December 1988 No. 298

THE EVOLUTION OF AGRARIAN STRUCTURE IN LATIN AMERICA: AN ECONOMETRIC INVESTIGATION OF BRAZIL

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Emblematic of Latin American agriculture, Brazil in the early 1960's was uniformly mired in a "latifundio-minifundio complex" according to CIDA (1966). Ownership of land resources was highly concentrated, and the classic CIDA study identified little hope that either this structural complex, or the undesirable factor use and distributional patterns associated with it, would change.

Yet rapid agricultural growth over the last two decades seemingly contradicts the stasis implied by the CIDA description. Since the CIDA study, Brazilian agriculture has exhibited significant capitalization and growth (e.g., see Graham et al. 1987 and Thiesenhuesen and Melmed 1988). But whether growth has reshaped agrarian structure and relieved the economic and social tensions identified by the CIDA study, or whether it has worsened them as Maybury-Lewis (1988) argues, is hotly debated.

The Brazilian debate expresses a classic question in the political economy of agricultural development: How does agrarian structure evolve as agriculture capitalizes and grows? Does modern economic growth eliminate the latifundio-minifundio complex together with its grosser inequalities and inefficiencies in factor use? And, if so, does small, medium or large farm agriculture displace it? Perhaps the clearest expression of these questions has been the debates over the fate of the peasantry, extending from the European debate of Lenin-Chayanov-Kautsky to their latter day descendants writing on Latin America, Asia and Africa. Somewhat belatedly, formal neoclassical economic analysis has been extended to the structural question of whether small, medium or large farms will come to dominate agrarian structure (e.g., see Eswaran and Kotwal 1986 and Carter and Kalfayan 1988).

This paper contributes an empirical dimension to the debate over the evolution of agrarian structure in Latin America. Others (e.g., Scott 1985) have lamented the lack of the time series analysis needed to address competing structural hypotheses. Using census data on the distribution of farm operating units from 1940 to 1980, this paper estimates non-time-varying Markov models of the evolution of Brazilian agrarian structure. Methodologically, the paper relies on McCrae's (1978) non-linear generalized least squares specification. On the assumption that the estimated Markov process remains stationary over time, the paper projects future structure in the form of long run distributions of farm area and units. While interesting in themselves, the perhaps more important contribution of the long term projections is to summarize the structural tendencies operating in the present. In addition, the projections are used to calculate rates of farmer displacement and thereby they help clarify the implications of competing theories of structural evolution, particularly the small and medium farm theories discussed below.1/

This paper is organized as follows. Section 1 provides a static snapshot of agrarian structure in Brazil, briefly reviewing the issues of poverty and unemployment which are seen to be intertwined with structure. Section 2 introduces the general debate over the evolution of agrarian structure and sketches the competing theories of the evolution of agrarian structure in Latin America. Section 3 reviews the general econometric methodology. Section 4 presents the estimated Markov probability structures and calculates long term projections of agrarian structure and farm displacement and growth. Section 5 concludes the paper by considering implications of the estimates for both Brazil and the general theoretical debate over structural evolution.

SECTION 1 AGRARIAN STRUCTURE AND PERFORMANCE IN BRAZIL

Figure 1 displays the size distributions of agricultural establishments and agricultural area for Brazil in 1980. The size classes refer to operating units, not ownership units. Size classes have been defined to coincide with concepts used in the literature (see Section 2):

0-5 Hectares	Sub-family or Semi-Proletarian Farms;
5-10 Hectares	Peasant Farms;
10-50 Hectares	Capitalized Family Farms;
50-500 Hectares	Large Scale Capitalist Farms;
≥ 500 Hectares	Latifundia.

While it might have been desirable to define region specific farm size class boundaries, this simpler approach was taken here.

The structural snapshot in Figure 1 reveals what has come to be known as a "bimodal" structure--the mode of the area distribution is in the largest size class, while the mode of the establishment distribution is the smallest size class. As can be seen, over 50% of all agricultural establisments are less than 10 hectares in size, while in excess of 55% of all agricultural area is cultivated in units larger than 500 hectares.

Based on research undertaken in the early 1960's, CIDA (1966) offers a particularly severe indictment of this sort of bimodal structure (which it labels the "latifundio-minifundio complex"), and the highly unequal distribution of land ownership which underlies it. A concentrated distribution of property rights would in general be expected to increase the inequality of rural income distribution. In addition, CIDA concludes that bimodal structure generates inappropriate factor proportions, leading to inadequate employment, poverty, premature migration to cities and waste of agricultural resources.2/

However, in the quarter century since the CIDA study, Brazilian agriculture has undergone tremendous commercialization, growth and change. Graham, Gauthier and de Barros (1987) describe the 1965-1980 period as an era of modernization in Brazilian agriculture with huge shifts toward remunerative export crops and increases in the use of agricultural chemicals and fertilizers. Agricultural output grew at a brisk average rate of 5% per year over the 1965-'80 period.

Has this era of rapid growth erased the validity of the structural hypothesis argued so strenuously by CIDA? Put differently, are structural concerns the sole domain of "pre-modern agriculture" where competitive market pressure has yet to eliminate differential and inefficient behavior across strata? Recent work by Thiesenhuesen and Melmed-Sanjak (1988) suggests not. Utilizing data from the Brazilian 1980 agricultural census, these authors find the same sharp differences in factor proportions and productivity across size strata which underlay the CIDA conclusions. Suggesting an even stronger answer to he question of structural relevance, Maybury-Lewis (1988) argues that the problems of premature labor displacement, poverty and migration find their most severe expression in areas where agricultural growth and modernization have been most rapid.

In a study of income distribution and poverty over the 1970-'80 period, Denslow and Tyler (1984) divide Brazil into three constituent regions, the Northeast, Southeast and Frontier. By their calculations, mean rural income grew most quickly in the Frontier (149% over the decade) and the South

(135%), with a slower rate of growth in the Northeast (107%). In the Frontier, the Gini index rose from 0.34 to 0.50, in the South it rose from 0.45 to 0.56, while in the relatively stagnant Northeast it rose only from 0.40 to 0.47. While far from definitive, this correlation between growth and inequality is consistent with the hypothesis that growth excaberates rather than ameliorates the problems associated with unequal land distribution.

More pointedly, however, these regional differences encourage examination of the implicit characterization of Brazil as homogeneously bimodal in agrarian structure--a characterization explicitly accepted by CIDA (1966). It is of course the sheer diversity of Brazil which has sent many authors, and, administratively, the Brazilian government, in search of regionalization schemes. The regionalization scheme used by Denslow and Tyler, and the one which is used in this study, divides Brazil on the basis of states into the following regions:

Northeast: Maranhao, Piaui, Ceara, Rio Grande do Norte, Paraiba, Pernambuco, Alagoas, Sergipe, Bahia;

South: Minas Gerais, Espirito Santo, Rio de Vaneiro, Sao Paulo, Parana, Santa Catarina, Rio Grande do Sul; and,

Frontier: Rondonia, Acre, Amazonas, Roraima-Ampa, Para, Mata Grosso do Sul, Mata Grosso, Goias, Distrito Federal.

Haller (1982) derives a systematic regionalization scheme using factor analysis and municipal level data. His aggregate macro regions, which he labels the "Underdeveloped Northeast," the "Affluent South" and the "Underdeveloped Frontier" are defined on the basis of shared demographic, social and economic characteristics. With the exception of a few municipalities, Haller's scheme corresponds to that indicated above.

The Northeast, South and Frontier regions do exhibit rather different agrarian structures, as Figures 2 through 4 illustrate. The Northeast, with its long history of a latifundio-minifundio agriculture (see for example, Tollini and Veiga 1985) is the most markedly bimodal. The South, parts of which were colonized by middle class farmers in the late 19th century, exhibits a higher proportion of land in the 10-50 hectare category. This strata in the South contains approximately 55% of establishments and 25% of agricultural area. In the Frontier, land concentration is more extreme than in the bimodal Northeast, and almost presents what might be termed large farm unimodalism.

The regional disaggregation of Brazil reveals the diversity of its contemporary agrarian structure. But, does the diversity captured by the structural snapshot hide a common evolutionary destination? How is this structure evolving, particularly under the force of rapid agricultural capitalization and growth? As a prelude to the econometric analysis designed to answer these questions, Section 2 introduces competing theories of structural evolution.

SECTION 2 THEORIES OF STRUCTURAL EVOLUTION IN LATIN AMERICAN AGRICULTURE

Commentators on the contemporary evolution of agrarian structure in Latin America have come to draw heavily on the early twentieth century debate about the fate of European peasantries. An important contribution to that debate was Lenin's "Junker road" thesis which maintains that the peasantry disappears in a process of differentiation of rural economy into large scale capitalists and free wage laborers. In contrast with this thesis was Chayanov's conception of a dynamically stable, independent peasantry. Intermediate to the two was Kautsky's position that the peasantry, while maintaining direct control over some means of production, becomes functionally attached to and dominated by a capitalist sector.

The contributions to the contemporary Latin American debate can be grouped under three headings: Large Farm Capitalism (e.g., Kay 1980); Capitalized Family Farming (e.g., Lehman 1982, 1985 and Scott 1985); and, Symbiotic Bimodalism (e.g., de Janvry 1981).[3/] Discussing strucutral change in the Amazon, Hall (1988) similiarly classifies the competing theories. The Leninist theory of Large Farm Capitalism implies elimination of the small fry, with a consequent shift in the densities of both of the farm unit and farm area distributions in Figure 1 toward the larger farm size classes. The theory of Capitalized Family Farming predicts a movement to a uni-modal structure where both area and establishment distributions are concentrated at a small or medium farm size class. Kautskian Symbiotic Bimodalism imparts a stability to the bimodalism characteristic of 1980 Brazil shown in Figure 1.

While all three theories and their classical European antecedents draw on broad-ranging political economic analysis, they each rely on a core microeconomic insight. The economic factors which are used to justify the persistence and/or domination of a particular farm size class can be grouped into three categories: technical scale economies; scale-differentiated market access and prices; and, structure of rural labor supply and its general equilibrium interaction with land distribution. Carter and Kalfayan (1988) systematically explore these factors with a formal general equilibrium model. Here a brief review is offered to motivate the alternative structural hypotheses to be explored econometrically.

2.1 Technical Scale Economies and the Road to Large Farm Capitalism

Technical scale economies which create a competitive edge for "factories in the field" would thereby create market pressure to shift agricultural resources towards a technologically determined optimum firm size. In the context of the Latin American structure debate, Kay's (1980) large farm capitalism thesis conforms to this logic. Kay argues that significant segments of Latin American agriculture are evolving towards a traditonal two class structure dominated by large holdings operated as unified and centralized units and employing wage labor.

The dynamics which Kay discusses are typified less by changes in the ownership distribution of agriculture than by shifts in land rentals and hence in the distribution of farm establishments. Concentrated ownership is an attribute of Latin American agriculture which was inherited from an earlier period of colonial primitive accumulation. The post-World War II evolution of agricultural capitalism, which Kay labels "internal proletarianization," resulted from the replacement of decentralized haciendas (where a significant portion of land was effectively rented out and cultivated as small units) by centralized haciendas run on a large scale with wage labor. According to Kay's analysis, scale economies of new technologies led the type of Leninist land concentration discussed earlier. Hall (1988) and Bakx (1988) provide numerous reference to similiar Leninist perspectives, particularly with regard to the Frontier regions of Brazil.

2.2 Multiple Market Failures and the Capitalist Family Farm Path

Absent technical scale economies, the simple case for large farm capitalism vanishes along with a technologically determinate optimum farm size. More intriguing is the prospect that even with technical scale neutrality, size differentiated input and output prices (caused by policy-induced distortions or by intrinsic market failures) promote the profitability and growth of a particular farm size stratum.

Binswanger (1987) identifies a series of tax and finance policies which prompt the expansion of large scale farm units on the Brazilian Amazon. Graham et al. (1987) identify official credit policies, which are systematically biased against small farm credit access, as a factor which promotes the differential profitability and growth of the large farm sector.[4/] While both Binswanger and Graham et al. identify a structural tendency toward large farm agriculture, it is a tendency born of policy distortions rather than an intrinsic path of agricultural capitalist development.[5/]

The literature on the economics of the agricultural household as a joint production-consumption unit, rooted in the classic contribution of Chayanov, identifies an alternative, market failure-based, rationale for size-differentiated prices. The basic Chayanovian thesis (which realizes its most refined neoclassical rendition with Singh Squire and Strauss 1986) demonstrates that in the absence of a labor market, the shadow price of labor will be correlated with farm size. A similar farm size-shadow price relationship is maintained in literature which assumes that a labor market exists but is burdened by principal-agent enforcement problems (e.g., see Brewster 1952, Eswaran and Kotwal 1985 and 1986, Feder 1985, Carter and Kalfayan 1988). The common feature of these labor market imperfection theories is that cheap labor is unmarketably locked up on small holdings, creating incentives for land to move (through sales or rentals) in the direction of the cheap labor.

Perhaps offsetting the structural tendencies created by cheap labor is the relatively high shadow price of capital faced by small farm units. This size differentiated price may be the result of the sort of policy distortions discussed by Graham et al. (1987), or it may be the intrinsic result of information-based market failures (see Carter 1988). Regardless, access to capital stratified by farm size has become incorporated as a stylized fact in recent analyses (e.g., Feder 1985, Eswaran and Kotwal 1986, and Carter and Kalfayan 1988). The crucial structural question concerns the interplay between these labor and capital market failures.[6/] In an ambitious summary of evidence on the growth of medium-sized agriculture in Latin America, Scott (1985) hypothesizes that it is the medium sized farms which benefit from labor and capital market failures. Relative to large farms, medium-sized units enjoy cheap family labor, while relative to small peasant farms they enjoy better access to capital.

This set of labor and capital market configurations could make it possible for these intermediate units to survive, prosper and outcompete alternative forms of agricultural production for resources over time. Lehman (1982a and 1985) labels such a structural trajectory the Capitalized Family Farming (CFF) path.[7/] From this point of view, smaller scale farming is doomed neither to extinction, nor to subordination. Unlike the theoretical visions of Large Farm Capitalism and Symbiotic Bimodalism (discussed below) where there is no middle ground between hacienda and impoverished peasant, the CFF hypothesis predicts the development of an agrarian structure containing, or even be dominated by a middle segment of small or medium scale capitalist producers.[8/]

Attention to family farms as a viable structural alternative in Latin American agriculture has resulted in part from empirical observation of successful small and medium-sized producers.[9/] As noted above, the 1980 census data for South Brazil presented in Figure 3 display a quantitatively significant, if not quite numerically dominant, class of medium-sized producers. Lehman (1982b) describes this region as one which has escaped the traditional bounds of large farm-small farm categories and which is travelling down the CFF path. Bakx (1988) tellingly titles his challenge to the Large Farm Capitalism hypothesis "From Proletarian to Peasant."

As Scott discusses in some detail, the precise definition of a capitalized family farm is unclear, with empirical studies using an array of rather elastic definitions. Even less clear is whether the evolution to CFF is a broadly inclusionary movement, or whether it is characterized by significant displacement and differentiation. Lehman (1982a) does distinguish his capitalized family farm from Chayanovian peasant agriculture, noting at one point that this dynamic small farm sector rises on the graves of the peasantry. Scott echoes similar concerns when he questions whether the CFF development pattern ameliorates the poverty and landlessness associated with large farm agrarian structure. By making possible inference about farm displacement over time, this study will remove at least some of this uncertainty concerning the CFF path.

2.3 Persistent Bimodalism and the Structure of Labor Supply: A Neoclassical Rendition of Kautsky

Unlike the Large Farm Capitalism hypothesis which posits the disappearance of peasant and other forms of small scale production, Symbiotic Bimodalism maintains that small scale, semi-proletarian and large scale capitalist agriculture coexist symbiotically. Yet, like the Large Farm Capitalism hypothesis, it deems the small scale sector to be economically non-competitive, incapable of capital accumulation, and existing in a subordinate relation to a dynamic capitalist sector.

The hypothesized persistence of a small scale sector in the face of an economically superior large scale sector can, at the first level, be logically sustained by noting, as Kautsky did, that "in industry it is possible to multiply the means of production at will; in agriculture the decisive means of production, land, constitutes a fixed magnitude under given circumstances and cannot be increased at will" (quoted in Alavi 1987, p. 192). Land concentration thus requires the actual dispossession of small producers, a process which may be slow if smallholders possess secure legal title and weak alternative employment opportunities. Reflecting this logic, Lehman (1982b) explains the persistence and even proliferation of small holdings in Northeast Brazil because they serve as refuges from poverty.

This refuge from poverty explanation of small farm persistence challenges the pace but not the ultimate destination of the Large Farm Capitalism hypothesis. Kautsky (1976, p. 35)himself went on to develop a more durable rationale for the persistence of the small scale sector:

> Despite the technical superiority the large holding can never establish an exclusive domination, even in the area of its predominance. In most cases, the shortage of manpower is the basic cause for the retreat of large holdings before smaller ones.

In other words, labor comes more cheaply when it is supplied by a semi-proletarian smallholder sector then when the work force is a landless proletariat. This labor market linkage is the essence of the Kautskian symbiotic relationship between large and small farm sectors. In the Latin American context, de Janvry and Garramon (1979) write that the semi-proletariat can produce part of its own subsistence and can thus supply labor more cheaply than a proletarianized worker who is completely dependent on labor market earnings. They label this hypothesized gap between the supply price of landed and landless labor the "semi-proletarian subsidy" to capitalist wage costs.

This Kautskian argument can be reformulated in terms more consistent with neoclassical price theory (Carter and Kalfayan, 1988 offer a rigorous analysis). Semi-proletarian labor, resident on small holdings in the agricultural sector, could be hypothesized to supply marginal units of labor at their (low) marginal opportunity cost. However, geographic isolation from non-agricultural labor markets may limit the ability of landless labor to supply marginal units of labor to the agricultural sector. Labor supply from the proletariat would, in this instance, only be forthcoming if wages were high enough to justify residence in the isolated rural sector. In such a situation, dispossession of small holders would create an equilibrating increase in the market wage, eliminating incentives for further large farm expansion, as in the Kautsky story. One implication of this neoclassical refinement of Kautsky is that it implies that bimodal structures will tend to persist in relatively isolated and economically stagnant areas.[10/] In more dynamic regions, with closer links to population centers, there would seem to be little in the Kautsky story to inhibit the growth of Large Farm Capitalism.

SECTION 3 A MARKOV METHODOLOGY FOR THE ANALYSIS OF STRUCTURAL CHANGE IN AGRICULTURE

To what extent, then, has the evolution of agrarian structure in Brazil verified these competing theories and their underlying model of the causes and consequences of agricultural growth? Changes in the distribution of land across farm size classes can result from the reallocation of land between farm size classes and from the expansion or contraction of area cultivated. In Brazil, there has been a tremendous expansion in area cultivated since 1940. Fully 43% of Brazil's surface area was cultivated in 1980, as opposed to only 23% in 1940. To avoid problems of dealing with the entrance and exit of farm units, the analysis here will be established in terms of the distribution of land. Each hectare of land is in one of six exclusive and exhaustive states, either in one of the five farm size class categories listed in Section 1, or in a residual non-agricultural use category.

Following a standard Markov specification, $x_j(t)$, the proportion of the land stock in the jth farm size category in censal period t, can be expressed as follows:

$$\begin{aligned} x_j(t) = P_{1j}\, x_1(t-1) + P_{2j}\, x_2(t-1) + P_{3j}\, x_3(t-1) + P_{4j}\, x_4(t-1) \\ + P_{5j}\, x_5(t-1) + P_{Nj}\, x_N(t-1) + \varepsilon_j \end{aligned} \tag{1}$$

where P_{ij} $(i,j = 1\text{-}5)$ is the probability that a hectare in the i-th farm size class in censal period t-1 will be in the j-th class in period t. P_{Nj} is the probability that an uncultivated hectare in period t-1 will enter the j-th size class in period t. Terms of the form P_{jj}, which give the probability that a hectare in class j will remain in class j, will be called the <u>simple reproduction probabilities</u>. In the most general model, the P_{ij} would be subscripted to reflect a time varying probability structure. The term ε_j captures variation between actual and predicted land proportions of land in class j.

A transition equation such as (1) can be written down for each farm size class and for the proportion of uncultivated area, yielding the following system of transition equations:

$$x_1(t) = [\sum_{i=1}^{N} P_{i1}\, x_i(t-1)] + \varepsilon_1$$

$$x_2(t) = [\sum_{i=1}^{N} P_{i2}\, x_i(t-1)] + \varepsilon_2$$

$$x_3(t) = [\sum_{i=1}^{N} P_{i3}\, x_i(t-1)] + \varepsilon_3$$

$$x_4(t) = [\sum_{i=1}^{N} P_{i4}\, x_i(t-1)] + \varepsilon_4$$

$$x_5(t) = [\sum_{i=1}^{N} P_{i5}\, x_i(t-1) + \varepsilon_5$$

$$x_N(t) = [\sum_{i=1}^{N} P_{iN}\, x_i(t-1)] + \varepsilon_N$$

where by definition it must be the case that

$$\sum_{j=1}^{N} x_j(t) = 1$$

$$\sum_{j=1}^{N} P_{ij} = 1, \forall_i .$$

This system of equations can be more compactly written as

$$\underline{x}(t) = P' \, \underline{x}(t-1) + \underline{\varepsilon}$$

where the matrix P is the six by six Markov probability matrix. Note that the diagonal elements of P are the simple reproduction probabilities.

It would be possible to estimate each transition equation separately with ordinary least squares. However, such a procedure, besides being inefficient, is unlikely to yield probability estimates (the P_{ij}) which are all between zero and one. This latter problem motivates the search for a functional form which will appropriately restrict probability estimates. McCrae (1978) suggests a multinomial logit specification in which the "log odds" are specified as a function of a vector of parameters $\underline{b}_{ij}$ and exogenous, or predetermined variables $\underline{z}(t-1)$:

$$\text{(2)} \qquad \ln (P_{ij}/P_{iN}) = F_{ij}(z(t-1),\ \beta_{ij}) \qquad (j \neq N).$$

Note that for convenience sake P_{ij} has been normalized by P_{iN}, the probability that a hectare in the i-th class is withdrawn from cultivation.

Equation (2) as written permits the log odds and the transition probabilities to vary over time as the exogenous z systematically change. In an effort to identify the basic pattern of structural evolution, a non-time-varying specification is used here. Specifically, it is assumed that

$$F_{ij} = \beta_{ij} \quad .$$

Under this specification, the individual transition probabilities can be written as:

$$\text{(3)} \qquad P_{ij} = \exp(\beta_{ij})/(1+D_i), \text{ where}$$

$$1/(1+D_i) = 1/(1 + \sum_{j=1}^{5} \exp(\beta_{ij})] = P_{iN}.$$

Substituting (3) into the Markov matrix and dropping the redundant sixth equation yields a five equation model

$$\text{(4)} \qquad \underline{x}^*(t) = P(\underline{\beta})^{*\prime}\ \underline{x}(t-1) + \underline{\varepsilon}^*$$

where the P* is P trimmed of its last row, and $\underline{x}^*$ and $\underline{\varepsilon}^*$ have each been trimmed of their final element. Non-linear least squares can be applied to (4) to obtain estimates of $\underline{\beta}$, from which estimates of P* and P can be calculated using (3) and the adding-up restrictions.

While consistent, these non-linear least squares (NLLS) estimates are inefficient. As McCrae points out, the $\underline{\varepsilon}$ will be heteroscedastic. Intuitively, one would expect that the size of the error variance for any equation would be proportional to the area within the size category. Application of NLLS to the model would be expected to undervalue errors on small farm size equations, leading to weak small sample estimates for those equations.

For the present application using census data (i.e., perfectly observed proportions), McCrae shows that the variance of $\underline{x}(t)$ conditional and $\underline{x}(t-1)$, denoted $\Omega(t)$, has typical element:

$$\Omega_{jk}(t) = \sum_{i=1}^{6} - P_{ij} P_{ik} x_i(t-1)/N$$

where N is the total number of hectares to be distributed between the six strata. The corresponding conditional covariance matrix for $\underline{x}^*(t)$ is denoted $\Omega_*(t)$. The non-linear generalized least squares estimator of (4) is thus to minimize the sum over all T observations of

$$(5) \qquad \sum_{t=1}^{T} (\underline{e}_*(t))'[\Omega_*(t)]^{-1} \underline{e}_*(t),$$

where the residual $\underline{e}_*(t) = \underline{x}_*(t) - \bar{P}_*'\underline{x}(t-1)$. In practice, $\Omega_*(t)$ is unknown. Following McCrae an iterative procedure, which uses the NLLS estimates to calculate an initial estimate of the $\Omega_*(t)$ and updates Ω_* on subsequent iterations, was used to calculate the Non-Linear Iterative Generalized Least Squares (NLIGLS) estimates of β.

Finally, to derive the variance-covariance matrix of β, it was noted that (5) can be transformed to conform to the standard NLS model,

$$(5') \qquad \sum_{t=1}^{T} \left(\tilde{e}_*(t)'\tilde{e}_*(t)\right)$$

$\tilde{e}_*(t) = C(t)'e_*(t)$ and the matrix C is the Cholesky decomposition of $[\Omega_x(t)]^{-1}$ such that $C(t)'C(t) = [\Omega_x(t)]^{-1}$. The transformed residual, $\tilde{e}_*(t)$, fulfills the assumptions of the homoscedastic NLLS model, permitting $V(\beta)$ to be derived using the standard NLLS formula. The variance-covariance matrix for the underlying Markov probabilities (the P_{ij}) was derived using a Taylor series approximation.

SECTION 4 1980, 2030 AND BEYOND: ESTIMATES OF THE PATTERN OF STRUCTURAL EVOLUTION

The Markov model outlined in the previous sections was applied to decennial Brazilian agricultural census data for 1940, 1950, 1960, 1970 and 1980. Data are available for each of Brazil's 25 states, yielding a pooled sample of 100 observations on the complete 5 equation model. Estimated parameters thus give the probability that a hectare of land will shift over a ten year period. Tables 1-4 present the estimated probability structures for all Brazil as well as for the three regions defined in Section 1 above. A "pseudo-R^2"11/ is reported for each equation.

Table 1 presents NLLS and NLIGLS estimates calculated on the restrictive assumption that all regions of Brazil are subject to the same evolutionary process. The simple reproduction probablilities, printed in bold faced type, estimate the probability that a hectare of land stays within the same farm size category. As expected, the more efficient NLIGLS estimates improve the pseudo-R^2 on the smaller size categories at the expense of the dominant (in terms of area cultivated) large farm categories. Most remarkable about the NLIGLS Markov matrix is its dearth of non-zero off-diagonal elements. The only structural movement indicated by these estimates is a tendency for new land to enter cultivation, and for farms in the largest size class to shift land to the next smallest farm size category. However, given the heterogeneity of Brazil's agriculture, the apparent structural stasis may simply be a result of averaging disparate regional patterns.

Tables 2-4 present separate NLIGLS estimates for the Northeast, South and Frontier regions, respectively. The Northeast, as the prototypical bimodal region of Brazil, shows little sign of structural change. The smallest size categories are estimated to reproduce themselves with probability one. As with the Brazil-wide estimates, the largest estates are shown to be breaking down, with a 12% probability that land in that class will over ten years shift to either a 10-50 or a 50-500 hectare farm.

The Table 3 estimates for South Brazil, which has been identified as an area of capitalized family farming, contrast markedly with the Northeast estimates. None of the diagonal simple reproduction probabilities exceed 93%. Structure is much more fluid. The point estimates for the two smallest farm size classes indicate that 20% to 25% of the area in these strata would be expected to be subsumed into larger farms over a ten year period.

In the Frontier region, the probability of a small semi-proletarian or peasant farm simply reproducing itself over a ten year period is only 20%. Land in these farms is estimated to shift toward the 50-500 and greater then

500 hectare farm size classes. It is also estimated that newly cultivated land primarily enters farms in these two large farm size classes.

The longer run implications of the estimated transition matricies can be examined by calculating the future agrarian structure they imply. These structural projections, calcualted as

$$(P^{t/10})'\underline{x}(1980),$$

(where t is the length of the projection and $\underline{x}(1980)$ is the 1980 distribution), assume that the estimated Markov processes remain stationary over the projection period.[12/] The lower panels of Tables 2-4 present 50 and 500 year projections along with the the actual 1980 distributional data. Area distributions have been normalized so that they represent the percent of agricultural area contained in each size strata. The figures in square brackets give the percent of total surface area, farm and non-farm, contained in the strata. Farm unit distributions which correspond to the area projections have been calculated on the assumption that average farm size in each class remains constant over time. Also calculated is the implied net entry or exit of farm units in each size class for the 2030 projections. The percent of land not under agricultural use is also presented as the last column in each table. Figures 2-4 graphically present the actual 1980 and the projected 2030 distributions.

These projections strongly confirm the hypothesis of persistant bimodalism for Brazil's Northeast. After 50 years, two thirds of farm units are estimated to be below 5 hectares in size, while the two largest farm strata would still contain nearly 75% of agricultural area. The decline in farm area within the greater than 500 hectare latifundia category reflects the entrance of new land into the other size categories, rather than an absolute shrinkage of the latifundia sector. Projected forward 500 years, the latiafundia sector does disappear although the basic bimodalism remains. While these long term estimates are probably not very useful as projections per se (as the assumed stationarity of the Markov process is a less credible assumption as the projection period becomes longer), they do summarize the forces at work within the present historical moment.

The implications of the fluid Markov matrix for South Brazil become clearer with the projections. Over the fifty years to 2030, the 10-50 hectare capitalized farmily farm sector (CFF) grows steadily picking up proportinately a bit more area and, with 262,000 new farm units, comes to contain 55% of all farms in the region. At the same time, land in the smallest farm strata is subsumed into larger production units at a rate which implies the dissappearance of 138,000 semi-proletarian and peasant farms. Continuation of this pattern of structural evolution for 500 years would create a CFF strata containing 75% of farm units and 31% of farmed area. The virtual dissappearance of small holdings below 10 hectares in the South stands in marked contrast to the Northeast where these small units would still compose 78% of farm units in 2480. Paralleling the growth of the CFF sector in the South is the growth of largest (greater then 500 hectares) category. The 2480 projections thus present a novel form of bi-polarity with the CFF and the latifundia together compromising 78% of units and 84% of the farmed area.

Finally, the estimated Markov process for the Frontier displays a rapid march to large farm capitalism. In fifty years, the largest two strata are projected to include 95% of farm area and approximately half of all farm units. The continued subsumption of the small fry would leads to a pronounced large farm unimodalism by the year 2480.

Finally, Table 5 puts together the all Brazil projections using the regional estimates. Matching the estimated Markov matrix presented in Table 1, the all Brazil distributions shows remarkable stability over time. However, as is now apparent, the static bimodalism at the national level results from the interaction of quite distinct and contrary regional patterns.

SECTION 5 CONCLUSION

Econometric analysis of Brazil brings us to the conclusion that all three competing theories of strucutural evolution are correct, at least to the extent that they do not claim exculsivity for their respective road of evolution. The sharply bimodal structure of the Northeast is highly resillant and lends support to the Kautskian general equilibrium logic discussed in Section 2.3. The capitalized family farm sector more than holds its own in all regions, particularly in South Brazil. In South Brazil, the small farm sector is demolished over time, although the estimates are consistent with the notion that the small farms disapper by growing up and out of the small farm strata. The estimated CFF trajectory in South Brazil could thus be a broadly inclusionary one, rather than one where the total number of farm units falls over time. Finally the estimates for the Frontier imply an inescapable march to ever increasing land concentration in that region. The role of small scale peasant agriculture in the felling of the Amazon would thus seem to be transitory at best.[13/]

In the end, the estimates presented here are primarily descriptive and do not directly identify the particular economic forces which drive structural evolution. But, whatever those forces are, the estimates indicate that they leave space for the growth of medium-sized CFF agriculture, although much less so for traditionally small-scale agriculture. Similarly, there is little evidence that the large scale sectors are being competitively eradicated. To the extent that the bimodalism of the Northeast represents the serious equity and efficiency problems identified by CIDA and other studies, these estimates evidence little hope of change. While a CFF sector does seem capable of growing up in the shade of the traditional bimodalism in the Northeast, the latiafundia themeselves are going nowhere, or at least not very quickly.

TABLE 1

ALL BRAZIL: MARKOV MATRIX ESTIMATES

Non-Linear Least Squares
Estimated 10 Year Transition Probabilities

FROM: \ TO:	0-5 Has	5-10 Has	10-50 Has	50-500 Has	>500 Has	Non-Ag	Pseudo-R^2
0-5 Has	**0.640**	0.010	0.004	0.332	0.005	0.010	0.65
5-10 Has	0.012	**0.618**	0.006	0.273	0.072	0.018	0.57
10-50 Has	0.000	0.000	**0.999**	0.000	0.001	0.001	0.92
50-500 Has	0.000	0.000	0.000	**0.925**	0.075	0.000	0.94
>500 Has	0.001	0.002	0.014	0.090	**0.889**	0.005	0.67
Non-Ag	0.006	0.003	0.011	0.023	0.059	**0.905**	0.58
					Unweighted SSR		0.624

Non-Linear Iterative Generalized Least Squares
Estimated 10 Year Transition Probabilities

FROM: \ TO:	0-5 Has	5-10 Has	10-50 Has	50-500 Has	>500 Has	Non-Ag	Pseudo-R^2
0-5 Has	**0.999**	0.000	0.000	0.001	0.000	0.000	0.86
5-10 Has	0.000	**0.999**	0.000	0.001	0.000	0.000	0.81
10-50 Has	0.000	0.000	**1.000**	0.000	0.000	0.000	0.91
50-500 Has	0.000	0.000	0.000	**1.000**	0.000	0.000	0.94
>500 Has	0.002	0.006	0.007	0.032	**0.953**	0.000	0.65
Non-Ag	0.001	0.000	0.007	0.017	0.046	**0.930**	0.58
					Unweighted SSR		0.652

TABLE 2

NORTHEAST BRAZIL NLIGLS MARKOV ESTIMATES AND PROJECTIONS

Estimated 10 Year Transition Probabilities[1]

FROM: \ TO:	0-5 Has	5-10 Has	10-50 Has	50-500 Has	>500 Has	Non-Ag	Pseudo-R^2
0-5 Has	**1.000^{f}**	0.000^{e}	0.000^{g}	0.000^{g}	0.000	0.000	0.89
5-10 Has	0.000	**1.000**	0.000	0.000^{f}	0.000^{g}	0.000	0.92
10-50 Has	0.000^{d}	0.002^{d}	**0.998^{e}**	0.000^{e}	0.000^{g}	0.000^{g}	0.91
50-500 Has	0.000^{b}	0.000^{b}	0.000^{c}	**1.000^{c}**	0.000^{d}	0.000^{d}	0.96
>500 Has	0.017^{a}	0.011^{a}	0.058^{a}	0.058^{b}	**0.854^{c}**	0.002^{c}	0.52
Non-Ag	0.000^{a}	0.000^{a}	0.000^{a}	0.026^{a}	0.093^{a}	**0.880^{a}**	0.22
					Unweighted SSR		0.102

Actual and Projected Area Distributions[2]

Size Strata

Year	0-5 Ha Area	0-5 Ha Units	5-10 Ha Area	5-10 Ha Units	10-50 Ha Area	10-50 Ha Units	50-500 Ha Area	50-500 Ha Units	>500 Area	>500 Units	Non-Ag Area
1980	.028	.558	.023	.120	.129	.208	.384	.105	.436	.011	
	[.016]		[.013]		[.074]		[.219]		[.248]		[.430]
2030	.048	.613	.035	.117	.186	.190	.435	.075	.295	.005	
	[.037]		[.027]		[.143]		[.335]		[.227]		[.231]
Entry/Exit[3]	1812.7		316.3		418.2		135.4		-2.2		--
2480	.089	.646	.075	.144	.265	.156	.557	.055	.007	.000	
	[.089]		[.075]		[.265]		[.557]		[.007]		[.007]

1. Superscripts in the table indicate the size of asymptotic standard errors (ASE) according to the following scheme: "a": ASE ≤ .05; "b": .05 < ASE ≤ .1; "c": .1 < ASE ≤ .2; "d": .2 < ASE ≤ .3; "e": .3 < ASE ≤ .4; "f": .4 < ASE ≤ .5; "g": .5 < ASE ≤ 1.0; and, no superscript indicates an ASE greater than 1.0.

2. Figures in square brackets give the area in each size strata as a proportion of the total land stock in the region.

3. "Entry/exit" is the net change in farm units measured in thousands of farms.

TABLE 3

SOUTH BRAZIL NLIGLS MARKOV ESTIMATES AND PROJECTIONS

Estimated 10 Year Transition Probabilities[1]

FROM: \ TO:	0-5 Has	5-10 Has	10-50 Has	50-500 Has	>500 Has	Non-Ag	Pseudo-R^2
0-5 Has	**0.755**	0.073	0.000	0.129	0.032	0.010	0.39
5-10 Has	0.000	**0.802**	0.000	0.174	0.022	0.001	0.42
10-50 Has	0.000[b]	0.000[b]	**0.925**[c]	0.007[c]	0.067[c]	0.000[c]	0.81
50-500 Has	0.000[a]	0.001[a]	0.000[a]	**0.903**[a]	0.097[a]	0.000[a]	0.85
>500 Has	0.001[a]	0.001[a]	0.000[a]	0.000[a]	**0.933**[a]	0.064[a]	0.89
Non-Ag	**0.006**[a]	**0.012**[a]	**0.066**[a]	**0.138**[a]	**0.000**[a]	**0.777**[a]	0.03
						Unweighted SSR	0.064

Actual and Projected Area Distributions[2]

Size Strata

Year	0-5 Ha Area	0-5 Ha Units	5-10 Ha Area	5-10 Ha Units	10-50 Ha Area	10-50 Ha Units	50-500 Ha Area	50-500 Ha Units	>500 Area	>500 Units	Non-Ag Area
1980	.009	.194	.021	.171	.169	.446	.395	.172	.405	.018	
	[.007]		[.017]		[.137]		[.321]		[.329]		[.189]
2030	.006	.143	.012	.143	.177	.545	.291	.148	.417	.022	
	[.006]		[.015]		[.177]		[.291]		[.417]		[.095]
Entry/ Exit[3]	-89		-39		262		-32		9.8		--
2480	.004	.084	.011	.080	.305	.755	.143	.058	.537	.022	
	[.004]		[.010]		[.288]		[.135]		[.507]		[.056]

See notes for Table 2.

TABLE 4

FRONTIER BRAZIL NLIGLS MARKOV ESTIMATES AND PROJECTIONS

Estimated 10 Year Transition Probabilities[1]

FROM: \ TO:	0-5 Has	5-10 Has	10-50 Has	50-500 Has	>500 Has	Non-Ag	Pseudo-R^2
0-5 Has	**0.246**	0.009	0.003	0.728	0.004	0.009	0.18
5-10 Has	0.011	**0.185**	0.005	0.693	0.090	0.016	0.10
10-50 Has	0.000	0.000	**0.998**	0.000	0.000	0.000	0.64
50-500 Has	0.000[c]	0.000[a]	0.000[f]	**0.967**	0.033	0.000	0.71
>500 Has	0.000[a]	0.000[a]	0.000[a]	0.026[b]	**0.973**[b]	0.000[b]	0.62
Non-Ag	0.000[a]	0.000[a]	0.002[a]	0.011[a]	0.033[a]	**0.952**[a]	0.38
					Unweighted SSR		0.446

Actual and Projected Area Distributions[2]

Size Strata

Year	0-5 Ha Area	0-5 Ha Units	5-10 Ha Area	5-10 Ha Units	10-50 Ha Area	10-50 Ha Units	50-500 Ha Area	50-500 Ha Units	>500 Area	>500 Units	Non-Ag Area
1980	.002 [.001]	.193	.003 [.001]	.016	.033 [.010]	.315	.206 [.060]	.322	.755 [.219]	.065	[.710]
2030	.001 [.0004]	.077	.001 [.0001]	.041	.040 [.018]	.390	.271 [.120]	.432	.607 [.305]	.060	[.556]
Entry/ Exit[3]	-52.1		-29.4		180.6		217.6		17.2		--
2480	.0001 [.0001]	.008	.0002 [.0001]	.005	.049 [.046]	.405	.400 [.374]	.541	.550 [.514]	.041	[.065]

See notes for Table 2.

TABLE 5

ALL BRAZIL

Actual and Projected Area Distributions[1]

Size Strata

Year	0-5 Ha Area	0-5 Ha Units	5-10 Ha Area	5-10 Ha Units	10-50 Ha Area	10-50 Ha Units	50-500 Ha Area	50-500 Ha Units	>500 Area	>500 Units	Non-Ag Area
1980	.011 [.005]	.367	.014 [.006]	.138	.102 [.044]	.316	.312 [.136]	.160	.561 [.245]	.021	[.564]
2030	.014 [.008]	.407	.014 [.008]	.117	.118 [.070]	.316	.325 [.190]	.143	.529 [.311]	.017	[.413]
Entry/Exit[2]	1395		235		923		328		29		--
2480	.018 [.017]	.435	.017 [.016]	.116	.137 [.130]	.299	.385 [.365]	.139	.442 [.419]	.011	[.053]

1. Figures in square brackets give the area in each size strata as a proportion of the total land stock in the region.

2. "Entry Exit" is the estimated net change in farm units measured in thousands of farms.

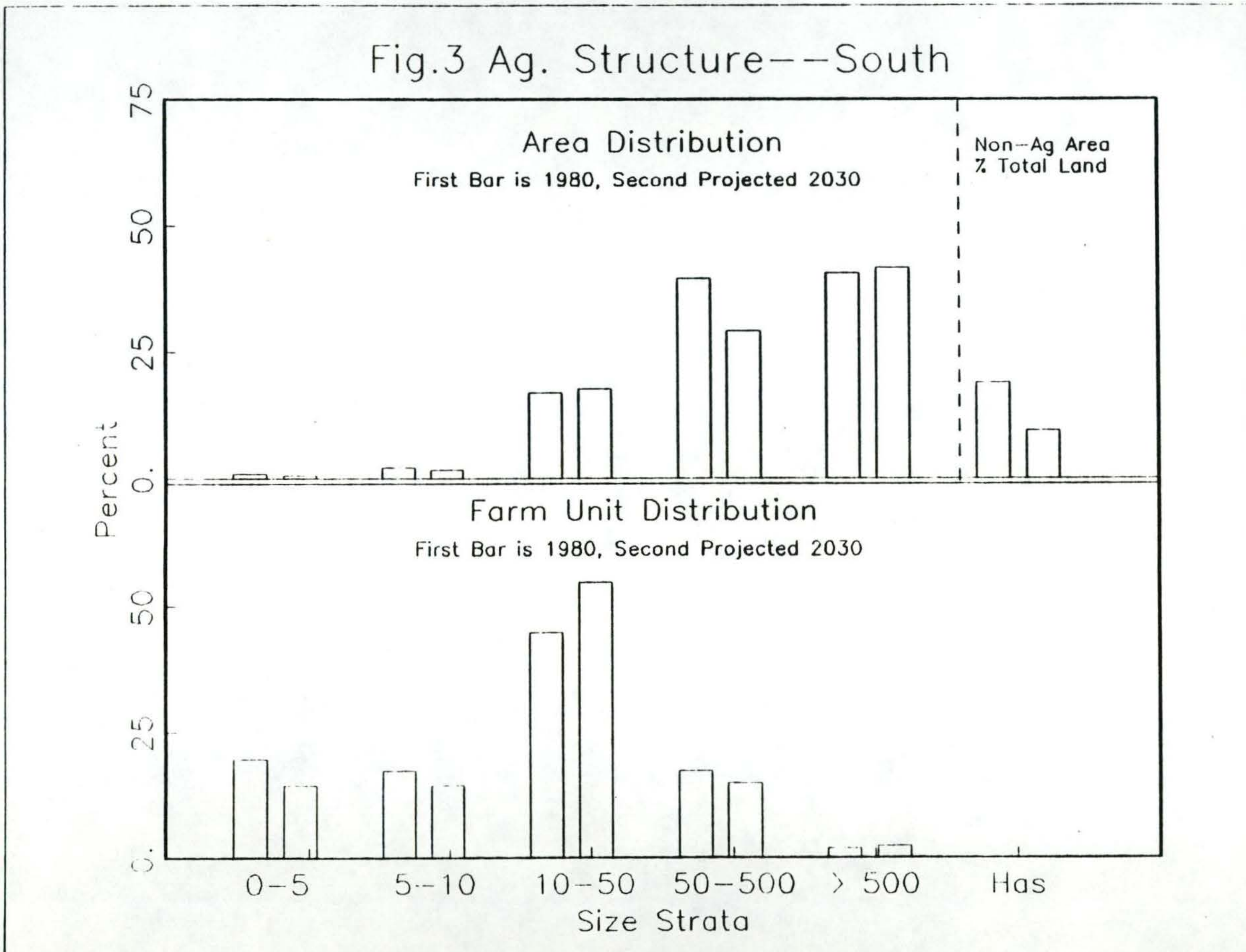

Fig.3 Ag. Structure--South
Area Distribution
First Bar is 1980, Second Projected 2030
Non-Ag Area
% Total Land
Farm Unit Distribution
First Bar is 1980, Second Projected 2030
Percent
75
50
25
0.
50
25
0.
0-5
5-10
10-50
50-500
> 500
Has
Size Strata

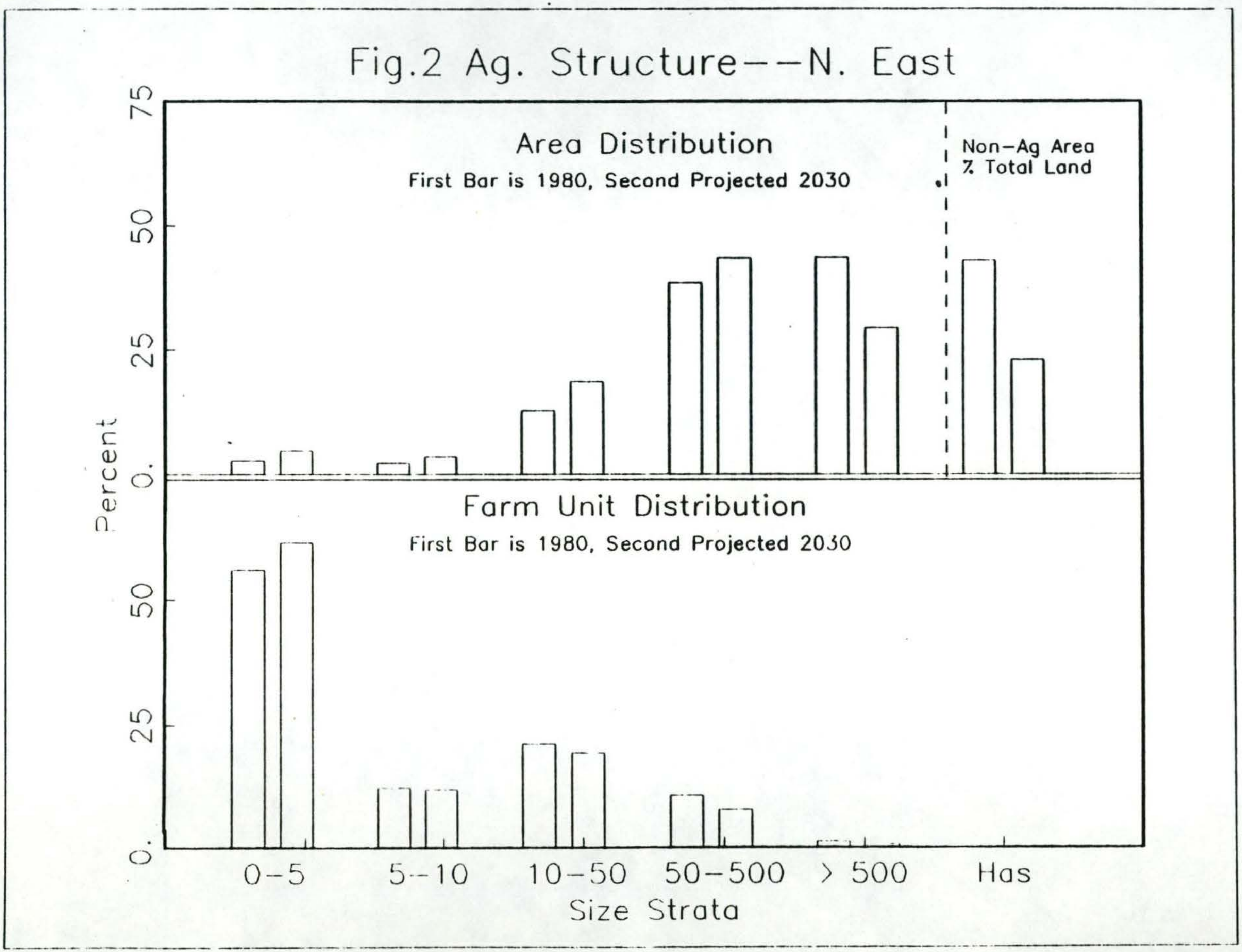

Fig.2 Ag. Structure--N. East
Area Distribution
First Bar is 1980, Second Projected 2030
Non-Ag Area
% Total Land
Farm Unit Distribution
First Bar is 1980, Second Projected 2030
Percent
75
50
25
0.
50
25
0.
0-5
5--10
10-50
50-500
> 500
Has
Size Strata

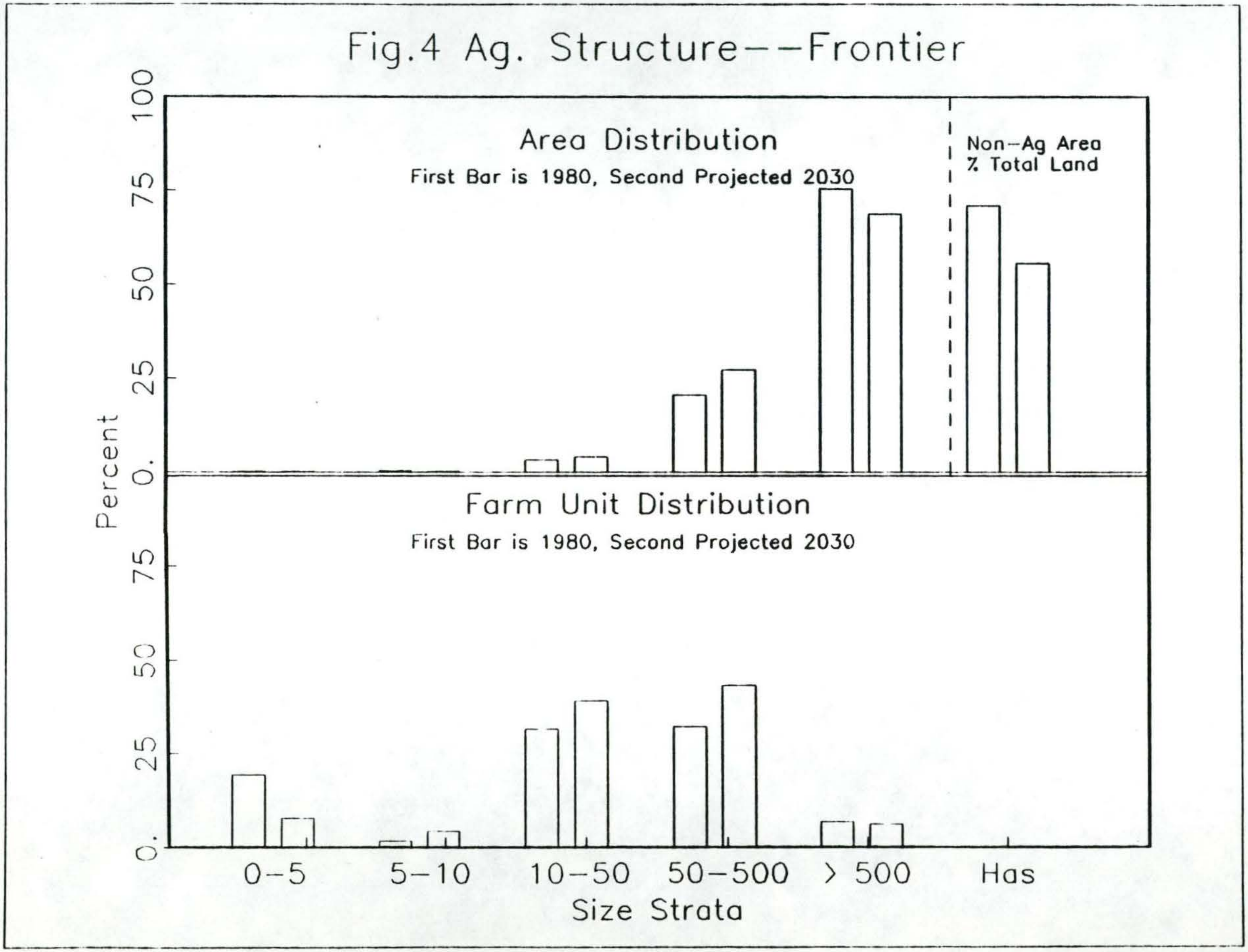

Fig.4 Ag. Structure--Frontier
Area Distribution
First Bar is 1980, Second Projected 2030
Non-Ag Area
% Total Land
Farm Unit Distribution
First Bar is 1980, Second Projected 2030
Percent
100
75
50
25
0.
75
50
25
0.
0-5
5-10
10-50
50-500
> 500
Has
Size Strata

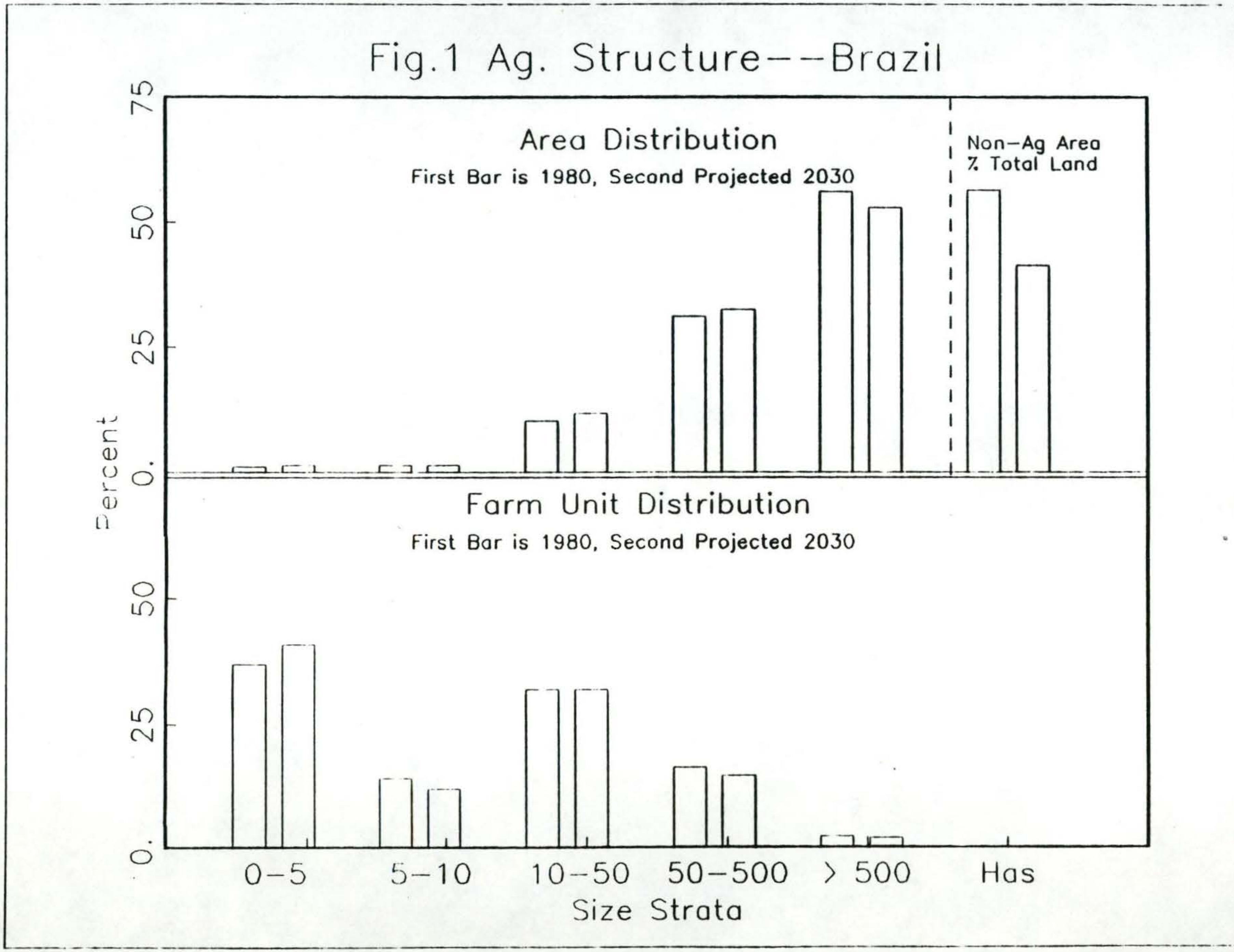

Fig.1 Ag. Structure--Brazil
Area Distribution
First Bar is 1980, Second Projected 2030
Non-Ag Area
% Total Land
Farm Unit Distribution
First Bar is 1980, Second Projected 2030
Percent
75
50
25
0.
50
25
0.
0-5
5-10
10-50
50-500
> 500
Has
Size Strata

NOTES

1/ As is discussed below, recent theories of the emergence of a dominant small and medium sized farm sector are unclear in terms of whether they are to be understood as fundamentally egalitarian or inegalitarian.

2/ The CIDA indictment indicates that property rights "matter" for more than purely distributional considerations. In terms of competitive general equilibrium theory, property do not matter in the transaction costless world of the first welfare theorem. That property rights so matter indicates the market failures of a second best world and the absence of what Carter and Kalfayan (1988) call super scale neutrality.

3/ Despite these labels, it would be incorrect to simply equate to simply think of these positions as reflecting the Lenin, Kautsky and Chayanov views. Lenin expounded an American or farmer road to agricultural capitalism, a fact which has been of great comfort to some proponents Bimodal and peasant capitalism. The work of Chayanov on peasant resource allocation has become particularly important to Kautskian theoreticians, and even offers insights relevant to the Leninist large farm position. (Banaji 1976 makes this latter point at the same time that he notes that the Lenin's classic statements completely lacked microeconomic content, creating a vacuum which Chayanov's work can fill.)

4/ Strictly speaking, these policies would seem to promote the formation of large ownership units. The distribution of operational units would depend on the interaction of the ownership distribution with labor, land rental and secondary capital markets. Neither Binswanger nor Graham et. al. indicate why the structural implications of these ownership incentives are not mutated by secondary transactions, although one can imagine a series of market failures which might inhibit them.

5/ From a political economy point of view, however, one might argue that such policy biases are anything but arbitrary and reflect the systematic power of large scale farming classes (e.g. see de Janvry, Sadoulet and Faufchamps 1987).

6/ Feder (1985) and Carter and Kalfayan (1988) analyze this interplay in formal models of agrarian structure.

7/ He identifies privileged access to extended family labor as a key factor which establishes the initial economic viability of small scale agriculture. Lehman argues that the capitalization and take-off of such units is powered by "agricultural ladder" devices like sharecropping which make capital available to new, young upwardly mobile farmers.

8/ The precise scale of these units is unclear. Scott (1985), summarizing and FAO sponsored workshop, refers to a sector of middle-sized producers (sector de mediano produccion, SMP). Besides not being large by the standards of Latin American haciendas, a defining characteristic of these farms would seem to be heavy dependence of family labor and machinery rather than wage labor.

9/ To the other structural theories discussed above, such producers are a potentially embarrassing anomaly. The hypothesis of viable capitalized family farming is an explicit effort to rationalize the existence of small scale producers who not only fail to disappear, but who actually seem to prosper in the shade of large farm agriculture. Scott (1985) summarizes an impressive array of empirical data which testify to the importance of the non-large farm sector across the continent.

10/ Lehman (1982a) tends to completely discount the importance of the cheap labor aspects of the bi-modal theory, apparently rationalizing persistent structural dualism in terms of the poverty refugee hypothesis. De Janvry (1981) seems to unambiguously claim that the semi-proletarian subsidy applies.

11/ The pseudo-R^2 is calculated as one minus the ratio of the unweighted sum of squared residuals for each equation to the total sum of squared deviations of the dependent variable around its mean.

12/ The largest eigen-value for a Markov matrix is one. The corresponding eigenvector, $\underline{v}$, will satisfy $(P)'\underline{v} = \underline{v}$--i.e., it is a steady state distribution. It can also be shown that the distribution under the Markov process will converge to $\underline{v}$ (see Strang 1980). Limiting distributions were calculated here. In all but one case, these were very close to the 500 year projections. For the exceptional case, a small off-diagonal element drove the limiting distribution to an unusual position. The 500 year projections were chosen as more representative of the process.

13/ Bakx (1988) argues that whether small holders survive in the Frontier or not depends on the interaction of social, economic and political factors. He goes on to identify examples and circumstances where small scale producers have in fact survived in a competitive economic environment in the state of Acre.

REFERENCES

Alavi, (1987). "Peasantry and Capitalism: A Marxist Discourse," in T. Shanin (ed) Peasants and Peasant Society (Oxford: Basil Blackwell).

Bakx, K. (1987). "From Proletarian to Peasant: Rural Transformation in the State of Acre, 1870-1986," Journal of Development Studies

Barraclough, S. and A. Domike (1966). "Agrarian Structure in Seven Latin American Countries," Land Economics 42 (November):391-424.

Binswanger (1987). "Fiscal and Legal Incentives with Environmental Effects on the Brazilian Amazon." World Bankd Discussion Paper, ARU 69.

Brewster, John (1952). "The Machine Process in Agriculture and Industry," Journal of Farm Economics 32 (February).

Carter, Michael R. (1988). "Equilibrium Credit Rationing of Small Farm Agriculture," Journal of Development Economics.

Carter, M.R. and J. Kalfayan (1987). "An Economic Model of Agrarian Structure in Latin America," U.W. Ag Economics Staff Paper 279.

de Janvry, A. The Agrarian Question and Reformism in Latin America. Baltimore: Johns Hopkins University Press, 1981).

de Janvry and Garramon (1977). "The Dynamics of Rural Poverty in Latin America: An Interpretation," Journal of Peasant Studies 4 (April):206-216.

Denslow, D. and W. Taylor (1984). "Perspectives on Poverty and Income Inequality in Brazil," World Development 12(10).

Eswaran, M. and A. Kotwal (1985). "A Theory of Contractual Structure in Agriculture," American Economic Review 75 (June).

----- and ----- (1986). "Access to Capital and Agrarian Production Organization," Economic Journal 96 (June).

Feder, G. (1985). "The Relation between Farm Size and Farm Productivity: The Role of Family Labor and Capital Constraints," Journal of Development Economics 18.

Grahm, D., H. Gauthier and J.R. Mendonca de Barros (1987). "Thirty Years of Agricultural Growth in Brazil: Crop Performance, Regional Profile and Recent Policy Review," Economic Development and Cultural Change 36(1).

Hall, A. (1987). "Agrarian Crisis in Brazilian Amazonia: The Grande Carajas Programme," Journal of Development Studies

Haller, A. (198?). "A Sociio-Economic Regionalization of Brazil," Geographical Review 72(4) (October).

Kautsky, K. (1976). "," Economy and Society 7.

Kay, C. (1980). "The Landlord Road and the Subordinate Peasant Road to Capitalism in Latin America," Etudes Rurales (January-March):5-20.

Lehman, D. (1982a)."Beyond Lenin and Chayanov: New Paths of Agrarian Capitalism." Journal of Development Economics 11 (1982): 133-161.

----- (1982b). "Peasantization and Proletarianisation: Recent Agrarian Changes in Brazil and Mexico," in S. Jones P.C. Joshi and M. Murmis (eds.) Rural Poverty and Agrarian Reform (Bombay: Allied Publishers).

----- (1986). "Two Paths of Agrarian Capitalism: A Critique of Chayanovian Marxism," Comparative Studies in Society and History (October).

Maybury-Lewis, B. (1988). "The Debate over Agrarian Reform in Brazil" Paper presented at the Latin American Studies Association Annual Meeting, March, 1988, New Orleans, LA USA.

McCrae, E.C. (1977). "Estimation of Time-Varying Markov Processes with Aggregate Data," Econometrica 45 (January):183-198.

Sampaio, Y. (1985). "Consequencias de estrutura Agraria no Processo de Desenvolvimento Socio-Economico do Nordeste," Discussion Paper 164, Economics Faculty, Univerdidade Federal de Pernambuco.

Scott, C. (1985). El Ascenso de la Mediana Produccion en la Agricultura Latinoamericano. (Rome: FAO, Taller sobre el ascenso de la Mediana Produccion en la agricultura Latinoamericana)

Strang, G. (1980). Linear Algebra and Its Applications. (Orlando, Florida: Academic Press).

Thiesenhuesen W.C. and J. Melmed-Sanjak (1988). "Brazil's Agrarian Strucutre: Changes from 1970 through 1980," Unpublished paper, Land Tenure Center, University of Wisconsin-Madison.

Tollini, H. and A. Vega (1985). "El Campesino sin Tierra en Brasil," mimeo (Brasilia).