ISSUES IN POLICY ANALYSIS OF AGRICULTURAL DEVELOPMENT AND INTERNAL MIGRATION

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FOREWORD

Roughly 1.6 billion people, 40 percent of the world's population, live in urban areas today. At the beginning of the last century, the urban population of the world totaled only 25 million. According to recent United Nations estimates, about 3.1 billion people, twice today's urban population, will be living in urban areas by the year 2000.

Scholars and policy makers often disagree when it comes to evaluating the desirability of current rapid rates of urban growth and urbanization in many parts of the globe. Some see this trend as fostering national processes of socioeconomic development, particularly in the poorer and rapidly urbanizing countries of the Third World; whereas others believe the consequences to be largely undesirable and argue that such urban growth should be slowed down.

This paper examines the interdependence between internal migration and technological change in agriculture. It identifies the various direct and indirect impacts that choice of technology in the agricultural sector may have on the national population and its territorial distribution. Drawing on the experience of Japan the author argues that a dispersed and rurally-oriented settlement pattern can confer important advantages during the course of a nation's structural transformation.

A list of the papers in the Population, Resources, and Growth Series appears at the end of this paper.

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ABSTRACT

This paper investigates the interdependence between internal migration and technological change in the agricultural sector, stressing the impact of alternative agricultural technologies on migration and human settlement patterns. An immediate objective is to supplement representative computable general equilibrium models by focusing on issues in policy analysis related to the choice of technology within agriculture and to the pattern of migration and urbanization. The nature of technological change interacts not only with the share of incomes accruing to a majority of farmers but also with the intersectoral and spatial reallocation of population, and ultimately with demographic changes in the countryside. It is argued that there are important advantages in a dispersed, rurally-oriented pattern of population reallocation and in avoiding excessive concentration of the growth of industrial output and employment in a few established large cities.

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I. INTRODUCTION

As computable general equilibrium models multiply in number and become sophisticated in their structural characteristics, a persistent neglect becomes increasingly conspicuous. Oversimplification of certain aspects of the economy has caused a glaring imbalance in the overall construction of such models.

There are two areas of the economy that are especially deserving of more attention. These are:

(1) The interrelationships between technological and economic factors in agricultural production, and the resulting patterns of agricultural development

(2) The interactions between economic and demographic variables in agriculture, especially in the small-scale subsector of agriculture, where self-employed household-based farming is practiced and where most of the rural poor find themselves

Contemporary developing nations are now finding a relatively easy access to the mechanical and biological technology of the

West: harvesters, new varieties of seeds, and fertilizers. It has become quite apparent that alternative technologies in agriculture demand the attention not only of engineers and agronomists but also of social scientists and, above all, policy analysts. The nature of technological change in agriculture, through its impact on the demand for factors of production, influences the sector's employment, income distribution, and intersectoral flows of resources, including internal migration of labor, and patterns of human settlement. It goes without saying that, given the size of the rural population in less developed countries, the indirect effects of these primary changes can be substantial in determining the character of the economy's development.

One of the conspicuous omissions of the newer models is the persistent lack of understanding concerning the nature of agriculture in less developed countries and the technological alternatives open to them. In the construction of the agricultural sector in any given model this omission becomes a self-imposed constraint on the nature of the model itself. This is unfortunate because agriculture in these countries occupies an important position in terms of population, labor force, and use of land.

Two factors seem to reinforce this tendency in general equilibrium models. In the first place, in a two-sector development model, the agricultural sector is generally treated as a "traditional" sector to be contrasted to the manufacturing "modern" sector. Whether a particular general equilibrium model is composed of two, four, or fifty sectors does not make any difference in the construction of the agricultural sector component. It is usually the case that, just as in the manufacturing sector, agricultural production is treated in the context of only two factors of production, capital and labor. When land is added, it is done in a manner that is most convenient for the analytical development of capital-labor substitution, or of technological change biased either by capital or labor. Land is often being relegated to the position of a second-class primary factor. Not only is land denied the same treatment as capital and labor in the analysis of production, but also it is stripped of its role in technological change in agriculture altogether. With the restrictive assumptions under which intermediate inputs are introduced into agriculture, the nature of technological change as well as complementarity/substitution relationships between capital, labor, land, and intermediate inputs is assumed away.

Secondly, because these models focus primarily on general equilibrium solutions for economic variables, in most cases the demographic interactions are limited to the labor force and migration variables which are determined independently of technological change in the agriculture sector. Once again the particular significance of the small-farm subsector of agriculture is overlooked. Interactions between economic and demographic variables that govern mortality and fertility in the countryside are most important among the lower-income agricultural households. In such households mild forms of chronic malnutrition may hold sway and govern mortality and fertility in poor countries. A decline in fertility may depend on a minimum level of income, food energy, and nutrient intake (as well as a minimum level of health services) which improves the survivorship of children. To many, this is a realistic assessment of the problem and modeling of the agricultural sector must include this component.

It is the first objective of this paper, therefore, to pay explicit attention to examining these and other issues in modeling the patterns of agricultural development. The second objective is to make a structured inquiry into the important variables and their relationships in internal migration and patterns of human settlement. These variables are influenced by alternative technologies in agriculture and, therefore, alternative patterns of agricultural development.

It is well understood today that urban population growth and urbanization are the direct consequence of the rapid growth in population and of net rural-to-urban migration. Historically, this type of internal migration has been considered a response to structural imbalances between spatial distributions of labor demand and labor supply arising from industrialization. Thus viewed, internal migration acts as an equilibrating process which tends to correct the structural imbalances.

This basic idea has come to be questioned for understanding urbanization in contemporary developing countries. For one thing, in many instances urbanization seems to be occurring independently of economic development. For another, the process of internal migration seems to be aggravating, rather than correcting, the structural imbalances. The so-called "overurbanization" argument describes the existing conditions of many cities in developing countries correctly because "the growth of population has probably run ahead of industrialization, and the development of administrative and other service occupations which are characteristically concentrated in cities" (Hoselitz, 1957). However, an alternative model that takes this argument into account and is as rich in analytical content as the historical model has not yet been developed.

The basic objective of agricultural development can be thought of not only as increasing food supplies for the urban population but also as achieving satisfactory increases in output and incomes to be shared by the majority of farmers and, at the same time, lessening the debilitating effects of poverty among them. From this perspective, it is apparent that technological change in agriculture interacts with the farmers' share of incomes, the reallocation of population, and ultimately with the demographic changes in the countryside.

Recently Ledent and Rogers emphasized the importance of distinguishing between *projected urban growth*, which deals with the increase in size of urban population, and *urbanization*, which measures changes in the ratio of the urban population to total population (Ledent and Rogers, 1979). Using these concepts perhaps a bit differently, one may think of two ways in which population reallocation can occur. Obviously, one is by way of internal migration, where people move from rural areas to large cities, enhancing the population growth of the already established cities. A second route is by annexation and/or incorporation of small rural towns into cities, thereby increasing the urban population and its ratio to the total. In the second case, it is not so much the movement of people that leads to urbanization as the urbanization of rural towns and districts. In reality both can occur at the same time. Analytically, however, the distinction seems fundamental. The first case implies a pattern of urbanization centered on established cities. The second implies, in contrast, a dispersed, rurally-oriented pattern of population and occupational reallocation in the development process.

It is basically correct to characterize usual forms of internal migration as an equilibrating process. If the process creates "overurbanization", it is worth considering the types of "structural imbalances" that give rise to such developments. Without minimizing the importance of the unprecedented population pressures exerted on many developing countries, in this paper it is argued that the "structural imbalances" can be created, just as different technologies can be adopted or rejected, by policy measures, directly or indirectly, explicitly or implicitly. Internal migration under these circumstances can indeed enhance disequilibrium. It is attacking the symptoms to blame migration and not to correctly diagnose the underlying disease. One basic reason for the types of imbalances characterizing many developing countries is the dualistic pattern of agricultural development (and implied capital-using technological change) that is being promoted, as in Mexico and in Colombia, or, conversely, the broad-based pattern of agricultural development (and implied labor-using technological change), experienced in Japan and Taiwan, that is being neglected.

This paper is divided into six sections. The second section focuses on the nature of technological change, both neutral and biased, in a two-sector economy. It is the purpose of this section to prepare the theoretical groundwork for specification of the functional form characterizing agricultural production and of the macroeconomic nature of intersectoral relations. In the third section the discussions are directed to empirically significant issues on the patterns of agricultural productivity growth. The historical review makes a special reference to the experience of Japanese agriculture both before and after the Second World War.

In the fourth section the issues deemed relevant in modeling the patterns of agricultural development are examined. This is done in two stages. First an attempt is made to order and give a logical structure to the interactions between technology and economic variables in the alternative contexts of agricultural dualistic growth or broadly-based growth. Secondly, the basic interactions between demographic and economic variables are analyzed. Attention is directed to the relations between food energy and nutrient intake and mortality of offspring on the one hand, and between income and urbanization and decline in fertility on the other. The basic objective of this section is to provide an ordered structure of issues to be considered in modeling the demoeconomic interactions in agricultural development. In the fifth section this is tied together with internal migration and urbanization in order to complete the examination for modeling the patterns of agricultural development for policy analysis. The sixth section consists of concluding remarks and lessons of history learned through policy analysis.

II. TECHNOLOGICAL CHANGE IN A TWO-SECTOR ECONOMY

Neutral Technological Change in a Two-Sector Economy

In a well-known paper, Herbert Simon provides a theorem stating that if two sectors in an economy have the same rate of technological progress, labor will migrate towards the sector in which the demand for the product is more income-elastic (Simon, 1947). William Baumol showed in 1967 that in a model of unbalanced growth there is a tendency for the output of the "nonprogressive sector"--whose demands are not too highly price-inelastic--to decline and perhaps vanish (Baumol, 1967). This case of Baumol's was later recast in a form compatible with the question of labor migration by Artle, Humes, and Varaiya. In this version, in the case of unbalanced growth of two sectors, labor migrates towards the progressive (non-progressive) sector if the demand for its output is *elastic (inelastic) to its own price* (Artle, Humes, and Varaiya, 1977).

These results were examined recently by Vislie. The Vislie version further specifies the conditions under which the Simon and the Baumol conclusions hold. However, Vislie used a model that characterizes the production functions of the two sectors with only one variable factor (labor) and neutral rates of technological progress. It suffices here to point out that Vislie's "central relation of the model" is indeed rich in analytical content despite the simplicity of the model itself (Vislie, 1979).

Migration of labor between sectors responds to elasticities of demand with respect to income and to price (other prices as well as own price). It is clear also that the impact on the demand of products would depend on direct and indirect effects of technological progress on changes in income and prices. In the first place, the *size* of the sector in question (say, agriculture) is important for comparing the relative importance to the national growth rate of a one percent rise in the rate of technological progress between one sector and another, say agriculture and non-agriculture. As agriculture's share in national income diminishes over time, the contribution to the growth of national income of a one percent rise in the rate of the technological change in agriculture would be less than would be achieved by a one percent rise in the rate of nonagricultural technological change.

Moreover, it is also true that an equal percentage change in technological progress would have varying impacts on the growth rate of national income if the *sectoral levels* of the productivity of factors were different. If the productivity level of factors in agriculture was lower than in the nonagricultural sector, a one percent change in the rate of technological progress in agriculture would contribute less to the national income growth than an equal percentage change in technological progress of the nonagricultural sector (Binswanger and Ruttan, 1978, p. 111).

Thus, neutral technological progress that increases national income may generate a relative decline in the use of factors in agriculture, if the income elasticity of demand for agricultural products is lower than that for nonagricultural products. Given that the income elasticity of demand for food and fibers tends to be lower than nonagricultural goods' elasticity of demand with respect to income, such a technological change in agriculture may turn the terms of trade against its products. Because, if the (own) price elasticity of demand for agricultural products was inelastic (which tends to be the case), the positive impact on its demand would not be sufficient to offset the reduction in factor use per unit of output brought about by technological progress. The factors used in agriculture will have to migrate out of the sector in due course.*

On the other hand, neutral technological progress in the nonagricultural sector generates a stronger demand for its products. As their prices drop following the technological progress in that sector and national income is added, the demand for nonagricultural products rises more than proportionally. This in turn will more than offset the factor saving per unit of output brought about by the technological progress. Thus, under these assumptions, neutral technological progress in nonagriculture "pulls" resources out of agriculture into itself.

*In other words, neutral technological change in the agricultural sector tends to increase the output of the nonagricultural sector, despite the rise in the relative price of the nonagricultural output. The price effect is being outweighed by the income effect in this case. These results follow unambiguously if the production function in agriculture is a Cobb-Douglas function with the assumptions of constant returns to scale and of the elasticity of substitution between any pair of inputs equaling unity.

Biased Technological Change in a Two-Sector Economy

Increases in the demand for factors of production generated by a producing sector depends on the bias of a technological progress as well as on its intensity. In the two-factor case the most widely known measure of bias is Hicks'. In his original definition, for example, a labor-saving technological change would, at the constant factor ratio, increase the marginal rate of factor substitution between capital and labor. If factor prices remained constant, therefore, more capital (and less labor) would be used at the margin per unit of output than previously. Another common measure of bias uses proportional change in the capital-labor ratio due to technological change. If the proportional change in the capital-labor ratio turns out to be positive, it is labor-saving. Obviously in such a situation an increase in the demand for labor would not be as large as it might otherwise be, or it might decrease if the intensity of innovation is offset by the bias and changes in the marginal productivity of labor.*

In a supply-oriented model of international trade characterized by two products, two factors, and two countries, the effects of a biased technological change can be derived without ambiguity. Given the customary Heckscher-Ohlin assumptions along with the strong factor-intensity assumption, a labor-saving innovation in the labor-intensive sector would lead to a rise in the relative reward for labor, a rise in the sectoral output at constant output prices and hence a fall in the relative price of the output of the sector, turning the terms of trade against it. The time-honored 2 x 2 x 2 model is fundamentally inappropriate for use in analyses of agricultural development. Not only does it assume infinitely elastic commodity demand for any sector, but also it assumes that a sector can obtain additional factors only by withdrawing them from other production sectors. Furthermore, the

*These two definitions turn out to be equivalent for the Cobb-Douglas production function case when the elasticity of factor substitution is unity. Unless the substitution elasticity is zero (in such a case there is no way to define bias as there will be no factor substitution) the two measures do not differ much in substance. Measured differences would be dependent only on the elasticity of substitution and, therefore, equal to a scalar multiple of the elasticity of substitution.

standard open economy model loses its compact structure when a nontraded good is introduced, if there is a produced input, or if there is a third factor. As the concept and the definition of factor intensity become ambiguous, many of the results associated with the neoclassical model of trade do not hold.

It is obvious that in specifying the production function of agriculture, land must be included. Furthermore, if one wants to consider substitution and complementarity relationships among a variety of inputs (not limited to the customary two primary factors) and the implied elasticity of demand for, say, labor in agriculture, one must consider the purchased inputs of seeds and fertilizer (or self-produced inputs of these goods) as well as machines. There is, however, an obvious trade-off between the number of variables in the argument of the production function and the neat and simple Hicksian definition of bias in technological change.

In Japan's historical experience it is well known that the nation's efforts for technological innovations in agriculture were concentrated on biological-chemical technologies. This was essentially the development of fertilizer-responsive, high-yielding varieties of grains and related cultural practices (including the development of land-infrastructure, irrigation, and drainage). In the prewar and postwar years particularly, the growth of land productivity occupied a dominant share of the total productivity growth. In order to confront the issues of the "land-saving bias" and biological-chemical technology in Japan's agricultural technological progress, one must depart from the Hicksian definition of bias and also from the simple two-factor production function.*

Another related consideration in specifying the agricultural production function is, of course, the functional form relevant to the questions being posed. Consider the example of an economy with two factors and two products, which undergoes a labor-saving innovation, say at the rate of λ. The same results can be obtained

*In departing from the Hicksian definitions, bias must be defined in terms of the proportional change in factor shares due to technological change. A decline in the share of the i-th factor is defined as i-saving technological change.

by considering that such a labor-saving innovation implies the marginal cost, $MC(w/\lambda, r)$, where w is the wage rate and r is the return to capital. The Euler expansions of the two sectoral marginal costs can then be used in the usual way to derive the relations between λ, the output levels and the factor prices. This is in fact the dual of a method customarily used in deriving the nature of bias in technological change.

The usual method calls for a specification of factor augmentation in the production function. As Binswanger has pointed out, however, this method must assume that changes in the quality of a factor can be measured as rates of augmentation (of one factor and not of another) in a factor-augmenting production function. Furthermore, such factor augmentation cannot be used meaningfully within the context of a Cobb-Douglas production function, because whatever factor-augmentation assumptions one makes the implied technological progress must always be neutral.* A logical alternative would then be a multi-factor constant-elasticity-of-substitution (CES) production function. This function has been used for characterizing the production process of the nonagricultural sector (with factor augmentation) by Kelley and Williamson (1979). It is proposed here that we use the CES specification for the agricultural sector also.**

The Production Function in the Agricultural Sector

In specifying the production function in agriculture we face two types of decisions at the outset. The first has to do with what variables are to be included and at what level of aggregation. We include land and the intermediate inputs of seeds and

*For the use of factor augmentation in production functions and its inadequacies see Binswanger and Ruttan (1978) pp. 159-168.

**It is interesting to note that Adelman and Robinson use a CES specification only for agricultural sector production in their "basic model". Their justification is that the elasticity of substitution between capital and labor is low in traditional agriculture, when the production function is defined to exclude land and improvements on it. In their model, land is included in the productivity parameter. Moreover, their CES returns to scale parameter is adjusted to show decreasing returns to scale in capital and labor only. Strictly speaking, their agricultural production function is a Cobb-Douglas one with land and "other factors", where "other factors" is a CES aggregation of labor and capital (Adelman and Robinson, 1978a).

fertilizers as well as capital and labor. Land is included because it is a primary agent in the processes of agricultural production and not a mere space (as in an industrial site). It receives precipitation and solar energy among other natural gifts required for biological growth of the crops and animals. The intermediate inputs of seeds and fertilizers are included because they are as much the agents of technological progress in agriculture as the machines and farmers that are customarily included.

More importantly, the explicit recognition given to seeds and fertilizers (including agricultural chemicals) in this paper reflects serious questions being posed by analysts of technological progress, in areas not confined to agriculture, of the exclusion of intermediate inputs in productivity studies. For example Christensen underscores Hulten's (1974) argument that the exclusion of intermediate inputs assigns all measured technical progress to capital and labor input, ruling out increased efficiency in the use of purchased inputs (Christensen, 1975, p. 912). In the case of agriculture improved seeds would be outstanding among such purchased inputs. If improved seeds are introduced in the course of agricultural development, and productivity studies are conducted on the basis of value-added with the conventional two primary inputs of capital and labor, the gains in productivity attributable to the improved seeds would be assigned by default to the two primary inputs.

The second set of decisions in specifying the production function of agriculture is more complicated. In specifying how the explicitly selected variables are to be related to each other, i.e., in the choice of the functional form of agriculture's production function, we face problems of empirical importance as well as of purely theoretical interest. Important among the criteria for choosing functional forms are (1) parsimony in parameters, (2) ease of interpretation, (3) computational ease, (4) interpolative robustness, and (5) extrapolative robustness. The property of separability that influences both the generality and the simplicity of the chosen form is also important in the specification of production functions. In view of the number of variables included and the use to be made of the production function, the two most important considerations concern separability and extrapolative robustness.

Separability is of direct interest in a production model with many factors as it concerns an important structural property which may "permit economic analysis to be carried out in terms of subsets of the total set of possible variables, in stages, or with consistent aggregates of variables" (Fuss, McFadden and Mundlak, 1978, p. 221). Hypotheses concerning separability of variables in a production model would permit, therefore, "two-stage" aggregations of variables and "nested" construction of input variables in describing the production processes.

As we include more variables in the production function of agriculture, thereby increasing rapidly the number of possible combinations of input pairs, the function's extrapolative robustness becomes increasingly important. This property requires, in the context of this paper, that the functional form chosen be compatible with the maintained hypotheses of production technology outside the range of observed data.

The significance of the foregoing discussion would perhaps become more concrete and the issues more explicitly delineated by contrasting some important functional forms often adopted for analyzing production processes. For this purpose the transcendental logarithmic production function (Christensen, Jorgenson, and Lau, 1971) is contrasted with the Cobb-Douglas and the CES production function.

The transcendental logarithmic (translog) production function expresses the logarithm of output as a quadratic function of inputs in logarithms. Because this function can be used for analysis of multi-input (i.e., more than two inputs) production technology without imposing *a priori* any restrictions on the elasticities of substitution between any pair of inputs, its use has spread not only in agricultural applications but also in resource economics (Humphrey and Moroney, 1975; Halvorsen, 1977; and Pindyck, 1979).

There is clear awareness of the importance of substitutability and complementarity relations in multi-input technology, involving, say, natural resources as well as capital and labor. Certain natural resources would complement capital and substitute for labor. The rich implications of these relations cannot be captured by the ordinary CES function, let alone by the Cobb-Douglas function. The translog function can be used to analyze the partial elasticities of substitution among all pairs of multi-input production factors. It permits, therefore, not only substitution relations but also complementarity relations in various input pairs. It thus represents a useful generalization by comparison with the Cobb-Douglas function and the ordinary CES function.

A translog production function may be written as

$$\ln Y = \ln Q_0 + \sum_i Q_i \ln X_i + \frac{1}{2} \sum_i \sum_j \beta_{ij} \ln X_i \ln X_j \qquad (1)$$

where Y denotes output, Q_i are parameters, Q_0 represents the state of technology, and X_i and X_j are inputs. It is clear that this function reduces to a multi-input Cobb-Douglas function, if the log-quadratic terms are disregarded. Thus, the quadratic terms can be regarded as amendments to the Cobb-Douglas assumption of unitary elasticity of substitution (i.e., if one or more of β_{ij} is non-zero). The β_{ij} coefficients are technologically determined parameters. They are used to derive point-estimates of partial elasticities of substitution. The β_{ij} parameters are assumed to be constant in empirical regression analyses. However, the partial elasticities of substitution implied by the parameters are variable.

The multi-input Cobb-Douglas function can be derived as a special case of the translog function, where all partial elasticities of substitution are restricted to unity. The multi-input CES function (without "nesting") would require either the partial elasticities of substitution between all pairs of inputs to be constant and identical or the *ratios* of substitution elasticities to remain constant (Mukerji, 1963). Despite these restrictive requirements regarding flexibility of substitution elasticities, it is known that the Cobb-Douglas and the CES functions possess the important property of "self-duality". For these functions both the production function and the cost functions are members of the same family of functional forms. For example, the dual of a Cobb-Douglas production function is a cost function of the Cobb-Douglas form. Likewise, the dual of a CES production function is a cost function of the CES form. Therefore, it is a matter of indifference whether a given production technology is described by a CES (Cobb-Douglas) production function, or by a CES (Cobb-Douglas) cost function. In both, the same maintained hypotheses of technology are employed (Burgess, 1975). If the production function implies constant returns to scale, so does the "self dual" cost function of the Cobb-Douglas or the CES type. This fundamental property is not, however, shared by the translog function.

Indeed, there are almost deceptive similarities between the translog production function (1) and the translog cost function of the type often used in empirical work as follows:

$$\ln C = \ln v_0 + \sum_i v_i \ln W_i + \frac{1}{2} \sum_i \sum_j \gamma_{ij} \ln W_i \ln W_j \qquad (2)$$

where C is the minimum cost corresponding to the cost-minimizing input levels X_i^* in the production function. W_i's are the prices of input services and v_0, v_i, and γ_{ij} are parameters. The latter parameters can be used to derive point-estimates of partial elasticities of substitution and those of elasticities of factor demand. These derivations are much the same as in the use of technology parameters in (1).

Despite the similarities, their affinities are more apparent than real. If the production technology is assumed to be homogenous of degree one, the transcendental logarithmic approximation to the production function will also be homogeneous of degree one. By contrast, however, the translog cost function assumes only that there exists *some* production function, whose explicit form remains unspecified. Thus, a translog cost function may be homogeneous of degree one, as in (2), without implying that the corresponding production function is homogeneous of degree one. Indeed, the production function implied by the translog cost function (2) differs from the quadratic function in logarithms in output and input levels such as represented by (1). The property of "self duality" does not hold for the translog function. The maintained hypotheses of the production function would be different from the maintained hypotheses of the translog cost function, if one were to adopt both (1) and (2).

Furthermore, the flexible functional form of the translog function can be viewed as linear-in-parameters expansions which approximate an arbitrary function. In production applications the form is generated by use of a Taylor series expansion to second-order (thus approximation) *about a point* representing a vector of input quantities (or input prices). Obviously, a problem arises because the approximation of the form is only in a small neighborhood of this point. In other regions of interest, the form may be a poor approximation to the true function, and may "even fail to satisfy basic properties of the true function such as monotonicity, or convexity" (Fuss, McFadden, Mundlak, 1978, p. 234).*

In spite of certain attractive properties of the translog form, it is abandoned except for the empirical results derived from it. This is because the production function must be extrapolatively robust, it should maintain plausible hypotheses of technology, and it must retain ease of interpretation. The concentration is, therefore, on the "nested" or "two-level" CES form with the four inputs of importance in agriculture.

Separability implies uniform or invariant behavior of certain economic quantities. If the marginal rate of substitution between input i and input j is independent of the level of input k, it is then said that input i and input j are (weakly) functionally separable from input k. Intuitively, this means the following. Suppose, for instance, that the use of fertilizers increases while the use of labor and capital is held constant. If the increased flow of fertilizers makes possible a proportional increase in the marginal productivities of labor and capital (which, by the way, is the observational equivalent of Hicks' neutral technological change in the two input case), then labor and capital are functionally

*These properties of monotonicity and convexity are testable empirical questions in the use of translog functions. In the study by Toshiyuki Kako these properties were satisfied for the relevant regions from which his empirical results were derived (Kako, 1978).

separable from fertilizers. In this case, it is appropriate to have labor and capital nested and the resulting combination, in turn, joined together with fertilizers. It was Kazuo Sato's contribution to propose a "two-level" or "nested" CES taking advantage of the separability property in variables. In this form the CES function could accommodate different elasticities of substitution between different pairs of input factors (Sato, 1967).

In specifying CES functions for the "modern" *nonagricultural* sectors both Adelman and Robinson, and Kelley and Williamson adopt the "two-level" approach. Adelman and Robinson first aggregate labor across the skill categories in a Cobb-Douglas form which in turn is combined with capital in the CES function. Thus, their nonagricultural production function (specified but not used) is a CES with capital and labor, where labor is a Cobb-Douglas aggregation of various types of labor. Adelman and Robinson explain this specification by stating that

> .....it was unreasonable to assume that the elasticity of substitution between all types of labor was the same and equal to that between labor, on the one hand, and capital, on the other. Capital is likely to be complementary to high-level skills and substitute for low-level skills (Adelman and Robinson, 1978, p. 207).

Their adopted procedure, however, fell far short of their intent in theory. What Kelley and Williamson have done, in this regard, is to carry through the logic of the Adelman and Robinson procedure. They specify a CES function for the aggregation of capital and skilled labor (to take account of complementarity), and combine this composite index of skills and conventional capital in another CES function with unskilled labor to allow for more likely substitution relations (Kelley and Williamson, 1979).

Both Adelman and Robinson and Kelley and Williamson adopt the Cobb-Douglas form in specifying the production of agriculture. In the case of Adelman and Robinson it is a "nested" Cobb-Douglas with land and "other factors", where "other factors" is a CES aggregation of labor and capital. The underlying hypothesis is that land is (weakly) functionally separable from capital and labor. In the case of Kelley and Williamson, agriculture's production function is a straight-forward Cobb-Douglas in labor, capital, intermediate inputs (home produced and imported), and land. There is no "nesting", as there is with their "modern" sector production functions. One outstanding characteristic of their specification is that agricultural factor augmentation is allowed only for labor and capital and that the exogenously given land stock is not augmented by technological progress.

In the present model agriculture's production function is specified as a "nested" CES in four input factors.* We have a number of "nesting" alternatives, therefore, depending on the alternative hypotheses we adopt concerning separability of variables. Among these alternatives substantive ones are taken to be the following

$$V = \left[(L,\ K)\ ;\ (R,\ C)\right] \qquad (3.a)$$

$$V = \left[(L,\ R)\ ;\ (K,\ C)\right] \qquad (3.b)$$

$$V = \left[(L,\ C)\ ;\ (K,\ R)\right] \qquad (3.c)$$

$$V = \left[(L,\ K,\ R)\ ;\ C\right] \qquad (3.d)$$

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*It is assumed that the agricultural sector production function includes labor, capital, land, and fertilizers (the last of which representing also seeds and agricultural chemicals) in the argument. This assumption implies, of course, that the stated four inputs are functionally separable from "all other intermediate inputs" left out of the argument (and netted out of the gross output on the left hand side of the function). The function can be written in the following form:

$$Y = \left[f(L,\ K,\ R,\ C)\ ;\ \emptyset\right] ,$$

where Y is gross output, L is labor input, K is capital services, R is land input and C is current cost of seeds and fertilizers, and where $\emptyset$ represents "other intermediate inputs". Defining $V = Y - \emptyset$, we have

$$V = F\left[L,\ K,\ R,\ C\right]$$

For example, equation (3.a) states that labor and capital are (weakly) functionally separable from land and fertilizers, and vice versa. Equation (3.d) says that labor, capital, and land are (weakly) functionally separable from fertilizers. The choice of the best alternative, however, must depend on balanced theoretical and empirical judgment.

In his recent study, T. Kako derives empirical estimates of relevant parameters for rice production in Japan (Kako, 1978). He uses a translog cost function of the (2) form, corresponding to a production function that describes the relation between physical output of rice and input services from land, labor, machinery, fertilizers, and "other intermediate inputs". The estimated elasticities of substitution between pairs of inputs are reproduced in matrix form in Table 1.

Table 1. Estimated Elasticities of Substitution, Rice Production, Kinki, Japan 1953 and 1970.

1953	Labor	Machinery	Fertilizers	Others
Land	.76	-.25	.61	.21
Labor		.93	.21	2.24
Machinery			.12	1.71
Fertilizers				5.21
1970				
Land	.82	.36	.51	.70
Labor		.93	-.90	1.91
Machinery			-.42	1.35
Fertilizers				6.04

Source: Kako, 1978, p. 632.

In the translog approach, either in the case of the translog production function or in the case of the translog cost function, the relative cost shares are used as dependent variables in the estimation of the partial elasticities of substitution. As the relative cost shares change with the levels of input usage, which in turn is influenced by changes in the input prices, the estimated partial elasticities of substitution would vary over time. Thus, they may be estimated at the sample means. Those in Table 1 were calculated on the basis of the average input price levels in each year 1953 and 1970.

On the basis of the estimated partial elasticities of substitution the following observations can be made.

1. Machinery and land are substitutes for labor. The substitutability of labor for machinery (or vice versa) tends to be quite high at 0.93, similar to the estimated values based on the traditional two-input (capital and labor) models.
2. Fertilizers and land are substitutes.
3. Fertilizers were a substitute for labor in the early 1950s, but have since become a complement to labor. Similarly, fertilizers were a substitute for machinery in the early 1950s, but have become a complement to machinery more recently.
4. The estimates indicate that technical possibilities of substitution are high (elasticities being greater than one) between "other inputs" on the one hand and any of the non-land inputs, i.e., labor, machinery, and fertilizers, on the other.

It is to be noted that the technical conditions in Japanese agriculture in the early 1950s were essentially "traditional", based on small-scale, household farming with its exclusive reliance on human and draft animal power in field operations and on yield-increasing technology of seeds and fertilizers. Of course, the economic environment of the sector changed drastically compared with that of the prewar decades.* Nonetheless, it is appropriate to regard the technical conditions in the Japanese agriculture in the early 1950s as characterized by biological-chemical technology.

As the rapid growth of the Japanese economy began thereafter, and as the demand for labor and land originating in the industrial sector started drawing labor and land from the agricultural sector at a remarkable rate,** the technical conditions in agriculture underwent a drastic series of changes. By the early 1970s small machine mechanization (represented by power cultivators and sprayers) was complete and large-scale machines (such as riding tractors, harvesting machines and transplanting machines) had become increasingly prevalent. Thus, one may characterize the technical emphasis in Japanese agriculture in the 1970s as mechanical engineering technology.

A positive partial elasticity of substitution between fertilizers and labor estimated in the early 1950s implies that a rise in wage rates induced substitution of fertilizers for labor. This reflected the process of induced substitution of commercial fertilizers for self-supplied fertilizers which were much more labor-intensive. The increased importance of agricultural chemicals, such as pesticides and herbicides, in the "fertilizer" category as defined here explains the new relationships of complementarity between fertilizers and labor in the 1970s. Thus, the transition from the substitution relationship in the early 1950s to one of complementarity in the 1970s between fertilizers and labor as well as between fertilizers and machinery is attributable in part to the changing composition of the fertilizer input category. It is indicative, nonetheless of the nature of

*The shortage of almost all types of food shifted the terms of trade very much in favor of agriculture (until about the middle of the 1950s). The defeat and dissolution of the Japanese Empire meant that the domestic farming was insulated from colonial competition. As the consequence of the postwar land reform (which was completed by the early 1950s), farmers became capable of accumulating sizeable funds for the first time. In addition, the postwar inflation contributed to liquidating the debts that farmers had formerly accumulated (Kaneda, 1967, p. 1446).

**The number of workers engaged in agriculture decreased from 15.4 million in 1953 to 10.3 million in 1970. Arable land also decreased from 6.0 million hectares to 4.9 million hectares during the same period (Kako, 1978, p. 628).

technological innovations of the respective periods. We shall utilize these results in characterizing the production functions of agriculture below.

A general, nested CES function with four input factors for the agricultural sector can be written as follows:

$$G = A_1 \left[\partial L^{-\rho} + (1 - \partial) K^{-\rho} \right]^{1/\rho} \tag{4}$$

$$H = A_2 \left[\lambda R^{-\gamma} + (1 - \lambda) C^{-\gamma} \right]^{1/\gamma} \tag{5}$$

$$V = A \left[\alpha G^{-\beta} + (1 - \alpha) H^{-\beta} \right]^{1/\beta} \tag{6}$$

where A's are efficiency parameters, ρ, γ, and β are elasticity of substitution parameters, ∂, λ, and α are distribution parameters, V is value-added, G is the index of composite input of labor and capital, H is that of land and fertilizers. For the sake of brevity the time subscript and the subscripts representing farm types are suppressed. If we adopt the proposition that the partial elasticity of substitution between capital and labor in agriculture is not significantly different from unity we may write G simply in the Cobb-Douglas form as follows:

$$G = A_3 L^{\mu} K^{1-\mu} \quad , \tag{7}$$

where μ is the elasticity of output with respect to labor. Then, the production function of agriculture is a CES with two composite inputs. One composite is a Cobb-Douglas aggregation of capital and labor. The other is a CES aggregation of land and fertilizers.

The novelty of this approach rests, first, in recognizing land and fertilizers in a functionally separable relationship with labor and capital. Secondly, it is in incorporating flexibility (of substantive importance) in specifying either a substitution or a complementarity relationship between land and fertilizers, on the one hand, and capital and labor on the other. We thus avoid a restrictive assumption of the same identical (if not unitary) elasticities of substitution among all pairs of two inputs as would be done with the use of the four-input CES (if not Cobb-Douglas) function.

Public investments in land-infrastructure, such as water control (irrigation and drainage) and reclamation, and those in agricultural research of various types can be represented by the neutral shift parameters in the equations (4) through (7). Although it is difficult (and often impossible) to assign the impacts of such investments specifically to any one of the factor inputs, it seems worthwhile to distinguish those on the composite of capital and labor and those on the composite of land and fertilizers. Roughly speaking, public investment of the type that enhances biological-chemical technology should have a greater impact on A_2 of equation (5) than on A_1 in equation (4). On the other hand, public investment affecting largely mechanical-engineering technology may be thought to improve the efficiency of labor as well as of machines. Therefore, investment expenditures of this type can be considered to affect A_1 more than A_2. The impact on agricultural output would differ, depending on the nature of public investment, as it enters the V function through either G or H.

Those types of public investment in agriculture that can neither be designated reasonably as biological-chemical technology nor as mechanical-engineering technology may have to be treated as affecting shifts in the neutral efficiency parameter A in equation (6).

III. THE SOURCES AND RATES OF PRODUCTIVITY GROWTH IN AGRICULTURE

It has now become quite common to consider productivity gains in agriculture in terms of an identity,

$$O/L = (A/L)\ (O/A) ,$$

where O stands for output, A cultivated acreage, and L labor. The productivity of labor in agriculture is the product of land area per worker (A/L) and output per acre (O/A). Thus, growth in the productivity of labor can be decomposed into growth in land area per worker and output per land area. Alternatively, the identity indicates that productivity growth in agriculture can be derived either from an increase in land area per worker or from an increase in output per acre. On the one hand, increases in land area per worker can be achieved through technological innovations that allow a worker to cultivate a greater amount of land: the mechanical-engineering innovations. On the other hand, increases in output per acre are achieved by better seeds, more water control, fertilizer use, multiple cropping and better cropping mix: the biological-chemical innovations.

It is clear that there are many ways in which factors of production can be combined to achieve a certain level of output. For any given set of factor prices different techniques of production (i.e., different combinations of factors) can be arranged in order of increasing unit production cost. For any given price of the product this is also the order of decreasing profitability.

Where a particular factor is relatively abundant, the price of that factor is low, and vice versa. The criterion of economic efficiency dictates that output per unit of scarce resources be maximized by combining abundant resources with a unit of the scarce resource. If land is in ample supply and labor is scarce, the primary emphasis of agricultural development will be on an acreage per worker, using capital in such a way as to bring about this increase, and thus raising the output of each worker in the sector.

Conversely, if labor is abundant and land is scarce, the basic theme in the growth of agricultural productivity will be an increase in yields per acre to enhance the output per unit of land, using the available funds for this purpose.*

In Japan, broadly speaking, three distinctive periods can be discerned in the growth of agricultural productivity since the Meiji modern growth began. A rather rapid progress before World War I is contrasted to the relative stagnation after the 1920s until World War II. The productivity of labor in agriculture, however, has risen impressively once again since the 1950s, once the disastrous influences of World War II were absorbed. According to one study, during the earlier period the growth in output per hectare accounted for approximately 70 percent of the growth in total output and for over two-thirds of the growth in output per worker (Binswanger and Ruttan, 1978, p. 53).

Given Japan's limited endowment of land, a decline in the price of fertilizer relative to the price of land can be expected to increase fertilizer use per hectare. A strong negative relationship can be hypothesized (in fact, has been empirically confirmed) between the price of fertilizer relative to the price of land and fertilizer per hectare. Alternatively, the use of land per worker increases as the price of land relative to the price of labor declines. As an increase of acreage per worker would

*In many countries, because of market imperfections and systems of discriminating "incentives" incorporated in taxes, subsidies, tariffs and the artificially pegged exchange rates, prevailing prices of the factors of production do not reflect their opportunity costs. In such economies the "shadow prices" of the factors, as well as those of intermediate and final goods must be substituted for the observed "market" prices.

A standard objection to the use of the "factor proportions in agriculture" argument as given here is that factor costs may change markedly over time as a result of economic and demographic developments. It suffices here to note that the opportunity cost of labor in land-poor countries is expected to remain low until the structural transformation of the economy takes place, often, in several decades hence (Kaneda, 1969).

Another standard argument against this line of reasoning (which is cast in comparative statics for simplicity) emphasizes the possibilities of reinvesting the surpluses resulting from labor-saving technologies (say, mechanized, highly profitable farms). The related points are discussed in Section IV, entitled "Demo-economic Modeling of Agricultural Development Patterns".

be made possible by increased use of machinery, a decline in the price of machinery relative to the price of labor should also lead to an increase in the use of land per worker. A strong negative relationship is hypothesized (and empirically confirmed in Japan and in the U.S. among others) between land area per worker and the price of machinery relative to the price of labor.

The advance made in mechanization and land productivity in relation to changes in the share of output of the farms of different types in Japan can be studied by a method of (logarithmic) linear decomposition.

About ten years ago and again quite recently I studied the sources and rates of productivity growth in Japanese agriculture (Kaneda, 1967, and Kaneda 1978). A part of these studies aimed at empirically estimating the importance of the postwar (the so-called "MacArthur") land reform on the *productivity* of labor in agriculture.* The productivity of labor observed after the reform reflects the combined effects of (1) technological innovations and changes in inputs that enhance yields per hectare, (2) technological innovations and changes in inputs that *decrease* labor requirement per hectare, and (3) changes in the share of output of the two tenure types (owner-cultivators and tenant-farmers) between two time periods (before and after the reform).

Because the output per unit of labor (labor productivity) is given by the product of acreage per unit of labor and yields per unit of land, one can decompose an increase in labor productivity into changes in labor input per hectare and those in yields per hectare. The national average output per unit of labor is taken to be the weighted average of labor productivity for each tenure type. The productivity change is then the change in the weighted national value of labor productivity between two dates. If we consider each variable and each grouping of variables as a factor with a measurable independent effect, we can compute values indiciating the relative importance of the factors in question.

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*It should be clear that the productivity impact of a land reform is only one of the effects of tenurial change. Impacts on consumption, saving and, therefore, investment cannot be neglected as income shares change between former landlords and former tenants. Over the *longer run* one would expect the reform to affect the level and productivity of these sources of growth.

To analyze the effect of the transfer of landownership from owners to tenants reflected in the change in the tenurial weights, separately from the effects of changes in labor input per hectare and yields per hectare, I calculated an index with changes in the period values of the variables, generating a family of eight indices. The independent effect of a factor then was taken as the mean difference between the indices where it appeared in a period 2 (post-reform) value and where it appeared in a period 1 (pre-reform) value. Similarly, the independent effect of a group of factors was obtained by linear combination of indices, accounting for the combined effects of these factors.

For analysis of the periods after 1951, when the land reform program was already completed and virtually all Japanese farmers were owner-cultivators, the size of farm operations became far more important than tenurial types. The weights derived from the share of output of farms in different sizes replaced the tenurial weights of the immediate post-war period. The stipulation, of course, is that for the period of rapid growth of the economy of Japan and of the tightening labor conditions in agriculture it is desirable to measure the importance of the economies of scale at least indirectly. The relative importance of the factors was calculated using the identical method as above (with the size weights instead of the tenurial weights). The results for the decade of the 1950s and for the period between 1965 and 1975 as well as those for the period straddling across the land reform are quite interesting and instructive for the purpose at hand.

According to the accompanying table, labor productivity increased by some 65 percent during the period between 1939-41 and 1946-48. Of this, the contribution of the gains in land productivity was the most important factor. Fully three quarters of the change in the productivity of labor are accounted for by the growth in land yields. Next comes the contribution made by labor savings. The computation shows that the shift in the share of output between owner-cultivators and tenants as the consequence of the land reform (as indicated by the relative importance of the "weight" factor in Table 2) was responsible for an almost insignificant part of the increase in the national average productivity of labor.

Table 2. Gains in the productivity of labor attributable to components of Japanese agriculture, selected years.

	1939-41 to 1946-48	1952-54 to 1959-61	1965 to 1975
V (weights)	2.6	4.4	8.6
L (labor inputs per *tan*)	17.9	42.2	56.7
Y (output per *tan*)	75.8	43.3	27.4
VL	-2.6	6.7	0.4
VY	4.0	-5.6	2.0
LY	3.3	10.0	4.5
VLY	-1.1	-1.1	0.4
Total	100.0	100.0	100.0

Notes: 1) The weights for 1939-41 to 1946-48 are the shares in the total number of farms of owner-cultivators and tenant-farmers. Those for later periods are the shares of farms classified according to five size groups.
2) A *tan* is about one-tenth of a hectare.

Source: Kaneda, 1967, p. 1449; and Kaneda, 1978, pp. 14 and 16.

Between 1952 and 1961 the productivity of labor in agriculture rose by some 40 percent. In terms of measured independent effects, the contribution of the gains in land productivity was still the most important factor, although mechanization (along with other methods of substituting capital for labor, such as the use of insecticides and herbicides) accounted for more than 40 percent of the gains. Taken together, these factors accounted for more than 95 percent of the gains in the productivity of labor during the 1950s. It is significant to note that the proportion of the gains attributable to the improvement in land productivity showed a relative decline, between the forties and the fifties, while the share contributed by the advance in mechanization and other methods of substituting capital for labor increased impressively (from 18 percent to 42 percent) between the two decades.

The decade of the sixties and the early seventies witnessed dramatic developments in Japanese agriculture. The growing shortage of farm labor in the sixties, when approximately half a million annually flowed out of the agricultural labor force, prompted mechanization of an increasing number of agricultural operations. The use of machines in harvesting, and even in transplanting, has spread to all parts of Japan, particularly to rice farms.* The process of mechanizing most field operations and that of increased application of a variety of chemicals were the *prima facie* evidence of the shift of emphasis from the centuries of land-productivity-oriented growth to labor-productivity-oriented growth in Japanese agriculture.

During the period between 1965 and 1975 the national average productivity of labor in agriculture increased by some 57 percent. It is evident that in this period the contribution of the gains in labor saving innovations alone was more than half of the overall gain. Yield-enhancing innovations were still important, although in comparison with the earlier decades, their relative importance was clearly on the wane. The computation showed further that the interscale shift in the share of output was responsible for a significant part of the gains in the national productivity of labor in agriculture.

The substantial growth in agricultural labor productivity during the period of rapid economic growth was consistent with the speed and the pattern of urbanization in postwar Japan. In comparison with the experiences of many countries during that period, Japan has escaped almost all of the most serious problems that have accompanied rapid urbanization elsewhere. Of course, the problems of the quality of urban life in terms of housing, environmental pollution and the general lack of space have indeed plagued most Japanese cities. However, violent

*Mechanization in Japanese agriculture was largely limited to ancillary (post-harvest) operations and irrigation systems until about the middle of the 1950s. Handheld tractors (called "cultivators") and sprayers were the first to be introduced into field operations. They spread widely in the late 1950s and early 1960s. Since about the mid-1960s, however, riding tractors, transplanting machines, and harvesters came to be widely adopted by Japanese farmers.

crimes, drug abuse, group antagonisms, be they racial, tribal, or economic class-oriented, have not been serious. The homogenous population, language, customs, etc., must all have contributed to this situation. So has the rapid growth of the economy, especially in the industrial sectors, which has generated enough employment opportunities for absorbing labor. Indeed, there has been virtually no large pool of unemployed in the cities. It is being recognized also that the high quality of Japanese education outside the cities has contributed to this rather enviable pattern (Mills and Ohta, 1976). However, more often than not the role played by the agricultural sector in the process of urbanization seems to have escaped the literature on Japanese urbanization.

It appears important, therefore, to analyze the ways in which types of technological innovations in agriculture contributed to retaining labor when it was not needed elsewhere and releasing labor when it was needed. Also pertinent to the issues for analysis is the way in which agricultural growth was shared by the bulk of the nation's farmers and, as a consequence, was able to contribute to developments in rural based activities dispersed geographically (although in the general sphere of economic activities of the large metropolitan centers). It is significant that the rapid urbanization in the 1960s resulted from the growth of the urban population due to the annexation of rural areas in the 1950s (Mills and Ohta, 1976). It is incorrect, therefore, to attribute Japanese urbanization solely to internal migration of people from rural areas to large cities, as is customarily done in specification of migration equations.*

*More on this later in Section V, "Population, Reallocation, Migration, Urbanization, and Structural Change."

IV. DEMO-ECONOMIC MODELING OF AGRICULTURAL DEVELOPMENT PATTERNS

One of the most important strategic questions in agricultural development concerns the alternatives of "the progressive modernization of the entire agricultural sector" and "the crash modernization strategy that concentrates resources in a highly commercialized subsector". Johnston and Kilby refer to the first alternative, illustrated by the patterns of agricultural development in Japan and Taiwan, as a "unimodal strategy" and to the second alternative, as found in Mexico and Colombia, as a "bimodal strategy" (Johnston and Kilby, 1975).

Colosio has characterized the dualistic nature of Mexican agriculture by hypothesizing the existence of two subsectors of agriculture represented by two production functions of different functional forms (Colosio, 1979). In his framework, commercial agriculture is composed of all irrigated farms having relatively capital-intensive techniques, with relatively large rates of total factor productivity growth, larger yields per hectare, and most of its output commercialized. The other subsector is characterized as rain-fed agriculture, with low capital intensity, relatively low technical progress, and most of its output destined for subsistence consumption. The first subsector is represented by a CES production function, homogenous of degree 1, with capital, labor, and land in the argument. Partial elasticities of substitution between any pair of factors are assumed to be equal (and presumably less than one). The subsistence subsector is represented by a Cobb-Douglas production function, because, according to Colosio, variations in factor shares have not been substantial.*

There are several substantive ways in which Colosio's formulation can be extended for the purpose of modeling the duality in the agricultural sector. I would like first to focus on some fundamental interactions between technological and economic factors. Attention to interactions between demographic and economic

*It is interesting to observe that Colosio specifies factor augmentation only for the CES case and not for the Cobb-Douglas case.

factors shall then follow. At the outset, however, it is to be understood that the model of dualistic agriculture in the following is not strictly Mexican. Instead of a strictly subsistence subsector, the existence of a small-farm subsector, which is composed mainly of family household farms, largely self-employed, and paracommercial is assumed.

Interactions Between Technological and Economic Factors

In the first place, one of the outstanding differences in the two subsectors is their respective input structure. Purchased machinery would be important in the commercialized subsector while it would be virtually absent in the small-farm subsector. Needless to say, modern farm equipment and power machines are so expensive that it is advantageous to develop larger farms in order to make full use of the assets and hold down unit costs. Introduction of large machines, therefore, necessitates large management units.*

Furthermore, once investments are made on fixed assets, the short-run cost function becomes "lower" than its long-run counterpart. Since fixed costs are costs foregone in the short run, they do not affect the short-run supply of output. In the short run, so far as the commercialized subsector is concerned, the price of the product can fall to the levels that cover only variable costs and not fixed costs. Such a situation would be disastrous to the other subsector, whose total costs are largely variable. Thus, the difference in input structures produces an important difference in the capacity to withstand adverse developments for the two subsectors.

Secondly, inputs in agriculture can also be divisible. In contrast to the large machines, inputs such as seeds, fertilizers, and agricultural chemicals are divisible and, because of this

*Of course, it is possible to design tractor hire-service arrangements that can be used for many small management units. The basic technological and economic superiority of large management units under these circumstances, however, is undisputable.

can be made neutral to the scale of operation of farms. If the conditions for their use are feasible (availability of credit, easy access to water, extension services, etc.), small farms can adopt these inputs with only minor adjustments. The implied strategic question is to choose between alternative ways of either involving the great bulk of small farmers or concentrating on the commercial subsector in directing innovation activities and allocating investments.

In the third place, it is important to consider the substitution and the complementary relationships between these types of inputs and the farm resources of labor and land. It is often observed that biological-chemical inputs increase the use of labor on farms by making it possible to grow more crops, more lucratively, per hectare of cultivated area. In contrast, tractors and combines are more often than not alleged to be labor-displacing. Thus elasticities of substitution between any pair of inputs, primary and/or intermediate, become rather important parameters to be considered explicitly.*

Fourthly, it is a matter worth remembering that over a long period of development the small-farm subsector of agriculture must contain the majority of the nation's farmers. From the point of view of rural development objectives (with a specific target population of the rural poor), this subsector is overwhelmingly more important than the commercial subsector, although the latter contributes the larger amount of marketable agricultural commodities. It is apparent, however, given the socio-institutional structure as well as the demographic conditions of most rural areas, that the growth rate of output in the small-farm subsector (rather than the wage bill of the commercial sector) determines by and large the rate of increase of incomes of most of the rural population.

Fifthly, it is worth considering the economic relations between the two subsectors in agriculture and other sectors outside agriculture. On the one hand, there is the interdependence of sectors through direct intermediate (goods) deliveries.

*If there are only two goods, as in the customary primary factors, they must be substitutes.

Obvious examples are cash crops to be processed, such as cotton, coffee, and sugar on the agricultural output side, and machines, implements, fertilizers, and pesticides on the industrial output side. On the other hand, each of the sectors can be a source of effective demand for the final products of another. The dualistic structure of agriculture is likely to be characterized by the direct intermediate delivery relationships exclusively between the commercialized subsector and the urban (capital-intensive) manufacturing sector while the small-farm subsector is left "dammed up" without comparable intersectoral relationships. Alternatives ought to be analyzed for the growth of intersectoral relationships between the small-farm subsector and the manufacturing activities in both urban and rural areas. In Japan's experience a broad-based agricultural development pattern contributed to the creation of dispersed rural markets for developing indigenous industries. It is likely that there exists a positive intersectoral relationship derived from the types of technological change fostered in agriculture. Small equipment and implements are more likely to be produced for local markets than larger ones. The complementary relationships between agriculture and rural industries, as they are affected by technological change, must therefore be considered explicitly.

Finally, given the demographic conditions in many less developed countries, promoting the capacity of agriculture to retain its labor force when alternative employment opportunities are not opening up, may well be as important as developing employment opportunities in urban, industrial, and service sectors. It is unlikely that the highly capital-intensive subsector will accomplish this task, as its marginal capital-labor ratio would be disproportionately high. The small-farm subsector, however, would be able to achieve this objective only if it could increase the productivity of labor within its subsector at a substantial and sustained rate. It seems reasonable to suppose that the overriding concern of new entrants into the labor force (rural youths in particular) is not so much the comparative rural-urban levels of earnings at the time of entry as the age-earnings profiles in alternative sources of employment. This is clear in an economy characterized by "life-time employment practices". The concern, however, is more or less universal. A slower growth of labor productivity in the subsector that contains rural youths must increase their annual outflow. This outflow can be expected to increase still more if situations do not improve. The usual consequence of this is, of course, the augmented population pressures on urban centers and the creation of serious urban problems.

The following deserve further consideration:

(1) The share of investment allocation (public and private) at time t of the small-farm subsector relative to that of the commercial subsector as well as the allocation of labor, current inputs, and land

(2) The differences and changes in parametric values characterizing production, demand for factors, and intermediate deliveries, arising from the differences in substitutability and complementarity of inputs between the small-farm and the commercial subsectors, giving rise to differences in cost structures

(3) Differences that exist in economies of scale, biases in technological change, and the intensities of technological progress

(4) Impacts over time of the factor shares in each subsector on incomes and expenditure patterns in the overall rural sector. (Here one must consider whether the tastes of the income earners of the commercial subsector demand the "non-indigenous" type of goods and services, which require technology and capital beyond the capability of existing or potential local enterprises.)

(5) Differences that may exist between the migration patterns in the small-farm subsector and those in the commercial subsector. (It is necessary in modeling this aspect of population reallocation to consider, *inter alia*, (i) the share of potential migrants in the small-farm subsector, and (ii) the rate of growth of the wages in rural activities relative to the urban wage growth.)

Interactions between Demographic and Economic Factors

In the recent literature on the economics of development, attempts at linking demographic and economic variables have centered on postulating a relationship between population growth and per capita income growth. Mostly the focus has been on the number of births. Mortality changes were often ignored. In more sophisticated versions of demoeconomic models, however, age-specific fertility rates are hypothesized as a function of the gross reproduction rate. And, the survival rates are defined by sex and age groups and are made functions of the life expectancy at birth. Both the gross reproduction rate and the life expectancy, in turn, are assumed to be functions of the development level, represented by GNP per capita or national income per capita, and of time. On the other side of the loop, interactions between demographic and economic factors are represented by national income derived from the output elasticity of labor on one hand, and labor supply on the other, which in turn relate age-sex-specific labor force participation rates to population.

The argument here, however, is not to make models more complex. The version just described would be sufficient if our concerns were focused on the aggregate aspects of agriculture and national economy. There seem to be two important considerations in the context of this paper that require attention in modeling demoeconomic dynamics.

In the first place, owing in part to our common association of the level of per capita income with that of economic development, what seems to have been lost in much recent literature in economic development is the *direct* link relating food supply (specifically, calories and protein intake per capita and its distribution among the rural population in the small-farm subsector) to the factors that govern mortality. There appears to be an emerging recognition, however, that this direct linkage is significant in early phases of development when physiological and behavioral consequences of "Protein-Energy Malnutrition" (PEM) on infants and children are serious. PEM is recognized as causing high mortality and morbidity of infants and children, especially through the significant two-way interactions between nutritional status and the incidence and seriousness of diarrhea and other infectious diseases (Johnston and Clark, 1979, p. 29). It is the most widespread and serious nutritional problem in developing countries, specifically among the poor in rural areas.

Past attempts at relating demographic variables to agricultural macroeconomic variables have not proved to be successful. However, a greater understanding may be gained by relating demographic variables (both mortality and fertility) to calories intake per capita. The commercial subsector of agriculture mainly supplies urban areas and the trade sector. Thus, the substantive direct link between food supply and the factors that govern mortality and fertility exists in the small-farm subsector. For reasons discussed below it is possible that both mortality and fertility can be affected by food energy intake levels and other intervening variables in the early phases of economic development. It is clear that the effect on mortality of infants and children is the most important during these phases. It follows, therefore, that demoeconomic modeling efforts covering early phases of development must include the effects of food calorie intake and other factors in the small-farm subsector of agriculture (which may contain up to 80 or 90 percent of the population).

It is extremely difficult to establish a relation between mortality and fertility, especially if a time structure of interactions were to be introduced. It is safe to say, however, that a decline in mortality is not a necessary nor a sufficient condition for an immediate decline in fertility. If the desired family size remains unchanged, as mortality of infants and children declines, *ceteris paribus*, a rational adjustment process would imply a reduction of births. Obviously the specification of variables that enter into this adjustment process or affect it exogenously is crucial.

The determinants of the desired family size are difficult to specify empirically. According to Easterlin, the immediate determinants are income, the cost of children relative to other goods, and tastes, the last of which affects some of the attitudinal considerations such as the "norm" of family size and the "quality" of children (Easterlin, 1976). It suffices here to appreciate the difficulty of empirically specifying a universally acceptable cost of children or of introducing "tastes" as an empirical variable.

The distinction made by Easterlin of the premodern situation prior to the demographic transition and the modern situation thereafter is particularly useful. High infant mortality and high fertility that characterize the premodern situation, represent a desired family size exceeding the actual family size. So long as this situation continues, there is no desire for fertility regulation. As the infant and child survivorship improves, however, with a time lag often extending over several decades, a new situation emerges in which the achievable family size exceeds the desired.* In this modern demographic situation fertility control is exercised to match low levels of mortality. Moreover, the desired family size may decline as development proceeds due to changed perceptions of economic costs and benefits of children as well as to the changed life environment reflected by increased urbanization.

According to studies of the demographic history of Japan, since the beginning of the seventeenth century the country has progressed through a four-phase process. During the seventeenth century, immediately following the nationwide consolidation of power by the founding of the Tokugawa Shogunate, Japan's population rose rather rapidly. Then, during the eighteenth and the nineteenth centuries, a plateau was reached. There was a virtual stagnation in population growth until about 1870, characterized by a near balance between relatively low fertility (observed/recorded) and low mortality.** After this, Japan entered a third phase of significantly positive, and sustained rates of population growth during the Meiji modern economic growth. The fourth period between 1920 and World War II shows a gradual decline in marital fertility and an even more rapid decline since the end of the war.

*Of course, the uncertainty as to the length of the time lag is due to the simultaneous variations of many relevant variables.

**It is known that the recorded births underestimated fertility considerably during the Tokugawa period. Infants were registered at the time of their first new year celebration, which in some cases came almost a year after birth. Those who died (or were allowed to die) were not registered (Mosk, 1979, p.21).

Scholars agree on these basic trends of the demographic history of Japan. Interpretation of this history, particularly that of the second half of the Tokugawa period, however, has become quite controversial since Hanley and Yamamura advanced their thesis on economic and demographic changes in the Tokugawa period (Hanley and Yamamura, 1977). For many years, Japanese economic historians interpreted this period as one of stagnation in both economic and population growth. In contrast, Hanley and Yamamura argue that economic growth continued during the second half of the Tokugawa period, that the Tokugawa peasants tended to choose a higher living standard rather than a larger family, and that they manifested this motivation in their control of fertility. This is said to explain the uniqueness of Japan among other Asian nations in demographic behavior which, together with the consequent sustained rise in per capita income, paved the way for her initial spurt into industrialization during the latter half of the nineteenth century.

The Hanley and Yamamura thesis is that during the Tokugawa period both fertility and infant mortality remained constant and that the Tokugawa peasants could control the actual family size at the desired low levels. Carl Mosk argues, however, that this thesis is nothing but an assertion on a scanty data basis and that their economic interpretation of the late Tokugawa period is incorrect because their demographic thesis is wrong (Mosk, 1977 and 1979). The controversy is interesting because it is the first one sharply focused on demographic-economic interactions in Japan's premodern period.

Central to this controversy is the interpretation of the fertility transition in Japan since the second half of the Tokugawa period. According to Mosk's alternative interpretation, desired fertility exceeded the reproductive capabilities of most couples in the Tokugawa period, the critical constraints being fecundity and the survivorship of the offspring. During Meiji industrialization marital fertility rose in Japan, Mosk argues, because increased income per head and increased calorie and nutrient consumption raised fecundity and reduced infant mortality. The Mosk thesis is that during the post-Tokugawa period achievable fertility increased and perhaps came to exceed the desired levels, which for reasons of compulsory education, urban job opportunities for women and influences of urbanization, began to decline simultaneously (Mosk, 1979).

This historical review and its alternative interpretations, taken together, are useful in pointing out some critical variables and relationships in demoeconomic interactions. It seems reasonable to hypothesize that observed fertility is a function, the argument of which would include the desired number of children, the survival prospect of children, and *natural fertility* (fertility without any deliberate methods of birth control). This function can be thought of as being constrained by physiological factors, such as children's survivorship and fecundity associated with women's health and nutritional status.* Further constraints are social and economic factors that influence the desired number of children. One may list in this category such factors as age of marriage, and economic costs of acquiring information and practice of birth control.

The influences of the constraints on fertility may be positive or negative depending on the specific socioeconomic circumstances. The time-structure of interactions between economic variables and these constraints is not well understood. Our knowledge of which of the constraints is binding when and how each constaint interacts with, say, income per capita, is rather limited. Note, however, that when modeling efforts are directed at the demoeconomic experience of a population over a few generations, or at drawing inferences on economies whose per capita incomes may range from $100 to $1,000, it is necessary to pay special attention to constraints that do not vary monotonically with income per capita.

The following are the essential considerations in this part of the model.

*Physiological constraints on fecundity appear to be associated with a longer postpartum nonsusceptible period and a shorter reproductive period (due to relatively late menarche and early menopause) of a couple subjected to mild but persistent malnutrition and recurrent infectious diseases.

(1) What is the relationship between mortality of infants and children and the per capita income and/or per capita foodgrain output in the small-scale subsector at income levels or "daily caloric intake levels" below a certain minimum? The relationship between the age-sex specific survival rates and per capita income above the minimum levels is also important.*

(2) Specification of the function relating the observable fertility to constraints listed in the paragraph must be considered. In practice, this specification would probably be a simple (age-specific) fertility rate structure as a function of income per capita [above the minimum specified in (1)]. It would be important to include some measure of "urbanization" or "structural transformation" when this function is differentiated between rural and urban areas (and between the subsectors in agriculture), as sectoral incomes and occupational structures differ.

(3) Finally, it is important to combine the two considerations above with a structure of time lags, possibly in some parametric fashion.

The basic hypothesis underlying this specification of the demographic and economic interactions in agricultural development is that a decline in births depends on a minimum level of income and on a minimum level of food energy and nutrient intake that allows for greater survivorship of offspring. The bulk of rural population, in the poorest of the less developed countries, reaches these minimum levels only if the pattern of agricultural growth is broad-based and the increments arising from that growth are widely shared. The immediate impact of the rising incomes of the majority of the rural people to minimum levels may reduce mortality rates, and even increase fertility rates. It is assumed

*It is to be determined whether this minimum income level is equivalent to the level of income just sufficient to purchase the minimum required amounts of essentials in the modified Stone-Geary expenditure function used by Kelley and Williamson (1979). Needless to say, food calorie intake can be derived not only from foodgrains but also from other foods.

in the model that the eventual course of fertility is a lagged response to the course of declining mortality.*

V. POPULATION REALLOCATION, MIGRATION, URBANIZATION, AND STRUCTURAL CHANGE

The historical experiences of advanced economies indicate that the degree of urbanization is highly correlated with the level of development. The development process has, therefore, come to be identified simply with shifting the center of gravity of a population and its economic activities from primarily agrarian to urban, industrial-service oriented areas. In simplified development models internal migration would be treated as sectoral labor transfer and it is usually assumed to respond to intersectoral (or interregional) wage differentials.

Intersectoral flows of resources need not be the same as interregional flows of resources. In fact, a rural-to-urban flow is only one of the manifestations possible for intersectoral flows in the process of economic development and structural change. It is the working hypothesis of this section that intersectoral flows inevitable in the process of development can take various forms and that locational changes are but one of their dimensions. To put it another way, urbanization as a result of movement of population to large cities, is not a sufficient or necessary condition for economic development.

*It is well known that a country with a history of high fertility has a high proportion of women in the reproductive ages and, therefore, even though the age-specific birth rates undergo an immediate drop (which is unlikely), high crude birth rates would continue long after the age-specific rates have dropped (Keyfitz, 1971).

Again, one may find the experience of Japan in the Meiji era instructive. Throughout the early period of industrialization, and most of the years prior to World War II, Japan increased her industrial output without reducing the number of households engaged in agriculture. In particular, it was not large city-located industries that were mainly responsible for the pre-1914 growth; it was "the expansion of Japan's basic economy--agriculture and small-scale industry built on traditional foundations--which accounted for most of the growth of national productivity and income during this period" (Lockwood, 1954, p. 25). Lockwood estimates that half of Japan's 5.5 million farm families had some nonagricultural employment in the 1930s and that for about one-fourth of these farm families the income from nonagricultural activities exceeded that derived from farming (Lockwood, 1954, p. 491).

The experience of Japan indicates a case to be made for deconcentration of industries to the rural area and for promotion of nonfarm activities in country and rural towns, allowing both agricultural and industrial growth to proceed without causing excessive spatial imbalances in population distribution. By means of small-scale rural activities it was possible for the nonfarm activities not only to utilize labor on the farm in slack seasons, but also to marshall and utilize on-farm resources such as family savings and local raw materials that would otherwise have remained idle.

Eventually many local industrial towns in Japan became urban, as the structural transformation of the economy occurred. Because of this, and because of migration and natural increases the percentage of the urban population rose. It is to be emphasized, however, that this form of urbanization *was a consequence* of economic development and structural change.

This section focuses on the interrelationships and interactions between this form of urbanization and the patterns of agricultural development with an emphasis on input of labor in the small-farm subsector of agriculture in order to highlight important interrelationships as well as complications.

Intersectoral Flows of Labor in the Small-Farm Subsector of Agriculture

As is evident, observed inputs of labor in agriculture depend not only on the supply and demand conditions in the agricultural sector but also on a good number of factors outside agriculture. Reasonable accounts of agricultural labor input must, therefore, reflect: (1) the rate of participation by individuals in the economic labor force of the community (2) the age, sex- and skill structure of the labor force in order to explicitly account for the differences (say, overtime) in the composition of the labor force, and (3) the apportionment of labor inputs between strictly defined agricultural activities and non-agricultural activities.

It is, of course, necessary to clearly distinguish between the stock and the flow concepts of labor input. If attractive opportunities draw a part of the current agricultural labor to towns and cities, and if some form of compulsory leaves are imposed on a part of the existing agricultural population, be it formal schooling, labor conscription, or military obligations, the potential stock of agricultural labor force will have to decline. On the other hand, the flow requirement for labor changes according to production and marketing organization, technology, and capital inputs which are in turn influenced by the scope and depth of the capital market and the products favored (Kaneda, 1973).

This distinction between the stock and the flow concepts acquires added significance, when one considers the fundamental characteristics of the small-farm subsector of agriculture. When making their decisions on labor input, small-farm proprietors take into account several relevant considerations. Given the anticipated amount of labor input required for a certain agricultural enterprise, they may (1) decide to put their own working hours to the enterprise, (2) choose to have available family members do a portion of the work, (3) have hired workers take over a part of the work, and/or (4) make use of the labor pool arrangement of the community, whereby labor is exchanged among farm families according to the individual needs of the proprietors.

The third case above inevitably entails payment of wages, whereas the others do not. The significance of this difference arises from the fact that a cost is sunk before the returns are realized, representing a prior commitment on uncertain monetary yields. In itself this cost appears to be no different from any other commitment of funds for the purchase of current inputs. Problems of uncertainty aside, the proprietor's decision variable is the family income--the sum of earnings by the farm's own resources including family members' labor. Then, the flow of family labor input will depend crucially on their net earnings relative to the wages payable to hired workers in agriculture and nonagriculture. The expected increases in the proportion of nonagricultural activities of a "representative" farm household and the expected changes in farm labor input by different family members reflect these economic forces at work in both agricultural and nonagricultural sectors.*

Taken together, these considerations mean that labor in the small-farm subsector of agriculture, can flow intersectorally in a variety of ways. Given a stock of labor in a farm household, for example, family production of nonfarm goods may be carried out on a part-time basis by all the family members, by only some of the family members on a full-time basis, or by any other combination. Similarly, if rural nonfarm employment is available, all the family may work for wages part-time, only some of them full-time, or only one full-time. In these cases either a stock of labor, a flow of labor, or both would have undergone intersectoral movements, even though none of the family members changed the original place of residence.

In the situations of this type, however, it is not clear whether changes in the farm household's stock of labor would change labor input in flow terms of the household's various

*To complicate the matter further, it would be common in the small-farm subsector of agriculture to have a variety of enterprises to be carried out by an individual farm, where production processes as well as marketing are intimately bound up with the growing characteristics of the crops and animals. As a consequence, depending on the season or the stage of growth of crops and animals, peak and slack seasons appear and different tasks are required of labor.

economic activities. It is quite possible that the effect of withdrawal of self-employed and unpaid family workers could be counteracted by an increase in the average output of the remaining self-employed and unpaid family workers. A.K. Sen has made an important distinction between the marginal productivity of a worker and the marginal productivity of a manhour in agriculture. He has shown that the former could be zero, even though the latter would be substantially above zero (Sen, 1966 and Zarembka, 1972, Ch. 1). If this turns out to be the case in the small-farm subsector, we may consider the following possibilities with respect to labor inputs.

(1) Agricultural output of the subsector depends not so much on the input of labor in flow terms (such as in man-years or adult-equivalent man-hours, etc.) as on the number of households in the subsector that cultivate the land as family units.

(2) Output of rural nonfarm, small-scale activities (manufacturing and services as well as para-agricultural activities)* also depends on the number of households and not on who works for how long in the household.

That is to say that, in the extreme case, there is no substitution between rural farm and nonfarm activities, so far as labor input is concerned, but only contemporary and symbiotic relationships. Alternatively, there exists "disguised unemployed" in the subsector where self-employed and unpaid family workers are important.

Of course, substituting for the services of family members who are no longer in residence in the household cannot go on forever. Nor is it possible to keep increasing outputs of both farm and nonfarm activities, under a given stock of labor, without continuous capital deepening and technological change. Thus, there must be limits to the maximum "tautness" that the subsector's stock of labor can tolerate in "taking up the slack", as

*Sericulture and processing of farm waste products, such as rice straws, were important para-agricultural activities in Japan.

it were. More realistically speaking modeling efforts must specify the trade-off relationship between self-employed and unpaid family workers on the one hand and, say, wage-salary employment on the other.

Fundamentally at issue here is the question of comparative efficiency of the stock of labor in household activities and wage-salary employment outside the household. When a young woman leaves a farm to work in town, the effect of her disappearance on the farm household's output could be made good by an increase in the output of the remaining family workers. Alternatively, this can be achieved by a small increase in wage employment in the farm household. That is to say, the marginal productivity of this young woman's labor hour was positive in the household but well below that in the wage-salary employment sector.

One way of dealing with this situation in modeling is to use a parameter linking the stock of labor in the farm household subsector and that in the wage-salary employment sectors outside. For example, if the value of this parameter is assumed to be one-third, then one unit of labor input in wage-salary employment is assumed equivalent to three units of labor performed by self-employed and unpaid family workers. In terms of the wage rate, the assumption is that the wage rate in the wage-salary employment sector is three times that in the farm household subsector.

Another way is to assume that the small-farm household subsector of agriculture is a residual employment sector. Employment levels in the economy are based on the principle that labor in the wage-salary employment sectors is determined first, on the marginal productivity criterion, and that the rest of the available stock of labor is absorbed in the small-farm subsector of agriculture. In this case the level of employment in the small-farm agricultural subsector is variable and, therefore, the "institutional wage" which often is defined as the average product in the subsector, is also variable.

Subjective Equilibrium of the Farm Household

The question of whether a small family farm could survive in competition with a large agricultural business has attracted the attention of students of agriculture since the last century. There are two broad views among those who are hopeful of the small farm's prospects. The first focuses on the nature of agricultural production processes, which are principally organic, and observes that the scale advantage of large farms utilizing machines is not as great as the advantage in industrial (principally mechanical) production. According to this view, the technical superiority of large agricultural businesses was not overwhelming as long as mechanical power depended on steam and electric power. It was quite another matter, however, when the combustion engine was developed and the use of tractors grew.

A second view focused on the small household farm as representing an organization form of a nature peculiar to agriculture. A peasant farm is run mainly (or entirely) by the work of the peasant family, in contrast to large commercial farms, which are run by hired labor. The peasant family is assumed to maximize household utility. This idea can be traced to Russian agricultural economists of about the turn of the century, for example, S. Bulgakov and A.V. Chayanov, and has since been elaborated and extended by a number of Japanese agricultural economists represented by Chihiro Nakajima (1969). The marginalist representation of the original idea can be summarized by the use of two curves, one of which represents increasing marginal disutility of labor at a successive increase in the family labor input, and the other a falling subjective valuation of a gradually larger income from labor (which enables family consumption). The peasant farm household's subjective equilibrium is reached at the intersection of the curves, where the balance of labor-consumption is struck.

The work force resources of the peasant farm are determined not only by the number and the composition of the peasant family, with regard to age, sex, and other attributes, but also by its consumption requirements. Thus, the extent of utilization of the family work force in production is determined as much by the needs of consumers (including nonworkers) as by the available labor resources in the family. In a more recent representation by Nakajima it is posited that the peasant farm produces to the point at which the marginal valuation of family labor equals marginal product of labor. This marginal product of labor would be less than that on the commercial farm, which is set equal to the wage rate, if off-farm job opportunities for peasant families are limited.

Fundamental in deriving this result is the notion that it is impossible to vary the manpower resources of the peasant farm arbitrarily in combining the factors of production. The availability of other production factors, land, capital, and intermediate inputs, must then be flexible enough to create "technically optimal proportions" for the utilization of the family manpower capacity. For this to be the case the peasant family must be able to alter not only the extent of land utilization, but also the use of its equipment and other inputs. There must be an unencumbered access to the free land and capital markets. If, on the other hand, there is a binding constraint on the variability of these non-labor inputs, say, if the land area is severely limited, then "technically optimal proportions" cannot be achieved and output (income) cannot reach the desired level. The peasant family has to seek employment outside the family farm to establish labor-consumption (subjective) equilibrium.

In discussing the ultimate triumph of the small over the large farming unit in Japan, T.C. Smith focuses on the "unique ability of the family labor force to combine farming with other occupations: to supplement farm income with earnings from by-employment" (Smith, 1959, p. 129). As trade and industry developed providing new employment in rural areas, it became possible to reduce underutilization of labor on family-size holdings. In contrast, despite the expansion of off-farm job opportunities, underemployment of hired labor in larger farms (particularly of those hired on longer term contracts) became more serious.* As the peasant family succeeded in reducing the extent of idleness, its per capita earnings (from both farm and non-farm activities) became greater than those of hired labor in large farms. According to T.C. Smith, labor in large farms could not be employed fully enough to be paid competitively, once off-farm jobs became available to members of peasant families.

Whether one emphasizes the importance of by-employment possibilities or not, or whether one emphasizes the limited availability of land or not, it is clear that the subjective equilibrium analysis is intimately bound up with the dualistic theory of agriculture. Dualism in this context is the coexistence of "commercial" large farms and small-scale, peasant farms. We shall illustrate this dualism by means of two diagrams.

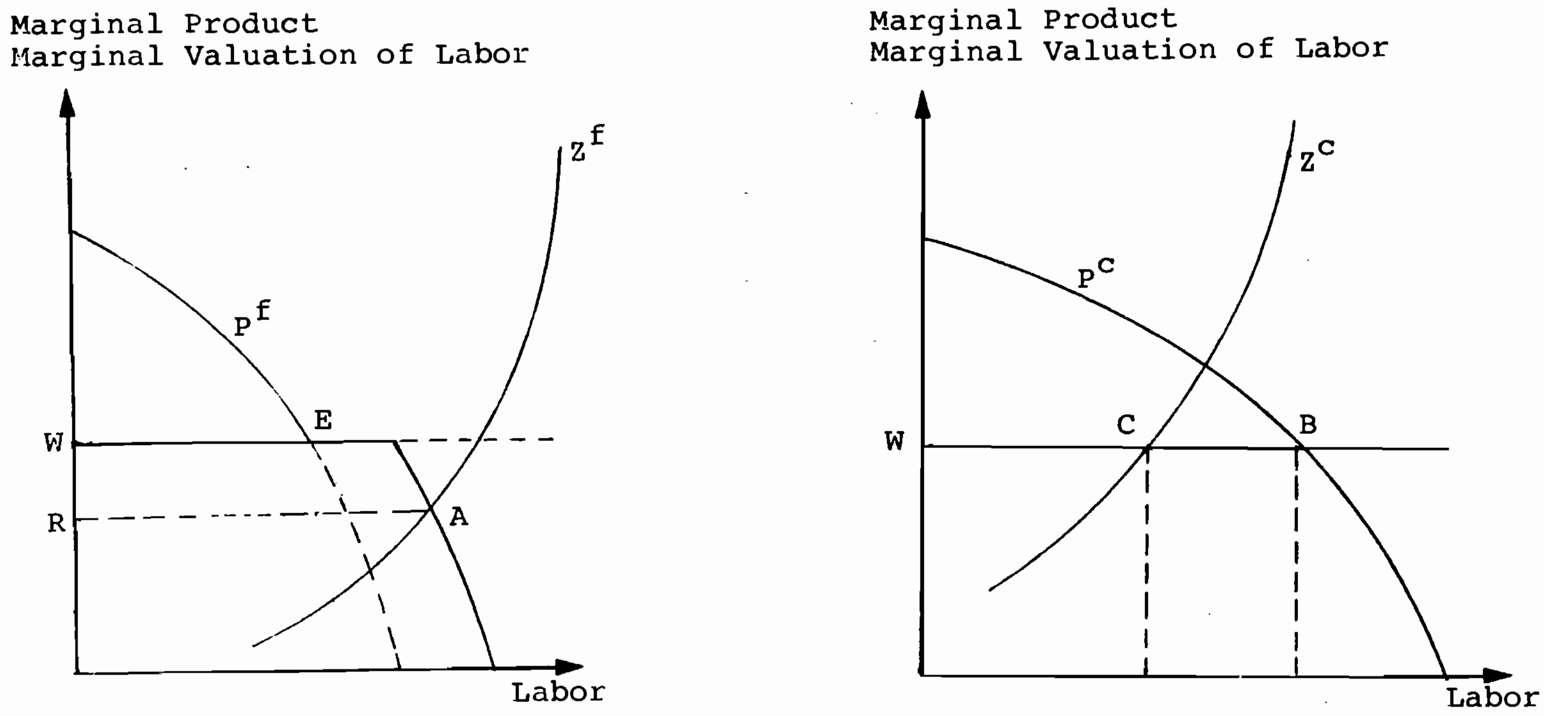
For the sake of simplicity of illustration, we assume here that agricultural output is a homogeneous product whose production requires only two factors, land and labor. We further assume that a typical peasant farm has the option of cultivating its own land and leased-in land, or of engaging in wage labor on other farms or non-farm activities. A commercial farm is assumed to have the option of cultivating land with the use of its own and/or hired labor or of leasing out land to small, peasant farms. The essential elements in illustration are (i) that the peasant farm's owned land is far too small for the family's work force capacity and (ii) that the amount of leased-in land as well as off-farm wage employment opportunities are limited.

For a utility-maximizing peasant farm the point of subjective equilibrium is given at point A on Figure I(a), where the marginal valuation of labor (Z^f) equals the marginal product of

*Georgescu-Roegen (1971, p. 252) has observed that:

> Nature, as a silent partner of man, not only dictates to man when he should start an agricultural process, but also forbids him stopping the process until it is completed. In industry we can interrupt and start again almost any process when we please, but not so in agriculture.

As a consequence, underutilization of labor and capital (and "overpopulation" and "overcapitalization" of agriculture) is the predicament of farming as an economic activity. Furthermore, according to Georgescu-Roegen, to do away with this type of nature-enforced agricultural idleness is a well-nigh impossible problem.



(a) Peasant Family Farm (b) Commercial Farm

Figure 1. Subjective Equilibrium of Peasant Farm

labor (P^f). The point of intersection is below the wage rate (W). Of the total labor utilized by the peasant farm, AR, the segment E is labor devoted to activities off the peasant's own farm. The assumption here is that *the off-farm employment opportunities are limited strictly to the amount of E.* The gap results, therefore, between the marginal valuation of labor and the wage rate.

For a commercial farm the maximization of utility implies that the marginal valuation of own labor (Z^C) equals the wage rate (R). Profit maximization requires that the marginal product of labor (P^C) also equals the wage rate. Thus, the equilibrium is at point B on Figure I(b). The segment CW is the commercial farm's own labor and the segment BC is hired labor.

Given that the land area available to the peasant farm is limited, and off-farm employment opportunities are also initially limited, there exists a dualism in the labor market of agriculture. Formally this dualism can be represented by the following expression

$$Z^f = \omega W \qquad (8)$$

where ω stands for the extent of the gap in the two variables and $0 < \omega < 1$. Since the subjective marginal valuation of labor by the peasant farm is below the wage rate, additional labor is supplied by the family if employment opportunities arise either in other farms or in non-farm activities. In this perspective, then, it is quite natural for peasant families to exploit off-farm job opportunities and combine farming and non-farming activities without causing a decline in total farm output.

The income of the peasant family will increase (as will its per capita earnings), as employment opportunities are expanded, until its marginal valuation of labor equals the wage rate. When $\omega = 1$, the slack in the family's work force utilization will have disappeared, and so will the dualism of agricultural labor.

Formally, given the production function of agriculture characterized by equations (5) through (7):

$$G = A_3 \, L^{\mu} \, K^{1-\mu}$$

$$H = A_2 \left[\lambda R^{-\gamma} + (1 - \lambda) \, C^{-\gamma} \right]^{1/\gamma}$$

$$V = A \left[\alpha G^{-\beta} + (1 - \alpha) \, H^{-\beta} \right]^{1/\beta}$$

then, the marginal productivity of labor (MP_L) is given by

$$MP_L = \alpha\mu \left(\frac{AG}{V} \right)^{-\beta} \frac{V}{L} \tag{9}$$

This marginal productivity of labor is equal to the real wage rate, if $\omega = 1$, or is less than the real wage rate, if $\omega < 1$. Thus,

$$\begin{aligned} \omega = 1 \quad &: \quad \alpha\mu \left(\frac{AG}{V} \right)^{-\beta} \frac{V}{L} = \frac{W}{P} \\ \omega < 1 \quad &: \quad \alpha\mu \left(\frac{AG}{V} \right)^{-\beta} \frac{V}{L} = W^{*} < \frac{W}{P} \end{aligned} \tag{10}$$

where W^* is the shadow price of time for the peasant family, representing the ratio of the marginal utilities of time and income.

If W^* is less than W/P, it indicates that the marginal productivity of the peasant's family labor falls below the current wage available by working for someone else. The situation may reflect that the decision to seek employment from another, in village society, is not strictly economic, as it entails at the same time social and personal relationships. Thus, in order to avoid the stigma attached to working for another, the small peasant's family may choose to depress the "internal" margin of labor productivity below the "external" (Marglin, 1976, p. 13). It is likely, however, as Marglin points out, that the stigma attached to working for one's neighbor does not carry over to working for a non-farm enterprise removed from one's village. Thus, it is more likely for non-farm enterprises to draw agricultural "slack" labor of the peasant family at less of a cost to society than the wage rate indicates.

From another perspective, the peasant farm is a unit in the self-employment sector, acting as the residual employer. All work force capacity which does not have non-farm employment is absorbed by the peasant farm sector and is to be "engaged" therein.

In the context of developing modeling one ought not to assume a constant parameter value between the stock of labor in the wage-salary sectors, measured in efficiency units, and that in the self-employment sector. An assumption of constancy in the parameter value means that the wage differentials are constant. In fact, actual intersectoral wage behavior reveals that the wage differentials are flexible, widening in times of downswing and narrowing when aggregate demand conditions strengthen (Taira, 1970, Ch.3). Thus, it is clear that the relationship between paid labor and self-employed labor must be determined endogenously, allowing the parametric value to vary depending on the demand and supply conditions for labor in the paid sectors of the economy.

Internal Migration

Changes in the sectoral composition of labor force result from: (1) sectoral and occupational choice of the new entrants in the labor force, (2) intersectoral and interoccupational transfer of those already employed, and (3) sectoral and occupational job turnovers resulting from retirement and resignation in specific sectors and occupations. The underlying economic relationships that account for the changes are well known. The relative decline of agriculture, due to a low income elasticity of demand and an inelastic price elasticity of demand for its products, is contrasted with the nonagricultural sector which has greater possibilities of technological progress and of appropriating the fruits of that progress within itself (as discussed in Section II). The demographic characteristics that interact with these economic relationships are higher rates of natural increase in rural population than in urban areas.

Given that the secularly rising relative importance of the nonagricultural sector would be the source of increasing employment opportunities, the direction in which labor moves is self-evident. Simply put, internal migration occurs when a stock of labor moves from agriculture to urban sectors. The volume of migration, from the demand side, however, depends on urban factors. The growth rate of nonagricultural employment opportunities would be high or low depending on (1) the rate of expansion of labor-intensive sectors, (2) the share of labor employed in these sectors, and (3) the responsiveness of employment growth in the faster growing sectors. Thus, intersectoral transfer of labor must be determined endogenously in the interplay of rural and urban factors.

As the volume is clearly affected by the aggregate demand conditions, in the short run, internal migration from agriculture to urban sectors fluctuates with aggregate demand. Remembering that the wage differentials widen in downswings and narrow in upswings, one may state that internal migration fluctuates inversely with the intersectoral wage differentials.*

*This is consistent with the usual specification of the migration function where migration is positively related to wage differentials. In these migration functions wage differentials are weighted by the probability of obtaining a job in the urban sector. In downswings of economic activities that probability would worsen despite the widening of the intersectoral wage differentials.

It has been argued above that intersectoral movement of labor in the small scale subsector of agriculture takes place on a farm household basis, and that the movement can take a variety of forms, depending in part whether it is the stock of labor or the flow of labor of family members. As rural-to-urban migration of labor is clearly one form of such transfers, it is quite logical to presume that the decision to migrate, or more specifically, the decision for someone in the family to migrate, is taken at the family level. It is the family's decision (though it may be subject to the proprietor's dominant influence) to maximize their expected income, rather than the prospective migrant's decision.

As mentioned earlier, the agriculture of Japan maintained the sectoral labor force of some 5.5 million farm households since the Meiji period to World War II. In the meantime, the sectoral composition of labor force changed drastically, from a high of about 83 percent in the primary sector in 1880 to 44 percent in 1940 (and to less than 12 percent in 1975). Underlying this structural transformation of the economy, and the absorption of rural labor into urban sectors in particular, were the intergenerational transfers of labor from rural to urban sectors based largely on the Japanese family structure in the countryside. According to Japanese demographers and sociologists, the pattern of primogeniture in land inheritance reinforced by the Civil code enacted in the late nineteenth century was important (Fukutake, 1967). After one of the sons became heir to the farm the siblings migrated out of agriculture. Generations of farmers' children, therefore, entered into nonfarm activities in towns and cities and still larger metropolitan areas.*

*Important indeed were the spread of public education and its impact on internal migration. Education of siblings in farm families was at once an investment in human capital and a form of division of family assets for those who were not inheriting land. Thus, in the prewar years the sectoral composition of labor force changed due largely to the majority of new entrants in the labor force choosing nonagricultural sectors and occupations. In the mid-1950s and thereafter, however, the rapid growth in the demand for labor in urban sectors has absorbed not only new labor force entrants but also many presumed heirs to farms as well as those already engaged in agriculture. Therefore, in the postwar period of rapid growth intergenerational transfer of labor was complemented by intragenerational transfers of labor.

Young migrants were often recruited by urban-based enterprises under parental approval. If migrants were not already recruited, their families customarily made special efforts to ensure that they would find suitable employment quickly. Recruitment bonuses were paid to the family. Remittances to the family were unquestionably important. Although these Japanese examples appear rather unique, more or less similar patterns seem to prevail much more widely. It has been empirically observed in many less developed countries (Yap, 1975) that rural-to-urban migrants suffer less unemployment than their strictly urban counterparts, that they find urban employment rather quickly, that the familial ties are rather strong (especially in terms of the extended family structure), and that remittances from urban centers to rural areas often amount to substantial sums. These facts are all consistent with the postulates of family-based decision making in migration.

From the modeling point of view, these all add to the conclusion that rural-to-urban migration should be directly connected with intersectoral transfers of resources as specified in the preceding section. To reiterate, internal migration is only one manifestation, although the most visible one, of resource transfers from agriculture. There is an analogy to be made between the relationship of the variables that affect fertility and a similar relation of variables that influence internal migration. As both pertain to the household's behavior in adjusting to the desired family size, much can be gained by studying them in a more general framework of a multiperson adjustment process under constraints. At the moment, however, it is necessary to remind ourselves that a separate migration function is needed for each of the separate classes of households in agriculture, since per capita income, the family (age-sex) composition, and the motivation for moving varies.

Internal migration usually subtracts labor from rural activities and adds it to urban ones. Therefore, it is the case in most general equilibrium models that internal migration affects production in the economy by adding to urban supplies and subtracting from rural supplies. The terms of trade then change in the rural sector's favor as the products of the rural sector become scarce. On the other hand, the migrants from rural areas "quickly" adopt urban consumption patterns, thereby reducing the relative demand for agricultural commodities (since urbanites have a lower Engel ratio and a lower income elasticity of demand for agricultural goods). Obviously, the net result of internal migration must depend on which of these effects predominate. In the Adelman and Robinson model, the production effect dominates and, therefore, internal migration tends to raise the agricultural terms of trade and rural incomes (Adelman and Robinson, 1978b).

What if the withdrawal of workers from the rural sector adds to urban supplies and yet does not subtract from rural ones? Because of the existence of the "slack" in the utilization of the peasant farm's work force, additional capacities for work are available for offsetting those that are withdrawn to urban activities (regardless of whether they be withdrawn by outright migration or by commuting). If the marginal product of the worker withdrawn is not zero in the rural sector, so long as the peasant family makes up for the emigrant's work, there is no reduction in the output of the family in farming or in non-farm activities. In fact, whether or not the marginal productivity of labor in agriculture is literally zero is beside the point. Labor is in surplus in agriculture, in the peasant farm subsector, so long as its marginal productivity is less than the marginal productivity elsewhere in the economy.

There is a crucial difference between paid labor and self-employment of the peasant farm variety. The wage rate of paid labor is equated to the marginal value product of labor, whereas the self-employed family appropriates all its product as its income after payments for other inputs in production. Peasant accounting, quite understandably, fails to distinguish between the product of labor and the product of other owned resources, say, capital and land. When several persons employ themselves jointly, they appropriate the total net product. If the group is a family, and if one of the five brothers, for example, leaves the village for employment in the city, "the remaining four are likely to divide their brother's one-fifth share of *total* income among themselves, not just that portion of income which was his marginal product" (Marglin, 1976, p. 14).

This reasonable practice has two important economic implications. In the first place, as is well known, the industrial (or urban) wage would have to be at least equal to the average product in the peasant family in order to induce one to migrate completely out of the village. In the second place, however, when economic conditions turn adverse, the migrants can return to their families for participation in the family economic activities. As employment increases in urban occupations in response to a rise in aggregate demand, the workers who had been sheltered under self-employment or family labor during the economic adversity return to paid jobs. It is to be noted, therefore, that the supply of paid labor in the industrial labor market increases without an appreciative rise in the level of industrial wages (Taira, 1970, p. 62). The rural sector, particularly the peasant family subsector, is the residual employment sector of the economy.

Taira observed that migration from agriculture to industry tended to increase (or decrease) in association with a narrowing (or widening) of the intersectoral wage differential. Were the intersectoral wage differentials weighted by the relative probabilities of being employed in industry and agriculture, the flow of rural labor to urban sector jobs would perhaps move in association with a widening of the differential as suggested by models of migration such as Harris-Todaro's (1970). The complications would arise, however, when there is more than one source of labor for paid employment in industry: (1) the self-employed labor force of the urban sector itself, and (2) the agricultural labor force (comprising the paid agricultural labor force and the peasant family labor force). These two sources should be carefully distinguished not only sectorally but also spatially.

One important relationship with respect to migration must be accounted for. In cases where urban-to-rural flows of funds are important, a way must be found to incorporate such financial flows as a part of family savings, particularly in the small-farm subsector. Another potentially important relationship is between migration and urban patterns of natality. When predominantly younger generations move from rural to urban areas, as in prewar Japan, patterns of the age at marriage and, therefore, marital fertility would be expected to undergo observable changes.

Patterns of Settlement

Economists consider migration as an inevitable and necessary adjustment mechanism for dynamic change. Sociologists are often more concerned with the negative factors leading to outmigration in frustrating confluence of socio-cultural circumstances of rural areas, on one hand, and a sense of alienation and deterioration in the "quality of life" in the recipient urban areas, on the other. Geographers tend to use models adapted from physics in more or less detached studies of migration. Thus, geographers and some demographers would utilize the gravity model, or its more recent variants, in describing and predicting migration flows. The essence of these models is that migration is affected by conditions of populations in both sending and receiving areas and also by the distance between them.*

From location theorists' point of view, one of the greatest simplifications in the migration literature in economics must be the complete absence of reference to spatial distribution of economic activities, perfunctory reference to "urban" and "rural" and to some transport and/or communication costs notwithstanding. The spatial distribution of non-farm activities is crucial in determining the locational aspects of migration and, therefore, the pattern of human settlements. E.A.J. Johnson refers to this as a "hierarchy of central places, functionally dispersed over a landscape in descending scale of utility and size" (Johnson, 1970, p. 152).**

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*The entropy model is built on the assumption of satisficing behavior on the part of the migrants and a stochastic choice procedure in the selection of feasible migration patterns. According to this approach, if the migration costs, assumed to be linearly dependent on distance, are subject to an upper constraint, migration flows will be a product of population potentials in the sending and receiving areas and an exponentially decreasing function of the distance between areas (Andersson and Holmberg, 1977, Ch. 1).

**Johnson remarks, quite appropriately, that "what Lord Bacon said about money can be said about urbanization", which remark is footnoted as follows: "Money is like muck, not good unless spread" (Johnson, 1970, p. 157).

In Johnson's "central place" approach, the critical factor is a community's marketing performance. The size of the market defined in terms of average incomes and the number of inhabitants covered depends on the length of market radius. So does the effectiveness of competition and the range of consumers' choice. A community must, therefore, be integrated into a larger market system, in graduated hierarchies comprising towns, small cities, and medium-size cities. Spatial design of this type, for a given community, makes possible satisfactory market performance that stimulates and impels the community's producers to raise productivity. The question is, how to make this approach operational in the context of rural development or regional development?

In the context of the issues addressed in this paper, the following are some relevant considerations.

(1) In more densely populated parts of the world where the small-farm subsector of agriculture is of overwhelming importance, shorter radii can cover more people. If, by emphasizing divisible (biological-chemical) technologies, satisfactory productivity growth is achieved and is shared by the people more broadly, the economic size of this smaller area can then match that of a larger area with extensive land use.

(2) It is reasonable to presume that, if a migrant is proceeding from a location in an area surrounded by densely distributed opportunities, he/she would have a shorter migrating distance on the average than if he/she were to migrate from a location in an area where opportunities are more sparsely distributed. The secondary impacts arising from the income-expenditure linkages of the broadly based pattern of agricultural growth (emphasizing interactions with local non-farm enterprises) would contribute in distributing non-farm employment opportunities locally.

(3) As the process of economic development proceeds on the lines discussed above, and as the economy undergoes structural transformation, these towns, small cities, and medium-sized cities that are production, trade, and service centers would themselves become larger. Small cities may be incorporated into larger cities. Rural towns may do the same, eventually. And the percentage of population in urban residence rises due to this form of urbanization as well as to increases in the population of the established metropolitan areas. In the meantime, the country and the region would have had a dispersed pattern of urbanization without suffering from excessive imbalance in population distribution.

(4) It is true that the populations of some small cities decline, usually because of an imbalance between in- and outmigration. It is also true that large metropolitan centers, which attract waves of migrants over many years, later lose many residents to their places of origin. Factors responsible for the so-called "U-turn" phenomena and for ebbs and flows of place-to-place migration of this and other types are not well understood. It seems, however, that although they are important, the place-to-place migration patterns of this type are "second generation problems" in human settlement patterns. It also appears that the population dynamics involved in these phenomena are largely independent of the changes in which agriculture plays a dominant role, and that they are to be distinguished from rural-to-urban migration in modeling the "representative developing country".

In more formal models of spatial interaction and settlement structure, a spatially-distributed population exists and demands goods of various kinds. There are "centers" where organizations exist which produce and supply these goods. People travel to these centers to obtain goods as well as to be employed in production and distribution. Location of the firm is determined by usual assumptions about production functions and profit maximization in a spatial context. Consumer's behavior is derived from the assumptions of utility maximization and the consumer's trade-off of the benefits of a location and the cost of overcoming the distance to that location. The attractiveness of centers on the upper levels of the hierarchy are due to the variety of goods offered or to a greater number of functions performed. The cost of travel to such centers is correspondingly higher.

Perhaps the most interesting aspect of spatial interaction models is the possibility of including the feedback relationship between the population locating because of the supply of jobs and centers, and centers locating because of the population (Wilson, 1978, p. 142). The simplest model to include such a feedback appears to be I.S. Lowry's "model of metropolis" (Lowry, 1964). Although the model was originally formulated to analyze metropolitan land uses and densities, later developments seem to emphasize the spatial and sectoral interactions that are equally relevant to non-metropolitan applications (Wilson, 1974, and MacGill, 1977).

In the Lowry model employment is divided into "basic" and "retail". The location of basic employment is not dependent on the distribution of population, since the activities of this sector are essentially export oriented. The growth of exports causes the growth of employment. The level of exports is, however, exogenously determined. On the other hand, "retail" employment is locally oriented and is assumed to be dependent on the spending power of the population. That is to say, the income/expenditure linkage of the local population is explicitly recognized. People are located "around" their work places, and the "retail" sector around people. The kernel of the simplest of this type of model lies in the assumptions concerning the linear dependence of retail employment on city (local) population and the aggregate population on total employment (Miron, 1979). It can be shown algebraically that the total employment is some multiple (greater than unity) of basic employment.

It is tempting indeed to adopt this model structure for the purpose of this section. In a rural context it seems reasonable to designate farming activities as the "basic" employment sector and non-farming, rural manufacturing and service employment as the "retail" employment sector. The linear dependencies postulated between employment and population in the original model can be reformulated in terms of the relationships of employment variables implied by the production functions in rural area activities, subjective equilibria of peasants' households, and by the income/expenditure linkages derived from consumption/investment behavior of rural households. Further analytical work is necessary, however, for this aspect of spatial interaction and settlement structure to be formally modeled in a rural context.

What would a strategy of broadly-based agricultural development imply for the patterns of human settlement? This can be illustrated by asking, alternatively why is it that fewer migrants now go short distances to nearby towns and more move long distances to metropolitan centers in most developing countries? The diagnosis of those who emphasize "spatial development strategy" is not surprising. Be it the development of the "graduated hierarchy of central places" (Johnson, 1970) or transmuting existing rural settlements into a hybrid called "agropolis, or city-in-the-field", by "encouraging the migrants to remain where they are by investing in rural districts" (Friedmann and Douglass, 1977), the prescription is predictable. In the context of the issues addressed in this paper, it is appropriate to indicate that a broadly-based agricultural development pattern, which encourages and benefits from the two-way interactions between locally dispersed farm and non-farm activities, is the *sine qua non* of the spatial development strategy represented by the examples above.

VI. CONCLUDING REMARKS

In the process of economic development a nation's resources flow among the sectors of the economy as well as among regions in the nation. Intersectoral flows of capital and labor have long attracted economists' attention. The "primitive accumulation" of capital in Karl Marx's thesis dealt with mobilization of "economic surplus" in agriculture as a major source of funds for industrial capital formation in the early phase of capitalist development. In socialist economies too, the agricultural sector generated savings to be transferred to the modern industrial sector. It is well known that the industrialization of the Soviet economy was financed in this fashion.

In the more recent literature of economic development the issues involving the intersectoral flows of capital are more controversial. On the one hand, it is argued that traditional peasant economies, based on small-holder agriculture prevalent in Asia, can increase productivity in agriculture at a rate sufficient to generate savings for industrial capital formation. Empirical studies on the historical experience of Meiji Japan, which generated the needed savings mainly from agriculture, provide clear evidence for such a proposition. On the other hand, the relevance of the Japanese experience to the contemporary developing countries has been questioned. According to the alternative view, increasing agricultural production in Asia and elsewhere at a rate sufficiently high to meet the rapid growth in population requires an enormous investment in irrigation and water control. It is argued, therefore, that the possibility of capital outflow from agriculture is limited, and that the direction of net flow may have to be from nonagriculture to agriculture.

Unlike the case of capital, there is no real controversy as to the direction of labor and population flows. Along with industrialization the developed countries have witnessed the growth of cities and urbanization of populations. Urban population growth and urbanization have been a direct consequence of rapid growth in population and of net rural-to-urban migration. This type of internal migration, in turn, has been a response to structural imbalances between spatial distribution of labor demand and labor supply arising during the course of industrialization.

Achieving satisfactory increases in agricultural output and incomes to be shared by a majority of farmers is the basic objective of the development of agriculture. For this purpose changes in agricultural technology must take place. It has been argued in this paper that the nature of technological change interacts not only with the share of incomes accruing to the majority of farmers but with the intersectoral and spatial reallocation of population, and ultimately with demographic changes in the countryside. Of particular interest has been the effect of agricultural technological change on the magnitude of internal migration and patterns of settlement. Special attention has been focused in this paper on a dispersed, rurally-oriented pattern of population reallocation as contrasted to a pattern of urbanization centered on established large cities. It has been argued that there are important advantages in a dispersed pattern of industrialization and in avoiding excessive concentration of the growth of industrial output and employment in a few established large cities.

In various parts of this paper reference has been made to certain aspects of the Japanese pattern of development in order to learn from her experience and to gain some insights into important interrelationships and interactions. It is worthwhile to learn from the Japanese experience. In order to avoid the usual pitfalls of rather simplistic approaches to this type of exercise, it seems useful to clarify the meaning of a lesson of history.

Actual reality represented in a model is composed of three essential elements:

(1) Variables, both endogenous and exogenous, predetermined or otherwise, in the parlance of policy analysis, policy instruments, constraints, or objective variables

(2) Functional relationships among variables, either behavioral or definitional, specifying the logical structure in which variables are related significantly to one another and in which functions are organized consistently

(3) Parameters and initial conditions, the former of which indicate the direction and the intensity of associations of one variable to another and the latter of which concern the levels of variables in equilibrium before time paths are generated

If one takes the view that a model is a structured conceptualization of reality, it is clear that one may learn a lesson from history in substantive ways by distinguishing the source and the nature of that lesson in the framework of the three elements above. Obviously, a lesson learned from a history resulting from a certain prescribed level of an exogenous variable, or a set of parametric values, is not as relevant or important for policy decisions as, say, one resulting from policy variables and their interactions.

If one takes the view, furthermore, that a policy analysis is an organized exercise in decision making in a given structure of interacting relationships, then the three elements of a model must be specified as much as possible with a keen sense of what are important problems and issues as revealed in history while excluding irrelevant factors. Obviously, in the sense discussed above what is important historically differs from one country to another. Japan, as a latecomer in the developed world, and the first non-western nation to join it, provides a perspective and a range of issues rather distinct from the experiences of western countries. Thus, to study the experience of Japan is to enrich the insights for specification exercises for a policy analysis.

Given a specified structure of interacting relationships, a policy analysis can simulate and estimate the consequences of alternative courses of action open to a decision maker. It may very well turn out that exact replication of the Japanese experience in certain aspects would be impossible under the given circumstances. That in itself should not mean, however, that the decision maker cannot learn from the experience of Japan, or any other country. How Japan chose under her structure of interacting relationships, or contrarily how Japan did not pursue a certain course of action, is as much a lesson of history as not.

Perhaps the most important lesson to be learned from modeling exercises is to understand in a consistent and systematic framework of conceptualization what may actually have happened. To define a problem is often half its solution. Thus conceptualizing and organizing the structural relationships that are deemed important, examining the internal logic of the structure, and seeing the sequential interactions of its parts, allows one to discover the lessons of history without falling into the pitfalls of irrelevance, inconsistency, or impracticable alternatives.

This is not to say that we know all that is necessary in good modeling exercises. Far from it. As has been made quite evident in the development of this paper, there are gaps in our knowledge about the interactions between demographic and economic factors, for example. In fact, ignorance and uncertainty are inevitable parts of our decision making process involving substantive matters. Nevertheless, we proceed on the assumption that we know enough, and that we can cope with uncertainty using our ideas about probability distributions of events. As history unfolds, unforeseen events and circumstances emerge, however. A decision maker must learn quickly to minimize the damage and promote his/her effectiveness over a longer period.

To learn from this type of experience one needs a clearly established frame of reference which helps one to identify the subsumed uncertainty and ignorance. A good policy analysis model would do this by indicating what the missing variables are, what the missing relationships are, as well as what the parametric values brought about by unforeseen developments are.

This means that one can learn a lesson from one's mistakes and one's ignorance, provided that one's initial course of action can be systematically described, and that the structure of relations underlying the decision making process can be changed to account for the newly acquired knowledge. A good analysis model designed for developing countries, but constructed on the basis of the principle (i.e., the neoclassical paradigm) and the experiences of developed countries, should thus be amenable for modification by feedback relations of this type.

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