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*Von Thünen's Model of the Dual Economy***

Imagine a very large town, at the centre of a fertile plain which is crossed by no navigable river or canal. Throughout the plain the soil is capable of cultivation and of the same fertility. Far from the town, the plain turns into uncultivated wilderness which cuts off all communication between this State and the outside world.

There are no other towns on the plain. The central town must therefore supply the rural areas with all manufactured products and in return it will obtain all its provisions from the surrounding countryside.

J. H. von Thünen (1826;1842, p. 11)

INTRODUCTION

Models of economic growth and development in the dual economy tend to give short shrift to the role of preferences and to demand.[1] The rationale for this is clear: in the long run, rates of growth of the capital stock or population and labour supply and the rate of technological progress determine the path which the economy follows. The composition of demand and preferences, except insofar as they affect individuals' allocations between present and future, do not affect the stationary equilibrium paths, provided such exist. Two things must, however, be said in this connection: First, the notion of a stationary path is itself a very artificial construct; there is no reason why in the course of development such proportional growth should obtain. Transitions are all important. Second, although dual-economy models of growth do emphasize the allocation of labour between the two sectors and the consequent change in the composition of total product, the effects of changes in the terms of trade between agriculture and industry (or traditional and modern, or between whatever two sectors are distinguished), and the arbitrary nature of assumptions made concerning demand, preclude an understanding of the role which relative *commodity prices* may play in the allocation of labour.

Recently, Samuelson (1983) has given an extended appreciation of the work of von Thünen's contributions to location theory and, above all, to the development of the neoclassical theory of marginal factor productivity and distributive

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shares.[2] In his appreciation, however, Samuelson brings out very nicely the general equilibrium nature of von Thünen's location theory. Except by geographers concerned with economic development, the spatial aspects of growth have been generally neglected in the economic literature.[3] In particular, the role of transportation costs in determining the spatial distribution of commodity prices and, therefore, real wages and the spatial distribution of labour is nowhere treated adequately. The general spatial equilibrium model of von Thünen, as expounded by Samuelson, may be used to fill this gap and to provide a basis for both equilibrium and disequilibrium models of growth of the dual economy. Although von Thünen is widely regarded as the father of location theory and now appreciated as the independent discoverer of the marginal productivity theory of distribution, he is also, in my view, the author of the first, and in some ways the best, model of the dual economy; a model which with a little effort can be turned into a model of dual economy development having considerable relevance to the developing economies of the world today in which high costs of transport are pervasive and are significant determinants of relative commodity prices.

The next section provides a general discussion of von Thünen's general equilibrium model of the location of economic activity following Samuelson's appreciation. The last section indicates how the comparative statics of the model can be used to generate equilibrium models of growth and provides some discussion of the problems of formulating disequilibrium dynamic models based on the von Thünen framework.

VON THÜNEN'S EQUILIBRIUM MODEL

We make the following assumptions:

(a) All land is homogeneous except for distance from the town. The town exists as a point.

(b) There are only two goods: A manufactured commodity, say cloth, produced in the town, and an agricultural commodity, say corn, produced in the countryside.

(c) Cloth is produced by labour alone (any raw materials used are available at the site of the town). To simplify the exposition, assume constant returns to scale, although this is unnecessary.

(d) Corn is produced by labour and land according to a mainly constant returns production function. It is useful, however, to assume that a minimum application of labour per unit of land is necessary to grow anything at all. This translates into a minimal, non zero land rent at the extensive margin of cultivation.

(e) All people, whether landowners or labourers, have identical, homothetic preferences.

(f) All commodity markets clear instantaneously at every point; the total demand for cloth equals its supply as does the total demand for and supply of corn; prices adjust accordingly at every point.

(g) Transport costs for both commodities, although different, are proportional to distance (logarithmically linear in distance).

(h) Labour is homogeneous and, for the moment, assumed to be perfectly mobile. The distribution of a fixed labour force between town and country, and in the country at different distances from the town, is determined so as to equalize the real (utility) wage everywhere. Because the prices of cloth and corn may differ from location to location, however, money wages vary from point to point. Labour is assumed to live where it works. Introduction of disequilibrium in the labour market is one suggestion for making the von Thünen model dynamic.

(i) Landowners who receive land rent are located on the land they own, and consume, in corn equivalents, exactly the rent they receive. The assumption of homothetic preferences simplifies matters since, as shown below, given relative prices, demand will be proportional to total income and will not depend on the number of persons among whom it is divided.

Independent variables of the analysis are the technology of production, preferences for corn and for cloth, transport costs (or technology), and population or labour force. Subsuming the necessary minimal labour per unit of land as a technological parameter, all other variables, such as relative prices at each point, the location of the extensive margin of cultivation, the real wage, money wages at each point, the amount of labour applied per unit of land, land rent at each point, and the total consumptions of cloth and grain, and the distribution of these in space, are all endogenous variables determined within the von Thünen system by the equilibrium of factor and product markets.

To see how the system works, proceed as follows: All distances may be measured in terms of the distance from the town, r. Indeed, all behaviour at every point on a circle of radius r, with the town at the centre, is identical. Let the subscript 0 denote cloth (manufacturers) and 1 denote corn (agricultural products).

Production of cloth, Q_0, may be assumed to be proportional to the labour used in cloth production, who live in the town, L_0.

$$Q_0 = f_0 L_0, \tag{1}$$

where $f_0 > 0$ is assumed constant. Production of grain at a distance r from the town, $Q_1(r)$, depends on the labour applied, $L_1(r)$, to the quantity of land planted to corn, $A_1(r)$. We assume that agricultural production takes place according to a constant returns production function, so that the *yield of corn per unit area*, $q_1(r)$, is a function of the labour applied per unit area, $\lambda_1(r)$,

$$q_1(r) = f_1[\lambda_1(r)],\ f_1' > 0,\ f_1'' < 0. \tag{2}$$

The function, f_1, is increasing and concave from below. If R is the extensive margin of cultivation, the distance from the town at which '... the plain turns into uncultivated wilderness,' then the total production of corn is

$$Q_1 = 2\pi \int_0^R q_1(r) r\, dr. \tag{3}$$

The total labour force in agriculture is, similarly,

$$L_1 = 2\pi \int_0^R \lambda_1(r) r\, dr. \tag{4}$$

If $L = L_0 + L_1$ is the total labour force available, given exogenously, then the labour force in the town is

$$L_0 = L - 2\pi \int_0^R \lambda_1(r) r\, dr. \tag{5}$$

Wage payments in the town in terms of cloth exhaust the total product. Since no land is used, there is no rent (and no rentiers live in the town). It is convenient to choose cloth as the numeraire in any case. Thus the wage rate in the town is

$$w_0(0) = f_0. \tag{6}$$

Let $P_0(r)$ = the price of cloth at a distance r from the town and $P_1(r)$ = the price of corn.

$$P_1(r) = P_1(r)/P_0(r) \tag{7}$$

is thus the price of corn in terms of cloth at a distance r from the town. The wage, $w_1(r)$, paid to labourers engaged in grain production a distance r from the town in terms of corn is

$$w_0(r)/p_1(r) = w_1(r). \tag{8}$$

where $w_0(r)$ is the wage rate in terms of cloth a distance r from the town.

Wage payments in corn at any location outside the town equal the marginal product of labour in agriculture there:

$$w_1(r) = f_1'[\lambda_1(r)] \tag{9}$$

But this does not exhaust the product at r; there is a positive residual equal to rent per unit of land in corn:

$$y_1(r) = f_1[\lambda_1(r)] - \lambda_1(r) f_1'[\lambda_1(r)] > 0, \tag{10}$$

because of the assumed concavity of the production function $f_1[\,]$. Note also that rent falls to zero as the labour/land ratio tends to zero. I will show wages in corn rise with distance from the town so that land is increasingly substituted for labour until some minimal labour/land ratio, perhaps zero, is reached; at this point, say R, all cultivation ceases. R is, of course, endogenous in von Thünen's model.[5]

To show that wages in corn increase with distance from the town, we have to look carefully at the relative prices of corn and cloth at different locations, at how these prices affect real wages, and at how labour mobility in response to real wage differentials affects wages in corn or in cloth.

For every r, the ratio of the price of corn to the price of cloth must be such that producers are just indifferent between selling the grain locally for $P_1(r)$ or shipping it to the town where the price is higher but having to deduct the costs of transport. Von Thünen makes a series of careful calculations in which he reckons the costs of transport to consist largely of grain consumed on the way by the oxen pulling the load; thus, as a first approximation, we can assume transport costs in grain to be proportional to the quantity transported per mile. A bushel of grain in the countryside r miles from town becomes $e^{-a_1 r}$ bushels in town. It follows that

$$P_1(r) = P_1(0)e^{-a_1 r}, \qquad (11)$$

where a_1 is a parameter reflecting the costs of transport; the higher a_1, the greater the costs of transport. Although there is no argument for doing so, other than symmetry and simplicity, assume that the costs of transporting cloth to the countryside also have the same proportionate form

$$P_0(r) = P_0(0)\, e^{a_0 r \; (6)}. \qquad (12)$$

Thus, the relative price of corn and cloth at a distance r from the town is given by

$$p_1(r) = p_1(0)\, e^{-(a_0 + a_1)r.} \qquad (13)$$

Given positive transport costs, this price is always falling independently of the special exponential form of the relationship assumed. Because labour is mobile, it follows that the grain wage must rise to compensate workers for the rise in cloth prices relative to corn with increasing distance from the town in order to keep their real wage constant. This is the first crucial point at which preferences enter the von Thünen model of the dual economy. Factor markets must be in equilibrium; preferences are a key element in the process. (The second point at which preferences enter is in the process equilibrating product markets.)

In order to determine the variation of rents with distance from the town, it is necessary to determine the precise way in which grain wages rise with distance. In this connection, it is helpful to follow Samuelson in assuming that preferences are homothetic so that income effects are ruled out.[7] The grain wage a distance r from the town is the marginal product of labour in grain production from (9). From (8), we see that $w_0(r)/w_1(r) = P_1(r)$. Thus, from (12)

$$\begin{aligned} w_0(r) &= p_1(0)\, e^{-(a_0 + a_1)r w_1(r)} \\ &= p_1(0)\, e^{-(a_0 + a_1)r} f_1'[\lambda_1(r)]. \end{aligned} \qquad (14)$$

(14) establishes the connection between wages in cloth and wages in grain given the relative price of cloth and grain in the town. Wages in grain is determined as the marginal product of labour. The assumption of homothetic preferences enables us to express utility in terms of these two wage rates.

If utility is maximized subject to the budget constraint $M = P_0 x_0 + P_1 x_1$, where

x_0 is the consumption of cloth and x_1 is the consumption of corn, maximum utility may be expressed as

$$\text{Max } u(x_0, x_1) \text{ such that } M = P_0 x_0 + P_1 x_1$$

$$= M\, u^*(P_0, P_1) = u^*\left(\frac{P_0}{M}, \frac{P_1}{M}\right), \tag{15}$$

provided u( ) is homothetic. u*( ) is called the *indirect* utility function. All the indifference curves are simply scaled up versions of any one of them. Choose M to be the money wage at r. Then the condition that real utility wages be everywhere the same reduces to

$$u^*[w_0(r)^{-1}, w_1(r)^{-1}] = u^*[w_0(0)^{-1}, w_1(0)^{-1}],$$

which simplifies to yield

$$[w_1(r)\, u^*[\frac{e^{(a_0+a_1)r}}{p_1(0)}, 1] = f_0\, u^*[1, P_1(0)].] \tag{16}$$

Solving for $w_1(r)$ gives us the grain wage at a distance r from the town which will keep real utility wages the same everywhere, *given* the relative price of grain and cloth in the town. The latter is determined so that the product markets will be in equilibrium everywhere.

Once grain wage rates are determined at a distance r, the condition that labour's marginal product in agriculture equals its wage determines the labor/land ratio, $\lambda_1(r)$, and the rent of land, $y_1(r)$, from (9) and (10), respectively. From (16) it is easily seen that

$$w_1(r) = \frac{f_0\, u^*[1, p_1(0)]}{u^*[\frac{e^{(a_0 + a_1)r}}{p_1(0)}, 1]}, \tag{17}$$

is increasing in r since u* ( ) is decreasing in any of its arguments. It follows, then, that $\lambda_1(r)$ is decreasing in r since $f_1'' < 0$, and that $y_1(r)$ is also decreasing by the concavity of $f_1(\ )$.

To determine $p_1(0)$ from the condition that the markets for cloth and for corn must be in equilibrium everywhere, we need to compare the total demand for cloth, D_0, with its supply, Q_0, from (1), and the total demand for corn, D_1, with its supply, Q_1, from (3). Note, if the labour/land ratio is known everywhere, then $q_1(r)$ is determined by (2) for every r. The demand functions are found by differentiating the indirect utility functions with respect to their arguments.[8] Thus for homothetic utility

$$D_i = V_i(P_0/M, P_0/M)$$

$$= M\, V_i(P_0, P_1),$$

$$V_i(P_0/M, P_1/M = \frac{\partial \log u^*\left(\frac{P_0}{M}, \frac{P_1}{M}\right)}{\partial\left(\frac{P_i}{M}\right)}, \tag{18}$$

where $i = 0,1.$

Although at any r the demands for all labourers are the same and workers and rentiers have the same utility functions, the actual quantities demanded per caput are different for the two groups because their incomes are different. As we shall see in a moment, however, the division of the total product between the two groups does not matter on account of the assumed homotheticity of the utility function common to all individuals. Moreover, we need only determine the condition for one of the two markets to be in equilibrium since the other will then automatically be, by Walras' law. Let us do this for grain. The total income of town workers who produce only cloth is f_0L_0 so the demand for grain in the town is

$$f_0L_0V_1[1,p_1(0)].$$

Now the supply of grain to the town is equal to the total produced from (3) minus the grain consumed outside the town by labourers and rentiers, respectively. Because of the assumed homotheticity of the utility function, given relative prices, demand is proportional to income. (The income elasticities of demand are both +1.) So demand is independent of the number of rentiers or labourers at a distance r from the town and depends only on the total income received by the group, assuming, of course, that prices are given. Because of the assumption that all utility functions are identical and homothetic, given relative prices, demand is proportional to total income at each distance r from the town; total income in grain is just the total product, $f_1[\lambda_1(r)]$. Thus, integrating along a radius from the town to the extensive margin of cultivation and around the town, we obtain

$$2\pi \int_0^R r\, f_1\ [\lambda_1\ (r)]\ V_1\ [1\ , p_1\ (0)\ e^{-(a_0\ +\ a_1)r}\ ]dr.$$

From (9) and $w_1(r)$ as a function $p_1(0)$, we obtain $\lambda_1(r)$ also as function of $p_1(0)$. Thus, the condition

$$\begin{aligned} Q_1 &= f_0\ \{L - 2\pi\int_0^R \lambda_1 (r)\, r dr\}\ V_1\ [1,\ p_1\ (0)] \\ &+ 2\pi\int_0^R r\, f_1\ [\lambda_1 /r)] V_1\ [1,\ p_1 (0)\ e^{-(a_0 + a_1)r}\ ]dr, \end{aligned} \tag{19}$$

determines $p_1(0)$ since Q_1, from (3), is also a function of $\lambda_1(r)$ which is, in turn, a function of

$$p_1\ (0)\ e^{-(a_0\ +\ a_1)r} = p_1\ (r).$$

Thus, (19) determines the relative price of corn and cloth in the town and closes the system.

COMPARATIVE STATICS OF THE SOLUTION AND SUGGESTIONS FOR FORMULATING A DISEQUILIBRIUM MODEL

Von Thünen's Model of spatial equilibrium may be viewed as a model of the dual economy. It is thus natural to ask what sort of time path the economy will follow as population grows and technical change occurs. Although the model is not dynamic in its present form, one way to examine the growth process within its context is to compare alternative static equilibria for different values of exogenous variables or parameters of the model. The following are the principal *exogenous variables* or parameters of interest:

L = the total labour force (presumptively proportional to population which also includes rentiers);
f_0 = technology in the manufacture of cloth, the larger f_0 the more productive is the labour used in cloth production;
$f(\,)$ = technology in agriculture, the larger $f(\,)$ for a given labour/land ratio the more productive is agriculture;
a_0, a_1 = parameters related to transport costs, the smaller they are the lower transport costs;
$u(\,)$ = a utility function expressing preferences;
λ_1 = the minimum labour intensity needed to achieve any agricultural output.

Of the six, total labour force or population, technology, and transport costs are the ones we would like most to analyse. Note, however, that technological change in agriculture is more complicated to analyse than in industry since in agriculture changes may affect the marginal rate of substitution of labour for land, as well as the overall efficiency of the process.

The principal *endogenous variables* of interest are the following:

L_0,L_1 = the distribution of the labour force between industry and agriculture;
Q_0 = total production of cloth;
Q_1 = total production of corn;
$P_1(r)$ = the relative price of corn to cloth at distance r from the town;
$w_1(r)$ = wages in corn at distance r from the town;
$\lambda_1(r)$ = the land/labour ratio at distance r from the town;
R = the extensive margin of cultivation.

We might also be interested in the comparative level of real wages (or utility per caput) at different equilibria, or in the distribution of the agricultural product between rentiers and labourers.

The usual way to proceed in such an investigation would be to differentiate the system with respect to each of the endogenous variables and attempt to sign the derivatives. Because of the complexity of the von Thünen model, this is difficult to do in general. However, some conclusions seem warranted.

First, note that transport costs enter all relationships quite symmetrically. Thus a fall in either the cost of transporting cloth or in transporting corn will cause the relative price of corn to rise at every distance from the town *relative to its price in the town.* But we cannot say what the relative price of corn at a distance r will be in two different equilibrium situations without knowing what happens to that price in the town. This, in turn, depends on what happens to the supply of corn and of cloth, and the demand functions (preferences). Given homothetic preferences, all income elasticities are unity, so that given relative prices, the demand increases proportionately everywhere when real income increases. Obviously, a fall in transport costs makes the economy more efficient, so real incomes must rise everywhere, but relative prices will not remain unchanged. Thus, both more corn and more cloth will be demanded but we cannot say production increases proportionately. In fact, if both more corn and more cloth are produced, more labour must be used in manufacturing (since technology is fixed), and thus, for fixed populations, less must be used in agriculture. The only way for this to occur is for land to be substituted for labour so that the labour/land ratio falls everywhere. In general, therefore, rents will fall, relatively more for land closer to town, and the extensive margin of cultivation must move outwards.

Next, consider an increase in population with no change in technology or transport costs. More labour is available to support both greater cloth and greater corn production. How will it be absorbed? Again, it will be seen that preferences matter a great deal. If the number of rentiers and the number of labourers increase proportionately, aggregate demand is unaffected by the distribution of income since everyone's preferences are the same and homothetic. Moreover, there is no income effect of lower income per caput *per se*; a constant income would simply be divided among more individuals. But because more labour is available there will be somewhat more total income although insufficient to offset the increase in population because, despite constant returns to scale, using more land entails greater transport costs. Increases in the amount of labour devoted to cloth production in the town result in proportional increases in output. With an increase in labour input in agriculture, labour is substituted for land near the town and the extensive margin is pushed outward, but proportional increases in labour, in agriculture and in manufacturing, result in increases in corn production less than proportional to increases in cloth production. Thus the price of corn may be expected to rise somewhat relative to the price of cloth. It follows that more of the increased labour force will be absorbed in agriculture. As long as two equilibria are compared, it should not matter what the relative intensities of labour use in the two activities are.

If preferences are not identical as between rentiers and labourers, or if the numbers of each do not increase proportionately, there will be further effects due to a fall in wages relative to rents.

Finally, suppose there is technological progress in cloth production, but not in agriculture, so that only f_0 increases. Incomes rise so there is a greater demand for both cloth and corn but now cloth production has become more efficient relative to corn production. Because preferences are homothetic, this change in relative efficiency must result in a lower price of cloth relative to corn in the town and, because transport costs are unchanged, everywhere else, as well. This means that corn production becomes relatively more attractive, some labour is drawn off into the countryside, the labour/land ratio increases near the town and the extensive margin moves outward.

More detailed comparative static analyses can be carried out, but these remarks illustrate the richness of the von Thünen model of the dual economy and the central role of preferences quite apart from income effects, which are ruled out by the assumption of homotheticity.

How can the von Thünen model be made dynamic? Economic development in most parts of the world has resulted in extensive rural to urban migration. Migration to the town does not obviously result from changes in the exogenous variables or parameters of the model, except for falling transport costs, unless it is assumed that population increase occurs only, or mostly, in the countryside; and there is no reason why this should be so. We have not considered the effects of technological progress in agriculture, or introduced any capital formation in the model in either sector. Substitution of capital for labour in agriculture or falling transport costs make agriculture relatively more labour-efficient. Given homothetic preferences, such increases in efficiency will generally result in an outflow of labour from the sector.

Such an outflow need not occur instantaneously in response to differences in real income (utility) between countryside and city. A natural point at which to introduce disequilibrium in the model is in the labour market: labour moves in response to differences in real income but not instantaneously. One problem which one encounters immediately in this formulation is that space is continuous and labour is distributed continuously over it. Labour does not merely move from point A, at which real income is low, to point B, at which it is higher, but movement occurs everywhere in between since real income must vary continuously from A to B if it differs at all. Methods for dealing with equilibrium models in continuous space (due to Palander, Lösch, and others) are explained and extensively applied in a recent book by Beckmann and Puu (1985). Because all land is homogeneous in the von Thünen model and because there is only one town, the problem is simplified because we need only look at movement along a radius of a circle with centre at the town. But because the von Thünen model involves interactions between demands and supplies, and between relative prices and wages, disequilibration of the labour market results in partial differential equations of a high order of complexity. In future work, the behaviour of such a disequilibrium system will be explored primarily by means of simulation techniques.

NOTES

[1]A notable exception is the model of Kelley, Williamson and Cheetham (1972). For a fine survey incorporating many of his own original contributions, see Dixit (1973).

[2]The discussion concerning the marginal productivity theory of wages is continued in Dorfman (1986) and Samuelson (1986).

[3]Not so by T.W. Schultz (1953, especially Chapter 9, pp. 146–51). See also Katzman (1977), who gives an extended discussion of the spatial aspects of economic development in Brazil . Of course, many economists have dealt with the problems of urbanization, urban labour markets, and rural-urban migration in the course of economic development. See Kelley, *et al.* (1972, Chapter 7, pp. 234–55). But space itself seems largely incidental to the models developed.

[4]The total area under cultivation is, of course, $A_1 = \pi R^2$. The average, product of grain per unit land is thus

$$\frac{2}{R^2} \int_0^R q_1 \ (r) \ r \ dr.$$

[5]If the minimum labour/land ratio is λ_1 rent at the extensive margin will be

$$\varepsilon = y_1 \ (R) \equiv f_1 \ (\lambda_1) - \lambda_1 f_1 \ (\lambda_1).$$

Usually, one would want to take $\varepsilon = 0$, but, for example, in the case of a Cobb-Douglas production function, there is no labour/land ratio low enough to make the marginal product of land zero, so that the margin of extensive cultivation would be at infinity, at which a negligible amount of labour would be applied to a finite amount of land.

[6]Any form of transportation costs, monotonically increasing with distance, which caused grain prices to fall the further from the town, and cloth prices to rise, would suffice.

[7]Note that the assumption stands in sharp contrast to the emphasis in the more recent literature on growth in which, to the extent demand is introduced at all, different income elasticities for agricultural and industrial products play a major role and the role of prices is minimized.

[8]See Deaton and Muellbauer (1980, p. 40).

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DISCUSSION OPENING – JAMES F. OEHMKE

In the paper 'Von Thünen's Model of the Dual Economy' Marc Nerlove focuses mainly on the equilibrium locational aspects of von Thünen's work. However, he also mentions two possible additions to the model, disequilibrium and dynamics, and these merit attention in our discussion. My comments will cover each of the three topics: locational choice, disequilibrium, and dynamics. In each case I will attempt to explain what the topic is, how it relates to development and economic growth, and finally I will make some suggestions about how the literature might proceed from here.

A location model is an explanation of where people choose to live and work. The location model used by Nerlove is based on von Thünen's example. A single city producing manufactured goods is surrounded by an endless plain of arable land that is either used for farming or left idle. The distinguishing characteristic of the model is that each parcel of land is distinctly different from almost all other parcels. The distinctive property of a parcel of land is its distance from the city. Transport costs for a unit of a particular commodity depend on the distance that the commodity is transported. Hence the relative price of manufactured goods depends on the distance from the city that the manufactured goods must be transported. This variation in relative price influences the choice of where agents work and live, and is the driving force in this location model.

The only novel locational feature of Nerlove's presentation is that he has introduced locational decisions into development theory. As the title of his paper indicates, the central idea in this location model is not new—it is due to von Thünen and the formalism and equilibrium results are due to Samuelson. However, development theorists have traditionally been concerned with migration from rural to urban areas (for example Harris and Todaro, 1970); the introduction of locational choice into development theory suggests that rural to rural migration is an important phenomenon. Nerlove's first contribution is the introduction of a model that emphasizes locational decisions within the rural area.

In what situations will rural locational choice be important? As a first example suppose the agricultural sector produces a high bulk–low value good (corn) and a high value–low bulk good (beef or poultry). Then the relative proximities of corn and poultry production to urban areas is an interesting question. As a second example, suppose that the opportunity for off-farm employment depends on the distance from the farm to the city. Then the rural location decision becomes important in determining the composition of farmers' incomes. A third example is that of exogenous restrictions on rural to urban migration such as government prohibition (China comes to mind). In this case farmers who wish to improve their lot through migration must migrate to another rural or semi-rural area. Finally, catastrophic shocks to the system such as drought or war can cause massive labour migrations, and once again a general theory of migration that includes rural locational choice is needed.

The last comment I will make on location theory is that we need a better empirical base of knowledge about the effects of locational choice. For example, I have been involved in some preliminary studies in Pakistan that suggest that the distance to a village market affects crop choice and labour allocation (Oehmke and Husain, 1987). It is also likely that proximity to a city affects job availability and investment in human capital. To model these effects properly, we need much more precise empirical definition and measurement of locational effects.

The *second* topic I would like to cover is that of disequilibrium. In particular, Nerlove suggests that labour market disequilibrium is an important factor affecting migration and location decisions.

Disequilibrium occurs when prices fail to adjust in order to equilibrate quantity supplied and quantity demanded. In this case quantities must be allocated by some nonprice rationing scheme. In terms of the labour market, disequilibrium suggests sticky wages and migration limited by nonprice mechanisms. However, Nerlove does not provide a description of the causes of sticky prices, nor of the nonprice causes of migration (or the lack thereof).

There are two prerequisites for a well-developed, disequilibrium, locational model of growth or development. First, we must provide a thorough description of sticky prices, internal migration, and nonprice influences on labour mobility. This necessitates a series of empirical studies measuring these variables and their interactions (for example along the lines of Mundlak, 1979). Second, we must provide positive models of individual migration choices that are consistent with the empirical behaviour (for example Sjaastad, 1962 or Mincer, 1978). If standard Walrasian market clearing mechanisms are not used, then the model must include a description of the disequilibrium allocation mechanism—in this case the allocation of labour among various locations.

Finally, it is extremely important to understand how disequilibrium economics can be used in development models. In my opinion the most profitable use of disequilibrium economics is as a perspective that allows the investigator to notice types of behaviour and stimuli that might go unnoticed from a different perspective. These behaviour and stimuli then need not remain exclusively in the realm of disequilibrium economics—often they can be usefully incorporated into equilibrium models. For example, the 'first-come first-served' mechanism described above as a disequilibrium allocation is really an equilibrium mechanism where the price of the commodity includes the time cost of queueing. As a second example, the major emphasis of neo-Keynesian literature is to explain Keynesian labour market 'disequilibrium' in terms of underlying, structural equilibrium models (Rosen, 1985; Rotemberg, 1987).

The *third* ideal I would like to take up is that of dynamics. A dynamic locational model is an explanation of how locational choices change over time. In a static model individuals move instantly to their permanent equilibrium location. In a dynamic model this migration from the *ex ante* location to the equilibrium location may take place gradually, over a period of time. Clearly the latter model more closely fits the observed migration of labour out of agriculture.

Nonetheless, static disequilibrium models can capture some part of this migration. To see this, consider an economy in which the current allocation of labour is far from the long-run equilibrium (steady state) allocation – say there are currently more agricultural workers. This is a stock disequilibrium situation, since the stock of human capital in agriculture is higher than the equilibrium stock. The static equilibrium locational model has no hope of representing this situation since the model requires instantaneous movement of labour to the equilibrium allocation. The static disequilibrium model naturally accommodates stock disequilibrium – in fact, this is an assumption of such a model. Moreover, a stock disequilibrium model would assume some type of *ad hoc* stock adjustment mechanism that specifies how labour migrates out of agriculture. While *ad hoc* specifications will not help our understanding of the migration decision, the adjustment mechanism may be chosen to correspond with the currently observed migration flow.

To expand on this point, consider a migration out of agriculture that continues for several decades. Suppose that a static disequilibrium locational model is used to capture this migrational behaviour in some particular year, and suppose further that the model is reasonably accurate. Then this model may capture the short-run consequences of labour migration, and it may continue to do so over the next several years, if the migrational pattern is fairly steady. Hence the static disequilibrium can be a useful first exercise.

However, it must be noted that the disequilibrium model is only a first approximation. It is useful as an empirical correlation, not as a behavioural model. It is very dangerous to draw inferences about the nature and causes of labour movements from an *ad hoc* migration equation.

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