Unequal Distribution as a Cause of Market Failure, Low Productivity and Slow Growth:

Comparative Impact of Land and Output Taxes

By Mary M. Cleveland

Given transactions costs, inequality of land ownership necessarily creates a labor and land market failure; the greater the inequality, the more severe the failure. This failure explains the regressive land use characteristic of less-developed agriculture: the larger a landowner, the lower the ratio of labor to land, and the less the output per unit area for constant land quality. A land tax, far from the neutral tax of conventional theory, imposes income and marginal effects that counteract this market failure. An output tax compounds market failure.

I. Equality, Productivity and Growth

A. The Pervasiveness of Regressive Land Use, and Its Association With Unequal Distribution and Poverty

In his 1879 classic *Progress and Poverty*, Henry George argued that great inequality of wealth is not merely unjust, it also cripples economic productivity and growth. He focused attention on a phenomenon already clearly identified by Adam Smith: *regressive land use*. That is, holding land quality constant, larger property owners use their land less intensively than do smaller ones. Smith observed that:

> To improve land with profit, like all other commercial projects, requires an exact attention to small savings and small gains, of which a man born to great fortune, even though naturally frugal, is very seldom capable... He embellishes perhaps four or five hundred acres in the neighborhood of his house, at ten times the expense which the land is worth after all his improvements; and finds that if he was to improve his whole estate in the same manner, and he has little taste for any other, he would be a bankrupt before he has finished the tenth part of it...
>
> A small proprietor, however, who knows every part of his little territory, who views it with all the affection which property, especially small property, naturally inspires, and who upon that account takes pleasure not only in cultivating but in adorning it, is generally of all improvers the most industrious, the most intelligent, and the most successful. [Smith, 1952]

Smith in fact attributed the prosperity of the British Colonies in North America to the practice of distributing land in small holdings; he attributed the backwardness of the Spanish colonies to the practice of "engrossing the land"--distributing land in large estates.

LAND, LABOR AND OUTPUT IN SOUTH AMERICA

Figure 1

Most of the farm land in South America is held in small or large estates, known as latifundia. Mini-farms (too small to support a family) occupy under 2% of farm land, often of low quality.. Family farms occupy another 16%.

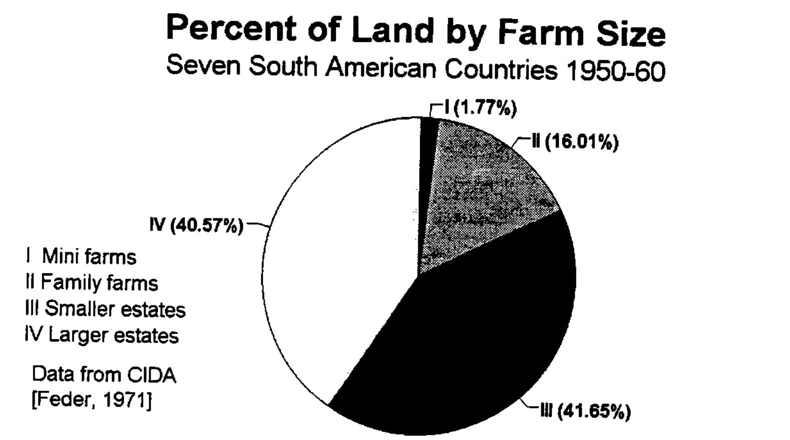


Figure 2

The ratio of workers to land is much higher on mini farms than on family farms or small estates. The latter in turn have much higher ratios than the larger estates. The smaller farms cultivate a larger portion of their land (55% on average) while the larger farms run more livestock.

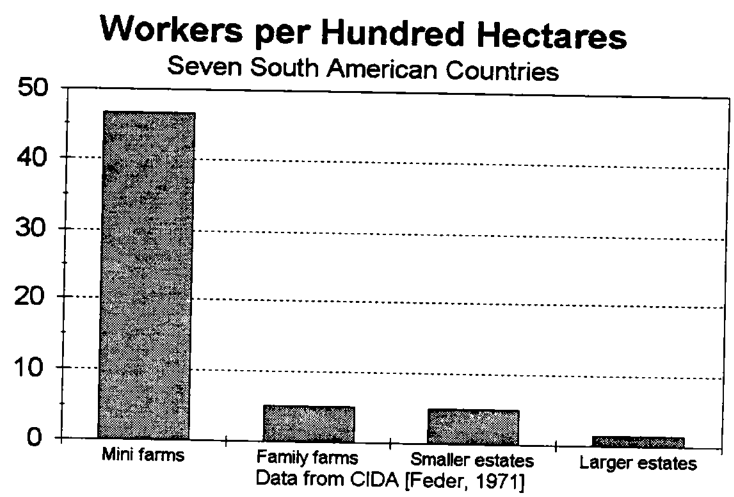


Figure 3

Regressive land use is particularly dramatic in Latin America, and fairly conspicuous in other less-developed countries. However the pattern occurs everywhere.

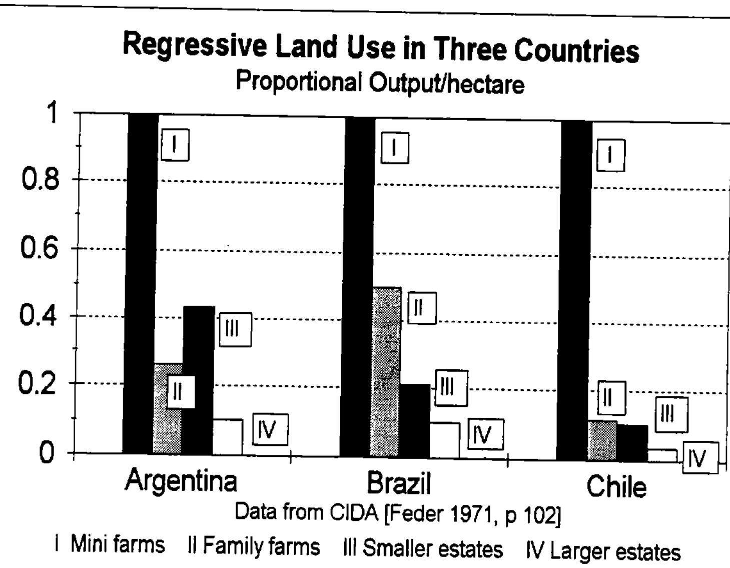
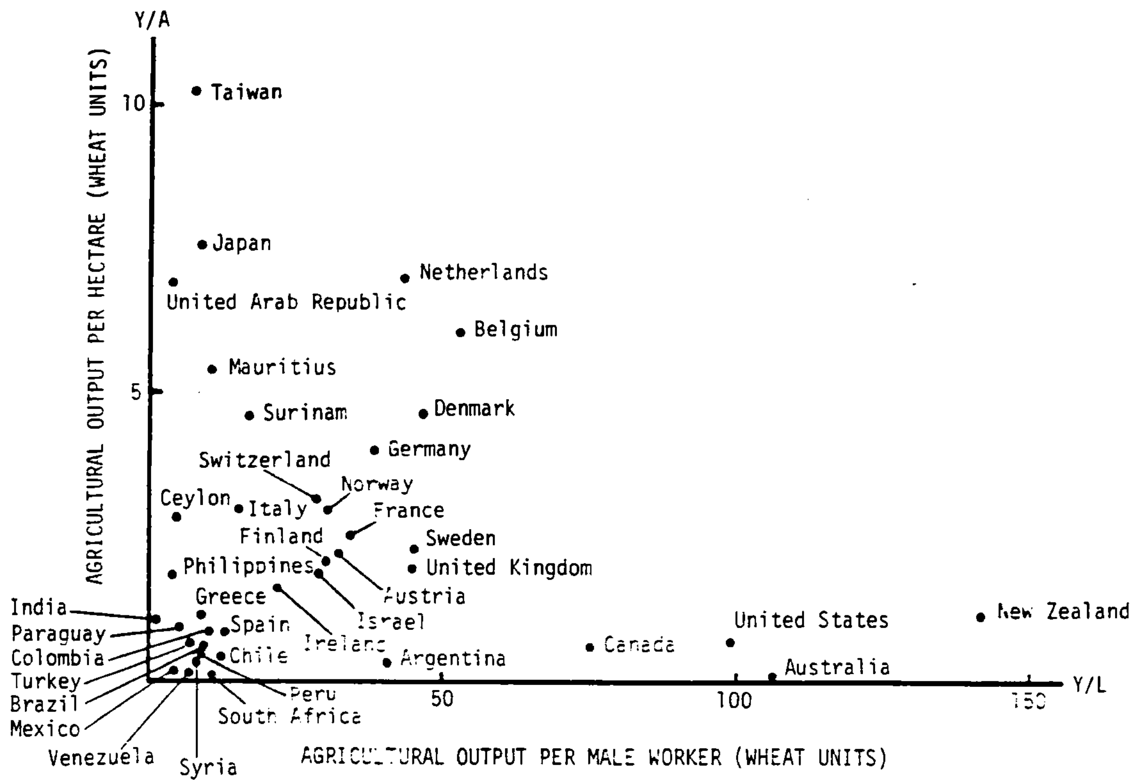


Figure 4: The Agricultural Productivity Gap Among Countries

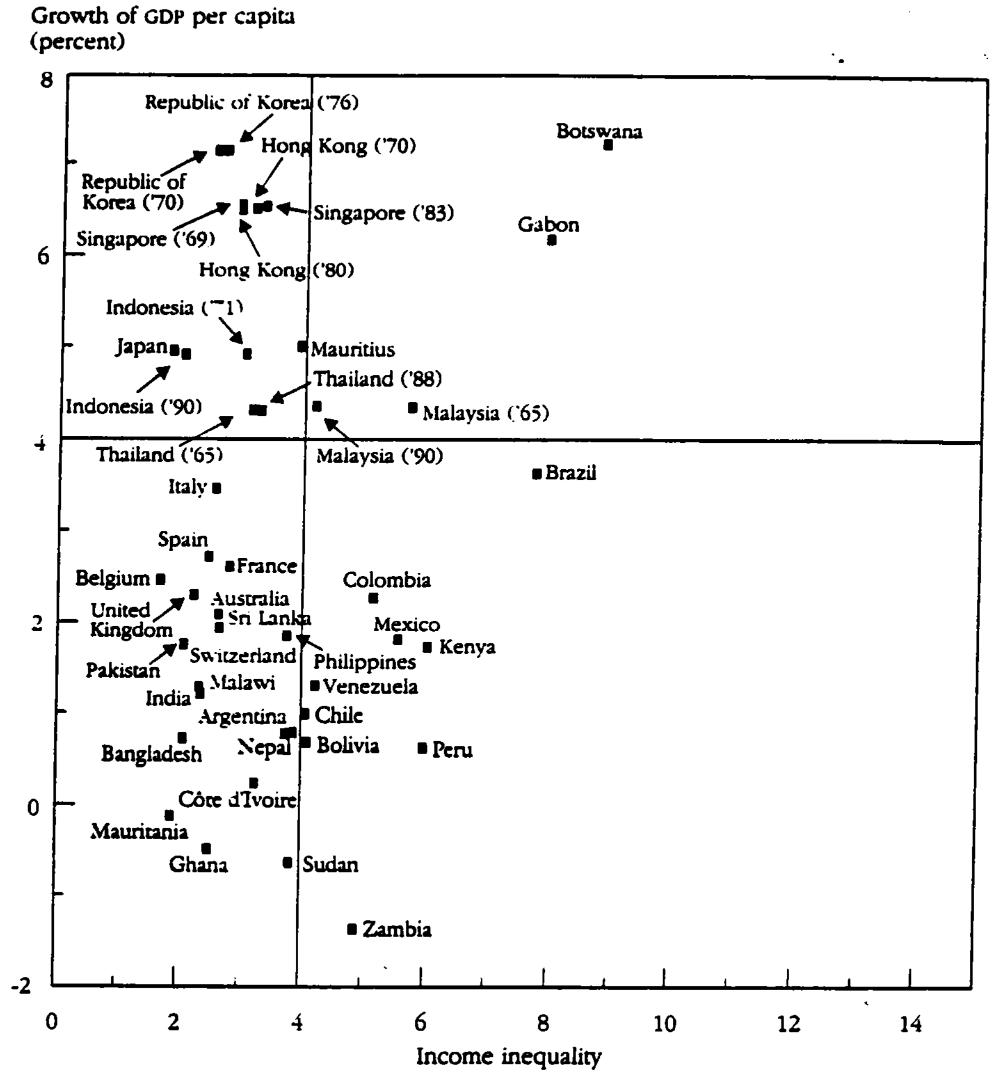


International comparison of agricultural output per male worker and per hectare of agricultural land. Output data are 1957-62 averages; and labor and land data are of year closest to 1960.

Note that densely-populated countries like Japan show a high output per hectare, but a relatively low output per man-hour; lightly populated countries like the United States show a high output per man-hour, but low output per hectare. Intermediate countries like Denmark lie in-between. But less-developed countries huddle in the lower left corner with low output per man-hour and per hectare, regardless of population density.

From: **Hayami, Yujiro & Vernon W. Ruttan**. *Agricultural Development: An International Perspective*, Johns Hopkins Press, Baltimore, MD, 1971, p. 71. (The 1985 revised edition contains the same figure with more recent data--graphed on a log scale which obscures the contrast between less-developed and developed countries.)

Figure 5. Income Inequality and Growth of GDP, 1965-89



Note: Income inequality is measured as the ratio of the income shares of the richest 20 percent to the poorest 40 percent of the population. For the East Asian economies, the change in that ratio is shown using the earliest and the latest year for which that ratio is available. For all other economies, the average of that ratio is taken using all years in the period 1965-89 in which the ratio was available. Source: World Bank (1994).

From: **Birdsall, Nancy, David Ross & Richard Sabot.** "Inequality and Growth Reconsidered: Lessons from East Asia" *World Bank Economic Review*, Vol. 9, No. 3, September, 1995, p 480.

George described a pattern of underuse or nonuse of large land-holdings around the world, from the newly-opened farmlands of California, to the estates of absentee British aristocrats in Ireland, to the feudal holdings of the *zamindars* of India--who served as tax-collectors for the British East India Company. He emphatically refuted the Malthusian doctrine that attributed the starvation of Irish or Hindu peasants to "overpopulation," pointing out that during the Irish potato famine, Ireland remained a major exporter of wheat. George saw more than mere inefficiency: he saw the root cause of the poverty that persisted and even increased in the face of growing economic prosperity. In his view, landlords withheld land from use, forcing down wages to subsistence. A land tax, he argued, together with an elimination of other taxes, would force landowners to release idle land for productive use, eliminating poverty.

Today, regressive land use remains a conspicuous feature of less-developed agriculture (and a still-significant feature of developed agriculture) [Berry & Cline, 1979]. Data from a major survey of Latin American land ownership dramatizes the contrast between large and small land holdings. See Figures 1-3, from [Feder, 1971]. Figure 4 shows how less-developed countries with such land use patterns show much lower output per man-hour and per hectare than do developed countries.

The inefficiency of less-developed land use patterns leads many prominent development economists to argue that growth cannot occur without significant redistribution of land. Irma Adelman in fact insists that redistribution must *precede* growth [Adelman & Robinson, 1989, p 984]. She and other development economists recommend redistribution by land reform--redistributing land in small parcels, by land taxes, or by some combination of both [de Janvry, 1993]. The two most thorough land reforms occurred in Japan just after World War II and in Taiwan in the early '50's, both--by no coincidence--under occupying armies. The reform in Taiwan has been maintained by heavy land taxes. More limited land reforms, as in South Korea, Mexico, Bolivia, and Egypt have also yielded good results [Dorner, 1971]. But most land reform attempts have foundered on the political power of large landowners. [de Janvry & Sadoulet, 1993]. The Brazilian 1964 Land Statute provided for taxing the unused land of large landowners, but the law has proved unenforceable. Groups of peasants periodically "invade" and attempt to cultivate large vacant areas--only to be slaughtered by the private armies of the landowners [Alston et. al., 1995].

Meanwhile, the Asian "Tigers"--South Korea, Taiwan, Singapore, Hong Kong, Japan, Indonesia, Thailand and Malaysia--have unequivocally demonstrated the close association of relative equality and high rates of growth. See Figure 5. The economic literature is now bursting with models and discussions of the phenomenon. [Galor & Zeira, 1993; Alesina & Perotti, 1994; Chang, 1994]. Nancy Birdsall posits a "virtuous cycle" in which egalitarian policies, notably universal access to good education, lead to greater labor productivity and higher wages, which in turn leads to more demand for investment in education, greater savings and investment by lower income groups, harder work by the same groups in the face of improved opportunity, greater economic stability, greater democracy, and less public spending on favored groups [Birdsall et. al., 1995].

B. Explaining Regressive Land Use with Transactions Costs and Other Market Obstacles

Despite his popularity and influence, George received little recognition as an economist. His attack on the Malthusian doctrine and the policies of the British Empire thoroughly antagonized the British establishment, including such economists as Alfred Marshall, who once publicly debated him. And a key part of his argument did not hold up very well: George explained land withholding as due to "land monopoly" or "land speculation." As Marshall asked, how could there be a land monopoly when there were many landowners and no apparent collusion between them? [Marshall, 1883] Absentee speculators obviously bought up large tracts of land and held them unused in newly-opened California irrigation districts where land values were rapidly rising, as George noted. But unused or underused tracts could be found where land values were stable as well. Poverty persisted and inequality increased where there was economic growth, as on the American frontier a hundred years ago. But poverty persisted in the absence of growth in the Old World or China or India.

Since then, economic theory has caught up with the problem. The last twenty years in particular have seen a rapid development in theories of transactions costs, property rights, principal-agent interactions, market failure, missing markets and so forth. These now make it possible to explain regressive land use with conventional neo-classical methods.

Capital market failure has long offered a partial explanation for regressive land use. As Rainer Schickele observed many years ago, when banks make loans, "The principle of allocation is collateral security, not marginal productivity...These two principles tend to work at cross purposes: with increasing collateral security, the marginal productivity of capital tends to decline, and vice versa. Instead of allocating capital to where it is scarce, our credit system allocates it to places where it is ample." [Schickele, 1943, p 240]. Mason Gaffney has extensively investigated the effects of capital market failure on land use [Gaffney, 1956, 1961, 1975]. Nancy Birdsall offers capital market failure as the primary explanation for the association of greater equality with higher growth; that is, in highly unequal economies, parents can neither pay for education for their children nor forgo their children's earnings where education is free, even though such education offers a very high return on investment.

But capital market failure cannot in isolation explain regressive land use. It does not permit a general equilibrium; there must also be a labor market failure to make the capital market failure effective. That is, suppose capital market failure prevents poor individuals from buying or renting land from the local landlords. These individuals should be able to work for the landlords at a wage and intensity such that the capital market constraint does not bind, and productivity remains unaffected.

Enter supervision costs, now very familiar from the principal-agent literature. An agent has an incentive to shirk. In an uncertain environment, necessarily the case in agriculture, the principal cannot verify the agent's performance without monitoring him. Supervision costs create a labor market failure that balances capital market failure. In fact, capital market failure itself ultimately arises from supervision costs in the capital markets.

The first published neo-classical model that clearly embodies the concept of labor market failure balancing capital market failure is that of Mukesh Eswaran and Ashok Kotwal [Eswaran and Kotwal, 1986]. They develop a model of five agrarian classes depending on working capital, with class boundaries determined by Kuhn-Tucker conditions: pure laborer, laborer-cultivator, self-cultivator, small capitalist and large capitalist. The laborer-cultivator cultivates a small plot and hires labor out, the self-cultivator neither hires in nor out. The small capitalist hires in, works his own land, and supervises his employees. The large capitalist hires in and only supervises his employees. Working capital is partly given, and partly borrowed in proportion to land-ownership, which is exogenous. Eswaran and Kotwal's model clearly predicts regressive land use.

Eswaran and Kotwal in turn acknowledge a debt to John Roemer, who in 1982 proposed a similar scheme of five classes dependent on capital ownership. [Roemer, 1982], as well as to Pranab Bardahn, who immediately applied Roemer's scheme to Indian peasant society [Bardahn, 1982]. Roemer's models are rather complex linear programming exercises involving only labor and capital. Roemer dismisses land altogether as a factor of production, by assuming an unlimited supply. This perhaps explains why Eswaran and Kotwal downplay land to focus on working capital, even in their title-- "Access to Capital and Agrarian Production Organization" instead of "Access to Land.." In fact they conclude that "the creation of institutions capable of accepting as collateral future crops rather than owned land-holdings would prove to be an effective tool for removing poverty as well as for improving efficiency." [p 196].

Others, notably Michael Carter, have elaborated on Eswaran and Kotwal's model. [Carter and Kalfayan, 1989; Carter and Mesbah, 1993; Wydick, 1994].

Working independently, I constructed models to explain regressive land use as a consequence of barriers to trade between individuals with different wealth endowments. [Cleveland, 1984]. To illustrate the basic concept, imagine a collection of Robinson Crusoes each occupying his own island an hour or two's canoe paddle from the others. If the islands vary in size, the occupants of larger islands may hire those of smaller islands. But the physical barrier of the canoe trip must obviously cause regressive land use. Moreover, the occupants of the smaller islands must necessarily experience a lower marginal product of labor and hence lower effective wage. In a simple agricultural model, wealth endowments likewise consist entirely of land; capital is unnecessary. The barriers to trade consist of supervision costs required when one person's labor combines with another person's land. The time and energy barrier of supervision costs mean that as an owner's land size increases, intensity of land use falls and the owner's wage rises.

Appendix A lays out a simple general equilibrium model of a one-period economy consisting of identical "farmers" who own different size pieces of otherwise identical land, or no land at all. "Richer" farmers may hire "poorer" farmers, but if they do, they must "supervise" them; the less they supervise, the less productive their employees.

Part II, following, shows graphically the results of a numerical version of this general equilibrium model, as distribution of land varies from equality to considerable inequality. It also shows how a land tax counteracts the effect of inequality, while an output tax aggravates it.

Part III draws implications for U.S. policy. In brief, at the very time that the economic desirability of greater equality has been proven beyond any reasonable doubt, the United States is slipping towards greater and greater inequality of wealth and income. Even worse, the Republican majority seems bent on accelerating the trend, by reducing public benefits to lower income citizens, while rending the income tax system more regressive.

II. A Numerical General Equilibrium Model Showing Effects of Unequal Distribution, Output Taxes and Land Taxes

The model assumes an economy consisting of 100 identical farmers occupying a uniform area of land. The individuals are divided into five groups, consisting of 5, 10, 15, 20, and 50 farmers respectively. The groups' share of land varies according to a formula from complete equality to the top 5% having almost 60% of the land. A required minimum parcel size renders an increasing fraction of the bottom 50% "landless" as distribution becomes more unequal. Farmers who hire in labor face a supervision cost in that the "effectiveness" of hired labor is reduced by a factor proportional to the ratio of own labor to hired labor. An optimization program (GAMS) computes the equilibrium over the range of distributions for three cases: no taxes, a 50% output tax, and a land tax (set to equal the output tax at equal distribution.) It is assumed that the taxes simply leave the economy.

As predicted, as the top 5%'s land share increases, so does their wage, their income, their output, their profit and *the hours that they work*. However, their ratio of labor to land decreases, as does their output per acre, their marginal product of land, and the effectiveness of their hired labor. For the entire economy, greater inequality brings lower effective labor supply, lower income, lower output, and lower profit.

The 50% output tax only slightly intensifies the relative effects of unequal distribution of land. However it proportionally reduces everything by about 50%, including the marginal product of land. The land tax, by contrast, sharply increases output even at the extreme of inequality. It reduces the income disparity caused by unequal land ownership. It increases labor and the marginal product of land. Most dramatically, at a relatively small degree of inequality, the land tax makes the farms of the top 5% unprofitable, as the marginal product of their land falls below the land tax rate. Thus if transaction cost barriers to sale maintain unequal distribution of land, an output tax reduces the benefit of overcoming the barriers; a land tax increases the benefit.

Because of economies of scale in production, labor plus land shares exceed output. This apparent impossibility in fact creates no problems at all. Labor share consists of own labor share plus hired labor share; only the hired labor share is actually paid from one individual to another. Due to supervision costs, land plus hired labor share cannot exceed output and there are no riots in the streets.

POPULATION, LAND, AND LABOR EFFECTIVENESS

Figure 6

Due to minimum parcel size, more and more of the bottom 50% become landless as distribution becomes more unequal. At the limit, 42 of the bottom 50 are landless and 8 are marginal.

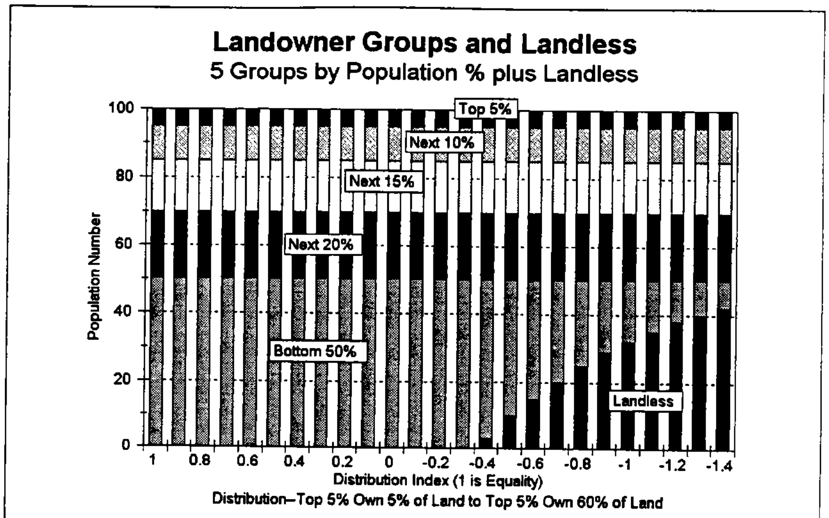


Figure 7

At the limit, the top 5% hold 56.3% of the land. Their parcel size is 2.25 units versus .056 units for the marginal farmers, a ratio of 40 to 1.

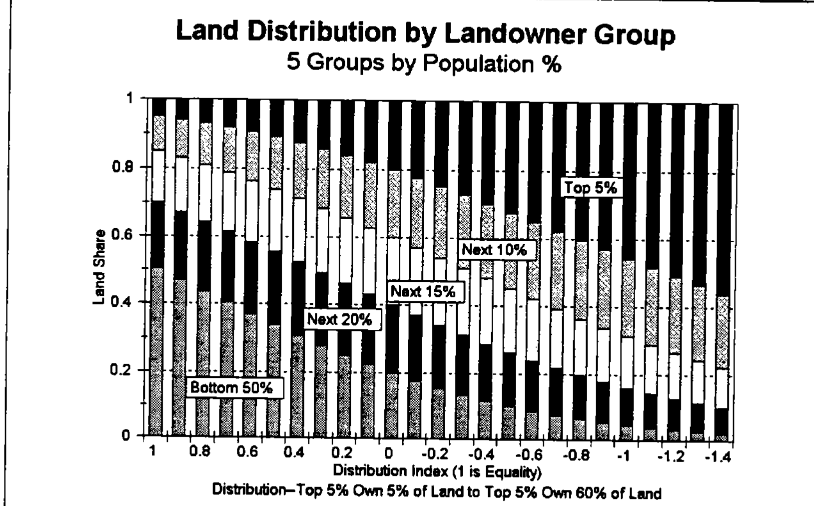
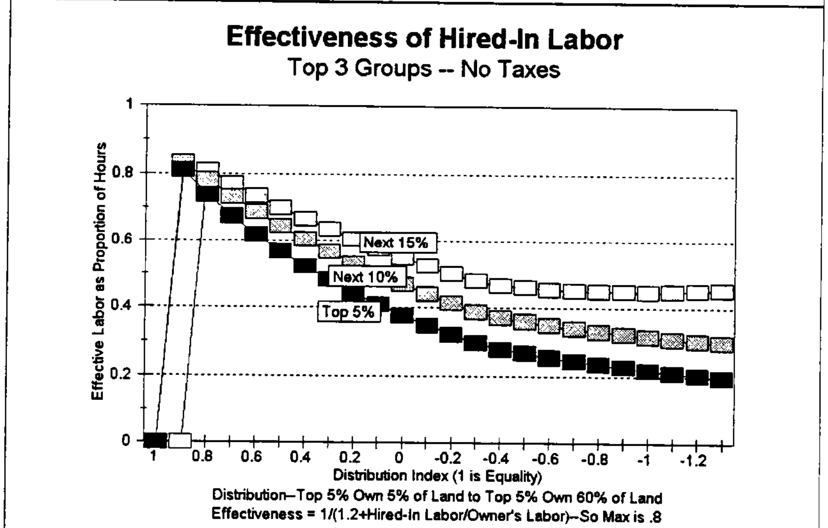


Figure 8

The bottom two groups do not hire labor over most of the range.



OUTPUT AND TAXES

Figure 9

Output falls over the range from 1574 to 1182, about 24.9%. At the limit the top 5%, with 56% of the land, produce 42.3% of output.

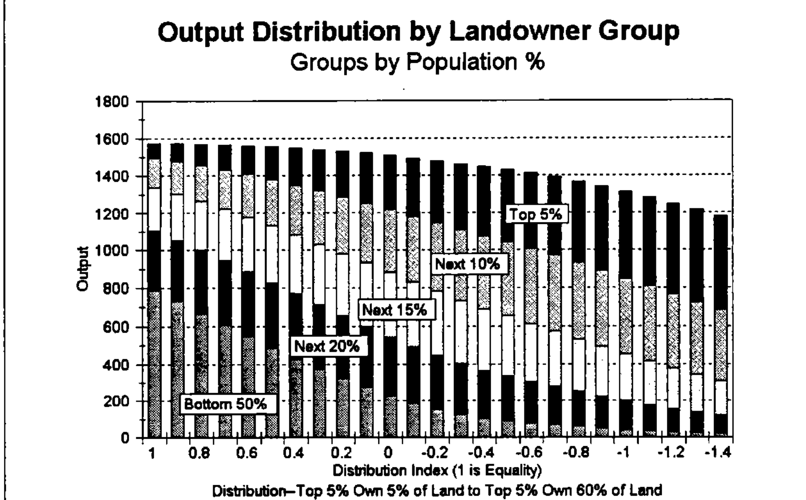


Figure 10

Output falls over the range from 1571 to 1177, about 25.1%. At the limit the top 5% still produce 42.3% of output. After-tax output and tax both = 588.5.

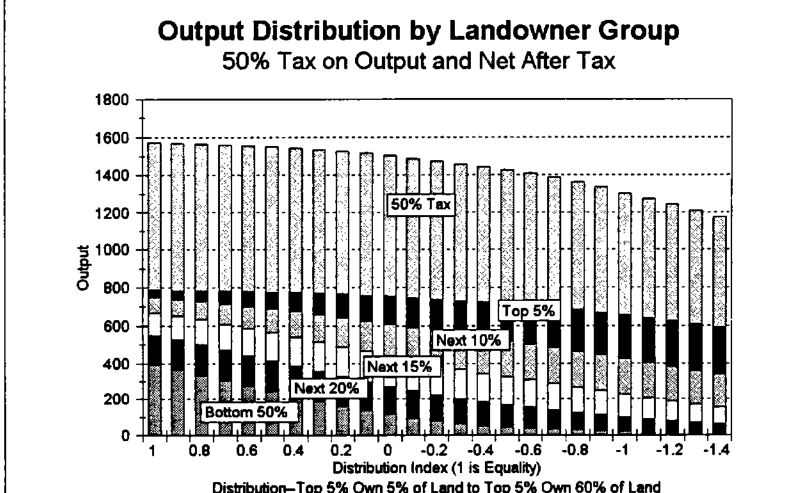
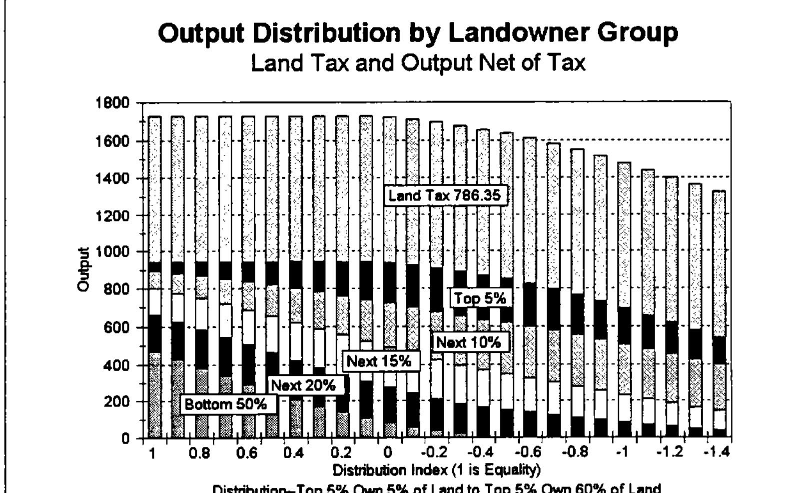


Figure 11

Output falls over the range from 1727 to 1327, about 23.2%, even though the tax remains constant At the limit the top 5% produce 43.7% of output. Tax remains 785, leaving after-tax output of 542.



INCOME PER CAPITA

Figure 12

At equality, per capita income is 23.9. At the limit, the top 5% income is 104.5, versus 4.89 for the marginal farmers of the bottom 50%, and 0.83 for the landless. So, with about 40 times the land of the marginal farmers, the top 5% get about 21x the income. They get about 126 times landless income.

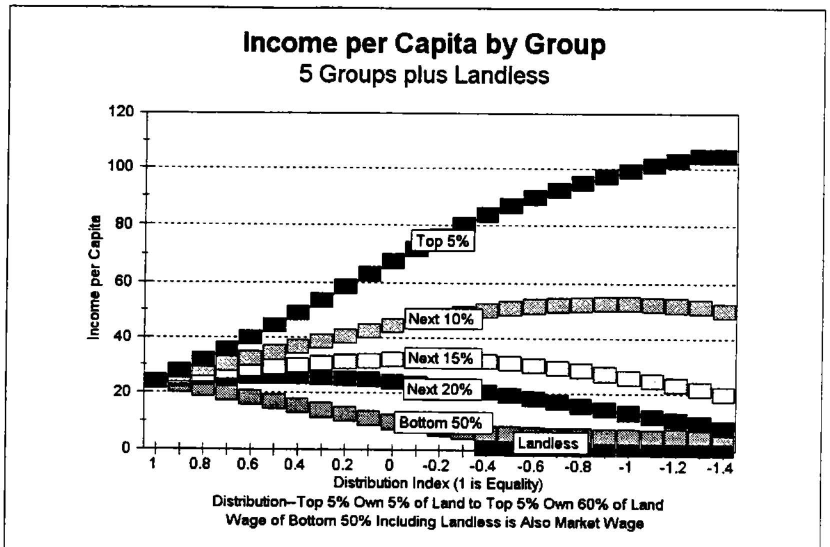


Figure 13

At equality, after tax per capita income is 12. At the limit, the top 5% income is 52.4, versus 2.49 for the marginal farmers of the bottom 50%, and 0.737 for the landless. Again, the top 5% get about 21x the income of the marginal farmers and 76 times landless income. (Scale is 1/2 that of graph above.)

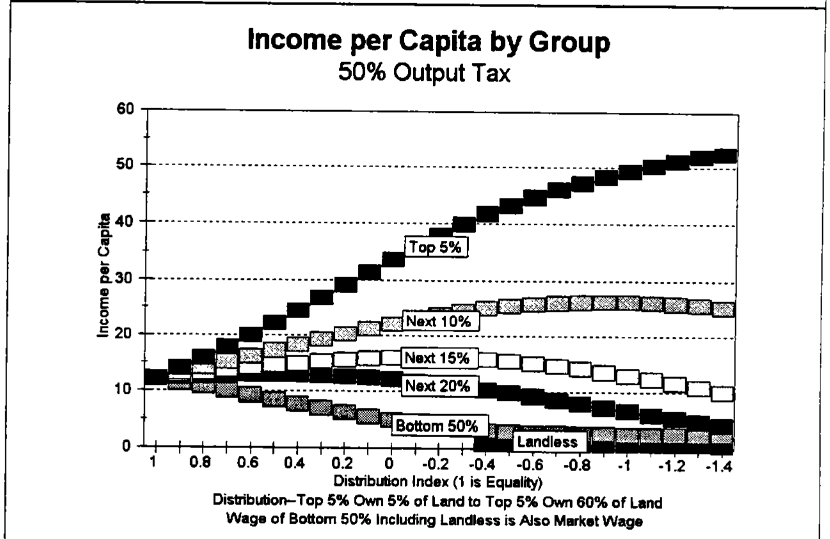
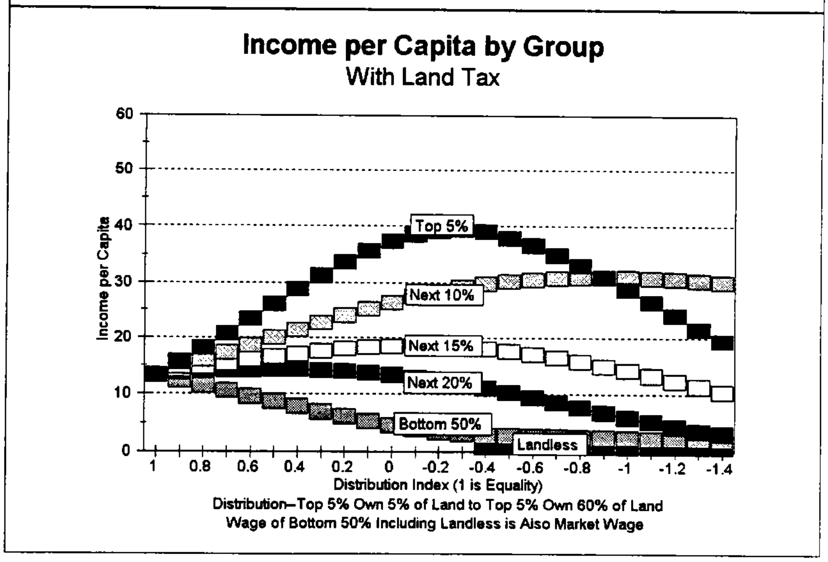


Figure 14

At equality, after tax per capita income is 13.2. At the limit, the top 5% income is only 19.4, less than the income of 30 for the next 10%! The marginal farmers get 2.1 and the landless get 0.8, --barely less than with no tax, and much more than with a 50% output tax.



INCOME DISTRIBUTION

Figure 15

Total income over the range falls from 2395 to 1515, a 36.7% drop. At the limit, the top 5% get 34.5% of income, while the bottom 50%, including landless, get 4.9%

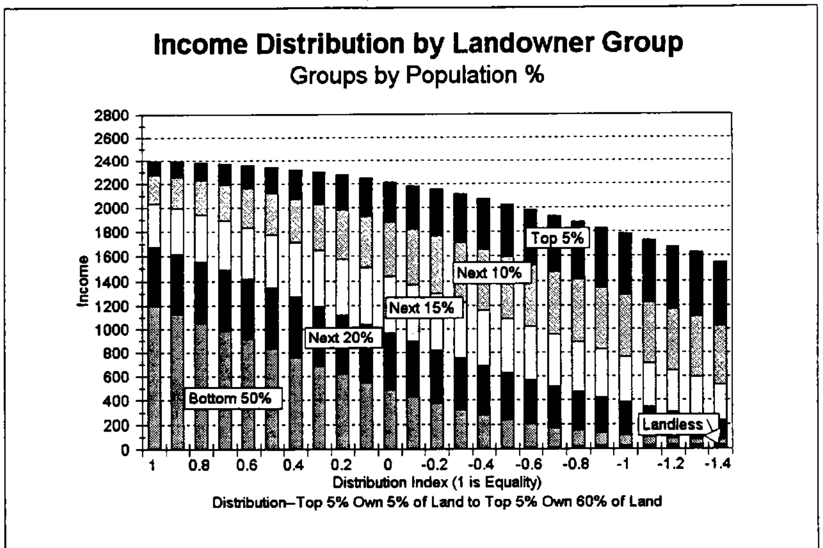


Figure 16

Total after-tax income over the range falls from 1200 to 767, a 36.1% drop. At the limit, the top 5% get 34.2% of income, while the bottom 50%, including landless, get 6.5%.

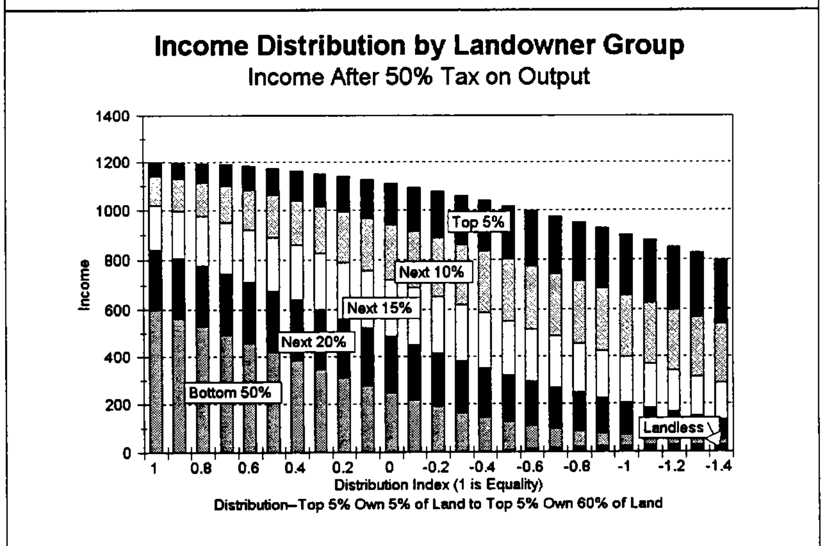
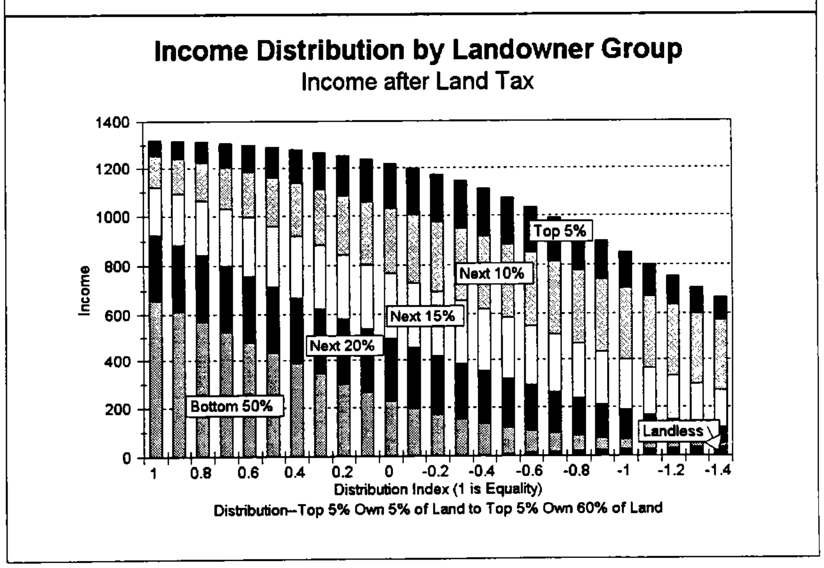


Figure 17

Total after-tax income over the range falls from 1319 to 699, a 47% drop. At the limit, the top 5% get 13.9% of income, the next 10% get 42.9% while the bottom 50%, including landless, get 7.2%



PROFIT DISTRIBUTION

Figure 18

Total profit over the range falls from 807 to 431, a 46.6% drop. At the limit, the top 5% get 15.4%, while the 8 marginal farmers in the bottom 50% get 4.1%.

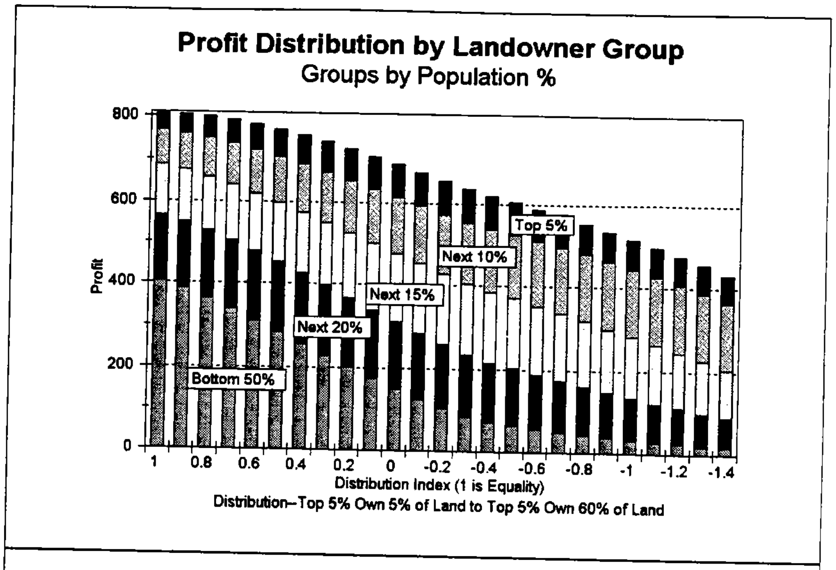


Figure 19

Total after-tax profit over the range falls from 401 to 215, a 46.4% drop. At the limit, the top 5% get 15.3%, while the marginal farmers get 4.0%.

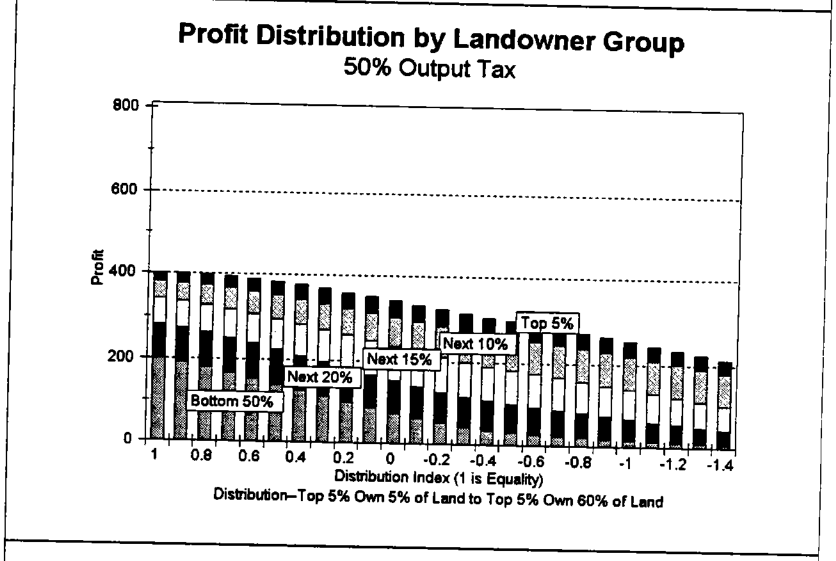
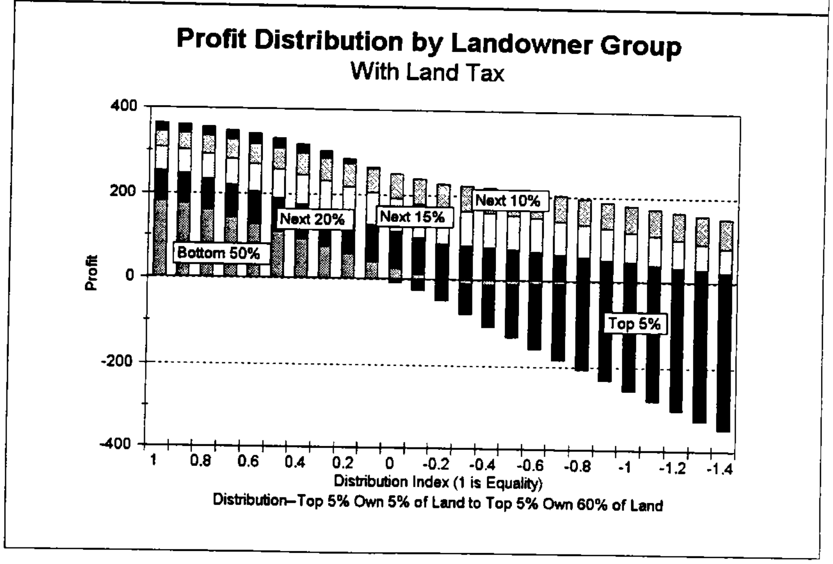


Figure 20

Catastrophe! Total after-tax profit over the range falls from 363 to -198, a 155% drop. At the limit, the top 5% get a huge negative profit of 349. They pay more wages (mostly to themselves) than they keep after-tax output. The top 10% gets a positive profit of 70, and the marginal farmers get all of .95.



INDIVIDUAL LABOR TIME

Figure 21

Maximum labor time per period = 1. At equality, everyone works .48. At the limit, the top 5% work .85, the marginal farmers work .17, and the landless work .83. Since the wage is the same for marginal and landless, the big difference in labor time shows the sensitivity of labor supply to profit at a low wage.

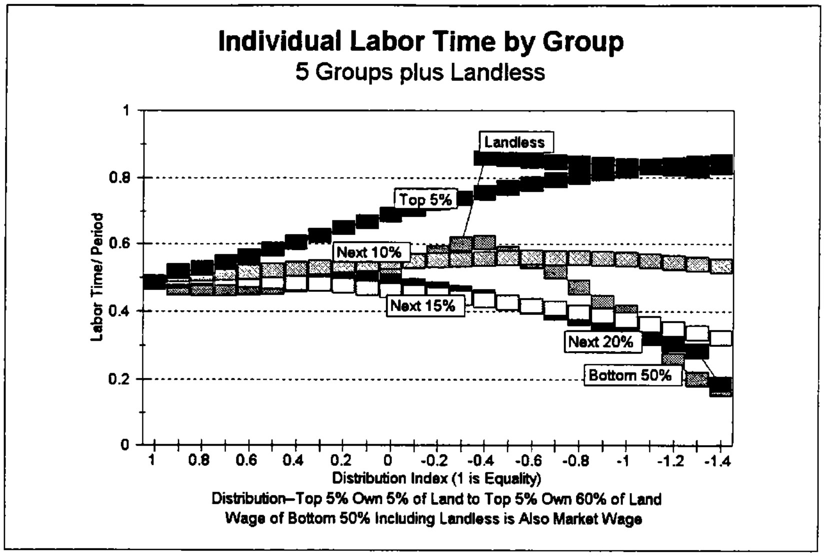


Figure 22

At equality, everyone still works .48. At the limit, the top 5% work .84, the marginal farmers work .19, and the landless work .74.

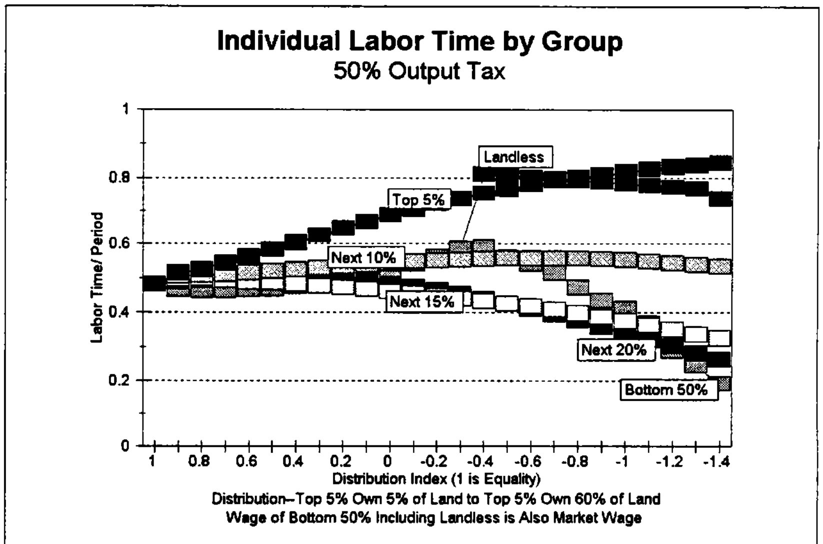
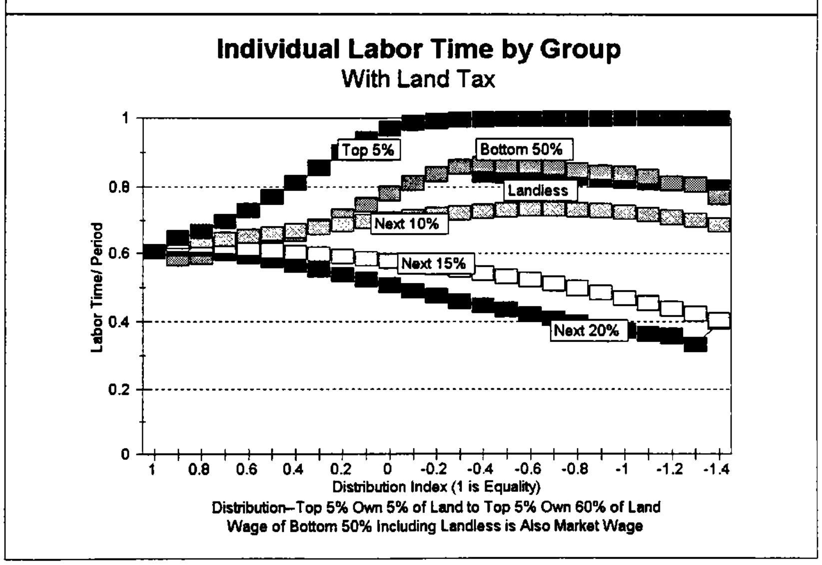


Figure 23

The land tax clearly makes everyone work harder. At equality, everyone works .60. At the limit, the top 5% work a pathological .999, the marginal farmers work .77, and the landless work .80.



TOTAL LABOR SUPPLIED AND APPLIED

Figure 24

Applied labor falls from 48.3 to 30.4, a 37.1% drop. Supplied labor starts at 48.3, rises to maximum of 56.0, and falls again to 54.5. The final ratio of applied to supplied labor is 56%, which means the other 44% is lost to supervision costs.

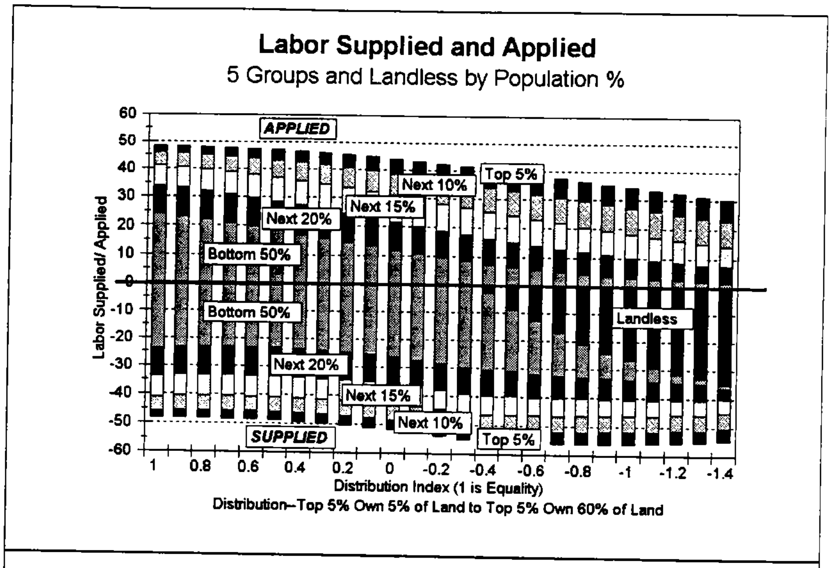


Figure 25

Applied labor falls from 48.1 to 29.9, a 37.8% drop. Supplied labor starts at 48.1, rises to maximum of 54.8, and falls again to 52.2. The final ratio of applied to supplied labor is 57.%, which means the other 43% is lost to supervision costs.

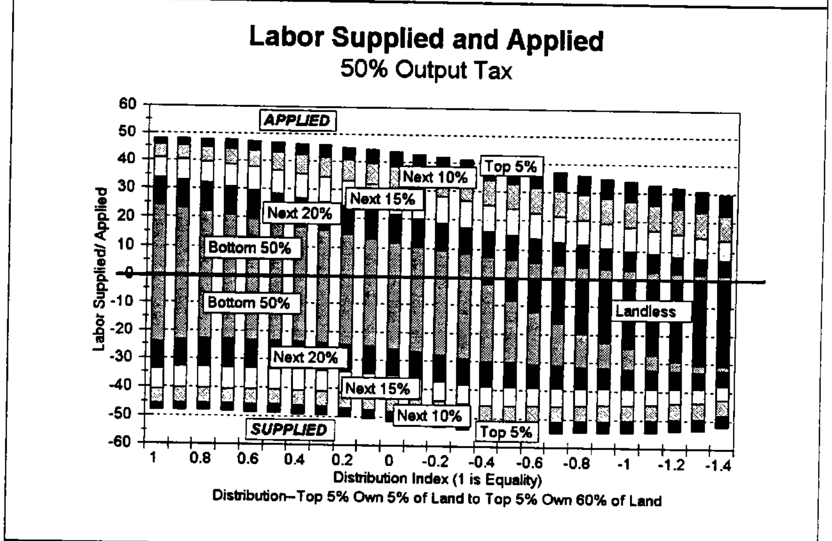
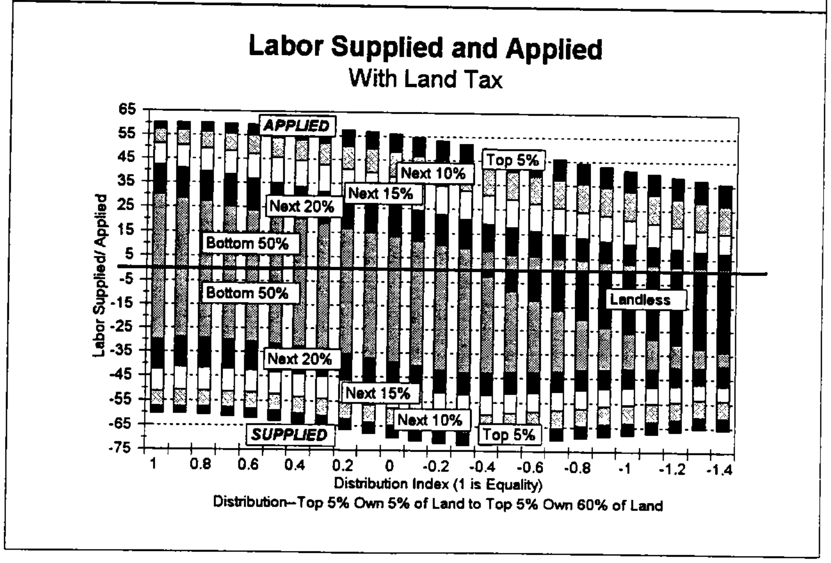


Figure 26

Applied labor falls from 60.5 to 36.0, a 40.5% drop. Supplied labor starts at 60.5, rises to maximum of 72.5, and falls again to 65.7. The final ratio of applied to supplied labor is 55.%, which means the other 45% is lost to supervision costs.



HIRED LABOR

Figure 27

Maximum hired labor (in or out) is 35. This is about 64% of total supplied labor.

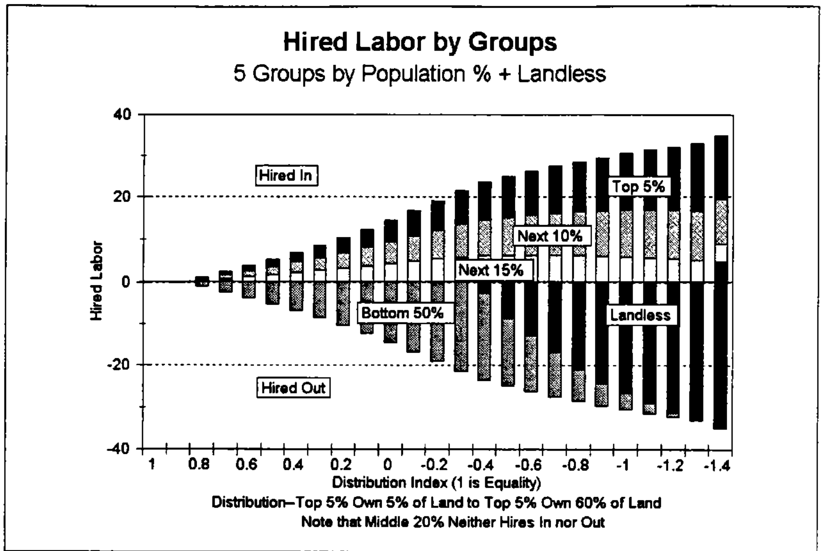


Figure 28

Maximum hired labor is only 31. This is about 59% of total supplied labor.

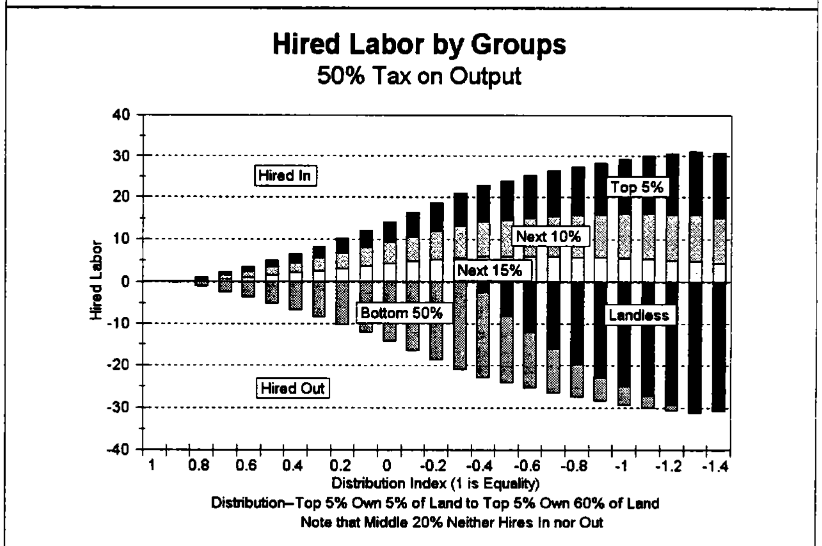
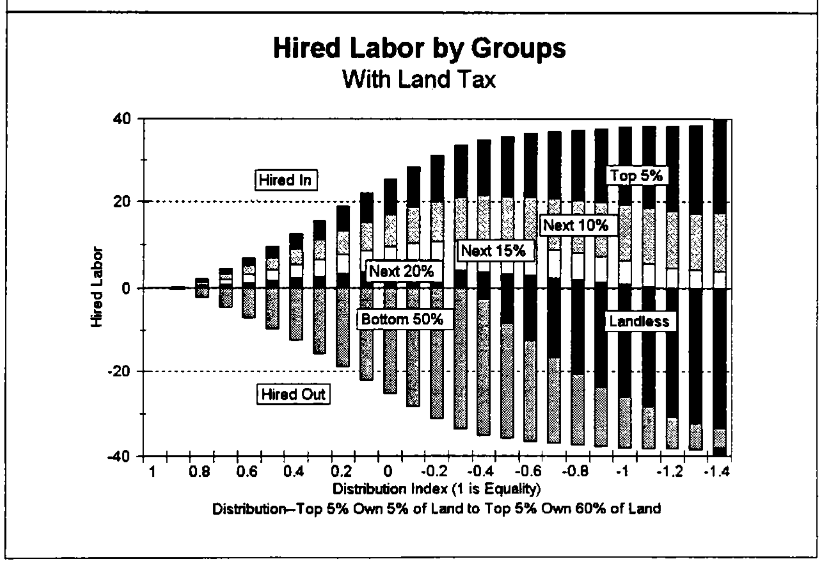


Figure 29

Maximum hired labor is 40. This is about 61% of total supplied labor.



RATIO OF APPLIED LABOR TO LAND

Figure 30

The maximum possible ratio is a bit over 4, where MP labor goes to 0. At equality, the ratio is 2.4. At the limit, the top 5% has a ratio of only .663. The marginal farmers have a ratio of 3.49, while the next 20% have the slightly higher ratio of 3.54 -- a reflection of economies of scale at small size.

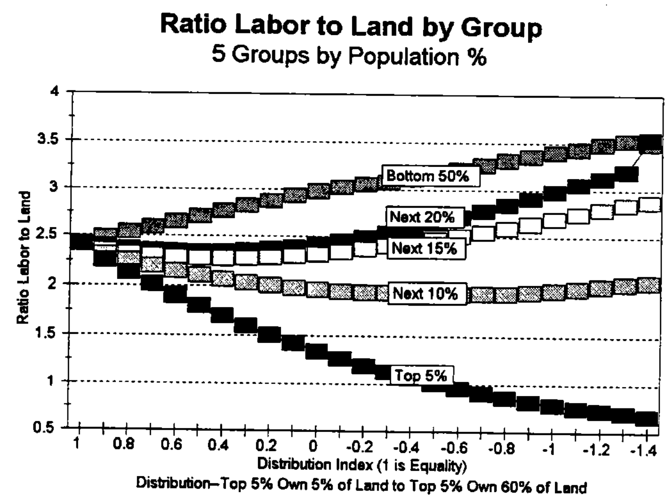


Figure 31

At equality, the ratio is 2.4. At the limit, the top 5% has a ratio of only .658. The marginal farmers have a ratio of 3.49, while the next 20% have the ratio of 3.25.

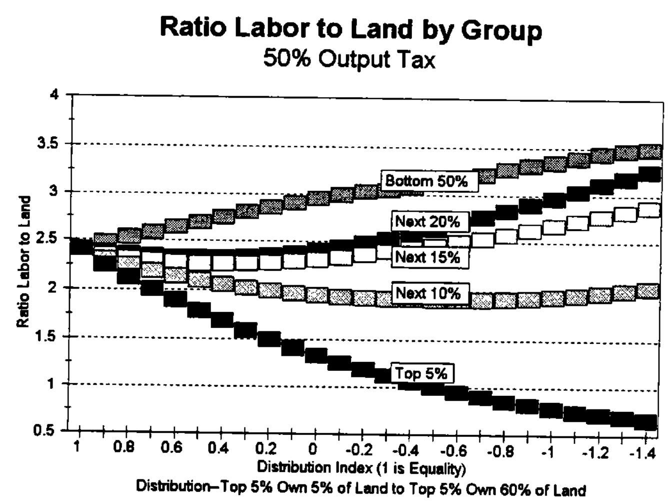
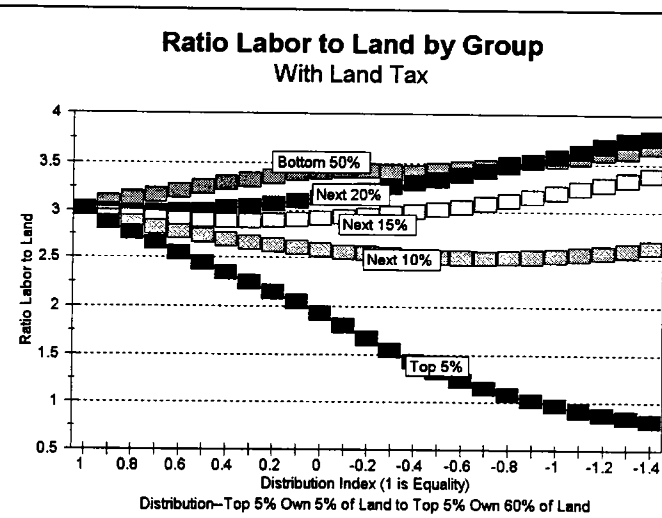


Figure 32

At equality, the ratio is 3.0. At the limit, the top 5% has a ratio of .79. The marginal farmers have a ratio of 3.67, while the next 20% have the slightly higher ratio of 3.76 -- a reflection of economies of scale at small size.



WAGE RATES

Figure 33

At equality, everyone's wage is 15.9. At the limit, the top 5%'s wage has risen to 91.3; the bottom and market wage has fallen to 2.83.

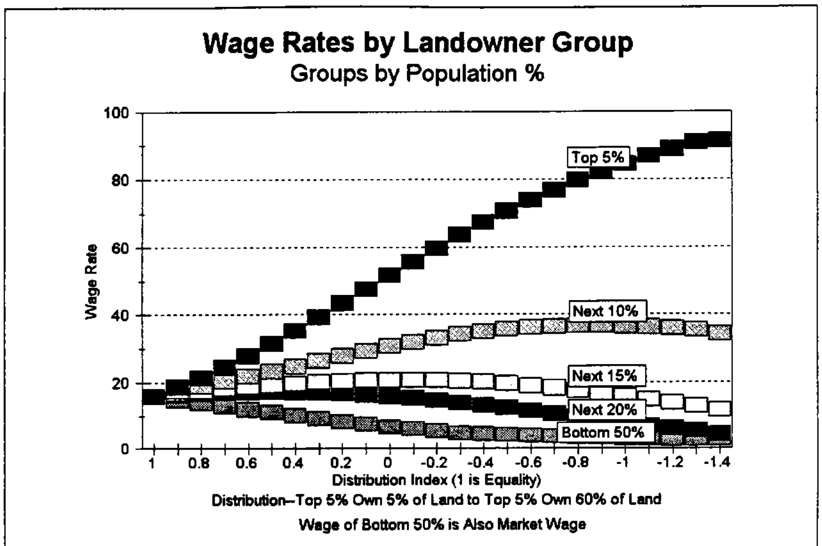


Figure 34

At equality, everyone's wage is 8.0. At the limit, the top 5%'s wage has risen to 45.9; the bottom and market wage has fallen to a dismal 1.42.

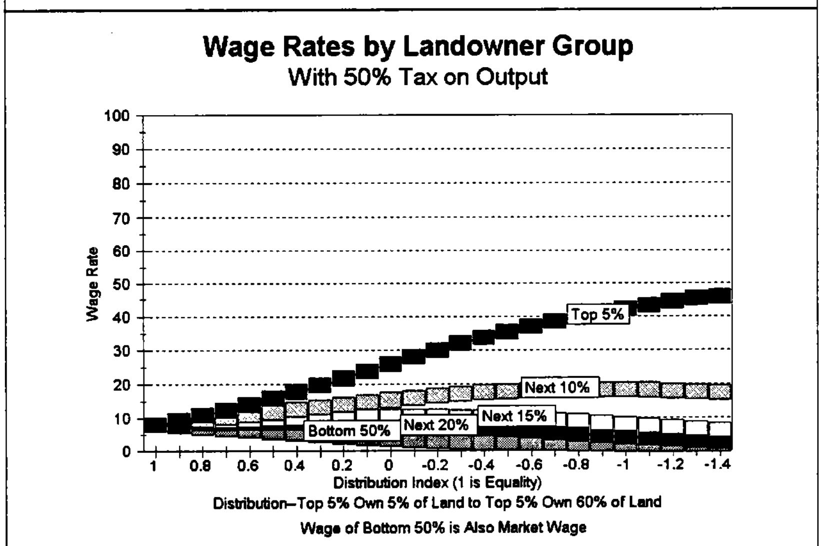
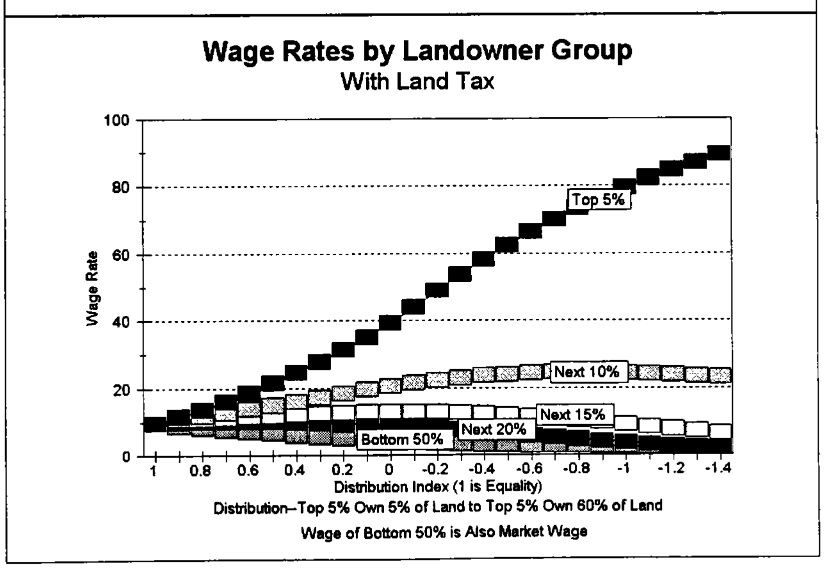


Figure 35

At equality, everyone's wage is 9.6. At the limit, the top 5%'s wage has risen to 89.2; the bottom and market wage has fallen to 2.0.



MARGINAL PRODUCT OF LABOR

Figure 36

At equality everyone's MP labor= wage = 15.9. At the limit, MP labor for the top 5% rises to 58.1, while that of the marginal farmers falls to 2.83, also their wage and the market wage. Wage and MP labor diverge for farmers who hire in, because MP labor is a weighted average of the farmer's own wage and the market wage.

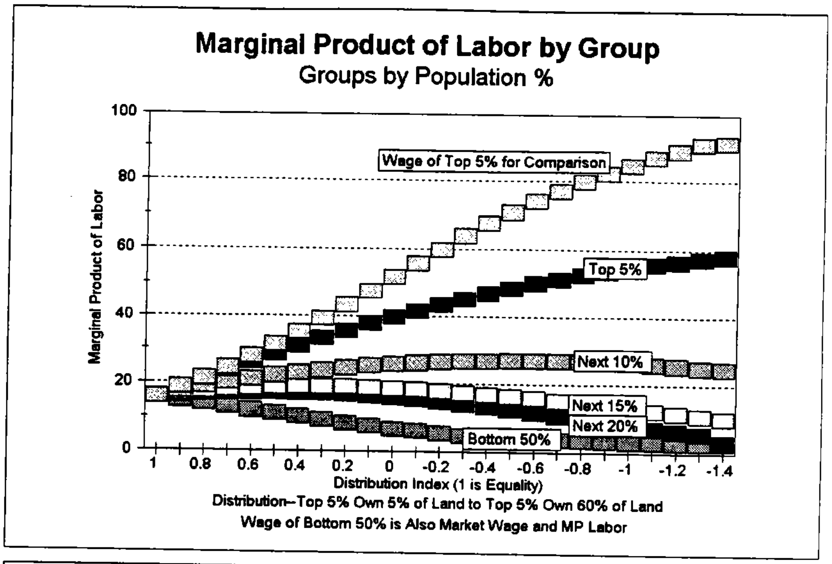


Figure 37

At equality everyone's marginal product= wage = 8.0. At the limit, MP labor for the top 5% rises to 29.1, while that of the marginal farmers falls to 1.42, still their wage and the market wage

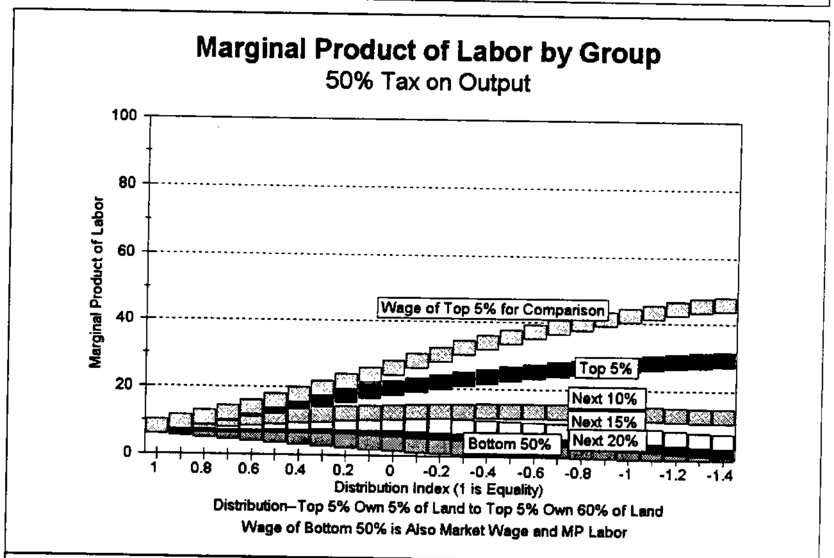
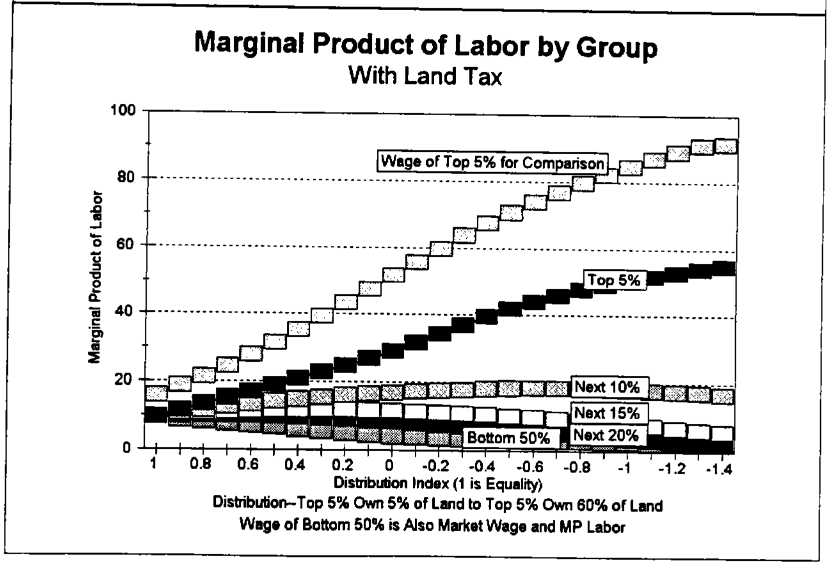


Figure 38

At equality everyone's marginal product= wage = 9.6. At the limit, MP labor for the top 5% rises to 54.9, while that of the marginal farmers falls to 2.0, still their wage and the market wage



MARGINAL PRODUCT OF LAND

Figure 39

At equality, the marginal product of everyone's land is 66.6. At the limit, MP land for the top 5% falls to 7.8, that of the marginal farmers rises to 69.5, and that of the next 20% to 82.3, a reflection of economies of scale at small land size.

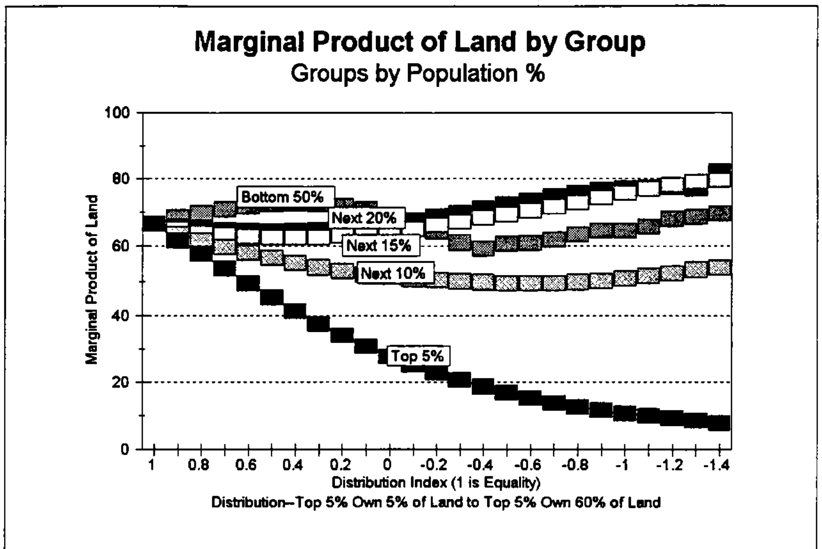


Figure 40

At equality, the marginal product of everyone's land is 33.1. At the limit, MP land for the top 5% has fallen to 3.9, that of the marginal farmers has risen to 34.7, and that of the next 20% to 37.9, a reflection of economies of scale at small land size.

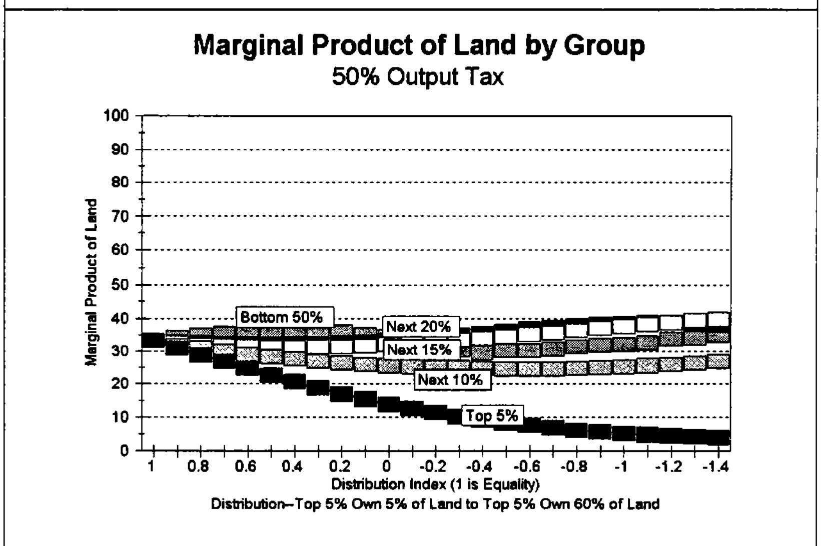
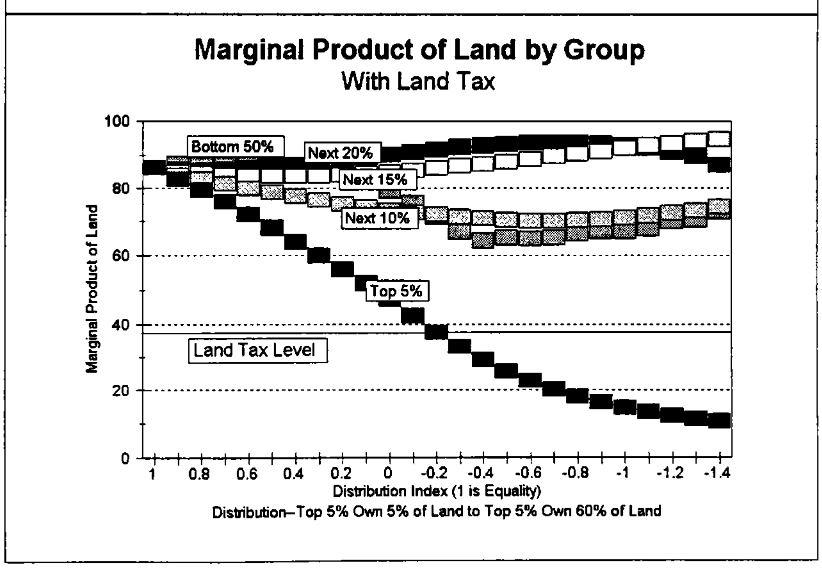


Figure 41

At equality, everyone's marginal product of land is 86.3. At the limit, MP land for the top 5% falls to 10.5, that of the marginal farmers rises to 72.7, and that of the next 20% to 87.1, a reflection of economies of scale at small land size. When the top 5%'s MP land falls below the land tax rate of 39, they lose money.



OUTPUT SHARES

Figure 42

Because of economies of scale in production, the sum of labor and land shares exceeds output. The excess falls from 33% of output at equality, to 19.7% at the limit, as supervision costs cut productivity.

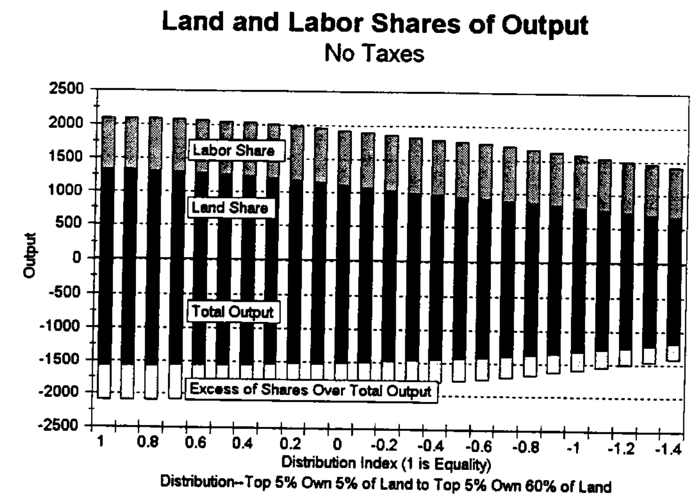
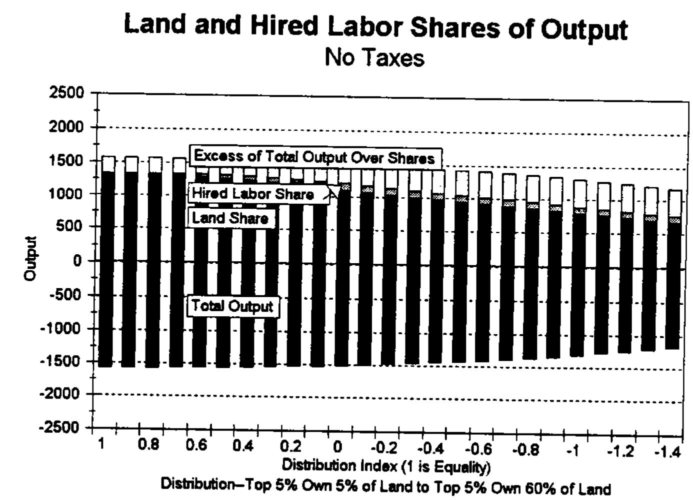


Figure 43

The sum of hired labor and land shares is always less than total output.



How can shares exceed output? Actually, there's a problem only if the shares go to different individuals. Here, the labor share of output consists of a large share going to the farmers as landowners, and a small share going to other farmers and landless as hired-out labor. *Land share* going to landowners plus the *hired labor share* going to different individuals do not exceed output. Landowners receive their land and labor income in a lump, a joint product which they cannot meaningfully split. Supervision costs, which tie the owner's labor to his land, together with minimum parcel size, keep economies of scale in production from blowing up the economy.

III. Inequality and Policy in the United States

Over the last twenty years, distribution of wealth and income have become increasingly unequal in the United States, as well as in Europe. For example, according to recent estimates by Edward Wolff, in the United States the share of net worth held by the top .5% rose from 25.9% in 1962 to 31.4% in 1989; the share of income received by the top .5% rose from 5.7% in 1962 to 13.4% in 1989 [Wolff, 1994]. (See Table 1). Worse, according to a just-released O.E.C.D. report, distribution of income is more unequal in the United States than in other developed countries (Figure 44).

Many explanations have been offered for the trend to greater inequality. These include the increase in stock prices relative to housing prices (Wolff) and Adrian Wood's controversial proposal that it represents a worsening in worldwide terms of trade for unskilled labor in developed countries [Wood, 1994]. In the United States at the state level, there has been a continuing shift from progressive to more regressive taxes, notably the shift from local property taxes to statewide sales taxes as happened in California after Proposition 13 (1978) and more recently in the Michigan shift of school finance from property to sales taxes. As Mason Gaffney has documented, the federal income tax itself, personal and corporate, was once a highly-progressive tax. In fact the legislators who created it, strongly influenced by Henry George, designed it to fall primarily on land income. But since then, the tax has filled with loopholes and exclusions, while the corporate share has shrunk. With the addition of Social Security taxes, the income tax is steadily devolving into a stiff payroll tax [Gaffney, 1991]. Meanwhile, the growth in the federal government has brought a growth in federal benefits. Contrary to popular impression, the bulk of these benefits go to the well-to-do. Peter Peterson estimated an annual flow of $570.7 billion to the non-poor vs. $109.8 billion to the poor. The average benefit to households with income over $100,000 exceeds that to households with under $10,000 [Peterson, 1994].

Whatever the cause, surely public policy should not aggravate the trend to greater inequality. Yet the Republican program openly and deliberately does just that. After the Republican victory last November, House Speaker Newt Gingrich proclaimed that:

> "It is impossible to take the Great Society structure of bureaucracy, the redistributionist model of how wealth is acquired and the counter-culture values that now permeate how we deal with the poor, and have any hope of fixing things...They are a disaster. They have ruined the poor. They create a culture of poverty and a culture of violence. They have to be replaced thoroughly...we have to simply, calmly, methodically reassert American civilization." [Gingrich, 1994].

Almost a year later, the Republicans have come a long way towards reasserting their version of American civilization. They are cutting safety-net programs for the poor, notably Medicaid. They are further reducing the progressivity of the income tax, including removing the earned income credit for low wage earners, and--a longtime goal--cutting the capital gains tax. In the background lurks the flat tax, and the even more drastic proposal of House Ways and Means Chairman, Bill Archer of Texas, for a "a complete replacement of the income tax," perhaps with a national sales tax [Archer, 1994].

The Democrats accuse the Republicans of heartless pandering to the rich. But they utterly fail to challenge the Republican claim that their program will boost the economy. Why not? It seems to me that Republicans and Democrats alike have bought the conventional supply-side argument that productivity and growth derive from investment by the rich. According to George Gilder's supply-side bible, *Wealth and Poverty*, "the upper classes [are] the cutting edge of the economy--the source of most investment." [Gilder, 1981].

The supply-side argument holds that since the rich save a higher proportion of income, therefore they contribute more to growth. As Nancy Birdsall notes, even the proposition that the rich save and invest more is questionable; while the rich channel more savings into the capital markets, where it is easy to measure, middle and lower income people invest more in education and sweat equity. But given transactions costs and capital market failure, middle and lower income people necessarily obtain a higher return on what investment they do make *precisely* because capital is scarce and expensive for them. (For example, Gary Becker and many subsequent researchers have demonstrated that grade-school education yields a higher return than high-school education, high-school a higher return than college, and college a higher return than graduate school--a pattern Becker and the others all attribute to capital market failure [Becker, 1975]). So even if middle and lower income people invest a lower percentage of income, they may more than compensate with a higher return on investment.

Not only is the supply-side argument ill-founded theoretically, but it does not stand up against the historical evidence. Today's booming low-inequality Asian countries are not unique. Growing nations historically have had a relatively large middle class and high social mobility. Adam Smith recognized that the innovative, hardworking and thrifty middle class--not the limp aristocracy--created England's tremendous growth and prosperity in the 18th Century. In 1776 middle-class English colonists, carrying democratic ideals to extremes never possible in their homeland, founded the fastest-growing and most prosperous nation of them all: the United States of America.

Table 1

GINI COEFFICIENT AND PERCENTAGE SHARES OF TOTAL WEALTH AND INCOME BY PERCENTILE GROUP AND QUINTILE, 1962, 1983, AND 1989

		Percentage Share of Wealth (Income) Held by						
Year	Gini Coeff.	Top 0.5	Next 0.5	Next 4.0	Next 5.0	Next 10.0	Bottom 80.0	All
A. *Net Worth (HW)*								
1962	0.80	25.9	7.5	21.2	12.4	14.0	19.1	100.0
1983	0.80	26.2	7.5	22.3	12.1	13.1	18.7	100.0
1989—Adjusted	0.84	31.4	7.5	21.9	11.5	12.2	15.4	100.0
1989—HW + autos	0.82	30.4	7.3	21.4	11.4	12.3	17.3	100.0
1989—Unadjusted	0.84	30.8	6.9	21.6	11.5	12.8	16.4	100.0
1984 SIPP	0.69							
1988 SIPP	0.69							
B. *Financial Net Wealth (FW)*								
1962	0.88	31.5	8.8	23.8	12.9	12.7	10.4	100.0
1983	0.89	34.0	8.9	25.1	12.3	11.0	8.7	100.0
1989	0.93	39.3	8.8	24.1	11.5	10.1	6.1	100.0
C. *Household Income*								
1962	0.43	5.7	2.7	11.3	10.2	16.1	54.0	100.0
1983	0.48	9.7	3.7	13.3	10.3	15.5	48.1	100.0
1989	0.52	13.4	3.0	13.3	10.4	15.2	44.5	100.0

	Percentage Share of Wealth (Income) Held by Quintile					
Year	Top	Second	Third	Fourth	Bottom	All
A. *Net Worth*						
1962	81.0	13.4	5.4	1.0	−0.7	100.0
1983	81.3	12.6	5.2	1.2	−0.3	100.0
1989—Adjusted	84.6	11.5	4.6	0.8	−1.4	100.0
1989—HW + autos	82.8	12.0	5.1	1.3	−1.1	100.0
1989—Unadjusted	83.6	12.3	4.9	0.8	−1.7	100.0
B. *Financial Net Wealth*						
1962	89.6	9.6	2.1	−0.0	−1.4	100.0
1983	91.3	7.9	1.7	0.2	−1.0	100.0
1989	93.9	6.8	1.5	0.1	−2.3	100.0
C. *Household Income*						
1962	46.0	24.0	16.6	9.9	3.5	100.0
1983	51.9	21.6	14.1	8.6	3.7	100.0
1989	55.5	20.7	13.2	7.6	3.1	100.0

Sources: Own computations from 1962 *Survey of Financial Characteristics of Consumers* and 1983 and 1989 *Survey of Consumer Finances*, except for 1984 and 1988 SIPP figures, which were computed from U.S. Bureau of the Census (1986), Tables 1 and 3, and U.S. Bureau of the Census (1990*b*), Tables 1 and 3.

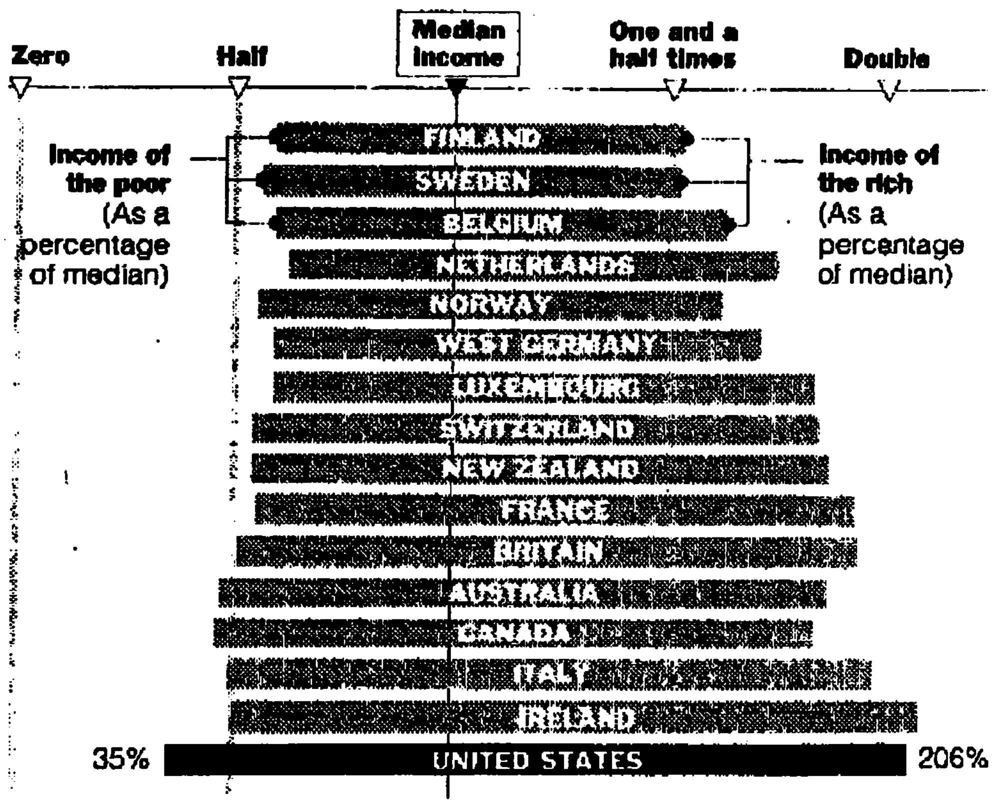
Wolff, Edward N. "Trends in Household Wealth in the United States, 1962-83 and 1983-89, *Rev. Income and Wealth,* Series 40, No. 2, June 1994, p. 153.

Figure 46

Measuring the Gap

After four years of analysis, a study for the Organization for Economic Cooperation and Development has concluded that the gap between the incomes of the rich and poor is wider in the United States than in 15 other industrial countries. The study used data supplied by governments from various years in the 1980's.

The authors calculated a median income per person after taxes for each country, adjusted for differences in family size. Then they examined the incomes of rich people at the 90th percentile and poor people at the 10th percentiles on the income scale — that is, people whose income exceeded that of precisely 90 percent of their compatriots or precisely 10 percent — and compared them with the median. The further apart the rich and poor incomes were in percentage terms, the wider the gap.



Organization for Economic Cooperation and Development
***The New York Times*, Friday, October 27, 1995**

Appendix A

A Single-Period General Equilibrium Model

A. The Consumer-Laborer

The model economy is populated by consumer-laborers. Consumer-laborers who own land are farmers. Those who don't own land are landless laborers.

A consumer-laborer consumes food and leisure. His labor supply equals the maximum time available in a period minus leisure.

Notation 1--Consumer-Laborer
w ... Consumer - laborer's wage
F... "Food," assumed to have unit price
P... Profit of Consumer - Laborer (exogenous)
D... Maximum time available for labor in a period, eg 24 hours in a Day.
Z... Leisure of Consumer - Laborer
$L = D - Z$...Labor supply of Consumer - Laborer
$\mathrm{u}(F,Z) = \mathrm{u}(F,D-L)$...Utility function in food and leisure

The consumer-laborer maximizes utility:

(1) $$\text{Max: } \mathrm{u}(F,D\text{-}L) \quad \text{st} \quad F = P + wL$$

First-order conditions:

(2) $$\left[\frac{\mathrm{u}_Z}{\mathrm{u}_F} - w\right] \geq 0 \quad \left[\frac{\mathrm{u}_Z}{\mathrm{u}_F} - w\right][D - Z] = 0$$

Income of Consumer-Laborer in one period:

(3) $$y = P + wD$$

Labor can be expressed as a function of income and wage, or profit and wage, where profit here is exogenous. Assume the labor supply function approaches a limit -- *D*-- as wage increases, holding income constant, or as income decreases, holding wage constant:

(4) $$L = \mathrm{a}(y,w) = \mathrm{a}(P + wD, w) \;\ldots\; \mathrm{a}_y < 0; \mathrm{a}_w > 0; \mathrm{a}_{yw} > 0; \mathrm{a}_{yy} < 0; \mathrm{a}_{ww} < 0$$

Assume further:

(5) $$\frac{\partial L}{\partial w} = \frac{\partial}{\partial w} a(P + wD, w) = \left[a_y D + a_w\right] > 0$$

That is, holding profit constant, labor supply does not bend backward. In general, assume that wage terms, a_w, dominate income terms, a_y, since any results that hold without backward-bending hold *a fortiori* with it.

B. The Consumer-Laborer as a Farmer

Combine a consumer-laborer with a piece of land to which he applies his labor, making him a farmer. How does farm size affect the farmer's behavior?

Notation 2--The production function:
T... Size of a parcel of land
A ... Labor Applied to land parcel
$F = f(T, A)$...Food output from T...$f_T > 0; f_A > 0; f_{TA} > 0; f_{TT} < 0; f_{AA} < 0$
$f_{TT} \cdot f_{AA} - [f_{TA}]^2 < 0$ and $f - f_T \cdot T - f_A \cdot A < 0$ for small T, ie, $\exists$ economies of scale

Notation 3--Hiring **Assumptions for Farmers who Hire In or Out**
v ... Market wage
$\vec{H}$ ... Hired - out labor
$\bar{H}$ ... Hired - in labor
$e\left(\frac{\bar{H}}{L}\right)$ = Effectiveness of hired labor. $e' < 0, e'' > 0, e < 1$ at $\bar{H} = 0$
$e\left(\frac{\bar{H}}{L}\right) \cdot \bar{H}$...Effective hired labor supply increases at a decreasing rate with $\bar{H}, \Rightarrow$
$e + e' \cdot \frac{\bar{H}}{L} > 0$ but steadily declining $\Rightarrow 2e' + e'' \cdot \frac{\bar{H}}{L} < 0$

1. Small Farmer Also Works for Hire

Maximize profit:

$$P = \mathrm{f}(T, A) - w \cdot L + v \cdot \vec{H} \quad (6)$$

subject to:

$$\vec{H} + A = L = \mathrm{a}(y, w); \quad \vec{H}, A \geq 0 \quad (7)$$
$$y = P + wD$$

First-order conditions:

$$\begin{aligned} &\vec{H}: \ [\mathrm{f}_A - v] \cdot \vec{H} = 0; \ \vec{H} \geq 0 \\ &A: \ [\mathrm{f}_A - w] \cdot A = 0; \quad A \geq 0 \end{aligned} \quad (8)$$

Small farmer also works for hire only when:

$$\mathrm{f}_A = v; \quad \vec{H} > 0 \quad [\mathrm{f}_A - w] \cdot A = 0 \quad (9)$$

The small farmer works for hire only as long as the outside wage equals the marginal product of labor on his own land. The more land the small farmer owns, given a market wage, the more he works on his own land, the less he works for hire, and the less he works in total. This is a pure income effect, since wage is fixed. If wage increases, holding land size constant, wage and income effects pull in opposite directions, but by assumption here, there are no backward-bending labor supply curves.

2. Self-sufficient Farmer

The farmer does not work for hire when:

$$\mathrm{f}_A > v; \quad \vec{H} = 0 \quad [\mathrm{f}_A - w] \cdot L = 0 \quad (10)$$

This is the self-sufficient farmer. The farmer's wage and marginal product of labor exceed the market wage. So he works only on his own land. The more land he owns, the longer hours he works, the higher his wage and marginal product of labor, and the lower the marginal product of his land. For of course the labor to land ratio falls as land size increases.

3. Farmer Can Hire Additional Labor:

Assume the effectiveness of hired labor is less than that of the farmer's own labor. Moreover, the effectiveness falls as the ratio of hired to own labor rises, due implicitly to the farmer's increasing difficulty of supervising.

Maximize profit:

$$P = \mathrm{f}(T, A) - w \cdot L - v \cdot \bar{H} \quad (11)$$

Subject to applied labor is effective hired labor plus owner's labor:

$$A = e\left(\frac{\bar{H}}{L}\right)\cdot\bar{H} + L \qquad e' < 0,\ e'' > 0,\ e < 1 \text{ at } \bar{H} = 0;\ \text{etc as above} \tag{12}$$

$$L = a(y, w);\quad \bar{H}, A, L \geq 0$$

$$y = P + wD$$

First-order conditions:

$$\begin{aligned} \bar{H}&: \left[f_A\left[e + e'\cdot\frac{\bar{H}}{L}\right] - v\right]\cdot\bar{H} = 0;\quad \bar{H} \geq 0 \\ L&: \left[f_A\cdot\left[1 + e'\cdot\frac{\bar{H}^2}{L^2}\right] - w\right]\cdot L = 0;\quad L \geq 0 \end{aligned} \tag{13}$$

a. Farmer does *not* hire additional labor.

$$\begin{aligned} \bar{H}&: f_A\cdot e - v < 0;\quad \bar{H} = 0 \\ L&: f_A - w = 0;\quad L > 0 \end{aligned} \tag{14}$$

The effective marginal product of hired labor is less than the wage for hired labor, v. So the farmer does not hire in labor. If he does not hire out labor either, as in ***b***. above then:

$$v < f_A = w < \frac{v}{e} \qquad \bar{H} = 0;\ \vec{H} = 0 \tag{15}$$

The market wage for hired labor is less than the marginal product of labor on the farmer's land, which equals his wage. However, the marginal product of hired in labor is less than the wage, due to the lower effectiveness of hired than own labor.

b. Farmer *does* hire additional labor.

$$\begin{aligned} \bar{H}&: f_A\cdot\left[e + e'\cdot\frac{\bar{H}}{L}\right] - v = 0;\quad \bar{H} > 0 \\ L&: f_A\cdot\left[1 - e'\cdot\frac{\bar{H}^2}{L^2}\right] - w = 0;\quad L > 0 \end{aligned} \tag{16}$$

From the assumptions about effectiveness of hired labor:

$$(17) \qquad \begin{gathered} 0 < \mathrm{e} + \mathrm{e}' \cdot \frac{\vec{H}}{L} < 1 \\ 1 < 1 - \mathrm{e}' \cdot \frac{\vec{H}^2}{L^2} \end{gathered}$$

So it follows that:

$$(18) \qquad v < \frac{v}{\left[\mathrm{e} + \mathrm{e}' \cdot \frac{\vec{H}}{L}\right]} = \mathrm{f}_A = \frac{w}{\left[1 - \mathrm{e}' \cdot \frac{\vec{H}^2}{L^2}\right]} < w$$

The marginal product of labor is greater than the wage for hired labor, but less than the farmer's own wage.

An increase in the outside wage leads to less hiring of labor, and an increase in the average product of labor. If the quantity of hired labor is small, the farmer's own labor will increase, to substitute for hired labor. If hired labor is large, the farmer's own labor will decrease.

C. Single Period Effects of Land and Output Taxes

What are the consequences of a land tax, γT, or an output tax, τF?

1. Small Farmer Also Works for Hire

Maximize profit:

$$(19) \qquad P = \mathrm{f}(T, A)[1 - \tau] - wL + v\vec{H} - \gamma T$$

subject to:

$$(20) \qquad \begin{gathered} \vec{H} + A = L = \mathrm{a}(y, w); \quad \vec{H}, A \geq 0 \\ y = P + wD \end{gathered}$$

First-order conditions:

$$(21) \qquad \begin{gathered} \vec{H}: \ \left[\mathrm{f}_A[1 - \tau] - v\right]\vec{H} = 0; \ \vec{H} \geq 0 \\ A: \ \left[\mathrm{f}_A[1 - \tau] - w\right]A = 0; \quad A \geq 0 \end{gathered}$$

The farmer does work for hire if:

$$(22) \qquad \mathrm{f}_A[1 - \tau] = v; \quad \vec{H} > 0 \quad \left[\mathrm{f}_A[1 - \tau] - w\right] \cdot A = 0$$

All else being equal, an output tax obviously makes hired out labor more attractive. But in equilibrium, the output tax on employers will push in the opposite direction, by lowering the outside wage. Because this model, in isolation, does not include transactions costs, a land tax is neutral except for an income effect. An increase in land tax, compensated by a decrease in output tax to keep income constant, leaves labor supply unchanged, and otherwise has the same marginal effects as a decrease in output tax.

2. Self-sufficient Farmer

Marginal product of labor is too high to justify hiring out:

$$f_A > v; \quad \bar{H} = 0 \quad \left[f_A[1-\tau] - w\right] \cdot L = 0 \tag{23}$$

In this case, transactions costs bar the farmer from hiring labor in or out. The output tax behaves as expected, reducing labor and output. But, remarkably enough, the land tax is no longer neutral. It pushes in the opposite direction from an output tax. It increases labor, production, and output per acre. Given market failure, the income effect produces marginal effects! When the income effect is compensated by a reduction in output tax, the effect of the land tax is reinforced:

3. Farmer Can Hire Additional Labor

Assume as before the effectiveness of hired labor is less than that of the farmer's own labor. Moreover, the effectiveness falls as the ratio of hired to own labor rises, due implicitly to the farmer's increasing difficulty of supervising.

Maximize profit:

$$P = f(T, A)[1-\tau] - wL - v\bar{H} - \gamma T \tag{24}$$

subject to:

$$\begin{aligned} A &= e\left(\frac{\bar{H}}{L}\right) \cdot \bar{H} + L; \quad e' < 0, e'' > 0, e < 1 \text{ at } \bar{H} = 0; \text{ etc as above} \\ L &= a(y, w); \quad \bar{H}, A, L \geq 0 \\ y &= P + wD \end{aligned} \tag{25}$$

First-order conditions:

$$\begin{aligned} \bar{H}&: \quad \left[f_A[1-\tau]\left[e + e' \cdot \frac{\bar{H}}{L}\right] - v\right] \cdot \bar{H} = 0; \quad \bar{H} \geq 0 \\ L&: \quad \left[f_A[1-\tau]\left[1 + e' \cdot \frac{\bar{H}^2}{L^2}\right] - w\right] \cdot L = 0; \quad L \geq 0 \end{aligned} \tag{26}$$

a. Farmer does not hire additional labor.

(27)
$$\begin{aligned} &\bar{H}:\ \ f_A[1-\tau]e(0)-v<0;\quad \bar{H}=0\quad 0<e(0)< \\ &L:\ \ f_A[1-\tau]-w=0;\quad L>0 \end{aligned}$$

For a given external wage, v, the output tax clearly offers a barrier to hiring, so that a farmer must be relatively richer to begin hiring than if the tax were not present.. If he does not hire out labor either, as in **1B**. above then:

(28)
$$\frac{v}{[1-\tau]}<f_A=w<\frac{v}{e(0)[1-\tau]}\qquad \bar{H}=0;\ \vec{H}=0$$

The output tax evidently both raises and widens the range of no hiring out or in for a given market wage, though, as will be seen, it also lowers the market wage.

b. Farmer does hire additional labor

The presence of taxes affects the first order conditions:

(29)
$$\begin{aligned} &\bar{H}:\qquad f_A[1-\tau]\left[e+e'\cdot\frac{\bar{H}}{L}\right]-v=0;\quad \bar{H}>0 \\ &L:\qquad f_A[1-\tau]\left[1-e'\cdot\frac{\bar{H}^2}{L^2}\right]-w=0;\quad L>0 \end{aligned}$$

And:

(30)
$$v<\frac{v}{\left[e+e'\cdot\frac{\bar{H}}{L}\right]}=f_A[1-\tau]=\frac{w}{\left[1-e'\cdot\frac{\bar{H}^2}{L^2}\right]}<w$$

D. A One-Period Numerical General Equilibrium

Imagine a uniform area of land populated by a number of consumer-laborer-farmers, differing, if at all, only in the quantity of land each owns. For a general equilibrium to work, the following conditions must hold:

1. The quantity of labor hired in by larger farmers must equal the quantity of labor hired out by smaller farmers and landless laborers, at a uniform market wage *rate*.

2. All the first order conditions and inequalities must hold for the four possible categories: landless laborers, small farmers who also hire out, self-sufficient farmers, and larger farmers who hire in.

For i individuals in the economy, the first condition may be written:

$$\sum_i \left(\bar{H}_i - \vec{H}_i\right) \cdot v = 0 \qquad (31)$$

--recognizing, of course, that for any individual, either hired-out labor is 0, or hired-in labor is 0, or both.

A numerical simulation model requires making specific assumptions about numbers of individuals, distribution, and functional forms.

Distribution. Imagine the economy consists of a uniform area of 20 units of land occupied by 100 identical farmers. The farmers are divided into five groups, with 5, 10, 15, 20, and 50 individuals respectively. The share of land held by Group N_i is:

$$S_i = \frac{N_i^\alpha}{\sum_i N_i^\alpha} \qquad (32)$$

This simple formula makes it possible to vary distribution by changing only one number: α. Distribution is equal for $\alpha = 1$. At $\alpha = -1.4$, the top 5% holds close to 60% of the land. The extreme figure is commensurate with Atkinson's estimate for Great Britain in the 1960's, where the top 1% of wealth-holders had 33-40%, and the top 5% had 59-64%. [Atkinson, 1975, pp. 289 & 308.] Less-developed countries show much greater inequality.

Minimum Parcel Size and Landless Farmers. Assume a minimum parcel size: .05 land units in this model. Consequently, when the share of the bottom 50 farmers falls below .05 per capita, some of them become landless. This way, the remaining "marginal" farmers retain at least the minimum parcel size. When α hits -0.4, three farmers become landless; at the extreme α of -1.4, 42 of the bottom 50 farmers are landless. Figures 1 and 2 show the distribution of population and landownership.

Labor Supply. An individual's labor supply, L, depends on exogenous profit, P, and wage, w:

$$L = \mathrm{a}(y, w) = \mathrm{a}(P + wD, w) \ \ldots\ \mathrm{a}_y < 0; \mathrm{a}_w > 0; \mathrm{a}_{yw} > 0; \mathrm{a}_{yy} < 0; \mathrm{a}_{ww} < 0 \qquad (33)$$

A simple function that meets these specifications is:

$$L = \frac{(D-L)w - P}{P_0 + (D-L)w - P}; \quad 0 \le L < D \qquad (34)$$

P_0 "base profit" and D "day" are constants, assumed to be .1 and 1, respectively. L behaves nicely, rising asymptotically towards the limit, D, as wage increases or profit falls. It never bends backwards. P_0 affects curvature; the smaller P_0, the faster L rises and then flattens. In order to avoid "stacking the deck" against the output tax, and because real world labor supply functions seem fairly inelastic, I chose a small value for P_0. Consequently, labor supply functions in the model operate mostly in the flat range, with very limited marginal effects.

Production Function. Production depends on land, T, and applied labor, A. There are economies of scale for small T:

$$(35)\qquad \begin{aligned} &F = \mathrm{f}(T,A);\quad \mathrm{f}_T>0;\mathrm{f}_A>0;\mathrm{f}_{TA}>0;\mathrm{f}_{TT}>0;\mathrm{f}_{AA}>0 \\ &\mathrm{f}_{TT}\cdot\mathrm{f}_{AA}-[\mathrm{f}_{TA}]^2<0;\quad \mathrm{f}-\mathrm{f}_T\,T-\mathrm{f}_A\,A<0 \text{ for small } T \end{aligned}$$

An unconventional but simple function that meets these specifications is:

$$(36)\qquad F = F_0\frac{TA}{T_0+T}\cdot\frac{1-b\dfrac{A}{T}}{1+a\dfrac{A}{T}}$$

F_0, T_0, a and b are positive constants, set equal to 80, .1, .1, and .1 in this model. T_0>0 creates economies of scale at small scale; the function becomes linear homogeneous at large scale. b >0 in the numerator means that the marginal product of labor can become 0 and then negative as the ratio of labor to land increases. (This is far more plausible than the assumption built into CES functions that the marginal product of labor remains positive at near infinite ratios of labor to land!) b sets a practical limit to the ratio of labor to land at 0 marginal product of labor:

$$(37)\qquad R_{\max} = \frac{\left[1+\dfrac{a}{b}\right]^{\frac{1}{2}}-1}{a}$$

For $a = b$, $R_{\max} = 4.142$.

T_0>0 means that as land size increases from 0, the marginal product of land first rises and then falls. An increasing marginal product of land will blow up a general equilibrium model; consequently, minimum parcel size must exceed the critical land size at which the MP land changes direction. However, the higher the ratio of labor to land, the larger the critical land size. b to the rescue! A safe minimum parcel size can be computed as a function of T_0 and the ratio of b to a; the lower the ratio, the higher the minimum parcel size. For $b=a$ as assumed, the safe minimum parcel size computes to about .19 T_0, or .019. The actual minimum parcel size used in the model was .05.

Effectiveness of Hired Labor. I assumed that farmers who hire in labor face a supervision cost in that the "effectiveness" of hired labor is reduced by a factor proportional to the ratio of hired-in labor, $\bar{H}$ to own labor, L_A. A simple formula for effectiveness of hired labor is:

$$(38)\qquad \mathrm{e} = \frac{1}{E+\dfrac{\bar{H}}{L_A}}$$

so that effective hired labor supplied is:

$$(39) \qquad \mathrm{e}\bar{H} = \frac{\bar{H}}{E + \dfrac{\bar{H}}{L_A}}$$

E is a constant, which must be >1 to make the effectiveness of hired-in labor always < 1, even at the point where hiring starts. For the model, $E = 1.2$.

Hence, when labor is hired in, total effective labor applied to land becomes:

$$(40) \qquad A = \mathrm{e}\bar{H} + L_A = \frac{\bar{H}}{E + \dfrac{\bar{H}}{L_A}} + L_A = L_A\left[1 + \frac{\bar{H}}{EL_A + \bar{H}}\right]$$

The farmer who hires in must work himself. The more he hires, the harder he must work.

Output and Land Taxes. It's easy to find the impact of a 50% output tax: just run the program with the output constant, F_0, divided by two. But how to construct a comparable land tax? I decided to set the land tax rate so that at equal distribution, the land tax collects just as much as the output tax. At equal distribution total output with no tax is 1573.61; with a 50% output tax output falls (barely) to 1570.52, half of which is 785.26. With 20 units of land in the economy, that comes to a tax rate of 39.26 per unit land. Of course as distribution becomes more unequal, collections from the output tax fall, while the land tax remains constant. Thus the land tax claims a larger share of output at more unequal distributions. To avoid having to worry about the distribution of tax benefits, I assumed that all taxes simply leave the economy.

Computing the Numerical General Equilibrium Model. Using these explicit functional forms, I wrote out the single-period equations and fed them to the GAMS optimization program. GAMS computed the equilibrium over the range of distributions and output results to a file readable by spreadsheet programs. I used the Borland Quattro Pro spreadsheet program to organize and graph the data.

The Results. I have summarized the results in Part II. The detailed results appear most vividly in the graphs of Part II.

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