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MARSHALL VS JACOBS AGGLOMERATION AND THE MICRO-LOCATION OF FOREIGN AND DOMESTIC FIRMS

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ABSTRACT

This paper examines the factors determining the subnational geographic location of the investments of multinational enterprises (MNEs). Building on the tension between the costs and benefits that agglomeration confers on firms, we compare and contrast Marshallian and Jacobian agglomeration mechanisms to understand the micro-location patterns of domestic and foreign firms. We test these ideas on a dataset of 387.000 workplace-year observations located across 93 municipalities in Denmark. The results show that while agglomeration is systematically related to both foreign and domestic location patterns, some of these relationships vary across agglomeration types and across subsamples of domestic and foreign workplaces. We also demonstrate the importance of controlling for global connectivity, which may otherwise confound these relationships.

Keywords: Agglomeration, Marshall, Jacobs, Global cities, Cluster, Location choice
JEL classification: F23

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1. INTRODUCTION

Foreign direct investment (FDI) remains an important driver of economic development for the location in which the investment takes place. FDI inflows are associated with economic growth, high-value employment, increased standard of living, productivity, innovation, know-how as well as capability enhancements (Barrell & Pain, 1997; Borensztein, De Gregorio and Lee, 1998; Buckley, Clegg, & Wang, 2002; Javorcik, 2004; Haskel, Pereira, & Slaughter, 2007). For these reasons, countries, regions, states, municipalities and even cities compete vigorously to attract such investments (Mudambi & Mudambi, 2005; Hutzschenreuter et al., 2020). This has not escaped the attention of scholars, who have devised location choice models to predict the investment choices made by Multinational Enterprises (MNEs). These studies have enriched our understanding of location factors that give rise to economic costs and benefits for MNEs as well as to market imperfections, including market size, entry barriers (e.g., taxes and tariffs), cost of transportation and production, quality of formal institutions, agglomeration economies, currencies, and government incentives (for a recent review, see Nielsen, Asmussen & Weatherall, 2017). A small but increasing subset of studies have furthermore investigated micro-spatial (micro-geographic) location decisions by firms (e.g., Dubé, Brunelle, & Legros, 2016; Cissé, Dubé, & Brunelle, 2020, Nielsen, Asmussen & Goerzen, 2018; Nielsen, Asmussen & Weatherall, 2017) though rarely distinguishing between domestic and foreign firms. For instance, a recent study by Ye et al. (2019) analyzed FDI location choice in the Pearl River Delta as a function of micro-geographical characteristics; Belkhodja and colleagues (2017) studied FDI micro-location determinants in Chinese economic zones; and Cissé and colleagues (2020) demonstrated the importance of congestion diseconomies in influencing new business formation. However, none of these studies explicitly compared domestic to foreign firm's location choices.

Among the location characteristics that have been studied, few have received as much attention as *agglomeration*. The idea that foreign investments are attracted to geographically dense populations of firms, i.e. clusters, has proven to be a powerful predictor of foreign location choices (Crozet & Mayer, 2004; Head, Ries, & Swenson, 1995). Yet, research on agglomeration and clustering has raised as many questions as it has answered. Multiple types of clustering have been identified (Beaudry & Schiffauerova, 2009); both predicted and observed effects of such clustering on foreign location have been found to vary in direction (Chang & Park, 2005); and a number of complementary and competing explanations for these effects, based on costs and benefits of agglomeration, have been developed by scholars (Baum & Haveman, 1997; Shaver & Flyer, 2000; Yang et al., 2019).

To reconcile these various ideas, this paper reviews the implications of agglomeration and develops the argument that the balance of costs and benefits differ across different types of agglomeration (Marshallian vs Jacobian and foreign vs domestic firms) as well as a across different types of investments (FDI vs domestic investments). We then empirically examine the relationship between agglomeration and location choice across this taxonomy in a large sample of workplaces in Denmark. Our key assertion behind this analysis, which is also confirmed by our results, is that foreign firms and domestic firms are inherently different in their characteristics and motivations for investment, and these differences translate into diverging locational patterns as observed in the relationship between specific agglomeration variables and workplace location.

2. AGGLOMERATION: AN ORGANIZING FRAMEWORK

A basic definition of agglomeration is the presence of a large number of companies in close geographic proximity to one another. The defining mechanism of agglomeration economies, then, is that the co-location of firms creates (positive and negative) externalities, and that these externalities are geographically bounded. As summed up in Figure 1, the literature points to a number of such externalities, broadly categorized into knowledge spillovers, market transactions, and competition. In addition, each of these externalities may occur both among firms within the same industry, in which case we refer to them as Marshallian, and across industries, in which case we describe them as Jacobian. The following sections elaborate on this framework.

*** Figure 1 About Here ***

Knowledge Spillovers

In his seminal work on agglomeration, Marshall (1920) described intra-industry knowledge spillovers as one of three key mechanisms leading to the formation of industrial clusters. As these spillovers are bounded in geographic space (Jaffe et al., 1993), firms need to locate in close proximity to one another to fully reap their benefits. Co-location of firms in an industry might, for example, improve the mobility of workers between the firms and enable workers to form social relationships across competing employers, two mechanisms by which (unintended) knowledge spillovers may occur. Of course, the pursuit of such knowledge spillovers through a locational strategy is a balance between the benefits of acquiring new knowledge and the risk of losing proprietary knowledge to current or potential competitors. As demonstrated by Shaver & Flyer (2000), this balance may be unfavorable for firms with particularly strong knowledge-based competitive advantages, who effectively might want to use geographic separation as an isolating mechanism. On the other hand, if a firm competes against rivals in other countries, the benefits of these knowledge spillovers might outweigh the costs.

Knowledge spillovers need not be confined within industry boundaries—in fact, industry-specific knowledge flows may be insufficient because clustering can create a risk of "groupthink" that can stifle innovation (Porter, 1998). Hence, as first described by Jacobs (1969), industrial diversity also stimulates innovation because breakthrough technologies in one industry can have unforeseen applications in other industries. Especially in early stages of product or process development, a diverse industrial environment might enable firms to experiment with different technologies (Duranton & Puga, 2001). Such diversity is likely to be present in major metropolitan areas and, in particular, in global cities (Sassen, 1991; Asmussen et al. 2019). Henderson, Kuncuro, & Turner (1995) show that high-tech industries are more likely to emerge in cities where diversity is high, attributing it to the importance of Jacobs type externalities in such industries.

Market transactions

Geographic proximity reduces market transaction costs through a number of mechanisms. First, co-location of buyers and sellers reduces search costs and thereby lead to more efficient matching of supply and demand (McCann & Folta, 2009). Second, the scope for opportunism may be reduced if buyers and sellers are located close to each other, both because the location-specific investments set up an expectation of repeated transactions and because it facilitates face-to-face contact, which in turn is associated with trust (Storper & Venables, 2003). Agglomeration of a certain industry in a certain location hence induces and is induced by agglomeration of related and supporting industries in that location also (Porter, 1990), leading to the second of Marshall's (1920) three industry-specific agglomeration mechanisms.

The market transaction logic can also be extended to the endogenous location of specialized human capital (Kottaridi & Nielsen, 2003). For example, software engineers move to Silicon Valley due to the abundance of jobs, and software firms locate there to tap into this labor force, reflecting labor market pooling as Marshall's (1920) third industry-specific agglomeration mechanism. Similar logic may apply to markets for technology. For example, Mowery and Ziedonis (2001) found that technology licensing was even more geographically localized than knowledge spillovers as evidenced by patent citations, ascribing this finding to the incomplete nature of licensing contracts and the need of licensees to tap into inventors' complementary tacit knowledge.

Like knowledge spillovers, however, market transactions need not only be industry-specific (e.g. such as the examples above pertaining to software engineers and technology licensing). Some suppliers deliver products or services that are applicable in a wide variety of industrial contexts, in particular *advanced producer services*, including finance, accounting, advertising, law, and consulting (Taylor, 2011). These go into the generic 'support functions' that exist in parallel to the value-added activities in all firms irrespective of the industries or markets they operate in. Furthermore, they exhibit at the same time a high degree of global integration (with the leaders in these industries having a worldwide presence) and a high degree of localization (often at district level as seen for example on Wall Street and Madison Avenue). Because of this, these services tend to agglomerate in global cities (Sassen, 1991). At the same time, industry-agnostic labor market pooling also occurs in such cities, where diverse industries create a demand for highly skilled labor such as managers, accountants, marketing specialists, etc.

Competition

In addition to the effects on knowledge spillovers and market transaction costs, agglomeration also influences the competition that firms face in product and factor markets (Du, Lu & Tao, 2008). In terms of product markets, when firms in a certain industry are concentrated in a certain location, customers may have low search and switching costs and be able to compare quality and prices more easily, leading to stronger rivalry between those firms (Porter, 1985). This is especially the case if the firms' distribution and sales activities have a low geographic reach and if there is a tendency toward mutual co-location of the firms and their customers (relating to the market transaction argument above).

Perhaps even more than for customers, firms in an industrial cluster also compete for scarce local production factors, including human resources (Nie & Sun, 2015). Hence, the flip side of the labor pooling benefits described above is the intensified competition for talent. For example, the best software engineers in Silicon Valley would have many outside opportunities and an according ability to drive up their salaries (a key reason for them to locate there to begin with). Which of these opposing effects that dominates may depend on the strength of the competitive advantages of a given firm, which determines its ability to profitably compete on salaries and benefits to get the most productive workers.

However, competition for local resources is not always industry-specific. In industry-diversified agglomerations, such as global cities, a similar type of competition for talent will take place in markets for managers and other workers specializing in headquarters support functions. In addition, a particularly important and industry-agnostic resource is physical space, which rapidly becomes in short supply as the degree of urban agglomeration intensifies. This implies that diseconomies of agglomeration set in, sometimes referred to as "congestion costs" (Nie & Sun, 2015; Nielsen et al., 2017; Cissé et al, 2020). In practice, firms will need to pay higher direct costs for office space, as well as higher salaries to compensate employees for their commuting and/or living costs. Whether it is rational for a particular firm to incur these costs depend, in turn, on the agglomeration benefits that it expects to reap in return.

Multinational Enterprises and Agglomeration Effects: Empirical implications

The discussion above suggests that agglomeration can be of the industry-specialized (Marshallian) or industry-diversified (Jacobian) type, and that each of these comes with various cost and benefits. However, it also suggests that an additional contingency moderating these effects is the geographic scope of the firm, since the costs and benefits of agglomeration may not apply evenly to domestic and foreign firms.

It is ambiguous how industrial clustering influences MNEs compared to domestic firms. On the one hand, foreign firms could be argued to benefit more from Marshall type externalities than domestic firms do, for several reasons. Specifically, MNEs can be considered as efficient vehicles for globally leveraging knowledge (Kogut & Zander, 1993), as they possess systems and capabilities to access local knowledge, mobilize it throughout the global MNE network, and monetize it in geographically dispersed markets (Doz, Santos, & Williamson, 2001). Furthermore, they have access to diverse knowledge from different knowledge environments and can combine complementary knowledge elements internally, an ability that is often considered a unique source of competitive advantage that domestic firms cannot gain (Kottaridi & Nielsen, 2003; Asmussen, Pedersen, & Dhanaraj, 2009; McWilliam et al., 2019). These factors create synergies between industrial clustering activities in the local environment and MNE activities in other countries. On the other hand, since MNEs are likely to have stronger knowledge-based advantages than domestic firms do, seeking out industrial clustering may put them at greater risk for unintended knowledge spillovers to local firms, who might in turn become competitors.

It is somewhat clearer that MNEs may draw greater benefits from Jacobian agglomeration than domestic firms do. Goerzen et al. (2013) demonstrate that MNEs are disproportionately attracted to global cities, where such agglomeration is prevalent. In particular, advanced producer service agglomerations are valuable to MNEs because the service firms themselves are global, and help their customers obtain global integration benefits and thereby achieve superior coordination and control.

Finally, the impact of agglomeration on entrant firms is also likely to be a function of the types of firms that constitutes the local cluster. Specifically, foreign firms in a local cluster may contribute to the local business environment with different resources and externalities compared to domestic firms. For instance, Borensztein and colleagues (1998) found that foreign firms contribute relatively more to local growth than domestic firms do presumably because they possess superior technologies, skills, and knowledge. This, in turn, has implications both for the strength of the knowledge spillovers that entrants can reap in a cluster and for the strength of the competition that they will encounter there.

In sum, the above review indicates that agglomeration is a multifaceted phenomenon where opposing arguments can be constructed contributing to *centrifugal* and *centripetal* forces influencing the location of firms. Thus, we would expect heterogenous impact of various positive and negative agglomeration effects, specific or agnostic to certain industries and/or ownership, on various firm populations (see also Fang et al., 2020 for inter-city linkage and agglomeration). Accordingly, we present an exploratory empirical study designed to inform us on these issues on a fine-grained level.

3. DATA AND EMPIRICAL METHODOLOGY

We apply sub-national data (Hutzschenreuter et al., 2020) from a small European welfare state—Denmark—and use within-country variation to look at the correlation between FDI and domestic investments on one hand, and micro-locations characteristics on the other—in 93 Danish municipalities**.** Our data consists of the full population of workplaces from the annual administrative records collected by Statistics Denmark for the years 2007-2016. Statistics Denmark collects data on both firms and the workplaces within these firms (e.g. locations or sites where the firm has employees), and we distinguish between foreign and domestic (Danish) ownership of these workplaces in different sectors. As a source of economic and demographic data, Statistics Denmark is unique in its scope and completeness and offers several advantages for our analysis. First, it provides a full population database, since all Danish firms are required by law to register their activity, and these activities are collected through the administrative records by Statistics Denmark. Second, it provides complete and matching records on firms, the workplaces under these firms, and the individuals working at these workplaces, a feature that enables us to construct a number of measures based on the concepts from our theory section. Hence, for every year, we have information on the location of each workplace in Denmark, all of its employees, whether it is Danish or foreign owned, variables on industrial clustering and global connectivity characteristics, and a number of other explanatory variables (e.g. unemployment in municipalities, share of workers with higher education, etc.). The spatial unit used in the analysis is municipalities and thus several of our control variables are measured at the municipality level.

The sample is restricted to workplaces with at a minimum of five full-time employees, due to irregular economic activity in the smallest workplaces. These workplaces hold around 30% of workplaces in the private sector, but they employ 85% of the workers in the private sector. Also, we focus on workplaces in the private sector to avoid considering the politically driven location decisions of workplaces in the public sector. In Denmark, the public sector accounts for around 30-35% of all full-time employees and this figure does not vary much across municipalities. With these limitations, we identify 79,811 unique workplaces (9,166 foreign and 70,645 Danish) in the period 2007-2016, equivalent to approximately 387,000 workplace-year observations.

Conditional Logit Model

In our analysis we use a conditional logit model to estimate the probability of a workplace choosing to locate in a municipality, given the set of alternative municipalities. Our choice of this model is based on precedence in the location choice literature (Nielsen et al., 2017), and it has been shown that this model, in spite of its restrictive assumptions, produces estimates similar to a random effects model (Haan, 2006). Following from our discussions above (summarized in Figure 1), positive and negative agglomeration effects produce location-specific performance elements which, in turn, are likely to influence firms' location choices. To formalize this argument, suppose that the profits of firm *i*, operating in industry j, when locating in municipality *k* is given by $\pi_{ijk} = f(x_k, z_{jk})$, where x_k is a vector of location characteristics for municipality *k*, and z_{jk} is a vector of agglomeration effects specific to the agglomeration of industry *j* in municipality *k*. We follow the convention (see e.g., Dubé et al, 2016) and assume that *f* is a linear and additive function of its arguments, such that

$$\pi_{ijk} = \beta_0 + \beta_1 \cdot x_k + \beta_2 \cdot z_{jk} + \varepsilon_{ijk}, \tag{1}$$

Where the β are coefficient vectors and ε is a random component. In the conditional logit model, the set of alternatives is included in the analysis and the model allows for differences in the available alternatives across individual locations (McFadden, 1973). The assumption is that the firm will choose municipality *k* (out of *K* possible alternatives) if it provides the highest expected profits, i.e. if $\pi_{ijk} = \max(\pi_{ij1}, \pi_{ij2}, \dots, \pi_{ijK})$. Based on this, the conditional logit model calculates the probability of a workplace locating in each of the municipalities in the stratum relative to all other alternatives, with the dependent variable equal to one for the alternative that was chosen (and zero for all other locations). In contrast to a regular logistic regression, the data in the conditional logit analysis are grouped and the likelihood is calculated relative to each group. It can be shown that, with certain assumptions about ε (see Maddala, 1983), the likelihood of locating in municipality *k* then becomes:

$$P_{ijk} = \frac{\exp(\beta_0 + \beta_1 \cdot x_k + \beta_2 \cdot z_{jk})}{\sum_{n=1}^{K} \exp(\beta_0 + \beta_1 \cdot x_n + \beta_2 \cdot z_{jn})} \qquad (2)$$

In Eq (2), P_{ijk} is the probability that workplace i, in industry j, locates in municipality k. K is the number of unordered alternatives, i.e. the number of alternative municipalities. We report the regression results as *odds ratios*, which is done by exponentiating both sides of the conditional logistic regression equation. For example, an odds ratio from this transformed model of 1 implies that the given characteristic is unrelated to the location choice, while if the odds ratio is equal to 2, a one-unit increase in an independent variable doubles the odds that the location is chosen. The conditional logit model allows estimation of probability of micro-location choice under various conditions of agglomeration in accordance with our theoretical framework. Our key interest is in the β coefficients which, based on our theoretical discussion, can be expected to diverge across the samples of domestic and foreign firms.

Agglomeration measures

Consistent with our theoretical framework, we operationalize agglomeration along two dimensions. First, we measure Marshall agglomeration with the density of workplaces within the *same* industry in the same municipality, while Jacobian agglomeration is measured as the density of workplaces in *other* industries (excluding the industry of the focal firm) in the municipality. Second, for each of these agglomeration types, we calculate the density of foreign owned workplaces and domestic owned workplaces separately. This results in four agglomeration measures that relate to different theoretical mechanisms.

Controls

A number of different control variables are used in the analysis in order to both rule out confounding effects but also investigate the importance of these for our main models (Nielsen & Raswant, 2018). Firstly, we include various global connectivity characteristics that have been shown to influence location choice (Asmussen et al., 2019). Seven different variables define the global connectivity in the analysis. The presence of advanced producer services is assessed using a density measure on number of producer service workplaces per square kilometer in the municipality. We also include three variables of cosmopolitanism. The variable for culture diversity in the municipality is measured with an inverse Herfindahl index ranging from 0 to 1. Furthermore, a variable for density of workplaces in culture and entertainment in the municipality, and a variable for number of museums per square kilometer, are included. The last subset of global connectivity characteristics concerns infrastructural sites. We use proximity to airports, and country borders, and a density measure for modular trucking platforms in the municipality. The proximity measures are inverse distances (in 100km) are measured with QGIS from the center of each municipality to the infrastructural sites, and all measurements are calculated via the Danish road network. In addition, we also include a number of more general controls. These include share of workers with higher education, population density, unemployment rate, and number of workers at the workplace divided by workers in the same sector in the municipality. Finally, we include a dummy for year of observation.

Descriptive statistics

Table 1 shows means and standard deviations for all variables used in the analysis for both the full sample, Danish workplaces and foreign workplaces. The t-tests for the Danish and the foreign workplaces show that statistic significant differences between the two samples' means exist.

Table 1 about here

First and foremost, we observe that foreign workplaces are located in municipalities with consistently higher agglomeration levels of all four types. In addition, table 1 also shows that foreign owned workplaces are located in more highly globally connected municipalities as evidenced by being situated closer to airports and borders and having higher densities for modular trucking platforms and producer services.

Table 2 shows the Pearson correlations amongst the variables in our model. As expected, we note that the four types of agglomeration (variables 2-5) are relatively highly correlated with each other. They also correlate with some of the control variables; specifically, some of the connectivity measures and population density. Given the very large sample size this should not negatively affect our results (Allen, 1997) and we proceed to interpret our conditional logit model.

Table 2 about here

4. RESULTS

We estimate the conditional logit model for the domestic and foreign workplaces separately. For each subsample (domestic versus foreign), we proceed in two steps. The first column (model 1) in Table 3 below shows the estimates for the four agglomeration variables only, while model 2 includes the control variables.

*** Table 3 about here ***

First, we look at the association of agglomeration with the location of domestic firms (models 1 and 2). Domestic Marshall agglomeration is positively related to domestic workplace location in both models 1 and 2, suggesting that domestic firms perhaps draw benefits such as knowledge spillovers and labor pooling amongst each other. However, the estimates of Jacobs agglomeration changes with the addition of the control variables (model 2) in various ways. Specifically, we observe that in the absence of controls, domestic Jacobs agglomeration has a negative significant association with domestic workplaces. Interestingly, however, when the controls are added, this changes to a positive significant relationship. This perhaps indicates that this type agglomeration co-occurs with certain negative externalities that are somewhat absorbed in the coefficient in model 1. As soon as we control for these negative externalities—in particular population density as seen in model 2—we see that the domestic Jacobs agglomeration has positive association with domestic workplace location. Hence, it appears that domestic firms like both Jacobs and Marshall agglomeration created by other domestic firms but dislike the congestion that comes with it.

For the foreign agglomeration variables, however, we see the opposite pattern; the coefficients on both foreign Marshall and Jacobs agglomeration are positive without controls but negative with controls. An interpretation of this is that the positive coefficients in model 1 are accounting for some of the positive externalities that co-occurs with foreign agglomeration; in particular cultural diversity and higher education as seen in model 2. Hence, it appears that once controlling for local human resource endowments, domestics firms are in fact hurt by foreign Jacobs agglomeration. This might be explained by increased congestion and competition brought by the foreign firms, while at the same time the domestic firms may not have the absorptive capacity to benefit from the diverse knowledge contributed by these firms.

Turning our attention to the location of foreign workplaces (models 3 and 4), we observe a somewhat similar pattern but with some key differences. First, we find that Marshall agglomeration (both foreign and domestic) is consistently positively associated with the location of foreign firms. We also find that foreign Marshall agglomeration seemingly has a stronger effect than domestic Marshall agglomeration does, consistent with the view of foreign firms bringing superior industry specific knowledge to the market (Porter, 1990).

The coefficient for domestic Jacobs agglomeration again is negative in model 3 but becomes positive when we include the control variables (model 4). This perhaps indicates that foreign firms benefit from domestic Jacobs agglomeration in a similar way as domestic firms do, e.g. by tapping into diverse knowledge inputs. Finally, foreign Jacobs agglomeration has a negative association with location of foreign firms. This is surprising inasmuch as one might have expected it to be positively related, at least to foreign location, based on arguments from the global city literature (Sassen, 1991; Sim et al., 2003; Goerzen et al., 2013). This perhaps indicates that negative competition effects dominate the positive innovation effects, pointing towards congestion in global cities as a key challenge for all types of firms. Still, the coefficient size of foreign Jacobs agglomeration indicates a less strongly negative (0.941 versus 0.880) relationship with foreign workplace location compared to domestic workplace location. This finding could indicate that foreign firms are better able than domestic firms to access and absorb the benefits of foreign Jacobs agglomeration and/or less hurt by the negative congestion effects.

The indication of congestion effects in our results supports and extends the recent findings by Cissé et al (2020). It is arguably surprising that these effects come out so strongly in our empirical context, as Denmark is a relatively small country where the largest city houses only approximately 1 million people. However, it is also a very densely populated country, underscoring that congestion is not as much driven by the absolute size of the population of suppliers and customers, but by the competition for access to scarce real estate that provide access to these populations. The fact that population density has a strong negative association with location (odds ratios around 0.6), and that its addition to the model (along with the other control variables) changes the agglomeration coefficients, indicates that it is very possible to misestimate agglomeration effects if one fails to adequately control for congestion.

*** Table 4 about here ***

Of course, the result we report here are grand averages over a wide variety of industries. As a robustness analysis, we therefore split our sample into four sectors and explore the extent to which the mechanisms we study diverge across these: manufacturing, retail and wholesale, services, and other industries (the latter including transportation and construction, among others). We report the results in Table 4. As shown in this table, the industry effects are most evident when looking at manufacturing. For manufacturing, domestic Marshall clustering is strongly related to domestic workplace location, and foreign Marshall to foreign workplace location, a pattern that is not seen to the same extent in the three other sectors. This could indicate that industry-specific clustering is particularly relevant for manufacturing, perhaps because of the importance of specialized labor and physical infrastructure, but also that such clustering is specific not only to the industry but also to the ownership—foreign or domestic—of the workplaces. Hence, it is possible that foreign manufacturing firms rely on entirely different types of knowledge spillovers, labor, and infrastructure compared to domestic firms, perhaps because the former are more technologically advanced than the latter and/or suffer from liabilities of foreignness. We can also see that the only type of foreign firm to apparently benefit from domestic Marshall clustering is in retail and wholesale. Arguably, at that point in the value chain the most knowledge-intensive stages of production have been completed and hence the origin of the firm matters less compared to more general logistical issues. These analyses underscore the importance of distinguishing between foreign and domestic firms when studying agglomeration effects.

5. CONCLUSIONS AND DISCUSSION

This paper has empirically demonstrated that agglomeration is a multifaceted phenomenon worthy of more investigation. We have distinguished between, on the one hand domestic versus foreign agglomeration, and on the other hand between Marshall and Jacobs type externalities. This distinction produces valuable new insights into the ongoing debate about determinants of micro-location choice (e.g., Goerzen et al., 2013, Asmussen et al., 2019; Nielsen et al., 2017). Specifically, we illustrate how Marshall and Jacobs agglomeration operate both simultaneously and independently to explain micro-location choice of both foreign and domestic firms. As such, we also contribute to the literature on clusters and the role of agglomeration in firm competitive and innovative behavior. For instance, our study points to both positive and negative externalities associated with particular types of agglomeration, which may help managers make decisions regarding how and where to locate and operate their activities (McWilliam et al., 2019).

We note that this study is exploratory in nature and we cannot make claims of establishing causality. In particular, we cannot rule out a degree of reverse causality, since we are including a full population of firms (some of which may have been around long enough to influence the local environment) rather than only new establishments (see Cissé et al, 2020). However, we would still be picking up the consequences of firms and workplaces that move in response to changing location characteristics, and our full population approach gives us a degree of statistical power in a small empirical context. While we have taken a first step towards disentangling dimensions of agglomeration, future research may seek to validate and extend our preliminary results by developing and testing specific hypotheses regarding the differential impact of Marshall and Jacobs agglomeration on firms' entry and location decisions, including domestic startup firms and foreign greenfield investments.

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Figure 1: Agglomeration externalities

Agglomeration Mechanism	**Within-Industry Marshallian**	**Across-Industry Jacobian**
Knowledge Spillovers	Industry- or product-specific technological knowledge	Knowledge diversity with fungible knowledge elements applicable across technological domains
Market Transactions	Value chain transactions with industry-specialized buyers and suppliers, or factor market transactions such as specialized labor	Transactions with industry-agnostic suppliers such as producer services
Competition	Product market competition and competition for specialized production factors such as labor	Competition for general production factors, in particular location and space, leading to congestion

Table 1: Means and standard deviations of variables included in the model

	All		Domestic workplaces		Foreign workplaces		Domestic vs. foreign
	Mean	Std. dev.	Mean	Std. dev.	Mean	Std. dev.	T test
Foreign ownership	0.133	0.340					
Domestic agglomeration/clustering variables							
Marshall: Number of workplaces in the same industry in the muni. (>5), per sqkm	1.407	2.974	1.345	2.932	1.814	3.203	***
Jacobs: Number of workplaces in other industries in the muni. (>5), per sqkm	6.647	12.200	6.343	11.992	8.622	13.305	***
Foreign agglomeration/clustering variables							
Marshall: Number of workplaces in the same industry in the muni. (>5), per sqkm	0.310	0.679	0.279	0.647	0.514	0.834	***
Jacobs: Number of workplaces in other industries in the muni. (>5), per sqkm	1.370	2.641	1.296	2.590	1.852	2.906	***
Controls							
Number of producer service firms in the muni. (>5), per sqkm	0.814	1.266	0.777	1.253	1.057	1.323	***
Culture diversity variance multipl. with share of immigrants in the muni.	6.960	3.604	6.820	3.561	7.870	3.747	***
Workplaces in culture & entertainment in the muni. (>5), per sqkm	0.395	0.789	0.376	0.774	0.520	0.870	***
Museums in the muni., per sqkm	0.078	0.214	0.075	0.213	0.094	0.222	***
Proximity to airport, 100 km	-0.498	0.334	-0.508	0.335	-0.428	0.317	***
Proximity to border, 100 km	-1.075	0.823	-1.100	0.824	-0.915	0.795	***
Modular trucking platforms in the muni., per sqkm	0.987	2.726	0.927	2.539	1.379	3.695	***
Share of workers with higher education in the muni.	30.436	7.997	30.169	7.929	32.169	8.222	***
Population density in the muni., divided with 1000	1.329	2.561	1.274	2.532	1.686	2.714	***
Employed at the workplace divided with employed in the sector in the muni.	0.215	0.746	0.203	0.726	0.292	0.863	***
Share of unemployed in the muni.	4.967	1.725	4.932	1.717	5.194	1.758	***
Year							
2007	0.101	0.303	0.102	0.303	0.099	0.299	**
2008	0.106	0.309	0.109	0.312	0.093	0.291	***
2009	0.101	0.301	0.101	0.302	0.096	0.295	***
2010	0.097	0.296	0.097	0.296	0.096	0.294	
2011	0.099	0.299	0.099	0.299	0.099	0.298	
2012	0.097	0.296	0.097	0.297	0.095	0.293	**
2013	0.096	0.295	0.097	0.296	0.094	0.292	*
2014	0.098	0.297	0.098	0.297	0.097	0.296	
2015	0.100	0.300	0.099	0.298	0.112	0.316	***
2016	0.103	0.304	0.100	0.301	0.119	0.324	***
Observations	387,187		335,570		51,617		

Table 2: Correlation matrix of variables included in the model

	Variable number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Foreign owned workplace	1	1														
Marshall: Number of domestic workplaces in the same industry	2	0.054	1													
Jacobs: Number of domestic workplaces in other industries	3	0.064	0.869	1												
Marshall: Number of foreign workplaces in the same industry	4	0.117	0.891	0.794	1											
Jacobs: Number of foreign workplaces in other industries	5	0.072	0.840	0.956	0.797	1										
Producer service workplaces	6	0.075	0.751	0.838	0.695	0.784	1									
Cultural diversity	7	0.099	0.768	0.845	0.736	0.830	0.745	1								
Workplaces in culture & entertain.	8	0.062	0.895	0.970	0.828	0.941	0.751	0.856	1							
Museums	9	0.029	0.705	0.764	0.595	0.679	0.614	0.603	0.758	1						
Proximity to airport (inverse 100km)	10	0.082	0.474	0.525	0.466	0.522	0.534	0.583	0.509	0.365	1					
Proximity to border (inverse 100km)	11	0.076	0.455	0.504	0.452	0.502	0.536	0.546	0.488	0.353	0.247	1				
Modular trucking platforms	12	0.056	-0.040	-0.041	0.085	0.020	0.065	0.194	0.063	-0.105	0.112	0.130	1			
Percent with higher education	13	0.085	0.635	0.701	0.600	0.703	0.566	0.767	0.693	0.511	0.514	0.388	-0.084	1		
Population density	14	0.055	0.894	0.971	0.783	0.898	0.807	0.812	0.955	0.811	0.507	0.488	-0.064	0.694	1	
Share of local empl. in sector	15	0.041	-0.097	-0.082	-0.095	-0.085	-0.057	-0.110	-0.086	-0.061	-0.066	-0.001	0.007	-0.110	-0.080	1
Percent unemployed	16	0.052	0.364	0.394	0.364	0.412	0.308	0.499	0.403	0.236	0.100	0.163	0.142	0.314	0.352	-0.068

Table 3: Choice of municipality for each workplace
(Conditional logistic model with odds ratio)

	(1) Danish workplaces	(2) Danish workplaces	(3) Foreign workplaces	(4) Foreign workplaces
Domestic agglomeration/clustering variables				
Marshall: Number of workplaces in the same industry in the muni. (>5), per sqkm	1.221***	1.427***	1.149***	1.253***
	(0.002)	(0.003)	(0.004)	(0.007)
Jacobs: Number of workplaces in other industries in the muni. (>5), per sqkm	0.981***	1.142***	0.977***	1.100***
	(0.000)	(0.002)	(0.001)	(0.004)
Foreign agglomeration/clustering variables				
Marshall: Number of workplaces in the same industry in the muni. (>5), per sqkm	1.088***	0.820***	1.488***	1.358***
	(0.005)	(0.006)	(0.014)	(0.019)
Jacobs: Number of workplaces in other industries in the muni. (>5), per sqkm	1.125***	0.880***	1.234***	0.941***
	(0.002)	(0.002)	(0.004)	(0.007)
Number of producer service firms in the muni. (>5), per sqkm		0.629***		0.647***
		(0.003)		(0.008)
Culture diversity variance multipl. with share of immigrants in the muni.		1.108***		1.131***
		(0.001)		(0.004)
Workplaces in culture & entertainment in the muni. (>5), per sqkm		0.505***		0.446***
		(0.009)		(0.017)
Museums in the muni., per sqkm		1.294***		1.214***
		(0.014)		(0.031)
Proximity to airport, inverse 100 km		0.908***		1.263***
		(0.006)		(0.025)
Proximity to border, inverse 100 km		0.704***		0.762***
		(0.002)		(0.006)
Modular trucking platforms in the muni., per sqkm		1.000		1.007***
		(0.001)		(0.002)
Share of workers with higher education in the muni.		1.050***		1.068***
		(0.000)		(0.001)
Population density in the muni., divided with 1000		0.672***		0.756***
		(0.003)		(0.009)
Employed at the workplace divided with employed in the sector in the muni.		0.617***		0.584***
		(0.007)		(0.020)
Share of unemployed in the muni.		1.097***		1.176***
		(0.002)		(0.007)
N	31,208,010	31,208,010	4,800,381	4,800,381

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 4: Choice of municipality for each workplace in sectors (Conditional logistic model with odds ratio)

	(1)	(2)	(3)	(4)
	Manufacturing		Retail & Wholesale	
	Danish workplaces	Foreign workplaces	Danish workplaces	Foreign workplaces
Domestic agglomeration/clustering variables				
Marshall: Number of workplaces in the same industry in the muni. (>5), per sqkm	5.512***	1.102	1.404***	1.228***
	(0.241)	(0.107)	(0.008)	(0.012)
Jacobs: Number of workplaces in other industries in the muni. (>5), per sqkm	1.217***	1.103***	1.193***	1.173***
	(0.008)	(0.017)	(0.004)	(0.006)
Foreign agglomeration/clustering variables				
Marshall: Number of workplaces in the same industry in the muni. (>5), per sqkm	0.214***	6.119***	0.771***	1.217***
	(0.020)	(1.370)	(0.008)	(0.0236)
Jacobs: Number of workplaces in other industries in the muni. (>5), per sqkm	0.878***	1.039	0.787***	0.795***
	(0.010)	(0.030)	(0.005)	(0.010)
Number of producer service firms in the muni. (>5), per sqkm	0.438***	0.485***	0.625***	0.649***
	(0.009)	(0.030)	(0.005)	(0.010)
Culture diversity variance multipl. with share of immigrants in the muni.	1.092***	1.074***	1.095***	1.112***
	(0.004)	(0.00928)	(0.002)	(0.005)
Workplaces in culture & entertainment in the muni. (>5), per sqkm	0.364***	0.320***	0.503***	0.398***
	(0.022)	(0.0393)	(0.016)	(0.022)
Museums in the muni., per sqkm	1.630***	1.649***	1.389***	1.229***
	(0.080)	(0.139)	(0.028)	(0.043)
Proximity to airport, 100 km	0.927***	1.258***	0.911***	1.227***
	(0.015)	(0.053)	(0.011)	(0.036)
Proximity to border, 100 km	0.714***	0.817***	0.728***	0.809***
	(0.005)	(0.014)	(0.004)	(0.010)
Modular trucking platforms in the muni., per sqkm	1.007**	1.020***	1.004**	1.027***
	(0.003)	(0.006)	(0.002)	(0.003)
Share of workers with higher education in the muni.	1.021***	1.030***	1.051***	1.076***
	(0.001)	(0.003)	(0.001)	(0.002)
Population density in the muni., divided with 1000	0.540***	0.848**	0.607***	0.676***
	(0.015)	(0.062)	(0.005)	(0.011)
Employed at the workplace divided with employed in the sector in the muni.	0.700***	0.657***	0.372***	0.308***
	(0.008)	(0.022)	(0.010)	(0.023)
Share of unemployed in the muni.	1.027***	1.184***	1.125***	1.175***
	(0.005)	(0.016)	(0.004)	(0.010)
N	4,759,647	751,533	10,497,468	2,279,244

Table 4: Continued.

	(1)	(2)	(3)	(4)
	Services		**Other**	
	Danish workplaces	Foreign workplaces	Danish workplaces	Foreign workplaces
Domestic agglomeration/clustering variables				
Marshall: Number of workplaces in the same industry in the muni. (>5), per sqkm	1.234***	0.989	1.365***	0.896***
	(0.008)	(0.016)	(0.009)	(0.017)
Jacobs: Number of workplaces in other industries in the muni. (>5), per sqkm	1.182***	1.142***	1.129***	1.131***
	(0.004)	(0.009)	(0.004)	(0.015)
Foreign agglomeration/clustering variables				
Marshall: Number of workplaces in the same industry in the muni. (>5), per sqkm	0.941**	2.309***	1.323***	18.81***
	(0.023)	(0.146)	(0.048)	(1.827)
Jacobs: Number of workplaces in other industries in the muni. (>5), per sqkm	0.842***	0.895***	0.877***	0.866***
	(0.007)	(0.018)	(0.004)	(0.017)
Number of producer service firms in the muni. (>5), per sqkm	0.633***	0.687***	0.640***	0.594***
	(0.007)	(0.018)	(0.006)	(0.024)
Culture diversity variance multipl. with share of immigrants in the muni.	1.175***	1.260***	1.078***	1.123***
	(0.003)	(0.010)	(0.003)	(0.009)
Workplaces in culture & entertainment in the muni. (>5), per sqkm	0.382***	0.333***	0.557***	0.323***
	(0.013)	(0.027)	(0.018)	(0.038)
Museums in the muni., per sqkm	1.324***	1.244***	1.196***	1.587***
	(0.025)	(0.064)	(0.024)	(0.137)
Proximity to airport, 100 km	0.768***	0.931	0.993	1.596***
	(0.013)	(0.049)	(0.012)	(0.077)
Proximity to border, 100 km	0.607***	0.577***	0.742***	0.771***
	(0.004)	(0.012)	(0.004)	(0.015)
Modular trucking platforms in the muni., per sqkm	1.020***	1.016***	0.995***	1.004
	(0.002)	(0.005)	(0.002)	(0.006)
Share of workers with higher education in the muni.	1.084***	1.104***	1.040***	1.060***
	(0.001)	(0.003)	(0.001)	(0.003)
Population density in the muni., divided with 1000	0.706***	0.790***	0.704***	0.761***
	(0.007)	(0.020)	(0.007)	(0.034)
Employed at the workplace divided with employed in the sector in the muni.	0.634***	0.642***	0.835***	0.902***
	(0.010)	(0.032)	(0.015)	(0.020)
Share of unemployed in the muni.	1.081***	1.136***	1.135***	1.269***
	(0.005)	(0.017)	(0.005)	(0.018)
N	6,745,383	997,983	9,205,512	771,621

Author statement

All authors have contributed equally to all aspects of this work.