Do Multinationals and Domestic Firms Benefit Differently from Location? Evidence on Agglomeration and Value Chains

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Abstract

This paper studies how spatial proximity and value-chain access shape firm productivity, with emphasis on ownership and organizational scope. Using a 10-year panel of about 29,000 Belgian firms, we estimate models with rich fixed effects and instrument agglomeration, input access, and market access using pre-period shift–share exposure. Three findings emerge. First, within-municipality agglomeration raises total factor productivity, and the effect is larger when endogeneity is addressed. Second, foreign multinationals have a level premium but weaker ties to local externalities; gains from agglomeration and access concentrate among domestically owned single-plant firms, and multi-establishment structures also dampen sensitivity to local inputs and demand. Third, sectoral asymmetries are pronounced, with strong agglomeration and market-access premia in services and muted effects in manufacturing. Results are robust to restricting to predetermined locations and to alternative input–output measures. Place-based improvements in density and market access yield the largest productivity gains for domestic single-plant firms and services.

1. Introduction

Why do some firms convert dense local environments and central locations into productivity gains while others do not? Much of the literature measures average agglomeration effects, but two margins central to place-based policy remain underexplored: how ownership and organizational scope mediate the conversion of local externalities into firm performance, and how density interacts with economy-wide input and market access rather than only intra-city co-agglomeration. Progress is also limited by endogeneity in agglomeration and access measures and by a narrow focus on local, rather than economy-wide, supply and demand linkages.

We address these gaps by combining economy-wide measures of input and market access with an identification strategy and rich heterogeneity. On measurement, we construct industry-weighted measures of supplier and customer access that summarize the size and proximity of all potential partners across the economy, not just nearby ones, extending co-agglomeration approaches beyond single-city industrial structures (Fujita and Krugman, 2004; Krugman, 2011; Diodato et al., 2018; Steijn et al., 2022; Bond-Smith and McCann, 2019). On identification, we use pre-period shift–share (Bartik) instruments based on industry shares and national shocks to instrument agglomeration, input access, and market access, and estimate models with firm and year fixed effects and strong first-stage diagnostics (Borusyak et al., 2022; Goldsmith-Pinkham et al., 2020). On heterogeneity, we allow responses to vary by ownership and organizational scope and examine sectoral asymmetries.

The framework guiding the empirics is grounded in trade and urban economics. Firms source a variety of intermediates and sell to a variety of customers with constant elasticity of substitution and love of variety (Krugman, 1991; Venables, 1996). Proximity to supplier depth lowers effective input costs, and proximity to customers raises effective output prices, which we operationalize with industry-weighted access indices consistent with multilateral resistance logic (Eaton et al., 2011). This anchors the analysis in economy-wide supply and demand fundamentals (Fujita and Krugman, 2004; Krugman, 2011).

Using a decade-long panel of about 29,000 Belgian firms, three results stand out. First, within-municipality agglomeration is positively associated with total factor productivity, and the baseline effect increases when endogeneity is addressed, consistent with classic evidence on agglomeration economies and local increasing returns (Jacobs et al., 2014; Barrios et al., 2006; Fingleton, 2003). Second, ownership and organization are first order. Foreign multinationals exhibit a level premium (Markusen and Venables, 2000; Alfaro and Chen, 2014), yet under instrumental variables the gains from input and market access are concentrated among domestically owned single-plant firms, with interactions for multinational status largely offsetting baseline access effects. Multi-establishment structures further attenuate sensitivity to local input depth and local demand and yield at most modest additional agglomeration returns, patterns consistent with internal sourcing and diversified customer networks (Nielsen et al., 2017; Ascani et al., 2016; Alfaro-Urena et al., 2022a). Third, sectoral asymmetries are pronounced: agglomeration and market-access premia are strong in services and muted in manufacturing, in line with human-capital and coordination mechanisms in dense labor markets and with the specialization of cities in information-intensive activities (Roca and Puga, 2017; Davis and Dingel, 2020).

Our estimates also speak to the balance between localization and urbanization forces. In fixed-effects OLS, related-neighbor intensity is positively associated with productivity, whereas under instrumental variables, the related-neighbor effect turns adverse, and unrelated diversity becomes beneficial. This pattern points to congestion or business-stealing in specialized settings and to cross-industry complementarities in more diverse environments, and is consistent with modern evidence on metropolitan accessibility and productivity (Heblich et al., 2020a). Recent UK evidence documents strong agglomeration effects within travel-to-work areas together with a reduced trade productivity premium in denser locations, a pattern also observed for Japan; while those studies do not analyze ownership, the trade-intensity channel they identify is relevant because multinationals are typically more exposed to international markets (Kauma and Mion, 2023; Mion and Zhang, 2025; Okubo and Tomiura, 2019).

We combine within-municipality agglomeration with economy-wide input and market access indices from the input–output structure, estimate models with firm and year fixed effects, and instrument agglomeration and access using pre-period shift–share exposure to national trends. Robustness exercises restricting to firms with predetermined locations and recomputing access with an alternative input–output matrix deliver the same economic content. The resulting picture is that place-based improvements in density and market potential deliver the largest productivity gains where firms cannot easily internalize spatial advantages, most notably among domestic single-plant firms and in services.

The remainder of the paper is organized as follows. The next section develops the theoretical framework that will guide the following empirical analysis. Section 3 introduces the data used and the estimation strategy. Section 4 reports the main empirical results, while Sections 5 and 6 present robustness analysis and discussion, respectively. Section 7 concludes.

2. Theoretical framework

2.1 Literature and setup

We consider the benefits of location and supply/value chain access on firm performance, with a particular emphasis on how these might differ according to ownership. Agglomeration effects have been noted since Marshall (1898). The more recent literature suggests they can be classified into a number of different types. One strand of the literature, following (Arrow, 1962; Jacobs, 1969; Porter, 1990; Glaeser et al., 1992), and including Barrios et al. (2006) and Jacobs et al. (2014) focuses upon learning by doing and knowledge spillovers. These spillovers are observed from clusters of industries, such as Silicon Valley, or Italian ceramics and design clusters (Porter, 1990). Advantages include sharing inputs, movement of skilled personnel through meetings and discussions. These knowledge spillovers tend to be particularly marked at a very local scale, although there are some differences between those studies which focus on intra-industry spillovers (Arrow, 1962; Romer, 1986; Porter, 1990) and those that see stronger spillovers being between related industries (Jacobs, 1969). Even though Glaeser et al. (1992) find the latter to be more supported at the city level in the USA, we focus more on the former, partly because we model inter-industry spillovers more specifically using different tools.

Other than knowledge spillovers, agglomeration can also be measured in terms of the benefits of proximity to suppliers and customers, including the benefits of competition and variety among those. Indeed, these are widely handled in the NEG literature ((Krugman, 1991; Fujita et al., 2001; Fujita and Thisse, 2013)), which formally models agglomeration economies.

However, while there is an extensive literature on these various agglomeration economies, relatively little is known about how these externalities benefit TFP differentially, according to ownership.[1] A meta-analysis in Melo et al. (2009) shows that foreign and domestic firms benefit differently from agglomera-

[1] Haddad and Harrison (1993) and Aitken and Harrison (1999) analyze whether the presence of foreign firms enhances other firms' productivity.

tion. In addition to agglomeration effects, Melitz and Ottaviano (2008) consider a theoretical framework where productivity depends on the level of competition, which also arises from market size and trade effects. With tough competition, the least productive firms are forced to exit, as in Melitz (2003).

From a NEG perspective, market potential is an important determinant of productivity (Fujita et al., 2001). Graham (2007a,b) for India and Combes et al. (2010a) for the UK, analyze this using cross-section data, while Holl (2011) employs time effects of the road network. These studies estimate agglomeration benefits consistent with other studies (Combes et al., 2010b, 2012; Puga, 2010; Melo et al., 2009). However, these studies overlook the roles of input access and ownership. MNCs are well known to be more efficient and more likely to export (Melitz, 2003; Yeaple, 2005). Thus, not accounting for ownership might bias estimates of market potential elasticities. From an empirical perspective market access does indeed matter (Redding and Venables, 2004; Hanson, 2005). Head and Mayer (2004) construct a measure of market potential (for Japanese firms locating in France) that accounts for aggregate demand from multiple locations weighted by distance, and show that an increase in market potential increases the likelihood of firms choosing a given location. This is close to our methodology, although we focus on productivity, not location decisions, and we model linkages using input-output data, *à* la Venables (1996), Hummels et al. (2001). Complementing this, recent evidence shows that geographic effects propagate primarily through product market and supply-chain networks (Grieser et al., 2022).

Other studies of agglomeration show a positive effect on plant productivity (e.g. Lall et al. (2004) for India, or Quintero and Roberts (2023) for Latin America), although sectors differ. For Sweden, Anderson (2011) adds to the production function a variable that captures the size of the region where a firm operates, confirming the benefits of agglomeration for the firm's productivity. Saito and Gopinath (2009) find that highly productive food manufacturing plants tend to concentrate where other food plants locate and the market size is relatively large. Furthermore, plants' self-selection outweighs agglomeration effects in improving regional productivity. Beyond productivity levels, agglomeration shapes survival and resilience: industry variety and clustering affect firm exit and post-crisis performance (Basile et al., 2017; Cainelli et al., 2019). Agglomeration also moderates the impact of financial frictions on innovation (Li and Zhang, 2023) and can reduce energy intensity at fine spatial scales, with effects attenuating by distance (Wang et al., 2022).

UK-based studies (Kauma and Mion, 2023; Mion and Zhang, 2025) find strong evidence of agglomeration effects (defined here as the presence of large numbers of firms within a travel-to-work area). Interestingly, the latter study finds this effect to be offset by a reduced trade productivity premium in areas of agglomeration - a result consistent with Okubo and Tomiura (2019)'s findings for Jaman. While these studies do not look at ownership effects or other measures of economic centrality, there is an interesting relevance to our work, as MNCs are generally held to be more active in international trade.

Several studies have addressed the importance of urban density for productivity.[2] Andersson et al. (2007) find a productivity premium in dense areas from more intensive worker-to-firm matching, and Behrens et al. (2014) support this. Combes et al. (2012) suggest that the advantage of large cities might well be due to firm selection, since less productive firms are unable to survive the tougher local competition. Relatedly, sorting accounts for a sizable share of large-city productivity advantages (Gaubert, 2018), and lower resource misallocation in dense areas contributes to the productivity premium (Fontagné and Santoni, 2019). Micro-level heterogeneity—such as top manager characteristics—can further mediate the agglomeration–performance link (Zhang, 2017).

Delgado et al. (2010) emphasize how clustering might lower the cost of starting a business. Existing firms tend to open new establishments where strong clusters are present (Enright (2000); Manning (2008)). In this respect, we provide a novel contribution to the literature, since we address how input and market access benefit firms' TFP, while exploring how different specifications might affect the point estimates. The literature tends to examine market potential in isolation, however, we argue that the effects will complement those of input access and clustering. We also analyze how ownership status might explain firm-level differences, and address this issue for both single and multi-location firms. Consistent with this emphasis, recent work underscores how related variety and regional institutions shape the diffusion of spillovers across ownership types (Zhu et al., 2019), how absorptive capacity and governance interact with agglomeration for innovation (Howell, 2020), how network propagation within industries underlies agglomeration economies (Grieser et al., 2022), and how economic complexity relates to firm performance in creative sectors (Burlina et al., 2023).

We adopt a formal modelling approach to make best use of the industry and location data in our database. We index producing firms by $h \in [1.....,H]$, each identified both with a particular industry, $i \in [1.....,I]$, and a municipality $m \in [1.....,M]$. We are interested in the relations between firms, either as purchaser, or supplier, or through clustering spillovers, and wish to investigate their effects on

[2] However, as Rocha et al. (2020) find, dense population clusters can have offsetting social problems.

productivity, and how the effects vary by ownership type.

We set up a monopolistically competitive framework, where each firm has the option to interact with each other firm, though the extent of interaction will depend on the relationship between the two industries, and upon the distance between firms. We assume that the number of firms is large in each case, and that, within each industry/municipality, firms are homogeneous. Hence we model the behaviour of a representative firm with constant markups.[3] Figure (1) illustrates the nested production structure.[4]

2.2 Input access: proximity to upstream value/supply chains

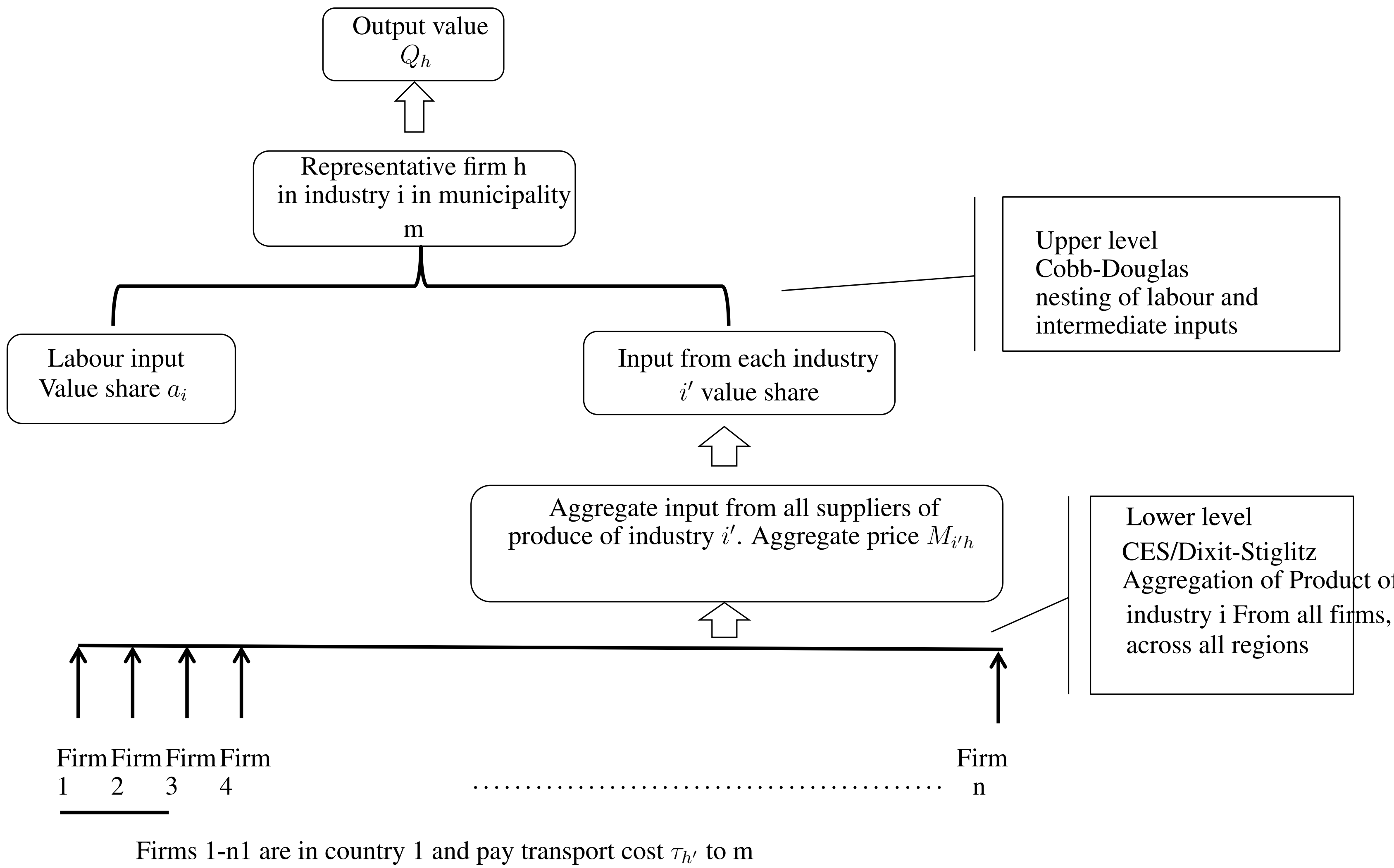
We start by considering **input access**: in the Krugman tradition, we assume that firm h purchases inputs from a wide variety of firms, h', in different industries and municipalities ($\{i', m'\}$). h loves input variety, and so spreads its purchases from i' across many firms, choosing more from municipalities where more varieties are available and where transport costs are lower. Hence the aggregate cost of inputs from i' will be lower for a firm which locates centrally relative to production in that industry.

h combines all inputs from industry i' to form an aggregate input. For example, a furniture manufacturer might aggregate inputs from all wood suppliers, to produce an aggregate wood input, which cost depends on average distance from these suppliers. We proceed with three main assumptions. (1) The number of varieties of i' (wood) produced in each municipality is proxied by total output of wood in that municipality. (2) The iceberg transport cost from i' to i, $\tau_{i,i'}$, is a function of distance between the municipalities, $\tau_{i,i'}(d_{i,i'})$, where $\frac{\partial \tau_{i,i'}}{\partial d_{i,i'}} > 0$. (3) h aggregates inputs with a constant elasticity of substitution, $\sigma > 1$. This combination of assumptions corresponds to the theory-consistent gravity models in the trade literature (Bergstrand (1985); Anderson and van Wincoop (2003)). Consequently, we can derive an aggregate price $M_{i',m}$ for inputs of i' to firms in municipality m, and we can show (see Online Appendix Section B) that this is closely proxied by an index $G_{i',m}$, of the output of i' across all municipalities, weighted by a function of distance:

[3] Incorporating firm heterogeneity does not affect results unless monopolistic competition is 'thick' - proof available from authors.

[4] The modelling setup is laid out in more detail in the Online Appendix.

Figure 1: Nested Production Function



$$G_{i',m} = \sum_{m'=1}^{\mu} \frac{Y_{i',h'}}{\tau_{i'}(d_{m',m})}. \tag{1}$$

Where $Y_{i',h'}$ is aggregate output across industries. The effect on overall input cost for h depends on the relative importance of i' in overall purchases by i, which is proxied by the input-output coefficient for i' into i, $b_{i',i}$. Hence, we produce an aggregate Input Access index:

$$IA_h = \sum_{i'=1}^{I} b_{i',i} lnG_{i',m}. \tag{2}$$

The logic is that a firm will reduce its costs by locating closer to input suppliers, particularly where those are in industries which weigh heavily as suppliers to industry i.

The gravity-weighted index in this model should be seen as a measure of centrality (c.f. ‘multilateral resistance’ in the gravity literature), but it is also the converse of the peripherality indices frequently used by geographers.

2.3 Market access: proximity to downstream value chains

Location can potentially affect performance through market potential, or market access. Since TFP is expressed in terms of value added per weighted unit of input, higher output prices are associated with a higher TFP. A firm can potentially obtain higher prices by selling to a wide variety of nearby customers (hence with low transport costs). In addition, greater market scale allows firms to exploit firm-level scale (Krugman, 1980), again raising TFP (although scale may be controlled for in empirical analysis). Hence, where the firm is closer to a concentration of customers, it may both achieve higher prices and gain scale economies.

We focus on demand by industry, and again utilise a gravity-weighted index, in this case

$$\Gamma_{i,i',m} = \sum_{m'=1}^{\mu} \frac{b_{i,i'} Y_{i',h'}}{\tau_{i'}(d_{m',m})}, \tag{3}$$

where we utilise the input-output coefficient for i into i', so that we can again relate demand for i to output of i' across all municipalities, weighted by a function of distance.

We then aggregate across customer industries and assume that h purchases from h'. This allows us to derive a market potential index,

$$MA_h = \sum_{i'=1}^{I} \mathit{\Gamma}_{i,i',m}. \tag{4}$$

Keeble et al. (1988) cite important features of peripherality indices. First, such an index should contain a measure of local economic activities. Second, it should take into account distances between regions. Finally, it has to account for border effects. Our derived gravity indices possess all these characteristics. They are calculated from municipality level economic activities, corrected for distances. We investigate the issue of borders in Section 4.2 in the Online Appendix.

2.4 The treatment of distance

Calculation of the **gravity indices** for each municipality, m and industry, i, is very computationally heavy, as for each industry and year we aggregate over approximately 1,000 postcodes' output in each other postcode weighted by a function of the distance between postcode pairs.Consequently, it was judged that varying the function $\tau_{i'}(d_{m',m})$ freely to maximise fit was computationally impractical. As a first step, therefore, we replaced $\tau_{i'}(d_{m',m})$ with an isoelastic parameter, $\tau_{i'}(d_{m',m}) = d^{\eta}_{m',m}$, and, following the common finding in the gravity literature that trade typically declines in roughly inverse proportion to the distance between localities, we set $\eta = \sigma$, the elasticity of substitution, so that in fact we start with $\tau_{i'}(d_{m',m}) = d_{m',m}$. Consequently, our approximate indices for baseline work are:

$$G_{i',m} = \sum_{m'=1}^{\mu} \frac{Y_{i',h'}}{d_{m',m}};\ \Gamma_{i,i',m} = \sum_{m'=1}^{\mu} \frac{b_{i,i'} Y_{i',h'}}{d_{m',m}}. \tag{5}$$

An important part of this study is to investigate whether this initial model produces similar results for firms of different **ownership types**. Here, we acknowledge that the asssumed distance elasticity in our baseline case is only approximate, and that some studies find that substitution elasticities potentially rise as one moves down the production chain. This implies that firms will tend to sell output over a geographically more diverse area than they buy: consistent with the finding of Conconi et al. (2020) that gravity effects are stronger for intermediate than final goods.

To consider the potential implications, compare two hypothetical firms A and B. If we assume that B has greater production efficiency, it will sell its products at a lower price to more customers, over a geographically more diverse area (including exports). It will also purchase from a wider range of suppliers, but the increase in inputs will likely be more on the intensive margin (purchasing more from existing suppliers), while the increase in sales will be more on the extensive margin (finding more new customers). Thus, it follows that A may well locate near a cluster of customers, while B will sell to a much wider market, while it will still buy from a relatively short list of suppliers. Consequently, location near to suppliers is of increased importance to B than A.

There is also a more direct effect, which is that a MNC which originated abroad will already have a client list of export customers, as in Yeaple (2005) and Ekholm et al. (2007). Given brand familiarity, it may be able to retain these as it moves production to a lower-cost country. By contrast, a firm which originated locally will probably have started with a more local client base.

Consequently, we should consider two effects: MNCs may sell more widely because they are more efficient, but in addition they may sell more widely simply because they originated abroad. Both effects weaken the benefit of location near a local market, while strengthening the potential pull of clustering for spillovers and of locating near suppliers.

3. Data and estimation strategy

3.1 Data

We use a large firm-level panel dataset (BELFIRST) covering value-added, employees' compensation, number of employees and hours worked for 29,000 firms between 2005-2014, in all industries, defined by NACE classification and location by municipality.

The database boasts extensive coverage of Belgian company information. It includes details on both public and private companies, their financial characteristics, ownership structures and key executives. This depth of information is particularly valuable when studying MNEs, as it enables researchers to access data on subsidiaries, parent companies, and their relationships, ultimately facilitating a holistic analysis of their activities and performance. It has been widely used in the literature to investigate several research questions; see e.g., Komorowski (2020); Baert et al. (2018); Deloof et al. (2007); Vandenberghe et al. (2013). Furthermore, to investigate the representativeness of this data for municipalities we plot in Figure 2 the correlation between the number of firms in our database at the municipality level and the official Census counts obtained from the Statistical Office of Belgium (Statbel). What emerges from this is an almost 45-degree line, which provides strong assurance of representativeness.[5]

The definition of MNCs in our sample is based by the ownership structure and the extent of foreign control over the corporations. We categorize the firms into different groups based on their ownership and geographical presence. Domestic Firms (Domestic): These are Belgian corporations domestically owned. In other words, these are companies predominantly owned by Belgian entities, and they are considered purely domestic in nature. Domestic-Foreign Hybrid Firms (Domestic-Foreign): This category includes Belgian corporations where domestic ownership is the majority but does not reach the 90% threshold (Ramamurti, 2012; Hymer, 1976; Rugman and Verbeke, 2004). These firms have some foreign ownership but are still primarily controlled by Belgian entities. And finally, Foreign-Owned Firms (Foreign): firms falling under this category are those where foreign ownership exceeds 51% (Caves, 1996; Buckley and Casson, 2015). These companies have a significant level of foreign control, making them multinational.[6] The motivation for this classification is to capture the diversity in ownership structures and the degree of foreign influence within the sample. It allows us to differentiate between purely domestic firms and those with varying degrees of internationalization. This approach provides a nuanced understanding of the sample composition, enabling us to analyze the impact of foreign ownership on the behavior and outcomes of these firms. It also facilitates more precise empirical investigation into the role of multinational corporations within the Belgian context.

We match the firm data to Belgian input-output data for 2005/2010 for 64 industries. Our complete dataset comprises 241,719 observations. We also used data by industry from Eurostat for Belgium's neighbouring countries. Table (1) presents summary statistics. We use the global ultimate controller of the firm to classify ownership type. We also distinguish firms by number of establishments.

[5]Albeit, in our database we might have some firms that are not subject to VAT. This information is not available in our database for us to restrict attention to only this group. On the other hand Figure 3 shows the distribution of firms across different municipalities.

[6]We relax these definitions by looking at alternative ownership structures and the results are fairly similar; these results are available upon request.

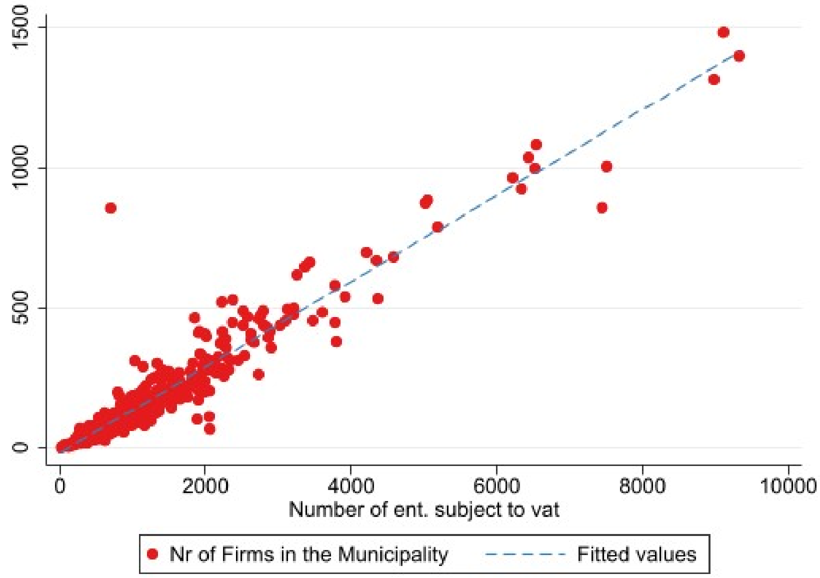


Figure 2: These graphs show the correlation between the number of firms in our sample in given municipality and the official number of VAT enterprises in the municipality derived from the Census by the Statistical Office of Belgium (BelSat).

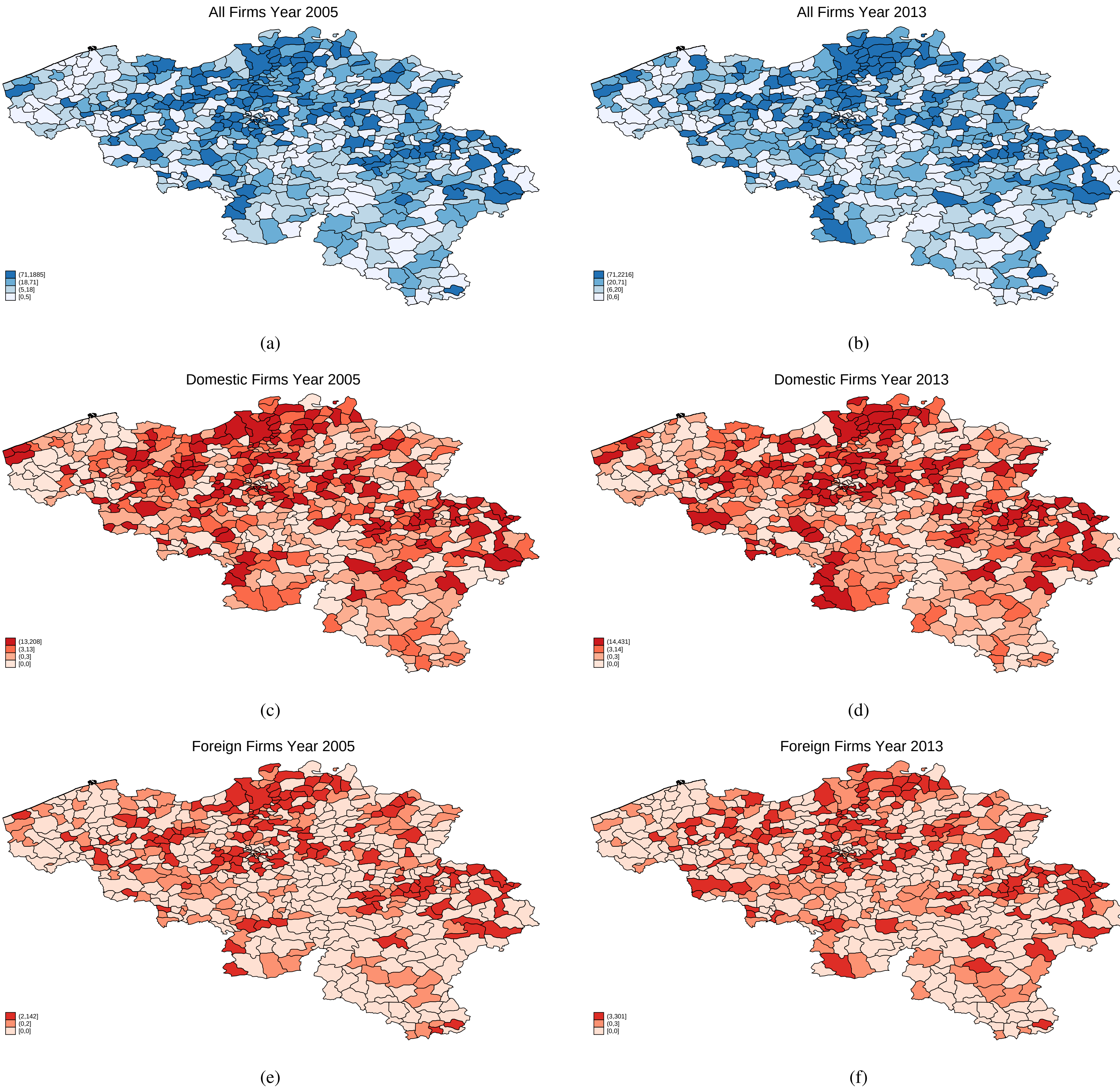


Figure 3: These graphs show the number of firms between 2005 and 2013 for all firms, domestic firms and foreign firms.[17] The dark area represents more firms in the municipality. Thus, both foreign and domestic firms tend to agglomerate in already congested areas.

Table 1: Summary Statistics

variables	All Firms					Domestic				
	mean	sd	min	max	N	mean	sd	min	max	N
ln(Employees)	2.413	1.483	0	6.460	241 187	2.202	1.404	0	6.459	136 448
ln(Capital)	7.033	1.847	2.773	12.851	241 187	6.926	1.699	2.772	12.850	136 448
ln(Net Added Value)	6.690	1.609	0	14.853	241 187	6.439	1.478	0	14.633	136 448
ln(Total Assets)	7.826	1.693	4.220	13.281	241 187	7.651	1.549	4.219	13.280	136 448
ln(Wage Bill)	13.023	1.729	0	21.056	241 187	12.720	1.629	0	20.338	136 448
ln(Agglomeration)	6.968	1.627	0	10.859	241 187	7.006	1.569	0	10.858	136 448
neighbour^{rel}	3.906	2.413	0	8.617	241 187	3.727	2.349	0	8.616	136 448
neighbour^{other}	8.372	1.454	0	11.629	241 187	8.216	1.427	0	11.629	136 448
ln(TFP)	2.976	0.597	0.639	4.688	241 187	2.900	0.566	0.638	4.687	136 448
Input Access	0.665	2.247	−12.034	11.738	241 187	0.385	1.893	−4.496	8.238	136 448
Market Access	0.295	0.795	−3.964	3.407	241 187	0.193	0.720	−1.262	2.597	136 448
Age	22.011	14.997	1	83	241 187	21.998	14.082	1	83	136 448
variables	Domestic MNCs					Foreign MNCs				
	mean	sd	min	max	N	mean	sd	min	max	N
ln(Employees)	2.173	1.309	0	6.460	55 662	3.021	1.649	0	6.459	49 077
ln(Capital)	6.507	1.650	2.773	12.851	55 662	7.624	2.199	2.772	12.850	49 077
ln(Net Added Value)	6.314	1.411	0	14.833	55 662	7.489	1.831	0	14.853	49 077
ln(Total Assets)	7.332	1.470	4.220	13.281	55 662	8.872	1.873	4.219	13.280	49 077
ln(Wage Bill)	12.673	1.513	0	21.056	55 662	14.259	1.672	0.693	20.524	49 077
ln(Agglomeration)	6.876	1.623	0	10.859	55 662	6.966	1.744	0	10.859	49 077
ln(neighbour^{rel})	3.781	2.330	0	8.617	55 662	4.419	2.555	0	8.616	49 077
ln(neighbour^{other})	8.320	1.474	0	11.629	55 662	8.747	1.445	1.098	11.629	49 077
ln(TFP)	2.924	0.575	0.690	4.688	55 662	3.181	0.645	0.644	4.687	49 077
Input Access	0.423	1.891	−4.496	8.238	55 662	1.729	2.800	−12.034	11.738	49 077
Market Access	0.222	0.763	−1.262	2.501	55 662	0.663	0.878	−3.964	3.322	49 077
Age	20.783	14.699	1	83	55 662	22.379	17.016	1	83	49 077

Note: The table presents the summary statistics of main variables used in this paper by firm type. We distinguish between purely domestic firms, domestic MNCs, foreign MNCs and foreign MNCs with domestic participation. In general, foreign MNCs tend to be more productive (higher TFP) and larger (number of employees). They also tend to have higher values of input and market access. Notice ln(Q) is the natural logarithm of localization/agglomeration.

Foreign MNCs are larger and have higher TFP, as well as better average input and market access measures, suggesting that they are located in much more central locations (Brussels and the Flemish Diamond[7]). Foreign MNCs tend to have more neighbours, both in the same economic class and in unrelated economic classes, while domestic MNCs tend to be younger and smaller than purely domestic firms.

The availability and coverage of the BELFIRST dataset is a strong reason for studying the case of Belgium. Nevertheless, we need to bear in mind the particular characteristics of the country being studied. Not only does Belgium have a very high population density (371 inhabitants per square km in 2014 compared to 35 and 145 inhabitants per square km in the USA and China respectively), along with the Netherlands it is very centrally located in the wealthy European economy. Benefits from industrial concentration in Belgium may potentially differ from other, large economies since Belgian firms have the potential to access a large number of consumers while benefiting from supply-side agglomeration. In section 4.3 in the Online Appendix we also investigate as a control[8] the multilingual and multicultural nature of Belgium.

3.2 Estimation strategy

Identification and Instrumental Variables Strategy

If we simply regress TFP on market access, input access *etc.*, estimates may be biased due to endogeneity of location decisions. For example, firms may choose location due to factors which are unobserved to the researchers, causing estimated coefficients to be biased, although we might mitigate this with control variables.

To tackle endogeneity, we employ an instrumental variables (IV) strategy that isolates variation in local market and input access plausibly orthogonal to unobserved productivity shocks. Following the "exogenous shifts" path in the shift–share literature, identification stems from as-good-as-random foreign shocks, while exposure shares are predetermined but need not be exogenous in levels (Adão et al., 2019; Borusyak et al., 2022).

[7]The prosperous area bounded by Brussels/Ghent/Antwerp and Leuven.
[8]c.f. Egger et al. (2013) for Switzerland

Formally, the instrument for municipality m at time t is:

$$Z_{mt} = \sum_{c} \sum_{i} \tilde{w}_{mci} \tilde{g}_{cit} \tag{6}$$

where $\tilde{g}_{cit}$ are residualised foreign gravity shocks (sector i, country c, time t) constructed from sectoral outcomes (output, value added, or wages) in neighboring economies.[9] Shocks are residualised for country-by-year and sector-by-year components to isolate idiosyncratic variation. The weights $\tilde{w}_{mci}$ are base year Belgian input–output exposure shares scaled by geographic frictions (distance), normalized to sum to one within each municipality m. Intuitively, a share-weighted average of many quasi-exogenous shocks is itself as-good-as-random provided no single shock dominates (Adão et al., 2019).

Exclusion requires that the residualized foreign shocks affect Belgian firm productivity only through the endogenous access and agglomeration variables. We take four steps to support this: (i) shock construction excludes Belgium and residualizes country-year and sector-year components; (ii) the second-stage always includes firm and year fixed effects (and province or industry dummies in OLS specifications), absorbing time-invariant firm heterogeneity and common macro shocks; (iii) for multinational affiliates, we implement a leave-parent-out variant that drops shocks from the parent's country of origin. We do not use distance-to-HQ or home-country entry frictions as instruments, since these may directly correlate with management quality or organizational practices (Bloom et al., 2012; De Beule et al., 2022); instead, we include them as controls, constructed in leave-one-out form to avoid mechanical correlation.

First-stage relevance is strong throughout (Kleibergen–Paap rk LM rejects underidentification; first-stage F-statistics are high). Overidentification tests do not reject the restrictions in IV specifications. Placebos yield similar second-stage estimates, as do donor sets that exclude geographically contiguous economies.

Production and agglomeration

We start with a theoretically-based regression specification

$$lnTFP_h = \widetilde{A} + \tilde{\beta}_1 \hat{M}A_h + \widetilde{\beta}_2 IA_h + \epsilon_i + \widetilde{\varepsilon}_{i,m}, \tag{7}$$

[9] We use the UK, the Netherlands, France, and Germany.

which includes a sector fixed effect term, where $lnTFP_h$ is TFP of the representative firm h . Eq.(7) provides the means to account for both input access and market access (or market potential) for firm h in municipality m.

We derive TFP by using a semi-parametric estimation technique proposed by Olley and Pakes (1996) (and alternatively by Levinsohn and Petrin (2003) and Ackerberg et al. (2015)), which deals well with issues of endogeneity and simultaneity.[10] The variable q_{ht} captures agglomeration externalities.[11]

We estimate the following equation:

$$lnTFP_{ht} = \beta_L q_{ht} + \beta_1 IA_h + \beta_2 MA_h + X'_{ht}\beta_x + \gamma_h + \gamma_t + \epsilon_{ht}. \tag{9}$$

We are particularly interested in the positive sign of β_L, which elucidates the reasons behind firms choosing dense regions. Additionally, positive signs for β_1 and β_2 are anticipated, aligning with the expectation that market access contributes positively to firm performance.

To explore the differential impact of agglomeration based on ownership, we apply equation (9) to sub-samples of domestic firms, domestic MNCs, foreign MNCs, and foreign MNCs with domestic participation. We also distinguish between single and multi-establishment firms. This nuanced approach enables us to fully capture the distinct characteristics of MNCs and discern how they respond to industrial concentration. We anticipate variations in the estimated coefficients across these groups, emphasizing the significance of ownership differences in shaping the impact of agglomeration on firms.

Near neighbour agglomeration

Marshall's (Marshall (1898)) classic work argues that agglomeration (or localization) economies are external to the firm, and are restricted to a given location. By contrast, more recent theories suggest that knowledge spillovers stemming from urban diversity may affect urban growth more than industry

[10] All approaches generate TFP distributions, which are highly correlated.

[11] We follow Holmes and Stevens (2002)'s definition:

$$q_{ht} = \frac{(E_{imt} - E_{himt})/(E_{mt} - E_{himt})}{(E_{it} - E_{himt})/(E_t - E_{himt})}. \tag{8}$$

Here, E_{imt}, E_{himt}, E_{mt}, E_{it} and E_t indicate total employees of industry i in municipality m, firm employment, total employment in m, total employment of industry i and total employment in year t respectively. The index captures benefits and spillovers from clustering of firms from the same industries, but excludes a firm's own employment. It accounts for whether industrial agglomeration in a municipality causes firms to be more productive.

specialization (urbanization economies), c.f. (Glaeser et al., 1992). This may be particularly true for foreign MNCs, since they might require local supply of professional services, especially following initial establishment, when they need to learn local market and policy conditions.

To take into account these possible effects, we consider the methodology of Holmes (1999), who proposes two measures of such externalities: i) total neighbour employment, in the same municipality as firm h and same 2-digit industry but different 5-digit industry classification ($neighbour_{ht}^{related}$); ii) total neighbour employment in the municipality but different 2-digit industry ($neighbour_{ht}^{other}$). The two measures are formalized as follows:

$$\begin{aligned} neighbour_{ht}^{related} &= E_{2digit,mt} - E_{5digit,mt} + 1; \\ neighbour_{ht}^{other} &= E_{mt} - E_{2digit,mt} + 1. \end{aligned} \tag{10}$$

E_{mt}, $E_{2digit,mt}$ and $E_{5digit,mt}$ represent total employment in m, total employment in the m and and same 2-digit industry and total employment in the m and same 5-digit industry in year t.[12]. To analyze the effects on firm TFP, we extend equation (9) a ccordingly. The inclusion of these measures allows us to pinpoint the effect of agglomeration externalities, considering potential variations driven by ownership disparities. If our localization externality, q_{ht}, exerts a substantial impact, the inclusion of measures of urbanization economies would not diminish its effect.

Ownership-related differences

Table (2) shows that foreign-owned MNCs average 3 times as many employees as local firms, have more capital per employee, pay a higher average wage and have 35% higher TFP. Belgian-owned MNCs are quite similar to other domestic firms, while foreign MNCs with Belgian participation seem broadly similar to other foreign MNCs. While we lack direct information on export by firm, Ito (2013) shows that MNCs in Belgium are highly export-driven.

[12] h's own employment is excluded,

Table 2: Comparative statistics

Sample means	Employees	Average wage	Capital per employee	ln TFP
Domestic	35.37	45559.64	419.68	2.89
Foreign MNCs	102.86	56869.41	677.15	3.19
Belgian MNCs	30.37	43983.03	269.46	2.92

4. Empirical results

4.1 Ownership differences: agglomeration, input and market access

Table 3 reports OLS estimates in columns 1–3 and 2SLS estimates in columns 4–5, addressing potential endogeneity of local agglomeration, input access, and market access Domestic firms are the omitted category throughout, and all OLS specifications include industry, province, and year effects, while the IV specifications include firm and year effects.

Column 1 shows a positive and precisely estimated association between within-municipality agglomeration and firm efficiency, with a coefficient of 0.286. This baseline result is consistent with classic evidence on localization economies and spatial externalities (Holmes and Stevens, 2002; Ahlfeldt et al., 2015).

Column 2 introduces ownership heterogeneity. Foreign MNCs exhibit a sizeable performance premium relative to Belgian-owned firms, about 23 percent, in line with Alfaro and Chen (2014) and Markusen and Venables (2000). At the same time, the agglomeration gradient is weaker for foreign MNCs: the baseline agglomeration effect is 0.195, while the foreign MNC interaction is negative and significant at 0.059. Domestic MNCs are not statistically different from domestic non-MNCs in their agglomeration response. These patterns suggest that proximity-based spillovers accrue more strongly to domestic firms, consistent with the idea that spatially mediated knowledge and network effects are more easily internalized locally (Glaeser et al., 1992).

Column 3 adds input and market access. The partial correlation of agglomeration attenuates to 0.124, as expected once broader access variables are controlled for. The foreign MNC differential in the agglomeration slope remains negative and statistically different from zero, though smaller in magnitude. Input access does not move the baseline domestic non-MNCs, but it raises foreign MNC performance significantly through the positive foreign MNC interaction (0.015), in line with the view that foreign affiliates leverage supplier depth and imported intermediate intensity (Helpman, 1984; Cantwell and Iammarino, 2000; Markusen et al., 2004). Market access is broadly beneficial for the baseline group (0.026) and is especially strong for domestic MNCs through an additional positive interaction, whereas the foreign MNC interaction is not statistically different from zero (Redding and Turner, 2015). This asymmetry suggests that demand-side access operates more through domestic firms, particularly larger domestic groups, while foreign MNCs rely less on local sales potential.

Columns 4 and 5 report 2SLS estimates to tackle endogeneity. Identification is strong and the instruments pass standard tests: the Kleibergen–Paap rk LM rejects underidentification, first-stage F-statistics are above 130, and Hansen J tests do not reject overidentifying restrictions (p-values between 0.56 and 0.68). In column 4, the baseline agglomeration coefficient rises markedly to 1.706. The slope is significantly flatter for MNCs, with a net effect of about 0.423 for foreign MNCs and a negative net effect for domestic MNCs. Input access turns strongly negative for the baseline group, while the interactions for both domestic and foreign MNCs nearly offset that baseline, leaving effects close to zero for MNCs. Market access displays a very large positive effect for domestic non-MNCs, which is again nearly neutralized for MNCs by large negative interactions. Taken together, the IV results indicate that once endogeneity is addressed, agglomeration and market access predominantly raise performance for domestic single-establishment firms, while MNCs' outcomes are less tied to local externalities and local demand.

Ownership differences: establishment type

Column 5 distinguishes single- and multi-establishment organizations. The baseline agglomeration effect remains large at 1.395, and multi-establishment firms enjoy small but statistically significant additional gains, with the largest increment for domestic MNC multi-plant groups (0.050). By contrast, input and market access exhibit sharp organizational heterogeneity: for single-plant firms, input access is strongly negative and market access strongly positive, whereas for any multi-establishment category the corresponding interactions almost fully offset these baseline slopes. The resulting pattern is that multi-plant firms, including foreign and domestic MNCs, are much less sensitive to local input and demand conditions, consistent with internal sourcing, networked production, and diversified market footprints.

These results reinforce three messages. First, agglomeration raises firm performance, but the gains are heterogeneous and accrue more to domestic than to foreign firms in OLS, and to domestic non-MNCs in the IV specifications. Second, in OLS foreign MNCs benefit relatively more from input-side depth than from proximity to local demand, whereas domestic MNCs mirror domestic firms' stronger link to market access; in IV, interactions largely neutralize both input and market access effects for MNCs, leaving small residuals. Third, organizational scope matters: multi-plant structures attenuate the role of local

Table 3: Ownership differences: agglomeration, Input and Market Access

	(1) OLS	(2) OLS	(3) OLS	(4) 2SLS	(5) 2SLS
Agglomeration	0.286***	0.195***	0.124**	1.706***	1.395***
	(0.051)	(0.050)	(0.050)	(0.568)	(0.476)
Agglomeration · Domestic MNCs Dummy		-0.003	0.009	-2.003***	
		(0.012)	(0.013)	(0.576)	
Agglomeration · Foreign MNCs Dummy		-0.059***	-0.031*	-1.283**	
		(0.015)	(0.017)	(0.571)	
Foreign MNCs Dummy		0.228***	0.173***		
		(0.024)	(0.027)		
Domestic MNCs Dummy		-0.004	-0.027		
		(0.019)	(0.021)		
Input Access			-0.001	-4.071***	-5.392***
			(0.003)	(1.511)	(1.443)
Market Access			0.026***	16.139***	20.878***
			(0.008)	(3.819)	(4.530)
Input Access · Foreign MNCs Dummy			0.015***	4.012***	
			(0.005)	(1.510)	
Market Access · Foreign MNCs Dummy			-0.014	-15.780***	
			(0.014)	(3.814)	
Input Access · Domestic MNCs Dummy			-0.005	4.028***	
			(0.005)	(1.511)	
Market Access · Domestic MNCs Dummy			0.026*	-15.970***	
			(0.014)	(3.815)	
Agglomeration · Foreign Multi-Estab. Dummy					0.035***
					(0.013)
Agglomeration · Domestic Multi-Estab. Dummy					0.012*
					(0.007)
Agglomeration · Domestic MNC Multi-Estab. Dummy					0.050***
					(0.018)
Input Access · Dom. MNCs Multi-Estab. Dummy					5.326***
					(1.443)
Market Access · Dom. MNCs Multi-Estab. Dummy					-20.557***
					(4.518)
Market Access · Foreign MNCs Multi-Estab. Dumm					-20.300***
					(4.517)
Input Access · Foreign MNCs Multi-Estab. Dummy					5.339***
					(1.443)
Market Access · Domestic Multi-Estab. Dummy					-20.618***
					(4.520)
Input Access · Domestic Multi-Estab. Dummy					5.353***
					(1.443)
Constant	1.918***	2.027***	2.104***		
	(0.198)	(0.197)	(0.198)		
Observations	239,205	239,205	239,205	239,205	239,205
R-squared	0.271	0.277	0.278		
Province Dummy	✓	✓	✓	-	-
Year FE	✓	✓	✓	✓	✓
Industry FE	✓	✓	✓	-	-
Firm FE	-	-	-	✓	✓
Number of id				33,176	33,176
KP rk LM statistic				10.69	31.01
First-stage F				130.78	136.90
Hansen J statistic				.340	.760
Hansen J p-value				.559	.683

Note: Clustered Robust standard errors at the municipality level in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$; The table presents the effect of agglomeration economies, input and market access on TFP (dependent variable in logarithms). We include time, industry and province dummies for OLS, and time and firm dummies for the other models. A set of firm-specific control variables are included, among which capital, employees, total assets, wages, age and current assets. Instruments used in 2SLS models include distance to HQ, start-up costs in the home country, and time and procedure to start a business in the home country.

input and demand access and slightly amplify the returns to agglomeration. The stronger input-side gains for foreign affiliates in OLS and the muted role of local demand for multi-plant firms are consistent with knowledge diffusion and sourcing through global supply chains (Marques et al., 2020). These findings show that both ownership and organizational form shape how firms convert place-based advantages into performance (Markusen, 1999; Head et al., 2010; Rodríguez-Pose and Burlina, 2021).

4.2 Neighbours and ownership differences

We investigate two effects: whether firms tend to be more affected by neighbours of the same economic activity as their own or alternatively by other unrelated economic activities and whether ownership differences matter; that is, localization externalities versus urbanization economies respectively (Holmes, 1999).

Table (4) reports the results of this specification, first not considering input and market access as endogenous, column 1, and then by using our IV approach, columns 2-3. Column 1 shows the point estimates of the fixed effect model.[13]

The positive and statistically significant impact of agglomeration on TFP aligns with the economic intuition that firms benefit from spatial proximity. This finding is consistent with Marshallian agglomeration economies (Marshall, 1898), where firms in close proximity experience cost reductions, knowledge spillovers, and enhanced productivity. The observed positive influence of agglomeration on TFP for foreign MNCs and the negative impact for domestic MNCs underscore the importance of considering ownership heterogeneity (Helpman et al., 2004). This aligns with previous research emphasizing that the benefits of spatial proximity may vary for different ownership structures (Markusen, 1999).

The varying impact of neighbouring effects on TFP, as indicated by the interaction terms with ownership dummies, resonates with the literature on spatial externalities (Fujita and Thisse, 1996). The positive effect for some ownership types and the negative for others suggest that the relationship between neighbouring firms and TFP is contingent on ownership structures. This aligns with the argument put forth by (Duranton and Puga, 2004), that the nature of interactions between neighbouring firms depends on specific contextual factors.

[13] First stage results are reported in Table **??**.

Table 4: Ownership differences: agglomeration, IA, MA and Urbanisation Economies

	(1) FE	(2) 2SLS	(3) 2SLS
Agglomeration	0.185**	0.191***	0.164***
	(0.044)	(0.011)	(0.030)
Agglomeration	0.115**	0.136	0.222
	(0.055)	(0.348)	(0.282)
neighbour^{rel}	0.005***	-0.101***	-0.094**
	(0.002)	(0.028)	(0.040)
neighbour^{other}	0.000	0.084*	0.073
	(0.003)	(0.043)	(0.051)
Input Access	0.005	-15.932***	-12.865*
	(0.009)	(4.331)	(6.650)
Market Access	0.008	18.285***	15.410**
	(0.009)	(4.327)	(6.387)
Agglomeration · Foreign Multi-Estab. Dummy			0.353*
			(0.208)
Agglomeration · Domestic Multi-Estab. Dummy			-0.057
			(0.049)
Agglomeration · Domestic MNC Multi-Estab. Dummy			-0.053
			(0.080)
Input Access · Dom. MNCs Multi-Estab. Dummy			1.335*
			(0.724)
Market Access · Dom. MNCs Multi-Estab. Dummy			-5.151**
			(2.196)
Market Access · Foreign MNCs Multi-Estab. Dumm			-1.410
			(1.237)
Input Access · Foreign MNCs Multi-Estab. Dummy			0.099
			(0.239)
Market Access · Domestic Multi-Estab. Dummy			-3.520**
			(1.546)
Input Access · Domestic Multi-Estab. Dummy			1.253*
			(0.648)
Agglomeration · Domestic MNCs Dummy	0.008		
	(0.010)		
Agglomeration · Foreign MNCs Dummy	0.005		
	(0.014)		
neighbour^{rel} · Domestic MNCs Dummy	-0.006**		
	(0.003)		
neighbour^{rel} · Foreign MNCs Dummy	-0.003		
	(0.003)		
neighbour^{other} · Domestic MNCs Dummy	-0.001		
	(0.002)		
neighbour^{other} · Foreign MNCs Dummy	0.015***		
	(0.003)		
Constant	2.109***		
	(0.200)		
Observations	239,205	239,205	239,205
Province Dummy	✓	-	-
Industry FE	✓	-	-
Year FE	✓	✓	✓
Firm FE	-	✓	✓
Number of id		33,176	33,176
Kleibergen-Paap rk LM statistic		21.369	6.037
First-stage F		91.896	65.836
Hansen J statistic		3.005	2.441
Hansen J p-value		.100	.118

Note: Clustered Robust standard errors at the municipality level in parentheses. *** p<0.01, ** p<0.05, * p<0.1; The table presents the effect of agglomeration economies, input and market access on TFP (dependent variable in logarithms). We include time, industry and province dummies for OLS, and time and firm dummies for the other models. A set of firm-specific control variables are included, among which capital, employees, total assets, wages, age and current assets.

The significant influence of input access and market access on TFP is consistent with existing literature highlighting the importance of considering both input and market-related factors in explaining regional productivity differences (Ellison and Glaeser, 1997). The positive coefficients indicate that firms with better access to inputs and markets tend to exhibit higher TFP. The differential impact of access variables for foreign MNCs and domestic MNCs underscores the importance of ownership-specific strategies and capabilities (Acs et al., 2009).

Establishment type and urban diversity

Table (4) shows that both groups benefit from industrial clustering, but with greater magnitudes for domestic multi-location firms; see Column(3). On the other hand, the point estimates suggest strong differences between single- and multi-establishment firms, depending also on the ownership status, suggesting that urban diversity might have some important implications in driving industrial clustering, depending on firms' establishment type and ownership status.

The results from multi-establishment dummies align with the literature on firm heterogeneity Bernard and Jensen (1999), indicating that the number of establishments a firm has in a region influences TFP differently based on ownership type. This finding contributes to the understanding of how the strategic decisions of multi-establishment firms play a crucial role in shaping regional economic outcomes (Baldwin and Forslid, 2000).

We investigate whether firms are more affected by neighbors in the same activity or by unrelated activities, and whether these effects vary by ownership, that is, localization versus urbanization economies in the spirit of Holmes (1999).

Table 4 reports a fixed-effects specification in column 1 and 2SLS specifications in columns 2–3. Column 1 treats input and market access as exogenous and includes province, industry, and year effects. Columns 2–3 implement our IV strategy and include firm and year effects. Instrument diagnostics indicate strong relevance and no evidence against overidentifying restrictions at conventional levels: first-stage F-statistics are about 92 and 66, and Hansen J p-values are 0.10 and 0.12.

Column 1 highlights that agglomeration is positively associated with TFP, and the agglomeration term is also positive and statistically distinct from zero, consistent with Marshallian localization forces

(Marshall, 1898). By contrast, input and market access are small and not statistically different from zero in this FE specification. The urbanization channels, the intensity of related neighbors is positively associated with TFP, whereas unrelated neighbors are neutral on average. Ownership heterogeneity shows up in these neighborhood effects rather than in the agglomeration slope: the agglomeration interactions with domestic and foreign MNC dummies are small and imprecisely estimated. In contrast, domestic MNCs benefit less from related neighbors than comparable domestic firms, while foreign MNCs benefit more from unrelated neighbors. This pattern is in line with the idea that the composition of nearby activity differentially shapes externalities across ownership types (Fujita and Thisse, 1996; Duranton and Puga, 2004).

Column 2 accounts for the endogeneity of access variables leaves the core agglomeration result intact and precisely estimated. Input access turns strongly negative, while market access becomes strongly positive (Donaldson, 2018; Heblich et al., 2020b). The additional agglomeration term is imprecisely estimated. The neighborhood composition results reverse relative to column 1: related neighbors are negatively associated with TFP, while unrelated neighbors are beneficial, albeit less precisely estimated. Once endogeneity is addressed, specialization in neighboring areas appears to capture congestion or business-stealing forces, while unrelated diversity supports cross-industry complementarities.

In Column 3, the baseline effects remain robust: agglomeration is positive, input access is negative, and market access is positive. The related-neighbor effect stays negative. Organizational scope matters. Foreign multi-establishment firms exhibit an additional agglomeration gain, whereas the corresponding increments for domestic multi-establishment and domestic MNC multi-establishment firms are not distinct from zero. For access variables, domestic multi-establishment groups partially offset the negative baseline slope on input access and dampen the positive baseline effect of market access through negative interactions. The foreign MNC multi-establishment interactions with access variables are not statistically different from zero. Overall, multi-plant structures reduce sensitivity to local input scarcity and local demand, consistent with internal sourcing, networked production, and diversified market footprints (Alfaro-Urena et al., 2022b).

Establishment type and urban diversity. Column 3 indicates that the incremental payoff to agglomeration is strongest for foreign multi-establishment firms, while domestic multi-establishment groups chiefly moderate the effects of access variables. The neighborhood composition results point to urbanization economies operating more through unrelated diversity once endogeneity is addressed, with related-neighbor intensity associated with lower productivity under IV. These findings suggest that both ownership and organizational scope shape how firms translate local externalities and access conditions into performance (Ellison and Glaeser, 1997; Markusen, 1999; Duranton and Puga, 2004).

4.3 Language effects

To examine the hypothesis that language diversity might have some implications for global value chain flows between firms (Egger et al., 2013), we analyse whether accounting for a common language affects our results. Table (5) reports the resulting estimates of language, agglomeration effect, input and market access on firms' TFP.

The positive coefficients associated with agglomeration in all model specifications underscore the pervasive benefits of spatial concentration consistent with economic theory. This resonates with seminal works highlighting the positive impact of agglomeration on economic activities (Ellison and Glaeser, 1997; Redding and Venables, 2004; Ellison and Glaeser, 1999; Duranton and Puga, 2004).
Overall, firms in German speaking municipalities do not show higher productivity with respect to firms of similar characteristics in French speaking municipalities (column 1). However, compared to foreign MNCs, domestic firms and domestic MNCs tend to exploit higher gains in Dutch and French speaking municipalities. The positive coefficients of language dummies, especially Dutch and German, underscore the role of language-based externalities in enhancing TFP. These results resonate with studies on language-based externalities and the impact of language on economic activities (Van Meeteren et al., 2016; Egger and Lassmann, 2012, 2015; Melitz, 2008). The language dummies introduce a cultural and linguistic layer to the discussion. Positive coefficients for Dutch and German languages affirm the productivity gains associated with a shared language. This aligns with economic geography theories that highlight the role of language as a conduit of knowledge exchange within spatially concentrated regions. The spatial dimensions of language effects resonate with the foundational principles of both economic geography and international business, where proximity and shared language foster collaboration and innovation (Head and Mayer, 2014).

Table 5: Ownership differences: Language and Cross Border Effect

	Language Effect		Border Effect			
	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	OLS	OLS	OLS	OLS	OLS	OLS
Agglomeration	0.102***	0.161***	0.077***	0.069**	0.158***	0.150***
	(0.028)	(0.028)	(0.028)	(0.028)	(0.028)	(0.028)
Agglomeration · Domestic MNCs Dummy	-0.001		0.006	0.007		
	(0.010)		(0.006)	(0.006)		
Agglomeration · Foreign MNCs Dummy	-0.078***		-0.033***	-0.032***		
	(0.011)		(0.008)	(0.008)		
Foreign MNCs Dummy	0.485***		0.176***	0.175***		
	(0.052)		(0.013)	(0.013)		
Domestic MNCs Dummy	-0.093**		-0.021**	-0.023**		
	(0.039)		(0.010)	(0.010)		
Input Access	-0.001		-0.001	-0.001	0.007***	
	(0.001)		(0.001)	(0.001)	(0.001)	
Market Access	0.031***		0.028***	0.027***	0.027***	
	(0.004)		(0.004)	(0.004)	(0.003)	
Input Access · Foreign MNCs Dummy	0.015***		0.015***	0.015***		
	(0.002)		(0.002)	(0.002)		
Market Access · Foreign MNCs Dummy	-0.022***		-0.016**	-0.016**		
	(0.007)		(0.006)	(0.006)		
Input Access · Domestic MNCs Dummy	-0.005**		-0.005**	-0.005**		
	(0.002)		(0.002)	(0.002)		
Market Access · Domestic MNCs Dummy	0.024***		0.025***	0.025***		
	(0.007)		(0.006)	(0.006)		
Language: Dutch Dummy	0.036***	0.019**				
	(0.010)	(0.009)				
Language: German Dummy	0.056***	-0.017				
	(0.021)	(0.019)				
Foreign Dummy·Dutch Dummy	-0.255***					
	(0.047)					
Foreign Dummy·French Dummy	-0.205***					
	(0.047)					
Domestic MNCs Dummy·Dutch Dummy	0.080**					
	(0.033)					
Domestic MNCs Dummy·French Dummy	0.088***					
	(0.032)					
Lille			0.326**		0.219	
			(0.163)		(0.163)	
Aachen			0.275		0.249	
			(0.269)		(0.273)	
Luxembourg			1.268		1.160	
			(0.775)		(0.774)	
Calais				6.816***		7.361***
				(1.122)		(1.119)
Rotterdam				5.558***		6.009***
				(1.050)		(1.051)
Eindhoven				-1.985***		-2.161***
				(0.331)		(0.331)
Agglomeration · Foreign Multi-Estab. Dummy		-0.001			-0.002	-0.002
		(0.003)			(0.003)	(0.003)
Agglomeration · Domestic Multi-Estab. Dummy		-0.006***			-0.006***	-0.005***
		(0.002)			(0.002)	(0.002)
Agglomeration · Domestic MNC Multi-Estab. Dummy		0.004			-0.009***	0.000
		(0.004)			(0.001)	(0.004)
Domestic MNCs Multi-Estab. Dummy		-0.079				-0.067**
		(0.049)				(0.027)
Foreign MNCs Multi-Estab. Dummy		0.188***			-0.075***	-0.077***
		(0.070)			(0.022)	(0.022)
Domestic Multi-Estab. Dummy		0.105***			-0.057***	-0.061***
		(0.037)			(0.013)	(0.013)
Input Access · Dom. MNCs Multi-Estab. Dummy		0.006				
		(0.005)				
Market Access · Dom. MNCs Multi-Estab. Dummy		-0.040***				
		(0.014)				
Market Access · Foreign MNCs Multi-Estab. Dumm		0.018*			0.019**	0.019**
		(0.010)			(0.009)	(0.009)
Input Access · Foreign MNCs Multi-Estab. Dummy		-0.008**			-0.009**	-0.009**
		(0.003)			(0.003)	(0.003)
Market Access · Domestic Multi-Estab. Dummy		-0.003			-0.002	-0.002
		(0.007)			(0.007)	(0.007)
Input Access · Domestic Multi-Estab. Dummy		-0.010***			-0.011***	-0.011***
		(0.003)			(0.003)	(0.003)
Foreign MNCs Multi-Estab. Dummy·Dutch Dummy		-0.270***				
		(0.067)				
Foreign MNCs Multi-Estab. Dummy·French Dummy		-0.268***				
		(0.068)				
Domestic MNCs Multi-Estab. Dummy·Dutch Dummy		-0.010				
		(0.042)				
Domestic MNCs Multi-Estab. Dummy·French Dummy		0.008				
		(0.042)				
Domestic Multi-Estab. Dummy·Dutch Dummy		-0.156***				
		(0.035)				
Domestic Multi-Estab. Dummy·French Dummy		-0.171***				
		(0.035)				
Observations	241,187	241,187	241,187	241,187	241,187	241,187
R-squared	0.274	0.272	0.274	0.274	0.271	0.272

Note: Clustered robust standard errors at the municipality in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$; The table presents the effect of agglomeration economies, input and market access, language and borders effect on TFP (dependent variable in logarithms) . We include time, industry-province pair fixed effect. A set of firm specific control variable are included in each model, which include capital, employees, total assets, wages, age and current assets.

The positive coefficients associated with the interaction terms involving Dutch and French language dummies highlight that, for multi-establishment firms, operating in regions where Dutch or French is spoken is associated with increased TFP. This suggests that linguistic commonality across multiple locations might facilitate knowledge transfer and coordination within the firm. On the other hand, the negative coefficient on the interaction term between foreign MNCs dummy and Dutch dummy suggests that the positive effect of being a foreign multinational corporation on TFP is attenuated in regions where Dutch is spoken. This could reflect challenges faced by foreign multinationals in leveraging linguistic synergies in regions with a distinct language (e.g., liability of foreignness as discussed by Goerzen et al. (2013)).

4.4 Cross-border effects

(Crozet et al., 2004) emphasise the tendency of MNCs to make their first foreign investment near their home country's border, in the case of France. Moreover, (Egger et al., 2013) shows that a common language with border countries increases the likelihood of trading.

To analyse the effect of foreign border towns on firm productivity we extend eq.(9) to take into account six main industrial cities just outside Belgium: Lille, Calais, Rotterdam, Eindhoven, Aachen and Luxembourg. We consider the cross-border effect as a smooth change in distance (Boschma, 2005) rather than a discontinuous effect that vanishes at the national frontier (Beugelsdijk and Mudambi, 2013). (Disdier and Head, 2008) estimate a mean distance effect of about 0.91 and the median is 0.87, with 1,466 estimates over 103 papers where the distance effect highlights the elasticity of bilateral trade with respect to distance. Hence, on average bilateral trade is nearly inversely proportionate to distance. Thus, it is reasonable to verify whether borders affect firms' performance given the relatively small open economy under consideration. Indeed, we may expect that these effects differ significantly by firm type. Many Belgian locations share a common language with the neighbouring country, which may reduce the effect of national borders.

We first take into account the closest cities around the border and then the relatively far away ones. The border effect variables in Table (5) delve into the impact of spatial borders on TFP. Specifically, the coefficients associated with the interaction terms between agglomeration and foreign MNCs dummy, domestic MNCs dummy, and foreign dummy offer insights into how firm ownership and the foreign-domestic dynamic intersect with spatial borders. The negative coefficient for foreign MNCs dummy suggests that, in the presence of foreign multinational corporations, the positive effect of agglomeration on TFP is attenuated. This may reflect the challenges faced by foreign firms in navigating and integrating into the local business environment hinting at potential barriers associated with cultural and institutional differences; this is a clear evidence of the liability of foreignness described by Goerzen et al. (2013). The spatial border dynamics manifest in the interaction terms emphasizing the relevance of economic geography in understanding how spatial boundaries can alter the impact of agglomeration economies, particularly for foreign firms operating in a different cultural and institutional context.

The inclusion of specific regions, such as Lille, Aachen, and others, introduces a geospatial context to the analysis. Regional coefficients showcase the diverse impact of language and border effects across different locations. This resonates with the regional science perspective, highlighting the spatial variability in economic phenomena. Acknowledging regional variations underscores the importance of the spatial configuration of economic activities within regions and the unique challenges and opportunities they present (Anselin et al., 1997).

The varying impacts of language and cross-border effects on multi-establishment firms highlight the need for a geographically tailored approach to managing and fostering the growth of these firms. Understanding how linguistic and spatial factors interact within the organizational structure provides valuable insights for policymakers and businesses aiming to optimize the performance of multi-establishment operations.

5. Robustness checks

5.1 Potential endogeneity of agglomeration

As discussed in Section 3.2, firms may choose locations in response to expected productivity, raising concerns about reverse causality. We address this by restricting to firms whose sites were chosen before the sample period (2005) and by measuring agglomeration at t-1. Table (6) replicates the main specifications on this sample, with columns 1–3 estimated by OLS and columns 4–5 by 2SLS.[14]

In OLS (columns 1–3), the agglomeration coefficient remains positive and attenuates as controls are

[14] First-stage results diagnostics indicate relevance and validity: the Kleibergen–Paap rk LM statistics are 37.1 and 7.5; first-stage F-statistics are about 60; Hansen J p-values are 0.34 and 0.44.

added. The agglomeration slope is flatter for foreign MNCs, while domestic MNCs are not meaningfully different from domestic firms. Market access remains positive, input access is negligible on average, and foreign MNCs display a stronger association with input access. In 2SLS without establishment scope (column 4), the baseline agglomeration effect is positive (0.373), input access turns negative and market access is positive for domestic non-MNCs; interactions for both MNC types largely offset these baselines, yielding small net access effects for MNCs. In 2SLS with establishment scope (column 5), the baseline agglomeration coefficient is turns to be statistically insignificant, but incremental agglomeration gains for multi-establishment firms are positive and statistically detectable, largest for domestic MNC multi-plant groups.

That is, agglomeration gains persist; domestic MNCs have a markedly flatter agglomeration gradi-ent, whereas foreign MNCs are not statistically different from the baseline. For access variables, large baseline effects are concentrated in domestic non-MNCs; for both MNC types, the significant interactions nearly fully offset these baselines, leaving small net responses.

5.2 Alternative IVs

Belgium is a small open economy strongly affected by demand and cost shocks in neighboring countries. To exploit this, we build gravity-type foreign indices that map sectoral activity abroad into Belgian exposure using pre-sample input–output links and geography:

$$G_{mct} = \sum_{i} b_{i'i} \frac{Y_{cit}}{\Delta_{mc}} \tag{11}$$

where $b_{i'i}$ are base (pre-sample) Belgian input–output shares linking Belgian sector i' to foreign sector i, Y_{cit} is sectoral activity (output, value added, wages/compensation) in country c, and Δ_{mc} is the distance between municipality m and country c. We use these gravity indices as an alternative instrument set (EU neighbors), and in a separate specification, employ an EU-only instrument. Conceptually, both

[15] We also re-estimate the models under alternative donor configurations, including pairwise and triple-country combinations, equal-weighted versus size-weighted shocks, and a pooled foreign-shock measure. Across these exercises, the coefficients on agglomeration, input access, and market access are qualitatively unchanged and statistically indistinguishable at conventional levels, and first-stage strength remains high.

Table 6: Ownership differences: agglomeration, with Exogenous Firms' Location

	(1) OLS	(2) OLS	(3) OLS	(4) 2SLS	(5) 2SLS
$Agglomeration_{t-1}$	0.356***	0.236***	0.146**	0.373**	1.375
	(0.063)	(0.062)	(0.062)	(0.181)	(1.196)
Agglomeration · Domestic MNCs Dummy		-0.001	0.009	-0.352***	
		(0.012)	(0.013)	(0.111)	
Agglomeration · Foreign MNCs Dummy		-0.059***	-0.033*	-0.085	
		(0.016)	(0.017)	(0.153)	
Foreign MNCs Dummy		0.233***	0.183***		
		(0.025)	(0.028)		
Domestic MNCs Dummy		-0.003	-0.023		
		(0.020)	(0.022)		
Input Access			-0.001	-2.920**	-9.737
			(0.003)	(1.451)	(9.061)
Market Access			0.028***	12.111***	36.431
			(0.009)	(3.793)	(30.429)
Input Access · Foreign MNCs Dummy			0.017***	2.883**	
			(0.005)	(1.449)	
Market Access · Foreign MNCs Dummy			-0.021	-11.829***	
			(0.015)	(3.779)	
Input Access · Domestic MNCs Dummy			-0.003	2.890**	
			(0.005)	(1.451)	
Market Access · Domestic MNCs Dummy			0.020	-11.962***	
			(0.014)	(3.790)	
Agglomeration · Foreign Multi-Estab. Dummy					0.034**
					(0.017)
Agglomeration · Domestic Multi-Estab. Dummy					0.012**
					(0.006)
Agglomeration · Domestic MNC Multi-Estab. Dummy					0.064***
					(0.024)
Input Access · Dom. MNCs Multi-Estab. Dummy					9.661
					(9.027)
Market Access · Dom. MNCs Multi-Estab. Dummy					-35.972
					(30.254)
Market Access · Foreign MNCs Multi-Estab. Dumm					-35.805
					(30.265)
Input Access · Foreign MNCs Multi-Estab. Dummy					9.691
					(9.044)
Market Access · Domestic Multi-Estab. Dummy					-36.163
					(30.353)
Input Access · Domestic Multi-Estab. Dummy					9.699
					(9.049)
Constant	1.942***	2.071***	2.163***		
	(0.208)	(0.206)	(0.208)		
Observations	198,288	198,288	198,288	196,018	196,018
R-squared	0.283	0.289	0.290	-3.534	-35.878
Province Dummy	✓	✓	✓	-	-
Year FE	✓	✓	✓	✓	✓
Industry FE	✓	✓	✓	-	-
Firm FE	-	-	-	✓	✓
Number of id				30,472	30,472
Kleibergen-Paap rk LM statistic				37.062	7.483
First-stage F				60.447	60.405
Hansen J statistic				.8937	.595
Hansen J p-value				.344	.440

Note: Clustered Robust standard errors at the municipality level in parentheses. *** p<0.01, ** p<0.05, * p<0.1; The table presents the effect of agglomeration economies, input and market access on TFP (dependent variable in logarithms). We include time, industry and province dummies for OLS, and time and firm dummies for the other models. A set of firm-specific control variable are included, among which capital, employees, total assets, wages, age and current assets. Here, we select only those that have at least 7 years of observed data in a particular municipality. Instruments used in 2SLS models include distance to HQ, start-up costs in the home country, and time and procedure to start a business in the home country.

approaches exploit foreign sector–country shocks weighted by Belgian exposure and geography.[15] Given distinct macro and regulatory environments across countries, these foreign shocks provide rel-evant and plausibly exogenous variation for Belgian access measures. Table 7 reports the corresponding IV results: market access and input access remain consistent and statistically significant, with differences across ownership types.

A potential concern is that EU members share policy or monetary shocks. As a further check, we therefore use a UK-only instrument set outside the euro area during our sample as our baseline specification. Estimated overidentification tests support exogeneity. First-stage strength remains high, and the Hansen J test and p-values confirm inference.

5.3 Adding local variables

To consider potential location-level shocks, such as infrastructure investments, which might benefit firms regardless of industry, e.g., local skill distribution and health. We run our baseline specification by including additional control variables such as percentage of individuals with higher (low) education, median income, mortality rate and number of patients per GP. These variables control for skill set shocks (e.g. employment) as well as health conditions and infrastructure facilities in a given municipality.[16] The results are reported in Table 8.

5.4 Manufacturing vs services

As highlighted by recent work on sectoral heterogeneity in externalities (e.g.,Diodato et al. (2018)), agglomeration forces can differ sharply across activities. Table 9 estimates our preferred 2SLS specifications separately for manufacturing (columns 1–2) and services (columns 3–4), and then allows for multi-establishment heterogeneity in columns 2 and 4.

[16] We run other specifications where we also include the number of tourists statistics as well as the crime rates. The results remain consistent with the baseline, despite the number of observations dropping due to missing values for some municipalities.

Table 7: Baseline: gravity instruments

	EU Gravity		UK Gravity	
	(1)	(2)	(3)	(4)
VARIABLES	2SLS	2SLS	2SLS	2SLS
Agglomeration	1.673***	1.222***	1.445***	1.429***
	(0.566)	(0.431)	(0.488)	(0.503)
Input Access	-3.645***	-2.958***	-3.805**	-5.751***
	(0.683)	(0.572)	(1.738)	(1.773)
Market Access	15.161***	15.138***	14.359***	21.788***
	(1.894)	(3.052)	(4.641)	(5.542)
Agglomeration · Foreign Multi-Estab. Dummy		0.034***		0.036***
		(0.013)		(0.013)
Agglomeration · Domestic Multi-Estab. Dummy		0.011*		0.012*
		(0.007)		(0.007)
Agglomeration · Domestic MNC Multi-Estab. Dummy		0.047***		0.051***
		(0.017)		(0.018)
Input Access · Dom. MNCs Multi-Estab. Dummy		2.893***		5.685***
		(0.572)		(1.771)
Market Access · Dom. MNCs Multi-Estab. Dummy		-14.829***		-21.465***
		(3.043)		(5.527)
Market Access · Foreign MNCs Multi-Estab. Dumm		-14.573***		-21.208***
		(3.043)		(5.527)
Input Access · Foreign MNCs Multi-Estab. Dummy		2.907***		5.699***
		(0.572)		(1.771)
Market Access · Domestic Multi-Estab. Dummy		-14.887***		-21.526***
		(3.043)		(5.530)
Input Access · Domestic Multi-Estab. Dummy		2.920***		5.712***
		(0.571)		(1.772)
Agglomeration · Domestic MNCs Dummy	-1.968***		-1.703***	
	(0.574)		(0.502)	
Agglomeration · Foreign MNCs Dummy	-1.254**		-1.045**	
	(0.569)		(0.491)	
Input Access · Foreign MNCs Dummy	3.586***		3.748**	
	(0.683)		(1.737)	
Market Access · Foreign MNCs Dummy	-14.803***		-14.005***	
	(1.891)		(4.635)	
Input Access · Domestic MNCs Dummy	3.602***		3.763**	
	(0.683)		(1.737)	
Market Access · Domestic MNCs Dummy	-14.993***		-14.195***	
	(1.892)		(4.635)	
Observations	239,205	239,205	239,205	239,205
Number of id	33,176	33,176	33,176	33,176
Year FE	✓	✓	✓	✓
Firm FE	✓	✓	✓	✓
Kleibergen-Paap rk LM statistic	167.790	74.979	33.396	26.630
First-stage F	101.466	101.680	67.391	75.648
Hansen J statistic	3.809	4.701	1.631	.702
Hansen J p-value	.282	.195	.201	.402

Note: Clustered Robust standard errors at the municipality level in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$; The table presents the effect of agglomeration economies, input and market access on TFP (dependent variable in logarithms). We include time, industry and province dummies for OLS, and time and firm dummies for the other models. A set of firm-specific control variables are included, among which capital, employees, total assets, wages, age and current assets. The table uses EU and the UK gravity indices as instruments as alternative specifications.

Table 8: Baseline: adding local variables

VARIABLES	(1) OLS	(2) OLS	(3) OLS	(4) 2SLS	(5) 2SLS
Agglomeration	0.233***	0.148*	0.063	0.352***	0.197***
	(0.088)	(0.078)	(0.070)	(0.0526)	(0.032)
Agglomeration · Domestic MNCs Dummy		-0.004	0.008	-0.937***	
		(0.012)	(0.013)	(0.278)	
Agglomeration · Foreign MNCs Dummy		-0.057***	-0.031	-0.242	
		(0.019)	(0.019)	(0.281)	
Foreign MNCs Dummy		0.222***	0.173***		
		(0.030)	(0.030)		
Domestic MNCs Dummy		-0.003	-0.025		
		(0.020)	(0.022)		
Input Access			-0.002	-2.598***	-1.878***
			(0.003)	(0.622)	(0.706)
Market Access			0.031***	11.774***	11.640***
			(0.010)	(1.733)	(2.999)
Input Access · Foreign MNCs Dummy			0.016***	2.519***	
			(0.005)	(0.621)	
Market Access · Foreign MNCs Dummy			-0.017	-11.332***	
			(0.018)	(1.730)	
Input Access · Domestic MNCs Dummy			-0.002	2.558***	
			(0.006)	(0.622)	
Market Access · Domestic MNCs Dummy			0.018	-11.593***	
			(0.016)	(1.731)	
Agglomeration · Foreign Multi-Estab. Dummy					0.031*
					(0.018)
Agglomeration · Domestic Multi-Estab. Dummy					0.032***
					(0.012)
Agglomeration · Domestic MNC Multi-Estab. Dummy					0.082***
					(0.029)
Input Access · Dom. MNCs Multi-Estab. Dummy					1.815**
					(0.708)
Market Access · Dom. MNCs Multi-Estab. Dummy					-11.355***
					(2.994)
Market Access · Foreign MNCs Multi-Estab. Dumm					-10.981***
					(2.989)
Input Access · Foreign MNCs Multi-Estab. Dummy					1.805**
					(0.708)
Market Access · Domestic Multi-Estab. Dummy					-11.356***
					(2.985)
Input Access · Domestic Multi-Estab. Dummy					1.825***
					(0.705)
Constant	2.194***	2.291***	2.347***		
	(0.238)	(0.229)	(0.229)		
Observations	233,621	207,610	233,621	233,591	233,591
R-squared	0.273	0.278	0.280		
Province Dummy	✓	✓	✓	-	-
Year FE	✓	✓	✓	✓	✓
Industry FE	✓	✓	✓	-	-
Firm FE	-	-	-	✓	✓
Number of id				32,510	32,510
Kleibergen-Paap rk LM statistic				72.218	11.918
First-stage F				68.086	36.392
Hansen J statistic				4.643	2.210
Hansen J p-value				.100	.331

Note: Clustered Robust standard errors at the municipality level in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$; The table presents the effect of agglomeration economies, input and market access on TFP (dependent variable in logarithms). We include time, industry and province dummies for OLS, and time and firm dummies for the other models. A set of firm-specific control variables are included, among which capital, employees, total assets, wages, age and current assets. The table includes additional local variables at the municipality level: e.g. percentage of individuals with higher (low) education, median income, mortality rate and number of patients per GP.

The agglomeration coefficient for manufacturing firms is small and imprecise in column 1 and remains imprecisely estimated once multi-establishment interactions are introduced in column 2. By contrast, input access is positively associated with productivity in column 1, while market access is negative. Ownership interactions indicate that these access responses are concentrated among domestic non-MNC manufacturers: the input-access premium for the baseline group is largely neutralized for both domestic and foreign MNCs, and the negative market-access slope for the baseline is offset for MNCs. With establishment-scope interactions in column 2, the access coefficients and their interactions become too imprecise to sustain inference beyond a small additional agglomeration increment for foreign multi-establishment manufacturers.

On the other hand, Services agglomeration is strongly positive in column 3 and remains positive in column 4, consistent with knowledge-based mechanisms that raise productivity in large, dense labor markets and with the specialization of cities in tasks intensive in information and coordination (Roca and Puga, 2017; Davis and Dingel, 2020). Market access is robustly positive in both specifications, in line with evidence that metropolitan accessibility is a key driver of urban productivity and city formation (Heblich et al., 2020a). Input access is near zero in column 3 but turns negative for single-plant firms in column 4 once establishment scope is considered. Organizational scope is a key mediator of access sensitivities: the negative baseline slope on input access for single-plant service firms is almost exactly offset by positive interactions for all multi-establishment categories, and the large positive baseline market-access effect is almost fully neutralized by negative interactions for multi-establishment firms. In column 3, MNC ownership also attenuates the agglomeration and market-access responses for services, consistent with foreign-affiliate networks and firm-to-firm linkages that reduce dependence on local input and demand conditions (Alfaro-Urena et al., 2022a).

The 2SLS evidence points to a clear sectoral asymmetry. Agglomeration premia are a service-sector phenomenon in our setting, while manufacturing performance is shaped more by input depth and, if anything, is adversely related to market access for single-plant domestic firms. Organizational scope and MNC ownership systematically dampen sensitivity to local input and demand conditions, consistent with internal sourcing, networked production, and diversified market footprints (Alfaro-Urena et al., 2022a; Heblich et al., 2020a).

Table 9: Manufacturing vs Services Firms

	Manufacturing		Services	
	(1)	(2)	(3)	(4)
VARIABLES	2SLS	2SLS	2SLS	2SLS
Agglomeration	-0.119	-2.564	1.057***	0.698**
	(0.428)	(5.502)	(0.333)	(0.312)
Input Access	3.159***	22.114	-0.732	-4.207***
	(1.122)	(30.171)	(0.736)	(0.962)
Market Access	-3.488**	-42.529	7.412***	14.869***
	(1.558)	(62.070)	(1.880)	(2.520)
Agglomeration · Foreign Multi-Estab. Dummy		0.043**		0.016
		(0.022)		(0.015)
Agglomeration · Domestic Multi-Estab. Dummy		0.033		0.011
		(0.032)		(0.007)
Agglomeration · Domestic MNC Multi-Estab. Dummy		0.055		0.062***
		(0.106)		(0.019)
Input Access · Dom. MNCs Multi-Estab. Dummy		-22.041		4.181***
		(30.030)		(0.962)
Market Access · Dom. MNCs Multi-Estab. Dummy		42.726		-14.662***
		(61.713)		(2.520)
Market Access · Foreign MNCs Multi-Estab. Dumm		43.173		-14.565***
		(61.985)		(2.516)
Input Access · Foreign MNCs Multi-Estab. Dummy		-22.211		4.213***
		(30.260)		(0.962)
Market Access · Domestic Multi-Estab. Dummy		42.449		-14.627***
		(61.799)		(2.517)
Input Access · Domestic Multi-Estab. Dummy		-21.930		4.170***
		(30.075)		(0.962)
Agglomeration · Domestic MNCs Dummy	-0.067		-1.325***	
	(0.461)		(0.346)	
Agglomeration · Foreign MNCs Dummy	0.260		-0.649*	
	(0.468)		(0.354)	
Input Access · Foreign MNCs Dummy	-3.152***		0.698	
	(1.125)		(0.736)	
Market Access · Foreign MNCs Dummy	3.827**		-7.178***	
	(1.559)		(1.878)	
Input Access · Domestic MNCs Dummy	-3.231***		0.720	
	(1.123)		(0.736)	
Market Access · Domestic MNCs Dummy	3.758**		-7.341***	
	(1.557)		(1.879)	
Observations	40,567	40,567	159,472	159,472
Number of id	5,248	5,248	22,353	22,353
Year FE	✓	✓	✓	✓
Firm FE	✓	✓	✓	✓
Kleibergen-Paap rk LM statistic	12.778	5.601	13.287	77.255
First-stage F	61.52	49.92	77.04	85.10
Hansen J statistic	1.121	1.658	1.646	1.081
Hansen J p-value	.848	.436	.151	.582

Note: Clustered Robust standard errors at the municipality level in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$; The table presents the effect of agglomeration economies, input and market access on TFP (dependent variable in logarithms). We include time, industry and province dummies for OLS, and time and firm dummies for the other models. A set of firm-specific control variables are included, among which capital, employees, total assets, wages, age and current assets. The table includes a distinction between manufacturing firms and services.

5.5 Using alternative Input-Output tables

Employing an I-O table from a year posterior to the analyzed period could lead to potential endogeneity issues, especially when some regressors are based on future values. To address this, the utilization of an alternative 2005 I-O table is proposed, allowing for an assessment of the robustness of our findings. Remarkably, the results in Table 10 from the alternative specification using the 2005 I-O table exhibit consistency with the baseline model. The key variables such as agglomeration, input access, and market access retain their expected signs and statistical significance across OLS and 2SLS estimations. This consistency provides confidence in the robustness of our baseline results.

The positive and significant coefficient of agglomeration in all models reaffirms its role in influencing TFP. This suggests that the concentration of economic activities in specific geographic locations contin-ues to be a driver of enhanced firm productivity. The nuanced effects of ownership and establishment characteristics persist in the alternative specification. Notably, the interactions of agglomeration with do-mestic and foreign MNCs, as well as multi-establishment dummy. Dummies, maintain their significance, emphasizing the importance of considering these distinctions in understanding agglomeration dynamics. As a robustness check, we recompute input and market access with the 2010 input–output table and re-estimate the main specifications. Table 10 reports OLS in columns 1 and 2SLS in columns 2–3 (with firm and year effects). Instrument diagnostics indicate relevance and validity: the Kleibergen–Paap rk LM statistics are 13.7 and 25.6, first-stage F-statistics are 84.2 and 72.3, and Hansen J p-values are 0.11 and 0.40.

In OLS (column 1), agglomeration remains positive, input access is close to zero, and market access is positive. Ownership heterogeneity appears mainly in access responses: foreign affiliates exhibit a stronger association with input access, while market-access interactions are modest. Under 2SLS without establishment scope (column 2), the agglomeration coefficient increases and remains positive. The domestic MNCs interaction on agglomeration is negative, while the foreign MNC interaction is smaller, implying a flatter agglomeration gradient for domestic MNCs only. Input access turns negative for the baseline group and market access becomes strongly positive; for both variables, interactions with domestic and foreign MNC status offset the baseline effects, leaving small net responses for MNCs.

Table 10: Baseline: Alternative 2010 Input-Output Table

VARIABLES	(1) OLS	(2) 2SLS	(3) 2SLS
Agglomeration	0.125**	1.101*	1.342*
	(0.058)	(0.565)	(0.736)
Input Access	-0.002	-1.282***	-2.332***
	(0.002)	(0.419)	(0.659)
Market Access	0.029***	8.106***	15.673***
	(0.008)	(1.634)	(5.244)
Agglomeration · Domestic MNCs Dummy	0.009	-1.486***	
	(0.013)	(0.565)	
Agglomeration · Foreign MNCs Dummy	-0.030	-0.676	
	(0.019)	(0.542)	
Foreign MNCs Dummy	0.173***		
	(0.030)		
Domestic MNCs Dummy	-0.027		
	(0.022)		
Input Access · Foreign MNCs Dummy	0.016***	0.550**	
	(0.004)	(0.273)	
Market Access · Foreign MNCs Dummy	-0.015	-6.532***	
	(0.016)	(1.509)	
Input Access · Domestic MNCs Dummy	-0.004	0.680***	
	(0.005)	(0.248)	
Market Access · Domestic MNCs Dummy	0.025*	-7.228***	
	(0.014)	(1.582)	
Agglomeration · Foreign Multi-Estab. Dummy			0.074
			(0.057)
Agglomeration · Domestic Multi-Estab. Dummy			0.015
			(0.016)
Agglomeration · Domestic MNC Multi-Estab. Dummy			0.034
			(0.044)
Input Access · Dom. MNCs Multi-Estab. Dummy			1.028***
			(0.368)
Market Access · Dom. MNCs Multi-Estab. Dummy			-13.932***
			(4.779)
Market Access · Foreign MNCs Multi-Estab. Dumm			-12.199***
			(4.365)
Input Access · Foreign MNCs Multi-Estab. Dummy			0.759**
			(0.382)
Market Access · Domestic Multi-Estab. Dummy			-13.379***
			(4.665)
Input Access · Domestic Multi-Estab. Dummy			0.826***
			(0.258)
Constant	2.102***		
	(0.201)		
Observations	239,205	239,205	239,205
Number of id		33,176	33,176
Industry FE	✓	-	-
Year FE	✓	✓	✓
Firm FE	-	✓	✓
Kleibergen-Paap rk LM statistic		13.671	25.647
First-stage F		84.235	72.338
Hansen J statistic		6.04	5.11
Hansen J p-value		.109	.401

Note: Clustered Robust standard errors at the municipality level in parentheses. *** p<0.01, ** p<0.05, * p<0.1; The table presents the effect of agglomeration economies, input and market access on TFP (dependent variable in logarithms). We include time, industry and province dummies for OLS, and time and firm dummies for the other models. A set of firm-specific control variables are included, among which capital, employees, total assets, wages, age and current assets. The table uses the 2005 IO table to construct our main variables of interest, e.g. input and market access.

Introducing establishment scope (column 3) leaves the baseline agglomeration effect positive, while the incremental agglomeration terms for multi-establishment categories are small and not precisely estimated. By contrast, access heterogeneity by organizational form is pronounced: the negative baseline slope on input access is attenuated by positive interactions for multi-establishment groups, and the large positive baseline market-access effect is substantially neutralized by negative interactions for multi-establishment firms (including domestic and foreign MNC groups). These patterns mirror the baseline results.

In other words, recomputing access with the 2010 input–output matrix leaves the economic content of our findings unchanged. Agglomeration remains beneficial on average. In IV, domestic MNCs display a flatter agglomeration gradient, and sensitivity to local input and demand conditions is concentrated among domestic single-plant firms, with multi-establishment structures and MNC ownership dampening these responses.

6. DISCUSSION

The empirical results provide a coherent picture of how agglomeration, access, and ownership–organization shape firm productivity, consistent with the P–SO framework. Across pooled specifications, within-municipality agglomeration is positively associated with productivity, and the IV estimates indicate larger baseline effects once endogeneity is addressed. These findings accord with established evidence on agglomeration economies and the productivity advantages of spatial concentration (Jacobs et al., 2014; Barrios et al., 2006; Rychen and Zimmermann, 2008) and with wage-based evidence of local increasing returns (Fingleton, 2003). Heterogeneity is central e.g. foreign affiliates display a performance premium yet a flatter agglomeration gradient in OLS, while in IV the attenuation is most pronounced for domestic MNCs. This pattern underscores that proximity-based gains accrue most strongly to domestically owned single-plant firms, whereas MNCs' outcomes are less tied to local externalities (**?**).

Input and market access play distinct roles once endogeneity is addressed. In IV, input access is negative for the baseline group, while market access is strongly positive. For both domestic and foreign MNCs, interactions nearly offset these baselines, yielding small net responses. Introducing establishment scope shows that organizational form mediates these channels: multi-plant structures substantially dampen sensitivity to both input and market access and offer, at most, modest additional returns to agglomeration. These results are consistent with internal sourcing, diversified demand, and firm-to-firm linkages that weaken dependence on local conditions (Nielsen et al., 2017; Ascani et al., 2016; Alfaro-Urena et al., 2022a). The strong role of urban market access in IV resonates with modern evidence on metropolitan accessibility and productivity (Heblich et al., 2020a) and aligns with mechanisms through which trade integration amplifies agglomeration forces (Pflüger, 2004). In line with recent work on the production side, the salience of intangible assets in driving firm-level productivity further helps interpret why large and networked firms internalize advantages that smaller single-plant firms source locally (Kaus et al., 2024).

The balance between localization and urbanization also depends on identification. In fixed-effects OLS, related neighbors are associated with higher productivity, while unrelated neighbors are neutral. Under IV, the sign pattern reverses: related-neighbor intensity is negatively related to productivity and unrelated diversity is beneficial, pointing to congestion or business-stealing in specialized settings and cross-industry complementarities in more diverse environments. This accords with evidence that the composition of nearby activity shapes externalities and co-agglomeration dynamics (Steijn et al., 2022).

Sectoral estimates further clarify these mechanisms. In services, agglomeration and market access are strongly positive, and both MNC ownership and multi-establishment scope markedly attenuate the large baseline access elasticities. These patterns fit knowledge-based mechanisms in dense labor markets and the specialization of cities in coordination- and information-intensive activities (Roca and Puga, 2017; Davis and Dingel, 2020). They are also consistent with innovation channels that operate through local collaboration, such as university–firm cooperation, and with the role of knowledge-based assets in raising productivity (Bragoli et al., 2024; Kaus et al., 2024). In manufacturing, agglomeration effects are not robustly different from zero in IV, input access is comparatively more salient, and market access is, if anything, adverse for single-plant domestic firms; ownership interactions in manufacturing largely neutralize these access responses. The organizational findings align with classic insights on multi-plant firms and spatial organization (McCann and Sheppard, 2003).

Two robustness exercises reinforce the baseline interpretation. First, restricting to firms with predetermined locations and lagging agglomeration leaves the qualitative conclusions intact, with some loss of precision in the most saturated IV specification. Second, recomputing access with the 2010 input–output matrix yields the same economic content: agglomeration remains beneficial on average, domestic MNCs display a flatter agglomeration gradient in IV, and responsiveness to local input and demand conditions is concentrated among domestic single-plant firms, with multi-establishment structures and MNC ownership damping these responses.

Finally, the ownership patterns we document align with evidence that the anchoring of foreign investment depends on local external conditions and incentives, particularly where agglomerations fail to materialize (**?**). More broadly, ongoing technological change can modulate the strength of local externalities: automation and AI adoption may reduce reliance on local labor pooling and local demand channels for larger and more networked firms, providing a macro-level rationale for the muted access elasticities among multi-plant organizations and MNCs (Cords and Prettner, 2022; Drydakis, 2024; Hötte et al., 2024). At the same time, place-based knowledge linkages and collaboration remain powerful complements to density, especially in services, consistent with the innovation and intangible-capital evidence (Bragoli et al., 2024; Kaus et al., 2024).

7. Conclusion

Our results confirm the main hypotheses within the P–SO framework. Foreign multinationals exhibit an intercept premium relative to Belgian-owned firms, yet their outcomes are less tightly linked to local externalities. Within-municipality agglomeration is positively associated with productivity in pooled estimates and remains economically important under instrumentation, consistent with established evidence on agglomeration economies and spatial concentration (Jacobs et al., 2014; Barrios et al., 2006; Rychen and Zimmermann, 2008; Diamond and Gaubert, 2022; Beugelsdijk et al., 2010).

Endogeneity-robust estimates clarify the channels. Input access is negative for the baseline group while market access is strongly positive; for both domestic and foreign MNCs, interactions nearly offset these baselines, leaving small net responses. Organizational scope is pivotal e.g., multi-establishment structures attenuate sensitivity to local input depth and local demand and yield, at most, modest additional gains from agglomeration, in line with internal sourcing and diversified market footprints (McCann and Sheppard, 2003; Nielsen et al., 2017; Ascani et al., 2016; Alfaro-Urena et al., 2022a). The importance of market access under IV is consistent with modern evidence on metropolitan accessibility and productivity (Heblich et al., 2020a).

We also document that the balance between localization and urbanization varies with identification.

In fixed-effects OLS, related neighbors are associated with higher productivity, whereas under IV the related-neighbor effect turns negative and unrelated diversity becomes beneficial, pointing to congestion or business-stealing in specialized settings and cross-industry complementarities in more diverse environments (Steijn et al., 2022). Sectoral estimates reinforce these mechanisms: agglomeration premia and market-access elasticities are pronounced in services and muted in manufacturing, aligning with knowledge-based advantages in dense labor markets and cities' specialization in coordination-intensive activities (Roca and Puga, 2017; Davis and Dingel, 2020). Recent evidence on university–firm cooperation and on the role of intangible capital complements this interpretation by linking local collaboration and intangible assets to higher firm productivity (Bragoli et al., 2024; Kaus et al., 2024).

Two robustness exercises sustain the conclusions. Restricting to firms with predetermined locations and lagging agglomeration leaves the qualitative patterns intact, and recomputing access using the 2010 input–output matrix yields the same economic content: agglomeration and market access primarily raise productivity for domestically owned single-plant firms; MNC status and multi-plant scope dampen dependence on local input depth and local demand. These ownership–organization gradients are consistent with evidence on multinational supply chains and internal networks (Alfaro-Urena et al., 2022a), and with broader perspectives on how city structure mediates productivity (Heblich et al., 2020a).

References

Ackerberg, D. A., Caves, K., and Frazer, G. (2015). Identification properties of recent production function estimators. *Econometrica*, 83(6):2411–2451.

Acs, Z. J., Braunerhjelm, P., Audretsch, D. B., and Carlsson, B. (2009). The knowledge spillover theory of entrepreneurship. *Small business economics*, 32:15–30.

Adão, R., Kolesár, M., and Morales, E. (2019). Shift-share designs: Theory and inference*. *The Quarterly Journal of Economics*, 134(4):1949–2010.

Ahlfeldt, G. M., Redding, S. J., Sturm, D. M., and Wolf, N. (2015). The economics of density: Evidence from the berlin wall. *Econometrica*, 83(6):2127–2189.

Aitken, B. J. and Harrison, A. E. (1999). Do domestic firms benefit from direct foreign investment?

Evidence from Venezuela. *American Economic Review*, pages 605–618.

Alfaro, L. and Chen, M. X. (2014). The global agglomeration of multinational firms. *Journal of International Economics*, 94(2):263–276.

Alfaro-Urena, A., Manelici, I., and Vasquez, J. P. (2022a). The effects of joining multinational supply chains: New evidence from firm-to-firm linkages. *The Quarterly Journal of Economics*, 137(3):1495–1552.

Alfaro-Urena, A., Manelici, I., and Vasquez, J. P. (2022b). The effects of joining multinational supply chains: New evidence from firm-to-firm linkages. *The Quarterly Journal of Economics*, 137(3):1495–1552.

Anderson, J. E. (2011). The gravity model. *Annual Review of Economics*, 3(1):133–160.

Anderson, J. E. and van Wincoop, E. (2003). Gravity with gravitas: A solution to the border puzzle. *American Economic Review*, 93(1):170–192.

Andersson, F., Burgess, S., and Lane, J. I. (2007). Cities, matching and the productivity gains of agglomeration. *Journal of Urban Economics*, 61(1):112–128.

Anselin, L., Varga, A., and Acs, Z. (1997). Local geographic spillovers between university research and high technology innovations. *Journal of urban economics*, 42(3):422–448.

Arrow, K. J. (1962). The economic implications of learning by doing. *The Review of Economic Studies*, 29(3):155–173.

Ascani, A., Crescenzi, R., and Iammarino, S. (2016). Economic institutions and the location strategies of european multinationals in their geographic neighborhood. *Economic Geography*, 92(4):401–429.

Baert, S., De Meyer, A.-S., Moerman, Y., and Omey, E. (2018). Does size matter? hiring discrimination and firm size. *International Journal of Manpower*, 39(4):550–566.

Baldwin, R. E. and Forslid, R. (2000). The core–periphery model and endogenous growth: Stabilizing and destabilizing integration. *Economica*, 67(267):307–324.

Barrios, S., Görg, H., and Strobl, E. (2006). Multinationals' location choice, agglomeration economies, and public incentives. *International Regional Science Review*, 29(1):81–107.

Basile, R., Pittiglio, R., and Reganati, F. (2017). Do agglomeration externalities affect firm survival? *Regional Studies*, 51(4):548–562.

Behrens, K., Duranton, G., and Robert-Nicoud, F. (2014). Productive cities: Sorting, selection, and agglomeration. *Journal of Political Economy*, 122(3):507–553.

Bergstrand, J. H. (1985). The gravity equation in international trade: some microeconomic foundations and empirical evidence. *The Review of Economics and Statistics*, pages 474–481.

Bernard, A. B. and Jensen, J. B. (1999). Exceptional exporter performance: cause, effect, or both? *Journal of international economics*, 47(1):1–25.

Beugelsdijk, S., McCann, P., and Mudambi, R. (2010). Introduction: place, space and organizationeconomic geography and the multinational enterprise. *Journal of Economic Geography*, 10(4):485–493.

Beugelsdijk, S. and Mudambi, R. (2013). MNEs as border-crossing multi-location enterprises: The role of discontinuities in geographic space. *Journal of International Business Studies*, 44(5):413–426.

Bloom, N., Genakos, C., Sadun, R., and Van Reenen, J. (2012). Management practices across firms and countries. *Academy of management perspectives*, 26(1):12–33.

Bond-Smith, S. C. and McCann, P. (2019). A multi-sector model of relatedness, growth and industry clustering. *Journal of Economic Geography*, 20(5):1145–1163.

Borusyak, K., Hull, P., and Jaravel, X. (2022). Quasi-experimental shift-share research designs. *The Review of Economic Studies*, 89(1):181–213.

Boschma, R. (2005). Proximity and innovation: a critical assessment. *Regional Studies*, 39(1):61–74.

Bragoli, D., Cortelezzi, F., and Rigon, M. (2024). Firms' innovation and university cooperation. new evidence from a survey of italian firms. *Oxford Economic Papers*, 76(1):136–161.

Buckley, P. J. and Casson, M. C. (2015). The internalisation theory of the multinational enterprise: A review of the progress of a research agenda after 30 years. *International business strategy*, pages 85–107.

Burlina, C., Casadei, P., and Crociata, A. (2023). Economic complexity and firm performance in the cultural and creative sector: Evidence from italian provinces. *European Urban and Regional Studies*, 30(2):152–171.

Cainelli, G., Giannini, V., and Iacobucci, D. (2019). Agglomeration, networking and the great recession. *Regional Studies*, 53(7):951–962.

Cantwell, J. and Iammarino, S. (2000). Multinational corporations and the location of technological innovation in the uk regions. *Regional Studies*, 34(4):317–332.

Caves, R. E. (1996). *Multinational enterprise and economic analysis*. Cambridge university press.

Combes, P.-P., Duranton, G., and Gobillon, L. (2010a). The identification of agglomeration economies. *Journal of Economic Geography*, page lbq038.

Combes, P.-P., Duranton, G., Gobillon, L., Puga, D., and Roux, S. (2012). The productivity advantages of large cities: Distinguishing agglomeration from firm selection. *Econometrica*, 80(6):2543–2594.

Combes, P.-P., Duranton, G., Gobillon, L., and Roux, S. (2010b). Estimating agglomeration economies with history, geology, and worker effects. In *Agglomeration Economics*, pages 15–66. University of Chicago Press.

Conconi, P., Magerman, G., and Plaku, A. (2020). The Gravity of Intermediate Goods. *Review of Industrial Organization*, 57(2):223–243.

Cords, D. and Prettner, K. (2022). Technological unemployment revisited: automation in a search and matching framework. *Oxford Economic Papers*, 74(1):115–135.

Crozet, M., Mayer, T., and Mucchielli, J.-L. (2004). How do firms agglomerate? a study of FDI in France. *Regional Science and Urban Economics*, 34(1):27–54.

Davis, D. R. and Dingel, J. I. (2020). The comparative advantage of cities. *Journal of International Economics*, 123:103291.

De Beule, F., Elia, S., Garcia-Bernardo, J., Heemskerk, E. M., Jaklič, A., Takes, F. W., and Zdziarski, M. (2022). Proximity at a distance: The relationship between foreign subsidiary co-location and mnc headquarters board interlock formation. *International Business Review*, 31(4):101971.

Delgado, M., Porter, M. E., and Stern, S. (2010). Clusters and entrepreneurship. *Journal of Economic Geography*, page lbq010.

Deloof, M., Lagaert, I., and Verschueren, I. (2007). Leases and debt: complements or substitutes? evidence from belgian smes. *Journal of Small Business Management*, 45(4):491–500.

Diamond, R. and Gaubert, C. (2022). Spatial sorting and inequality. *Annual Review of Economics*, 14:795–819.

Diodato, D., Neffke, F., and O'Clery, N. (2018). Why do industries coagglomerate? how marshallian externalities differ by industry and have evolved over time. *Journal of Urban Economics*, 106:1–26.

Disdier, A.-C. and Head, K. (2008). The puzzling persistence of the distance effect on bilateral trade. *The Review of Economics and Statistics*, 90(1):37–48.

Donaldson, D. (2018). Railroads of the raj: Estimating the impact of transportation infrastructure. *American economic review*, 108(4-5):899–934.

Drydakis, N. (2024). Artificial intelligence capital and employment prospects. *Oxford Economic Papers*, 76(4):901–919.

Duranton, G. and Puga, D. (2004). Micro-foundations of urban agglomeration economies. In *Handbook of regional and urban economics*, volume 4, pages 2063–2117. Elsevier.

Eaton, J., Kortum, S., and Kramarz, F. (2011). An Anatomy of International Trade: Evidence From French Firms. *Econometrica*, 79(5):1453–1498.

Egger, P., Lassmann, A., et al. (2013). *The causal impact of common native language on International trade: Evidence from a spatial regression discontinuity design, Book. Centre of Economic Policy Research.*

Egger, P. H. and Lassmann, A. (2012). The language effect in international trade: A meta-analysis. *Economics Letters*, 116(2):221–224.

Egger, P. H. and Lassmann, A. (2015). The causal impact of common native language on international trade: Evidence from a spatial regression discontinuity design. *The Economic Journal*, 125(584):699–745.

Ekholm, K., Forslid, R., and Markusen, J. R. (2007). Export-platform foreign direct investment. *Journal of the European Economic Association*, 5(4):776–795.

Ellison, G. and Glaeser, E. L. (1997). Geographic concentration in us manufacturing industries: a dartboard approach. *Journal of political economy*, 105(5):889–927.

Ellison, G. and Glaeser, E. L. (1999). The geographic concentration of industry: does natural advantage explain agglomeration? *American Economic Review*, pages 311–316.

Enright, M. J. (2000). Regional clusters and multinational enterprises: independence, dependence, or interdependence? *International Studies of Management & Organization*, pages 114–138.

Fingleton, B. (2003). Increasing returns: evidence from local wage rates in great britain. *Oxford Economic Papers*, 55(4):716–739.

Fontagné, L. and Santoni, G. (2019). Agglomeration economies and firm-level labor misallocation. *Journal of Economic Geography*, 19(1):251–272.

Fujita, M. and Krugman, P. (2004). The new economic geography: Past, present and the future. In *Fifty Years of Regional Science*, pages 139–164. Springer.

Fujita, M., Krugman, P. R., and Venables, A. (2001). *The spatial economy: Cities, regions, and international trade*. MIT press.

Fujita, M. and Thisse, J.-F. (1996). Economics of agglomeration. *Journal of the Japanese and international economies*, 10(4):339–378.

Fujita, M. and Thisse, J.-F. (2013). *Economics of agglomeration: cities, industrial location, and globalization*. Cambridge university press.

Gaubert, C. (2018). Firm sorting and agglomeration. *American Economic Review*, 108(11):3117–3153.

Glaeser, E. L., Kallal, H. D., Scheinkman, J. A., and Shleifer, A. (1992). Growth in cities. *Journal of Political Economy*, 100(6).

Goerzen, A., Asmussen, C. G., and Nielsen, B. B. (2013). Global cities and multinational enterprise location strategy. *Journal of International Business Studies*, 44:427–450.

Goldsmith-Pinkham, P., Sorkin, I., and Swift, H. (2020). Bartik instruments: What, when, why, and how. *American Economic Review*, 110(8):2586–2624.

Graham, D. J. (2007a). Agglomeration, productivity and transport investment. *Journal of Transport Economics and Policy*, 41(3):317–343.

Graham, D. J. (2007b). Variable returns to agglomeration and the effect of road traffic congestion. *Journal of Urban Economics*, 62(1):103–120.

Grieser, W., LeSage, J., and Zekhnini, M. (2022). Industry networks and the geography of firm behavior. *Management Science*, 68(8):6163–6183.

Haddad, M. and Harrison, A. (1993). Are there positive spillovers from direct foreign investment?: Evidence from panel data for morocco. *Journal of Development Economics*, 42(1):51–74.

Hanson, G. H. (2005). Market potential, increasing returns and geographic concentration. *Journal of International Economics*, 67(1):1–24.

Head, K. and Mayer, T. (2004). Market potential and the location of japanese investment in the european union. *Review of Economics and Statistics*, 86(4):959–972.

Head, K. and Mayer, T. (2014). Gravity equations: Workhorse, toolkit, and cookbook. In *Handbook of international economics*, volume 4, pages 131–195. Elsevier.

Head, K., Mayer, T., and Ries, J. (2010). The erosion of colonial trade linkages after independence. *Journal of International Economics*, 81(1):1–14.

Heblich, S., Redding, S. J., and Sturm, D. M. (2020a). The making of the modern metropolis: evidence from london. *The Quarterly Journal of Economics*, 135(4):2059–2133.

Heblich, S., Redding, S. J., and Sturm, D. M. (2020b). The making of the modern metropolis: evidence from london. *The Quarterly Journal of Economics*, 135(4):2059–2133.

Helpman, E. (1984). A simple theory of Trade with multinational corporations. *Journal of Political Economy*, 92(3).

Helpman, E., Melitz, M. J., and Yeaple, S. R. (2004). Export versus fdi with heterogeneous firms. *American economic review*, 94(1):300–316.

Holl, A. (2011). Market potential and firm-level productivity in spain. *Journal of Economic Geography*, page lbr030.

Holmes, T. J. (1999). Localization of industry and vertical disintegration. *Review of Economics and Statistics*, 81(2):314–325.

Holmes, T. J. and Stevens, J. J. (2002). Geographic concentration and establishment scale. *Review of Economics and Statistics*, 84(4):682–690.

Hötte, K., Theodorakopoulos, A., and Koutroumpis, P. (2024). Automation and taxation. *Oxford Economic Papers*, 76(4):945–969.

Howell, A. (2020). Agglomeration, absorptive capacity and knowledge governance: implications for public–private firm innovation in china. *Regional Studies*, 54(8):1069–1083.

Hummels, D., Ishii, J., and Yi, K.-M. (2001). The nature and growth of vertical specialization in world trade. *Journal of International Economics*, 54(1):75–96.

Hymer, S. H. (1976). The international operations of national firms: A study of foreign direct investment.

Ito, T. (2013). Export-platform foreign direct investment: Theory and evidence. *The World Economy*, 36(5):563–581.

Jacobs, J. (1969). *The Economy of Cities*. Vintage, New York.

Jacobs, W., Koster, H. R., and van Oort, F. (2014). Co-agglomeration of knowledge-intensive business services and multinational enterprises. *Journal of Economic Geography*, 14(2):443–475.

Kauma, B. and Mion, G. (2023). Regional productivity differences in the uk and france - from the micro to the macro. Working Papers 039, The Productivity Institute.

Kaus, W., Slavtchev, V., and Zimmermann, M. (2024). Intangible capital and productivity: Firm-level evidence from german manufacturing. *Oxford Economic Papers*, 76(4):970–996.

Keeble, D., Offord, J., Walker, S., and Europeas, C. (1988). *Peripheral regions in a community of twelve member states*. Office for official publications of the European communities, Luxembourg.

Komorowski, M. (2020). Identifying industry clusters: a critical analysis of the most commonly used methods. *Regional Studies, Regional Science*, 7(1):92–100.

Krugman, P. (1980). Scale economies, product differentiation, and the pattern of trade. *The American Economic Review*, pages 950–959.

Krugman, P. (2011). The new economic geography, now middle-aged. *Regional studies*, 45(1):1–7.

Krugman, P. R. (1991). *Geography and trade*. MIT press.

Lall, S. V., Shalizi, Z., and Deichmann, U. (2004). Agglomeration economies and productivity in indian industry. *Journal of Development Economics*, 73(2):643–673.

Levinsohn, J. and Petrin, A. (2003). Estimating production functions using inputs to control for unobservables. *The Review of Economic Studies*, 70(2):317–341.

Li, Y. and Zhang, X. T. (2023). Rent-seeking in bank credit and firm r&d innovation: The role of industrial agglomeration. *Journal of Business Research*, 159:113454.

Manning, S. (2008). Customizing clusters on the role of Western multinational corporations in the formation of science and engineering clusters in emerging economies. *Economic Development Quarterly*, 22(4):316–323.

Markusen, A. (1999). Sticky places in slippery space. *New industrial geography: Regions, regulations and institutions*, pages 98–124.

Markusen, J. R. et al. (2004). Multinational firms and the theory of international trade. *MIT Press Books*, 1.

Markusen, J. R. and Venables, A. J. (2000). The theory of endowment, intra-industry and multi-national trade. *Journal of International Economics*, 52(2):209–234.

Marques, L., Yan, T., and Matthews, L. (2020). Knowledge diffusion in a global supply network: a network of practice view. *Journal of Supply Chain Management*, 56(1):33–53.

Marshall, A. (1898). Principles of economics. vol. 1.

Mathys, C. (2009). Economic importance of the belgian ports: Flemish maritime ports, liège port complex and the port of brussels–report 2007.

McCann, P. and Sheppard, S. (2003). The rise, fall and rise again of industrial location theory. *Regional studies*, 37(6-7):649–663.

Melitz, J. (2008). Language and foreign trade. *European Economic Review*, 52(4):667–699.

Melitz, M. J. (2003). The impact of trade on intra-industry reallocations and aggregate industry productivity. *Econometrica*, 71(6):1695–1725.

Melitz, M. J. and Ottaviano, G. I. (2008). Market size, trade, and productivity. *The Review of Economic Studies*, 75(1):295–316.

Melo, P. C., Graham, D. J., and Noland, R. B. (2009). A meta-analysis of estimates of urban agglomeration economies. *Regional Science and Urban Economics*, 39(3):332–342.

Mion, G. and Zhang, D. (2025). Uk trade and productivity across space. Working Papers 59, The Productivity Institute.

Nielsen, B. B., Asmussen, C. G., and Weatherall, C. D. (2017). The location choice of foreign direct investments: Empirical evidence and methodological challenges. *Journal of World Business*, 52(1):62–82.

Okubo, T. and Tomiura, E. (2019). Regional variations in exportersâ™ productivity premium: Theory and evidence. *Review of International Economics*, 27(3):803–821.

Olley, G. S. and Pakes, A. (1996). The dynamics of productivity in the telecommunications equipment industry. *Econometrica*, 64(6):1263–1297.

Pflüger, M. (2004). Economic integration, wage policies, and social policies. *Oxford Economic Papers*, 56(1):135–150.

Porter, M. (1990). *The Competitive Advantage of Nations. the Free Press, New York.*

Puga, D. (2010). The magnitude and causes of agglomeration economies. *Journal of Regional Science*, 50(1):203–219.

Quintero, L. E. and Roberts, M. (2023). Cities and productivity: Evidence from 16 latin american and caribbean countries. *Journal of Urban Economics*, 136:103573.

Ramamurti, R. (2012). What is really different about emerging market multinationals? *Global Strategy Journal*, 2(1):41–47.

Redding, S. and Venables, A. J. (2004). Economic geography and international inequality. *Journal of International Economics*, 62(1):53–82.

Redding, S. J. and Turner, M. A. (2015). Transportation costs and the spatial organization of economic activity. *Handbook of regional and urban economics*, 5:1339–1398.

Rizov, M., Oskam, A., and Walsh, P. (2012). Is there a limit to agglomeration? evidence from productivity of dutch firms. *Regional Science and Urban Economics*, 42(4):595–606.

Roca, J. D. L. and Puga, D. (2017). Learning by working in big cities. *The Review of Economic Studies*, 84(1):106–142.

Rocha, H., Kunc, M., and Audretsch, D. (2020). Clusters, economic performance, and social cohesion: a system dynamics approach. *Regional Studies*, 54(8):1098–1111.

Rodríguez-Pose, A. and Burlina, C. (2021). Institutions and the uneven geography of the first wave of the covid-19 pandemic. *Journal of Regional Science*, 61(4):728–752.

Romer, P. M. (1986). Increasing returns and long-run growth. *Journal of Political Economy*, 94(5):1002–1037.

Rugman, A. M. and Verbeke, A. (2004). A perspective on regional and global strategies of multinational enterprises. *Journal of international business studies*, 35:3–18.

Rychen, F. and Zimmermann, J.-B. (2008). Clusters in the global knowledge-based economy: knowledge gatekeepers and temporary proximity. *Regional studies*, 42(6):767–776.

Saito, H. and Gopinath, M. (2009). Plants' self-selection, agglomeration economies and regional productivity in chile. *Journal of Economic Geography*, 9(4):539–558.

Steijn, M. P., Koster, H. R., and Van Oort, F. G. (2022). The dynamics of industry agglomeration: Evidence from 44 years of coagglomeration patterns. *Journal of Urban Economics*, 130:103456.

Van Meeteren, M., Neal, Z., and Derudder, B. (2016). Disentangling agglomeration and network externalities: A conceptual typology. *Papers in Regional Science*, 95(1):61–80.

Vandenberghe, V., Waltenberg, F., and Rigó, M. (2013). Ageing and employability. evidence from belgian firm-level d ata. *Journal of Productivity Analysis*, 40:111–136.

Venables, A. J. (1996). Equilibrium locations of vertically linked industries. *International Economic Review*, pages 341–359.

Wang, J., Sun, F., Lv, K., and Wang, L. (2022). Industrial agglomeration and firm energy i ntensity: how important is spatial proximity? *Energy Economics*, 112:106155.

Yeaple, S. R. (2005). A simple model of firm heterogeneity, international trade, and w ages. *Journal of international Economics*, 65(1):1–20.

Zhang, C. (2017). Top manager characteristics, agglomeration economies and firm p erformance. *Small Business Economics*, 48(3):543–558.

Zhu, S., He, C., and Luo, Q. (2019). Good neighbors, bad neighbors: local knowledge spillovers, regional institutions and firm performance in china. *Small Business Economics*, 52(3):617–632.

A. Online Appendix

A.1 The effects of Brussels and the ports

In Table (A1) we investigate the roles of Brussels and of the port cities. The most significant ports in Belgium are Antwerp and Ghent, which are estimated to have had a direct value added contribution in 2015 of E10.9bn and E3.8bn (the next largest port, Liege being about E1bn) according to Mathys (2009). As well as being hubs of industry in their own right, these ports are very important for access to foreign markets, both overseas and also inland into Germany in particular (since Antwerp, along with Rotterdam, is a major European transhipment point). We therefore incorporate dummies for distance to Antwerp and distance to Ghent.

Remembering that a negative sign on distance means that proximity is beneficial, we should note that in column 3 - our fullest OLS model - perhaps surprisingly, distance to Antwerp has a significant positive estimated coefficient for Belgian firms, although this is just about wiped out for foreign MNCs. Conversely, distance to Ghent significantly benefits domestic firms, although this effect is almost reduced to zero for foreign MNCs; it is significant and negative for foreign MNCs and insignificant and negative for Belgian MNCs. Local agglomeration benefits all firms, though foreign firms a bit less. Input access benefits foreign MNCs, but has little effect on domestic firms, and a negative effect on Belgian MNCs. Market access benefits domestic firms significantly and substantially, with Belgian MNCs benefiting even more, and foreign firms slightly less.

Column 4 is the 2SLS model (proxying input and market access using French, German and Dutch GDP fluctuations). Foreign firms are 21.6 per cent more productive than domestic firms (before taking into account other effects), while Belgian MNCs are 7.7 per cent more efficient.[18] Estimated coefficients on agglomeration, input access, and market access are summarised in Figures (A4)-(A5) (excluding insignificant effects). In 2SLS, agglomeration within a municipality has a negative, not a positive effect upon productivity, in marked contrast to the standard literature (Holmes and Stevens, 2002). Moreover, the effect is more strongly negative for foreign firms. Input access is strongly positive for both domestic

[18] First stage reported in Table (**??**).

Table A1: Agglomeration, Input and Market Access with Distance to Ports and Brussels' Effect

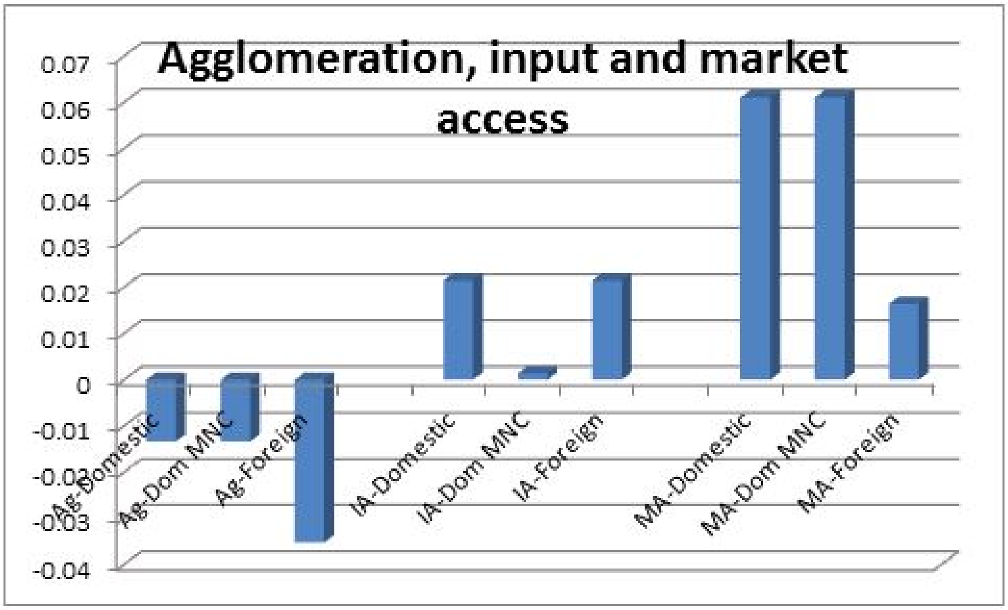
	(1)	(2)	(3)	(4)	(5)
	OLS	OLS	OLS	2SLS	2SLS Excluding Brussels
Agglomeration	0.269***	0.181***	0.122***	-0.0134***	-0.0377***
	(0.0274)	(0.0274)	(0.0275)	(0.00463)	(0.00477)
Agglomeration · Domestic MNCs Dummy		0.0100	0.0119	0.0135	0.0353***
		(0.00772)	(0.00773)	(0.00823)	(0.00830)
Agglomeration · Foreign Firms Dummy		-0.0214**	-0.0196**	-0.0218**	-0.00833
		(0.00921)	(0.00922)	(0.00968)	(0.00982)
Foreign		0.167***	0.111***	0.216***	-0.0518**
		(0.0116)	(0.0126)	(0.0189)	(0.0227)
Domestic MNCs		-0.000310	-0.0160	0.0769***	-0.187***
		(0.00991)	(0.0107)	(0.0175)	(0.0212)
Input Access			-0.00224	0.0215***	0.00173
			(0.00153)	(0.00425)	(0.00530)
Market Access			0.0270***	0.0611***	-0.231***
			(0.00418)	(0.0169)	(0.0300)
Input Access · Foreign Firms Dummy			0.0168***	0.00165	0.0274***
			(0.00223)	(0.00461)	(0.00569)
Market Access · Foreign Firms Dummy			-0.00375	-0.0447***	0.230***
			(0.00650)	(0.0172)	(0.0296)
Input Access · Domestic MNCs Dummy			-0.00720***	-0.0201***	-0.00475
			(0.00260)	(0.00478)	(0.00600)
Market Access · Domestic MNCs Dummy			0.0275***	-0.0296*	0.269***
			(0.00680)	(0.0177)	(0.0305)
Foreign · Distance to Antwerp		-0.000839***	-0.000274**	-0.00104***	0.00153***
		(0.000128)	(0.000136)	(0.000176)	(0.000215)
Foreign· Distance to Ghent		0.000174**	0.000261***	0.000156	0.000799***
		(8.82e-05)	(8.89e-05)	(9.83e-05)	(0.000107)
Domestic MNCs· Distance to Antwerp		-0.000171	-6.21e-05	-0.000952***	0.00143***
		(0.000104)	(0.000109)	(0.000155)	(0.000198)
Domestic MNCs· Distance to Ghent		-0.000181**	-0.000141*	-0.000234***	0.000484***
		(7.33e-05)	(7.40e-05)	(8.52e-05)	(9.48e-05)
Distance to Antwerp		0.000117	0.000345***	0.000584***	-0.00185***
		(9.98e-05)	(0.000102)	(0.000123)	(0.000174)
Distance to Ghent		-0.000442***	-0.000332***	-0.000299***	-0.00102***
		(9.21e-05)	(9.27e-05)	(5.37e-05)	(6.77e-05)
Constant	1.855***	1.963***	2.014***	2.386***	2.493***
	(0.0850)	(0.0859)	(0.0863)	(0.0111)	(0.0128)
Observations	249,719	249,719	249,719	249,719	219,747
R-squared	0.271	0.274	0.275	0.182	0.147

Note: Robust standard errors in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$; The table presents the effect of agglomeration economies, input and market access on TFP (dependent variable in logarithms). We include time, industry and province dummies for OLS, time and firm dummy for the other models. A set of firm specific control variable are included, among which capital, employees, total assets, wages, age and current assets. First Stage is not reported here due to space limitation, however the statistical significance is in line with previous table.

firms and foreign ones, though not for Belgian MNCs. Market access is strongly positive for Belgian domestic firms and Belgian MNCs, while it is less strongly positive for foreign firms. Hence this tends to confirm the proposition that foreign firms are more driven by access to inputs, since they may sell their output over a wider area. Multinationals (foreign and Belgian) benefit from proximity to either Antwerp or Ghent, while domestic non-multinational firms benefit from being near Ghent, but lose from being near Antwerp.

Column 5, excludes Brussels postcodes. Given the dominance of Brussels in the Belgian economy, with central government, financial institutions and international organisations (the EU and NATO), as well as a major airport and the convergence of the Eurostar and Thalys lines, it is important to check whether many of the effects we have noted are in fact specifically attributable to a Brussels effect. Interestingly, the intercept dummy for foreign firms is now below that for domestic firms. Other than that, the main effect is a dramatic fall in the importance of market access for domestic firms; this does seem to be a Brussels-led effect. Foreign firms still benefit considerably from input access. Proximity to the ports is beneficial to all firms, though this time domestic firms benefit most. It may well be that the fall in the market access parameter for domestic firms, once Brussels is removed, is because of collinearity with proximity to Antwerp; hence we suggest caution here.

While conclusions must be tentative, it seems that local agglomeration is less important than in the previous literature (Holmes and Stevens, 2002), and may even be of negative benefit (congestion effects) as discussed in Rizov et al. (2012). Market access may be important for Belgian firms, but it seems that this is a Brussels-dominated effect. Input access is clearly and consistently beneficial for MNCs, regardless of whether or not Brussels is included, while location near the ports is generally beneficial.



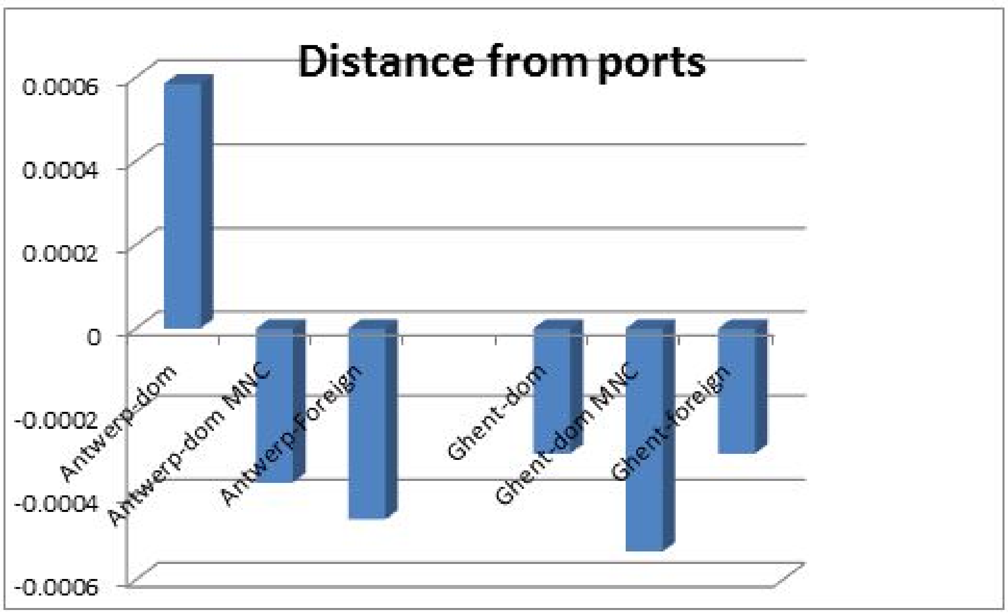
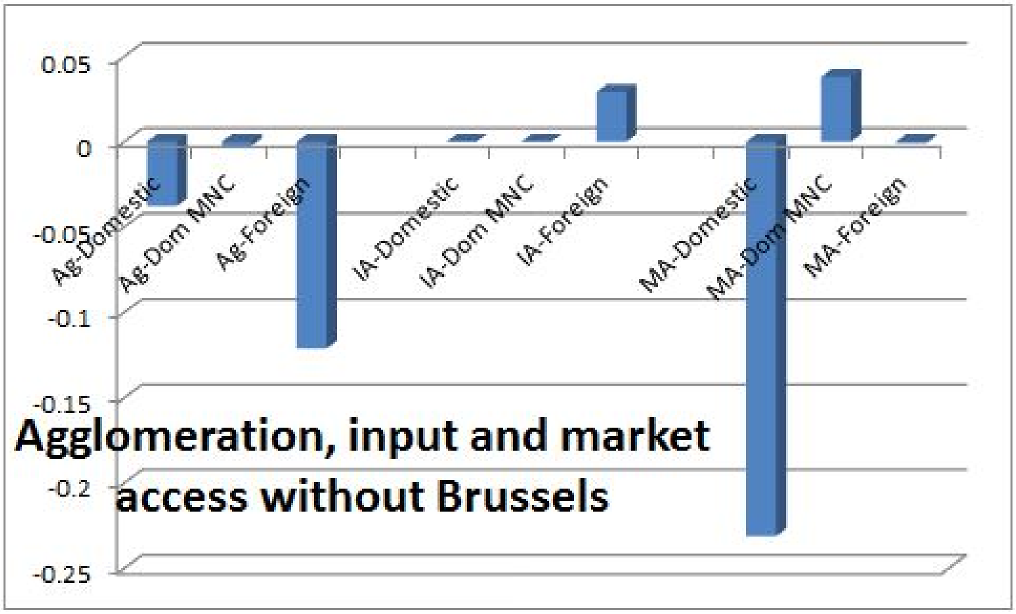


Figure A4: Graphical comparison of significant coefficients for different ownership types: 2SLS for all Belgium.



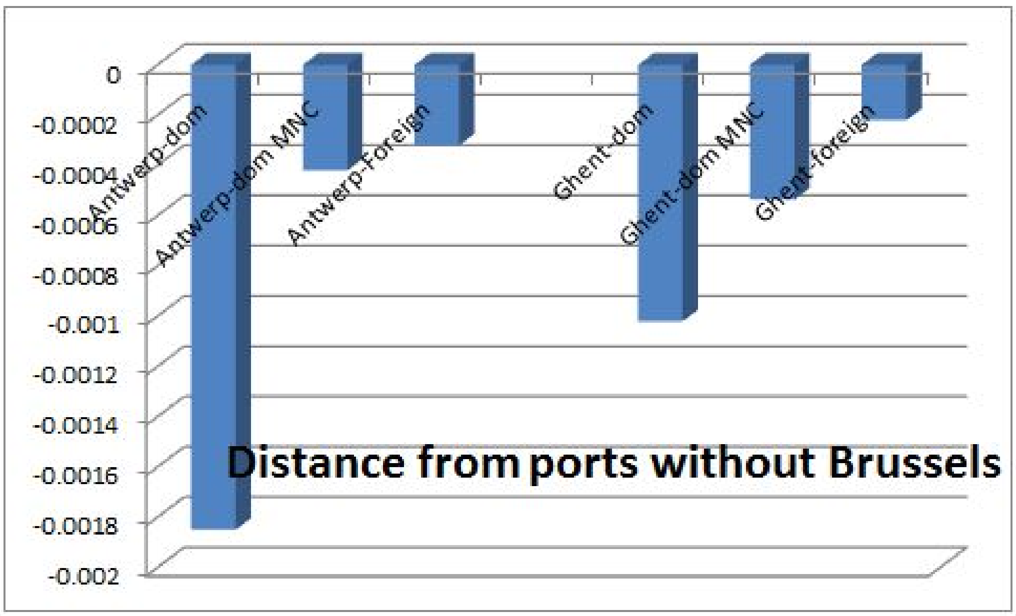


Figure A5: Graphical comparison of significant coefficients for different ownership types: 2SLS for Belgium excluding Brussels.

B. Online Theoretical Appendix: Derivation of indices for input access and market access

Because we work with a database containing detailed information on both location and industry for tens of thousands of firms, we adopt a modelling approach to make best potential use of this data. Production is carried out by H firms, which we index by $h \in H = [1, ..., hh]$. These firms are each identified both with a particular industry, $i \in [1, ..., I]$, and a municipality $m \in [1, ..., \mu]$. We are interested in the relations between the various firms, either as purchaser, or supplier, or through agglomeration spillovers, and we would like to invstigate the effects of these various relationships upon productivity, and how these effects vary by ownership type. We do this by setting up a monopolistically competitive model, where each firm has the option to interact with each other firm, though the extent to which they do so will depend on the degree of interaction between the two industries, and also upon distance between the firms. We assume that the number of firms is large in each case (so we can use constant elasticity markups), and that, within each industry/municipality, firms are homogeneous, which means we can model the behaviour of a representative firm.

We start by considering a firm $h = i, m$, and its relationship with each other firm, which characteristically we label $h' = i', m'$. The volume of sales is likely to depend upon a number of characteristics of h and of h' (sizes of the two firms, as well as the pair of industries in which they are located), as well as on the distance between them. We model this by a nested process: firm h purchases inputs from a variety of industries in relative amounts corresponding to the aggregate input-output coefficients of the pair of industries i and i', derived from the Belgian input-output tables. At a lower level, when seeking inputs from industry i', it spreads its purchases across a wide variety of providers in various localities, at various distances from m.

B.1 Modelling input access and market access in a two-stage nested model

Figure(1) outlines the nested production process. We start by considering **input access**: i.e. a firm's ability to access a wide variety of inputs cheaply. Consider a particular industry-municipality pair $\{i, m\}$. We denominate the representative firm in $\{i, m\}$ as h, while that in i', m' is h'. This firm will purchase goods from all other firms. In common with many models of intersectoral trade, we model production as a two-stage nested process, which we show in Figure 2. In the **lower level**, firm h combines its purchases from all firms within a particular industry, $i^{'}$, to form an aggregate good, of quantity $Q_{i',h}$, with an aggregate price $M_{i',h}$ (in the trade literature, e.g. Anderson and van Wincoop (2003), this price is also termed the 'multilateral resistance' for inputs of $i^{'}$ into h, hence our notation of $M_{i',h}$). $M_{i',h}$ is a CES aggregate of delivered prices (including a distance-related trade cost), using an elasticity of substitution, $\sigma > 1$, which generates a 'love of variety', and hence a gain from locating nearer to a wider range of suppliers. In the **upper level** of the production function, the aggregate inputs from all industries i' into h are again aggregated, this time using a Cobb-Douglas function, with value weightings drawn directly from the published input-output tables for Belgium.

Next, we outline the basics of the algebraic model.

B.2 Lower level aggregation of firms in an industry

A representative firm h purchases inputs from all firms in industry i', which are distributed across all municipalities. Following the standard Dixit-Stiglitz 'love of variety' formulation, purchases by h of all goods produced by industry i' are aggregated, so that we can derive a CES aggregate price $M_{i',h}$. Setting the CES elasticity of substitution $\sigma > 1$, so that there is a 'love of variety', allows us to write

$$M_{i',h} = \left(\sum_{m'=1}^{\mu} n_{i',m} \left(\tau_{i',m',m} P_{h'} \right)^{1-\sigma} \right)^{\frac{1}{1-\sigma}}, \tag{12}$$

where $\tau_{i',m',m}$ represents 1 + an iceberg trade cost between source municipality m' and destination municipality m[19]. $P_{h'}$ is the price at source and $h' \neq h$.

Following Shephard's Lemma, we differentiate (12) with respect to the delivered price, $(\tau_{i',m',m} P_{h'})$, to find the volume and value of purchases by h from all firms in h', relative to the total demand by h for produce of industry i':

$$x_{h',h} = \frac{q_{h',h}}{d_{i',h}} = n_{i',m} \left(\frac{\tau_{i',m',m} P_{h'}}{M_{i',h}} \right)^{-\sigma}; \tag{13}$$

$$\chi_{h',h} = \frac{\tau_{i',m',m} P_{h'} q_{h',h}}{M_{i',h} d_{i',h}} = n_{i',m} \left(\frac{\tau_{i',m',m} P_{h'}}{M_{i',h}} \right)^{1-\sigma}. \tag{14}$$

Assuming thick markets, firms charge a constant proportional markup over marginal costs: $P_{h'} =$

[19] We assume the iceberg cost share depends upon distance, but is independent of industry.

$\frac{\sigma}{\sigma-1}C_{h'}$. Hence, profits (before fixed cost) are a fixed proportion $\frac{1}{\sigma}$ of total output value. If each firm consumes a fixed volume of its own output, ϕ, and there is monopolistic competition, then $n_{h'} = \frac{Y_{h'}}{\sigma\phi P_{h'}} = \frac{Y_{h'}}{\sigma\phi}\frac{1}{\frac{\sigma}{\sigma-1}C_{h'}}$. Hence

$$\chi_{h',h} = \frac{Y_{h'}}{\sigma\phi}\frac{1}{\frac{\sigma}{\sigma-1}C_{h'}}\left(\frac{\tau_{i',m',m}\frac{\sigma}{\sigma-1}C_{h'}}{M_{i',h}}\right)^{1-\sigma} = \frac{Y_{h'}}{\sigma\phi}M_{i',h}^{1-\sigma}\tau_{i',m',m}^{1-\sigma}\left(\frac{\sigma}{\sigma-1}C_{h'}\right)^{-\sigma}. \quad (15)$$

Next, we rely on a 'stylized fact' of many gravity studies (e.g. Head et al. (2010)) that, once the correction is made for output scale and multilateral resistances, unit iceberg trade costs are roughly inversely proportional to distance, $d_{m',m}$, so

$$\tau_{h',m} = td_{m',m}^{\frac{1}{\sigma-1}}, \quad (16)$$

where t is a constant, which we may allow to vary by industry, so that

$$\chi_{h',h} = \frac{1}{\sigma\phi}\left(\frac{\sigma}{\sigma-1}\right)^{-\sigma}t^{1-\sigma}\frac{Y_{h'}}{d_{m',m}}C_{h'}^{-\sigma}M_{i',m}^{1-\sigma} = \quad \frac{Y_{h'}}{d_{m',m}}C_{h'}^{-\sigma}M_{i',m}^{1-\sigma}, \quad (17)$$

substituting in a constant ψ.

Summing across purchases from all sources, these add up to demand,$D_{i',h}$, so that

$$D_{i',h} = \psi M_{i',m}^{1-\sigma}\sum_{m'=1}^{\mu}\frac{Y_{h'}}{d_{m',m}}C_{h'}^{-\sigma} \implies M_{i',m}^{1-\sigma} = \frac{D_{i',h}}{\sum_{m'=1}^{\mu}\frac{Y_{h'}}{\triangle_{m',m}}C_{h'}^{-\sigma}}. \quad (18)$$

This gives us a formula for **input product-level multilateral resistance**. Next define

$$G_{i',m} = \sum_{m'=1}^{\mu}\frac{Y_{h'}}{\triangle_{m',m}}; \ \tilde{C}_{i',m} = \frac{\sum_{m'=1}^{\mu}\frac{Y_{h'}}{d_{m',m}}C_{h'}^{-\sigma}}{\sum_{m'=1}^{\mu}\frac{Y_{h'}}{d_{m',m}}}, \quad (19)$$

where G_{hz} is a gravity index (or inverse peripherality index) for product of industry h sold to municipality z and $\tilde{C}$ is a gravity-weighted index of production costs. We write

$$M_{i',m} = \varphi\left(G_{i',m}\tilde{C}_{i',m}\right)^{\frac{1}{1-\sigma}} \implies lnM_{i',m} = ln\varphi + \frac{1}{1-\sigma}lnG_{i',m} + \frac{1}{1-\sigma}ln\tilde{C}_{i',m}, \quad (20)$$

where φ is a constant.

B.3 Upper level of the production function: aggregation of the outputs of different industries

Next, firm h (the representative firm in i, m), combines inputs from each industry i' and labour. We model this by combining the aggregate price of each input i' in destination municipality m, $M_{i',h}$, which we then combine with the input price of all other industries and labour into h using Cobb-Douglas weightings.

$$C_{i,m} = a_i^{-a_i} \prod_{i'=1}^{I} b_{i',i}^{-b_i} M_{i'm}^{b_i} = \left(a_i^{-a_i} \prod_{i'=1}^{I} b_{i',i}^{-b_i} \right) \prod_{i'=1}^{I} M_{i',h}^{b_i}, \tag{21}$$

where a_h is the labour input share parameter, $b_{i'i}$ is the input share parameter for industry i' by industry i in municipality m. Combining share parameters as a constant, Ω_h, we can rewrite equation (21) in logs as

$$C_h = \frac{1}{\Omega_h} \left[a_i + \sum_{i=1}^{I} b_{i',i} ln M_{i',h} \right]. \tag{22}$$

Imposing the restriction that $a_h + \sum_{i'=1}^{I} b_i = 1$ ensures that costs are homogeneous of degree 1 with respect to input costs.

Defining input access,

$$IA_h = \sum_{i'=1}^{I} b_{i',i} ln G_{i',m}, \tag{23}$$

where $b_{i',i}$represents supply shares from the input-output tables, we can substitute into (20) to derive

$$lnC_h = A_i - BIA_h - B \sum_{i'=1}^{I} b_{i',i} ln\tilde{C}_{i',m}. \tag{24}$$

Note that B is negative. While we could model $\sum_{i'=1}^{I} b_{i',i} ln\tilde{C}_{i',m}$ econometrically as a location-specific fixed effect variable, there is potential collinearity with the input access parameter, so we prefer to use a proxy:

$$\sum_{i'=1}^{I} b_{i',i} ln\tilde{C}_{i',m} = \nu - \gamma IA_h + \varepsilon_{i',m}, \tag{25}$$

where ν and ε represent a constant term (fixed effect) and a stochastic term r espectively. Consequently, by substituting from equation(25) into equation(24) we can write the equation with a multiplied input access term and a location-specific fixed effect:

$$lnC_h = [A_i - B\nu] - B(1+\gamma) IA_h - B\varepsilon_{i',h}. \tag{26}$$

This forms the basis for the inclusion of input access in our estimating equation.

B.4 Market access

Given the 'thick' market assumption, representative firm h in i, m's which sales to other firms will be determined by a weighted sum of market potentials by industry (this time using the output ratio coefficients from the input-output matrix for weighting). Consider first its sales to all firms in h'. Adapting (17), and noting that purchases from industry i by industry i' in m' using input-output coefficients are $b_{_{i,i'}} Y_{h'}$, we can write

$$\chi_{h,h'} = \upsilon b_{i,i'} \frac{Y_{h'}}{d_{m',m}} C_h^{-\sigma} M_{i',m}^{1-\sigma}. \tag{27}$$

Considering sales by h to all firms in industry i' across all municipalities, the gravity formula will yield

$$X'_{h,i'} = \upsilon b_{i,i'} C_h^{-\sigma} \sum_{m'=1}^{\mu} \frac{Y_{h'}}{d_{m',m}} C_h^{-\sigma} M_{i',m}^{1-\sigma} = \upsilon C_h^{-\sigma} b_{i,i'} \mathit{\Gamma}_{i,i'm'} \tilde{M}_{i',m},$$

and we construct a gravity sales index

$$\mathit{\Gamma}_{m,i'} = \sum_{m'=1}^{\mu} \frac{Y_{h'}}{d_{m',m}}; \;\; \tilde{M}_{i',m} = \frac{\sum_{m'=1}^{\mu} \frac{Y_{h'}}{d_{m',m}} M_{i',m}^{1-\sigma}}{\sum_{m'=1}^{\mu} \frac{Y_{h'}}{d_{m',m}}}. \tag{28}$$

Consequently,

$$X'_{h,i'} = \upsilon b_{i,i'} C_h^{-\sigma} \mathit{\Gamma}_{i,i',m} \tilde{M}_{i',m}, \tag{29}$$

and summing across all purchaser industries,

$$y_h = \upsilon C_h^{-\sigma} \sum_{i'=1}^{I} b_{i,i'} \mathit{\Gamma}_{i,i'm} \tilde{M}_{i',m}. \tag{30}$$

Noting that the number of firms in i, m, $n_{i,m} = \frac{Y_{i,m}}{\sigma\phi}\frac{1}{\frac{\sigma}{\sigma-1}C_{i,m}}$, total sales by firms in i, m are

$$Y_h = n_h y_h = \frac{(\sigma-1)\,Y_h}{\sigma^2\phi}C_h^{-\sigma-1}\sum_{i'=1}^{I} b_{i,i'}\mathit{\Gamma}_{i,i',m}\tilde{M}_{i',m}. \tag{31}$$

We can rearrange this as

$$C_h^{\sigma+1} = \frac{(\sigma-1)}{\sigma^2\phi}\sum_{i'=1}^{I} b_{i,i'}\mathit{\Gamma}_{i,i',m}\tilde{M}_{i',m} \Longrightarrow C_h^{\sigma-1} \approx \mathit{\Upsilon}\sum_{i'=1}^{I} b_{i,i'}\mathit{\Gamma}_{i,i',m}, \tag{32}$$

holding $\tilde{M}$ approximately constant.

We define market access as

$$MA_h = \sum_{i'=1}^{I} b_{i,i'}\mathit{\Gamma}_{i,i',m}, \tag{33}$$

but we also note that the first-order Taylor series approximation around point ($\mathit{\Gamma}_{i,i',m}$ =1) is

$$\sum_{i'=1}^{I} b_{i,i'} ln\mathit{\Gamma}_{i,i',m} = 0 + \sum_{i'=1}^{I} b_{i,i'}\left(\mathit{\Gamma}_{i,i',m} - 1\right) = \sum_{i'=1}^{I} b_{i,i'}\mathit{\Gamma}_{i,i',m} - \sum_{i'=1}^{I} b_{i,i'}. \tag{34}$$

Hence we can replace MAi,m with a modified variable

$$\hat{M}A_h = \sum_{i'=1}^{I} b_{i,i'}\mathit{\Gamma}_{i,i',m}, \tag{35}$$

and an industry-specific constant, which is very similar in form to the calculation for input access (just using different weightings).