Regional Science and Urban Economics 40 (2010) 92–105

Contents lists available at ScienceDirect

Regional Science and Urban Economics

journal homepage: www.elsevier.com/locate/regec

Thick market externalities in a spatial model

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ARTICLE INFO

Article history:
Received 1 June 2009
Received in revised form 17 February 2010
Accepted 18 February 2010
Available online 26 February 2010

JEL classification:
R12
R13
R14

Keywords:
Agglomeration economies
Search and matching
Density
Thick market externalities

ABSTRACT

It is natural to think of thick market externalities as spatial phenomena. When agents are in close physical proximity, potential trading partners are more numerous and less costly to reach. Counteracting such agglomeration benefits is the dispersion force due to land being an essential input in production. The distribution of economic activities over space is an outcome of how decisions on location, land demand, and the search strategy of agents interact in spatial equilibrium. More desirable locations are those that allow their occupants more abundant and less costly access to potential trading partners. In spatial equilibrium, these are the densest locations, the occupants of which benefit from the strongest thick market externalities.

1. Introduction

It is natural to think of thick market externalities, those forces that give rise to more opportunities for exchange in a market with an increase in the size of the market, as spatial phenomena. Interactions are most frequent and take place at the lowest cost when people cluster. The logical conclusion of such an argument, of course, is that, other things being equal, it is best for people to all stay at a single spot as workplace to maximize trading opportunities and minimize the cost of trade. Obviously, such complete concentration of economic activities is precluded by land being an input in production. Thus, whereas concentration promotes interaction and helps strengthen any thick market externalities that may be in place, dispersion relieves crowding and can lower the cost of production. A basic force that determines the strength of thick market externalities then is how people decide where to stay and how much land to occupy.

This paper studies a model of how decisions on location, land demand, and the search strategy of economic agents interact to determine the density of economic activities across space, on which trading opportunities and the cost of trade for agents at various locations in a regional economy depend. The analysis is based on the model of production and exchange through search and matching in Diamond (1982), in which an agent carrying a unit inventory of output must seek another agent for exchange and consumption before she may begin production of the next unit of output. To the Diamond model I add the assumption that the production and exchange take place in a spatial economy, where each agent occupies a positive amount of land while searching for a trading partner — an assumption made to model the fact that land is often an essential input in production. In the formal analysis, I assume that land inputs are used for the maintenance of inventories rather than physical production. The calculations to follow are simpler, while the conclusions should apply equally well to the case where land is indeed used for production.

The thick market externality in the model comes from the assumptions that: (i) the rate at which an agent is matched with a potential trading partner increases with an increase in the population mass in the area across which the given agent searches; (ii) the cost to complete a bilateral trade is proportional to the distance separating the two agents in the trade. Two forces follow. First, agents will seek to move to locations around which potential trading partners are most numerous and least costly to reach. Second, it becomes important for agents to choose the areas across which the search should be carried out. To minimize the cost of trade, an agent may choose to search for a trading partner only in a small area centered around her own location. However, searching over a larger area can help one to conclude the search sooner as more people are included as potential trading partners. In sum, in a model economy in which search and spatial frictions interact, individual agents must make key decisions about: (1) location, (2) land demand, and (3) the distance that the search should cover.

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[1] I wish to thank two referees and an editor of the journal for their constructive comments and suggestions.

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doi:10.1016/j.regsciurbeco.2010.02.003

The analysis is simplest when everyone chooses to search from one to the other end of a region. In that case, the matching rate should be the same for everyone. However the cost of trade may not be the same. As long as the location distribution of agents is symmetric around the regional center, it is least costly to trade on average when one is right at the regional center. In the ensuring competition in the land market, there will be a downward-sloping rent gradient centered at the midpoint of the region. The higher land rents in turn will induce the occupants of central locations to substitute away from land for non-land inputs. There will then be a unimodal distribution of agents across space, whereby density decreases everywhere with increasing distance from the regional center.

With an exogenous increase in the regional population, everyone benefits by being able to trade more frequently. Meanwhile, the region expands horizontally. At some point in the expansion, agents at certain locations will no longer find it worthwhile to search over all locations in the larger region. If not all agents search over the same set of locations, a priori it is no longer obvious that central locations will offer their occupants less costly access to trading partners. Then it is not clear that a unimodal density centered at the midpoint of the region is an inevitable outcome of spatial equilibrium. Moreover, should the density turn out to be of any other shape, it is not even clear that central locations can offer the most abundant trading opportunities for their occupants.

A subtle but nevertheless intuitive result of the analysis is that central locations do turn out to be the best locations in spatial equilibrium even if agents at various locations endogenously choose to interact only with others in their vicinity. In a spatial-trade model, when one location becomes more attractive, so do neighboring locations. Such interdependence suffices to lead to a unimodal density, which decreases everywhere with increasing distance from the regional center.

If agents at denser locations experience stronger thick market externalities and thus are able to trade more frequently, then their rates of output rise concomitantly. Hence, a spatial model of thick market externalities is also a model of agglomeration economies, with a positive relation between population and density on the one hand and productivity on the other hand. Although the link between agglomeration and productivity in the present model hinges on the assumption of the Diamond model that an agent may resume production only after her last unit of output is successfully “sold”, this assumption is not at all unrealistic and can easily be justified by a certain cash-flow constraint that prevents firms from accumulating inventories indefinitely.

The mechanism of agglomeration economies explored in this paper is a variant of the matching mechanism of agglomeration economies in Kim (1989, 1991), Helsley and Strange (1990), and Berliant et al. (2006), where clustering helps raise productivity by improving the quality of matches. In the present model, clustering helps raise productivity by enabling producers to match more frequently.

What sets the present model apart from previous models of agglomeration economies is that in the former, space and density are basic elements underlying the local increasing returns. This is in contrast to the usual modeling practice in this strand of investigation, in which space and density do not feature explicitly in the mechanism of the local increasing returns but appear only in the mechanism of the centrifugal force that restricts the size of the urban center. For instance, in the typical model, firms are assumed to all cluster around a dimensionless city center, and that it is the overall scale of economic activities in the given city that determines the strength of the local increasing returns. The given production structure is then embedded in an urban model in which workers commute to the city center for employment.[2] In the present model, each economic agent takes up a positive amount of space as a producer. It is the extent to which production units cluster that determines the strength of the local increasing returns as well as the severity of the urban congestion that may restrict the extent of agglomeration.

The formal structure of the model is similar to that of models of the interaction of agents over space in Solow and Vickrey (1971), Beckmann (1976), and Borukhov and Hochman (1977). Assuming that everyone travels to interact with all others in a given locale, these models study the equilibrium location distribution of households and firms. More recently, Helsley and Strange (2007) extend such analysis by allowing households to choose the frequency of visits made to the city center. In the present paper, agents choose how far away from their own locations that they will travel, and thus may choose to interact only with a subset of all agents in the given locale. This is related to but distinct from Coulson et al. (2001), who study how workers choose between searching for jobs in either one of two given employment centers in a city.

By modeling how searches take place over a spatial economy, this paper is related to the urban labor market literature, which includes, among others, Wasmer and Zenou (2002), who study whether more central locations are occupied by employed or unemployed workers, and Brueckner et al. (2002) and Zenou (2009), who find that more productive workers reside closer to the employment center than do less productive ones. Similar to these models, the present model is concerned with how frictions in non-land markets interact with competition in the land market. In contrast to these models, the present paper does not assume that all economic interactions take place in a single location. More closely related to the present paper are Rouwendal (1998) and Gautier and Zenou (2010), in which workers choose the maximum commute to tolerate in a labor market with search frictions in much the same way that agents in the present model choose the maximum distance over which to conduct their search. In accepting a job offer, workers in the models of Rouwendal (1998) and Gautier and Zenou (2010) are committing to a long-term relationship while giving up the option to continue searching. Hence, the decision problems are somewhat more complex than those faced by agents in the present model, in which matches are formed and then dissolved in the very next instant. However, locations in these models are exogenous, whereas the present model analyzes the equilibrium location distribution of agents with endogenous space demand. In another strand of investigation, Gautier et al. (2010) and Gautier and Teulings (2009) find that people are more selective in accepting job offers and choosing potential mates for marriage in big cities, where matching opportunities are more abundant. These papers introduce an important manifestation of thick market externalities — how the loss due to less-than-perfect assortative matching may be reduced in thick markets. In contrast, the present paper is concerned with how the strength of thick market externalities is determined in the first place and how it differs across locations within and between regions. As a model of trade in the product market with spatial frictions, this paper is related to Berliant and Wang (1993) and Berliant and Konishi (2000), who study the endogenous formation of marketplaces. In Tse (2010), I study how the interaction of spatial and search frictions may give rise to a role for middlemen in helping others to trade at lower costs.

The rest of the paper is organized as follows. The next section presents the model and solves for the equilibrium location distribution of agents. In Section 3, I study the relation between productivity and density within and between regions. Section 4 discusses how equilibrium allocation differs from optimum allocation. Section 5 looks at alternative assumptions of the spatial structure, search and spatial frictions, and thick market externalities. Section 6 concludes with some brief remarks. Appendix A contains two lemmas on the analytical solutions of the equilibrium location distribution and the proof of Lemma 6 in the main text.

[2] Important exceptions include Ogawa and Fujita (1980), Fujita and Ogawa (1982), Lucas (2000), and Berliant et al. (2002), among others. However, the distance-dependent production externalities in these models are assumed rather than derived.