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Agglomeration, trade and selection ☆

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ABSTRACT

This paper studies how firm heterogeneity in terms of productivity affects the balance between agglomeration and dispersion forces in the presence of pecuniary externalities through a selection model of monopolistic competition with endogenous markups. It shows that firm heterogeneity matters. However, whether it shifts the balance from agglomeration to dispersion or the other way round depends on its specific features along the two defining dimensions of diversity: 'richness' and 'evenness'. Accordingly, the role of firm heterogeneity in selection models of agglomeration can not be fully understood without paying due attention to various moments of the underlying firm productivity distribution.

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1. Introduction

Does firm heterogeneity matter at the aggregate level? Since the seminal paper by Melitz (2003) on the associated 'new' gains from trade, the lack of systematic answers to such a fundamental question has created a gap between micro and macro applications. While firm heterogeneity has become a cornerstone in much recent micro modeling in international trade and, increasingly, in regional and urban economics, its impact on aggregate analyses has been so far rather subdued. Indeed, in one of the very few papers in international economics trying to bridge the gap between micro and macro, Arkolakis et al. (2012) conclude that firm heterogeneity does not really matter much for the aggregate gains from trade as only the first moment of the firm productivity distribution affects those gains. It is true that this result holds only under very restrictive assumptions that grant a perfect aggregation property of the Melitz model, thus looking very much like an 'impossibility theorem'. Still, the result is striking and defines a useful benchmark ("zero co-ordinate") for future research on the aggregate implications of firm heterogeneity.

Against this background, the aim of the present paper is to tackle the above general question from the specific viewpoint of regional and urban economics by focusing on the relevance of firm heterogeneity for one of its main issues: the emergence of spatial imbalances (Fujita and Thisse, 2002; Combes et al., 2008). In particular, the paper addresses the specific question whether firm heterogeneity affects the aggregate balance between agglomeration and dispersion forces in the presence of pecuniary externalities through a selection model of monopolistic competition with endogenous markups. This is achieved by introducing firm heterogeneity *à la* Melitz and Ottaviano (2008) in a core-periphery framework *à la* Ottaviano et al. (2002) noting that the endogeneity of markups as derived in those papers represents a major deviation from the restrictive set-up of Arkolakis et al. (2012). The present paper also builds on Ottaviano (2011) but with major departures. The model in Ottaviano (2011) is a dynamic model of capital accumulation with forward-looking agents in closed economy. Differently, this paper proposes a dynamic model of migration with short-sighted agents in open economy. As in Ottaviano et al. (2002), the economy is 'open' in terms of both goods trade and factor mobility while 'short sight' (due to heavy time discounting) is assumed in order to remove

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the possibility of self-fulfilling equilibria. These would add an extra layer of complexity beyond the scope of the present paper.

In the proposed model there are two locations that are identical in terms of their exogenous attributes. There are two factors of production: high-skill labor and low-skill labor. The former is freely mobile whereas the second is spatially immobile and evenly distributed between locations. There are two sectors: a perfectly competitive sector employing only low-skill labor to produce a homogenous good under constant returns to scale; and a monopolistic competitive sector employing both high-skill and low-skill labor to produce varieties of a horizontally differentiated good. In this sector high-skill labor is hired to design blueprints for the production of varieties and low-skill labor to produce the varieties according to those blueprints. In each period, high-skill workers first decide in which location to reside, then the monopolistic competitive firms decide whether and where to enter the market by hiring them. Subsequently high-skill workers engage in research and development with uncertain outcome in terms of the productivities of their blueprints. Once these productivities are revealed, firms decide whether to use the corresponding blueprints for production or just leave the market without producing. At the end of period, blueprints fully depreciate becoming useless. This admittedly stark assumption is made to abstract from sorting and focus on selection.

In this framework, the effects of heterogeneity on the balance between agglomeration and dispersion forces depend on which dimension of heterogeneity is affected and how it is affected. In particular, defining heterogeneity as 'diversity', heterogeneity is considered along two dimensions: 'richness' measures the 'number' of alternative productivity levels that can be drawn; 'evenness' is defined as the similarity between the probabilities with which those alternative productivity levels are drawn (Maignan et al., 2003). It is shown that, when productivity draws follow a Pareto distribution, the effects of more heterogeneity differ depending on whether more heterogeneity is achieved through more richness (captured by the "scale parameter" of the Pareto distribution) or more evenness (captured by the "shape parameter" of the Pareto distribution). There are two orders of reasons for this. First, under the Pareto distribution assumption, more richness comes with a higher chance of low productivity draws whereas more evenness comes with a higher chance of high productivity draws. Second, under the Pareto distribution assumption, the elasticity of the success rate of entry to tougher competition is affected by evenness but not by richness.

In terms of findings, the proposed model exhibits all the key feature of the model by Ottaviano et al. (2002) without urban costs and of similar models in the 'new economic geography' tradition (see, e.g., Baldwin et al., 2003). In particular, trade barriers regulate the balance between agglomeration forces (market-size and cost-of-living effects) and dispersion forces (competition effect): starting with high enough trade barriers, trade liberalization shifts the spatial equilibrium from dispersion to agglomeration. The proposed model, however, introduces firm selection as an additional force affecting the balance between agglomeration and dispersion.

A first implication of this additional force is that, differently from Ottaviano et al. (2002), the emergence of agglomerated equilibria is not catastrophic with the spatial economy suddenly moving from dispersion to full agglomeration when trade barriers fall below a certain threshold. It is, instead, smooth: as trade barriers gradually fall, at some point the dispersed allocation loses stability to two stable equilibria with partial agglomeration evenly spaced around it. These are initially in a neighborhood of the dispersed allocation. Then, as trade barriers keep on falling, they gradually move away from dispersion until the economy hits full agglomeration. Hence, thanks to selection among heterogeneous firms, the model is able to generate the realistic feature of partial agglomeration as a stable equilibrium outcome provided that trade barriers are neither too high nor too low. In this equilibrium, the larger location exhibits more entrants, more sellers and thus more product variety, lower average cost, lower average price, lower average markup. As all these features imply higher consumer surplus, the engineers' indifference condition that sustains the equilibrium holds due lower expected profits driven by a lower success rate of entry that more than offsets a higher average profit from successful entry.

A second implication concerns the impact of heterogeneity on the balance between agglomeration and dispersion forces for given trade barriers. More (cost-increasing) richness shifts the balance in favor of agglomeration forces. This happens because selection in the larger location gets weaker as worse productivity draws become possible. The impact of more (cost-decreasing) evenness is more complex. When the initial distribution of productivity draws is already rather even, more evenness shifts the balance in favor of agglomeration forces. Vice versa, when the initial distribution of productivity draws is rather uneven, more evenness shifts the balance in favor of dispersion forces. The reason for this is that, when the initial evenness is low, more evenness has a weak positive impact on the average profit differential and a strong negative effect on the entry success rate differential between locations, thus fostering dispersion. Vice versa, when the initial evenness is already high, more evenness has a strong positive effect on the average profit differential and a weak negative effect on the entry success rate differential, thus fostering agglomeration. Such ambiguity of the impact of more evenness is due to the fact that evenness affects the elasticity of the success rate of entry to the toughness of competition. Differently, more richness does not affect that elasticity.

The punchline of the paper is that firm heterogeneity matters for the balance between agglomeration and dispersion forces. However, whether it shifts the balance from agglomeration to dispersion or the other way round depends on its specific features along both the richness and the evenness dimensions.

There are a few related models in the spatial economics literature. These differ among themselves in terms of whether agents' heterogeneity is assumed to be revealed before or after their location decisions. Sorting models study how *ex ante* heterogenous agents self-select into locations of different sizes (Nocke, 2006; Baldwin and Okubo, 2006; Davis, 2010; Okubo et al., 2010; Okubo and Picard, 2011).[1] The present paper differs from these models in that it studies selection, where heterogeneity materializes *ex post* after agents have already committed to their locations and where agents self-select in whatever economic activities are available in those locations. In this respect, the most closely related models are the ones put forth by Behrens and Robert-Nicoud (2012) and Behrens et al. (2010). The former is a selection model that also builds on Melitz and Ottaviano (2008) where *ex ante* identical individuals decide whether or not to move from a common rural hinterland to cities. Their heterogeneity is revealed after this decision has been made and the decision itself is assumed to be irreversible so as to rule out sorting. They show that larger market size increases productivity not only through a finer division of labor driven by pecuniary externalities (richer availability of intermediates) but also through a selection process, whereas higher productivity increases market size by providing incentives for rural–urban migration. Behrens et al. (2010) analyze both sorting and selection in a model in which agglomeration is driven by technological externalities. They distinguish between *ex ante* heterogenity ('talent'), known to agents before they decide where to locate, and *ex post* heterogeneity ('luck'), revealed to agents after their location decisions have been made. Agents choose locations based on their talent and occupations in the chosen locations based on luck too. More talented agents stand a better chance of finding more productive occupations in larger locations and this complementarity between talent and market size leads to the sorting of more talented agents into larger markets. Then,

[1] While this and other papers focus on firm heterogeneity on the supply side in terms of productivity, the distinctive feature of Okubo and Picard (2011) is their study of heterogeneity on the demand side in terms of tastes.

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