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Transport Cost and Other Determinants of the Intensity of Cultivation in Rural Zaire

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CENTER DISCUSSION PAPER NO. 227

TRANSPORT COST AND OTHER DETERMINANTS OF THE INTENSITY OF
CULTIVATION IN RURAL ZAIRE

Lucy Cardwell and James McCabe

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I. Introduction*

Reliable estimates of the rate of net internal migration to urban areas in Zaire are difficult to obtain, particularly for recent time periods. Boute has made estimates of rates of urban population growth for the 1959-70 period, of which the net in-migration rate is an important component [1]. However, there is evidence that even these estimates of the total growth rate are subject to large errors since they are based on a comparison of administrative censuses, which have shown a marked tendency toward underenumeration in other countries.¹ Such a bias seems to be less serious in the 1970 census due to less fear of intimidation, taxation, or forced labor than it was in the 1959 census, so that any urban growth rate calculated from these census results may well be an overestimate of the actual rate.

In addition, to obtain estimates of net in-migration from urban growth rates would require information on urban rates of natural increase and net rates of immigration from abroad to urban areas. According to the 1970 administrative census [15], such immigration was negligible, but at least one other source indicates the contrary.² Although estimates of age-specific fertility and mortality have been made by Romaniuk [17] for both urban and rural areas for the 1955-57 period, these rates may not be applicable to a later time period. Applying Romaniuk's age-specific rates to the total number of persons by sex and age obtained in the 1955-57 demographic inquiry, which appears to be a better base estimate than the 1959 administrative census, an estimate of the 1970 population was obtained which fell substantially below (i.e., by over 10 percent) the adjusted

estimate obtained from the 1970 administrative census. The latter, 19.7 million persons, represents a correction by Boute for inflated populations in two provinces. Hence, it might well be concluded that age-specific fertility rose and/or age-specific mortality fell during the period from 1955-57 to 1970, making Romaniuk's vital rate estimates inapplicable in any computation of net in-migration. Support for this conjecture in the urban context is provided by the 1967 socio-demographic survey of Kinshasa, which indicates substantial increases in age-specific fertility when compared with the 1955 inquiry [14].

This is not to say that rates of net in-migration to urban areas have been insignificant during the post-Independence period. Even though intercensal comparisons require arbitrary assumptions and are otherwise subject to significant errors, socio-demographic surveys of individual cities suggest high rates of net in-migration. In Kinshasa, the capital city, for example, this rate has been estimated at about 6 percent per annum between 1955 and 1967, on the basis of the 1967 socio-demographic survey.

There are a variety of approaches to try to explain rural-urban migration rates in less developed countries. One method is to explain the rate of increase in a given socio-economic group due to net migration between two points on the basis of income and other variables at the **destination** relative to those at the source. Another approach, which we adopt in this paper, is to examine determinants of a major variable, rural employment, in which changes are inversely associated with the net rural-urban migration rate. Where there are significant errors in variables

amplified by calculating rates of change, this approach may well have advantages over the flow determination approach. More specifically, it may provide a means of obtaining more statistically efficient estimates of the qualitative association between certain socio-economic or geographic variables and the decision to migrate, than would be the case if a crude estimate of net flows were the dependent variable.

In this paper we analyze variables which may be expected to have opposite qualitative effects on rates of rural-urban migration and rural employment density. These variables include factors influencing the terms of trade faced by farmers such as the monopsony power of individual buyers, and the cost and availability of transport. They also include factors influencing the real opportunity wage in nearby cities such as money wages and commodity prices. A once and for all change in these variables will in a static model with no population growth alter agricultural employment permanently and bring about a short-run, though significant, deviation in the rural-urban migration rate from a stationary equilibrium.

In Part II a simple partial equilibrium model relating agricultural employment to transport cost and market structure will be presented. Part III outlines the empirical procedure used and tests some of the main relationships derived from the model, based on micro cross-section data from the 1970 agricultural census of Zaire. The last section will summarize the policy implications of our analysis.

II. Analytic Framework

In this paper we consider, in addition to the usual "pull" factors such as the real urban wage rate, two other sets of variables, which affect rural employment change and the rural-urban migration rate through the individual farmer's terms of trade. The first is 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, simply due to a shortage of middlemen in the local agricultural area.

Let us begin first by examining the a priori effect of transport cost change on agricultural employment variation and the rate of rural-urban migration.

Transport cost

Consider a very simple model in which there are only two factors of production, land and labor, and one crop, say manioc. Assume there is only one urban center and that part of the manioc is consumed by the farmer and part exported to the urban center in exchange for manufactured goods (M-goods), which are all imported from abroad. Land and labor are assumed to be the only inputs into farming and labor the only input into transporting.

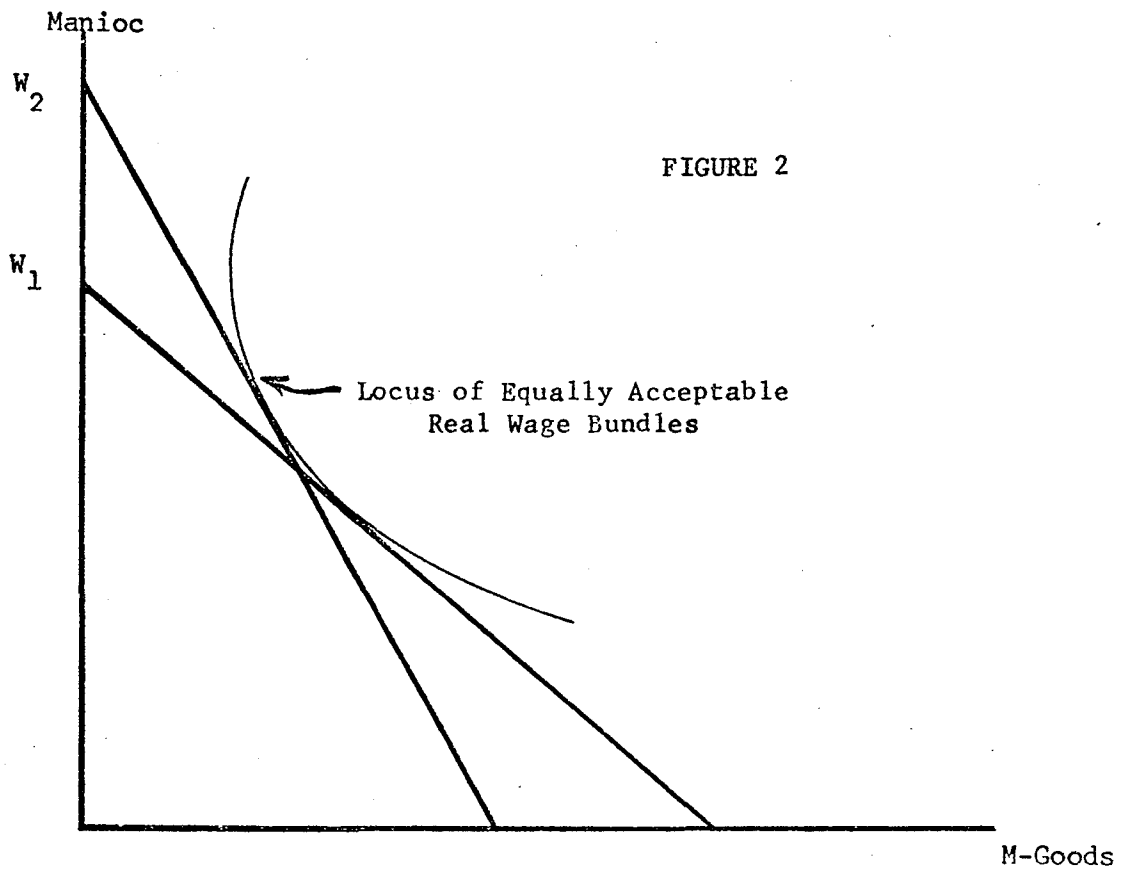
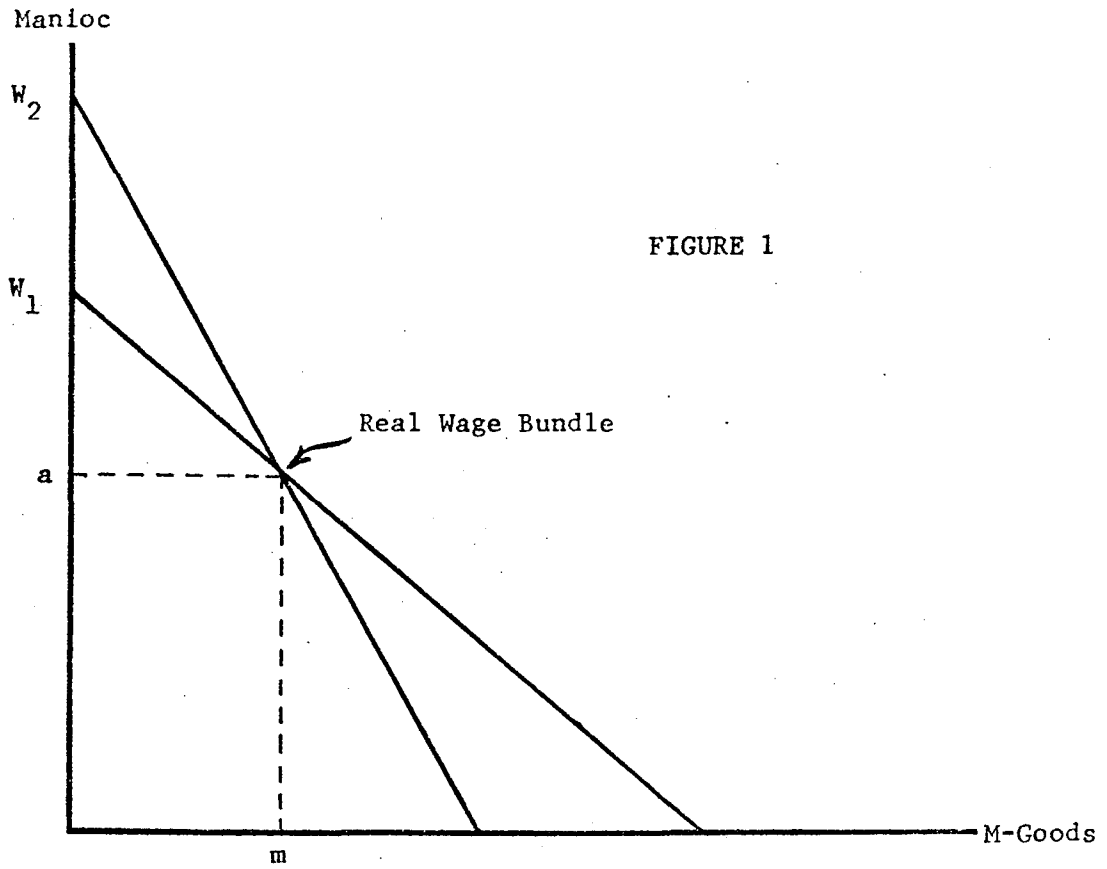
The real wage in each location is assumed to be made up of both M-goods and manioc. All workers are assumed to have identical tastes and the real wage may be a single bundle of goods or an indifference curve composed of equally acceptable bundles. In all locations, there is an infinitely elastic supply of labor at a certain specified real wage as a consequence of unemployment in urban areas.

Suppose that an infinitely elastic supply of both M-goods and manioc is available in the urban area at a fixed price (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 higher the cost of transporting goods from the farm to the urban area, the more we would expect the selling price of manioc at the farm to fall below the world price. By the same token, the higher the cost of back-haulage, 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, the higher will be the price of M-goods relative to manioc at the farm.

Because of this difference in the terms of trade due to variation in transport cost, different farms will have different costs of labor (explicit or implicit) in terms of manioc. Wage rates expressed in terms of manioc are measured along the vertical axes in Figures 1 and 2, taken from Pease's analysis [11]. The slopes of the budget lines in these diagrams are equal to $-P$, where P is the ratio of the price of M-goods to the price of manioc. In Figure 1, it is shown that, when this slope is steeper due to higher transport costs, a higher real wage (expressed in terms of manioc) must be offered in order for the laborer to consume the

same real wage bundle. The same is true even when the budget lines need only be tangent to the same indifference curve rather than intersect at the same point as shown in Figure 2. In both these diagrams, W_2 represents the cost of labor on a farm with relatively high transport costs and W_1 the cost of labor on a farm with relatively low transport costs.

Let us assume that the expected real wage rate in the city (expressed in terms of manioc), W_0 , is equivalent in utility terms to the real wage rates on the farms, so that the budget line for the urban wage is either tangent to the same indifference curve or intersects the other budget lines at the same point. Then, under the standard Harris-Todaro assumption [6], there will be no incentive to migrate provided the average product of labor on a family farm exceeds the equivalent in utility of the expected real wage bundle in the urban area. In fact, given the strong tendency for extended families to share in Zaire, urban relatives may be allowed to remigrate to the family farm under these conditions. Since the region associated with a specified total transport cost is finite, agricultural employment in a given region will be determined by the condition that the average product of labor be equal in utility terms to the expected urban opportunity wage, i.e., the expected utility of the real income that an adult would receive were he to move to the city. The higher the transport cost associated with the farming area, the higher the relative price of the M-goods relative to manioc. This implies that the average product of labor (equal in utility terms to the urban opportunity wage) must also be higher in this area and, other things being equal, employment per unit of land (standardized for quality) will be lower given diminishing returns.



This inverse association between transport cost and intensity of cultivation also exists in the case where hired labor is employed on farms. In this case, the profit-maximizing farmer will hire labor up to the point where the marginal rather than average product of labor is equal to the cost of labor in a given region. This cost is once again determined by an equilibrium condition which equates utility obtained from labor in rural with the expected utility gained from labor in urban areas. Aside from the fact that the land-labor ratio tends to be higher in hired labor agriculture than on a family farm 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.

If, in some region, there is a maximum marginal or average value product of labor at a given net price of manioc and the cost of labor determined by the urban opportunity wage exceeds this maximum, land there will not be cultivated. Note that a region may lie uncultivated even if there is no limit to the marginal or average product of labor in that region. If the import costs are so high that the cost of transporting a unit of manioc to the urban area exceeds its value in the urban area, then it is impossible to purchase M-goods with that region's budget. Workers 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 cost of transporting manioc and M-goods were simply a function of the distance from the urban area; then the amount of farm labor, manioc output, and possibly rental return per unit of land would all decline as the distance from the urban area increased. If the economy were large enough, there would be a frontier of cultivation at which the value of land would be zero and beyond it no cultivation would take place. The fact that, in this sense, some land is too costly to cultivate, not that there is a "surplus" of land, may well account for the large areas of Zaire which remain totally uncultivated.

Monopsony

The inverse association between agricultural employment and transport cost described above may be even stronger when monopolistic elements in the market for agricultural produce are allowed for. The marketing system in Zaire is a complicated one, with some parts of it characterized by intensive competition, but other parts apparently monopolistic. The competitive element that has been most frequently described occurs in the town market place, with market women selling side by side. The marketing element, however, which has been less well studied, but is more relevant to a discussion of the transport network, involves the role of the larger middlemen. There do not appear to be many middlemen who go from village to village buying produce. Truck costs are high even at the point of importation, and a good deal higher in the interior. Imperfect capital markets, then, restrict the number of truckers. In addition, the price of a given agricultural good may be artificially depressed not because of a shortage of self-employed middlemen but because the only middlemen are representatives of a processing firm (e.g. the cotton cartel) which is the sole producer or nearly sole producer of the final product derived from the raw agricultural good.

Throughout Zaire, food crops are sold by individual family farmers to middlemen in exchange for M-goods. With a breakdown in the transport system in the post-Independence period, the after-cost price offered by these middlemen for the crops they purchase has declined relative to the urban price for two reasons: (1) transport to urban areas is less frequently available, hence storage costs for middlemen have risen; (2) the direct cost of transport is higher per ton-mile when available. In addition, the middlemen are able to

some degree to decrease the price they pay for food crops by withholding demand. Such monopsony power exists because there are few middlemen relative to individual producers or limited competition among processors of the raw agricultural good.

To maximize his or his company's profits π , the middleman must choose a price such that the following expression is maximized:

$$(1.1) \quad P_u \sum q_i - \sum t \cdot q_i \cdot d_i - \sum P_i q_i = \pi$$

where P_u = urban price of the agricultural good (fixed)

P_i = price paid by middleman to seller at i

d_i = distance: i to market

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

q_i = output of seller at i .

From this maximization process, we obtain the relationship

$$(1.2) \quad P_i = \frac{P_u - d_i t}{1 + 1/\epsilon_i}$$

where ϵ_i is the elasticity of supply of the individual producer. Let

$$(1.3) \quad B = \frac{1}{(1 + 1/\epsilon_i)} .$$

Then we may write the expression for P_i as

$$(1.4) \quad P_i = B(P_u - d_i \cdot t) .$$

Provided the elasticity of supply is positive but less than infinity, 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

$$(1.5) \quad P_i = P_u - d_i t .$$

Though lower, the price of producers is less sensitive to transport cost changes with pure monopsony than with no monopsony at all. From (1.4), it is clear that a reduction (increase) in unit transport cost, t , will result in a less than proportional increase (decrease) in the price received by the producers. Part of the reduction in unit transport cost, t , leads to a rise in the profits of the monopsonist while part of a rise in t comes out of his profits. Thus, with the number of buyers constant in a given region, monopsony reduces the sensitivity of agricultural employment to changes in transport cost, although it also implies a lower level of agricultural employment at a fixed level of transport cost. This result changes with inter-regional mobility of buyers. A localized improvement in transport can further increase in some regions the monopsony profits of truckers or the company they represent. Because of scarce capital, the truckers or the company can choose to purchase only in those areas where transport costs are relatively low and profits relatively high, leaving the more remote areas with fewer transport alternatives. In spite of the assumptions of the internationally determined terms of trade and the real wage, it is possible that a region not directly covered by transport investment can be harmed by the investment, and as a consequence have a higher rate of outmigration. Truckers will be induced into the region in which the investment takes place because of higher monopsony profits.

III. Empirical Tests

The 1970 FAO agricultural census of Zaire[13] provides a statistical base for testing some of the relationships between transport cost, monopsony power, the urban wage and the intensity of cultivation discussed in the previous section. This survey consisted of 20,000 agricultural units in the traditional sector, which were interviewed from March, 1970, to March, 1971. It comprised approximately 1/2 per cent of all units in the sector, and was selected randomly.³ Our sample consists of a 10 per cent random sample of this entire survey.

We have investigated three main lines of argument, all of which relate the intensity of cultivation to the profitability of agricultural or urban employment. The first has to do with the cost of transport; the second with the effects of commercial middlemen and of monopolistic buyers of agricultural produce; and the third with the alternative of urban employment. In each case, we can compare the response of women and men to these economic incentives. To the extent that the determinants of the intensity of cultivation differ by sex, rural-urban migration patterns by sex are also likely to differ. As well, we compare the response on those farms that produce for market with those that do not.

Our first hypothesis predicts that transport costs per commodity unit are negatively associated with employment per unit of cultivated land and positively associated with physical output per employed person in agriculture. The higher the transport cost to the nearest market, the less favorable will be the terms of trade which the farm faces and the greater will have to be the physical return to labor to compensate for rural-urban price differences.

Direct estimates of transport cost cannot 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 real income of the individual farming unit. There is a great deal of transport cost which is absorbed by the individual producing unit. If, for example, farmers must transport their produce to roads or river ports where trucks or boats come only infrequently, there may well be substantial time lost in household activities and deterioration of produce prior to its being sold to the shipper. These costs are not incurred by the ship operator or trucker in hauling the good. For these reasons, we utilize proxy variables for total transport cost per physical unit of the good.

One proxy for total transport cost (including that which must be imputed to the individual farming unit) is distance. We expect the distance a farm lies off a single straight road leading to an urban area to rise, the farther a given point on the road is from the urban area. From this it follows that transport cost increases more than proportionately with distance, as access roads and frequency of trucks decline, and as storage and deterioration costs rise.

Transport costs, however, are not adequately represented by the distance to the nearest market. For this reason, we have also included a number of dummy variables reflecting the type of transport used by the farmer to carry his produce to the nearest market. These variables, however, have certain important defects. For one thing, some of the transport costs are borne directly by the farmer, while others are borne by the middleman and reflected in the price of marketed surplus. For another, the method of transporting agricultural produce to the first location of sale might obscure subsequent transactions and the cost of reaching the final destination. A unit may use a very primitive form of trans-

port such as the back of a man to get his product to market, and yet the market may be located next to a railroad track or a river. In this case, a relatively sophisticated transport mode would be used across most of the distance to the final destination. In many instances, farmers situated in the more remote areas would not transport the goods to market themselves, but rather wait for middlemen to approach, in which case no mode of transport would be specified on the questionnaire. On balance, however, we would expect employment per unit of cultivated land to be higher on farms using more advanced transport than the back of man or a push cart.

Our second major hypothesis suggests that monopsony power either by middlemen or by agricultural processors should lower the price received by the farmer, decreasing the intensity of cultivation. We have measured the effect of monopsony in two ways. The first method uses a dummy variable for those farms that sell to a monopolist in the final product market and can be interpreted as part of the long run terms of trade.⁴ The second uses the terms of trade at the time of the produce sale, as measured by the relative price of manufactured goods plus transport cost to the average price of marketed surplus. To the extent that monopsonistic middlemen do not represent monopolists in the processed goods market, this "short run" terms of trade should, but the dummy variable should not, be significant.

Finally, we test our third hypothesis--that a higher real urban wage is inversely related to the intensity of cultivation--by using both an urban wage in terms of manic and the relative price of manufactured goods to manic in the city. Ideally, we would include the effect of urban unemployment. Accurate estimates, however, of the urban employment

rate are available for only one city, Kinshasa, and even here it is questionable whether this is a complete indicator of employment opportunities [12].

Whether the data comes from the agricultural census or from other sources, a number of the variables we are using might be subject to extreme errors in measurement. For example, the survey units were asked the number of weeks each member worked between visits. It is highly unlikely that the respondents could give accurate retrospective estimates of weeks worked particularly over a time period as long as 3 or 4 months. On the other hand, a variable such as the average number of persons per visit would be subject to considerably less bias. And, although there is some problem in estimating age, a more accurate measure of employment than weeks worked may be simply the number of persons 15-64 years of age, which is also provided in the survey. Farm size is among the other variables subject to considerable measurement error. In addition, the correct interpretation of the transport mode dummies, listed in Table 1, cannot be verified.

Unfortunately, a number of the variables we need cannot be obtained from the available data. Only in nine cities is it possible to estimate a manufactured good's price. Since budget studies do not exist even in these cities, we must confine ourselves to making a comparison of individual agricultural and manufactured goods prices rather than comparing price indices. We chose simply a ratio of the price of a frequently used clothing item to the price of a frequently used food item. Wage rate data are available for only twenty-one cities. Distance is estimated by the number of kilometers from an administrative region's center to the nearest of the twenty-one cities for which we had salary data.

Table 1

Transport and Market Structure Variables

T ₁	Unit uses "back of man" to take marketed surplus to first location of sale
T ₂	Unit uses "beast of burden" to take marketed surplus to first location of sale
T ₃	Unit uses "cart" to take marketed surplus to first location of sale
T ₄	Unit uses "bicycle" to take marketed surplus to first location of sale
T ₅	Unit uses "truck" to take marketed surplus to first location of sale
T ₆	Unit uses "railroad" to take marketed surplus to first location of sale
T ₇	Unit uses "other" to take marketed surplus to first location of sale
V ₁	Unit is part of a commercial or industrial enterprise
V ₂	Unit delivers part or all of its produce to an agricultural industry
V ₃	Unit delivers its produce to a monopoly
V ₄	Unit's produce buyer takes an interest in the unit's management

To sum up, in our regression equations we can use as explanatory variables distance, dummies for the mode of transport, dummies for market structure, the short run terms of trade, the real urban wage rate and a proxy for the relative price of the manufactured good. We also included farm area, as an important determinant of intensity of cultivation. Most cultivated area in Zaire is communally allocated among different households by the tribe. Wage labor is rare. We expect, then, the farm area variable to be inversely related to intensity of cultivation. Those areas which tend to have higher land allotments per adult, such as in the savannah or where soil quality is low, should be associated with lower intensity of cultivation.

We compared the role of men to that of women in Zaire agriculture by considering three different dependent variables: total persons 15-64 per hectare; males 15-64 per hectare; and females 15-64 per hectare. These variables are essentially labor force rather than employment measures, but are reasonable proxies for the latter. This breakdown by sex is especially important considering the descriptions in much of the anthropological literature.

The system of shifting cultivation, which characterizes traditional agriculture in Zaire, involves farming an individual plot only temporarily until its natural fertility declines. At that time, the farming household puts a new plot of land under cultivation, and abandons the old one. Each year there is some clearing of forest and underbrush so that new plots can be put under cultivation. Although there are major tribal exceptions, these tasks are generally said to be reserved for men. On the other hand, most of the planting, maintenance, and harvesting tasks are performed by women. Thus, although the work of men prevents a

long-run fall in crop yields, nearly all tasks vital to short-run production in agriculture seem to be performed by women. In fact, most studies indicate that the hours put in by men in agriculture fall substantially short of those put in by women.

Since functions performed by the two sexes differ significantly, an attempt should be made to explain male and female employment separately, as well as total employment [9]. Rates of migration, by implication, will also differ. It may be argued that some of the independent variables of our equations have a significant effect on male employment but not on female, and vice versa. The real wage rate in the nearest city (expressed in terms of agricultural goods), for instance, may well be negatively associated with male but not female employment in a given agricultural region. Women are not generally formally employed in urban areas, and hence, the real opportunity wage rate in a proximate urban area is not an indication of the opportunity cost of their remaining in agriculture. Since work involving machinery tends to be limited to men, we would expect the mechanical transport mode dummies to have a greater positive association with male than they do with female employment.

We have also divided the production units into groups that market some produce during the time period covered by the survey and those that do not.⁵ Again, we would expect the two groups to respond differently to production and migration incentives. Production on a farm which is outside the market economy might not react strongly to a deterioration in the terms of trade. On the other hand, family members can still migrate in hopes of obtaining the urban wage. In fact, migration might be the only possible way to improve income, if the unit is unable to sell produce.

The first equation estimated took the form

$$(2.4) \quad E_{im} = b_0 + b_1 w_{jm} + b_2 q_{jm} + b_3 d_{ijm}^2 + b_4 H_{im} + \sum_{k=1}^4 b_{4+k} V_{kim} + \sum_{k=1}^7 b_{8+k} T_{kim}$$

where E_i is employment (male, female, or total) per hectare on a farm unit i ; w_j is the real wage expressed in terms of food in city j ; q_j is the price of manufactured goods relative to the price of food in city j ; d_{ij} is the average distance between farm unit i and city j ; H_i is the average hectares per farm unit; V_{ki} are dummies for market structure; and T_{ki} are dummies for transport mode. In each case, m defines whether the farm produces for the market or not. The hypothesized sign of the coefficient for the w_j variable in the equation is negative, that of the relative price q_j positive and that of H_i negative. One would expect the coefficients for the more primitive transport modes to be smaller than the less primitive, and one would expect the coefficients for the second and third market structure variables to be negative, but ambiguous for the first and fourth. If d_{ij}^2 is a proxy for the cost of shipping goods, we would expect its coefficient to be negative.

The equations for total, male and female employment per cultivated hectare were fitted to data for 1313 farms with marketed surplus and 724 without (a 10 per cent random sample of the original survey). The independent variable coefficients for equations based on farms with marketed surplus, together with the coefficients of determination, are presented in Table 2. The equations based on data from farms that did not sell for the market are not reproduced at this stage, but only later with a better specification of the model. The coefficients of determination are very high for cross-section data, and the F ratios are well above the 1 percent critical value.

In every equation predicting employment per hectare, at least four

Table 2

Employment per Cultivated Hectare of Units with Marketed Surplus^a

Independent Variables	Total Adults (15-64)/ hectare	Total Males (15-64)/ hectare	Total females (15-64)/ hectare
Farm area	-.007 (11.533)***	-.004 (11.667)***	-.003 (10.088)***
^b Wage _j /P(food) _j	.452 (1.641)	.094 (.613)	.358 (2.248)*
^c P(mfg) _j /P(food) _j	-.084 (1.322)	-.042 (1.174)	-.042 (1.154)
^d Distance squared	-10 ⁻⁴ (2.500)**	-3x10 ⁻⁵ (1.500)	-7x10 ⁻⁵ (3.500)***
Back transport	.944 (.373)	.385 (.272)	.560 (.383)
Truck transport	32.309 (3.579)***	19.197 (3.804)***	13.112 (2.515)**
^e Other transport	24.549 (2.332)**	16.058 (2.729)**	8.491 (1.397)
^f Sell to monopolist	-6.427 (2.573)**	-2.713 (1.943)	-3.714 (2.574)**
Intercept	45.255	22.198	23.056
R ²	.113	.091	.092
F(DF=8,1304)	20.684***	16.312***	16.474***

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

^bSalary data for twenty-one cities taken from Kazadi wa Dile, Politiques Salariales et Développement en République Démocratique du Congo, Recherches Africaines XV (Paris: Éditions Universitaires and Institut de Recherches Économiques et Sociales, Université Lovanium de Kinshasa, 1970), Annexe I. Price of food is the price of manioc in the zone nearest the city as estimated by the Institut Nationale de la Statistique.

^cMfg. price \equiv price of clothing in nine cities.

^dThe distance variable gives the number of km's from the zone centers to the nearest of twenty-one cities for which we had salary data.

Notes continued on next page.

Notes to Table 2

^e"Other" transport refers mainly to river transport.

^fWe originally had three monopoly type variables, of which the second was statistically most significant:

- (i) Does the unit deliver part of all of its produce to an agricultural industry?
- (ii) Is the enterprise to which produce is delivered a monopoly?
- (iii) Does the enterprise to which produce is delivered take an interest in the unit's management?

variables are significantly non-zero near the five per cent level when a two-tailed test is used and many are highly significant. The most startling among these is the average farm size variable. While the coefficient has the predicted sign, its significance is probably partly due to measurement error. Hectarage appears both on the right hand side of the equation and in the denominator of the dependent variable. Therefore, any error in measurement creates a negative bias in the coefficient. The distance variable has the hypothesized sign and is significant for adults and women, and near the five per cent level of significance using a one-tailed test for men. Of the transport mode variables, preliminary tests showed that only three had coefficients at least as large as their standard errors in absolute magnitude,⁶ and hence, these alone were included in the regression equations presented in Table 2. Still, the relative magnitude of the coefficients is in line with our hypothesis. The coefficients for the more advanced transport modes, "truck" and "other," are greater than that for the "back of man" mode. Moreover, the coefficients for "truck" and "other" are for the most part statistically significant. Only one of the market structure variables--the proportion of units selling their produce to a monopolistic enterprise--has a coefficient greater than its standard error. It was always of the hypothesized sign and both more significant and stronger for women than for men.

The urban real wage and the relative urban prices are neither of the predicted sign, nor significant. It is possible that those farms which are able to market a surplus are located in relatively fertile areas. The direction of causation might run from relatively productive cultivation to relatively high population density, high opportunity cost of labor and a high urban wage. For the farms which did not produce a marketed surplus,

the opposite and expected sign for the real urban wage was obtained. In this case, it is likely that the urban wage acted to pull labor into the city, rather than in response to agricultural productivity.

To go into more detail, it is useful to contrast the male and female equations. The independent variables explain slightly less of the total variations in male and female employment per hectare than they do in the case of total adult population. As hypothesized, the magnitude and statistical significance of the coefficients vary between the two sexes. First of all, those transport variables which we would expect to be more important for men than for women have both larger and more significant coefficients for men. The t-ratios and coefficients for "truck" and "other" transport are higher, whereas those for "back of man" are lower in the equation explaining male employment. This is quite consistent with women transporting produce primarily by back, rather than by truck.

Again, as predicted, whether or not a farm sells to a monopolist has a greater and more significant impact on women, who supposedly do more of the agricultural work than do men. If we are correct in interpreting the real urban wage as a proxy for soil fertility, we obtain as expected, a more significant association between the urban wage rate and female employment than between the urban wage rate and male employment. This is consistent with the view that women have a great deal of earning ability in rural areas. By contrast, men will migrate to the city in response to a smaller change in the expected real wage than will women, with little effect on agricultural employment.

Similarly, distance from market has a larger and more significant impact on female employment than male. This relationship is perfectly consistent

with our interpretation of distance as one component of the long-run terms of trade. It could also, however, be indirect evidence of the monopsony model presented in Section II. In that case, distance will affect employment through its association with transport cost by affecting the number of monopsonists. Thus we would expect a much larger number of buyers close to the city where monopsony profits are relatively high than far away from the city where monopsony profits are relatively low. This implies that total transport cost per physical unit measured by distance will have a negative impact on agricultural employment independent of any effect on the terms of trade.

One way of testing for this is to include the terms of trade in the regression equation, along with a separate distance variable. One possible specification is derived as follows. Suppose that price $P(M)_i$ of a given manufactured good on farm i imported from region j is given by $P(M)_i = P(M)_j + td_{ij}$ where $P(M)_j$ is the price of the manufactured good in city j , d_{ij} is the distance between i and j , and t the transport cost per kilogram-kilometer.

It is assumed that the general employment per cultivated hectare equation takes the form

$$E_{im} = \mu_0 + \mu_1 H_{im} + \mu_2 W_{jm} + \mu_3 Q_{jm} + \mu_4 \frac{P(M)_i}{P(A)_{im}} + \mu_5 d_{ij}^2 + C \cdot V'_m$$

where C is a row vector of coefficients; V' is a column vector of transport-mode and market-structure variables; and $P(A)_i$ is the average price of marketed surplus received by the unit i . All the other variables are as before. When the equation determining $P(M)_i$ is substituted into this equation we have

$$E_{im} = \mu_0 + \mu_1 H_{im} + \mu_2 W_{jm} + \mu_3 Q_{jm} + \mu_4 \frac{P(M)_j}{P(A)_{im}} + \frac{\mu_4 t d_{ij}}{P(A)_{im}} + \mu_5 d_{ij}^2 + C \cdot V'_m$$

The hypothesized signs of the coefficients in this equation are:

$$\mu_1 < 0$$

$$\mu_2 < 0$$

$$\mu_3 > 0$$

$$\mu_4 < 0$$

$$t > 0$$

$$\mu_5 < 0$$

The results of estimating this equation for total, male, and female adult population are shown in Tables 3 and 4.

A comparison of these tables corroborates our previous findings, but also provides new insight into the interpretation of cost and availability of transport. First, a summary of the conclusions that carry over from the earlier discussion. The long-run terms of trade measured by distance and the monopoly dummy continue to be more significant for women than for men. Moreover, as one would expect, these terms of trade are considerably more important for farms that market a surplus than for those that have a potential but no actual surplus. The short-run terms of trade, however, are generally not significant. This weak effect could be due to one of several difficulties. For one thing, the price data is subject to short-run random fluctuations which do not influence employment and production decisions in the household. For another, as we argued above, the costs borne by the farmer are not fully measured by the prices paid or received. The various transport mode dummies are an attempt to allow for these non-market transport costs.

Table 3

Farms with Marketed Surplus:
Distance and Terms of Trade Effects^a

Independent Variables	Adults/ hectare	Dependent Variables		Females/ hectare
		Males/ hectare		
Farm area	-.007 (11.583)***	-.004 (10.667)***	-.003 (10.089)†	
Wage _j /P(food) _j	.179 (.514)	-.074 (.382)	.254 (1.260)	
P(mfg) _j /P(food) _j	.028 (.261)	.028 (.467)	-.000 (.001)	
^b P(mfg) _j /P(a) _i	-.020 (1.292)	-.012 (1.455)	-.007 (.840)	
^b Distance/P(a) _i x 1000	5.5x10 ⁻⁴ (.809)	2.6x10 ⁻⁴ (.684)	2.9x10 ⁻⁴ (.744)	
Distance squared	-1.3x10 ⁻⁴ (2.167)*	-4x10 ⁻⁵ (1.333)	-9x10 ⁻⁵ (3.000)†	
Back transport	.816 (.320)	.346 (.243)	.469 (.319)	
Truck transport	32.330 (3.546)***	19.429 (3.812)***	12.901 (2.449)†	
Other transport	24.656 (2.337)**	16.242 (2.575)**	8.414 (1.380)	
Sell to monopolist	-6.596 (2.613)**	-2.764 (1.960)*	-3.831 (2.627)†	
Intercept	46.291	22.961	23.328	
R ²	.114	.093	.092	
F(DF = 10,1302)	16.713***	13.284***	13.241***	

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

^bP(a)_i is a weighted average of local crop prices, using local marketed surplus weights.

Table 4

Farms with No Marketed Surplus:
Distance and terms of Trade Effects^a

Independent Variables	Dependent Variables					
	Adults/ hectare		Males/ hectare		Females/ hectare	
Farm area	-.029	(12.973)***	-.014	(11.950)***	-.015	(10.761)***
Wage _j /P(food) _j	-.986	(1.922)	-.572	(2.073)*	-.414	(1.322)
P(mfg) _j /P(food) _j	.280	(1.694)	.156	(1.757)	.124	(1.227)
^b P(mfg.) _j /P(a) _i	-.052	(2.120)*	-.034	(2.542)**	-.018	(1.232)
^b Distance/P(a) _i X(1000)	.001	(.579)	.001	(1.148)	-.000	(.071)
Distance squared	-.000	(1.500)	-.000	(1.600)	-.000	(1.333)
^c Back transport	5.237	(1.406)	.788	(.394)	4.449	(1.956)
^c Truck transport	20.131	(1.022)	17.910	(1.691)	2.221	(.185)
^c Other transport	21.058	(1.300)	20.053	(2.303)*	1.004	(.102)
^d Sell to monopolist	-1.935	(.368)	.477	(.169)	-2.412	(.752)
Intercept	79.934		39.303		39.631	
R ²	.206		.181		.156	
F(DF=10,713)	18.446	***	15.777	***	13.221	***

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

^bP(a)_i is a weighted average of local crop prices, using local marketed surplus weights.

^cThe transport would be used if the unit had marketed surplus even though it currently does not.

^dUnit would sell part of its marketed surplus to a monopolist if it had any.

If we consider Table 4, showing the results for farms without market sales, we observe that both "truck" and "other" transport are significantly more important for men than for women. It seems reasonable to interpret this finding as an indicator of migration routes rather than as a proxy for the cost of transporting produce. These farms, after all, are not marketing a surplus. It is very likely that men migrating to urban areas congregate at ports and railway stops, where there is cheap and easy transport. Women, however, respond less to the availability of long distance modes of transport. In Table 3, where transportation facilities can represent both the migration network and the cost of shipping goods, we expect and find a large increase in the importance of "truck" and "other" transport modes for women, and a much smaller change in their impact on men. This again is consistent with women's role in agriculture.

A second indication that commercialized and non-commercialized farmers behave differently, is shown by the effect of the urban real wage. The non-commercialized farmers, who are not increasing their real income through trade, are more likely to migrate in response to urban salaries. This is true for both men and women, though the relation is stronger for men. In fact, the wage variables are insignificant in Table 3, partly because fertile areas with more commercialized farms are likely to influence urban salaries, so that the direction of causality is reversed.

Finally, we have not been able adequately to test the hypothesis that increasing transport costs and increasing distance, controlling for terms of trade, should increase monopsony power. To the extent that the transport mode variables are proxies for the terms of trade faced by farmers with marketed surplus, the distance variable is a sign of increasing monopsony with distance from the city. While this conclusion is speculative, it has important policy implications. Suppose the total number of rural middlemen remains fixed. Then the improvement in transport infrastructure in a given region will be expected to increase employment in that region by attracting middlemen and decrease it in others by drawing them away.

IV. Conclusions

In this paper, we have examined the qualitative relationship between the intensity of cultivation in rural areas on the one hand and a set of variables linked to monopsony power, transport cost, and earnings foregone as a result of not migrating to the city. For the most part, our empirical results based on straight cross-section data taken from the 1970 agricultural census were consistent with the hypothesized qualitative relationships. However, any policy implications drawn from these results regarding the effect of changes in certain variables on agricultural employment over time, let alone the rate of rural-urban migration, are subject to considerable qualification. To begin with, it should be recognized that our model omits certain critical variables, in particular soil quality, in its explanation of the intensity of cultivation. In addition, distortion is created because a great many of the individuals in the data set have initiated but not completed a step-wise migration process. In other words, a model which assumes an equilibrium between rural and urban labor returns is being tested in a context in which a substantial disequilibrium may well exist. For example, there is a strong positive association between adult males per cultivated hectare and the availability of truck and river transport. Yet, the available evidence indicates that this is true not simply because transport cost is relatively low and the terms of trade relatively favorable along roads or at river ports, but because moving to such places represents a logical first step for a person migrating from the hinterland to an urban area. Hence, increasing the number of ports or roads may, contrary to our hypothesis, decrease rural employment in the long-run and significantly increase the rural-urban migration rate in the short and intermediate term.

A number of robust conclusions have, however, emerged from our work. It seems to be unequivocally true that the cost of transport is inversely associated with the long-run number of adult women per cultivated hectare. Since this relationship is either positive or, if negative, substantially weaker in the case of males, we would expect increases in the cost and decreases in the availability of transport to decrease the long-run ratio of adult women to adult men in agriculture. Under these conditions, we would expect a lower ratio of men to women outmigrants from the rural sector, even though the effect of changes in the availability and cost of transport on the overall rate of migration remains ambiguous. This helps explain why the proportion of women in adult urban populations rose substantially between 1959 and 1970 [1, p. 817]. During this period, there was a marked deterioration in the transport infrastructure and rising transport cost in rural areas [8], which may well have contributed to the altered pattern of sex-selective migration.

The qualitative effect of changes in monopsony power on long-run labor-intensity in agriculture is much more clearcut than that of transport cost or availability. If they sold their produce to a monopolistic processor, farms with positive marketed surplus, according to our results, had significantly lower numbers of total adults per cultivated hectare and women per cultivated hectare. The number of men per cultivated hectare was also lower if the farm with positive marketed surplus sold to a monopolistic processor, though not significantly so by conventional statistical standards. Hence, our evidence indicates that increased

competition in food processing would increase intensity of cultivation in agriculture and decrease the short-run rate of outmigration from rural areas.

FOOTNOTES

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¹The 1959 administrative census was part of a series of population registers used as a basis for taxation and forced labor during the period of Belgian control. Hence, there was a definite incentive to avoid being counted. Moreover, there is a tendency to map boundaries poorly in administrative censuses. William Duncan of the U.S. Bureau of the Census has pointed out to us that experiments in Ghana have demonstrated that using administrative "village" listings as opposed to full cartographic mapping can result in underenumeration of about 25 per cent.

²There is evidence that immigration had an important impact on population growth between 1959 and 1970 in Zaire. Even though the 1970 administrative census lists only 938,000 foreign born, Hugh Brooks, et. al. in another source [13] indicate that during 1966-67 alone 728,000 refugees entered Zaire from neighboring countries.

³An 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 the census year by an interviewer. In addition, a final quick visit was made to all units by the interviewers to complete certain data on the third questionnaire.

⁴Other dummy variables representing different market structures are listed in Table 1.

⁵The farms producing for market are not easily distinguishable from those that do not. While they do have fewer household members per hectare (34 adults compared with 42), the difference is not significant. Nor are the differences between average terms of trade, distance from market, availability of transport etc. significant. Perhaps an omitted variable, such as soil fertility, is the crucial factor.

⁶This is attributable to the fact that very few zones have a significant number of units using train or cart transport. Some of the units failed to report any transport mode. By far the most frequently used was the most primitive "back of man."

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