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REGIONAL PRODUCT PRICE DIFFERENCES AND THE SECTORAL DISTRIBUTION OF LABOR IN L.D.C.'S

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ABSTRACT

A model is presented in which open unemployment exists as a result of an adverse terms of trade in rural areas, combined with a binding urban wage floor. This unfavorable product price ratio has created an excess supply of labor available for urban employment at the minimum wage. In contrast to previous investigations involving sector-specific wage rigidity, the present analysis considers a third sector transport, in addition to farming and manufacturing. It deals with policies affecting farm output such as transport infrastructure investments that are more easily administered than the wage or production subsidies examined earlier. The three-sector model predicts that, under certain conditions, large areas of unutilized land will be present despite high urban unemployment rates, a common phenomenon in sub-Saharan Africa. Therefore, the model is tested empirically using primary data from the 1970 agricultural census of Zaire.

I. Introduction

A great many of the models of intersectoral labor allocation in developing countries have the following characteristics: (1) a real wage rate in manufacturing which is inconsistent with full-employment in urban areas; (2) a constant amount of utilized land; (3) relative product prices that are equal across regions; and (4) an equilibrium condition that equates the expected real wage rate in urban areas (expressed in terms of a numeraire good) with the real wage rate in rural areas (expressed in terms of the same good). See, for example, Bhagwati and Srinivasan [3], Harris and Todaro [7], and Stiglitz [18]. Characteristic (3) is necessary for characteristic (4) to make sense. In the case where relative product prices differ across regions, there would be an incentive to migrate between rural and urban areas even if the equilibrium condition associated with (4) were met. Characteristics (2) and (4) imply that the real wage and employment rates in the urban area uniquely determine the level of agricultural employment. Except in the labor turnover models [18] which involve additional structural equations, the level of urban manufacturing employment is predetermined. The ratio of this variable to the difference between the total adult population and the level of agricultural employment is defined as the urban employment rate, thus closing the system. The analysis, therefore, abstracts from the effect on both rural and urban employment of transport cost and other factors causing relative product prices to vary across regions. Yet, for some developing countries, there is empirical evidence indicating a large spatial variation in relative product prices, as well as supply sensitivity to the terms of trade. Rao, for example, shows that foodgrains may be as much as 19 percent cheaper and urban goods 34 percent more expensive in rural than in urban areas of India [16].

The purpose of the present paper is to develop and test a general equilibrium model in which there is open unemployment in the city, interregional variation in terms of trade, and endogenous determination of the total amount of land under cultivation. The crucial relationships in this model are those linking the number of rural areas under cultivation and the labor intensity of cultivation in each rural area to spatial differences in the terms of trade. These relationships, derived from individual utility maximization and an agricultural production function, imply that the labor intensity of cultivation will decline to zero across agricultural regions as the terms of trade become more adverse due, for example, to higher per unit transport costs between the agricultural region and the nearest city. This association between the terms of trade and the labor-intensity of cultivation is based on shifts in the labor-supply curve faced by the individual farmer. It has been analyzed elsewhere by Pease [15, Chapter II] in the context of a full-employment model.[1] In the present paper, Pease's relationship is incorporated into a general equilibrium model in which there is open unemployment in the urban area. The latter is due to a binding minimum wage for manufacturing workers expressed in terms of a utility index. A reduced form relationship derived this model is tested using microdata for the 1970 agricultural census of Zaire. This is an especially relevant data base because of the substantial differences in regional terms of trade in post-independence Zaire.

Among other things, this analysis explains the seeming paradox of high rates of urban open unemployment in countries with large uncultivated land areas, prevalent in sub-Saharan Africa.[2] It also explains the positive simple correlation between distance and rural-urban net migration rates observed in countries experiencing significant increases in internal transport cost during a post-colonial period. This association has been observed, for instance, by Barnum and Sabot in the Tanzanian case [2].

II. Partial Equilibrium Relationships

In the present paper I consider two sets of variables which affect rural employment levels through the individual farmer's terms of trade. The first is the transport cost between the point where the agricultural good is produced and the point of its final destination; the second is monopsony power, i.e., the capacity of an individual buyer by withholding demand to reduce the price of the agricultural good which the farmer offers. Such power may arise because the buyer represents a company which is imperfectly competitive in the final product market for the raw agricultural good being purchased. It may also arise, in spite of a high degree of competition among processing companies, because barriers to entry such as high transport cost create a shortage of middlemen in the local area.

<u>Transport Cost</u>

To understand the effect of transport cost,consider a very simple model in which there are only two factors of production, land and labor, and one crop, say cassava. Assume there is only one urban center and that part of the cassava is consumed by the farmer and part exported to the urban center in exchange for manufactured goods (m-goods), which are partly imported from abroad. Land and labor are assumed to be the only inputs into farming and labor the only input into transporting.

The consumer's real wage in each location, expressed in terms of a utility index, is assumed to be made up of both M-goods and cassava. All consumers are assumed to have identical tastes and the consumer's real wage is an indifference curve, associated with a given utility level and composed of equally acceptable bundles. In all locations, there is an infinitely elastic supply of labor at a specified utility wage.

Suppose that all externally traded goods are shipped directly to and from the urban area. Suppose, further, that an infinitely elastic supply of both M-goods and cassava is available in the urban area at fixed (c.i.f.) prices, determined in world markets under perfect competition. Then the terms of trade for individual farms located outside the urban area will differ from this world terms of trade. The more labor required to transport goods from the farm to the urban area, the more we would expect the selling price of cassava at the farm to fall below the world price. By the same token, the higher the labor requirement for backhaulage, the more we would expect the cost of M-goods in the farming area to exceed their world price. Thus, the higher the cost of transport (measured in terms of the per unit wage bill of transport labor), the higher will be the price of M-goods relative to cassava at the farm.[3]

Because of this difference in the terms of trade due to variations in the transport cost, farms in different regions will have different costs of labor (observed or imputed) in terms of cassava. To show this quantitatively, I investigate the indirect utility function of the individual farm worker in region i. This function takes the form

$$u_i = V^i(w_i, p_i)$$

where w_i is the wage rate in physical units of cassava, and p_i is the ratio of the price of the manufacturing good to that of cassava in region i . Holding the utility level constant and differentiating this expression totally with respect to its two arguments, we obtain

$$(1) \qquad \frac{dw_i}{dp_i} = \frac{V^i_p}{V^i_w}$$

where V_p and V_w represent the partial derivatives of $V^i(w_i, p_i)$ with respect to p_i and w_i respectively. Denote the compensated demand function for M-goods in all regions by $D^M(u_i, p_i)$ and let x^M_i be the per worker quantity of the M-good demanded in the i^{th} region. Then substituting Roy's identity into (1) yields

$$(2) \qquad \frac{dw_i}{dp_i} = x^M_i = D^M(u_i, p_i) \text{ .}$$

Thus, provided the initial per capita quantity demanded of M-goods is positive in region i, an infinitesimal rise in p_i will require the cassava wage associated with a given level of individual utility in region i to increase. The region with the higher p (due to a higher transport cost per physical unit of each good) will have the higher cassava wage rate in an equilibrium where utility per worker is equal across regions. The finite difference in the cassava wage rate between any two regions, i and j, is given by the expression

$$(3) \qquad w_i - w_j = \int_{p_i}^{p_j} D^M(u^*,p)\, dp; \; p_i > p_j$$

where u* is the equilibrium per worker utility. The RHS of (3) is the area to the left of the compensated demand function between the relative prices p_i and p_j. This area may be closely approximated from observed demand functions by Willig's method [18].

Neglecting migration costs,[4] I assume that the cassava wage rate in the city is equivalent in its expected utility level to the cassava wage on the farm. That is, if I let e, w_0 and p_0 denote respectively the employment rate, the cassava real wage rate, and the relative price of M-goods in the urban area, then I am assuming that the equilibrium condition

$$(4) \qquad V(w_i, p_i) = eV(w_0, p_0) = u^*$$

holds.[5] It is easy to show that the labor-land ratio for farms in each region will be uniquely determined by this condition. The price ratio p_i is predetermined by p_0, transport labor requirements, and the urban cassava wage and employment rate. See relationship (A.2) in the Appendix. With p_i determined in this manner and p_0 given, picking values of w_0 and e will uniquely determine the equilibrium values of w_i implied by condition (4). These are the values at which there is no incentive to migrate either to or from the urban area. For example, consider a situation in which there is communal land ownership and allocation, and in which individual farm workers forego their rights to land rents upon migrating to the city. Then, given constant returns to scale, the labor-land ratio of the representative farm in each region will be determined by equating w_i with the average product of labor. Increases in w_i, brought on by increases in transport cost and accompanying increase in p_i, will increase the equilibrium average products of labor and the equilibrium land-labor ratios.

This inverse association between transport cost and labor intensity of cultivation also exists in the case of individual land ownership discussed in Pease [15, Chapter II]. The profit maximizing landowner will hire labor up to the point where the marginal rather than average product of labor is equal to the cassava wage in a given region. This producer's real wage is once again determined by an equilibrium condition which equates workers' expected utility in urban and rural employment alternatives. Aside from the fact that the land-labor ratio tends to be higher in hired labor agriculture than under a communal system and rental returns must be assigned to landowners, the qualitative relationship between agricultural employment and transport cost remains the same. The higher the transport cost, the higher will be equilibrium marginal product of labor and the lower will be employment per unit of land given diminishing returns.

Beyond the proportion normally left fallow, land in a particular region will remain uncultivated for two reasons. First, assume that there is a maximum marginal or average product of labor in the region. If the cassava wage determined by the expected utility of urban employment and the local terms of trade exceeds this maximum, the region's land will not be cultivated. In the second situation, a region will lie uncultivated even if there is no upper limit on its marginal or average product of labor. The cost of transporting a unit of cassava to the urban area may exceed its value in the urban area. If this is true, it is impossible to purchase M-goods with the cassava output of the region. Thus, as Pease points out [15, p. 37], laborers who demand some M-goods as part of their real wage bundle will be unwilling to work in such a region, making cultivation of its land impossible.

Suppose that (a) all land in the economy were identical except for transport cost and (b) the per-unit cost of transporting cassava and M-goods were simply a function of the distance from the urban area; then the amount of farm labor, cassava output, and possibly rental return per unit of land will all decline as the distance from the urban area increases. If this Von Thünen type economy [6] composes a large enough geographic area, then there will be a frontier of cultivation. At this frontier, the value of land (either to the communal group or the individual) will be zero, and beyond it no cultivation will take place. Proportional rises in per unit transport cost at all distances will increase p (and, under certain conditions, the rate of out migration to the city) by a greater percentage for regions close to the frontier than for regions close to the city. See equation (A.9) in the Appendix.

Monopsony

Throughout the developing world, food crops are sold by individual family farmers to middlemen in exchange for M-goods. To the extent that they can influence demand, these middlemen are able to lower the farm-gate below the urban price by a greater proportion than the usual transport cost plus "going" rate of return markup. Such monopsony power exists because of barriers to entry restricting the number of middlemen or because of limited competition among agricultural processors that the middlemen represent.

To maximize profits in the monopsony case, the middleman must choose farm-gate prices such that the following expression is at a maximum:

$$(5) \qquad p_0^a \sum_{i=1}^{m} q_i - \sum_{i=1}^{m} t \cdot q_i \cdot d_i - \sum_{i=1}^{m} p_i^a q_i = \pi ,$$

where p_0^a = urban price of the agricultural good (fixed)

p_i^a = price paid by middleman to seller at i

d_i = distance: i to market

t = per kilogram kilometer transport cost (including storage cost), assumed constant

m = number of regions served by middleman

q_i = output of seller at i

π = total monopsony profits per middleman.

From this maximization process, I obtain the relationship

$$(6) \qquad P_i^a = \frac{P_0^a - d_i t}{1 + 1/\epsilon_i}$$

where ϵ_i is the elasticity of supply of the individual producer. When labor is paid its average value product, this condition simplifies to

$$(6a) \qquad \frac{w_i P_i^a}{(P_0^a - d_i t)} = MP_{Li}$$

where MP_{Li} is the marginal physical product of labor in region i. This is precisely the condition that would hold if there were no monopsony and labor was paid its marginal value product. In this respect, monopsony and pure labor surplus are completely offsetting distortions. Labor is paid its average value product at the depressed local price (P_i^a) and its marginal value product at the world price less per unit transport cost $(P_0^a - d_i t)$.

Let

$$(7) \qquad B = \frac{1}{(1 + 1/\epsilon_i)} .$$

Then I may write the expression for P_i^a as

$$(8) \qquad P_i^a = B(P_0^a - d_i t) .$$

Provided the elasticity of supply is positive but less than infinite, the coefficient B will be less than unity. Therefore, in this case of pure monopsony, the price received by the producer will be lower than in the case where there is no monopsony power and the producer's price is simply

$$(9) \qquad P_i^a = P_0^a - d_i t \ .$$

Though lower, the price of producers is less sensitive to transport cost changes with pure monopsony than with no monopsony at all.

If the land producing the raw material were leased to an otherwise monopsonistic processor, nothing would happen to employment and production in the labor surplus case. On the other hand, a leasing arrangement would increase output and employment if labor was initially paid its marginal value product at local prices, but less than its marginal value product at the world price less per unit transport. Condition (6a) would be profit-maximizing equilibrium condition under leasing in both the labor-surplus and competitive labor market cases.

III. A General Equilibrium Model

Thus far, in the discussion, I have assumed that the urban unemployment rate is given. I shall now present a general equilibrium system which endogeneously determines this variable. To do so, I shall initially assume that buyers of agricultural goods have no monopsony power and examine the effects of incorporating monopsony into the system briefly at the end of the section. Consider a function relating total persons employed in agriculture (including those in transport activities) to the expected utility of urban employment. From the analysis presented in the preceding section, the following effect is clear: as expected utility in the city increases, employment in each region and the number of regions under cultivation both will decrease. In the Appendix, sufficient conditions are derived for an increase in the expected utility of employment, u^*, to decrease total employment of transport sector, as well as farm sector, labor. These conditions also ensure that a rise in the world price ratio p_0, u^* fixed, will lead to a decline in both transport sector and farm employment. Therefore, with a specified transport infrastructure, we may write a function of the form

$$(10) \qquad L_A = L_A(u^*, p_0)$$

where L_A is the sum of transport-sector and farm employment. It is assumed that both $\partial L_A(u^*, p_0)/\partial u^*$ and $\partial L_A(u^*, p_0)/\partial p_0$ are negative, which will be true if the sufficient conditions derived in the Appendix are met.

M-good production is assumed to take place in the urban area. The production function in the manufacturing sector may be written in the form

$$(11) \qquad Q_m = H(\overline{K}_m, L_m)$$

where Q_m is manufacturing output, $\overline{K}_m$ is the specified level of capital services, and L_m is the number of persons employed in manufacturing. It is clear that once $\overline{K}_m$ and the real wage in the urban area expressed in terms of the M-good are known, L_m will be determined by the condition

$$(12) \qquad \frac{w_0}{p_0} = w_m = H_2(\overline{K}_m, L_m)$$

where $H_2(\overline{K}_m, L_m)$ represents the marginal product of labor, and w_m is the ratio of the nominal wage in manufacturing to the consumer price of the manufactured good in the city. Denote the minimum real wage in the urban area (expressed in terms of a utility index) by $\bar{u}$, and assume that this minimum is binding, i.e., $\bar{u} = v(p_0, w)$. From this assumption and (12), I obtain

$$(13) \qquad L_m = L_m(\bar{u}, p_0, \bar{K}_m), \quad \partial L_m/\partial \bar{u} < 0, \ \partial L_m/\partial p_0 > 0, \ \frac{\partial L_m}{\partial \bar{K}_m} > 0$$

It is assumed that the production function in the manufacturing sector is homogeneous of degree one, so that this function may be written as

$$(14) \qquad q_m = H(\ell_m, 1) = h(\ell_m)$$

where $q_m = Q_m/\bar{K}_m$ and $\ell_m = L_m/\bar{K}_m$. The partial elasticity of manufacturing sector employment with respect to w_m, $\eta_{L_m w_m}$ is simply

$$(15) \qquad \eta_{L_m w_m} = \frac{h(\ell_m)}{H_1(\bar{K}_m, L_m)} \sigma_m = \frac{1}{\beta_m} \sigma_m$$

where σ_m is the elasticity of substitution in production in the M-good sector, $h(\ell_m)$ is the average product of capital, $H_1(\bar{K}_m, L_m)$ is the marginal product of capital, and β_m is the capital elasticity of output Under the usual competitive equilibrium assumptions, β_m may be interpreted as the gross profits share. Since β_m is always less than unity, the partial elasticity of manufacturing employment with respect to the real wage can be greater than unity in absolute magnitude even though the elasticity of substitution is less than unity.

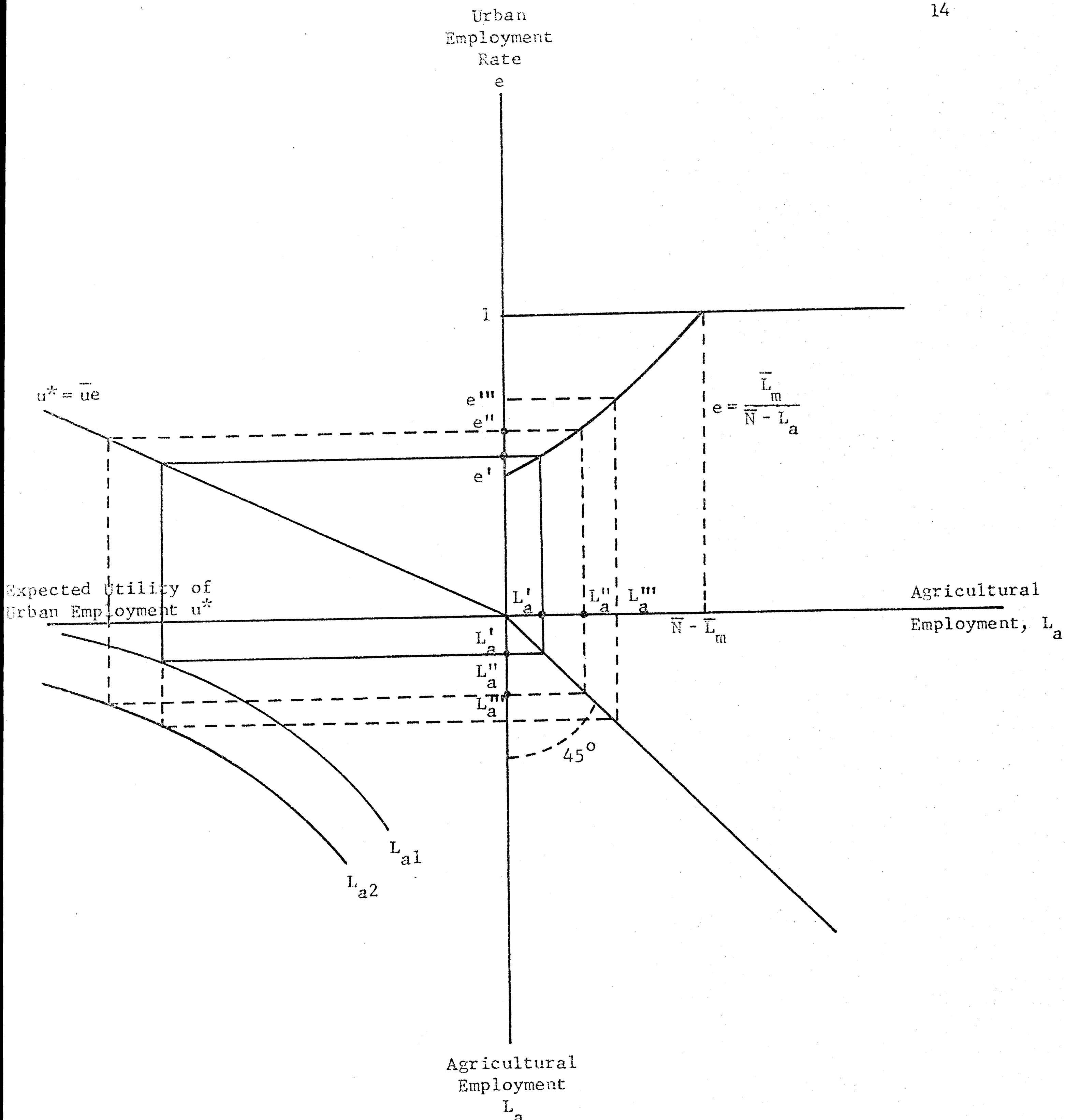
Assuming that unemployment exists only in the urban area, the urban employment rate will be uniquely determined by employment in agriculture (including transport sector) and industry. The identity determining the urban employment rate can be written in the form

$$(16) \qquad e \equiv \frac{L_m}{\bar{N} - L_A}$$

where $\bar{N}$ is the exogenously determined total labor force. When L_m is determined by a specified utility level for employed persons in manufacturing and a given p_0, this relationship implies a positive association between agricultural employment, L_A, and the urban employment rate. Since the second derivative of (16) with respect to L_A is positive, the slope of this curve increases as L_A rises, as shown in the upper right hand quadrant of Figure 1.

Consider now the entire general equilibrium system as depicted in Figure 1. In addition to that determining the urban employment rate, this diagram also depicts the function determining L_A from u^* (in the lower left-hand quadrant) and the identity equating u^* with the product of the minimum utility wage and the urban employment rate e (in the upper left-hand quadrant). The initial equilibrium employment rate in the urban area is e' and the initial equilibrium level of transport plus farm employment is L_A'. The level of urban unemployment is given by the distance between L_A' and $(\bar{N} - L_m)$ on the horizontal axis.

The transport infrastructure investment is assumed to cause a fall in the labor time required to transport a unit of each of the two goods between a given region and the nearest city. Hence, even though it increases farm employment, it may decrease transport-sector employment in a region already under cultivation. Sufficient conditions for a transport infrastructure investment to cause total employment to increase in such a region are presented in the Appendix. For simplicity, I consider only those



Urban Employment Rate e
1
$u^* = \bar{u}e$
e'''
e''
e'
$e = \frac{\bar{L}_m}{\bar{N} - L_a}$
Expected Utility of Urban Employment u^*
L_a'
L_a''
L_a'''
Agricultural Employment, L_a
$\bar{N} - \bar{L}_m$
L_a'
L_a''
L_a'''
45°
L_{a1}
L_{a2}
Agricultural Employment L_a

FIGURE 1

transport infrastructure investments which are "employment creating" in this sense. Under these conditions, an investment in transport infrastructure will cause the function depicted in the lower left-hand quadrant of Figure 1 to shift outward. In other words, for any value of u^*, there will be a higher value of L_A than before.

It can easily be seen in Figure 1 that such a shift will initially imply both a higher value of agricultural plus transport employment (L_A''') and a higher urban employment rate (e'''). This, however, will cause a disequilibrium in the labor markets, in that the new expected utility of employment in the urban area will exceed that in the rural area and labor will be attracted to the city. The final equilibrium levels of rural employment, L_A'', and the urban employment rate, e'', will therefore tend to be smaller than the immediate post-project values, L_A''' and e'''. Moreover, it can also be shown that total welfare of rurally employed workers, in final equilibrium u^*L_A'' will in most cases be lower than that immediately following the project u^*L_A'''. Total land rents, if they exist, will decline in the regions not served by the infrastructure investment, although there will be a net rise in the region served. Under the assumptions of this model, partial equilibrium analysis of a transport project which considers only the first-round rise in income and employment will be likely to overstate the social return to the project.

The effects of other exogenous changes on the endogenous variables are obtained by differentiating totally the equilibrium condition

$$
\begin{aligned}
(17) \qquad u^* - e\bar{u} &= L_A^{-1}(L_A, P_0) - \left[\frac{L_m(\bar{u}, P_0)}{\bar{N} - L_A}\right]\bar{u} \\
&= (\bar{N} - L_A)L_A^{-1}(L_A, P_0) - L_m(\bar{u}, P_0)\bar{u} \\
&= \emptyset(L_A; \bar{u}, P_0) \\
&= 0
\end{aligned}
$$

where $L_A^{-1}(L_A, P_0) = u^*$ is derived by inverting $L_A(u^*, P_0)$. The signs of the partial derivative of each endogenous variable with respect to $\bar{u}$ and P_0 are summarized in Table 1. A rise in the manufacturing production subsidy has an unambiguous positive effect on the urban employment rate, as well as the level of manufacturing employment. The qualitative effect of change in P_0 on the urban employment rate is ambiguous because it has opposite qualitative effects on rural and urban employment, neither of which is dominant in all cases.

TABLE 1

Exogenous Variables	Endogenous Variables L_A	L_m	e
$\bar{u}$	?	-	-
P_0	-	+	?

Though the effect of an exogenous increase in $\bar{u}$ on L_A will in general be ambiguous in sign, an additional not very restrictive assumption makes the qualitative association between these variables clear. For a given P_0 , an increase in $\bar{u}$ or the real wage in manufacturing will decrease urban employment. If the elasticity of substitution is not less than the share of capital in manufacturing production, u^* (which depends on both $\bar{u}$ and e) will fall and agricultural employment in equilibrium will rise. This is immediately clear from the expression

$$(18) \qquad \frac{\partial L_A}{\partial \bar{u}} = \frac{L_m\left(1 + \dfrac{\eta_{L_m w_m}}{\eta_{uW_0}}\right)}{(\partial \phi / \partial L_A)}$$

where η_{uW_0} is the elasticity of utility of the urban employed worker with respect to W_0 , and $\eta_{L_m w_m}$ is given by (15). Since $\partial \mathcal{Y}/\partial L_A$ is negative, the partial derivative of L_A with respect to $\bar{u}$ will be positive if

(19) $$\eta_{L_m w_m} + \eta_{uW_0} < 0 \ .$$

If the indirect utility function is concave in income, η_{uW_0} will be positive but less than unity. As indicated by (15), $\eta_{L_m w_m}$ is greater than the elasticity of substitution in manufacturing. Assuming that η_{uW_0} is less than or equal to unity, condition (19) will be met if the elasticity of substitution, close to unity by most empirical estimates [10, p. 39; 17], is not less than the share of capital in manufacturing.[6]

Suppose that the manufacturing sector utilizes the domestically agricultural good as an intermediate input, but that its intermediate input requirements are partially met also by importation of the agricultural good at a fixed world price. The marginal supply price of the agricultural input will then be equal to this world price. Given constant returns to scale in raw materials, capital and labor, the value added gross output ratio will be uniquely determined in the manufacturing sector by P_0 . However, if the manufacturing firms have spatial monopsony power they will alter their purchases of the domestic agricultural good so that a condition such as (6) is met. Therefore, for most farmers the offering price of the agricultural input will fall short of the world price by substantially more than per unit transport cost to the city. Under these conditions domestic agricultural production will be artificially depressed and the domestic manufacturer will have "excess profits" depending on the extent of the monopsonistic purchases.

Expanding the system to include this type of spatially monopsonistic manufacturing sector will not greatly affect the qualitative general equilibrium results. As a result of this modification, we would expect the function $L_A(u^*, P_0)$ to shift out less in response to a given transport investment, although the transport investment would still increase L_A and e. A decline in P_0 would still increase agricultural employment, with a quantitatively weaker effect. However, the manufacturing real wage rate (w_0/p_0) will increase by a smaller pecentage than the ratio of the agricultural good price to the manufactured good price $(1/p_0)$ given that $\bar{u}$ remains constant.[7] Hence if labor and raw materials are substitutes in manufacturing, employment in that sector (agriculture) may increase (decrease) as a result of a decline in P_0, but this requires a substitution effect that dominates the effect of a decline in manufacturing output on the demand for both variables.

Under certain conditions, making equipment a variable input into transport and allowing it to be mobile between transport and manufacturing will not for the most part affect the qualitative results. The reduced form of this modified model is similar to the Harris-Todaro model with two mobile factors analyzed by Corden and Findley [4], where the effects of the simpler model are generally augmented, not reversed.[8]

IV. Empirical Tests

Although it is difficult to test all the implications of the general equilibrium model empirically, it is possible to estimate the reduced form relationship between the exogenous variables and the labor-land ratio for individual farming units. From the partial equilibrium model in Section II, I derived the following relationship determining employed labor per cultivated hectare on farm k, ℓ_k:

$$\ell_k = f^k(\bar{u} \cdot e,\ p_k)\ ,\quad f_1^k < 0\ ,\quad f_2^k < 0\ . \tag{20}$$

The general equilibrium model in Section II indicated that the employment rate in the nearest city, e, is determined by $\bar{u}$, p_0, and a set of exogenous variables representing the state of the combined rural-urban labor market and denoted by the column vector X . This vector includes variables such as per unit transport labor requirements between each region and the city, the degree of monopsony power in each region, and the labor force available to the entire labor market, $\bar{N}$. Based on the results in Section III, the reduced-form relationship determining the urban employment rate may be expressed as

$$(21) \qquad e = \mu(\bar{u}, p_0; X) , \quad \mu_{\bar{u}} < 0 , \quad \mu_{p_0} \gtreqless 0 .$$

Note that the expression determining the individual farmer's terms of trade such as (A.2) in the Appendix takes the form

$$(22) \qquad P_k = P^k(p_0, e, \bar{u}; X_k) , \quad P_1^k > 0 , \quad P_2^k \gtreqless 0 , \quad X_k \in X$$

where X^k includes only those exogenous variables in the vector X influencing the terms of trade faced by farm k (e.g. labor required to transport a unit of each good between farm k and the city). Substituting (21) and (22) into (20) yields the function to be estimated

$$(23) \qquad \ell_k = \hat{f}^k(\bar{u}, p_0; X_k, X) = \hat{\hat{f}}^k(w_0, p_0; X_k, X)$$

$$\hat{\hat{f}}^k{}_{w_0} > 0 \quad \text{and} \quad \hat{\hat{f}}^k{}_{p_0} < 0 \quad \text{if} \quad \hat{f}^k_{\bar{u}} > 0 .$$

The sign of $\hat{f}^k_{\bar{u}}$ will be positive unless, as seems unlikely, the elasticity of substitution between capital and labor is less than the profits share in manufacturing.

The 1970 FAO agricultural census of Zaire provides a statistical basis for estimating equation (23). This survey consisted of 20,000 units (mainly family farms), which were interviewed from March 1970 to March 1971. It comprised approximately .5 percent of all units in the traditional farm sector, and was selected randomly. The sample examined in the present paper involves those farms with marketed surplus, and consists of a 10 percent random sample of the units in this category.[9]

The rural areas in proximity to each of 21 major cities in Zaire were treated as separate labor markets. These labor markets are characterized by high open unemployment rates and politically determined minimum wages in urban areas [9, pp. 80-107; 11]. Estimates of p_0 and w_0 in the major city nearest the individual farm are used as independent variables in explaining the farm's ratio of labor to cultivated land. The exogenous variables in vector X, other than those specific to the individual farm (X_k), were omitted in the regression equations reported below. An alternative set of regressions were run in which additive dummy variables specific to each of 20 cities were included and the variables w_0 and p_0 excluded. These dummies were designed to capture the effect of the omitted exogenous variables in X, as well as p_0 and w_0. Both the results of this more general specification and that including w_0 and p_o are reported below.

The vector of exogenous variables, X_k, which is included in the regression equations explaining ℓ_k, consists of proxies for per unit transport cost and the degree of monopsony power faced by farm unit k. The sole measure of monopsony power was a dummy variable indicating whether or not the farm sold its produce to a single agricultural processing firm.

Direct estimates of labor or other transport input requirements could not be made. Moreover, even if conventional source-to-destination estimates of haulage cost could be obtained, these would not adequately represent the full cost of transport as reflected in the time foregone by the individual farming unit. There is a great deal of transport labor time which is provided by the individual producing unit rather than by the middleman. Take, for example, the foregone leisure or labor time resulting from waiting for trucks or river boats. For this reason, we use proxy variables for total transport labor time required per physical unit of each commodity.

One proxy for total per-unit transport cost (including that which must be imputed to the individual farming unit) is distance. We expect the average minimum distance from the farm to either the water route, highway, or railroad to rise, the farther the farm is from the urban area. From this it follows that total required transport inputs per physical unit of the commodity rises more than proportionately with distance.

Per unit transport cost, however, is inadequately represented by distance to the nearest urban market. The available evidence [8, pp. 126, 234], indicates the per unit transport equipment and labor requirements are substantially lower over the same distance by boat, as compared to truck or railroad haulage. For this reason, I also included a number of dummy variables reflecting the type of transport mode used by the farmer to send his produce to the nearest market: truck, water, railroad, push cart, and back of man. In line with the available direct estimates of transport cost, the only one that proved statistically significant was the dummy variable corresponding to whether or not water transport was used.

In its final form, one regression equation approximating (23) was

$$(24) \qquad \ln \ell_k = a_0 + a_1 \ln w_{0j} + a_2 \ln p_{0j} + a_3 D_{kj} + a_4 \delta_k^r + a_5 \delta_k^m + \xi$$

where ℓ_k is working age adults (either male or female) per cultivated hectare on farm unit k, w_{0j} is the real wage expressed in terms of food in city j, p_{0j} is the ratio of the price of manufactured goods to the price of food in city j, D_{kj} is the average distance between farm unit k and city j, δ_k^r is a dummy variable with a value of 1 if farm k used water transport and 0 otherwise, δ_k^m is a dummy variable with a value of 1 if the farm sold its produce to only one buyer (generally an agricultural processor) and 0 otherwise, and ξ is a normally distributed error term. The hypothesized sign of the coefficients in this equation are: $a_1 > 0$, $a_2 < 0$, $a_3 < 0$, $a_4 > 0$, $a_5 < 0$.

The separate regression estimates of (24) involving each of the two different dependent variables are presented in the first two columns of Table 2, fitted to data for 1,313 farms with marketed surplus. The specifications presented in columns (3) and (4) are similar except that city dummies have been substituted for w_{oj} and p_{oj}. Although the coefficients of determination (R^2's) are low, their corresponding F statistics are well above the 1 percent critical values. The coefficients in all the equations have the hypothesized sign and are significantly different from zero at the 5 percent level for the most part. The coefficient for the dummy variable corresponding to whether or not a farming unit sold its produce to a single buyer is both insensitive to specification change and statistically significant at the .1 percent level in all equations. It indicates that on average farms selling to a single buyer have from 26 to 22 percent fewer men or women per cultivated hectare than do farms which face some competition among purchasers of their products. Both distance to the nearest city and the water transport dummy are statistically significant at the 1 percent level in at least one of the equations in Table 2. The magnitudes of the significant coefficients on the dummy variable for water transport, in the equations in columns (1) and (3), indicate that

TABLE 2

Employment per Cultivated Hectare of Units with Marketed Surplus[a]

Independent Variables	City dummies removed: (1) ln[Males (15-64)/ hectare]		(2) ln[Females (15-64/ hectare]		City dummies included: (3) ln[Males (15-64/ hectare]		(4) ln[Females (15-64/ hectare]	
$\ln[Wage_j/P(food)_j]^b$	.34	(4.0)***	.40	(4.8)***				
$\ln[P(mfg)_j/P(food)_j]^c$	-.19	(2.5)*	-.21	(2.8)**				
Distance[d]	$-6.3\text{x}10^{-4}$	(2.1)*	$-8.0\text{x}10^{-4}$	(2.8)**	$-6.2\text{x}10^{-4}$	(2.1)*	$-3.6\text{x}10^{-4}$	(1.2)
Water Transport	.70	(3.0)***	.39	(1.7)	.47	(2.0)*	.25	(1.1)
Sell to Monopsonist	-.24	(4.3)***	-.22	(4.0)***	-.26	(4.7)***	-.23	(4.3)**
Intercept	-.14		-.15					
R^2	.04		.04		.08		.11	
F	10.9 ***		10.3***		13.5***		11.1***	
	(DF = 5,1307)		(DF = 5,1307)		DF = 8,1304)		(DF= 15,1297)	

NOTES TO TABLE 2

[a]The t-ratios are in parentheses. One asterisk (*) means that the coefficient is significantly non-zero at the five percent level using a two-tailed test, two asterisks (**) represent a one percent level, and three (***) asterisks represent a .001 level.

[b]Minimum legal wage-rate data for twenty-one cities taken from Kazadi wa Dile, Politiques Salariales et Développement en République Démocratique du Congo, Recherches Africaines XV (Paris: Editons Universitaires and Institut de Recherches Économiques et Sociales, Université Lovanium de Kinshasa, 1970), Annexe I. Price of food is the price of cassava in the zone nearest the city as given in the original 1970 agricultural census data.

[c]The manufactured good price is the price of cloth given in Institut National de la Statistique, Prix et Indice des Prix a la Consommation Familiale, 1970 issues.

[d]The distance variable gives the number of kilometers from the zone center in which the individual farm was located to the nearest of twenty-one cities for which minimum wage rate data were available.

[e]Only those of the 20 city dummies with coefficients significant at the 10 percent level were in the regressions in columns (3) and (4). Five city dummies were retained in the regressions explaining males per hectare and twelve in the regressions explaining females per hectare. The estimates for these dummies and the intercept are not reported for regressions in columns (3) and (4).

working-age men per cultivated hectare are from 63 to 47 percent higher for farms using than not using river transport. The distance coefficients indicate that men per cultivated hectare will fall by about 6.2 percent and women by 8.0 to 3.2 percent if the distance from the nearest city is increased by 100 kilometers. Therefore, instruments influencing relative commodity prices in rural areas are significantly associated with the labor intensity of cultivation (as measured by the number of persons of working age per hectare) and the magnitude of effect, at least for the monopsony and water transport variables, is substantial. Finally, the coefficients for the labor-market controls, ℓnp_0 and ℓnw_0 in columns (1) and (2) are for the most part significant at the one percent level, as well as being of the hypothesized sign.

Especially in columns (3) and (4), the coefficients for the water transport dummy, distance variable, and monopsony dummy are in most cases smaller and in some insignificant when the dependent variable involves women, as opposed to men, per cultivated hectare. The coefficients for the two transport variables are jointly different at the five percent significance level in the specifications where city dummies are used. (Complete estimates for the pooled regressions are not reported.) Men are better educated and more mobile in Zaire and hence tend to have a greater response to differences in the terms of trade due to variation in transport cost.[10] In addition, the cost of transport to the nearest urban area may be positively associated with the proportion of men temporarily residing in the rural area who are for portions of the year engaged in job search or in part-time urban employment.[11]

V. Conclusions

In the present paper, I have shown that, by improving the terms of trade in rural areas, it is possible to attract labor out of the pool of urban unemployed into productive agricultural employment, and thus increase national income at world prices. Empirical evidence from the 1970 agricultural census of Zaire suggests that certain policies which improve a region's terms of trade will have this result. Such findings, however, must be regarded as necessary but not sufficient conditions for these policies to be socially desirable once their distributional effects and opportunity costs are considered. For one thing, the rental income of private landowners outside the region affected by transport infrastructure investment will decrease if the investment increases the urban employment rate.

For another, if it "crowds out" other investment, the transport infrastructure investment may cause social welfare to decline in future time periods. T ensure that crowding out of other investments will not occur, the transport investment must produce aggregate increases in taxable nonwage income whose present discounted value equals the investment's cost. In the case of surplus labor in agriculture, where land rents need not exist at all, this criterion may be impossible to meet. Moreover, even a costless transport infrastructure investment may diminish national income at world prices in the future, if the urban minimum real wage becomes no longer binding, but some labor-surplus distorition remains. (Immiserizing growth is possible because the world price line will intersect the full-employment transformation surface if labor is not paid its marginal value product.)

In this, as well as in the case of competitive rural labor market, a significant net social gain can be achieved if there are domestic food processors with spacial monopsony power in agricultural areas where at least some labor is paid its marginal value product. These benefits in the form of higher agricultural production and employment would be the result of eliminating the incentive for these processors to withold their domestic raw-material demand. One promising approach, discussed in section II, would be to allow otherwise monopsonistic processors to lease the lands on which their agricultural raw materials are produced, thus making land rents a fixed rather than variable cost for these firms. Although it may be politically infeasible, this policy has distinct advantages over one which entails legislated minimum commodity prices in rural areas.[12] Even if these lower limits were set at their optimum values (the urban price less per unit transport cost), the minimum price policy would re-institute the labor surplus distortion in areas where monopsony pricing had offset the effect of labor being paid its average value product at local prices.

APPENDIX

LABOR MARKET STABILITY, INFRASTRUCTURE INVESTMENT, AND THE DERIVED DEMAND FOR TRANSPORT LABOR

A sufficient condition for labor market stability, i.e., $\partial L_A(u^*, P_0)/\partial u^* < 0$, is that the partial derivative of the demand for transport workers with respect to u^* be negative. To derive the partial derivatives of the demand for transport workers with respect to u^* and P_0, let us first examine the relationship between these variables and the relative price of the M-good in region i, P_i.[13]

Assuming that transport workers spend all their income in the city at price ratio P_0, the terms of trade in region i is given by the formula

$$(A.1) \qquad P_i = P_0 \left[\frac{1 + r_i^m\left(\frac{a}{P_0} + m\right)}{1 - r_i^a(a + P_0 \cdot m)} \right]$$

where r_i^a is the fixed number of workers required to transport one unit of the agricultural good from region i to the city, r_i^m is the number of workers required to transport one unit of the M-good from the city to region i, a is the amount of the agricultural good, and m the amount of the M-good in the transport worker's wage bundle. If transport workers are paid a wage equal to that of employed urban workers, changes in the urban employment rate will have no effect on this wage bundle. If, on the other hand, we assume that the utility level of transport workers is the expected utility of urban employment, u^*, and that their Hicksian demand functions are $a = \gamma^a(u^*, P_0)$ and $m = \gamma^m(u^*, P_0)$, then we may write

$$(A.2) \qquad P_i = \psi^i(u^*, P_0) = \frac{P_0\{1 + r_i^m[\gamma^a(u^*,P_0)/P_0 + \gamma^m(u^*,P_0)]\}}{\{1 - r_i^a[\gamma^a(u^*,P_0) + P_0\gamma^m(u^*,P_0)]\}}$$

where

$$\psi_1^i = \frac{\partial\psi^i(u^*,P_0)}{\partial P_0} > 0 \ , \quad \psi_2^i = \frac{\partial\psi^i(u^*,P_0)}{\partial P_0} > 0 \ ,$$

and $\qquad u^* = e\bar{u} = ev(p_0, w_0)$.

In the labor surplus case, the number of transport workers employed in region i , J_i , is given by

$$(A.3) \qquad J_i = (r_i^a P_i + r_i^m) m_w^i L_i$$

where m_w^i is the quantity of the M-good demanded by workers in region i , and L_i is the number of farm workers employed in region i . Denote the uncompensated own price elasticity of demand for the manufactured good in region i by $\eta_{P_i}^m$, the income elasticity of demand for the M-good in this region by $\eta_{w_i}^m$ and the marginal utility of wage income by v_{w_i} . Denote the function determining farm output per cultivated area of land by $g(\ell_i)$ where ℓ_i is the labor-land ratio in region i . Assume that $w_i = g(\ell_i)/\ell_i$. The partial derivatives of J_i with respect to u^* and P_0 are:

$$(A.4) \qquad \frac{\partial J_i}{\partial u^*} = [r_i^a(1 + \eta_{P_i}^m) + \frac{1}{P_i} r_i^m \eta_{P_i}^m]\psi_1^i m_w^i L_i$$

$$+ \left\{\eta_{w_i}^m - \left[1 - \frac{g'(\ell_i)}{w_i}\right]^{-1}\right\}(\psi_1^i m_w^i + 1/v_{w_i})\frac{m_w^i L_i}{w_i}(r_i^a P_i + r_i^m)$$

$$(A.5)\qquad \frac{\partial J_i}{\partial P_0} = [r_i^a(1+\eta^m_{P_i}) + \frac{1}{P_i} r_i^m \eta^m_{P_i}]\,\psi_2^i m_w^i L_i$$

$$+ \left\{\eta^m_{w_i} - \left[1 - \frac{g'(\ell_i)}{w_i}\right]^{-1}\right\}(\psi_2^i m_w^i)\frac{m_w^i L_i}{w_i}(r_i^a P_i + r_i^m)\ .$$

From these expressions, it is clear that sufficient conditions for both $\partial J_i/\partial u^*$ and $\partial J_i/\partial u^*$ to be non positive are that $\eta^m_{P_i} \leqq -1$ and $\eta^m_{w_i} < [1 - g'(\ell_i)/w_i]^{-1} = [1 - g'(\ell_i)\ell_i/g(\ell_i)]^{-1}$.

In the case of hired labor

$$(A.6)\qquad J_i = (r_i^a P_i + r_i^m)(m_w^i L_i + M_r^i)$$

where M_r^i is the quantity of M-goods purchased by the region i land-owners. In this case, it can be shown that $\partial J_i/\partial u^*$ and $\partial J_i/\partial P_0$ will both be negative provided the worker and landowner uncompensated own price elasticities of demand for M-goods are less than or equal to unity and the landowner's marginal propensity to consume the M-good is greater than that of the workers--a condition consistent with Engel's law.

These conditions being met in each region will ensure that the derivatives of total transport employment, J , with respect to u^* and P_0 , will be negative, since

$$(A.7)\qquad \frac{\partial J}{\partial u^*} = \sum_{i=1}^{n} \frac{\partial J_i}{\partial u^*} \quad\text{and}\quad \frac{\partial J}{\partial P_0} = \sum_{i=1}^{n} \frac{\partial J_i}{\partial P_0}\ ,$$

where n is the number of regions.

To analyze the qualitative effect on J_i and L_i of a transport infrastructure investment that causes r_i^a and r_i^m to fall by the same proportion, I substitute $\lambda\bar{r}_i^a$ and $\lambda\bar{r}_i^m$ for r_i^a and r_i^m . In this case, λ may be interpreted as a shift parameter associated with the transport infrastructure investment. If it can be shown that the partial derivative of $(L_i + J_i)$ with respect to λ is negative, then the transport infrastructure investment will unambiguously cause total agricultural employment (farm and transport) to rise in region i at a constant u^*.

Denote the compensated own price elasticity of demand for the manufactured good by η^*_{mp}. Denote the elasticity of farm employment with respect to w_i by η_{Lw} and the partial elasticity of p_i with respect to λ by $\eta_{p\lambda}$. A sufficient condition for a fall in λ to increase total agricultural employment in region i is that, with λ initially equal to 1,

$$(A.8) \qquad \left(\frac{\frac{m^i p_i}{w}}{w_i}\right)\eta_{Lw} + \eta^*_{mp} < \frac{-J_i/L^*_i(1/\eta_{p\lambda}+1)}{(1+J_i/L^*_i)}$$

where $L^*_i = L_i + J_i$. In the labor-surplus case,

$$\eta_{Lw} = -\left[1 - \frac{g'(\ell_i)}{w_i}\right]^{-1} .$$

In the case where labor is paid its marginal value product,

$$\eta_{Lw} = -(1/\beta_T)\sigma_a$$

where β_T is the relative share of land and σ_a is the elasticity of substitution between land and labor. By differentiating (A.2), we obtain

$$(A.9) \qquad \eta_{p\lambda} = \frac{\bar{r}^m_i(a/P_0+m)}{[1+\bar{r}^m_i(a/P_0+m)]} + \frac{\bar{r}^a_i(a+P_0 m)}{[1-\bar{r}^a_i(a/P_0+m)]} .$$

A sufficient condition for a finite decrease in λ to increase L^*_i is obtained by (a) substituting 1 for J_i/L^*_i and (b) assuming that all expenditure shares and elasticities are locally constant.

FOOTNOTES

[1]The partial effect of a relative product price change on the acceptance wage of rural workers (paid in kind) is illustrated geometrically but not derived algebraically in Pease's dissertation. In contrast to the more general analysis in the present paper, Pease only considers the case where this wage is equated to the marginal, not the average product of labor. Moreover, he confines himself to the effects of only one variable --transport cost--and ignores other determinants of farm gate prices such as monopsony power.

[2]For example, there is a great deal of evidence in West and Central Africa of both arable land of high quality which is never cultivated [13, p. 521] and high urban open unemployment [11; 1, p. 49]. Even allowing for a 15 year fallow period, Gourou's data indicates that only 31 percent of the available land surface was cultivated in Zaire in 1948 [5]. Evidence of abandoned areas in Zaire with at least average fertility for their setting (forest or savannah) is provided by Nicolai [14] for the Kuilu area.

[3]The exact expression for the terms of trade in a given rural location is provided by equation (A.1) in the Appendix.

[4]Migration costs are nonetheless present. They must be high enough to discourage buying goods in one location and consuming them in another. For example, it is assumed to be less expensive to purchase an M-good in the local rural area than to send a family member round trip to buy it in the nearest urban area. Migration costs are not, however, large enough to cause significant long-run differences in expected utility level for working households in different regions.

[5]Rather than by e, the probability of urban employment may be more accurately approximated by $\rho(e) = (r+h)\{[e]/(1-e)\}$ where r and h represent constant retirement and quit rates. Replacing e with $\rho(e)$ in (4) will, however, only complicate the analysis, without affecting the main qualitative results.

[6]If e in the equilibrium condition (4) is replaced by $\rho(e) = (r+h)[e/1-e]$ as suggested in footnote 5, then condition (19) becomes $(1-e)\eta_{uW_0} + \eta_{L_m w_m} < 0$ which is less stringent than $\eta_{L_m w_m} + \eta_{uW_0} < 0$.

[7]From Roy's identity, it follows that,
$0 < d\log(w_0)/d\log(P_0)\Big|_{d\bar{u}=0} = \alpha_m < 1$ where α_m is the expenditure share of the manufactured good in the consumption budget of the urban worker.

[8] These conditions include: (1) that transport services between two points are determined by a function of labor and equipment inputs, which is homogeneous of degree one in its two arguments; (2) that the uncompensated own and cross partial elasticities of demand for L_A and transport equipment with respect to u* and the equipment rental rate must be negative; and (3) that the real equipment rental rate (expressed in terms of either good using the urban terms of trade) is the same in the transport and manufacturing sectors. These, together with the assumption that expression (15) is greater than one, will ensure that a rise in $\bar{u}$ will increase (decrease) farm and transport (manufacturing) employment. If a transport infrastructure investment is equivalent to a labor-augmenting technical change in the transport sector and is "employment creating" as defined in the text, then it will increase farm employment and national income at world prices, but decrease manufacturing output.

[9] An agricultural unit is defined as a unit under a single direction and on which the same aids to production are used. Each of these units was visited three times during a census year by an interviewer. In addition, a quick visit was made to all units by the interviewers to complete certain data on the third questionnaire. For a description of the preliminary results of the agricultural census, see [20].

[10] This explanation was suggested by Paul Schultz.

[11] Only those city dummies whose coefficients were significant at the 10 percent level were included in the regressions reported in Table 2. Even when all the dummies were included in both equations, the coefficients for the transport-cost variables in the equation explaining working age women per cultivated hectare were smaller than those in the equation explaining working age men.

The geometric mean of working age women per cultivated hectare is 13 percent higher than is the geometric mean of working age men per cultivated hectare, which is consistent with the presumption that agriculture in Zaire is mainly female, in which women contribute more total hours of labor time per year than do men [12]. E. Nelson has shown, as part of his ongoing dissertation work at Yale, that the percentage distribution of the rural population by age and sex obtained from the 1970 agricultural census is quite similar to that in the 1955-57 demographic survey, considered to be highly accurate by African standards. The main function of men in female agriculture is clearing. Since this function takes up only a small proportion of labor time over the year, it may be possible for men facing low migration cost to maximize the expected value of their annual income by working in the country during their productive part of the year and the rest of the year in the city at a lower expected daily wage. Hence an increase in migration cost may have a net positive (negative) effect on the male wage rate(employment) in rural areas.

[12] The minimum local price policy is currently in effect in Zaire *de jure* but not *de facto*.

[13] For simplicity the effect of changes in u* and p_0 on the number of regions under cultivation is ignored. This does not harm the results, since the increase in the number of regions under cultivation caused by a fall in these variables will have a positive effect on transport employment.

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