Commuting, Migration, and Rural Development

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2003

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Abstract: This paper develops a theoretical framework to simulate expansion of non-farm businesses and population in rural areas. It follows the new economic geography modeling approach with a focus on the role of urban land rents in limiting the sustainability of agglomeration in the urban region. In most new economic geography models such centrifugal forces cause dispersion of people and firms that leads to emergence of new cities. In this model, households make residential choices and move to rural areas surrounding the urban region. This increases demand for goods and services in the rural region and hence makes firms to follow households. While the business location decision improves employment prospects in the rural region, a good proportion of households may keep their jobs in the city and hence commute between the two regions. This explains the current trends of rural in-migration and linkages between urban and rural regions with a focus on complementary relationship between migration and commuting.

Key words: agglomeration economies, household residential location, commuting cost, rural development

1 INTRODUCTION

There has been a reversal of the historical trend of population dynamics in most advanced economies during the last three decades. This phenomenon is characterized by the redistribution of population away from the larger urban regions to rural areas. The literature on the subject is growing focusing on the reasons for rural population turnaround. Renkow and Hoover (2000) identify that most explanations fall into one of two categories. The first one is referred to as the regional restructuring hypothesis and it is production based (or job-led). This relates to the spatial redistribution of employment opportunities, which is caused by globalization and economic restructuring in most advanced economies. The second explanation is consumption based (or people-led) in that the prime source of the rural population turnaround is sought to lie in household residential location preferences. This view is commonly referred to as the de-concentration hypothesis.

The motivation for this paper comes from two strands of the literature on the subject. The first one is empirical studies of the changes in rural-urban population dynamics while the second strand comes from theoretical models of the new economic geography. This paper brings these separate developments together and develops an analytical framework for simulating the process of urban-rural population dynamics. We focus on the relationship between household residential location and commuting cost.

2 CONCEPTUAL ISSUES

It proves useful to provide an overview of the empirical and analytical literature that has motivated this work. We highlight each of these in turn.

2.1 Empirical Observations

Champion (1996) observes that urban-rural migration follows a cascading pattern of population redistribution or a progressive shift of the population down the urban hierarchy. The key point here is that short-distance migrations are likely to be associated with commuting.

Renkow and Hoover (2000) have undertaken an econometric analysis using data from North Carolina to test for the competing views of economic restructuring and the decentralization hypothesis. Their findings confirm Champion's observation that the changes in urban-rural population dynamics are primarily attributable to changes in residential locations that are accompanied by commuting (Renkow and Hoover 2000, p. 282).

2.2 Analytical Framework

The new economic geography (NEG) provides a useful analytical framework for our purpose. The NEG models explain spatial distribution in terms of tensions between "centripetal" and "centrifugal" forces. Centripetal forces include both pure external economies and market size effects (forward and backward linkages). Centrifugal forces include urban land rents (Krugman and Livas, 1996, p. 141). However, the NEG literature mostly treats population changes as outcomes of changes in employment locations (Fujita, Krugman, Venables, 1999; Krugman and Livas, 1996). These models emphasize forces of spatial agglomeration. Kilkenny (1998) argues the emphasis on forces of agglomeration reduces the usefulness of the NEG models to explain rural re-population.

Following the tradition of the NEG models, we allow forces of agglomeration to operate. However, the focus of this study is on one force of dispersion: urban land rent or commuting cost. The latter is introduced to motivate household migration to accessible rural areas and then allow for their commuting back to the urban region. We then examine how this change affects general equilibrium results of the standard NEG models.

The study closely follows two separate applications. The first one is Kilkenny (1998) that was used to analyze the implications for rural development of business location decisions and increases in rural population due to "workplace choice" in the "people-follow-job" fashion. Our approach differs from this work in that we introduce urban land rent but we share a common concern for rural development. The other model is a theoretical formulation of links between urban land rent and agglomeration (Krugman and Livas, 1996) where land rent is introduced to simulate intra-urban commuting. However, we use land rent to motivate inter-regional migration and commuting. This study then brings together separate formulations in the NEG literature and links commuting cost, population de-concentration, and rural development.

3 A FORAM MODEL

3.1 Overview

We imagine a closed regional economy with two locations: rural and urban. The economy is characterized by full employment of the labor force. Each region has two sectors (agriculture and manufacturing) and two types of households (workers and farmers). Throughout this paper we denote regions generically as *r* (the reference region) and *s* (the other region), or specifically as 1 (urban) or 2 (rural). The rural region has a fixed share of regional land area, denoted by ϕ_2, which also represent the share of the rural region in the total number of farmers. The latter are not mobile between regions while manufacturing workers are mobile between locations. The share of urban region in the total manufacturing labor force is denoted by λ_1.

Production takes place at a central business district (CBD). However, workers need a fixed amount of living space, a unit of land. Given a relatively high land rent in the urban region, workers are motivated to move to rural areas where land rent is cheaper. However, it takes time to travel a certain distance to their workplace in the city. Let's assume that a worker has a unit of labor available for work. If she commutes, then she arrives with a net amount of labor to sell of only $1\text{-}2\gamma d$, where γ is the amount of labor time spent per unit distance, *d* is the distance between the CBD and worker residential places (see Krugman and Livas 1996, p. 141 for this formulation). We recognize rural-urban commuting but ignore commuting within the boundary of the urban region (intra-regional commuting). Hence, d takes a value of 0 or 1. Commuting cost is incurred in terms of potential labor earnings. With a given urban manufacturing wage rate, W_{m1}, a commuting worker receives a net wage of only, $(1\text{-}\gamma)W_{m1.}$ Workers who live in the city, however, receive the full amount of the urban wage rate but she pays an offsetting high land rent.

Shipments of goods between locations involve costs. As in most NEG models, the "iceberg" form of transport cost is used to avoid a separate transport industry. If a unit of a good is shipped between regions, then only $1/T_m$ of the original unit actually arrives at the destination.

3.2 Determination of Equilibrium

Table 1 provides a condensed system of equations discussed for this paper (Gelan 2002 provides further details). The solution strategy lies in reformulation key relationships for each region separately: four equations for each region and eight equations in total (Fujita, Krugman, Venables 1999, p.65). Eqs. 1 and 2 represent regional income which is determined by the share of workers and farmers (λ_r and ϕ_r); proportion of commuting workforce η and amount of time spent on commuting, γ; the level of nominal wage rate; and marginal propensity to consume manufactured goods and agricultural products, μ_m and μ_a respectively. Note that local income depends not only on local wages but also the level of wage in the other region because of commuters' income.

Table 1 Condensed system of equations

$$Y_1 = (1-\eta)\mu_m \lambda_1 W_{m1}(1-\eta\gamma) + \mu_a \phi_1 W_{a1} \quad (1)$$

$$Y_2 = \mu_m \lambda_2 W_{m2} + \eta \mu_m \lambda_1 W_{m1}(1-\eta\gamma) + \mu_a \phi_2 W_{a2} \quad (2)$$

$$G_1 = \left[\lambda_1 W_{m1}{}^{(1-\sigma)} + \lambda_2 \left(W_{m2} T_m\right)^{(1-\sigma)} \right]^{\frac{1}{1-\sigma}} \quad (3)$$

$$G_2 = \left[\lambda_1 \left(W_{m1} T_m\right)^{(1-\sigma)} + \lambda_2 W_{m2}{}^{(1-\sigma)} \right]^{\frac{1}{1-\sigma}} \quad (4)$$

$$W_{m1} = \left[Y_1 G_1^{(\sigma-1)} + Y_2 G_2^{(\sigma-1)} T_m{}^{(1-\sigma)} \right]^{\frac{1}{\sigma}} \quad (5)$$

$$W_{m2} = \left[Y_1 G_1^{(\sigma-1)} T_m{}^{(1-\sigma)} + Y_2 G_2^{(\sigma-1)} \right]^{\frac{1}{\sigma}} \quad (6)$$

$$\omega_1 = W_{m1}(1-\eta\gamma) G_1^{-\mu} W_{a1}{}^{(\mu-1)} \quad (7)$$

$$\omega_2 = W_{m2} G_2^{-\mu} W_{a2}{}^{(\mu-1)} \quad (8)$$

In determining the regional price indices (eqs. 3 and 4) and nominal wage rates (eqs. 5 and 6), we follow the standard NEG formulation, with the parameter σ representing the degree of substitutability between monopolistically competitive manufacturing varieties (ibid.). The real wage in each region (eqs. 7 and 8) is determined as a function of local nominal wage rate, the price index, and commuting cost. Changes in relative real wages cause labor mobility across regions. This leads to variations in the distribution of economic activity across locations over time. Hence, we have $d\lambda_1 = \theta(\omega_1 / \omega_2)$, where d denote time derivative and θ represents speed of labor mobility.

3.3 Theoretical Analysis

The question we would like to answer is this: under what condition is the concentration of people and manufacturing in the urban region is in equilibrium? We begin assuming that manufacturing is initially fully concentrated in the urban region (i.e., $\lambda_1 = 1$). We then examine circumstances that affect sustainability of the core-periphery structure. For this, we examine changes in relative real wages. If $\omega_1 > \omega_2$, then the concentration of labor in the urban region is an equilibrium. If this condition is violated, then the concentration is not in equilibrium.

We imagine a firm that considers locating in the rural region. It can break-even only if the nominal wage it pays in the rural region is less than that in the urban region. The reason is that a significant proportion of its output would be sold in the urban region. It follows from the "iceberg" transport cost formulation that final sales to consumers in the urban region would be T_m times larger than the mill price in the rural region. Goods produced in the peripheral region must have a sufficiently low mill price to be sold as competitively as goods produced in the central region. However, in this model, mill prices are simply proportional to local wage rates, and hence we have the following relationship:

$$\frac{W_{m2}}{W_{m1}} = \left(Y_1^* T_m{}^{1-\sigma} + Y_2^* T_m{}^{\sigma-1} \right)^{\frac{1}{\sigma}} \quad (9)$$

It is worth noting the two terms in the bracket. Y_1^* is the level of urban income and it is weighted by $T_m^{1-\sigma}$, which is less than unity because we assume $\sigma>1$. This results from the transport cost disadvantage that a firm in the peripheral region faces in supplying the urban market. On the other hand, the income level in the rural area, Y_2^*, is symmetrically weighted by $T_m^{\sigma-1}$, which is greater than unity. This indicates the transport cost disadvantage that the firm would face in supplying the rural region if it decides to stay in the urban region. Thus, if the firm chooses to move to a rural location, then it must have weighed the disadvantage of giving up a larger market against the benefit of paying a relatively lower wage and then expecting to do well in the smaller market.

It is now appropriate to examine how household location decisions affect this process. It is straightforward from the income equations (1 and 2) that the existence of rural-urban commuters unambiguously affects the relative sizes of markets in each region. In eq. 1, the first term denotes income generated in the manufacturing sector net of commuters' income in the urban region. The first term of eq 2, on the other hand, represents the amount by which household income, and the size of the local market, has increased in the rural region. Clearly, commuting reduces the size of the market in the city but increases that of the rural region.

The ratio of real manufacturing wages is shown in the following equation:

$$\frac{\omega_2}{\omega_1} = \frac{T_a^{1-\mu}}{T_m^{\mu}} \frac{1}{1-\eta\gamma} \left(Y_1^* T_m^{\;1-\sigma} + Y_2^* T_m^{\;\sigma-1} \right)^{\frac{1}{\sigma}} \tag{10}$$

The cost-of-living in the peripheral region differs from that in the urban region by the first two terms: $\frac{T_a^{1-\mu}}{T_m^{\mu}} \frac{1}{1-\eta\gamma}$. These relationships follow from the fact that the rural region has cheaper agriculture and land rent but more expensive manufacturing than the urban region. If the ratio given by eq. 10 is less than unity, then the initial concentration is in equilibrium. This means that manufacturing labor has no incentive to deviate from the city and move to a rural location. The existence of commuting cost or urban land rent affects the terms in the bracket in eq. 10. The term $1/(1-\eta\gamma)$ shows an additional route through which the existence of the urban land rent affects relative real wages. This comes from household final demand for land. In summary, changes in the relative real wage depend on the tension between changes in transport cost of manufacturing, transport cost of agricultural goods, and urban land rents.

The analytical discussions in this section may have highlighted some of the key relationships. However, the model is far too complicated to solve analytically and show relationships between all variables. Thus, it becomes necessary to use numerical simulations.

4 NUMERICAL SIMULATIONS

The exogenous variables take the following values: σ=5; μ_m=0.4; ϕ_1=0.5; T_a=1.0 for all simulation scenarios (figures 1-5). In all simulation runs, we vary T_m. For figures 1-4, ν=0 and η=0, as in most NEG models. The curves show the relationships between ω_1/ω_2 and λ_1. Any point where ω_1/ω_2=1 is an equilibrium. Such an equilibrium is stable if the curve is sloping downward but unstable if it is sloping upwards. The intersection of the curves with the vertical axis yields a corner solution where labor could be fully concentrated in one region and stay there if the real wage there remains higher than that of the other region.

In figure 1, we assume a relatively high urban manufacturing transport cost, T_m=2.0. With a high transport cost, manufacturing firms find it costly to produce in one region and supply to another. Thus, firms mostly sell in local market. If one region has greater number of firms, then competition in the local market drives some of the firms out until the number of firms (and hence the size of labor force) in both regions is equal. Thus, figure 1 illustrates a case in which high transport cost leads to even and stable distribution of businesses and people between regions. Figure 2 represents the intermediate case with T_m = 1.7. It shows a rather complicated picture. As in the figure 1, the symmetric equilibrium is stable but this is surrounded by two unstable equilibria. The key point to understand this outcome is to note that the agglomeration force still too weak to destabilize the symmetric equilibrium. However, it is strong enough to ensure that if all firms were concentrated in one region this would be a locally stable equilibrium. Figure 3 is plotted for a relatively low parameter value, T_m = 1.5. The symmetric equilibrium becomes unstable with the curve sloping strictly upward indicating a relatively strong agglomeration. The only stable equilibria are the corner solutions, full concentration in one region or the other. Figures 1 to 3 show that manufacturing agglomeration critically depends on the transport costs. Figure 4 summarizes the relationships shown in Figures 1-3. In this case, instead of taking a snapshot of the critical parameter value, we plot a broader range to see the limits within which agglomeration is sustainable. The real wage differential slopes downward at a relatively low transport cost. This corresponds with the patterns of changes displayed in figure 3. The core-periphery structure becomes sustainable at a relatively low transport cost. However, with an increase in transport costs, the curve turns up which means that the rural real wage begins to rise relative to the urban real wage. The point at which the curve crosses the horizontal line, where regional real wages are equal, defines the *sustain value* of T_m. Below the sustain value of T_m, the core-periphery structure is an equilibrium but at any point more than the sustain value the core-periphery structure is not an equilibrium.

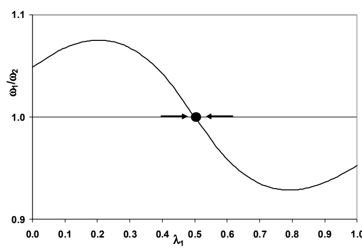

Figure 1 Real wage differentials: T_m = 2.0

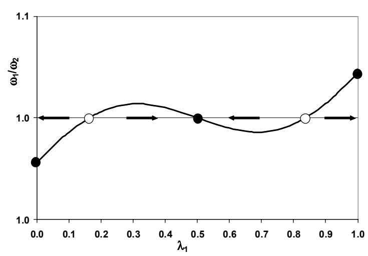

Figure 2 Real wage differentials: Tm = 1.7

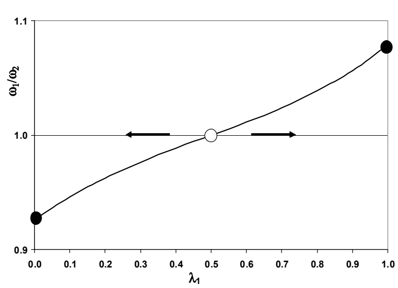

Figure 3 Real wage differentials: T_m = 1.5

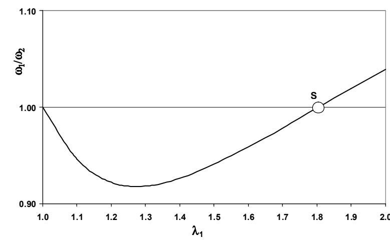

Figure 4 Sustain curve: γ = 0

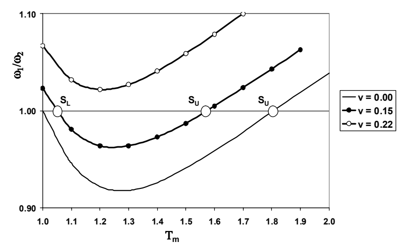

Figure 5 Sustain curve: γ >=0

Figure 5 illustrates real wage ratios as a function of T_m for three different levels of commuting cost, γ. For convenience, we assume that the commuting labor time ratio is equal to the commuter ratio. The lowest curve, γ = 0, is exactly as in figure 4 but it is plotted here to facilitate comparison with the other curves. Agglomeration is sustainable for any value of $T_m < S_U$. The second curve is plotted for an intermediate level of urban land rent, γ=0.15. Now agglomeration is sustainable only in a narrower range of transport cost (S_L-S_U). With γ>0, there is a positive level of rural-urban commuting because the urban region becomes more expensive for manufacturing workers. Recalling our assumption of negligible land rent in the rural region, households are likely to gain by migrating to the rural region and then commuting back to the urban region. This initiates a further cumulative process of firms deciding to move to the rural region. Critically, when all worker households are concentrated in the urban region, firms would find it beneficial to stay in the urban region even when transport cost is zero. Note that at any point below S_U, agglomeration is sustainable and firms would stay in the urban region. This corresponds with the case of the corner solution (figure 3) whereby firms and households stay in a region that has some initial advantage. However, the introduction of a centrifugal force to the model disturbs the stable equilibrium and starts a cumulative unraveling process. With some households already locating themselves in the rural region, firms would not find it beneficial to stay in the urban region if transport cost is reasonably low. Therefore, some firms would begin to locate in the peripheral region when transport cost ranges between $0<T_m<S_L$. The highest curve is plotted for $\gamma=22$. This level of parameter value is high enough to make the agglomeration process totally unsustainable. Thus, it is clear from figure 5 that the advantage of staying in the urban region (or the disadvantage of locating in the rural region) gets smaller, the higher urban land rents, the larger the number of commuters and the lower the transport cost. With the lowest curve, the agglomeration process is relatively strong but as the parameter value for urban land rent gets larger the sustain curve moves up until it reaches a stage where the force of agglomeration disappears.

It is useful to link back the outcome of this numerical simulation to the pattern of rural-urban population dynamics that we raised at the beginning of this paper. It is convenient to focus on the intermediate sustain curve in figure 4 and then imagine a historical decline in transporting manufactured goods. If the force of dispersion is not too strong, then the economy passes through three stages. The first stage is where agglomeration is not sustainable because the level of transport is too high (in figure 5 this is when $T_m > S_U$). Decline in transport cost makes it possible for people and economic activities to agglomerate in cities and this process continues as long as transport costs continue to decline. However, this process comes to a halt when the disadvantage of concentration outweighs (because of increases in land rents, etc) the benefit from low transport cost to urban regions. Thus, a cumulative unraveling process begins when the centrifugal forces dominate centripetal forces. This simulation experiment confirms our intuitive arguments in earlier sections.

5 CONCLUSION

This paper simulates links between migration, commuting cost, and rural development. With a focus on accessible rural areas, a rural-urban general equilibrium was formulated using the NEG approach. Simulation experiments were undertaken measure effects of changes in commuting cost on locations of people and economic activities. We have established links between land rents, household and business location decisions. The key point is that the introduction of land rents to the model reveals that agglomeration is less sustainable than in the standard NEG models. A cumulative unraveling process begins when households begin to migrate from the urban region to the rural region because of a relatively high land rent. This makes the rural region more attractive for business location.

In contrast to other NEG models, our model explains the movement of households and businesses to rural areas accessible to urban regions. This means at least some of the households keep their city jobs and commute between workplace and residence locations. The implication for businesses is that they can continue selling some amount of their output in urban market from their place of production in rural areas. Thus, the migration of households and businesses does not necessarily cause a new urban centre to emerge.

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