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A theory of rational spatial agglomerations ☆

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ABSTRACT

We model the behavior of rational forward-looking agents in a spatial economy. The economic geography structure is built on Fujita et al. (1999)'s racetrack economy. Workers choose optimally what to consume at each period, as well as which spatial itinerary to follow in the geographical space. The spatial extent of the resulting agglomerations increases with the taste for variety and the expenditure share on manufactured goods, and decreases with transport costs. Because forward-looking agents anticipate the future formation of agglomerations, they are more responsive to spatial utility differentials than myopic agents. As a consequence, the emerging agglomerations are larger under perfect foresight spatial adjustments than under myopic ones.

1. Introduction

In this paper we study the emergence of spatial agglomerations in a continuous spatial economy which are consistent with individual intertemporal maximizing behavior. For this purpose, we study how forward-looking workers respond optimally to spatial return differentials in the racetrack economy introduced by Krugman (1996) and Fujita et al. (1999). We follow a pure microeconomic description by formulating the decision problem at the worker level. Stated differently, we specify the worker's individual return of locating in some location as well as his individual moving cost. Workers choose optimally what to consume at each period, as well as which spatial itinerary to follow in the geographical space.

In the case of a two-region model, conditions leading to spatial convergence or divergence are related to the relative importance of increasing returns, transport costs, and the share of manufactured goods in expenditure; see Krugman (1991a), Robert-Nicoud (2005), and Mossay (2006a). In a multi-location version of the same model, numerical simulations suggest that multiple agglomerations systematically emerge and are roughly evenly spaced across the geographical landscape; see Krugman (1993). In a continuous location version of the same model, Krugman (1996) and Fujita et al. (1999) showed that the economy always displays regional divergence. The continuous spatial approach is crucial in that it allows to determine the spatial extent of emerging agglomerations, which is one of the main relevant features of a spatial economy. In their work, Krugman (1996) and Fujita et al. (1999) characterised the shape of emerging agglomerations by performing numerical computations of the preferred wavelength, i.e., the wavelength of the dominant unstable spatial perturbation. Because continuous spatial models allow to derive *endogenous spatial scales*, they are undoubtedly a step towards the comprehension of the functioning of a global economy.

In most economic geography models, spatial adjustments have been assumed to be myopic in that the decision to migrate has been

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based on current available returns only. A direct consequence of this is that migration flows are positively correlated with spatial return differentials. However, in reality, agents are interested not only in current available returns but also in the returns they expect in the future; see Krugman (1991b). Two major approaches have been used so far to deal with migration and forward-looking behavior. The first approach relies on migration adjustment costs, e.g. Mussa (1978), Krugman (1991b), and Fukao and Benabou (1993). The role of expectations turns out to be crucial. It has been shown in two-country models that expectations can give rise to self-fulfilling prophecies: when time discounting is low enough, that is when future matters, the steady-state of the economy is determined by the expectations that agents have about the evolution of the economy. This issue has been first examined in new economic geography models by Baldwin (2001) and Ottaviano (2001). Baldwin (2001) considers the original core-periphery model by Krugman (1991a) and analyses the forward-looking dynamics by relying on numerical computations. On the other hand, Ottaviano (2001) uses a footloose-entrepreneur variant of the core-preriphery model which is analytically tractable. Ottaviano's analysis has been extended to the case of asymmetric regions by Oyama (2009a). The second approach to migration with forward-looking behavior relies on a sticky-price approach used in Matsuyama (1991) where migration opportunities arrive according to independent Poisson processes. Oyama (2009b) uses the latter approach in a footloose-entrepreneur model by Pflüger (2004) extended to the case of many countries asymmetric in terms of size and trade cost. Assuming that trade costs depend on the destination country only, Oyama relies on a potential function, a concept used in the theory of potential games, so as to identify a uniquely absorbing and globally accessible stationary state. In this paper, as we assume variable individual migration costs, our paper belongs to the first strand of literature by providing further micro-foundations to the spatial adjustment process. This said, our approach contrasts sharply with that of other existing perfect foresight economic geography models in that strand of literature which assume external congestion in the migration process and thus heterogeneity among migrants. As we model the migration decision as part of the worker's individual consumption-location problem, our analysis follows Mussa (1978), where the adjustment cost is also part of an individual investment decision, rather than Krugman (1991b), where the adjustment cost depends on aggregate migration flows. Because of this, the complications raised by Fukao and Benabou (1993) and Oyama (2009a) regarding the migration dynamics in Krugman (1991b) do not apply here.

Though the *temporal role of the rational expectation assumption* has been somewhat explored in the literature concerning two-country models, we are not aware of any attempt to explore the *spatial role that rational behavior* may have in the core-periphery model involving more than two locations in the presence of individual migration adjustment costs. One reason for this is that the approach followed in the two-region models described above, can hardly be extended to a model involving additional regions. According to us, the main obstacle preventing it comes from the fact that in those models, migration dynamics is set up at the region level by relating directly the migration flow to the intertemporal utility differential between these regions. This implicitly assumes sufficient heterogeneity among migrants so as to prevent them to move all together. Here workers located in the same location are homogeneous and will move together.

Our results are the following. First we show that, like in the continuous economic geography models involving myopic migration (see Krugman, 1996; Fujita et al., 1999; Mossay, 2003 (the case of homogeneous location taste)), spatial divergence always occurs. This reemphasizes the role of the local market structure on the convergence process: scale economies at the local level and spatial mobility contribute to spatial divergence regardless of the temporal foresight ability of agents. The size of agglomerations increases with the taste for variety and the expenditure share on manufactured goods, and decreases with transport costs. Because forward-looking agents anticipate the future formation of agglomerations, they are more responsive to spatial utility differentials than myopic agents. As a consequence, the spatial extent of the agglomerations is larger under perfect foresight spatial adjustments than under myopic ones (in which case, the emerging agglomerations have a very small spatial scale; see Mossay, 2003). The role of rational spatial adjustments with respect to myopic adjustments is thus to distort the relationship between the amplification factor and the preferred wavelength.

As our objective is to explain the emergence of spatial agglomerations as a result of the market aggregation of optimal individual decisions, we need to describe the evolution of regions over time as resulting from agents' individual behavior. So we need to describe what happens in a given location as time evolves. This will be referred to as the space-description of the economy as opposed to its agent-description which describes the optimal time behavior of agents. We will show how to derive the space-description of the economy from its agent-description. Note that this procedure is not necessary in the case of an economy composed of myopic agents. This is because in that case the space-description can be used at the outset by identifying migration flows between regions with spatial return differentials; see e.g., Krugman (1996), Fujita et al. (1999), or Mossay (2003).

As in any other aspatial model, introducing forward-looking behavior and rational expectations in the racetrack economy may potentially lead to multiple market equilibria and steady states for some given initial state of the economy. However, in this paper, as is standard in the literature on models with a continuum of locations, we restrict the analysis of agglomerations to the behavior of the spatial economy around the uniform steady state, often referred to as the flat-earth steady state, see Krugman (1996) and Fujita et al. (1999). By focusing on a subset of market equilibria, this local instability approach to agglomerations neglects issues related to other market equilibria. So as to study the spatial divergence process, we use the normal mode method that has been applied by Krugman and Venables (1995) to study a spatial model of international specialization, and by Krugman (1996) and Fujita et al. (1999) to perform numerical computations of the preferred wavelength of emerging agglomerations. It has also been used by Mossay (2003) to determine the conditions under which agglomerations may emerge as a balance between agglomeration and dispersion forces, and by Picard and Tabuchi (2010) to study the stability of spatial equilibria for a general class of transport cost functions. The corresponding discrete technique had also been used by Papageorgiou and Smith (1983). Their purpose was to find the conditions under which some spatial externality may lead the uniform spatial equilibrium to be unstable. In this paper we will use the normal mode method to determine how rational spatial agglomerations emerge from local instability of the uniform steady state.

The rest of this paper is organized as follows. Section 2 lays out the economic environment. We describe the instantaneous equilibrium of the spatial economy in Section 3. The worker's intertemporal decision problem is described in Section 4. In Section 5 we discuss the space-description of the economy and derive it from the agent-description described in Section 4. In Section 6 we define a market equilibrium for the spatial economy. In Section 7 we study the spatial divergence away from the uniform steady state. Finally, Section 8 summarizes the main results.

2. The economic environment

In this section, the economic environment is described. We consider a spatial economy extending along a circle $\mathbb{C}$ of radius R. Time is denoted by $t \in [t_0, \infty[$. There are two types of consumers: mobile workers and immobile peasants. The densities of workers and peasants in location s at time t are denoted respectively by