Policy, Planning, and Research

WORKING PAPERS

Agricultural Policies

Agriculture and Rural Development
Department
The World Bank
WPS 176
May 1989

Credit Rationing, Tenancy, Productivity, and the Dynamics of Inequality

Avishay Braverman
and
Joseph E. Stiglitz

When credit to farmers is rationed, changes in technology may lead to a long-term increase in sharecropping and then to reduced productivity. The development of *effective* rural financial institutions would reduce the likelihood of these negative effects.

Public Disclosure Authorized

Policy, Planning, and Research

WORKING PAPERS

Agricultural Policies

Why, when given the same resources, might productivity be lower on farms operated through sharecropping than on owner-run farms, even though sharecropping is an efficient institution in economies in which land is unequally distributed? The reason is that sharecropping, much less wage contracts, cannot overcome the divergence of interests between those who till the land and those who own it. Only land redistribution can do that.

Braverman and Stiglitz present notes toward a general equilibrium theory of land tenancy that suggests how changes in technology and in publicly provided infrastructure can affect the equilibrium distribution of land in countries where credit to farmers is rationed.

They argue that the prevalence of share tenancy is directly related to inequality in the distribution of wealth — and of landholding in particular. But inequality should be viewed as an endogenous variable, affected by decisions of both large landholders and peasants about (1) techniques and (2) forms in which to hold their wealth. These decisions and their consequences are affected in turn by changes in technology and in the rural infrastructure.

When credit to farmers is rationed, changes in technology can increase the inequality in landholdings — with a long-term increase in share tenancy. This in turn might reduce productivity, at least partially offsetting the initial improvements.

Braverman and Stiglitz suggest that the development of effective rural financial institutions would reduce the likelihood of these negative effects on equality and productivity. They caution though that past attempts in creating such institutions largely failed because of a lack of accountability and of enforcement procedures.

This paper, a product of the Agricultural Policies Division, Agriculture and Rural Development Department, is forthcoming in Pranab Bardhan, ed., *The Economic Theory of Agrarian Institutions*, Oxford University Press. Copies are available free from the World Bank, 1818 H Street NW, Washington DC 20433. Please contact Cicely Spooner, room J2-084, extension 37570.

CREDIT RATIONING, TENANCY, PRODUCTIVITY & INEQUALITY

Table of Contents

Page

INTRODUCTION.. 1

PRODUCTIVITY & SHARECROPPING.. 5

Land Reform & Land Taxes... 7

A MODEL OF LAND VALUATION...10

A Slight Generalization..19

TECHNICAL CHANGE & THE REDISTRIBUTION OF LAND........................21

A DYNAMIC MODEL...23

CONCLUSION..29

References..30

Figures

9.1A..15

9.1B..15

9.2...18

9.3...18

9.4...22

9.5...27

CREDIT RATIONING, TENANCY, PRODUCTIVITY AND THE DYNAMICS OF INEQUALITY

Introduction

In earlier work, we argued that it was mistaken for economists to treat institutions as given: many institutions frequently found in market economies arise endogenously as a response to informational considerations and inequality in the distribution of wealth. In particular, these considerations can explain the persistence and pervasiveness of sharecropping in LDCs (Stiglitz, 1974 and Braverman & Stiglitz, 1986a) and credit rationing in capital markets in both developed and less-developed countries (Stiglitz & Weiss, 1981).

This chapter has three objectives: to show how sharecropping and capital market imperfections affect rural productivity; to sketch a general equilibrium theory of land tenancy; and, finally, to show how changes in technology and in publicly provided infrastructure may affect the equilibrium distribution of land, and hence, the prevalent tenancy relationships. These relationships are important because they influence the long-run increase in national income made possible by changes in technology and infrastructure.

Recent literature has considered the effect of inequality on technological change. Concern has been expressed, for instance, that the inequality within LDCs has impeded the adoption of certain innovations. [1]

1/ See, for instance, Bhaduri (1973, 1980), who contends that landlords will resist innovations which reduce their power to exploit the workers.

In an earlier paper (Braverman & Stiglitz, 1986b) we examined the validity of that contention and showed that, although the standard exploitation arguments may not be valid, there were indeed innovations that might increase output, for each level of input, that would not be adopted; these innovations, however, exacerbated the incentive problems (e.g., those associated with sharecropping).

This paper is concerned with the other side of the relationship between technological change and inequality: the long-run effect of technical change on inequality, and the effect of inequality, in turn, on productivity. We shall show that an increase in inequality may have a deleterious effect on productivity.

The effect on output of changes in technology and infrastructure may be ambiguous. For some changes, long-run inequality is reduced, and for these changes, the long-run productivity gains are accordingly likely to be greater than those in the short run. On the other hand, for some changes, long-run inequality is increased. These innovations, while increasing output in the short run, may -- in the absence of countervailing actions by the government -- in the long run have a deleterious effect on the economy. It is important to recognize this possibility, so that attention can be drawn to institutional reforms designed to ameliorate these inequality-related long-run productivity effects.

The fact that technological change can have an adverse effect on inequality has long been recognized. Indeed, it is known that it is possible that a technological change would so reduce the demand for, say, unskilled labor that not only its share, but also the absolute value of the real wage of unskilled workers might fall. This might be the case, for instance, if the innovation is labor-augmenting (so that one worker can do what ten workers previously could) and the elasticity of substitution between unskilled labor and other factors is very low (so that, given the increase in the effective supply of labor, the wage per efficiency unit falls more than proportionately to the increase in the productivity of the workers).

The mechanism by which technological change can have an adverse effect on workers in our analysis is, however, quite different. It is based on two hypotheses:

- Many forms of technological change are capital-using; that is, they require as complementary inputs additional capital. (Equivalently, at the original levels of capital and labor inputs, the value of the marginal product of capital is increased.)
- Capital markets are imperfect, so that poor farmers cannot easily borrow the additional required capital. Even if they could, of course, the technological change could have an adverse effect on the distribution of wealth (income); for it will increase the scarcity value of capital, and thus the return to capital. But our concern is not with this static or short-run effect, but rather with a long-run effect that is a consequence of credit rationing.

The lack of access to capital means that, after a technological change, land will be more valuable to someone who has the capital to use with it than to someone who does not. This, in turn will induce some of the poorer farmers to sell their land to richer landlords. In the short run, this simply represents a change in the form in which wealth is held. But because the wealth distribution in one period depends not only on the distribution of wealth in the previous period, but also on the form in which different wealth groups hold their wealth, this sale of land may have adverse long-run effects on the wealth distribution.

Finally, an adverse effect on wealth distribution has an adverse effect on productivity. The reason for this is that as inequality increases, it is more likely that sharecropping arrangements will be employed; [2] and, although sharecropping arrangements may be Pareto efficient (that is, given the constraints on monitoring the worker and the risk aversion of workers, there may not be an alternative contractual arrangement between workers and landlords that makes both better off), still, output may be significantly lower with sharecropping than it would be with owner-operated farms. [3]

Our contention then that certain changes in technology (certain governmental projects, such as irrigation projects) may have long-run adverse effects on the economy which partly offset the short-run effects, requires a number of steps to establish, each of which is of some interest in its own right. In the subsequent sections, we provide simple models establishing conditions under which each of the contentions we have put forward is valid.

2/ There are, of course, other reasons why wealth inequality may give rise to a reduction in productivity. Dasgupta & Ray (1986) for instance, discuss the consequences of inequality in the context of an economy in which productivity depends on nutrition.

3/ Although sharecropping contracts are pairwise efficient, in the sense that they maximize the welfare of the worker given the expected rents of the landlord, they may not be globally efficient; that is, there may exist governmental interventions (say taxes or subsidies) which make all individuals better off. This is a general result in the theory of imperfect information and incomplete markets; see Greenwald & Stiglitz (1986).

PRODUCTIVITY AND SHARECROPPING

The standard formulation of the sharecropping contractual arrangement (where the contract is chosen to maximize the expected utility of the worker, subject to a constraint on the expected return per acre of the landlord) makes it clear that such contracts are (at least pairwise) efficient. But that does not mean that national income might not be higher -- significantly higher -- in the absence of sharecropping.

Here we ask the question: What would happen if the land that a sharecropper currently works were redistributed to the worker, so that he now received the rents? The classical argument against sharecropping was that, because the worker received only a fraction of his marginal return, he would work less than he would if he received his marginal product and accordingly, such contracts were inefficient. We have already argued that sharecropping contracts are pairwise efficient. The former contention that individuals would work less, is not obvious either since as we transfer resources to the worker, he becomes better off, and because he is better off, he may work less hard.

The question of whether output would be higher or lower under a land reform is thus close to the question of whether an increase in wages increases or decreases the labor supply (measured in terms of hours or effort). While an increase in the wage has a positive incentive (substitution) effect, it has a negative income effect, and the net effect is ambiguous. The question is similar, but not the same as, the question of whether the standard labor supply curve is backward-bending, because the marginal return to labor in the circumstances under examination here is a stochastic variable (Braverman & Srinivasan, 1981). We can show that so long as workers are not too risk averse (that is, so long as there is not a too strongly diminishing marginal utility of income), the substitution effect will outweigh the income effect, and a land reform will increase output.

To see this, we postulate that workers are risk averse with a utility function of the form [4]

$$U(Y,L) = u(Y) - v(L) \tag{1}$$

where

$$u' > 0, \quad u'' < 0, \quad v' > 0, \quad v'' > 0$$

and where Y is income and L is the worker's labor supply measured in terms of effort. We assume that the agricultural production function takes on the simple form of

$$Q = ag(\theta)f(L/a) \tag{2}$$

where f is output per acre, θ is a random variable, and a is the representative worker's plot size. For simplicity, we shall normalize a at unity.

We assume a simple sharecropping system where the tenant worker gets a fraction α of the return. For simplicity, we assume that this is his entire income, so that

$$Y = \alpha gf. \tag{3}$$

4/ Implicitly, in this formulation we are assuming that the individual's utility depends on his current income; i.e., there are not capital markets in which he can borrow or lend. This is obviously an extreme assumption, but it is far better than the opposite extreme, in which it is postulated that workers can borrow and lend at a fixed (low) real market rate of interest. Thus, the assumption of capital constraints appears as an implicit assumption even in the traditional models of sharecropping. This analysis could be extended to the case where borrowing and lending are feasible, in which case U becomes the lifetime utility function, and Y is interpreted as lifetime wealth.

Then the first order condition for the level of effort is [5]

$$Eu'\alpha gf' = v'. \qquad (4)$$

We can depict the consequences of a land reform as turning over control of the land to the worker, that is, as an increase in α to 1. Thus, differentiating (4), we immediately obtain

$$\text{sign } dL/d\alpha = \text{sign } Egf'u'(1-R) \qquad (5)$$

where $R = -u''Y/u'$, the elasticity of the marginal utility of income or the Arrow-Pratt measure of relative risk aversion. Thus, provided

$$R < 1, \qquad (6)$$

that is, provided workers are not too risk averse, a land reform will increase effort, and hence will increase mean national output. (The analogous condition for the deterministic case is in Braverman & Srinivasan, 1981.)

The magnitude of the response may be quite large: crop shares typically are in the order of magnitude of 50 percent; thus, a land reform has the same effect as the elimination of a 50 percent income tax.

Land Reform & Land Taxes

This analysis provides some suggestions concerning the longstanding issue of the desirability of land taxes, as opposed to output taxes. Land taxes provide fixed payments to the government, just as rental payments provide fixed payments to the landlord. Output taxes are equivalent to sharecropping agreements; the government shares in production

---

5/ This formulation assumes that effort is exerted before the random variable θ is known.

risks (as well as price risks). Land taxes have preferable incentive properties, just as rental payments do. But, just as earlier analyses (e.g., Stiglitz, 1974) argued that sharecropping contracts were preferable to fixed rents when tenants are risk averse, so too are output taxes preferable to land taxes when landlords are risk averse. Indeed, the case for the desirable risk-sharing properties of output taxes is even greater, for the government is able to diversify the risks that it faces better than the typical landlord can. [6] To put it another way, the assumption e in the literature that landlords are risk neutral is a much closer approximation to describing the government than it is to describing the representative landlord, particularly in Asia and Africa. And by switching from output taxes to land taxes, the feasible set of, say, mean and standard deviation of income of landlords and workers is made worse.

Moreover, in the more general case of linear sharecropping contracts, with

$$Y = \alpha gf + \beta,$$

6/ This discussion has, of course, ignored what may be the central criticism against land taxes, the administrative problems associated with levying such taxes in an equitable manner, and the abuse to which such taxes are subject. Moreover, in practice, such taxes are usually based not on the intrinsic value of the land, but on the "improved" value of land. Thus, they a... in effect, a tax on (the present discounted value of) land rents plus a tax on capital. Because they are a tax on the present discounted value of land rents, they serve to increase the risk borne by landlords, since the present discounted value of land rents is likely to be much less variable than the annual value of land rents (and besides, tax authorities usually revise the appraised value of land only periodically). Moreover, the fact that capital is taxed, while labor is not, introduces an important distortion. As is usually the case in the theory of the second-best, it is not obvious whether a uniform distortion (taxing labor, land, and capital) is better or worse than a selective distortion (taxing land and capital). This is a question we hope to investigate on another occasion.

the shift from an output tax to an equal-expected-revenue land tax may result in a rise in α, the crop share, and an offsetting change in β, the fixed rent or wage, as the landlord shifts some of his increased risk to the worker. Note that welfare may be reduced, even though average rural income may be increased (as a result of the greater effort exerted by workers because of the greater share provided by the equilibrium contract under the land tax). In the case where the landlord is risk averse, expected utility of workers and/or landlords will be reduced. Only in the case where the landlord is risk neutral will the switch from an output tax to an equal-expected-revenue land tax leave the equilibrium unchanged. [7]

7/ This follows from the fact that total expected payments to landlords and the government are fixed, and hence the solution to the problem of maximizing the worker's expected utility subject to that constraint is unaffected.

A MODEL OF LAND VALUATION

To ascertain the effect of technical change on the distribution of land, we first need to construct a model of land valuation.

We will find it useful to distinguish between the value of land to a landlord who lets out his land, and the value of land to a farmer who works his own land. Moreover, we will need to extend the production model described in the previous section to incorporate the effects of technical change and capital availability. We thus postulate that the average output per acre of a plot of land is represented by a production function of the form

$$q = \bar{f}(k,\lambda,t) \tag{7}$$

where k is capital per acre, λ is the amount of effort which each sharecropper supplies per acre of the sharecropping land (hence, $\lambda = L/a$), t is the state of technology, and $Eg(\theta) = 1$ (and so is suppressed). Changes in t can be thought of as reflecting not only technological changes, but also changes in the level of certain publicly provided services, such as irrigation and extension services.

Under a sharecropping contract with a fixed share α, the present discounted value of the returns to the landlord of an acre worked at intensity λ with capital k is just [8]

8/ For simplicity, we assume that the rate of interest is constant (or that the market values assets as if the rate of interest were constant). (This might be true, for instance, if the rate of interest was described by a random walk, so that the expected value of future rates of interest was equal to the current value of the rate of interest.) We also assume, somewhat less plausibly, that the market ignores all future possibilities of technological change (or changes in government-provided facilities which affect productivity). This may not be a bad approximation if such changes occur only sporadically, and real interest rates used for discounting are relatively high.

$$V^s = (1-a)\,\tilde{f}\,(k, \lambda, t)/r \qquad (8)$$

where k and λ are both endogenously determined, and r is the rate of interest at which future income flows are discounted. [9] In principle, we should also make a an endogenous variable, [10] but in practice a seems to vary little, even over quite extended periods, and even in the presence of some significant changes in technology. Here we take a and the number of workers on each plot of land as fixed, leaving for a later occasion the extension to the more general case where both are endogenous.

From the first-order condition for effort (equation (4) above), we can immediately derive the equilibrium level of effort of a worker as a function of the amount of capital per acre provided by the landlord, the state of technology, and the size of the plot of land that the worker works: [11]

9/ Clearly, if there were a perfect capital market, r would be the rate of interest at which landlords could borrow and lend. In an imperfect capital market, it is a more subtle matter to determine r. Although in principle r itself may be affected by changes in technology, for the purposes of this analysis, we treat r as fixed.

10/ And indeed, we should introduce more complicated sharecropping contracts, e.g., with a fixed (rental or wage) component, or with cost sharing. Each of these terms should, in principle, also be endogenously determined, and thus vary with t. Introducing these extensions would, we suspect, considerably complicate the analysis without changing the basic qualitative results.

11/ For the moment, we assume that the worker engaged in sharecropping can work only on the sharecropping land. If the sharecropper has alternative opportunities, e.g., if he can work as a wage laborer, or if he owns or rents a plot of land, then this will obviously affect the amount of labor that he supplies on the sharecropping land. The landlord, in such situations, would attempt to restrict the sharecropper's access to these opportunities.

$$\lambda = \phi\ (k,a,t) \tag{9}$$

where, as before, a is the number of acres per worker engaged in sharecropping. (In the previous section, it will be recalled, we took a to be unity.) k is then chosen to maximize

$$(1-\alpha)\ \bar{f}\ \{k,\lambda\ (k,a,t)\ t\} - rk; \tag{10}$$

that is,

$$(1-\alpha) \left\{\bar{f}_k + \bar{f}_\lambda\ (d\lambda/dk)\right\} = r. \tag{11}$$

Note that in this formulation all the capital costs are borne by the landlord; this follows naturally from the assumption, which will play a central role in the subsequent analysis, that landlords have access to capital but workers do not. [12]

Equation (11) has some interesting implications: while the fact that the landlord can appropriate only a fraction of the marginal returns from his application of additional capital discourages the use of capital, the fact that additional capital may elicit greater effort on the part of workers may encourage the use of capital. $d\lambda/dk$ will be positive if capital and labor are complements, that is, if an increase in the supply of

---

12/ At the same time, Braverman & Stiglitz (1986a) show that in the absence of an asymmetry of information concerning θ, it makes no difference whether the contract specifies that the landlord or the tenant supply capital, so long as the capital input is observable.

capital increases the marginal return to labor [13] by enough to offset the reduction in effort supply resulting from the higher income provided by the increased input of capital.

We now derive the effect of a change in technology on the value of sharecropping land. Assuming that the landlords optimally adjust the level of k, we obtain (here, as in the remainder of this section, we drop the bar over f)

$$dV^s/dt = (1-\alpha)\ \{f_t + f_\lambda\ (d\lambda/dt)\}/r. \tag{12}$$

13/ From the first-order condition for λ (taking α as given), we obtain

$$\text{sign } d\lambda/dk = \text{sign } E\ u'g\ \left[f_{\lambda k} - R\ f_k f_\lambda/f\right].$$

The income effect (the increased capital increases income at a fixed effort level) discourages effort; but the substitution effect encourages it, provided $f_{\lambda k} > 0$. The substitution effect will exceed the income effect, provided only that $R < ff_{k\lambda}/f_k f_\lambda = 1/\sigma$, that is, provided that the product of the elasticity of marginal utility (the Arrow-Pratt measure of relative risk aversion) and the elasticity of substitution is less than unity.

Note that, if there were a fixed fee element to the sharecropping contract, which the landlord could adjust to offset the increased income resulting from the increased capital (making, in effect, the tenant pay for the capital) or if the landlord could adjust the share downward, to compensate for the increased capital, then there would not be an income effect. The presumption then that an increase in capital will result in greater effort will be stronger; see Braverman & Stiglitz (1986a).

In words, the change in technology has a direct effect (at fixed levels of inputs of effort and capital) and an indirect effect, through the effect on the supply of effort. If the technological improvement increases the marginal productivity of effort, as in Figure 9.1A, then again there is a presumption that the supply of effort will be increased. [14]

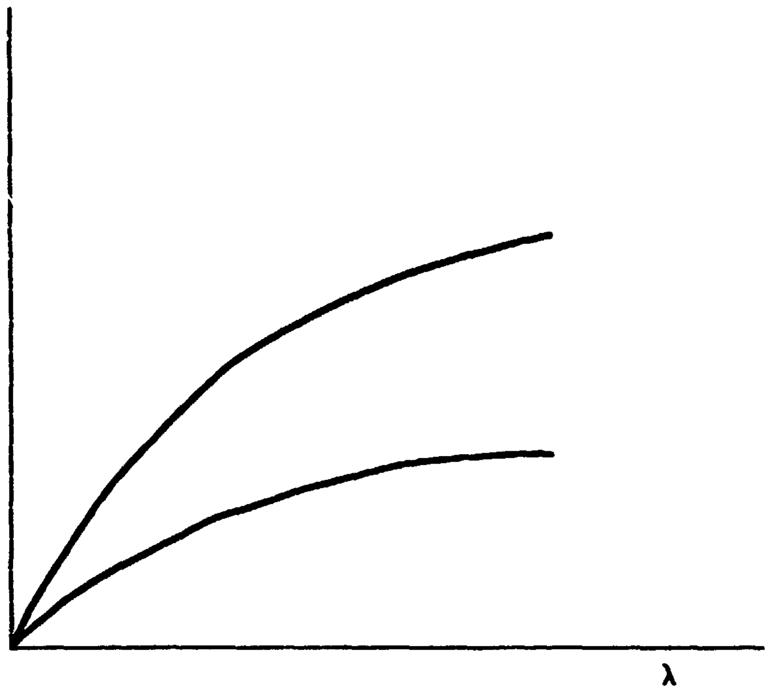
But if the technological improvement reduces the marginal productivity of effort in the relevant range ($\lambda(t) > \bar{\lambda}$, i.e., at the old equilibrium level of inputs in Figure 9.1B), then the supply of effort will fall. Indeed, if the technological improvement reduces the marginal productivity at the old level of output by enough, then the indirect effect of reduced effort will outweigh the direct productivity effect, and equilibrium output will be lower.

14/ Again, there is an income effect and a substitution effect. As in n.13, we can show that

$$\text{sign } d\lambda/dt = \text{sign } E\, u'g\, (f_{t\lambda} - R\, f_\lambda f_t/f).$$

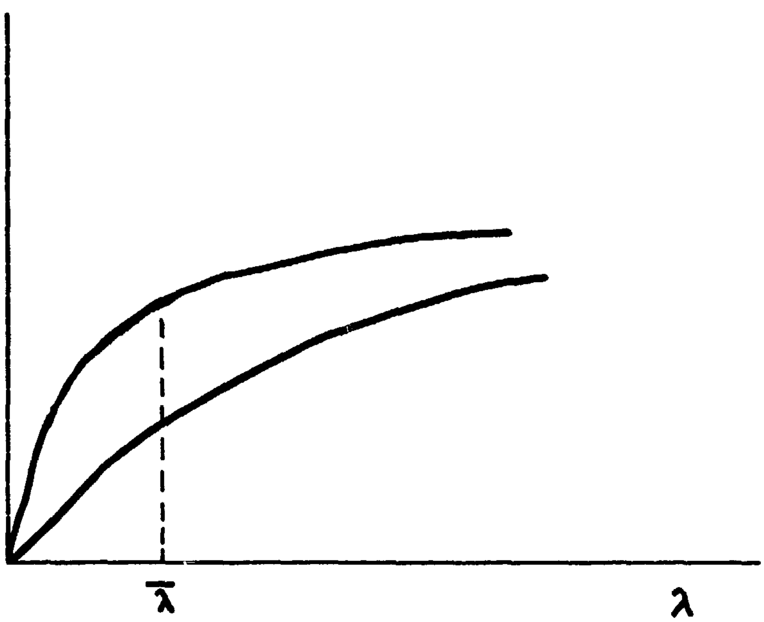
There is, of course, no presumption that a technological change will, at a fixed level of labor and capital inputs, increase the marginal productivity of labor. Figure 9.1 illustrates two possibilities. For a more extended discussion of these issues, see Braverman & Stiglitz (1986b).

FIGURE 9.1A



At all levels of input, technical change increases the marginal productivity of labor.

FIGURE 9.1B



At all levels of input above λ, technical change reduces the marginal productivity of labor.

The indirect effect of a small change in technology on the input of capital can be ignored, by the envelope theorem. But the indirect effect on k of a large change in technology cannot be ignored:[15]

$$\Delta V^s = \frac{1-\alpha}{r}\left[f\{k(t'),\lambda(t'),t'\}-f\{k(t),\lambda(t),t\}\right] - \{k(t')-k(t)\} \quad (13)$$

where t is the original technology, t' the new technology, and $k(t)$ ($k(t')$) represents the capital input with the original (new technology), and where $\lambda(t) \equiv \phi\{k(t), a(t), t\}$ and $\lambda(t') \equiv \phi\{k(t'), a(t'), t'\}$ are similarly defined.

We now turn to the effect of the technological change on the value of owner-worked land. We first express this value in terms of the present discounted value of utility generated by the land, under the hypothesis that the worker-owner does not have access to capital. Then the value of an a-acre farm is

$$V^o = \max_{\lambda} \frac{1}{r} E\left[u\{ag^f(0,\lambda,t)\} - v(\lambda)\right] \quad (14)$$

from which it follows that

$$dV^o/dt = (aEu'gf_t)/r \quad (15)$$

15/ This analysis assumes that sharecropping land is purchased with its workers, i.e., that one cannot change the number of workers per acre. More generally, of course, the value of land is a function of the number of workers per acre, which itself is an endogenous variable. Obviously, if the landlord does not need to change the terms of the contract to offset a decrease in the acreage per worker, he would increase the number of workers per acre without bound, or at least until certain efficiency wage effects became significant.

Again, because of the envelope theorem, we can ignore the induced change in the supply of effort; but for large changes in technology, we cannot, and we obtain

$$\Delta V^{o} = \frac{1}{r}\left\{Eu[af\{0,\lambda(t'),t'\}g] - Eu[af\{0,\lambda(t),t\}g]\right\} - \frac{1}{r}\left\{v[\lambda(t')]-v[\lambda(t)]\right\} \quad (16)$$

Comparing (16) and (13), it is apparent that a technological change can have quite different effects on land that is sharecropped and land that is worked by its owners. In the limiting case, where capital is required to take advantage of the new technology, there is no change in V^{o}. More generally, the technological improvement will have a larger effect on sharecropped land relative to owner-worked land:

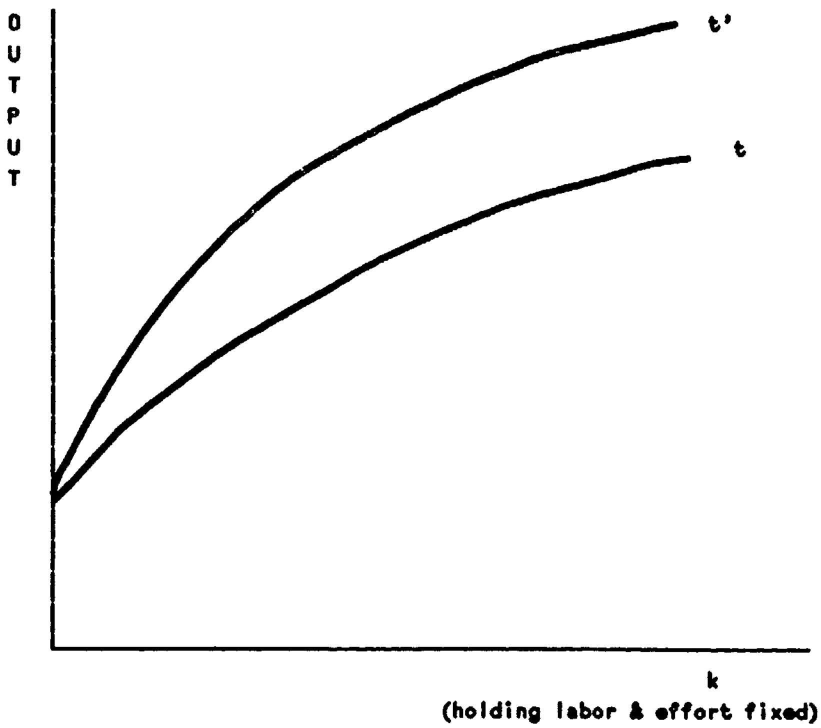
a. the more the improvement depends on the level of capital (Figure 9.2);

b. the less the improvement depends on the level of labor effort (Figure 9.3); that is, the new technology does not increase output at very labor-intensive technologies as much as at less labor-intensive technologies; [16] and

c. the greater the effect of the technological change on the marginal productivity of effort (at least, at the levels of labor and capital employed in sharecropping).

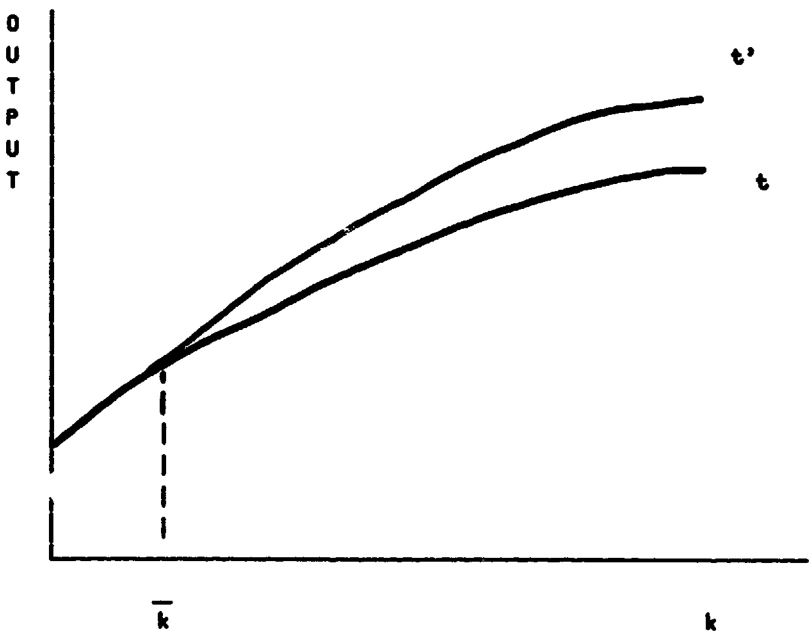
16/ Recall from the earlier discussion of sharecropping that labor input will be lower with sharecropping, provided the income effects are not too large.

FIGURE 9.2



Technological change leaves values of capital-constrained owner-run farms unchanged, but increases values of share-cropped land.

FIGURE 9.3



Technological change leaves output unchanged at levels of capital input below $\bar{k}$

A Slight Generalization

The model presented above assumed that poor farmers who worked their own land had no access to capital. A better assumption might be that they can obtain capital only by selling their land. Assume that with the initial technology the owner-farmer uses no capital, and that in fact capital is not productive. The technological change alters this. Assume that he can sell his land to a rich landowner for a price V^s per acre, and assume that his initial endowment of land is a^*. If he retains any land to farm himself, assume that it will be optimal for him to use the proceeds of the sale to buy capital equipment. Then he will choose a, the number of acres he retains, to maximize his expected utility:

$$\max_{(\lambda, a)} Eu[gaf\{V^s(a^* - a), \lambda, t\}] - v(\lambda) \tag{17}$$

that is,

$$Eu'g\,(f - af_k V^s) = 0 \qquad (\text{if } a < a^*) \tag{18}$$

or

$$f = af_k V^s \tag{19}$$

or

$$(a^* - a)/a = f_k k/f = b(k, \lambda) = \text{the "share" of capital in output.} \tag{20}$$

We can again consider the effects of technical change on the welfare of the owner-worker. Since, by assumption, with the original technology the owner employs no capital, by the envelope theorem, the effect of a small technological improvement is again described by equation (15). But the effect of a larger technological improvement is now given by

$$\Delta V^o = \frac{1}{r}\Big\{Eu[g\, a(t')f[V^s\{a^* - a(t')\}, \lambda(t'), t']] - Eu[ga^*f\{0, \lambda(t), t\} - v\{\lambda(t')\} + v\{\lambda(t)\}]\Big\} \tag{21}$$

where it should be noted that the labor supply is now different from what it was earlier, because of the change in k and a.

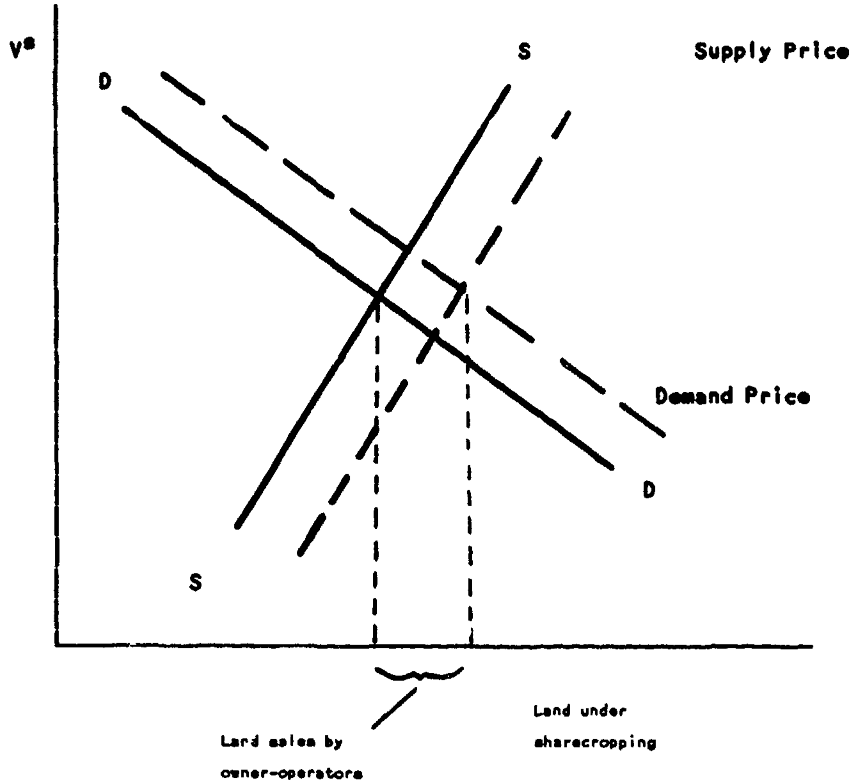
TECHNICAL CHANGE AND THE REDISTRIBUTION OF LAND

In the preceding section, we showed that a change in technology or infrastructure could have a markedly different effect on the value of sharecropped land (the welfare of landlords) and on the welfare of farmers working their own land. We now consider the effect of technical change on the distribution of land, and the effects that this in turn has on output.

Figure 9.4 shows the equilibrium in the land market under the assumption that the owner-workers can sell land to obtain capital. The curve SS is derived from equation (19). It shows the amount of land that the owner-workers are willing to sell as a function of the market price, V^s. In the figure, we have depicted the case where as V^s increases, they sell more, although this is not necessarily the case.[17] The curve DD represents the demand for sharecropping land. If we assume that the number of available sharecroppers is fixed, then an increase in land under sharecropping tenancy will tend to decrease the value of each acre; V^s will normally fall. (Even if the substitution effect leads each worker to work harder, the effective labor supply per acre will fall.) Thus, the demand curve in Figure 9.4 is downward sloping.

17/ We need to differentiate the first-order conditions with respect to V^s. From equation (20) it is clear that if we have a Cobb-Douglas production function, a is independent of V^s.

FIGURE 9.4



Technical change results in a shift in land ownership.

Now consider the effect of a technical change which increases the return to capital. This shifts the supply curve to the right, and may well shift the demand curve up. Thus, as depicted in Figure 9.4, land will be transferred from owner-operators to landlords as a result of the technical change: the technical change has resulted in an increase in the inequality of land-ownership.

In this static model, the change in the distribution of land ownership is welfare (and productivity) enhancing: it enables the poor farmers, who otherwise would not have access to capital, to take advantage of the new capital-using technology. But the productivity effects are more ambiguous in a dynamic context.

A DYNAMIC MODEL

In spite of the enhanced productivity that might result from selling their land and using the proceeds to purchase capital, poor landowners may be reluctant to do so. They may feel that they are holding the land, which they inherited from their parents, in trust for their children. In any case, decisions to sell land may not be based solely on a rational calculation.

Land sales may occur in the event of certain stringencies, such as a crop failure or the need for funds for an emergency. Even if it is only under these circumstances that land sales might occur, this does not mean that economic factors do not affect the decision. How serious the crisis must be before land is sold may depend on how much could be obtained for the land, particularly relative to what is being obtained from it at present, and what one would obtain if one became a sharecropper.

In this section, we develop a simple, stylized model to bring out the central issues. We assume that land sales do <u>not</u> occur simply on the basis of the kinds of considerations presented in the previous section. Changes in technology or infrastructure do not cause any instantaneous reorganization of land tenure arrangements. These occur only slowly. Individuals sell their land <u>only</u> in crises. For simplicity, we assume that all farms are of a fixed size; and that a farm is either tilled by its owner or under a sharecropping contract. The question then is, what fraction of aggregate land is tilled under sharecropping contracts?

We postulate that the probability that a farm which is owner-tilled will be sold, and thus become sharecropped, is

$$F = F(V^s, V^o, t)$$

The frequency of an owner-farmer selling his land depends on V^s and V^o, as well as on the technology itself, which may determine, for instance, the likelihood of a crop failure. What is perhaps more crucial than the absolute level either of the expected returns while owner-tilled (reflected in V^o), or the price one can obtain for selling one's land (reflected in V^s) is the ratio of the two, and for subsequent discussion, we postulate that F takes on the simpler form

$$F = F(V^o/V^s, t).$$

The changes in technology or infrastructure with which we are concerned here decrease V^o/V^s, the value of owner-tilled land with binding capital constraints (the farmers who must sell their land in the event of a crisis) relative to sharecropped land. This effect by itself increases F.

The direct effect on F of technological or infrastructure changes is ambiguous. It is often argued that the Green Revolution, while increasing mean returns, has increased the variance of the returns; the seeds are more sensitive to lack of rainfall, and thus the probability of a crisis is increased. If that is the case, then $F_t > 0$; the direct effect of the technological change is to increase the probability of a land sale. There are, of course, other changes in technology which reduce the likelihood of a crisis. Irrigation projects, by making farmers less sensitive to the vagaries of weather, are likely to do this. It is even possible that this direct effect outweighs the indirect "market value" effect, so that the overall probability of an owner-tiller selling his land is decreased.

To derive an equilibrium distribution of land ownership, we have to have a theory of how some land becomes converted back to owner-worked land; otherwise, the model would predict that eventually all land would be owned by large landowners. Any model in which there are some stochastic events that impinge on landowners, eventually converting a small fraction of tenancy land into owner-tilled land, will do. Since this is not the focus of our concern here, we simply postulate that there is a probability $\tau(t)$ of an acre of sharecropped land being converted into owner-worked land. [18] The equilibrium pattern of land-ownership with a given technology is thus described by

$$S\tau = (1 - S)F$$

or

$$S = F/(F + \tau)$$

where S is the share of land that is sharecropped. Thus, if a change in technology increases F/τ, it will increase the proportion of land under sharecropping.

It is thus apparent that a technological change (or change in infrastructure) that induced more owner-farmers to sell their land (increased F) could, in the long run, lead to more inequality in land ownership and an increased proportion of land under sharecropping. This is true even though the productivity on both owner-run farms and sharecropped farms has increased, so long as the productivity on sharecropped farms has

---

18/ Clearly, we could make τ depend on the value of land under the alternative institutional arrangements. Moreover, the changes in the probability distribution of returns which affect the likelihood of owner-tilled land being converted to tenancy are also likely to affect the likelihood of tenancy land being converted to owner-tilled. For instance, if the variance of returns is large, then some sharecroppers will have large returns, enabling them to become owner-tillers. As we show below, what is crucial is the effect of technology on the ratio F/τ.

increased relatively, say because of the increased productivity of capital.[19] This change in the distribution of tenancy may have a deleterious effect on national productivity.[20]

By the same token, a technological change or change in infrastructure which reduces F/T, that is, which induces fewer owner-farmers to sell their land, or which enables more sharecroppers to acquire the capital to make it possible (desirable) for them to be owner-tillers, has a long-run productivity effect which may be far in excess of the immediate, short-run impact.

Similar results can be obtained in a more general model. The wealth distribution at time $v+1$ depends on the wealth distribution at time v and the nature of the stochastic technology. Let $\Omega_i(v)$ be the fraction of the population with wealth i at time v. Let M_{ij} be the transition matrix, a function of t (both directly, and indirectly, through the choices, say, of effort that it induces). Then in a steady state, in the obvious notation,

$$\Omega^* M(t) = \Omega^*.$$

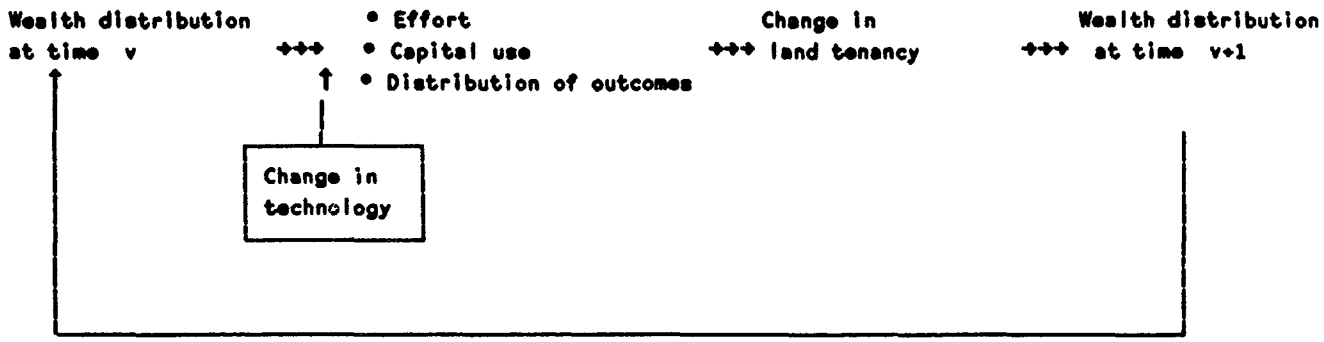
Changes in technology will change the distribution of outcomes under any given pattern of tenancy, and will thereby change the fraction of land under tenancy (Figure 9.5). Hence, changes in technology will affect the

---

19/ Assuming that credit is rationed, and that credit constraints are more binding upon poor farmers than upon wealthier farmers.

20/ The change in tenancy arrangements will have a more deleterious effect on productivity, the greater the difference in productivity on tenancy farms and on owner-run farms; this difference is likely to be larger the greater the elasticity of the supply of effort, and the smaller the extent to which an increase in capital increases the marginal product of effort.

FIGURE 9.5



Changes in technology lead to changes in the long-run distribution of wealth and tenancy arrangements.

steady-state wealth distribution, and this in turn will have real productivity effects. Virtually all changes in technology which change the transition matrix M will lead to a changed long-run distribution of wealth, landholdings, and tenancy arrangements.

Three tasks now lie before us. First, we need to be able to show how particular changes in technology lead to particular changes in the transition matrix M(t). We need to ascertain the precise conditions under which changes in technology are likely to change significantly the long-run equilibrium distributions, both positively and negatively. Our discussion has suggested that adverse distribution effects are more likely to arise from changes in technology which increase the variance of output (or more precisely, the likelihood of a serious crop failure, sufficiently serious that the farmer has to sell his land); and which increase the return to capital.

Secondly, if there is an adverse distribution effect, we need to know the magnitude of the effect on productivity.

Thirdly, the fact that the distribution of landholdings (tenancy arrangements) may have a significant impact on productivity suggests that institutional and other reforms which increase equality may have an important side effect of increasing output. Economists have long focused on the tradeoff between inequality and output. This analysis suggests either that there may not be a tradeoff in the long run, or that the amount of output that need be sacrificed for an improvement in equality may be less than previously thought.

Our analysis suggests particular institutional reforms that might either ameliorate any negative distribution effects or accentuate any positive distribution effects. We have emphasized the role of capital constraints. Credit rationing, we have argued, is the natural result of informational imperfections. Informational problems are no less important for the government than for private lenders. This is not a market failure for which there is an obvious public remedy. On the other hand, our analysis points to the potential role of credit cooperatives in promoting rural development. Examples of successful cooperatives are found in Korea, Taiwan, and Kenya. Unfortunately, credit cooperatives in many other countries have failed. The reasons for the predominance of failures over successes, and an analysis of the enforcement mechanisms in credit cooperatives, are found in Braverman and Guasch (1989).

CONCLUSION

We have argued here that even if share tenancy is Pareto-efficient, productivity with share tenancy may be lower than with owner-operated farms. The prevalence of share tenancy is directly related to the inequality in the distribution of wealth, and of landholding in particular. But the degree of inequality should itself be viewed as an endogenous variable, affected by decisions by both large landholders and small peasants concerning the choice of technique and the forms in which to hold their wealth. Both these decisions and their consequences, in turn, are affected by changes in technology and in the rural infrastructure. In the presence of credit rationing, changes in technology may increase inequality in landholdings, with a long-run increase in the prevalence of share tenancy. This in turn *may* have long-run deleterious effects on productivity at least partially offsetting the initial improvements. We have suggested that the development of effective rural financial institutions would reduce the likelihood of these negative effects on equality and productivity.

Here, we have only sketched the outlines of a general theory. We have, however, provided a framework which should enable one to determine whether, in any particular case, changes in technology or infrastructure have the possible adverse effects we have noted.

REFERENCES

Bhaduri, A (1973), "Agricultural Backwardness under Semifeudalism", Economic Journal, 83:120-137.

_________ (1980), "Agricultural Backwardness Under Semifeudalism: A Rejoinder", Economic Journal, 89:420-421.

Braverman, A and L. Guasch (1989), "Institutional Analysis of Credit Cooperatives", in P. Bardhan, ed., The Economic Theory of Agrarian Institutions. Oxford University Press.

Braverman, A and L. Guasch (1986), "Rural Credit Markets and Institutions in Developing Countries: Lessons for Policy Analysis from Practice and Modern Theory", World Development, 14:1253-1267.

Braverman, A and T.N. Srinivasan (1981), "Credit and Sharecropping in Agrarian Societies", Journal of Development Economics, 9:289-312.

Braverman, A and J.E. Stiglitz (1986a), "Cost Sharing Arrangements Under Sharecropping: Moral Hazard, Incentive Flexibility and Risk", American Journal of Agricultural Economics, 68:642-652.

_________ (1986b), "Landlords, Tenants, and Technological Innovations", Journal of Development Economics, 23:313-332.

Dasgupta, P and D. Ray (1986), "Inequality as a Determinant of Malnutrition and Unemployment: Theory", Economic Journal, 96:1011-1034.

Greenwald, B and J.E. Stiglitz (1986), "Externalities in Economies with Imperfect Information and Incomplete Markets", Quarterly Journal of Economics, 101:229-264.

Greenwald, B., J.E. Stiglitz and A. Weiss (1984). "Informational Imperfections and Macroeconomic Fluctuations". American Economic Review, 74:194-199.

Stiglitz, J.E. (1974), "Incentives and Risk Sharing in Sharecropping", Review of Economic Studies, 41:219-255.

Stiglitz, J.E. and A. Weiss (1981), "Credit Rationing in Markets with Imperfect Information", American Economic Review, 71:393-410.

PPR Working Paper Series

	Title	Author	Date	Contact
WPS155	Measuring Adult Mortality in Developing Countries: A Review and Assessment of Methods	Ian Timaeus Wendy Graham	April 1989	S. Ainsworth 31091
WPS156	Credit Cooperatives in Israeli Agriculture	Yoav Kislev Zvi Lerman Pinhas Zusman	March 1989	C. Spooner 37570
WPS157	A Policy Model for Tunisia with Real and Financial Flows	Martha de Melo Marc Leduc Setareh Razmara	January 1989	A. Bhalla 60359
WPS158	Labor Redundancy in the Transport Sector	Alice Galenson	February 1989	W. Wright 33744
WPS159	Current International Gas Trades and Prices	Kay McKeough	March 1989	M. Fernandez 33637
WPS160	Evaluating the Performance of Public Enterprises in Pakistan	Mary M. Shirley	March 1989	R. Malcolm 61708
WPS161	Commodity-Indexed Debt in International Lending	Timothy Besley Andrew Powell	March 1989	J. Raulin 33715
WPS162	Ups and Downs in Inflation: Argentina Since the Austral Plan	Miguel A. Kiguel		
WPS163	The Impact of Infrastructure and Financial Institutions on Agricultural Output and Investment in India	Hans P. Binswanger Shahidur R. Khandker Mark R. Rosenzweig	March 1989	J. Arevalo 30745
WPS164	Intersectoral Financial Flows in Developing Countries	Patrick Honohan Izak Atiyas	March 1989	W. Pitayatonakarn 60353
WPS165	Developing Countries' Exports of Manufactures: Past and Future Implications of Shifting Patterns of Comparative Advantage	Alexander J. Yeats		

PPR Working Paper Series

	Title	Author	Date	Contact
WPS166	Achieving and Sustaining Universal Primary Education: International Experience Relevant to India	Nat J. Colletta Margaret Sutton	March 1989	M. Philiph 75366
WPS167	Wage Determination in Rural Bangladesh: The Welfare Implications	Martin Ravallion		
WPS168	Technological Change from Inside: A Review of Breakthroughs!	Ashoka Mody	March 1989	W. Young 33618
WPS169	Financial Sector Reforms in Adjustment Programs	Alan Gelb Patrick Honohan		
WPS170	General Training Under Asymmetric Information	Eliakim Katz Adrian Ziderman	April 1989	C. Cristobal 33640
WPS171	Cost-Effectiveness of National Training Systems in Developing Countries	Christopher Dougherty	March 1989	C. Cristobal 33640
WPS172	The Effects of Peru's Push to Improve Education	Elizabeth M. King Rosemary T. Bellew	March 1989	C. Cristobal 33640
WPS173	Staffing and Training Aspects of Hospital Management: Some Issues for Research	Julio Frenk Enrique Ruelas		
WPS174	Trade Restrictions with Imported Intermediate Inputs: When Does the Trade Balance Improve?	Ramon E. Lopez Dani Rodrik	March 1989	M. Ameal 61466
WPS175	An Integrated Model of Perennial and Annual Crop Production for Sub-Saharan Countries	Robert D. Weaver	May 1989	A. Daruwala 33716
WPS176	Credit Rationing, Tenancy, Productivity, and the Dynamics of Inequality	Avishay Braverman Joseph E. Stiglitz	May 1989	C. Spooner 37570