Can Time and Markets Eliminate Costly Land Ownership Inequality?*

Michael R. Carter
University of Wisconsin-Madison
USA

and

Frederic Zimmerman
University of Washington
USA

April 2000

Paper prepared for the Annual Bank Conference on Development Economics
18 –20 April 2000

* This paper assembles and summarizes a number of the authors' writings. As such, it is indebted to a long list of individuals and institutions who have supported us over time. Particular thanks are due to the John D. and Catherine T. MacArthur Foundation and to the IRIS research program at the University of Maryland. An earlier version of this paper was presented to the conference on Asset Distribution, Poverty and Economic Growth, Brasilia, July 1998.

Can Time and Markets Eliminate Costly Land Ownership Inequality?

In no region of the world has land ownership inequality been starker and more persistent than in Latin America. The Barraclough studies of the 1960s (summarized in Barraclough 1967), exhaustively documented this persistent status quo. What Coles (1994) calls the "land reform period" of Latin American agricultural policy was intended as (or, more cynically, intended to appear as) a frontal assault on what was perceived as an economically, socially and politically costly inequality.

Times of course change, and irrespective of whether we have witnessed the death of land reform as conventionally known (see Lipton, 1994 versus Lehman, 1978), there can be little doubt that agricultural policy regimes across Latin America have shifted to a more open and liberal stance. New markets, technologies and exports have accompanied this opening, and property rights and land markets have in many cases been secured and de-regulated in an effort to secure investment incentives and promote efficiency-seeking transactions even as fiscal austerity has overseen the demise of public agricultural banks and extension services.

The impact of these changes on land ownership structure (and on the old "agrarian question" about the fate of the peasantry) has been ambiguous. An early optimism that the fiscal exhaustion of the interventionist state would generate less distorted prices and open the space for the less well-off to participate directly in the benefits of growth (see de Janvry and Sadoulet 1993), has given way to a more sanguine view of the constraints that limit the participation of the peasantry in these new economic opportunities. Studies of agro-export booms in Chile, Guatemala and Paraguay (summarized in Carter, Barham and Mesbah, 1995 and Carter and Barham, 1996) identify a pervasive effect of capital constraints on the participation of the peasantry, leading either to what in Chile has been called an "exclusionary growth" trajectory, or to growth that is muted in its impacts on the income and wellbeing of the less well-off.

Against this backdrop of old questions and new realities, we turn in this paper to dynamic models of savings and asset accumulation to see what we know and can say at a theoretical level concerning the post-liberalization persistence of economically costly land ownership inequality. More specifically, we ask if time and land asset markets are allies in the search for what Birdsall *et al.* (forthcoming) call inequality-reducing growth strategies.

Getting the answer right to this question is vital from a policy perspective. In Mexico, Honduras, and Nicaragua, the answer would speak directly to concerns about the short and medium term distributional consequences of recent reforms that have liberalized land law and opened up the land market in agrarian reform sectors. In Brazil, Colombia and that most structurally Latin American of African countries, South Africa, active efforts are underway to actively utilize the land market as part of negotiated or market-assisted land reform programs. In these countries as well, a correct understanding of time and markets is vital to the success of these programs.

This paper's theoretical exploration of time, the market and the agrarian question is organized into three sections. The first puts forward a single period production model that highlights the forces that shape production and land use decisions which are important part of the asset value of land, specifically the interactions between informationally-constrained labor and capital markets. In order to capture the wealth heterogeneity that rests at the core of the agrarian question, the model is analyzed over a two-dimensional endowment space that highlights what might be termed (endogenous) class differences in the use and productive returns to land.

The paper's second section then presents Carter and Zimmerman's (forthcoming) analysis savings and asset accumulation in an inegalitarian agrarian economy that is built upon the base of that model. Their numerical analysis of the resulting dynamic, general equilibrium model finds that indeed time and markets steadily erode the *latifundia* sector in this model, despite the barriers that confront land accumulation by low wealth agents. However, convergence to a more egalitarian economy is both slow and costly in economic terms. Moreover, this convergence takes place in an economy which has been shorn of the risk that many authors (e.g., Braverman and Stiglitz, 1989) have hypothesized blunt the accumulation of the peasantry.

To gain insight on this problem, Section 3 then presents results from Zimmerman and Carter's (1999) dynamic programming analysis of the impact of both production risk and endogenous 'asset price' risk on consumption smoothing and asset accumulation decisions. Calibrated on the risky environment of West Africa, this second dynamic analysis issues a strong cautionary note about the ability of time and the market to eliminate costly asset inequality. Finally, section 4 summarizes the paper's implications for research, policy and politics.

Section 1 Production and Accumulation Incentives in a Single Period Model of an Inegalitarian Agrarian Economy

This section lays the groundwork for our exploration of the persistence of inequality by laying out a static model that captures important features of technology and labor and capital markets that have been hypothesized to shape the competitiveness of different classes of producers and the evolution of Latin American agrarian structure (e.g., see Scott, 1985). As a prelude to the later dynamic analysis of the land accumulation and structural evolution question, this section also uses this static framework to derive clues about the impact of these features on the accumulation incentives of the different economic classes implied by the model.

1.1 Production and Class in an Inegalitarian Agrarian Economy

Given endowments of land (T), Labor (L^0), and money (M), we assume that each agent attempts to maximize household income defined as:

$$\pi \equiv \{ p_c Q - w L^d - F\, P_f - 1[z + irB] \} + \{ w\phi(L^s)\} + \{ irS \} \qquad (1)$$

where the first term in curly brackets gives the net-income from agricultural production, the second term gives labor market earnings, and the third gives returns to money invested in a bank over the production cycle. Agricultural output is produced with a simple Cobb-Douglas technology,

$$Q = DF^{\alpha} T^{\alpha} L^{\alpha} \qquad (2)$$

where F measures inputs purchased at a price P_f, T is the land stock, and L is labor measured in quality-adjusted, efficiency units. Efficiency labor is produced according to the following technology:

$$L = L^h + \lambda[\gamma(T, L^h)L^d] + [1-\lambda][-\nu(L^d) + \gamma_0 L^d] \qquad (3)$$

where L^h is family labor devoted to home production, L^d is hours of hired labor and the endogenous indicator variable λ takes the value of 1 if the household uses informal, family labor supervision and equals one if the agent formally supervises its labor force with hired supervisors. The employment function, $\phi(L^s)$ gives days employed as a function of days of labor supplied to the off-farm job market. We assume that $\phi(L^s) \to L^s$ as $L^s \to 0$, and that $0 < \phi' < 1$ to capture the notion that employment becomes increasingly difficult to obtain as increased desire to sell labor forces one to search for employment in the slack season.

Maximization of (1) is further constrained by an *ex ante* working capital constraint:

$$wL^d + P_f F + P_c R_0 \leq M - S + w\phi(L^s) + 1[B - z] \qquad (4)$$

which simply says that the agent needs sufficient cash on hand to finance cash costs of production plus family subsistence over the rainy season $(P_x R_0)$.[1] Working capital can be obtained from money that is not saved $(M\text{-}S)$, from contemporaneous off-farm wage earnings, and from the net proceeds of any loans taken out by the household, $l[B\text{-}z]$, where B is the gross loan amount, z is a fixed transaction cost and l is a indicator taking the value of one if B is positive. Finally, each agent faces a borrowing ceiling tied to the amount of land owned,

$$B \leq \beta T\ , \qquad (5)$$

and the following miscellaneous non-negativity restrictions:

$$(L_0 - L^h - L^h), S, L^d, B \geq 0 \qquad (6)$$

The agents objective is thus to maximize (1) subject to (2)-(6) and we denote the optimum value function corresponding to this problem as $\pi^*(T, M)$ to emphasize its dependence on endowments.

This income maximization problem gives prominence to the intrinsic (asymmetric information-based) capital and labor market imperfections that have been extensively discussed in the context of developing country agriculture. The working capital constraint (3) makes the specification of the rules of access to capital of primary importance. While some would argue that because of asymmetric information, small farmers are completely rationed out of credit

[1] Although this consumption requirement constrains farmers in their use of money for production, we have adopted the conservative assumption that it does not bind on the intertemporal accumulation problem: households can choose to spend up to their full agricultural income acquiring land. In the numerical parameterization of this model, the wage is high enough so that even a full time wage worker can meet the subsistence requirement.

markets (e.g., see Eswaran and Kotwal, 1986 and Carter, 1988), we more conservatively assume that all agents have equal access to credit at a given market rate of interest. Borrowers do, however, face a fixed transactions cost, *z*, that is associated with the cash and opportunity costs of loan application, investigation and approval. The fixity of *z* makes small loans unattractive for all agents (rich or poor). Note that because of these transactions costs and the consequent reluctance of some agents to borrow, the shadow price of the working capital constraint (3)—which we denote as μ—will endogenously vary over the endowment space even though there is a parametrically given market rate of interest.

The second feature of the production problem is that output depends on inputs of labor effort, not just labor time. The non-contractability of labor effort in spatially disperse, biologically based production process has a long history in agricultural economics (e.g., see Brewster, 1950), and we follow Bowles (1985) in specifying labor extraction technologies (2) that transform labor power or time into labor effort. Family labor may be used for supervision, but consistent with the findings of Frisvold (1994), the efficacy of family labor supervision diminishes as farm size grows and family labor becomes spread too thinly over a large area. Specifically we assume that $\gamma(T, L^h) < 1$ and that $\partial\gamma/\partial T < 0$. Because of the diminishing efficacy of informal, family labor supervision, larger farmers are thus likely to switch to hierarchical supervisory technology, thereby releasing the farm-size constraint on labor extraction, but adding significantly to labor costs (Bowles, 1985; Carter and Kalfayan, 1989).[2] Like hired labor supervised informally, hierarchically supervised hired labor is never more productive than family labor ($\gamma_0 < 1$) and we assume further assume that the supervisory costs, $\nu(L^d)$, contains both a fixed and a variable component.

As with the shadow price of capital, the combined effects of this labor market specification is to make the effective or shadow price of labor endogenous to the individual's choices and, ultimately, their endowments. The end result is an analogue to the Chayanovian world in which the opportunity cost of labor is subjectively (or endogenously) determined. While the more recent literature on household models has tends to characterize an endogenous shadow price of labor as reflecting a non-seperarability between consumption and production decisions (e.g., see Singh, Squire and Strauss, 1986), it results here, as in those household models, from the fact that labor markets are thin or otherwise imperfect.

Maximization problem (1) admits a variety of solution regimes, depending on which constraints bind at the optimum. The labor and capital market imperfections that lie at the heart of the production model create the differentiated shadow prices for capital and labor for each of these regimes. Because these marginal shadow prices guide variable input choice, they shape the marginal income that an agent would receive from an incremental increases in either land or money endowments. An agent with access to effectively cheap labor and capital will obviously cultivate an incremental unit of land more intensively, and realize greater income increases with it, than would an agent with correspondingly higher priced variable factors of production. Other

---

[2] In addition, agents wishing to hire out their labor must pay a search cost in terms of time that is related to the amount of time they wish to sell. Without this assumption, the shadow price of labor would be constant for households that do not hire in labor. With this assumption, the shadow price of labor for non-labor hiring households increases with farm size and decreases with family size similar to a Chayanovian specification.

things equal—and leaving aside for the moment the strategic complexities of dynamically rational decisionmaking—we might expect the first agent to be willing to pay more than the high cost second agent for the incremental unit of land.

There is, however, no easy way of unambiguously determining which agents and classes have access to the cheapest factors of production. The labor market failures tend to advantage agents with low land endowments. It is precisely this privileged access to cheap family labor that led Chayanov and latter day advocates of family labor farms, to postulate the long term stability of peasant farming. However, standing against this "Chayanovian advantage" are the fixed transactions cost in the capital market which tend to increase the shadow price of capital for smaller scale producers. Such countervailing disadvantages seem to underlie the view of Patnaik (1979) who disputes the notion that peasant poverty and weak labor market opportunities suffice to make small-scale producers for long term expansion and survival.

1.2 Insights from the production model about the economics of accumulation in inegalitarian agrarian economies

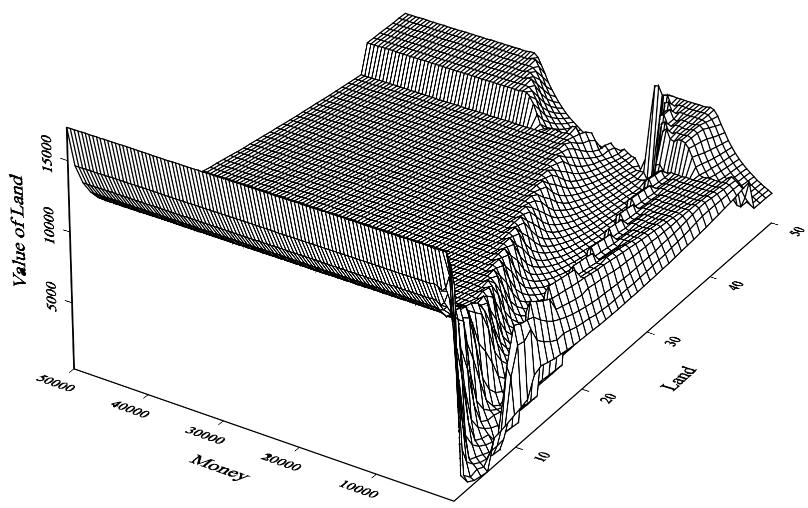
One way to explore these countervailing market failures and aggregate their cross-cutting economic impacts is to examine the marginal net present production value (NPPV) of land defined as:

$$\rho = \sum_{t=1}^{\infty} [\Delta(T,M)]/(1+\mu(T,M))^{t} \qquad (8)$$

where $\Delta = \partial\pi^*(T,M)/\partial T$ and the discount rate, μ is the shadow price of the capital constraint given in expression (3) above. Note that this expression will not in general be independent of relative factor prices and technology, as these two things effectively shape how costly any particular market failure is. As written, expression (8) assumes that prices and technologies persist indefinitely into the future.

Using the numerical specification of the production model detailed in Carter and Zimmerman (1998) and the prices from the final period of the dynamic simulation to be discussed below, Figure 1 graphs expression (8) evaluated over the same endowment or state space defined by the asset variables *T* and *M*. Reflecting the Chayanovian advantage of small scale producers, the net present production value of land is very high for very small land endowments regardless of the money endowment. However, a land-poor agent with little financial wealth who tried to accumulate land would quickly run into the trench that cuts across the NPPV surface. This trench corresponds to a band of capital-constrained classes. For agents in the trench, the shadow price of capital is extremely high (as they neither have the funds to self-finance production, nor is it worth their while to borrow given transactions costs), and their resulting factor intensities and productivities are low. Assuming a market price above the level of the trench (which it is in the dynamic simulation below), any agent traversing the trench through land accumulation will not only have to sacrifice current consumption, they will also have to sacrifice some future income as well given that the land price will exceed the NPPV of the land obtained.

Figure 1: Net Present Production Value of Land



This trench, and the interacting market imperfections that underlie it, thus stand as non-trivial barriers to land accumulation by low wealth agents and to the elimination of economically costly asset inequality. At best strategies to traverse the trench, or to circumnavigate it, may take substantial time and sacrifice of consumption. Whether or not agents will find it worthwhile to undertake such sacrifice requires proper specification of the dynamic choice problem to which we now turn.

Section 2 Time and the Persistence of Costly Inequality in an Economy without Risk

Is time a powerful enough alley to permit low wealth agents to breakdown a costly, inegalitarian land ownership structure in the face of the interacting multiple market imperfections? To gain insight on this question, this section uses the static production structure detailed in the prior section as the base for a dynamic model of accumulation and structural evolution. The emerging literature on dynamic models of wealth distribution has also begun to explore similar issues. Aghion and Bolton (1997), for example, develop a model in which a lucrative (but risky) activity is available to those who can finance the investment costs. Since the rich are more likely to have a larger portion of the cost of capital, they are more likely to be able to borrow the remainder at a lower interest rate. While the rich thus get richer initially, the cost of capital to the poor declines, and the distribution of wealth can actually become more equal over time.[3] Banerjee and Newman (1991; 1993) present models in which agents have a choice of occupations, ranging from subsistence *rentiers* to labor-hiring entrepreneurs. The choice each agent makes depends either on capital endowments (Banerjee and Newman, 1993) or on willingness to bear risk (Banerjee and Newman, 1991). Because both of these factors are assumed to depend on inheritance, these models create an intertemporal link between current income and future production that tends to perpetuate inequality. Similarly, Galor and Zeira (1993) allow agents to invest in education, a lumpy investment with a high return. Because of capital market imperfections, educational investment depends on initial wealth endowment, and the current wealth distribution has an effect on both future wealth distributions and present and future aggregate output.

These models reveal that a financial market imperfection can create a link between the structure of the economy and its long term performance, even when it is possible for agents to accumulate the assets for which there are imperfect markets. Several of the authors suggest policy implications along the lines of asset-redistribution or tax policy that can improve economic performance, although the policy implications are not always clear. However, a major shortcoming of this literature is that the accumulation decisions of the agents (or lineage dynasties) are not intertemporally rational. In Banerjee and Newman (1991; 1993) agents' bequests are governed not by the effect of the transfer on children's utility, but on a "warm glow" that parents feel from giving. Parents may therefore over- or under-endow children relative to what their accumulation decisions would have been for themselves had they lived longer. Similarly, Piketty (1997) assumes that bequests are a fixed fraction of income, while Aghion and Bolton (1997) don't allow accumulation at all. Moreover, the models are not equipped to explore the potentially significant effects of the changes in equilibrium prices. Yet as endowments change and some factors become more or less scarce, the prices of these and other factors are bound to change in response. Full intertemporal rationality would require that agents recognize and account for this endogenous evolution in factor prices as they make accumulation decisions.

2.1 A Dynamic Programming Model of Land Accumulation and the Agrarian Question

In order to more fully explore the incentives to use intertemporal accumulation to work around imperfect financial markets, Carter and Zimmerman (forthcoming) analyze the following infinite horizon problem:

$$\begin{aligned} &\max U_0(\underline{c}) = \sum_{t=0}^{\infty} \delta^t u(c_t \mid \underline{P}_T, \underline{p}) \\ &s.t. \\ &c_t + (M_{t+1} - M_t) + (T_{t+1} - T_t)P_{T_t} \leq \pi_t^*(M_t, T_t, L_0 \mid p_t) \quad (\forall t) \end{aligned} \tag{9}$$

[3] Piketty (1997) models a related scenario under which a high probability of project failure and scant aggregate working capital can trap the economy in a situation in which high initial interest rates ration out a large proportion of the population and aggregate growth is too low to ever build up sufficient capital to lower the interest rate.

where c_t is consumption in period t, L_0 is the fixed family labor stock, the accumulable assets T (land), M (money) are the state variables, P_T is the (endogenous) asset price of land and p_t is the vector of endogenous non-land factor prices. The terms $\underline{c}$, $\underline{P}_T$ and $\underline{p}$ represent streams of these variables into the future. The prices are expected future prices. In addition to these endogenous prices, there is one important difference between (9) and the canonical Ramsey optimal savings problem. Whereas the right hand side of the budget constraint for the Ramsey problem is linear and additively separable in assets (*e.g.*, it would be $M_t + P_{T_t} T_t + wL_0$ in the current 3 asset model), here the returns to any particular asset combination are given by the generally non-linear and non-separable value function, $\pi_t^*(M_t, T_t, L_0 \mid p_t)$ that is defined by optimal resource allocation in the face of imperfect capital and labor markets.

The theoretical challenge is thus to merge a non-separable income generation-process with a model of intertemporal decision-making that is fully faithful to the rationality of agent behavior and expectations. The approach to be taken here is similar to a multi-period CGE model except that asset accumulation is intertemporally rational at the household level and all agents hold rational expectations about future price trajectories. Because we model production decisions to be separable from consumption and accumulation decisions, we can split each time period or year into two seasons: A production season in which short term variable factors are allocated to production; and, a post-production consumption and accumulation season.

At the beginning of each production season, agents have predetermined (but ultimately endogenous) endowments of land and money. They maximize profits through borrowing, labor allocation and variable input ("fertilizer") decisions. In so doing, they determine aggregate demand and supply for factors and goods. Following a standard Walrasian *tâtonnement* process, the production season model iterates on the model's endogenous factor prices (for labor and fertilizer) until agents' choices are mutually consistent in the sense that supply equals demand in input markets. Production occurs, completing the production season.

Once incomes have been realized, agents make consumption and accumulation decisions according to optimization problem (9). Choices in this season depend on both the current land price and on the sequence of future prices for land and the variable factors of production. Initially agents are given a set of arbitrary (but reasonable) expectations for the future price sequences. Conditional on those future price expectations, a post-harvest season *tâtonnement* process is used to adjust contemporaneous land price so that the land market clears in every period based on the net demands for land defined by the solution to (9). Once that market-clearing price is found, consumption and accumulation decisions are made and agents' holdings of land and money holdings are updated accordingly. The economy then enters a new production period. Repetition of this process for n periods creates an n-period history that is conditional on the initial expectations about the future price sequences.[4]

[4] Note however that the market clearing prices that emerge each period over the course of the n-period history may not correspond with the prices that were expected for that period according to the initial expectations used to generate the sequence. It is part of the computational challenge and the methodological contribution of this paper to assure that they do. To implement fully dynamically rational behavior and expectations, the full n-period history is then itself iterated. The sequence of equilibrium asset and factor prices that emerged in the first iteration of the n-period history is used as the base for the price expectations for the second iteration. More generally, history k begins with price expectations built around the sequence of equilibrium prices generated by history k-1. This iterative

Corresponding to the infinite-horizon problem (1) is the true value function,

$$J^*(T_t, M_t) = \max_{\{T_{t+1}, M_{t+1}\}} \{u(c_t) + \delta J^*(T_{t+1}, M_{t+1})\} \tag{10}$$

which expresses directly the tradeoffs between current consumption and the value of accumulating the state variables, land and money. Understanding how the value of $J^*(T,M)$ changes over its domain helps in understanding the structural evolution generated by the model's multiple market imperfections. Like the net present production value (NPPV) measure (8) examined in the previous section, the true value function is defined over the endowment or state space. But whereas the NPPV measure captures the value of accumulating land at the margin and holding just that increment forever, the true dynamic value of accumulating land supplements the valuation of this direct benefit flow with the strategic value of land: having more land makes it easier to acquire yet more land. When returns to land are constant this distinction is unimpressive. However, in a model of multiple market imperfections, in which the NPPV of land is highly non-linear as in Figure 1, this strategic component of the dynamic value function can be important. Agents may highly value land whose marginal NPPV is low because it puts them closer to a land-holding size where accessing capital markets become feasible and high marginal returns climb sharply.

Because of the multiple non-linearities of this model, the value function is complex. If there were no capital market imperfections in the model, then the holding of money stocks would not impinge on production decisions, and the value function would be additively separable in its arguments: $J(T,M) = J_1(T) + J_2(M)$. Further, if there were no labor market imperfections, then the first derivative of J_1 with respect to T would be continuous and monotonic. These modifications would convert the problem into an analogue to the classical Ramsey problem discussed in Section 2 and would lead to an analytically tractable value function. Accumulation trajectories for all agent would become straightforward. However, under the specified market imperfections, the value function is analytically intractable, and numerical methods are necessary to characterize it (see Carter and Zimmerman, forthcoming for computational details).

2.2. Dynamic Class Strategies and the Erosion of Land Ownership Inequality

In order to explore the dynamics of asset inequality, we chose technology and asset distributions parameters intended to represent the inegalitarian economies of Latin America. Sensitivity testing was undertaken to insure that the results obtained were not an artifact of the particular numerical values that were chosen. The model was run for 50 periods, creating a 50 year, dynamic general equilibrium history for this economy. The successive solutions toward a rational expectations equilibrium in prices converged in 5 iterations of the 50 year history. In the final iteration, the mean absolute deviation of prices from expectations was 0.005%. Over the

---

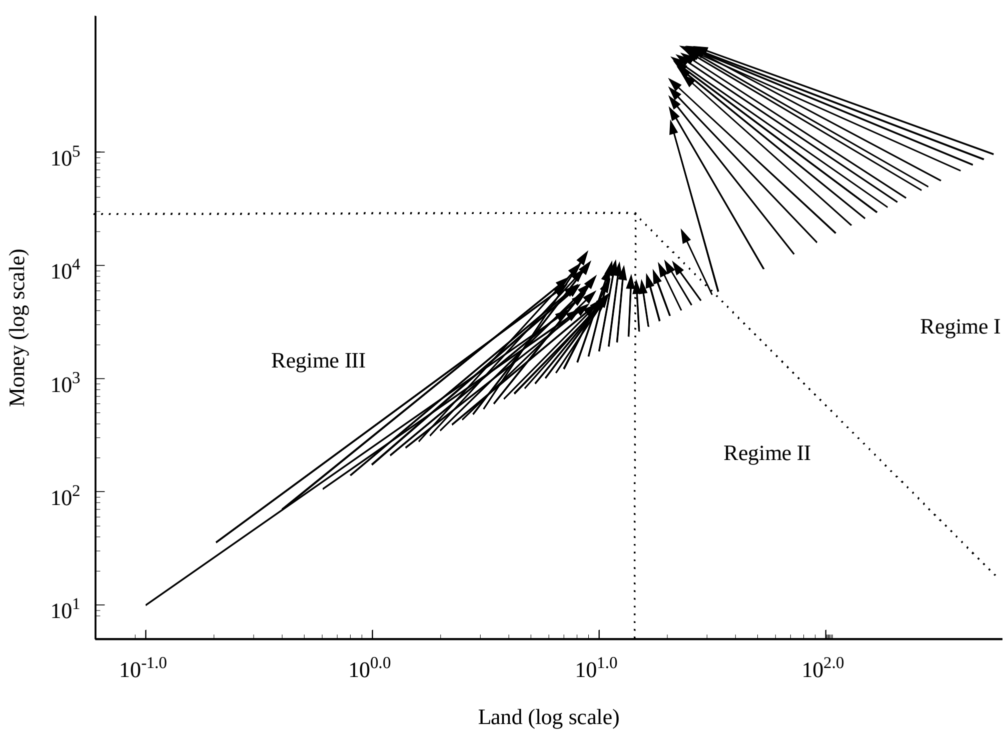
process continues until a history is reached whose sequence of endogenously realized land and factor prices is arbitrarily close to the expectations upon which the history was conditioned. This iterative approach to rational expectations is similar to the approach in Imrohoroglu, Imrohoroglu and Joines (1993).

course of the history, the equilibrium wage and fertilizer price increase in the first 25 periods, with the fertilizer price stabilizing and the wage dropping off slightly thereafter. The general increase in these factor prices can be attributed to the more efficient use of labor and fertilizer as land is redistributed by the market. The wage ebbs somewhat later in the model as more of the large farms enter less labor-intensive forms of production. As would be expected in a dynamic model the price of land—an asset that can be costlessly stored across periods—is relatively stable over time at about 7000 units of money per *manzana*.

As Carter and Zimmerman (forthcoming) show, a "class map" can be derived that identifies those regions of the endowment space that correspond to each of the possible solution regimes for the production period problem (1). An analogue mapping from initial endowments to behavior exists for the dynamic trajectories of accumulation and consumption. Figure 2 portrays this dynamic class map. Each arrow summarizes the accumulation history for a particular agent, with the beginning point of the arrow fixed at the agent's initial endowment position, and the endpoint signifying the agent's portfolio holding of land and money in year 50. Arrows are shown only for a subset of agents in the model and have been selected to capture the full range of the endowment space from which agents are pulled onto similar accumulation trajectories. Class I, the Latifundistas, are enticed by the favorable market price for land to sell off large quantities of land over the 5 decades of simulated history, boosting both their consumption and money holdings along the way. Class II is comprised of a class of persistent capitalized family farmers. Over time, they modestly adjust their land holdings and build-up sufficient funds to internally finance the production process.

The third and final dynamic class is comprised of agents who were either initially assetless, or whose land holdings were below about 11 manzanas. Over 5 decades of simulated history these agents move—often dramatically so—toward the asset levels of the persistent capitalist family farmers. The specific, year-by-year trajectory of the land and money accumulation is more complex than Figure 2 shows, however. Agents in this group confront the brunt of the labor and capital market imperfections. Dependent on the labor market for a large portion of their livelihood, and with capital needs too small to make it worth their while to pay the fixed costs associated with borrowing, these agents must devise a way to expand their holdings, while maintaining some minimal level of self-finance for the production they do have, while not sacrificing too much of current consumption. These Class III agents slowly accumulate land over the first several years, drawing down any initial money endowment to aid in land purchase and defense of their consumption standard. Still selling a large portion of their labor time on the market, these agents use their wage earnings in part to meet the up-front costs of production.

Figure 2: Dynamic Class Map of Accumulation Regimes



After the first few years of land accumulation, these agents arrive at farms sizes beyond which they can no longer self-finance production. By year 15 of the simulation, most of these agents are capital-constrained. Because of their undercapitalized production processes, the net present production value of land (equation 8 above) to these agents falls drastically. In terms of Figure 1 above, these agents find themselves in the trench that cuts across asset space. Despite facing land prices well in excess of their marginal net present production value of land, Group III agents continue to accumulate land, though they move onto a balanced accumulation trajectory in which they acquire both land and money. Still by the end of the simulation, nearly half of Class III agents remain capital constrained, though moderately so, as they work their way out of the trench. The other half of the Class III agents have, by history's end, reached an economic position where they can self-finance a production process which equates the shadow price of the capital constraint to the market rate of interest.

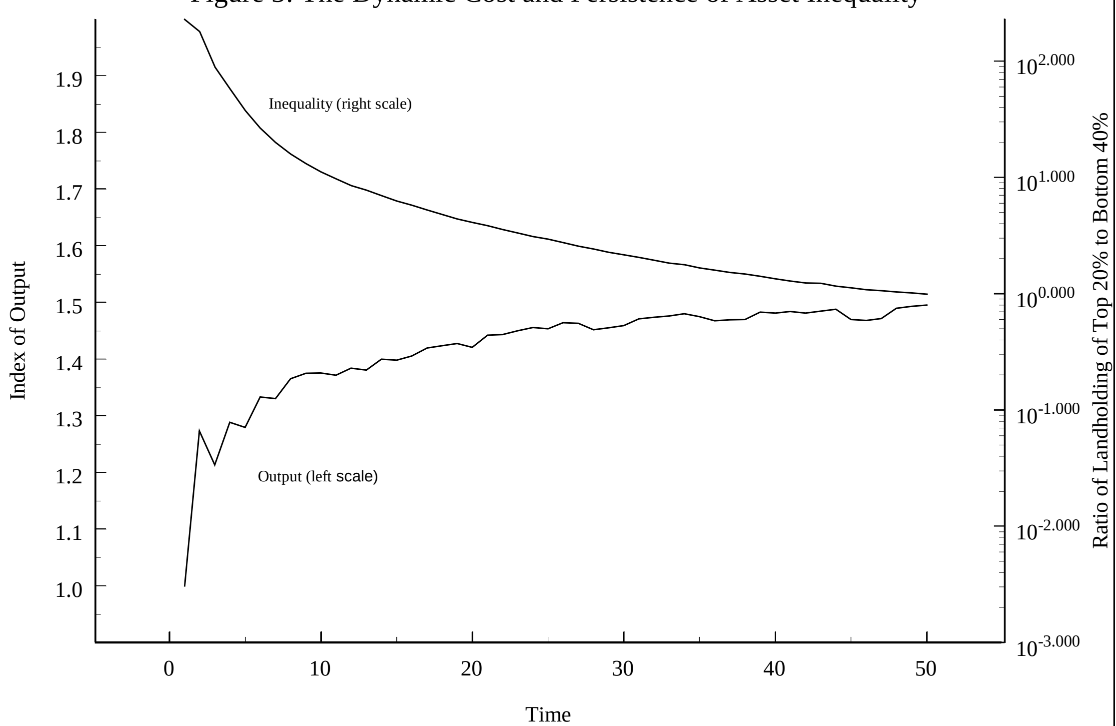
In addition to its social importance to be discussed below, the (dynamically rational) behavior of Class III farmers illustrates the value-added of the dynamic modeling strategy developed here. The static, net present value of land measure (equation 8 and Figure 1) would indicate that agents would stop short of accumulation decisions that moved them into the trench in the net-present-value of land surface. The fact that they do move into and slowly across the trench in the dynamic programming problem indicates that in an environment of multiple market imperfections, asset accumulation has not only an immediate income value, but also has a longer term strategic value as it moves the agent toward a portfolio mix and scale which will permit him or her to circumvent market imperfections. Although this evolution is of course rational on the part of the accumulating household, it may mean a loss to society as the household's production becomes temporarily constrained by a shortage of important factors.

2.3 Costs and persistence of asset inequality

As seen in Figure 2 above, over the 50 years of simulated agrarian history there is a strong tendency toward an egalitarian land distribution as all agents converge toward a single holding size, irrespective of their initial endowment. Figure 3 graphs a single, summary inequality measure—the ratio of the land of the top 20% to that of the bottom 40%—over the simulation period. As can be seen, land inequality by this measure has nearly evaporated by the final year, declining from 230 to 1.0.

This finding suggests that time and inter-temporal choice suffice to dampen the endowment sensitivity in an agrarian economy with the sorts of multiple market imperfections highlighted in the agrarian institutions literature. Left to its own devices, the market redresses inequalities in the land distribution, even in the presence of multiple factor market imperfections which, as discussed earlier, place significant barriers in the way of land accumulation by low wealth agents.

Figure 3: The Dynamic Cost and Persistence of Asset Inequality



This market-driven redistribution is not without a cost, however. Output is considerably lower in the earlier periods than it would be under an egalitarian land distribution. The output index, also shown in Figure 3, rises steadily over time as the land distribution slowly becomes more equal. By the end of the simulation, the more egalitarian economy produces nearly 50% more output off the same aggregate land-labor endowment. The present value of the cumulative output cost of inequality over the 50 years is 2 ½ times the total output of the first period. A government-led redistribution early on would therefore generate a considerable social surplus. Such findings provide an important numerical calibration of the theoretical observations of Bardhan, Bowles and Gintis (1998) and others, who argue that equity and efficiency need not be substitutes in social policy.

Section 3 Time and the Persistence of Costly Inequality under Risk and Subsistence Constraints

The results in the prior section suggest that the time is indeed an ally of equality as agents over time are able to circumvent the static accumulation barriers created by multiple market failures and the economy moves toward greater land ownership equality. However, the process is slow and the magnitude of the accumulated costs suggests that well-designed redistributive policies could potentially dominate the *laissez faire* operation of the asset market. Moreover, it should be noted that these results are, if anything, biased in favor of the dynamic efficiency of asset markets. The model both ignores transactions costs in the land market and, more significantly, the impact of risk on desired portfolio mix that less well-off agents might desire to hold. The model also ignores subsistence constraints and hence the feasibility of the consumption trajectories employed by initially low wealth agents. As Carter and Zimmerman (forthcoming) report, in the early periods of their dynamic simulation models, low wealth agents are saving and investing nearly a third of their total income, implying low rates of consumption.

To gain purchase on the time, markets and asset inequality under risk and subsistence constraints, we turn to the dynamic stochastic programming analysis presented in Zimmerman and Carter (1999).

3.1 A Dynamic Model of Consumption Smoothing and Asset Accumulation

Each household *i* in a village economy enjoys specific initial asset endowments of land, T_{i0}, and grain, M_{i0}. Following the realization of its income, the household must in each period choose a level of consumption, as well as accruals to its asset stocks. Over time, these choices generate an infinite vector of the choice variable consumption, starting in period *0* (denoted $\underline{c}_{i0}$), and infinite vectors of the state variables, starting in period *1* ($\underline{T}_{i1}$, $\underline{M}_{i1}$), with T_{i0} and M_{i0} given as the initial endowments. Household decision-making is assumed to be intertemporally rational in the sense that these vectors are chosen to solve the following dynamic choice problem:

$$\max_{\{\underline{c}_{i0},\underline{T}_{i1},\underline{M}_{t1}\}} E_0\left\{\sum_{t=1}^{\infty}\delta^t u(c_{it}) \middle| \Omega_0\right\} \quad (11)$$

where Ω_0 represents the household's information set at time *0*, including full information over the distribution of production shocks, and the joint distribution of these shocks with the endogenous land asset price.

Household utility for the *t*-th period is given by the following utility function:

$$u(c_{it}) = \begin{cases} (c_{it}/R)^{\varepsilon} \text{ if } c_{it} \geq R \text{ and } c_{is} \geq R \text{ For all } s \in \{1,2,...t\text{-}1\} & \varepsilon < 1 \\ 0, \quad \text{otherwise} \end{cases} \quad (12)$$

Note that as specified, if consumption in any period falls below a subsistence minimum, *R*, the household suffers an irreversible loss of productive capacity that permanently reduces its capacity for future utility. This formulation follows Rosenzweig and Wolpin (1993), and is a simplification of the discussion of this issue found in Dasgupta (1993).[5]

Household income in period *t* is given by:

$$F(T_{it}, M_{it}, \theta_{it}, \theta_{vt}) = \theta_{it}\theta_{vt}D\cdot(T_{it})^{\sigma} + \mu M_{it} \quad (13)$$

Where μ is the rate of return on grain stocks, θ_{it} and θ_{vt} are idiosyncratic and covariate production shocks; *D* is a land productivity parameter, and σ is an output elasticity parameter. To capture in a simple way the classic Chayanovian notion that households with lesser land endowments tend to cultivate their land more intensively because of imperfectly marketable family labor, we assume that this output elasticity is less than unity. Given that land is economically scarce, this assumption of diminishing returns to land (holding family labor fixed) generates a structural specific asset scarcity and creates incentives for land transfers between households with greater and less land endowments. Note that by adding covariate shocks and both productive and non-productive assets, (13) generalizes Deaton's (1991) model (where in our notation income is generated according to $\theta_{it} + \mu M_{it}$), and Rosenzweig and Wolpin's (1993) model (where income is generated according to $\theta_{it}D\cdot(T_{it})^{\sigma}$).[6]

---

[5] One can imagine a subtler relationship between consumption (or nutrition) and productivity. A household who is facing a subsistence shortfall in year 1, would, for example, have diminished labor capacity in year 2. However, if the household's assets were such that in year 1 it fell into a subsistence shortfall, then in year 2, with lower labor capacity, it would be in even greater danger of facing a subsistence shortfall. Its labor capacity would be then even lower yet in year 3. In this fashion the household would be almost sure to lose its entire labor endowment over a period of several years. The formulation adopted here is therefore a simplification of this process, and a not unreasonable one in the context of the dynamic nutrition-productivity literature.

[6] In practice, many assets beside land and grain are available, including livestock, cash, equipment, labor power, and human capital. Land and grain are chosen because they are at the extremes of the distribution in terms of fungibility, riskiness of yield and productivity. The rate of return on grain in this model is assumed to be zero, with certainty. In practice, grain storage is subject to losses due to pests or theft that make the return on stored grain negative and variable, but our assumption of a stable, zero return on grain is motivated by the ability of households to store cash as well as grain.

The household's consumption and asset accumulation choices each period are thus constrained by the following budget constraint:

$$c_t \leq F(T_{it}, M_{it}, \theta_{it}, \theta_{vt}) - P_{Tt}(T_{it+1} - T_{it}) - (M_{it+1} - M_{it}) \quad (14)$$

and non-negativity restrictions (borrowing constraints) where P_{Tt} is the endogenous land price that adjusts to clear the village market in every period *t.* Note that as described above, the two assets, *T* and *M*, are distinguished both by whether their returns are stochastic, and by whether they are subject to price risk in their conversion to consumable goods. Expression (14) also reflects an assumption of autarchic consumption smoothing (i.e., agents do not have recourse to insurance nor to durable customary social structure that enforces customary reciprocity arrangements).

In order to endogenize asset prices (and the covariance of asset prices with production shocks) and fully analyze the dynamic problem defined by (10)-(14), Zimmerman and Carter (1999) turn to numerical dynamic programming methods. For the purposes of numerical solution, a stylized village of 100 households was created, within which the productive-asset (land) market clears endogenously, generating a land price. Each household is endowed with land and grain at the beginning of the simulation according to empirically observed asset distributions in Burkina Faso. Each period of the simulation is characterized by a production cycle—in which households realized production according to (13)—and an asset-adjustment and consumption cycle—in which households solved the optimization problem (10) by allocating available resources to consumption and to land and grain accumulation or deaccumulation. This simulation was repeated for 35 periods, thereby creating a time series of endogenous prices. Agents in the model are endowed with rational beliefs, meaning that they correctly know the mean and first moments of the distributions of the stochastic variables. As in the Carter and Zimmerman work described above, rational beliefs were achieved in the model by an iterative method. We turn now to consider their main results.

3.2 Consumption, Income and Asset Smoothing under Optimal Portfolio Management

Starting from an initial distribution of agents across the two dimensional asset space, numerical analysis of the model developed in the prior section reveals that each agent gravitates towards one of three types of portfolio strategies. Each strategy is characterized by a pattern of short-term asset management that is followed in the wake of realized shocks, and by a long run equilibrium portfolio position: *i.e.*, a grain-land combination to which the household returns following short term adjustments to shocks.

The first of the portfolio strategies is simply the collapse to a zero wealth position, subsistence crisis and the suffering of the permanent utility loss described above.[7] The second is a defensive portfolio strategy characterized by conservative, relatively low-yielding long-run equilibrium portfolio (i.e., income smoothing) and a pattern of short-term asset management that we will call asset smoothing or asset protection. The third is an entrepreneurial strategy characterized by a relatively high yielding portfolio and a more conventional pattern of liquidating assets to buffer shocks and smooth consumption.

[7] The origin is an absorbing state because at this point agents have no income to allocate to asset investment.

As analyzed in detail by Zimmerman and Carter (1999), the defensive portfolio strategy is characterized by both a much lower portfolio value than the entrepreneurial strategy and by a less productive portfolio composition. Although the maximum attainable expected return is higher for lower wealth agents,[8] the expected rate of return for the poorer agents who pursue the defensive strategy (5.3%) is actually lower than that for the wealthier agents who pursue the entrepreneurial strategy (5.9%). Indeed, the lower wealth households who optimally follow the defensive strategy pay an 18% premium (in terms of foregone rate of return on wealth), a figure that dwarfs the 0.4% premium paid by wealthier households. This 18% premium is a stark indicator of poorer households' willingness to pay for insurance, and is in line with empirical studies that have tried to measure the insurance premia implicit in the behavior of low wealth agrarian households.[9]

While income and consumption are smoother for the poor who pursue the defenisve strategy than for the rich, as measured by the standard deviation of the realized annual levels, income for the poor is very much smoother (the standard deviation of income for the poor is about one-sixth that of the rich), consumption for the poor is only somewhat smoother (the standard deviation of consumption for the poor is about one-half that of the rich). Indeed, the coefficient of variation of consumption reveals that after adjusting for average consumption levels, the poor have *more variable* consumption streams than the rich, even though their income streams are more stable by the coefficient of variation of income measure.

These results reveal that the poor are using *consumption* to buffer *assets* in the wake of shocks—not the other way around. These results go against the common perception that agents with concave utility would want to smooth consumption to the greatest extent possible. In this dynamic model, given the threat to future labor productivity posed by letting consumption fall below subsistence, the poor do not smooth consumption as much as possible, but rather vary consumption to maintain assets. Agents who pursue this defensive strategy experience coefficients of variation of 0.7% and 1.3% in their stocks of land and grain, respectively, while the coefficient of variation of consumption is 13.5%. By contrast, for the wealthier agents away from the subsistence threat, the coefficients of variation in asset stocks are roughly 10 and 50 times higher than for poorer agents, while the coefficient of variation of consumption is of comparable magnitude.

Graphically, this point is brought out in Figures 3 and 4, where the distinctive buffering strategies that characterize the two strategies come out clearly. The wealthier agents have both greater asset movements as well as more symmetrical ones: poorer agents allow grain stocks to vary slightly, but there is no visible movement in land stocks over the entire 250-period simulation.

---

[8] This maximum rate of return is what a risk neutral agent would attain by holding a portfolio comprised entirely of land in the case of low wealth agents.

[9] For example, empirical results from von Braun, et al. (1989) suggest that the conservative adoption of risky, non-traditional export crops by small-scale Guatemalan vegetable producers costs these producers as much as 75% of income. Rosenzweig and Binswanger (1993), who find that the poor forego more potential income due to a safer investment strategy than do the rich. Moreover, the order of magnitude of the loss to the poor is the same.

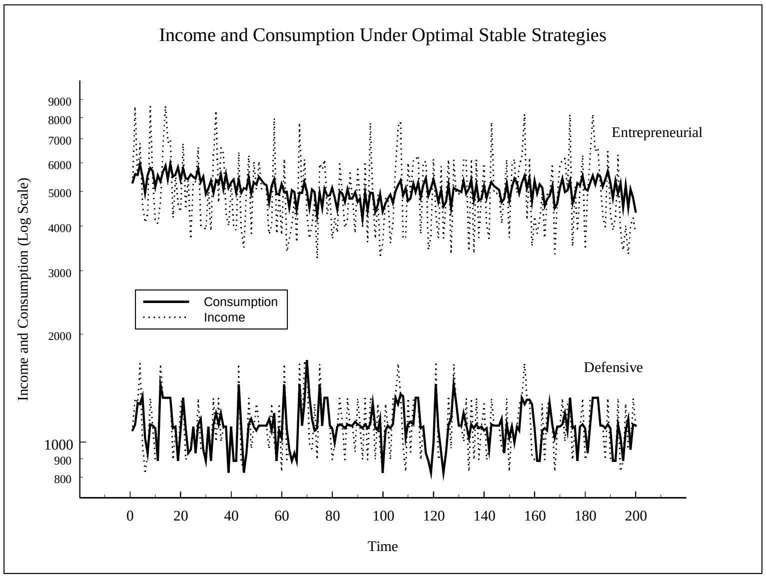


Figure 3: Income and Consumption under Optimal Portfolios

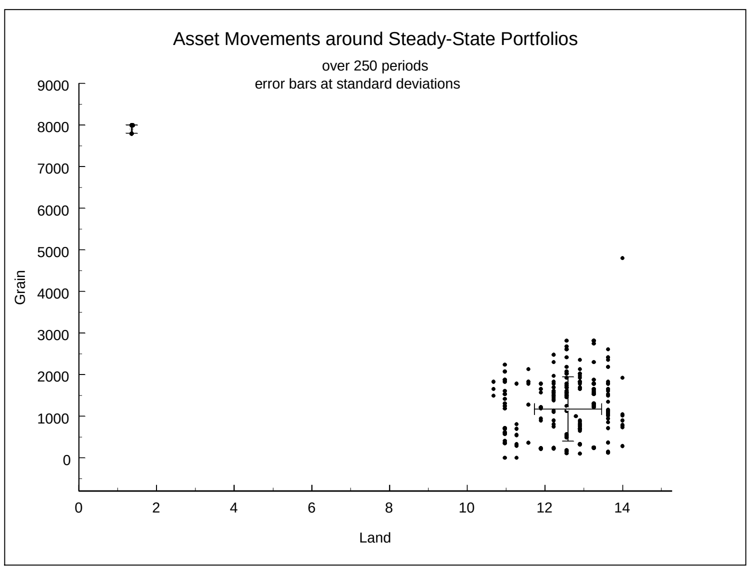


Figure 4: Asset Movements around Steady-State Portfolios

The failure of the poor to smooth consumption may seem at first counter-intuitive, especially in the context of a risk-management literature that often describes itself as a consumption-smoothing literature. Consumption smoothing is of course only one possible implication of dynamic utility maximization under risk as shown by this model and by the nutritional findings cited by Drèze and Sen (1989) that "...the reduction of food consumption tends to be an early response to the threat of entitlement failure, apparently motivated, at least partly, by the preservation of productive assets." Such findings suggests that literature's emphasis on consumption-smoothing, as opposed to asset-protection, might not be capturing the full dynamic story of risk management—especially for poor agents.

In the context of the model developed here, it is worth stressing that the low wealth, defensive portfolio emerges as a stable strategy despite the fact that individuals in low wealth positions expect higher returns from the accumulation of additional units of productive land at the margin. Despite their seeming technologically-based competitive advantage in the land market, there are two economic forces that lead these individuals cling to a conservative, grain-intensive portfolio. The first is simply that shifting wealth from land to grain serves to smooth income, since the returns to land are subject to yield risk. The second reasons results from a more subtle interplay between covariant risk, endogenous asset prices and subsistence constraints.

As detailed above, the defensive portfolio strategy is distinguished from the entrepreneurial strategy not only by its *ex ante* portfolio composition, but also by its distinctive pattern of *ex post* behavior in the wake of realized shocks.[10] While income-smoothing motives might explain the first, it cannot account for the second. If there were no asset price risk (i.e., no chance that the price of land relative to consumable foodstuffs would deteriorate), poor and rich agents would be equally inclined to use the productive asset as a buffer, since there would be no reason to buffer with an unproductive asset, and the poor would accumulate assets to the level of the rich. If asset price risk did exist but were not endogenous, then for low levels of exogenous asset price risk, holding the productive asset as a buffer would dominate the unproductive asset for all agents. For high levels of exogenous asset price risk, the unproductive asset would dominate for all agents. In either case agents would migrate from one stable optimal strategy to the other. Only for some range of asset price risk in between would there be multiple equilibria. Endogenizing asset price risk as in this model assures not only that the asset price risk is realistic, but also allows for the asset price risk to be endogenously placed in that intermediate range that drives the multiple stable equilibria.

To see why the endogenous price risk entails the multiple stable equilibria, it is useful to think of the asset-price-risk wedge between the productive and non-productive asset as reflecting the value of asset-based insurance. As with any kind of insurance, this one is in short supply: if everyone tries to buffer consumption against covariant income shocks with transactions in the productive asset market, then covariance between land price and production would climb, and the productive asset loses its value as a buffer. Land, in other words, can only be effectively used by some subset of agents to smooth consumption. This insurance must therefore be rationed, and the rationing mechanism is quantitative—it is the degree of covariant price variation of the productive asset. Since richer people are farther from a subsistence crisis, they are more willing bear some degree of asset price risk, and so they are better able to afford this form of insurance, and are more likely to buffer consumption with productive assets.

[10] Such results underscore the point made by Eswaran and Kotwal (1990) that credit-constrained households are more likely to pursue safer, less productive portfolios than non-credit-constrained households.

This model thus accounts for the emergence and stability of a low wealth defensive portfolio strategy in terms of covariant risk, endogenous asset prices and subsistence constraints. While other explanations of such behavior have been advanced, they are not as general or as complete in their endogenization of the elements of the explanations. For example, Morduch (1994, 1995) has suggested that a defensive portfolio strategy could derive from the poor having worse access to consumption insurance than do the rich. If such stratified access to insurance does exist, then it would tend to reinforce the results presented here. Moreover, differential access to formal or informal insurance is predicated on their ownership of assets, which, as expressed here, arises out of a dynamically endogenous accumulation process.

3.3 The Micawber Threshold and the Reproduction of Inequality

Our reliance upon numerical dynamic programming methods permits us to not only identify asset positions and strategies that are locally stable (as, say, Ray and Streufert, 1992 do), but also to show that they each draw in agents from meaningfully large portions of the asset space.

Figure 5 shows the actual accumulation trajectories of agents over the course of the entire simulation. As can be seen, the trajectories of all of the agents can be grouped into three classes of movements. First, agents in the lower left portion of the asset space stock out over the course of the simulation. Note that even agents who begin the simulation with little land but with grain stocks several times the subsistence minimum eventually draw them down and stock out.

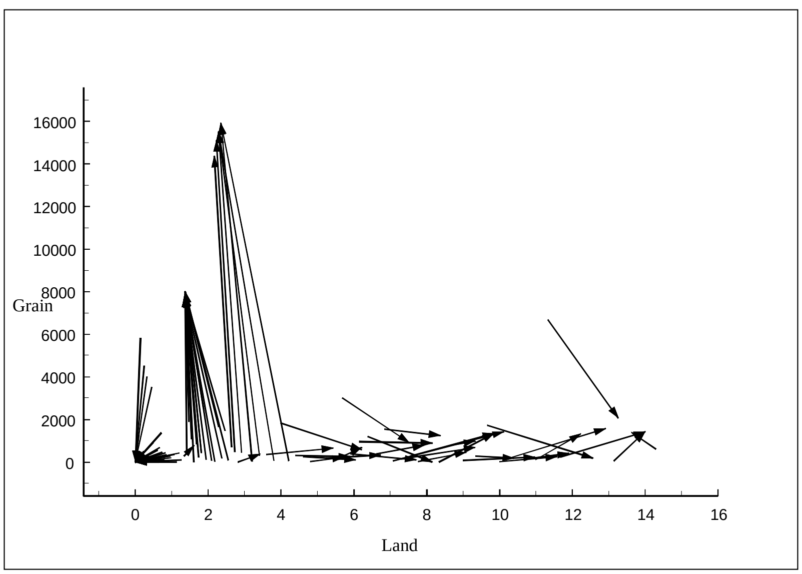


Figure 5: Evolution of Individual Portfolios

Second, agents who begin the simulation with between 1-1/2 and 4 hectares of land readjust their portfolios in the direction of a greater grain-to-land ratio. Here it should be noted that in so doing these agents reduce the average rate of return on their overall asset portfolio, but also reduce its yield riskiness and increase its fungibility. Finally, agents who begin the simulation with more than 4 hectares of land increase their land stocks. Significantly, these agents hold very low levels of grain stocks, as their production levels in even a bad year enable them to avoid a subsistence crisis. These agents experience risk aversion only in the standard, utility-curvature way (*i.e.*, their wealth makes them effectively immune from subsistence crises).[11]

The partitioning of initial asset space in Figure 5 highlights an important implication of the model for the dynamic reproduction of poverty and inequality. In addition to the Rosenzweig and Binswanger (1993) work already discussed, several writers have noted ways in which the dynamic implications of risk differ according to asset levels of households. Michael Lipton (1993) has written of a “Micawber Threshold,” below which it is difficult for agents ever to accumulate assets and live up to the Victorian expectations of David Micawber in Charles Dickens’ *David Copperfield*. Thomas Reardon and Stephen A. Vosti (1995) write of asset poverty lines, below which inter-temporal behavior and asset use patterns become distorted. Agents who begin with an asset base below the Micawber Threshold shown in Figure 5 are those that retreat northwesterly toward a defensive portfolio strategy. Motivated to avoid the fate of their slightly less well-endowed neighbors, these agents optimally shift toward a portfolio that brings them a rate of return on their wealth that is even less than that experienced by those initially wealthier individuals who pursue an entrepreneurial strategy. With rates of return positively correlated with initial wealth levels, this model implies a pattern in which initially inequality perpetuates and even deepens over time.

In addition to its implications for the reproduction of inequality, Figure 5 also highlights a productivity implication of the model. In general, several sorts of agent heterogeneity could generate differences in the shadow prices of an asset across agents, and hence engender an asset transaction. These differences—related to capital access, human capital, skill and risk—in general underlie a potential pareto improvement from an asset transaction that also implies an increase in aggregate productivity. The interplay between risk and subsistence constraints that drives transactions in this model as agents adjust to their long run portfolio positions is unique as a generator of heterogeneity in that it alone does not necessarily result in a transactions that enhance aggregate output.

This odd feature of risk is due to the fact that households making asset accumulation decisions equate the ratio of present to future marginal utility of consumption to the ratio of the marginal productivity of the asset to its price (to within discounting and expectations operators). Transactions can therefore occur which, though Pareto-improving, decrease aggregate output. While several authors have speculated on the potential importance and productivity implications of risk-induced distress sales (e.g., Braverman and Stiglitz, 1989), the result portrayed in Figure 5 that agents with more than 4 hectares of land accumulate land despite the presence of decreasing returns to land provides evidence of such transactions. The accumulation of land by

[11] These zones of attraction are probabilistic, rather than deterministic: near the borders of regions there are exceptionally lucky or unlucky agents who cross into neighboring regions of attraction.

the wealthy is therefore twinned with the process of stocking out among the poor. Because of the decreasing-returns technology of crop production, this process is deleterious not only to equity, but also to social efficiency. As in the models of Dasgupta and Ray (1987) and Ray and Streufert (1993), a case for redistribution can be made on both income distribution and productivity grounds.[12]

Section 4 Conclusion

While long a matter of intense debate, the evolution of agrarian structure in Latin America's inegalitarian economies—the "agrarian question"—has reemerged for a number of reasons, not the least of which is the growing body of evidence suggesting that inequality is economically costly. Motivated by programs and proposals to utilize the land market and individual inter-temporal accumulation decisions to redress land ownership inequality, this paper has turned to the microeconomic theory of asset accumulation to address the question, "can time and the land asset market be used to resolve the agrarian question in contemporary Latin America where economic liberalization has swept away many of the barriers and distortions suspected of having long perpetuated agrarian inequality?" While the dynamic general equilibrium analysis employed to address this question does not admit any simple, singular answer to this question, a number of quite pointed insights emerge with implications for research, policy and politics.

First, from a theoretical perspective, the models presented here suggest that:

- The competitive advantage of small scale, family labor farms in the land market is likely to be blunted by information-constrained, size-sensitive capital markets , and there can thus be no easy presumption that poverty, and the cheap labor born of it, insures the ability of peasant farms to outcompete their larger neighbors in a dualistic agrarian economy.

- The ability of households to use time to work their way around capital market failures by accumulating self-finance capacity (by trading off current for future consumption) adds an important additional dimension to the analysis of the agrarian question. This result does not imply that unadorned *laissez faire* is the optimal policy as the economic costs that accumulate with the slow erosion of the inegalitarian asset structure are non-negligible. Directly redistributive policies, or those designed to ameliorate the capital constraints that confront small-scale producers, may show significant social returns.

- Risk—unmediated by either insurance markets or customary social structure—potentially reverses the role of time. Far from resolving the agrarian question, time and markets may *deepen* costly asset inequality in this model. Having these forces work otherwise would require redress of the subsistence or asset price risk that underlies this

[12] Bardhan, Bowles and Gintis (forthcoming) observe that asset redistribution may be productivity enhancing without necessarily being Pareto-improving. That observation applies equally to this model in which compensatory payments following an asset redistribution would be infeasible as they would disrupt the stability of the new asset structure.

result.

From a policy perspective, the analysis here suggests that:

• While theory can identify potential problem areas, and solutions, its inherent ambiguity imparts a particular importance to empirical work as a complement to the design and the monitoring of redistributive projects that intend to rely on time and asset markets to redress structural inequality. An understanding of the "class competitiveness regime" (meaning the relationship between wealth and the shadow value of land), and the forces that shape it, must be the *sine qua non* of any such efforts.

• The inherent ambiguity of theory and the need for empirical work further suggest that policy has to be flexible and context specific. Unfortunately, in the presence of factor markets shaped by the reality of imperfect information, getting policy right becomes analytically onerous.

• Finally, the tasks of empirical analysis and policy design can be usefully merged with the political task of coalition formation. The rigidities of the old antagonistic agrarian politics have been shaken by the events and reforms of the last two decades. There would thus seem to be the political space for new coalitions, built not around a blind faith in either free markets or their completion negation, but rather around a more refined understanding of the role that time, markets and ancillary policies can play in resolving the agrarian question.

References

Albers, H. J. 1996. Modeling Ecological Constraints on Tropical Forest Management: Spatial Interdependence, Irreversibility, and Uncertainty, Journal of Environmental Economics and Management 30, no. 1, 73-94.

Bardhan, P. K. 1984. Land, labor, and rural poverty : essays in development economics, New York: Columbia University Press.

Bardhan, P., S. Bowles, and H. Gintis. 1998. Wealth Inequality, Wealth Constraints and Economic Performance. Handbook of Income Distribution. A. Atkinson and F. Bourguignon, North Holland.

Barraclough, Solon (1967). "Agrarian Structure in Seven Latin American Countries," *Land Economics.*

Binswanger, Hans, Klaus Deininger and Gershon Feder. 1995. Power, Distortions, Revolt and Reform in Agricultural and Land Relations. Handbook of Development Economics, Vol. IIIB. Amsterdam: North Holland.

Birdsall, N., C. Graham and R. Sabot (eds) *Inequality-Reducing Growth in Latin America*, (Johns Hopkins, forthcoming).

Bowles, S. 1985. The Production Process in a Competitive Economy: Walrasian, Neo-Hobbesian, and Marxian Models, American Economic Review, 75(1).

Braverman, A. and J. Stiglitiz (1989). "," in Pranab Bardhan (ed.) *The Economic Theory of Agrarian Institutions* (Oxford University Press).

Brewster, J. 1950. The Machine Process in Agriculture and Industry. Journal of Farm Economics.

Carter, M. R. 1988. Equilibrium Credit Rationing of Small Farm Agriculture. Journal of Development Economics, 28(1), pp. 83-103.

Carter, Michael "The Impact of Credit on Peasant Productivity and Differentiation in Nicaragua," *Journal of Development Economics,* August 1989.

Carter, Michael R. and Bradford Barham "Level Playing Fields and *Laissez Faire:* Post-Liberal Development Strategies in Inegalitarian Agrarian Economies." *World Development* 24(7): 1133-1150, 1996.

Carter, Michael, Bradford Barham and Dina Mesbah "Agro-Export Booms and the Rural Poor in Chile, Guatemala and Paraguay," *Latin American Research Review 31(1):33-65, 1996.*

Carter, Michael R. (1997). "Environment, Technology and the Social Articulation of Risk," *Economic Development and Cultural Change.*

Carter, Michael R. and Jonathan Coles "Inequality Reducing Growth in Latin American Agriculture: Towards a Market-Wise, Market-Friendly Policy Agenda," in N. Birdsall, C.

Graham and R. Sabot (eds) *Inequality-Reducing Growth in Latin America*, (Johns Hopkins, 1998).

Carter, Michael R. and Eduardo Zegarra (1995). “Reshaping Class Competitiveness and the Structure of Agrarian Growth with Well-Sequenced Policy Reform,” U.W. *Agricultural Economics Staff Paper 379* (revised).

Carter, Michael R. and Eduardo Zegarra (forthcoming). “Land Markets and the Persistence of Rural Poverty in Latin America: Conceptual Issues, Evidence and Policies in the Post-Liberalization Era,” Chapter 8 in A. Valdes and R. Lopez (eds.) *Rural Poverty in Latin America* (MacMillan Press).

Carter, Michael and Fred Zimmerman (forthcoming) “The Dynamic Costs and Persistence of Asset Inequality in An Agrarian Economy,” *Journal of Development Economics.*

Coles, Jonathan. 1995. Reforming Agriculture, in L. Goodman *et al.* (eds.) *Lessons of the Venezuelan Experience*. Baltimore: Johns Hopkins University Press.

Da Silva, Jose Graziano, “Comentarios sobre Lehman: Desarrollo Capitalista,” *Revista Andina* 3(2): 395-397.

Dasgupta, P., and D. Ray. 1986. Inequality as a Determinant of Malnutrition and Unemployment: Theory, Economic Journal, 96(384), pp. 1011-34.

de Janvry and Sadoulet 1993 “Relinking Rural Growth with Poverty Reduction,” in Michael Lipton and Jacques van der Gaag (eds), *Including the Poor* (World Bank).

de Janvry, A., M. Fafchamps, and E. Sadoulet. 1991. Peasant Household Behaviour with Missing Markets: Some Paradoxes Explained, Economic Journal,101(409), pp. 1400-417.

Dreze and Sen 1989. *The Political Economy of Hunger* (Oxford University Press).

Elster, J. 1994. Marxism, Functionalism, and Game Theory: The Case for Methodological Individualism. Foundations of analytical Marxism. Volume 2. J. E. Roemer. Aldershot, U.K., Elgar.

Eswaran, M. and A. Kotwal. 1986. Access to Capital and Agrarian Production Organization. Economic Journal. 96(382):482-498.

Feder, G. 1985. The Relation Between Farm Size and Farm Productivity: The Role of Family Labor, Supervision and Credit Constraints, Journal of Development Economics. 18:297-313.

Frisvold, G. B. 1994. Does Supervision Matter? Some Hypothesis Tests Using Indian Farm-Level Data, Journal of Development Economics 43, no. 2, 217-38.

Government of Nicaragua. 1975. Población de Nicaragua : compendio de las cifras censales y encuesta agropecuária. Managua.

Imrohoroglu, A., S. Imrohoroglu and D. H. Joines. 1993. A Numerical Algorithm for Solving Models with Incomplete Markets. The International Journal of Supercomputing Applications. Vol. 7, No. 3: 212-230. (Fall).

Kevane, M. 1996. Agrarian Structure and Agricultural Practice: Typology and Application to Western Sudan. American Journal of Agricultural Economics 78, no. 1, 236-45.

Lehman, David 1978 “The Death of Land Reform: A Polemic”, *World Development.*

Lipton 1993 “Land Reform as Commenced Business: The Case Against Stopping,” *World Development* 21(4): 641-658.

Lipton, Michael (1993). “Growing Points in Poverty Research: Labour Issues.” Paper presented to ILO Symposium, *Poverty: New Approaches to Analysis and Policy*.

Moene, K. O. 1992. Poverty and Landownership, American Economic Review 82, no. 1, 52-64.

Murdoch, J. (1994). “Poverty and Vulnerability,” *American Economic Review* 84:221-225

Murdoch, J. (1995). “Income Smoothing and Consumption Smoothing,” *Journal of Economic Perspectives* 9(3):103-114.

Patnaik, U. 1979. Neo-Populism and Marxism: The Chayanovian View of the Agrarian Question and its Fundamental fallacy, Journal of Peasant Studies 6, no. 4, 375-420.

Ray, D., and P. A. Streufert. 1993. Dynamic Equilibria with Unemployment Due to Undernourishment, Economic Theory, 3(1), pp. 61-85 .

Reardon, Thomas and Stephen Vosti (1995). “Links between Rural Poverty and the Environment in Developing Countries: Asset Categories and Investment Poverty,” *World Development* 23:1495-1506.

Rosenzweig, M. R. and H. P. Binswanger. 1993. Wealth, Weather Risk and the Composition and Profitability of Agricultural Investments, Economic Journal 103, no. 416, 56-78.

Scott, C. (1985). El acenso de la mediana produccion FAO.

Singh, I., L. Squire, et al. 1986. Agricultural Household Models: Methodological Issues. (Johns Hopkins University Press, Baltimore).

Streufert, P. 1990. Stationary Recursive Utility and Dynamic Programming under the Assumption of Biconvergence, Review of Economic Studies. (March).

Streufert, P.A. 1992. An Abstract Topological Approach to Dynamic Programming. Journal of Mathematical Economics, 21(1): 59-88.

Timmer, C. Peter (1987). “,” in *Handbook of Development Economics, vol 1* (North Holland).

Williams, J. C. and B. D. Wright. 1991. Storage and commodity markets (Cambridge University Press, Cambridge; New York and Melbourne).

Zimmerman, F. 1994. Structural Change and Evolving Institutions in Developing Agrarian Economies: A Dynamic Programming Simulation Analysis. (Ph.D. dissertation, Madison, Wisconsin).

Zimmerman, F. and M.R. Carter. 1999. "Asset Smoothing, Consumption Smoothing and the Reproduction of Inequality under Risk and Subsistence Constraints," Staff Paper 402 (revised), Department of Agricultural and Applied Economics, University of Wisconsin.