$

where q_i^j is the variety of output produced by sector j in region i in time period t; Z_i^j denotes the variety-specific component of gross output productivity, and L_i^j and K_i^j denote the firm demand for labour and capital, respectively. M_i^{jh} is sector h's output used as an intermediate input in sector j's

production. All these terms are sector-region specific. T_i^j is the fundamental exogenous component of measured value-added productivity, and scales value-added and not gross output. γ^j is the share of sector j income spent on value added, β^j is the income share of capital infrastructures on value added, and λ_n^{jh} is the share of sector j spent on intermediate inputs from each sector h. We assume the production function has constant returns to scale, such that $\sum_{h=1}^{H} \lambda_n^{jh} = 1$.

3.2 Final goods

The quantity of final goods in (i, j) is denoted by Q_i^j, while the demand of intermediate input is given by $\widetilde{q}_{i,t}^j$.

$$Q_i^j = \left[\int \widetilde{q}_i^j (Z^j)^{1-1/\eta} \phi^j(Z^j) dZ^j \right]^{\eta/(\eta-1)} \tag{2}$$

As in Eaton and Kortum (2002), we assume that, in every period, gross output productivity Z_i^j is a random draw from a Fréchet distribution with shape parameter θ^j that varies across sectors, such as $F(Z) = e^{-Z^{-\theta^j}}$, and where $\phi^j(Z^j)$ is the probability density function of the distribution. All draws are assumed to be independent across sectors and regions. For a given intermediate variety, the particular vector of productivity draws received by the different n regions is $Z^j = (Z_1^J, Z_2^J, ...Z_N^J)$. Measured gross productivity is calculated as the resulting composite $A_i^j = Z_i^j T_i^{j\gamma^j}$.

We adopt the continuum-of-varieties framework for two key reasons. First, it allows us to capture realistic within-sector heterogeneity in firm productivity without requiring firm-level data for each UK region—a practical necessity given data limitations at the ITL1 level. Second, this approach generates smooth, gravity-type trade flows between regions that are consistent with empirical estimates of trade elasticities. The Fréchet distribution yields closed-form solutions for regional trade shares, making the model tractable while still capturing how domestic trade costs shape the selection of producers into different markets. This is particularly important for analysing the United Kingdom's industrial structure, as heterogeneity in firm productivity fundamentally determines which regions specialise in which activities and how they integrate into domestic and international value chains.

3.3 Prices and factor payments

Final goods are non-tradable and are consumed by local agents in the same location i where they are produced. Firms in each region and sector (i, j) purchase intermediate inputs from other regions and sectors (n, h). Intermediate inputs are costly to trade. We assume that there exist iceberg costs that reduce trade of intermediate inputs across regions. These trade costs include transportation costs and other barriers to trade. These iceberg costs $\tau_{in} \geq 1$ affect the shipping of intermediate goods from region i to region n. As is standard in the literature, we assume that there are no trade costs within a region ($\tau_{ii} = 1$). Note that trade costs do not vary with sector j.

Markets are competitive: from the firms' cost minimisation problem, subject to technology 1,

the unit cost of input bundle is given by

$$x_i^j = \Omega^{jh}\left[\left(w_i^j\right)^{1-\beta^j}\left(r_i^j\right)^{\beta^j}\right]^{\gamma^j}\left(\prod_{h=1}(p_{ni}^h)^{\lambda_n^{jh}}\right)^{1-\gamma^j} \tag{3}$$

where $\Omega^{jh} = \left((\beta^j)\gamma^j\right)^{-\gamma^j}\left(\frac{1-\beta^j}{1-\beta^j}\right)^{-\gamma^j\beta^j}\left(\frac{\prod_{h=1}\lambda_n^{jh-\lambda_n^{jh}}}{1-\gamma^j}\right)$ is a constant term, w_i^j and r_i^j are the wage and rental rates of labour and capital respectively, and p_i^h is the price of sector-h's input from region n purchased by either sector in region i. The price of shipping produced goods from sector j in region n to location i depends on the iceberg trade costs and the input marginal costs:

$$p_{in}^j = \frac{\tau_{in}x_n^j}{Z_n^j(T_n^j)^{\gamma^j}} \tag{4}$$

The price paid for a particular variety whose vector of productivity draws is Z^j, $p_i^j(Z^j)$, is therefore given by the minimum of the unit costs across regions, adjusted by the transport costs τ_{in}, i.e., competitive buyers purchase the variety from the supplier in either region that offers the lower price,

$$p_i^j(Z^j) = \min_i\left\{\frac{\tau_{in}x_i^j}{Z_i^j(T_i^j)^{\gamma^j}}\right\} \tag{5}$$

Following Eaton and Kortum (2002), given the distribution of prices, the price of the composite sectoral final good j in region i may then be expressed as

$$P_i^j = \Gamma\left[\sum_{i=1}^{N}(\tau_{in}x_i^j)^{-\theta^j}(T_i^j)^{\theta^j\gamma^j}\right]^{-1/\theta^j} \tag{6}$$

where Γ is the Gamma function evaluated at $\left(1-\frac{\eta-1}{\theta^j}\right)^{1/(1-\eta)}$. Regional and sectoral trade patterns in this model depend on the dispersion of productivities (comparative advantage) and trade barriers (geographic or economic). A lower value of θ^j generates more room for comparative advantage, rather than trade barriers, in driving trade patterns. As in Eaton and Kortum (2002), under the Fréchet distribution assumption, the share of region i's expenditure on sector-j goods from region n can be derived as

$$\pi_{in}^j = \frac{(\tau_{in}x_n^j)^{-\theta^j}(T_n^j)^{\theta^j\gamma^j}}{\sum_{n=1}^{N}(\tau_{in}x_n^j)^{-\theta^j}(T_n^j)^{\theta^j\gamma^j}} \tag{7}$$

Therefore, the probability of importing sector j goods from region n to region i depends on sector j's productivity in region n, the cost of the input bundle x_{it}^j, and the trade costs of shipping from region n to region i, τ_{in}.

3.4 Household consumption

Workers do not have access to an investment technology, and choose their consumption of varieties to maximise their utility in their location. The utility function of a worker in location i depends on the consumption index C_i defined over the varieties supplied by each location:

$$U_i = b_i C_i = b_i \prod_{j=1}^{J} (C_i^j)^{\psi^j}, \qquad \sum_{j=1}^{J} \psi^j = 1 \tag{8}$$

where amenities (b_i) capture characteristics of a location that make it a more attractive place to live regardless of the wage and cost of consumption goods, and we assume that they are exogenous. We incorporate Han et al. (2023) assumptions on regional and international trade to represent the regional differences in trade balances. The budget constraint of a representative household is

$$\sum_{j=1}^{J} P_i^j C_i^j + (\iota_i^{\text{Dom}} + \iota_i^{\text{Int}}) w_i L_i = w_i L_i + (\xi^{\text{Dom}} + \xi^{\text{Int}}) L_i \tag{9}$$

where ι_i^{Dom} and ι_i^{Int} are modeled as the ratio of domestic and international net exports to total value-added for region i in the baseline economy. The net returns $\iota_i^{\text{Dom}} w_i L_i - \xi^{\text{Dom}} L_i$ and $\iota_i^{\text{Int}} w_i L_i - \xi^{\text{Int}} L_i$ govern trade imbalances that emerge from interregional and international trade, which satisfy:

$$\sum_i \iota_i^{\text{Dom}} w_{i,t} L_{i,t} = \xi^{\text{Dom}} \sum_i L_{i,t}, \qquad \forall i \in \{1, \ldots, J\}; \tag{10}$$

$$\sum_i \iota_i^{\text{Int}} w_{i,t} L_{i,t} = \xi^{\text{Int}} \sum_i L_{i,t}, \qquad \forall i \in \{1, \ldots, J+1\}. \tag{11}$$

Given that net exports sum to zero, the lump-sum transfers ξ^{Dom} and ξ^{Int} will equal 0 in the benchmark.

Agents move freely across regions. In equilibrium, households are indifferent between living in any region ($U_i = \tilde{U}, \forall i$). Utility maximisation implies that goods consumption expenditure on each sector is a constant share of overall goods consumption expenditure in each region:

$$P_i^j C_i^j = \psi^j P_i C_i \tag{12}$$

where the expression for total expenditure is given by (9). The consumption goods price index (P_i) in location i depends on the consumption goods price index for each sector j in that location P_i^j, as given by the profit maximisation problem:

$$P_i = \prod_{j=1}^{J} \left(\frac{P_i^j}{\psi^j} \right)^{\psi^j} \tag{13}$$

3.5 Market Clearing

Labour and capital markets. From the profit maximisation problem and zero profits, payments for labour and capital in each sector are constant shares of revenue in that sector:

$$w_i^j L_i^j = \gamma^j (1-\beta^j) q_i^j \tag{14}$$

$$r_i^j K_i^j = \gamma^j \beta^j q_i^j \tag{15}$$

The immobility of capital across sectors and regions once installed implies that the rate of return on capital does not need to be equalised across sectors and locations outside of steady state ($r_{it}^j \neq r_{nt}^h$). We choose the total labour income of all locations as our numeraire: $\sum_{i=1}^{N} \sum_{j=1}^{J} w_i^j L_i^j = 1$. Regional labour and capital market clearing require that

$$\sum_{j=1}^{J} \sum_{i=1}^{N} L_i^j = \sum_{i=1}^{N} L_i = \tilde{L} \qquad \& \qquad \sum_{j=1}^{J} \sum_{i=1}^{N} K_i^j = \sum_{i=1}^{N} K_i = \tilde{K} \tag{16}$$

Profit maximisation by the variety producers in each region i implies that

$$w_i^j L_i^j = \frac{1-\beta^j}{\beta^j} r_i^j K_i^j \tag{17}$$

In equilibrium, workers in either sector are indifferent between living in any region $U_i^j = U_{i'}^{j'}$, which implies the spatial arbitrage condition:

$$b_i \frac{w_i^j (1 - \iota_i^{Dom} - \iota_i^{Int}) + (\xi^{Dom} + \xi^{Int})}{P_i} = b_{i'} \frac{w_{i'}^{j'} (1 - \iota_{i'}^{Dom} - \iota_{i'}^{Int}) + (\xi^{Dom} + \xi^{Int})}{P_{i'}} \tag{18}$$

The above profit maximisation condition (17), together with the free mobility condition leads to

$$L_i = \left[\frac{\omega_i (1 - \iota_i^{Dom} - \iota_i^{Int})}{\frac{P_i U}{b_i} - (\xi^{Dom} + \xi^{Int})} \right]^{\frac{1}{1-\beta^i}} K_i \tag{19}$$

where $\omega_i = \left(\frac{w_i^j}{\beta^j} \right)^{\beta^j} \left(\frac{r_i^j}{1-\beta^j} \right)^{1-\beta^j}$. Combining this with the labour market clearing condition, results in an expression for labour input in region i

$$L_i = \frac{\left[\frac{\omega_i (1 - \iota_i^{Dom} - \iota_i^{Int})}{\frac{P_i U}{b_i} - (\xi^{Dom} + \xi^{Int})} \right]^{\frac{1}{1-\beta^i}} K_i}{\sum_{i=1}^{N} \left[\frac{\omega_i (1 - \iota_i^{Dom} - \iota_i^{Int})}{\frac{P_i U}{b_i} - (\xi^{Dom} + \xi^{Int})} \right]^{\frac{1}{1-\beta^i}} K_i} \tilde{L} \tag{20}$$

This expression implies that the employment share in region i is increasing in its capital K_i and in the factor prices captured by ω_i. Conversely, employment in region i decreases with the relative size of the domestic and international trade surplus, as given by the ι_i^{dom} and ι_i^{dom}. Because the

lump-sum transfers ξ^{dom} and ξ^{int} are homogenous across regions, an increase in the former implies larger contributions to the national and international portfolios, which decreases the income per capita available in region i, pushing workers away.

Goods market Goods market clearing implies that income in each location and sector y_i^j is equal to expenditure on the goods produced by that location and sector X_i^j:

$$y_i^j \equiv w_i^h L_i^h + r_i^h K_i^h = X_i^j, \qquad y_i = \sum_{j=1}^{J} y_i^j \tag{21}$$

Because of the zero profit assumption in the final goods sector, total revenue exhausts total expenditure on intermediates. This means that total expenditure is equivalent to the purchase of intermediate inputs by each sector. Using the share of region n's expenditure on sector j from region i π_{ni}^j, the above can be expressed as

$$y_i^j = \sum_{n=1}^{N+1} \pi_{ni}^j X_n^j \tag{22}$$

Regional market clearing in final goods implies that

$$X_i^j = \sum_{h=1}^{J} \lambda_i^{hj} \sum_{n=1}^{N} \pi_{ni}^h X_n^h + \psi^j y_i L_i \tag{23}$$

where X_i^j denotes total expenditures on final good j in region i, equivalent to total revenue. In equilibrium, in any region i, total expenditures on intermediate inputs purchased from other regions must equal total revenue from intermediates sold to other regions, such that

$$\sum_{j=1}^{J}\sum_{i=1}^{N} \pi_{ni}^j X_i^j + \underbrace{(\iota_i^{dom} w_i L_i - \xi^{dom} L_i)}_{\text{domestic surplus}} + \underbrace{(\iota_i^{int} w_i L_i - \xi^{int} L_i)}_{\text{intl. surplus}} = \sum_{j=1}^{J}\sum_{i=1}^{N} \pi_{in}^j X_n^j \tag{24}$$

3.6 General Equilibrium

The general equilibrium in each period is determined as in a standard static international trade model.

Definition 3.1. Equilibrium: Given region-specific labour and capital endowment $\{L_i^j, K_i^j\}_{i=1}^N$ in each location, trade costs $\{\tau_{in}\}$, productivity processes $\{T_i^j\}$, location fundamentals $\{b_i\}$, and structural parameters, an *equilibrium* is a stochastic process of wages, capital returns, mass of workers and stock of capital in each location and sector $\{w_i^j, r_i^j, L_i^j, K_i^j\}_{i\in N}$, measurable with respect to the fundamental shocks, such that, given prices, the allocations satisfy the equilibrium conditions determined by the bilateral trade shares (7), the equilibrium location prices (6), the labour and capital markets clearing condition (16), and the equilibrium in the goods market (23).

4 Aggregation and changes in measured TFP and GDP

The following section formalises the measurement of the aggregate variables within our framework. We define the aggregation rules for calculating TFP and GDP, based on the disaggregated equilibrium outcomes across regions and sectors, and consistent with UK industry and regional trade data.

4.1 Measured TFP

We follow Caliendo et al. (2018) and calculate measured sectoral total factor productivity in a region-sector pair (i, j) as

$$\ln A_i^j = \ln \frac{w_i^j L_i^j + r_i^j K_i^j + \sum_{h=1}^{J} P_i^h M_i^{jh}}{P_i^j} - (1-\beta_i)\gamma^j \ln L_i^j - \beta_i \gamma K_i^j - (1-\gamma^j) \sum_{h=1}^{J} \lambda_i^{jh} \ln M_i^{jh} \quad (25)$$

where the first term denotes gross output revenue over the sectoral price, which is equivalent to Y_i^j / P_i^j, while the last three terms denote the logs of the production factors.

From the equilibrium condition in the factor markets (14), $q_i^j = w_i^j L_i^j / \gamma^j (1-\beta^j)$, we substitute this into the production of intermediate goods as

$$q_i^j(z_i^j) = \frac{p_i^j(z_i^j) q_i^j(z_i^i)}{y_i^j} z_i^i \left[T_i^j (K_i^j)^{\beta^j} (L_j^n)^{1-\beta^j} \right]^{\gamma^j} \left[\prod_{h=1}^{J} (M_{jh}^n)^{\lambda^{jh}} \right]^{1-\gamma^j} \quad (26)$$

Given that $p_i^j(z_i^j) = x_i^j / z_i^j (T_i^j)^{\gamma^j}$, $A_i^j = x_i^j / P_i^j$, and using the gravity equation (7) (π_i^j), we can calculate changes in measured TFP ($\widehat{A}_i^j$) using the ratio of the change in the cost of the input bundle to the change in the price of final goods, as

$$\ln \widehat{A}_i^j = \ln \frac{\widehat{x}_i^j}{\widehat{P}_i^j} = \ln \frac{(\widehat{T}_i^j)^{\gamma^j}}{(\widehat{\pi}_{ii}^j)^{1/\theta^j}} \quad (27)$$

Measured TFP at the level of a sector in a region is calculated based on gross output, so we use gross output revenue shares to aggregate these TFP measures into regional, sectoral, or national measures. Consider first the region-sector (i,j) that experiences a change or increase in fundamental productivity, T_i^j. The expression above implies that an increase in productivity increases its region and sector comparative advantage, increasing its reliance on self-produced, domestic inputs π_{ii}^j and reducing that of other regions, that purchase inputs from region i.

4.2 GDP

Real GDP is calculated by taking the difference between real gross output and expenditures on intermediates. Given the equilibrium factor demands of the intermediate good producers, as well

as factor market equilibrium conditions, changes in real GDP may be written as

$$\ln \widehat{GDP}_i^j = \ln \widehat{w}_i^j + \ln \widehat{L}_i^j - \ln \widehat{P}_i^j \tag{28}$$

Using the gravity equation (7) (π_i^j), we can express changes in GDP resulting from changes in fundamental TFP as

$$\ln \widehat{GDP}_i^j = \ln \widehat{A}_i^j + \ln \widehat{L}_i^j + \ln \left(\frac{\widehat{w}_i^j}{\widehat{x}_i^j} \right) \tag{29}$$

Given that real GDP is a value-added measure, we use value-added shares in constant prices to aggregate changes in GDP. The impact on aggregate GDP is identical as that of measured TFP, but with two more effects. On the one hand, there is the impact of labour migration across regions and sectors. A positive productivity shock attracts workers to a given sector–region pair by means of higher marginal productivity and thus, higher wage rates, increasing GDP proportionally through $\widehat{L}_i^j$, as all production factors change in the same proportions and the production function of intermediates has constant returns to scale. On the other hand, through variations in factor prices, a productivity shock will alter the relative costs of capital and labour, which are embedded in x_i^j as in equation (3). As capital is fixed to a region, the relative price of capital falls more than wages, resulting in a decrease in GDP.

As we consider the aggregate economy-wide effects of a positive T_i^j, the end result for aggregate GDP may be larger or smaller than the original change. The overall impact will depend on whether the direct effect of migration dominates the strain on local resources in the region experiencing the change, i, as well as the intensity with which this fixed factor is used in the regions that workers migrate from.

5 Data and calibration

5.1 Regional Trade Flows

Our model requires the use of a multi-regional input-output framework disaggregated by sector. We use the most recently available 2022 data from the UK MRIOD by Ouyang et al. (2026), which is a time series of input-output data for the twelve UK ITL1 regions covering 105 sectors and 6 final demand categories from 2017 to 2022. The underlying data is sourced from the Office for National Statistics. To the best of our knowledge, the 2022 UK MRIOD is the most recent trade data publicly available for our purposes.

5.2 Sectoral Trade Elasticities

Trade elasticities capture the responsiveness of trade flows to changes in bilateral trade costs. In our Ricardian framework, sectoral trade elasticities θ^j are key parameters in our model as they function as the shape parameter of the Fréchet distribution of idiosyncratic firm productivity z_n^j. The intuition behind this relationship is as follows. A low dispersion of productivity for a given sector (high θ^j) implies that regions are similar in their efficiency in producing output for sector j.

A high dispersion of productivity (low θ^j) implies that a few regions dominate in their efficiency in sector j. In turn, when productivity dispersion is low, trade flows are highly sensitive to changes in trade costs (high θ^j) because even small changes to regional trade costs can be sufficiently large to incentivise switching trade partners. Conversely, when productivity dispersion is high, trade flows are inelastic to changes in trade costs (low θ^j) because a few regions are particularly productive in sector j and are therefore less sensitive to shocks that disrupt the cost of trade in sector j. We include the derivation of the trade elasticity in the Appendix, though we do not estimate this parameter within the paper.

We take sectoral trade elasticity values from the literature, shown in Table 2. We do not estimate these values ourselves, as estimating sector-specific transport costs for services is beyond the scope of this paper.[2] A key challenge for calibrating this model is obtaining elasticities that match the necessary level of regional and sectoral disaggregation. On regional disaggregation, Zofío et al. (2024) and Zofío et al. (2025) find national trade elasticities to be much larger than foreign elasticities. Trade elasticity estimates also tend to display greater heterogeneity at more granular levels of sectoral disaggregation (Broda and Weinstein, 2006; Francois and Hoekman, 2010; Imbs and Mejean, 2017; Fontagné et al., 2022).

Table 2: Sectoral Trade Elasticities

SIC07 code(s)	**Sector**	θ^j	**Source**
A	Agriculture	4.4	Zofío et al. (2025)
BDE	Mining and energy supply	4.7	Zofío et al. (2025)*
C	Manufacturing	8.8	Zofío et al. (2025)
F	Construction	5.3	Carrascal-Incera and Orea (2025)
GI	Distribution, hotels, and restaurants	4.8	Carrascal-Incera and Orea (2025)
HJ	Transport, storage, and communication	4.5	Carrascal-Incera and Orea (2025)*
K	Financial intermediation	7.1	Carrascal-Incera and Orea (2025)
LMN	Real estate and business	1.6	Carrascal-Incera and Orea (2025)*
OPQRST	Non-market services	7.3	Carrascal-Incera and Orea (2025)

Notes: To obtain trade elasticities from Zofío et al. (2025), we exploit the result $\theta = \sigma - 1$ as per Arkolakis et al. (2012).
* Elasticities are a GVA-weighted average. We assume the energy sector has a trade elasticity equal to the overall production sector.

To calibrate our model we draw from Zofío et al. (2025) and Carrascal-Incera and Orea (2025). The methodology and data used by Zofío et al. (2025) is highly suited to the calibration of our model. They use European trade flows data at the ITL2 level with sector-augmented generalised transport costs based on Persyn et al. (2022). However, they only estimate trade elasticities for Agriculture, Mining, and Manufacturing sectors. We take our services sector trade elasticities from Carrascal-Incera and Orea (2025), who estimate their elasticities using the multi-regional input-output database developed by Huang and Koutroumpis (2023). In terms of magnitude, the calibrated goods trade elasticities sit between those found by Freeman et al. (2025) and Carrascal-

[2] Zofío et al. (2024) show that using generalised transport costs without sector-specific information fails to generate meaningful dispersion in trade elasticities across sectors and regional dimensions (national vs international).

Incera and Orea (2025), which is a broadly representative range of the literature. The calibrated services trade elasticities are consistent with those found by Freeman et al. (2025) and Ahmad and Schreiber (2024).

The underlying trade matrix of our model encompasses UK ITL1 regions and an external "Rest of the World" trade partner. Our use of trade elasticities estimated at the more granular ITL2 level likely over-estimates the size of these parameters for our model, thereby understating the welfare gains from trade. That said, we do not think this over-estimation is large as our sectoral trade elasticities sit within the range of estimates found in the relevant literature, which predominantly focuses on international rather than regional trade. Given the uncertainty associated with trade elasticity calibration, particularly in settings with regional and sectoral disaggregation, we argue that our calibration strategy is appropriate.

Among goods-trading sectors, our calibration gives manufacturing the highest trade elasticity and agriculture the lowest. In terms of our Ricardian interpretation of trade elasticities, our calibration implies that, relative to manufacturing, agricultural trade patterns are less responsive to changes in trade costs because highly productive regions remain competitive even when trade frictions increase.

Interpreting Ricardian trade elasticities for services is inherently more fragile than for goods, as measured trade flows and trade costs may imperfectly capture non-price frictions, quality differences, and the delivery modes of intermediate services (including cross-region sourcing within production networks). This concern is particularly relevant for non-market services, where observed trade and pricing are shaped by institutional arrangements and measurement conventions. Accordingly, we caution against over-interpreting the services elasticities as precise structural objects. Nevertheless,the elasticities for services are generally lower than those for goods, consistent with the view that services are less substitutable and less readily traded. Using data from 2022, the GVA-weighted trade elasticity in our calibration is 8.3 for goods sectors and 5.7 for services sectors.

6 Counterfactual exercises

In this section we perform a series of counterfactuals to assess the relevance of sectoral linkages in shaping regional disparities in TFP, GDP and labour mobility. We consider shocks to fundamental productivity, local capital infrastructure, and trade costs between regions. We start the simulation with an initial guess on the price of the production factors. We compute sectoral price, input cost, intermediate input trade shares, income and gross output subsequently, updating the price of the production factors. A new general equilibrium is then solved with these new allocations.

We begin by analysing changes to all sectors in one region, which we refer to as regional changes. We then study changes to all regions in one sector, which we refer to as sectoral changes. Next, we examine specific sectoral-regional technology shocks. We continue with examining the impact of changes to variations in capital stock within a region. Finally, we reduce interregional trade costs to identify region pairs whose improved trade partnership would benefit national aggregate GDP

the most. In all these exercises, we focus on the role of interregional trade in intermediate inputs, such that international trade is represented by the contribution of the international trade balance towards each region's income, as described in section 3.4. The set of all detailed tables of results can be found in the annex, section 8.3.

The magnitude of the changes we apply to target variables in the baseline equilibrium are of 1% shocks are designed to be small, local perturbations. These will generate different outcomes that we report in terms of percentage elasticities across regional, sectoral and aggregate variables. In practical policy terms, these objects map into bundles of interventions (e.g., skills and innovation policies that raise effective productivity; transport/digital infrastructure and regulatory frictions that lower effective trade costs; or place-based investment that expands the effective local capital stock). The required scale to achieve a 1% change is policy- and context-specific, so we interpret the results as informative about relative leverage across regions-sectors rather than as literal forecasts from a single programme.

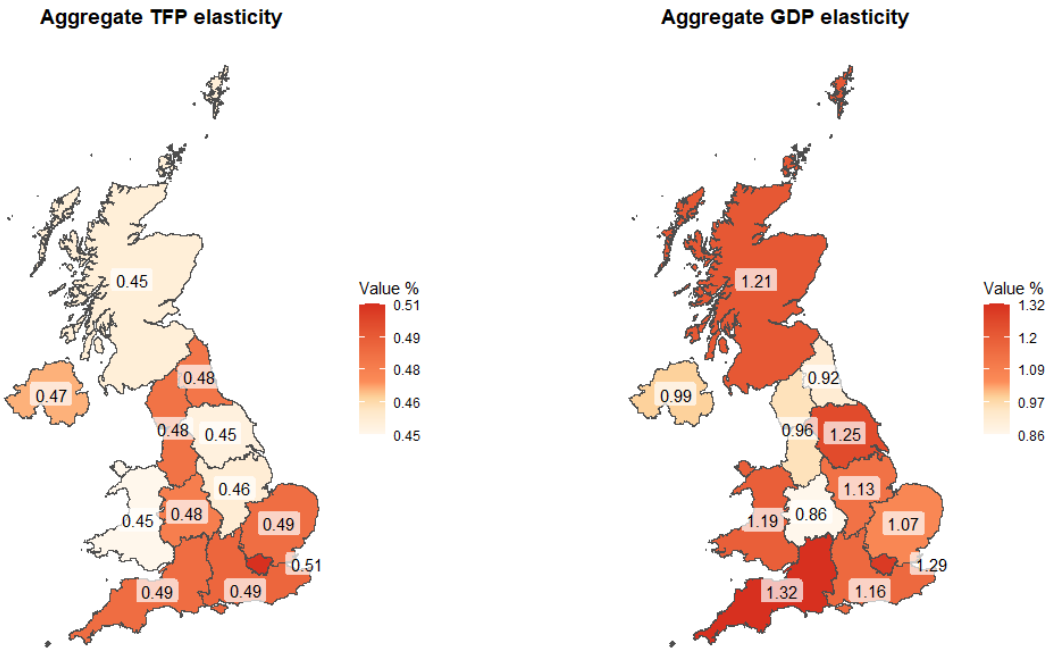
6.1 Regional productivity changes

We let $\widehat{T_i}^j = 1.01$ for a set of industries J and regions N and let trade costs remain constant, as $\widehat{\tau_{in}}^j = 1$, for all j, n, i. In this particular counterfactual exercise, we assume that all sectors in a specific region face the same shock. The rationale is to show the relative importance of each region towards its contribution to aggregate TFP and GDP. We do this by calculating national aggregate TFP and GDP elasticities, so to ease comparison of results across regions and sectors. As in Caliendo et al. (2018), we take the variation of the aggregate variable, and we normalise it using the relative size of the region in which the shock was originated.

As reflected in figure 8 for every single UK region, the TFP elasticity is lower than the magnitude of the productivity shock. This occurs because the shocks to fundamental productivity increase value-added, but measured TFP is based on gross output. The effect is attenuated by the share of intermediate inputs; the gains are effectively passed on as lower prices for goods and services along supply chains rather than being fully captured in the originating region's productivity. Although similar in magnitude, the results suggest that Southern regions have a higher impact on aggregate TFP than if the productivity shock originated in the North. Productivity gains in these regions are widely diffused as cheaper inputs for the rest of the UK economy.

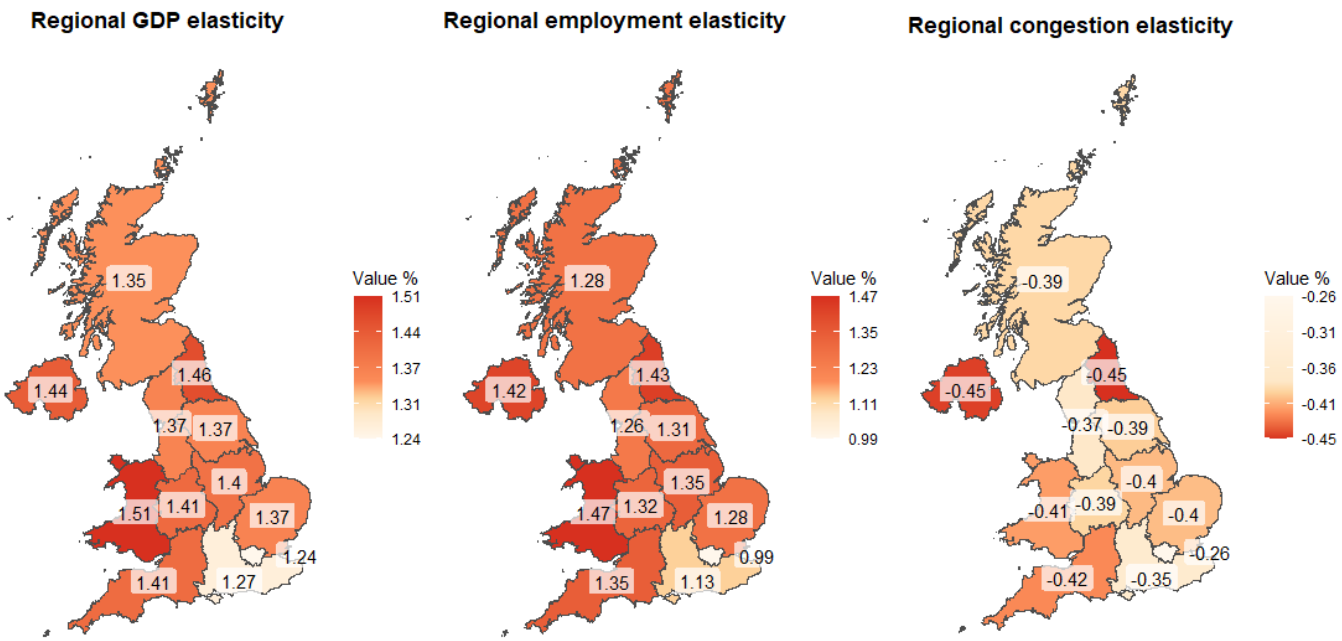
When examining the impact on aggregate GDP in panel b) of figure 8, which incorporates labour mobility and relative input cost, the results emphasise the regional disparities that highlight the UK's economic hierarchy. An increase of 1 per cent in the fundamental productivity of all sectors in London would increase national GDP by 1.29 per cent, in contrast with most other regions, where a similar shock would increase the UK's GDP by only slightly more than 1 per cent. A shock in one of the devolved nations would instead contribute less than 1 per cent. Note that despite the normalisation of these percentages using economic size, London and the Southern regions display the highest impacts on GDP, implying that these results are not just driven by their implied absolute variation.

Figure 8: Aggregate TFP and GDP elasticities



These impacts on aggregate national GDP can be measured in terms of the combined variation in each region's GDP, or through the channels described in equation (29). Panel a) in figure 9 displays the variation in regional GDP of the region in which the shock originates, showing that the impact is somewhat homogeneous. However, when we disaggregate the aggregate GDP elasticity using equation (29), we can compute the regional contributions of the TFP elasticity, labour mobility and the relative factor price effect. An increase in productivity in a region would provoke three effects that feed back to each other: first, it will directly increase regional GDP. Second, it will increase the marginal productivity of labour and hence the wage rate in the originating region, attracting workers from other regions. Panel b) in figure 9 shows that some regions would have a relatively stronger increase in their regional employment, specifically Northern Ireland (1.42 per cent), the North East and the Wales (1.47 per cent). Third, these flows of workers will alter the relative allocation of labour and capital input. Assuming in a static equilibrium that regional capital infrastructure is fixed, the resulting capital-labour ratio will show regional differences in the regional wage-capital rent ratios, reflected in turn in the production costs. These congestion effects contribute negatively to aggregate GDP in the region that receives the flow of workers, as capital cannot reallocate regionally to balance this. As such, some regions show a stronger negative congestion effect, such as Northern Ireland and the North East, partially offsetting the stronger employment effect on GDP.

Figure 9: Regional GDP, employment and congestion elasticities



To test the relative strength of the sectoral tradability channel, we conduct two counterfactual exercises in which we homogenize the trade elasticity (θ^j) across all sectors. First, we assume that all sectors have the same trade elasticity as manufacturing ($\theta^j = 1.6, \forall j$). This implies that tradability of all sectors increases, although just slightly given their initial magnitude. The results in figure 8 barely change, although we notice a slight decrease in the variation of the regional GDP elasticity and employment. The aggregate GDP elasticity for most regions have a non-significant decrease, except for the devolved nations (Wales, Scotland, Northern Ireland), which show a higher impact.

In contrast, reducing sectoral tradability by setting $\theta^j = 8$ for all sectors, a value closer to the literature, increases regional GDP and employment across all regions. Consequently, trade flows become highly sensitive to trade costs, weakening comparative advantage and thereby weakening the mechanism that makes intermediate inputs produce regionally cheaper. The effect on aggregate GDP is mixed but, as with the first counterfactual, all deviations from the baseline are quantitatively small.

6.2 Sectoral productivity changes

Our framework also allows us to recover the aggregate impact on TFP and GDP of sectoral shocks. In this counterfactual, we assume there is a 1 per cent fundamental productivity shock to a specific industry in all regions. This allows us to identify not only which industries have a higher

relevance in economic size terms, but also the channels through which their relevance operates. That is, whether their aggregate impact is driven mostly by a direct impact on TFP and GDP, or indirectly through variations in the productivity and production of the interlinked industries and regions.

Decomposing the aggregate TFP elasticity as in equation (27), these are lower than 1 per cent in all cases, as a result of the above mentioned impact of trade. However, sectoral linkages and trade also play a relevant role. The higher use of internally-produced intermediate inputs, i.e., inputs that the sector itself is producing to use by itself as an intermediate, reduces the impact of that sector on aggregate TFP. This is true in the case of manufacturing and construction (both around 0.44 per cent), which have higher coefficients of their own products in the input-output tables. The reason why is because improvements in productivity do not spread out that much to other sectors, which uses the intermediate inputs of these sectors in lower quantities and so, have a lower impact on their sectoral GDP and employment.

Table 3: Aggregate TFP and GDP elasticities of common sectoral shocks

Sector	Agg. TFP elast.	Agg. GDP elast..
Agriculture	0.558	1.439
Mining, quarrying, and energy supply	0.581	1.352
Manufacturing	0.439	0.875
Construction	0.448	0.744
Distribution, hotels and restaurants	0.536	0.786
Transport, storage and communication	0.539	1.29
Financial intermediation	0.551	1.318
Real estate and business activities	0.685	1.131
Non-market services	0.564	0.644

In turn, it is manufacturing and construction that show the lower impact on aggregate GDP, of 0.74 per cent and 0.78 per cent, respectively. In contrast, positive productivity shocks of 1 per cent in agriculture, mining and energy, financial intermediation, and transportation and communications have the higher impact on aggregate GDP, ranging between 1.3 and 1.45 per cent. As earlier, these magnitudes stem from a combination of increases in sectoral GDP, movements of workers across sectors, and relative factor price effects.

Distribution, hotels and restaurants, and non-market services are special cases regarding their comparatively lower impact on aggregate GDP. This is because these sectors exhibit strong local consumption bias—a significant portion of their output is consumed as final goods within the same region where it is produced, rather than traded as intermediate inputs to other sectors or regions. In the context of our model, this manifests through two complementary channels. First, their consumption shares (the ψ^j parameters) are relatively high, meaning productivity improvements primarily benefit local consumers through lower prices rather than enhancing the competitiveness of downstream industries. Second, as services with limited tradability (particularly for non-market services), the potential for positive spillovers through regional trade networks is constrained. While

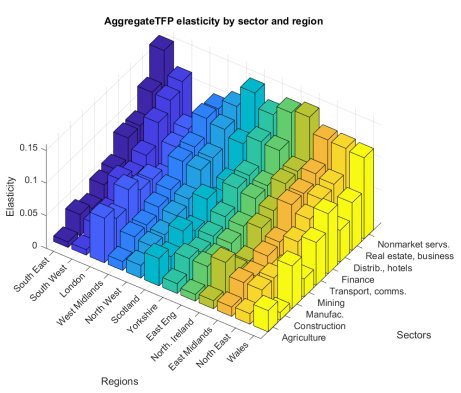
a fundamental productivity shock in these sectors raises regional real income, the limited scope for interregional reallocation of activity—through either trade in intermediates or labour migration toward more productive locations—reduces their aggregate GDP impact. Consequently, the benefits remain more geographically contained compared to sectors, where productivity gains rapidly propagate through domestic supply chains.

6.3 Regional- and sectoral-specific productivity shocks

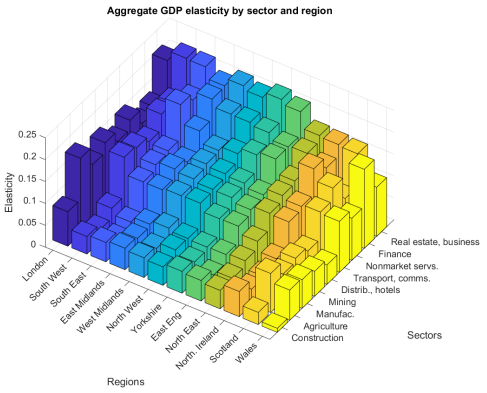
With this framework we can also trace the way in which TFP changes in specific regions and sectors propagate across all other sectors and regions in the UK economy. Figure 10 shows a representation of the impact of these shocks across the channels described above.

The aggregate TFP and GDP elasticities are displayed on panels a) and b), respectively, which show that the highest aggregate impacts on TFP and GDP result from improving productivity in the service sectors of London and the Southern regions. A 1 per cent productivity gain in non-market Services in the South East boosts aggregate GDP by 0.195 per cent—the single largest effect of any region-sector pair. Similarly, shocks to real estate & business activities in London and the South East, and to financial intermediation in the West Midlands and East Midlands, yield aggregate GDP elasticities above 0.2 per cent. Conversely, shocks in the devolved nations and peripheral English regions generally have smaller aggregate impacts. For instance, a comparable productivity improvement in Agriculture in Northern Ireland increases aggregate GDP by only 0.036 per cent. The exception is non-market Services in Scotland and Northern Ireland, which show relatively high elasticities (0.147 and 0.173 per cent, respectively).

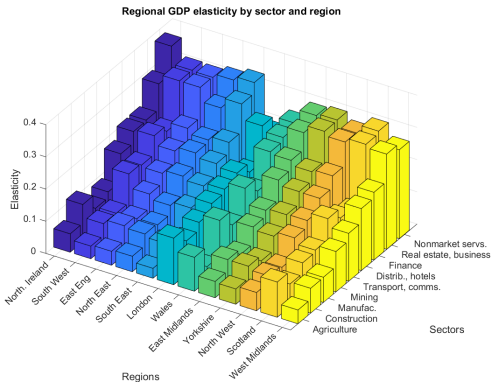
Figure 10: Aggregate and regional elasticities from a 1% shock to fundamental productivity.



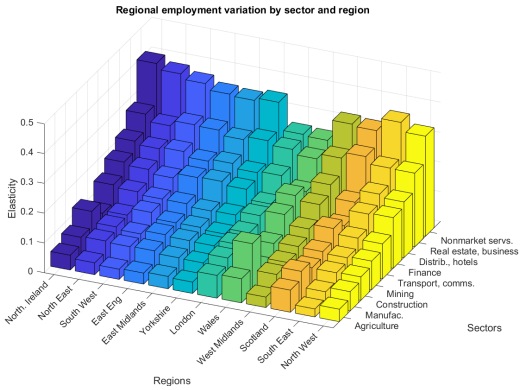
(a) Aggregate TFP elasticity



(b) Aggregate GDP elasticity



(c) Regional GDP elasticity



(d) Regional employment elasticity

Note: simulation results of individual shocks to fundamental productivity. Results show either the impact on aggregate GDP of a shock to a specific sector and region, or how regional GDP, employment and the congestion effect in that sector and region pair changes as a result of the shock. Elasticities are sorted out by average variation.

Comparing with the results in previous sections, a striking pattern emerges: productivity improvements in non-market services generate the highest aggregate GDP elasticities when the shock is confined to a single region. This stands in contrast to the sector-wide analysis, where non-market services showed the lowest aggregate GDP impact. The high local impact arises from different sources. First, non-market services constitute a large share of economic activity in every UK region. A productivity shock therefore generates a large initial regional GDP effect. Second, benefits are concentrated locally, as this sector is relatively less connected through trade in intermediate inputs, limiting positive spillovers to other regions. The productivity gain is not exported through cheaper inputs but instead translates directly into lower prices for local producers and consumers. In addition, as the sector is quite labour-intensive, the demand for labour increases substantially. This attracts workers from other sectors within the same region and from other regions. The result-

ing migration inflow creates a multiplier effect on regional GDP. While this labour inflow creates a negative congestion effect (reducing the local capital-labour ratio), the net effect on local GDP remains strongly positive due to the sheer scale of employment growth. On the aggregate impact, this interregional labour reallocation provokes a reduction of workers in other regions, resulting in reductions of output. The net effect on aggregate national GDP, while positive, is tempered by these offsetting reductions elsewhere, contributing to the the lower elasticities.

6.4 Variations in regional capital stock

Our framework features a fixed factor that we measure as the difference between gross value added and the compensation of workers in the data. Thus, we can use our calibrated model to analyse changes in capital infrastructure that result from particular investment projects or public transfers. To do so, we feed into the model an increase of 1% to the local capital stock in respective regions, and compute the regional aggregate TFP and GDP effects[3]. These shocks are best interpreted as the outcome of a bundle of infrastructure projects and complementary reforms that, taken together and possibly over multiple years, would raise the effective productive capital available to firms by 1%, rather than as the budget of a single programme.

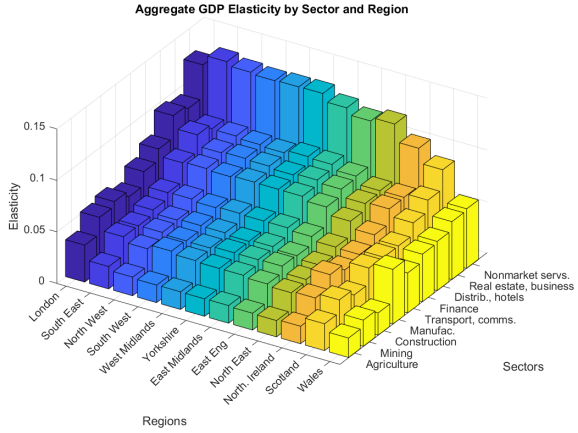
Capital stock changes also influence measured total factor productivity (TFP) through the channel identified in equation (27). Unlike a direct fundamental productivity shock ($\widehat{T}_i^j$), an increase in capital infrastructures affects measured TFP indirectly by altering production costs and regional trade patterns. From (17), depending on the initial factor allocation, the wage-capital rent ratio will increase in a higher proportion, increasing accordingly the unit production cost x_i^j. Through the gravity equation governing expenditures on intermediate inputs from either region (7), the origin region will have an increase in the expenditure on the domestically-produced inputs inputs through this mechanism, therefore contributing negatively to aggregate TFP. Our estimated TFP elasticities are all negative, but very small. This can be interpreted as a reduced gain from interregional trade, as the region relies less on potentially more efficient suppliers elsewhere. This is more a matter of measurement of gross output TFP rather than an actual deterioration of productivity, as the resulting increase in productive capacity is reflected in GDP rather than in measured TFP.

We summarise the results in figure 11, which as earlier, shows the ranking by sectors and regions of the impact of an increase in the capital infrastructure stock of 1 per cent in the specific region on aggregate TFP and GDP, which are of a maximum of a $0.15 - 0.2$ per cent elasticity.

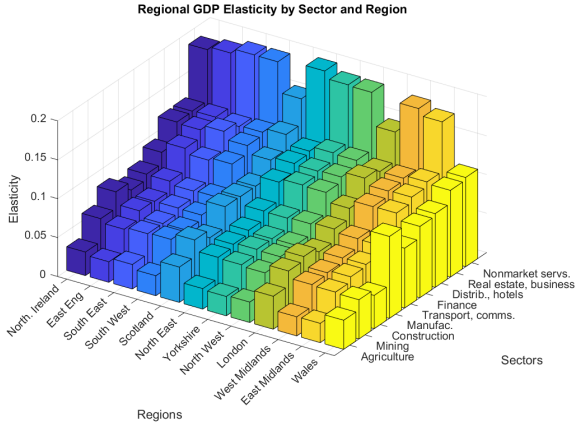
The results mirror those of the previous section regarding the impact of a productivity shock to specific regions and sectors qualitatively, however, the magnitude of the elasticities is comparatively lower when the shock is to the capital stock. This is because the shocks only alter the capital-labour ratio and subsequently, their relative cost, triggering changes in the total production costs that are

[3]In our calibration, we calibrate the size of capital rents by the difference between gross value added and the compensation of workers. Under this calibration, a 1% increase in capital stock corresponds to capital-equivalent injections of roughly £1,131 million in London and £948 million in the South East, with smaller regions requiring proportionately smaller amounts (e.g., around £211 million in the North East and £147 million in Northern Ireland). A more precise calibration would require regional and sectoral capital stock estimates. See Gardiner et al. (2020) and Daams et al. (2023) for recent analytical efforts employing regional measures.

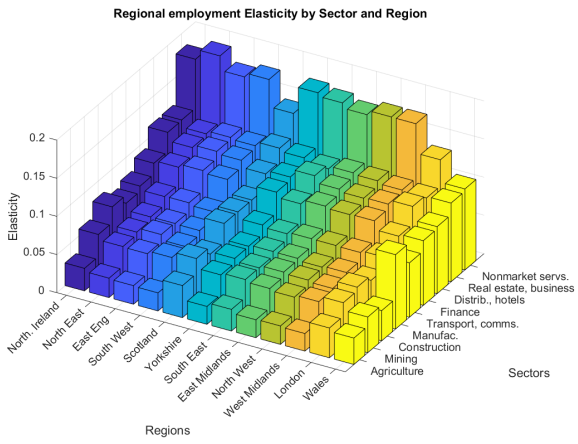
Figure 11: Aggregate and regional elasticities from a 1% shock to capital stock, by sector and region



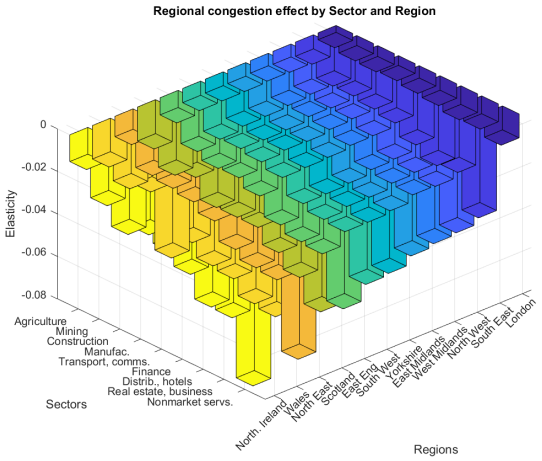
(a) Aggregate GDP elasticity



(b) Regional GDP elasticity



(c) Regional employment elasticity



(d) Regional congestion effect

Note: simulation results of individual shocks to capital infrastructure. Results show either the impact on aggregate GDP of a shock to a specific sector and region, or how regional GDP, employment and the congestion effect in that sector and region pair changes as a result of the shock. Elasticities are sorted out by average variation.

not accompanied with improvements in productivity, as in the earlier case. The mechanism for this divergence lies in how capital shocks propagate. Unlike a productivity gain that improves efficiency, a capital injection increases the scale of production in a location. Particularly for labour-intensive sectors, such as non-market services, this attracts inward migration of labour to complement the newly isntalled capital stock, adding to the positive contribution of regional GDP made by the increase in capital stock. The migration flows out of the other regions might improve or not their

regional GDP, as on the one hand they decrease their labour input use, while on the other hand it alleviates the congestion effect on the existing local capital infrastructures in the out-migrated regions.

Panel a) in figure 11 shows that increasing capital stock infrastructure by 1 per cent primarily in London would give on average the highest impact on aggregate GDP, followed by the Southern regions, the North West and the West Midlands. These contributions are mostly concentrated in the services sectors. On the regional GDP variations, as in panel b), Northern Ireland, the East of England and the South East would see the highest increases in percentage terms, concentrated in the services sectors, as a result of the relatively lower capital-labour ratio in these regions and sectors. As such, these regions as well attract the most workers (panel c)), while the negative congestion effects from expanding their capital stock is the lowest across all regions (panel d)). These congestion effects, capturing changes in the wage relative to the overall input cost, are uniformly negative but varies substantially across regions and sectors. These are systematically more pronounced in peripheral regions (Wales, Northern Ireland, the North East) than in core regions (London, South East). This reflects differences in initial economic structure: peripheral regions tend to have higher employment shares in labour-intensive sectors, making them more sensitive to variations in the capital-labour ratio. In contrast, London's more capital-intensive economic structure allows it to absorb additional workers with less deterioration in factor proportions.

6.5 Changes in domestic trade costs

In this section, we analyse how reductions in trade costs can have positive effects not just in specific regions, but also through their aggregate impact on GDP. We alter the gravity equation (7) in our model by reducing the trade cost parameter between two partner regions i and n, τ_{in}, by 1%, from a baseline value of 1. We could interpret this approach as a decrease in the cost of exporting goods and services due to less regulatory constraints, improvements in digital technologies that create trading opportunities across distant regions, or the effect of public expenditure on the highways or railroads connecting regions. Using our trade cost index, this represents a decrease in either the expected time taken and/or an increase in road distance travelled for a representative truck of goods between two regions. In this sense, a 1% change should be understood as a small change in an effective iceberg trade cost: it could reflect either a modest improvement in infrastructure performance (time/reliability), a reduction in administrative and information frictions, or changes that lower the fixed and variable costs of trading intermediate services across regions (e.g., interoperability of procurement and digital delivery). We compare the resulting equilibrium allocation and aggregation values with respect to our baseline allocations. More specifically, we compare the resulting regional and aggregate GDP with respect to the baseline scenario.

From the gravity equation (7), a reduction in trade costs will have the following impact. First, the share of a region's expenditure on goods produced in the other region will increase, and vice versa. From the expression of measured TFP (27), this also involves an increase in regional TFP, as both regions would be decreasing their expenditure share on domestically-produced inputs. This

in turn will have a positive effect on regional GDP, as shown by equation (29). The magnitude by which regional and aggregate GDP would increase will depend on the new access each region will have to cheaper intermediate inputs being produced in their partner regions, effectively increasing production. The relative price ratio between primary inputs (capital and labour) and the price of the intermediate input bundle will determine whether these partner regions substitute labour with cheaper intermediate inputs, or the increase in production improves the marginal productivity of labour, attracting inflows of workers from other regions.

Table 4: Ranking of regional trade partners that increase aggregate GDP

Region 1	Region 2	Elasticity
London	South East	0.3727
East Eng	London	0.1597
North West	Yorkshire	0.1461
London	South West	0.1139
North West	Scotland	0.1115
East Eng	South East	0.1104
South East	South West	0.1007
North West	London	0.0967
West Midlands	London	0.0818
East Midlands	London	0.0817
London	Scotland	0.0809
East Midlands	East Eng	0.0790
North West	West Midlands	0.0776
Yorkshire	East Midlands	0.0749
North West	East Midlands	0.0712
Yorkshire	London	0.0701
West Midlands	South East	0.0692
West Midlands	South West	0.0680
East Midlands	West Midlands	0.0680
North West	South East	0.0670

Table 4 ranks region pairs by the aggregate UK GDP gain from a 1% reduction in their bilateral trade costs. The London-South East pair dominates the ranking with an aggregate elasticity of 0.37%, more than twice the magnitude of the next pair (East of England-London at 0.16%). This reflects the combined economic mass of the UK's two largest regional economies together with the volume of intermediate-input flows that move between them. London appears in eight of the top twenty pairs, consistent with its role as the country's principal supplier of intermediate services to the rest of the economy. Beyond the London-South East axis, two further clusters emerge. A Northern industrial axis (North West-Yorkshire at 0.15%, North West-Scotland at 0.11%, North West-London at 0.10%) reflects the densely interconnected production network linking manufacturing centres along the M62 corridor with the Scottish economy. A Midlands cluster (East Midlands-East England at 0.08%, North West-West Midlands at 0.08%, Yorkshire-East Midlands at 0.07%) groups the regions that anchor the Midlands manufacturing belt. Connections between London

and more distant regions also generate sizeable aggregate gains: London-South West (0.11%), London-Scotland (0.08%), and Yorkshire-London (0.07%) all rank among the top pairs, suggesting that lowering frictions between the capital and peripheral regions produces meaningful aggregate spillovers despite the geographic separation.

Figure 12: Aggregate GDP elasticity of home region from reduced trade cost with trading partner

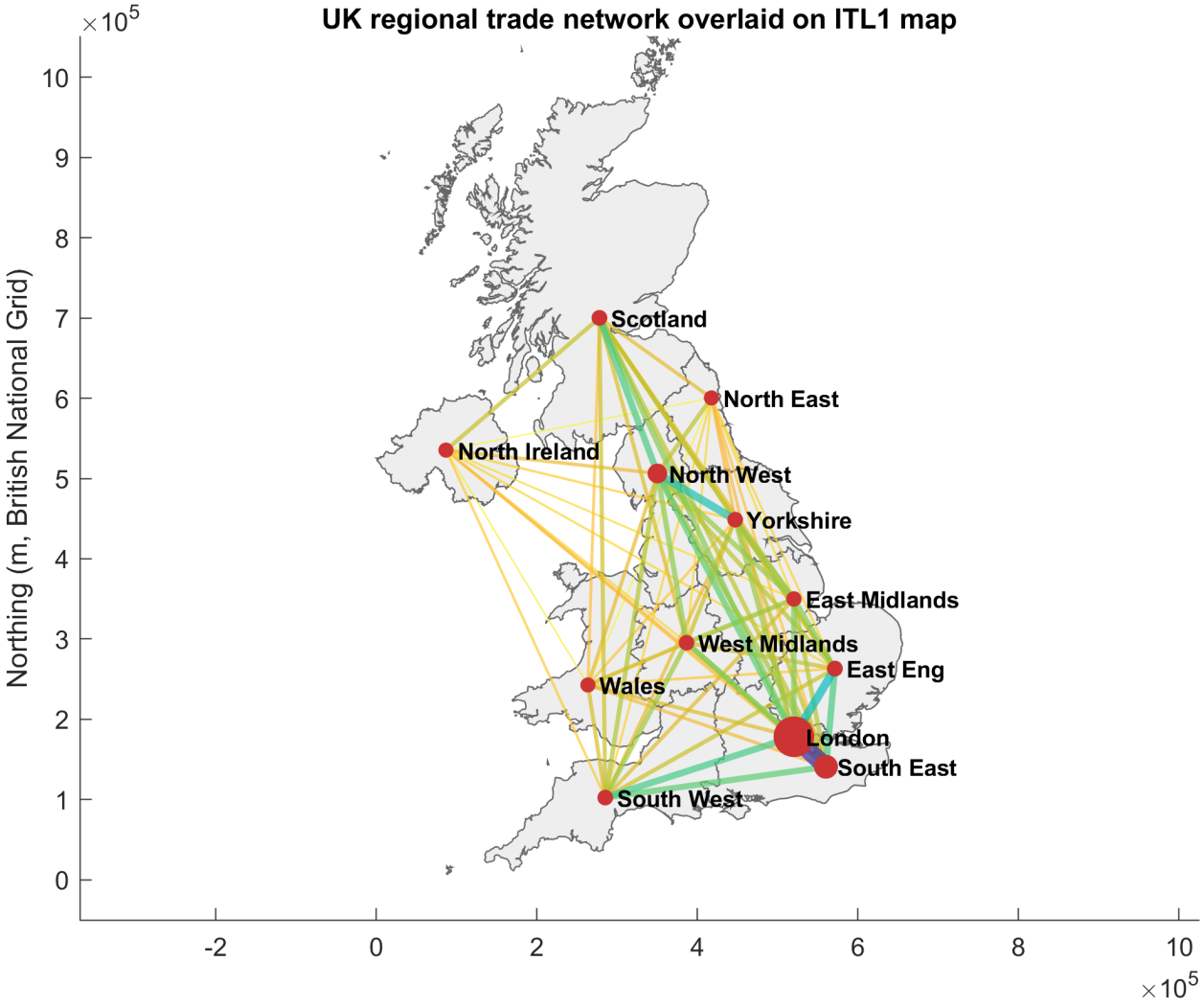


Figure 12 overlays this network on a map of the 12 UK ITL1 regions. Node sizes encode each region's cumulative contribution to aggregate GDP across its high-value trade pairings, and edge thickness and colour intensity scale with the pair's aggregate elasticity. London emerges as the dominant central node, anchoring most of the high-value bilateral connections, with the London-South East edge appearing as the thickest single link in the network. Two distinct geographic patterns stand out: a London-centred star network linking the capital with most other regions, and a denser Northern cluster centred on the North West with substantial connections to Yorkshire, Scotland and the Midlands. Wales and Northern Ireland are comparatively peripheral nodes in this aggregate ranking, although their bilateral pairings carry larger weight when measured against

their own regional GDP (see Table 5).

Table 5: Ranking of regional partners that increase regional GDP of Home region

Home region	Trading partner	Reg. Elast.
South East	London	0.7110
East Eng	London	0.5220
London	South East	0.5135
North. Ireland	Scotland	0.4149
North East	North West	0.4040
East Midlands	London	0.3825
Yorkshire	North West	0.3744
South West	London	0.3421
West Midlands	London	0.3415
East Eng	South East	0.3414
North West	Yorkshire	0.3383
North. Ireland	North West	0.3119
North East	Scotland	0.3111
Wales	London	0.3104
South West	South East	0.3021
Wales	South West	0.2865
East Midlands	Yorkshire	0.2864
West Midlands	South East	0.2816
North West	London	0.2795
North East	Yorkshire	0.2794

Table 5 shifts the focus from aggregate to regional outcomes, ranking the trade-cost reductions that yield the largest gains for the directly-affected home region. The magnitudes are substantially larger than the aggregate elasticities, ranging from 0.28% to 0.71% for a 1% trade-cost reduction. The single largest regional benefit accrues to the South East from cheaper trade with London (0.71%), followed by the East of England from London (0.52%) and London itself from the South East (0.51%). London features as the trading partner in seven of the entries in the top twenty list, with the South East, East of England, East Midlands, South West, West Midlands, Wales and the North West all gaining most from cheaper access to London. This pattern reflects the structural role of London as the principal exporter of intermediate services and inputs to the rest of the UK economy: lowering the cost of accessing London-produced inputs translates directly into substantial regional GDP gains across the country.

A second-order pattern emerges around the Northern axis. The North West appears in multiple high-value pairings as both home and partner, with bidirectional gains between the North West and Yorkshire (Yorkshire gaining 0.37% from cheaper trade with the North West, and the North West gaining 0.34% in the opposite direction) suggesting deep mutual integration in their production networks. Northern Ireland and the North East display markedly higher elasticities with their immediate neighbours than with London. Northern Ireland gains 0.41% from cheaper trade with Scotland and 0.31% with the North West; the North East gains 0.40% from the North West

and 0.31% from Scotland. This pattern reflects the role of geographic proximity and existing supply-chain links in regions that depend on a small number of close partners rather than on the London-centred network.

Figure 13: Regional GDP elasticity of home region from reduced trade cost with trading partner

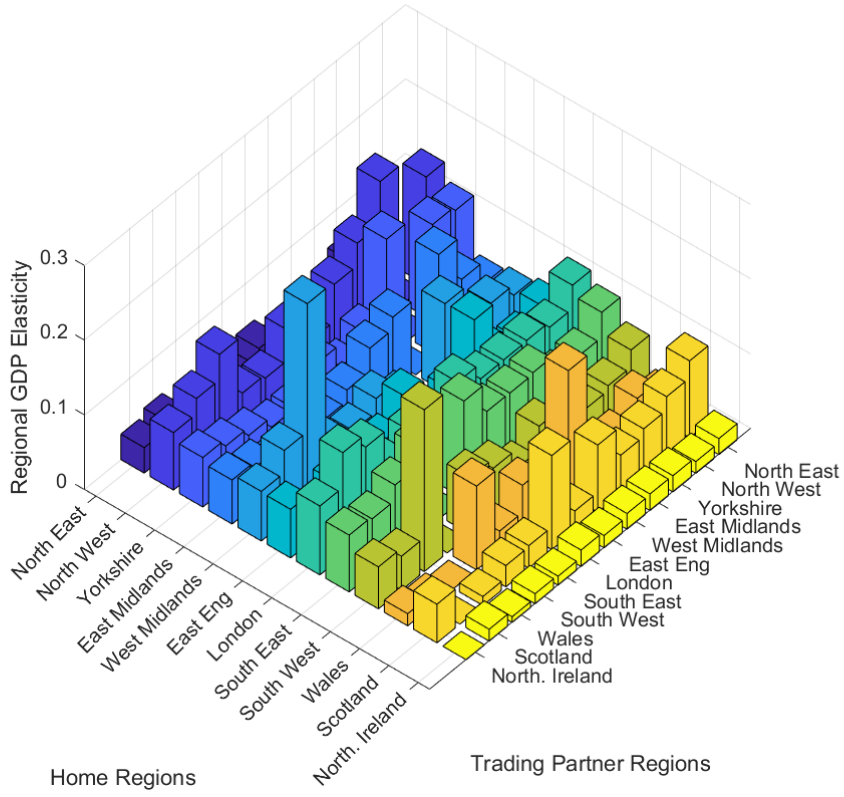


Figure 13 displays the full matrix of regional GDP elasticities by trading partner. The dominance of London as a beneficial partner is visible across the rows, with the elasticity column for London elevated relative to other partner columns in almost every home-region row. A Northern cluster is also visible: the North West, Yorkshire and the North East show notably higher mutual elasticities with each other than with Southern partners. Northern Ireland's strong reliance on Scotland and the North West stands out as a distinct pattern, consistent with its geographic and supply-chain position outside the Great Britain mainland network. The figure also makes clear that for several Southern regions (East of England, South West, West Midlands) the second-most-beneficial partner after London is the South East rather than a neighbouring Midlands region, reinforcing the centrality of the London-South East economic core.

These results carry several policy-relevant implications. First, the dominance of London-centred pairings in both rankings suggests that infrastructure investments that strengthen connections between London and the rest of the country (transport, digital connectivity, regulatory harmonisation) would generate the largest aggregate and regional GDP returns. Second, the Northern axis (North

West, Yorkshire, North East, Scotland) shows strong bidirectional gains from intra-Northern connectivity, supporting the case for sustained investment in regional infrastructure within the North. Third, the prominence of Scotland and the North West as beneficial partners for Northern Ireland highlights the importance of cross-Irish-Sea and Scotland-NI connectivity, an area where infrastructure has historically lagged. Fourth, the heterogeneity of partner-specific benefits within each home region implies that uniform trade-cost reductions are less efficient than targeted bilateral interventions, with the optimal target varying systematically across regions.

Comparing the aggregate and regional rankings reveals two convergent insights. The pair that dominates the aggregate ranking (London-South East, 0.37%) is also the pair that delivers the largest regional benefit (South East from London, 0.71%; London from South East, 0.51%). Across pairs that appear in both top-twenty rankings, the regional elasticities are typically between two and three times larger than their aggregate counterparts. The ratio reflects the geographic concentration of trade-cost-reduction benefits: a substantial share of the regional gain accrues to the two pairing regions themselves, with the remainder propagating across the network through labour mobility and input-output linkages. The pairs that maximise aggregate benefit are not always the pairs that maximise the home region's own gain, so policymakers face a trade-off between national-level efficiency and place-based targeting when allocating limited infrastructure budgets.

6.6 Changes in international trade costs

We now turn to the role of international trade in shaping aggregate and regional outcomes for the UK economy. We modify the gravity equation (7) to apply a shock $\widehat{\tau}_{i,N+1} = \widehat{\tau}_{N+1,i} = \widehat{\tau}$ to all UK–RoW pairs, in both directions and across all sectors. Within-UK iceberg costs ($\widehat{\tau}_{in}$ for $i, n \in \{1, \ldots, N\}$) are held fixed at unity. This setup isolates the contribution of international trade integration to UK regional and aggregate performance, and complements the interregional analysis in subsection 6.5 where the focus was on within-UK trade pairs. The international trade balance enters through the open-economy budget constraint (9), with the lump-sum transfer ξ^{Int} adjusting in equilibrium to reflect the new trade-balance configuration. Capital and labour mobility within the UK respond to the new pattern of regional incomes, while RoW prices, wages and labour are held exogenous, consistent with our small open economy assumption.

We consider a magnitude grid of trade-cost shocks spanning both integration scenarios ($\widehat{\tau} = 0.90, 0.95, 0.99, 1.01$) and friction scenarios ($\widehat{\tau} = 1.05, 1.10, 1.25$). The friction case at $\widehat{\tau} = 1.10$ corresponds to a 10% increase in UK–RoW trade costs, which approximates the trade-friction increase implied by the Brexit Trade and Cooperation Agreement (**?**). Their central estimate of the long-run UK GDP loss under the Deal-with-FTA scenario is 3.9%, providing an external benchmark for our open-economy extension. Table 6 reports the aggregate UK GDP and TFP responses across the magnitude grid. At $\widehat{\tau} = 1.10$, our model delivers a UK GDP loss of 3.8%, in line with the NIESR estimate. This consistency provides external validation that our regional structure, calibration, and trade elasticities translate trade-cost shocks into aggregate magnitudes that are consistent with the broader Brexit literature.

Table 6: Aggregate UK responses to UK–RoW iceberg trade-cost shocks

$\widehat{\tau}$	UK $\widehat{\text{GDP}}$	UK $\widehat{\text{TFP}}$	Δ UK GDP (%)
0.90	1.084	1.034	+8.4
0.95	1.033	1.014	+3.3
0.99	1.006	1.002	+0.6
1.01	0.995	0.998	−0.5
1.05	0.978	0.990	−2.2
1.10	0.962	0.983	−3.8
1.25	0.936	0.972	−6.4

The aggregate response is asymmetric: a 10% reduction in UK–RoW iceberg costs (consistent with deeper integration with major trade partners) raises UK GDP by 8.4%, more than twice the absolute magnitude of the 3.8% loss under a symmetric 10% friction increase. This asymmetry reflects the convex Fréchet response of trade shares to relative cost changes: deeper integration compounds gains while increasing frictions squeezes out marginal trade with diminishing impact. Table 7 decomposes the channel by sector at $\widehat{\tau} = 0.99$, where the small shock places the model in the linear regime and additivity across sector-specific shocks holds to high precision. Manufacturing, with by far the largest international trade volume in absolute terms, accounts for nearly 62% of the overall channel despite carrying the highest trade elasticity ($\theta^j = 8.75$). Real estate, whose low elasticity ($\theta^j = 1.56$) makes it the most responsive sector per unit of trade, is the second-largest channel at 11% of the total. Transport, non-market services and mining each contribute between 6 and 7%, while construction and agriculture contribute negligible amounts owing to their limited international tradability.

Table 7: Sectoral channels in the UK–RoW trade integration response, $\widehat{\tau} = 0.99$

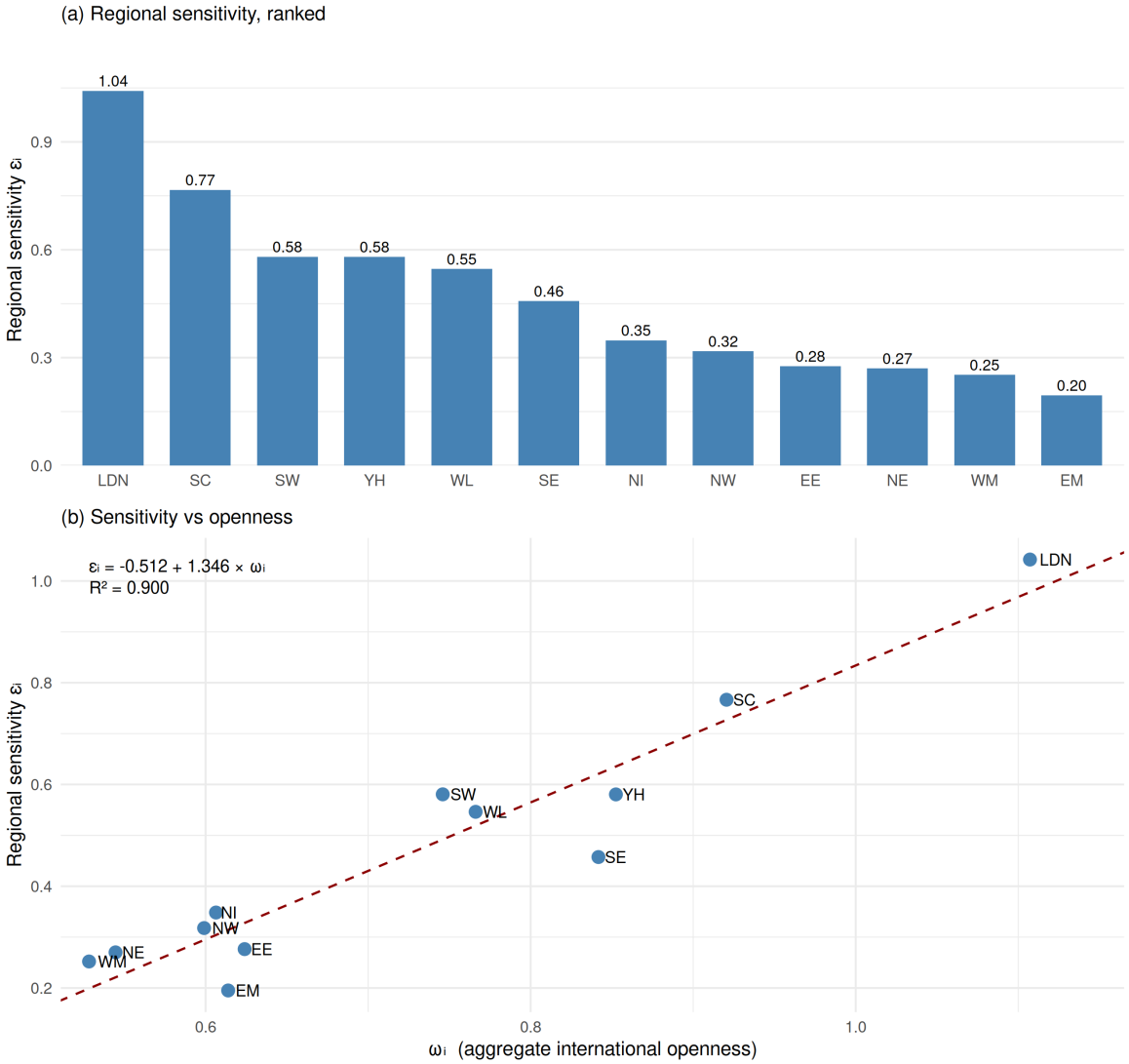
Sector	θ^j	$\bar{\varepsilon}^j$	Channel share (%)
Manufacturing	8.75	0.314	61.8
Real estate	1.56	0.056	11.0
Transport	4.47	0.034	6.7
Non-market services	8.23	0.034	6.6
Mining and energy	4.66	0.030	5.9
Finance	7.06	0.023	4.6
Distribution	4.77	0.018	3.5
Agriculture	4.44	0.001	0.2
Construction	5.33	≈ 0	≈ 0

Note: $\bar{\varepsilon}^j$ is the cross-region average of the GDP response per 1% UK-RoW trade-cost reduction in sector j alone, with all other sectors held at $\widehat{\tau} = 1$. Channel share is $\bar{\varepsilon}^j / \sum_k \bar{\varepsilon}^k$.

Figure 14 reports the cross-region heterogeneity in the response to a 1% UK–RoW trade-cost reduction at $\widehat{\tau} = 0.99$. London (1.04), Scotland (0.77), the South West (0.58), Yorkshire (0.58) and Wales (0.55) display the strongest sensitivity to international trade-cost shocks, while the

East Midlands (0.20), the West Midlands (0.25), the North East (0.27), and the East of England (0.28) display the smallest responses, a five-fold spread across UK regions. Aggregate openness $\omega_i = (\mathrm{EX}_i^{\mathrm{Int}} + \mathrm{IM}_i^{\mathrm{Int}})/(w_i L_i + r_i K_i)$ explains the bulk of this variation: a univariate cross-section regression yields $\varepsilon_i^{\mathrm{tot}} = -0.512 + 1.345\,\omega_i$ with $R^2 = 0.90$. The pattern is not core-periphery in the conventional UK sense; rather, regions with larger international exposure (through both their sectoral composition and the volume of UK–RoW trade originating in their territory) are those most sensitive to international trade frictions or integration.

Figure 14: Regional sensitivity to a 1% UK–RoW trade-cost reduction



Note: Panel (a) shows $\varepsilon_i^{\mathrm{tot}}$, the percentage GDP response of region i to a uniform 1% reduction in UK-RoW iceberg trade costs across all sectors at $\widehat{\tau} = 0.99$, sorted in descending order. Panel (b) shows the same elasticities plotted against region i's aggregate international openness $\omega_i = (\mathrm{EX}_i^{\mathrm{Int}} + \mathrm{IM}_i^{\mathrm{Int}})/(w_i L_i + r_i K_i)$, with the cross-section OLS fit $\varepsilon_i^{\mathrm{tot}} = -0.512 + 1.345\,\omega_i$, $R^2 = 0.90$.

To assess the role of general-equilibrium channels in amplifying these effects, we additionally consider the limit case in which all UK–RoW trade is closed off ($\widehat{\tau} \to \infty$). UK aggregate GDP falls by 10.6%, decomposed into a 4.5% TFP decline and substantial labour reallocation across UK regions, with the maximum-region labour share deviating by 9.4% from the benchmark. We compare this to the canonical **?** (ACR) welfare formula, $-\Delta \ln W_n^{\text{ACR}} = \sum_j \alpha_{j,n} (\theta^j)^{-1} \ln(1 - \pi_{\text{RoW},j,n})^{-1}$, where $\alpha_{j,n}$ is region n's consumption share of sector j and $\pi_{\text{RoW},j,n}$ is the share of region n's expenditure on RoW imports in sector j. The analytical aggregate welfare loss for the UK is 3.9%, less than 40% of the full-model figure. This 2.75-fold amplification reflects the GE channels absent from ACR: labour mobility across UK regions, IO linkages between sectors and regions, and the immobility of capital in industries adversely affected by the trade closure. Per-region amplification ratios scale broadly with openness, ranging from 1.6–2.5 in the less-open regions (West Midlands, North East, North West, Northern Ireland) to 2.8–3.9 in the more-open regions (London, South East, Scotland, Yorkshire). The amplification is largest precisely where the openness is largest, magnifying regional disparities in the welfare cost of trade closures.

These results highlight two policy-relevant findings. First, standard ACR-style "gains from trade" calculations applied to the UK using sector-specific trade elasticities understate the welfare implications of large trade-cost shocks for an economy with substantial labour mobility and interregional input-output linkages. The open-economy GE channels nearly triple the welfare cost of trade closures relative to ACR predictions, which has implications for evaluating both ex-post Brexit costs and ex-ante trade-policy proposals. Second, the regional incidence of international trade-cost shocks is highly heterogeneous: the same UK-wide shock falls on London with substantially greater intensity than on the West Midlands, both in proportional and absolute terms. While place-based trade-policy instruments (sector-specific tariff exemptions, targeted trade facilitation) could be designed to redistribute these effects, the size of the underlying disparities suggests that effective compensation may require non-trade policy instruments such as the productivity, capital and infrastructure policies discussed in earlier subsections.

7 Conclusion

In this paper, we have provided an analysis of the links between sectoral and regional economic structures and aggregate productivity in the United Kingdom. By integrating a unique dataset on interregional trade in goods and services into a quantitative spatial model, we have traced the propagation of economic shocks through the complex network of regional and sectoral linkages. Our findings reveal an homogenous landscape, with a highly differentiated aggregate impact that is concentrated in London and the Southern regions, highlighting the North-South divide in the United Kingdom.

Our sectoral trade elasticities for the UK context show considerable variation across sectors, ranging from a low of 1.56 in real estate to a high of 8.75 in manufacturing. These values are critical for our quantitative exercises; they determine how sensitively regional comparative advantage and trade patterns respond to cost shocks, thereby shaping the ultimate propagation of productivity

improvements through the economy.

Our counterfactual exercises, underpinned by these elasticities, yield several key policy-relevant insights. These insights should be interpreted as model-based rankings of relative leverage across regions and sectors, rather than as causal estimates of the effects of specific policy programmes. First, we find that the aggregate benefits of regional productivity improvements are proportional to regional economic size. While London and the South East exert the largest influence on aggregate GDP due to their scale, regions like the East of England and the South West exhibit a slightly higher potential for driving aggregate TFP gains. Second, from a sectoral perspective, shocks to agriculture, mining and finance's productivity are most effective at boosting aggregate GDP, while improvements in services sectors, particularly real estate and professional business services, have the most significant impact on aggregate TFP.

Our framework is static and therefore captures a comparison of equilibria under fixed local capital. For policies that are inherently dynamic (e.g., infrastructure investment, capital deepening, and regional development), the reported elasticities should be read as short-run comparative-statics, whereas longer-run effects will depend on investment adjustment costs, gradual migration, and other frictions that can either attenuate or amplify the propagation mechanisms. Our benchmark calibration relies on the Ouyang et al. (2026) UK multi-regional input-output dataset with 2022 as the baseline year, which captures the post-Brexit production network and incorporates international trade flows between the UK and the Rest of the World.

Our analysis of capital investment underscores that place-based policies, such as targeted infrastructure spending, can have meaningful spillover effects. We show that increases in a region's capital stock not only boost local output but also reallocate labour and alter production costs nationwide, with the largest aggregate GDP effects arising from investments in London and other southern regions. Our exploration of trade cost reductions highlights the importance of specific regional partnerships. Policies that enhance connectivity between London and the South East, or within the Northern axis of the North West, Yorkshire and Scotland, offer some of the highest returns in terms of aggregate GDP growth. The open-economy extension shows that the regional incidence of changes in international trade costs is highly heterogeneous: a uniform UK–RoW friction increase falls more heavily on regions with greater international exposure (London, Scotland, the South West) than on more domestically-oriented regions (West Midlands, North East).

Overall, our results underscore the importance of a dual approach to economic policy that is both regionally sensitive and sectorally targeted. A one-size-fits-all national strategy is ill-suited to address the deep-seated UK regional disparities. Instead, effective policy should account for the specific comparative advantages and sectoral specializations of different areas. Policies that combine targeted investment in physical and human capital with measures to reduce trade frictions, such as improving transport links and promoting e-commerce in services within the United Kingdom, could unlock significant gains in both local and national economic performance.

This research opens several avenues for future work. A key limitation of our static framework is the treatment of capital as a fixed, local factor. A dynamic model with capital accumulation and investment flows across regions would provide an improved understanding of adjustment paths

regarding variations in the allocation towards labour and capital. Incorporating a more granular analysis of labour skills or housing markets (such as distinguishing what fraction of capital infrastructure is dedicated to private commercial uses) would allow for a deeper investigation of the barriers to mobility that perpetuate regional inequalities. A further extension would be to disaggregate the Rest of the World into its main trading partners (the EU, the United States, and the rest), which would allow the model to speak more directly to bilateral trade-policy scenarios. Finally, applying this framework to evaluate specific, real-world policy interventions, such as the UK government's "Levelling Up" agenda, would be a natural and valuable extension.

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8 Appendix

8.1 Derivations: Intermediate inputs

In region $i \in 1, ..., N$ and sector j there is a continuum of goods' producers $z \in [0, 1]$ whose production technology is given by

$$q_{i,t}^j = Z_{i,t}^j \left[T_{i,t}^j (L_{i,t}^j)^{\beta_i^j} (K_{i,t}^j)^{1-\beta_i^j} \right]^{\gamma_i^j} \left[\prod_{h=1}^{J} \left(M_{i,t}^{jh} \right)^{\lambda_i^{jh}} \right]^{1-\gamma_i^j} \tag{30}$$

The unit cost of producing varieties with draw z^j is given by

$$\min_{L_{it}^j, K_{it}^j, \{M_{it}^{jh}\}_{h=1}^J} w_{it} L_{it}^j + r_{it} K_{it}^j + \sum_{h=1}^{J} P_{it}^j M_{it}^{jh} \tag{31}$$

$$\text{s.t.} \quad Z_{i,t}^j \left[T_{i,t}^j (L_{i,t}^j)^{\beta_i^j} (K_{i,t}^j)^{1-\beta_i^j} \right]^{\gamma_i^j} \left[\prod_{h=1}^{J} \left(M_{i,t}^{jh} \right)^{\lambda_i^{jh}} \right]^{1-\gamma_i^j} = 1 \tag{32}$$

where P_{it}^j is the price of final goods in sector j in region i. Let x_{it}^j denote the cost of the input bundle needed to produce intermediate input varieties in (i, j). Then

$$x_{it}^j = \Phi_i^{jh} \left[(w_{it})^{\beta_i^j} (r_{it})^{1-\beta_i^j} \right]^{\gamma_i^j} \left(\prod_{h=1} (p_{it}^h)^{\lambda_i^{jh}} \right)^{1-\gamma_i^j} \tag{33}$$

where

$$\Phi_i^{jh} = \left((1-\beta_i^j)\gamma_i^j \right)^{-\gamma_i^j} \left(\frac{\beta_i^j}{1-\beta_i^j} \right)^{-\gamma_i^j \beta_i^j} \left(\frac{\prod_{h=1} \lambda_i^{jh-\lambda_i^{jh}}}{1-\gamma_i^j} \right) \tag{34}$$

The unit cost of an intermediate input with idiosyncratic draw Z_i^j in region-sector pair (i,j) is then given by

$$\frac{x_{it}^j}{Z_{it}^j {T_{it}^j}^{\gamma_i^j}} \tag{35}$$

Firms located in region i and operating in sector j will be motivated to produce the variety whose productivity draw is Z_i^j as long as its price matches or exceeds $x_{it}^j / Z_{it}^j {T_{it}^j}^{\gamma_i^j}$.

Because the production function is Cobb-Douglas, profit maximisation implies that input de-

mands for all supplier sectors h satisfy

$$\frac{w_{it}L_{it}^{j}}{p_{it}^{j}q_{it}^{j}} = \gamma_{i}^{j}\beta_{i}^{j} \tag{36}$$

$$\frac{r_{it}K_{it}^{j}}{p_{it}^{j}q_{it}^{j}} = \gamma_{i}^{j}(1-\beta_{i}^{j}) \tag{37}$$

$$\frac{p_{it}^{h}M_{it}^{jh}}{p_{it}^{j}q_{it}^{j}} = \lambda_{i}^{jh}(1-\gamma_{i}^{j}) \tag{38}$$

These conditions imply that

$$w_{it}L_{it}^{j} = \frac{\beta_{i}^{j}}{1-\beta_{i}^{j}} r_{it}K_{it}^{j}$$

8.2 Derivations: Trade elasticities

We extend the methodology of Eaton and Kortum (2002) to estimate the vector of sectoral trade elasticities. From the bilateral trade shares equation (7), we obtain:

$$\frac{\pi_{in}^{j}}{\pi_{nn}^{j}} = \frac{(\tau_{in} x_{i}^{j})^{-\theta^{j}}}{(\tau_{nn} x_{n}^{j})^{-\theta^{j}}} \tag{39}$$

Taking logs gives:

$$\log\left(\frac{\pi_{in}^{j}}{\pi_{nn}^{j}}\right) = -\theta^{j}\left[\log(x_{i}^{j}) - \log(x_{n}^{j}) + \log\left(\frac{\tau_{in}}{\tau_{nn}}\right)\right] \tag{40}$$

Exploiting the normalisation of intra-regional trade costs, $\tau_{nn} = 1$, and substituting-in notation for exporter and importer fixed effects leaves us with the following equation:

$$\log\left(\frac{\pi_{in}^{j}}{\pi_{nn}^{j}}\right) = S_{i} - S_{n} - \theta^{j}\log\left(\tau_{in}\right) \tag{41}$$

where τ_{in} denotes the bilateral trade cost, S_i gives exporter fixed-effects, and S_n importer fixed-effects. The object π_{in}^{j} denotes region n's expenditure on intermediates from sector j produced by region i, while π_{nn}^{j} represents sector-specific intra-regional trade as region n's expenditure on intermediates from sector j produced by region n. The parameter θ^{j} is the trade elasticity for sector j.

8.3 Detailed tables of results

Table 8: Figure 10, panel a): Aggregate GDP elasticities from a 1% shock to fundamental productivity.

	NE	NW	YH	EM	WM	EE	LDN	SE	SW	WL	SC	NI
AG	0.016	0.02	0.015	0.015	0.014	0.01	0.068	0.008	0.008	0.033	0.042	0.012
MIN	0.029	0.042	0.034	0.039	0.044	0.035	0.058	0.042	0.061	0.028	0.031	0.02
MANUF	0.035	0.031	0.028	0.026	0.034	0.029	0.077	0.024	0.029	0.065	0.048	0.023
CONS	0.034	0.031	0.036	0.034	0.034	0.035	0.05	0.033	0.029	0.012	0.027	0.053
DIST HH	0.084	0.077	0.074	0.082	0.082	0.07	0.07	0.08	0.096	0.049	0.051	0.085
TPT COM	0.055	0.05	0.046	0.043	0.052	0.043	0.057	0.048	0.05	0.066	0.061	0.052
FIN	0.072	0.076	0.072	0.082	0.078	0.068	0.04	0.079	0.064	0.092	0.039	0.061
REST BUS	0.09	0.103	0.108	0.094	0.108	0.106	0.08	0.113	0.112	0.073	0.093	0.086
NMKT SERV	0.127	0.121	0.131	0.128	0.105	0.146	0.063	0.159	0.124	0.124	0.153	0.151

Table 9: Figure 10, panel b): Aggregate GDP elasticities from a 1% shock to fundamental productivity.

	NE	NW	YH	EM	WM	EE	LDN	SE	SW	WL	SC	NI
AG	0.042	0.054	0.044	0.044	0.039	0.032	0.173	0.025	0.027	0.069	0.089	0.036
MIN	0.072	0.105	0.088	0.1	0.105	0.089	0.154	0.1	0.139	0.057	0.069	0.05
MANUF	0.055	0.052	0.051	0.049	0.058	0.051	0.132	0.036	0.05	0.066	0.06	0.037
CONS	0.042	0.042	0.05	0.049	0.045	0.047	0.079	0.044	0.04	0.009	0.028	0.057
DIST HH	0.108	0.11	0.109	0.12	0.116	0.099	0.13	0.112	0.133	0.045	0.059	0.107
TPT COM	0.122	0.118	0.114	0.109	0.122	0.106	0.151	0.116	0.12	0.116	0.12	0.115
FIN	0.163	0.18	0.175	0.198	0.181	0.16	0.126	0.178	0.153	0.181	0.096	0.148
REST BUS	0.177	0.21	0.223	0.201	0.219	0.213	0.205	0.226	0.228	0.112	0.171	0.174
NMKT SERV	0.128	0.136	0.151	0.152	0.126	0.16	0.116	0.195	0.155	0.096	0.147	0.173

Table 10: Figure 10, panel c): Regional GDP elasticities from a 1% shock to fundamental productivity.

	NE	NW	YH	EM	WM	EE	LDN	SE	SW	WL	SC	NI
AG	0.048	0.057	0.048	0.051	0.043	0.043	0.145	0.031	0.039	0.105	0.11	0.057
MIN	0.107	0.127	0.112	0.121	0.125	0.122	0.153	0.119	0.164	0.107	0.11	0.088
MANUF	0.08	0.069	0.069	0.068	0.078	0.078	0.128	0.048	0.075	0.154	0.103	0.07
CONS	0.084	0.075	0.085	0.085	0.077	0.09	0.103	0.075	0.076	0.044	0.07	0.115
DIST HH	0.204	0.184	0.185	0.2	0.193	0.19	0.182	0.191	0.217	0.146	0.143	0.21
TPT COM	0.165	0.148	0.146	0.139	0.149	0.154	0.165	0.154	0.159	0.188	0.174	0.174
FIN	0.211	0.221	0.214	0.229	0.21	0.227	0.152	0.224	0.198	0.235	0.13	0.212
REST BUS	0.278	0.293	0.306	0.282	0.296	0.321	0.263	0.31	0.322	0.247	0.306	0.292
NMKT SERV	0.331	0.287	0.308	0.302	0.276	0.319	0.207	0.344	0.321	0.257	0.314	0.376

Table 11: Figure 10, panel d): Regional employment elasticities from a 1% shock to fundamental productivity.

	NE	NW	YH	EM	WM	EE	LDN	SE	SW	WL	SC	NI
AG	0.04	0.042	0.038	0.041	0.035	0.037	0.076	0.027	0.034	0.081	0.074	0.05
MIN	0.092	0.096	0.092	0.099	0.097	0.098	0.112	0.091	0.117	0.092	0.096	0.083
MANUF	0.077	0.065	0.067	0.068	0.075	0.076	0.099	0.049	0.074	0.163	0.102	0.074
CONS	0.089	0.079	0.088	0.09	0.08	0.094	0.109	0.077	0.081	0.05	0.078	0.125
DIST HH	0.208	0.187	0.191	0.206	0.197	0.198	0.196	0.197	0.214	0.158	0.154	0.218
TPT COM	0.135	0.118	0.12	0.118	0.121	0.127	0.134	0.121	0.127	0.153	0.138	0.143
FIN	0.174	0.17	0.171	0.181	0.167	0.179	0.137	0.166	0.162	0.181	0.111	0.183
REST BUS	0.249	0.248	0.262	0.25	0.251	0.266	0.249	0.249	0.268	0.233	0.272	0.273
NMKT SERV	0.388	0.336	0.355	0.346	0.329	0.351	0.264	0.367	0.371	0.259	0.323	0.407

Table 12: Figure 10: Regional congestion effect elasticities from a 1% shock to fundamental productivity.

	NE	NW	YH	EM	WM	EE	LDN	SE	SW	WL	SC	NI
AG	0.002	0.012	0.006	0.003	0.004	-0.005	0.097	-0.002	-0.007	-0.012	0.015	-0.014
MIN	-0.02	0.01	-0.004	0.002	0.007	-0.01	0.043	0.009	0.021	-0.035	-0.027	-0.033
MANUF	-0.022	-0.013	-0.016	-0.019	-0.017	-0.025	0.033	-0.012	-0.024	-0.097	-0.041	-0.037
CONS	-0.047	-0.037	-0.039	-0.041	-0.035	-0.047	-0.03	-0.033	-0.041	-0.041	-0.05	-0.068
DIST HH	-0.1	-0.077	-0.082	-0.085	-0.082	-0.099	-0.067	-0.085	-0.081	-0.114	-0.096	-0.111
TPT COM	-0.013	0	-0.006	-0.009	0.002	-0.021	0.017	-0.005	-0.007	-0.037	-0.018	-0.028
FIN	-0.011	0.01	0.004	0.016	0.015	-0.018	-0.011	0.012	-0.009	-0.001	-0.015	-0.035
REST BUS	-0.073	-0.038	-0.039	-0.049	-0.032	-0.053	-0.044	-0.023	-0.041	-0.121	-0.101	-0.099
NMKT SERV	-0.26	-0.2	-0.204	-0.194	-0.204	-0.191	-0.147	-0.172	-0.216	-0.163	-0.176	-0.233

Table 13: Figure 11, panel a): Aggregate GDP elasticities from a 1% shock to capital stock.

	NE	NW	YH	EM	WM	EE	LDN	SE	SW	WL	SC	NI
AG	0.016	0.018	0.017	0.017	0.017	0.016	0.036	0.022	0.017	0.019	0.026	0.017
MIN	0.032	0.035	0.036	0.036	0.037	0.034	0.052	0.04	0.039	0.025	0.038	0.034
MANUF	0.037	0.041	0.04	0.042	0.042	0.04	0.05	0.044	0.042	0.053	0.048	0.039
CONS	0.034	0.04	0.04	0.04	0.038	0.04	0.056	0.04	0.038	0.022	0.032	0.046
DIST HH	0.065	0.074	0.072	0.074	0.074	0.072	0.097	0.085	0.075	0.048	0.059	0.066
TPT COM	0.044	0.051	0.049	0.049	0.05	0.048	0.064	0.05	0.049	0.039	0.048	0.043
FIN	0.058	0.069	0.069	0.069	0.07	0.065	0.075	0.068	0.068	0.046	0.048	0.052
REST BUS	0.066	0.079	0.079	0.079	0.077	0.074	0.093	0.08	0.078	0.056	0.07	0.067
NMKT SERV	0.12	0.131	0.13	0.123	0.13	0.117	0.124	0.134	0.129	0.058	0.089	0.103

Table 14: Figure 11, panel b): Regional GDP elasticities from a 1% shock to capital stock.

	NE	NW	YH	EM	WM	EE	LDN	SE	SW	WL	SC	NI
AG	0.026	0.026	0.025	0.025	0.025	0.026	0.042	0.031	0.026	0.037	0.045	0.03
MIN	0.053	0.051	0.052	0.052	0.053	0.055	0.062	0.058	0.059	0.05	0.067	0.06
MANUF	0.061	0.06	0.059	0.061	0.06	0.064	0.06	0.064	0.064	0.105	0.083	0.07
CONS	0.057	0.058	0.059	0.058	0.055	0.065	0.067	0.058	0.058	0.043	0.057	0.081
DIST HH	0.108	0.107	0.106	0.107	0.107	0.116	0.115	0.123	0.113	0.095	0.103	0.118
TPT COM	0.073	0.074	0.072	0.072	0.072	0.077	0.076	0.073	0.074	0.077	0.083	0.077
FIN	0.097	0.101	0.102	0.1	0.1	0.106	0.089	0.099	0.103	0.092	0.083	0.092
REST BUS	0.11	0.115	0.117	0.114	0.11	0.119	0.11	0.116	0.117	0.111	0.123	0.119
NMKT SERV	0.2	0.19	0.191	0.178	0.186	0.188	0.147	0.195	0.195	0.115	0.156	0.184

Table 15: Figure 11, panel c): Regional employment elasticities from a 1% shock to capital stock.

	NE	NW	YH	EM	WM	EE	LDN	SE	SW	WL	SC	NI
AG	0.025	0.024	0.023	0.024	0.023	0.024	0.039	0.028	0.024	0.035	0.042	0.03
MIN	0.051	0.046	0.049	0.049	0.049	0.051	0.057	0.052	0.055	0.047	0.062	0.058
MANUF	0.059	0.055	0.056	0.058	0.057	0.059	0.055	0.058	0.059	0.097	0.077	0.068
CONS	0.055	0.053	0.055	0.055	0.051	0.06	0.062	0.052	0.053	0.04	0.052	0.079
DIST HH	0.104	0.099	0.1	0.102	0.1	0.108	0.106	0.111	0.105	0.088	0.096	0.115
TPT COM	0.071	0.068	0.068	0.068	0.067	0.071	0.07	0.066	0.068	0.071	0.077	0.075
FIN	0.093	0.093	0.096	0.095	0.093	0.098	0.082	0.089	0.095	0.085	0.077	0.09
REST BUS	0.106	0.106	0.11	0.108	0.103	0.11	0.101	0.104	0.108	0.103	0.114	0.116
NMKT SERV	0.193	0.174	0.18	0.169	0.174	0.174	0.136	0.175	0.18	0.106	0.144	0.18

Table 16: Figure 11, panel d): Regional congestion effects from a 1% shock to capital stock.

	NE	NW	YH	EM	WM	EE	LDN	SE	SW	WL	SC	NI
AG	-0.01	-0.006	-0.006	-0.006	-0.006	-0.008	-0.003	-0.007	-0.007	-0.016	-0.016	-0.013
MIN	-0.019	-0.012	-0.014	-0.013	-0.013	-0.017	-0.005	-0.012	-0.015	-0.021	-0.024	-0.025
MANUF	-0.022	-0.014	-0.015	-0.016	-0.014	-0.02	-0.005	-0.014	-0.017	-0.044	-0.029	-0.029
CONS	-0.021	-0.013	-0.015	-0.015	-0.013	-0.02	-0.005	-0.012	-0.015	-0.018	-0.02	-0.034
DIST HH	-0.039	-0.025	-0.028	-0.028	-0.026	-0.036	-0.009	-0.026	-0.029	-0.04	-0.036	-0.049
TPT COM	-0.027	-0.017	-0.019	-0.018	-0.017	-0.024	-0.006	-0.015	-0.019	-0.032	-0.029	-0.032
FIN	-0.035	-0.023	-0.027	-0.026	-0.024	-0.032	-0.007	-0.021	-0.027	-0.039	-0.029	-0.038
REST BUS	-0.04	-0.027	-0.03	-0.029	-0.026	-0.037	-0.008	-0.024	-0.03	-0.047	-0.043	-0.049
NMKT SERV	-0.073	-0.044	-0.05	-0.046	-0.045	-0.058	-0.011	-0.041	-0.051	-0.048	-0.055	-0.076

Table 17: Table 4: Aggregate GDP elasticity of reduced trade cost between trading partners. Weighted using the sum of both regions GDP share.

	NE	NW	YH	EM	WM	EE	LDN	SE	SW	WL	SC	NI
NE	0	0.041	0.045	0.02	0.02	0.019	0.039	0.025	0.023	0.012	0.033	0.014
NW	0.041	0	0.096	0.062	0.051	0.028	0.056	0.036	0.032	0.04	0.05	0.016
YH	0.045	0.096	0	0.089	0.036	0.025	0.051	0.027	0.022	0.016	0.032	0.019
EM	0.02	0.062	0.089	0	0.068	0.061	0.045	0.036	0.023	0.015	0.027	0.019
WM	0.02	0.051	0.036	0.068	0	0.026	0.049	0.04	0.038	0.1	0.049	0.019
EE	0.019	0.028	0.025	0.061	0.026	0	0.064	0.043	0.022	0.016	0.017	0.015
LDN	0.039	0.056	0.051	0.045	0.049	0.064	0	0.073	0.044	0.043	0.08	0.023
SE	0.025	0.036	0.027	0.036	0.04	0.043	0.073	0	0.06	0.021	0.026	0.013
SW	0.023	0.032	0.022	0.023	0.038	0.022	0.044	0.06	0	0.076	0.02	0.013
WL	0.012	0.04	0.016	0.015	0.1	0.016	0.043	0.021	0.076	0	0.004	0.004
SC	0.033	0.05	0.032	0.027	0.049	0.017	0.08	0.026	0.02	0.004	0	0.013
NI	0.014	0.016	0.019	0.019	0.019	0.015	0.023	0.013	0.013	0.004	0.013	0

Table 18: Figure 13: Regional GDP elasticity of home region from reduced trade cost with trading partner

Trading partner →	% Variation in regional GDP											
Home region ↓	NE	NW	YH	EM	WM	EE	LDN	SE	SW	WL	SC	NI
NE	0	0.145	0.122	0.048	0.054	0.062	0.113	0.1	0.072	0.031	0.103	0.022
NW	0.046	0	0.128	0.078	0.069	0.043	0.082	0.066	0.049	0.055	0.08	0.016
YH	0.059	0.188	0	0.136	0.059	0.047	0.089	0.062	0.043	0.028	0.062	0.022
EM	0.028	0.131	0.159	0	0.118	0.119	0.088	0.094	0.048	0.026	0.051	0.022
WM	0.026	0.101	0.06	0.102	0	0.05	0.088	0.091	0.07	0.167	0.09	0.021
EE	0.024	0.051	0.038	0.086	0.041	0	0.108	0.092	0.038	0.026	0.027	0.017
LDN	0.042	0.089	0.068	0.055	0.066	0.091	0	0.131	0.063	0.063	0.126	0.022
SE	0.026	0.05	0.032	0.04	0.048	0.056	0.092	0	0.076	0.027	0.03	0.012
SW	0.028	0.055	0.032	0.03	0.054	0.037	0.072	0.12	0	0.112	0.028	0.014
WL	0.024	0.132	0.046	0.037	0.268	0.051	0.121	0.093	0.217	0	0.012	0.008
SC	0.044	0.098	0.057	0.051	0.096	0.038	0.139	0.073	0.045	0.008	0	0.016
NI	0.034	0.077	0.066	0.059	0.066	0.065	0.092	0.076	0.056	0.016	0.052	0