CHANGES IN THE DISTRIBUTION OF FARM WEALTH IN THE UNITED STATES

by

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Abstract

This paper examines the changes in the farm sector wealth from 1950 through 1999. The study uses Theil's entropy-based measure of inequality of farm equity by ten regions of the U.S. The entropy-measure is then used to decompose U.S. inequality into within-region and between-region differences. Results show that for the period 1950 to 1993, relative to the number of farms per state, farm wealth in the U.S. became more equally distributed. Further, results show that inequality in wealth may be on the rise in recent years.

Key words: inequality, Theil's entropy, farm equity, regional decomposition.

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The adequacy of income and the well-being of the farm business sector have been prominent features of the farm policy debate. Since the early 1950s, the economic well-being of agriculture has varied significantly. Record levels of income and wealth were realized by the sector and many individuals (Mishra and Sandretto). However, agriculture also realized significant losses in equity, especially in mid 1980s, and saw a major reduction in farm numbers during the period. Specifically, U.S. farm business wealth fell from $379.0 billion in 1981 to $208.1 billion in 1986, a drop of $248.7 billion. This decapitalization of the U.S. farm sector was greatest in three regions: the Lake States, the Corn Belt, and the Northern Plains. These regions not only experienced a combined $171.0 billion loss of farm wealth, but also saw their share of total U.S. farm wealth drop from 46.6 percent in 1981 to 36.8 percent in 1986. Farm price and income support programs implemented in the 1930s were designed to help bring the average farm income to that of average urban households in America (Hallberg). Historically, the government has focused on stabilizing farm-sector income at levels that are "equitable" compared to incomes earned in the nonfarm sector (Robinson; Halcrow).

However, a true evaluation of equity (both horizontal and vertical) must include a measure of wealth (Hill, 2000). Hill points out that wealth is important because it gives rise not only to income in a variety of forms but also because it provides security, freedom to maneuver resources, and economic and political power. Within the economy as a whole, wealth seems to be much more unequally distributed than income and has a major influence on the overall degree of inequality (Atkinson). The importance of wealth as a contributor to the economic welfare of farmers cannot be denied, yet it rarely receives mention among agricultural economists.

Examining the distribution of wealth rests on the relationship between farm assets and equity values, and changes in current and future farm incomes (Melichar). Equity per farm represents the "average" wealth of U.S. farms. Although the average equity per farm is a helpful measure of well-being at a point in time, changes in the national average alone may not reflect significant changes in domestic agriculture. For example, due to a reduction in farm numbers, changes in the distribution of farm size, and the importance of off-farm income over the past six decades, average net worth may not reflect the distribution of farm assets and equity. Therefore, from a policy standpoint it may be more helpful to examine how shares of total farm business sector wealth are distributed over time and across regions and states.

The U.S. Department of Agriculture's Economic Research Service develops, interprets, and disseminates farm sector accounts information. This includes estimates of the value of assets used in the sector's production activities, debt associated with these assets, and the value of farm wealth (equity) of the farm business sector. Farm sector capital represents the accumulated stock of real wealth (assets minus debt). Saving and investments add to the capital stock. At the farm level, capital refers to the productive, income-generating assets like farmland, machinery, inventories, and financial assets. For the farm income and balance sheet series, the farm sector is considered as a single entity, with no adjustment made for differences in ownership or business arrangements among farms or other entities comprising the sector. Estimates generated by the farm sector national accounts program are also used to measure changes in farm sector performance and well-being. The amount of wealth held by farm businesses and the rates at which they accumulate it are important indicators of farm business economic well-being and

financial progress. Furthermore, the forms in which wealth is held provide a good measure of how responsive farm businesses can be in meeting financial crises.

We use the Theil's measure of inequality to examine changes in U.S. farm wealth for the period 1950 through 1999. The entropy-based measure quantifies the inequality of farm equity by state for the U.S. The measure decomposes the U.S. inequality into between-region differences and within-region differences using Economic Research Service (ERS) production regions.

Data

This study uses farm equity measures from the U.S. Department of Agriculture, Economic Research Service's (USDA, ERS) latest revised and updated state-level balance sheet data. These equity data are from the aggregate sector balance sheet statistics. Specifically, equity is the sector-wide measure of assets held in the sector (without regard to ownership) minus the sector-wide estimate of debt (without regard to who owes it). The Agricultural Resource Management Study (ARMS) survey data are combined with data from other sources such as Census of Agriculture, Bureau of Census; the Agricultural Economics and Land Ownership Survey (AELOS); National Agricultural Statistics Service (NASS) for farmland values and the number of farms; FDIC Call Reports; Farm Credit banks; and the Farm Service Agency to develop the total farm business assets and debt (excluding operator household debt) in each state.

Equity per Farm as a Measure of Wealth

Figure 1 shows that the average equity per farm in the United States increased from $18,000 in 1950 to a peak of about $341,000 in 1980. Several factors contributed to this increase in average

equity per farm, including farm size and land values. Average farm size increased from 235 acres per farm in 1950 to 425 acres per farm in 1980. Over the same period inflation resulted in an increase in the value of farmland in the U.S. from $10,000 to $300,000 per farm. However, during the farm financial crisis period, the value of farmland declined to $219,000 per farm (1986) and pushed farm equity down to $251,000. Since 1986, average equity per farm has increased from $251,000 in 1986 to about $429,000 in 1999 as farmers reduced their debt and assets values increased substantially (Figure 1). Regional data show that the increase in equity per farm was not uniform within the U.S. Figure 2 represents the average equity per farm for 3 of the 10 regions between 1950-1999. Trends in these three regions (major farming regions) display changes in farm wealth similar, but not identical, to the U.S. average. Figure 2 shows that U.S. farms lost nearly $250 billion in wealth in the farm financial crisis period (1981-1986). Farms in these regions (Northern Plains, Lake States, and Corn Belt) are generally large and are more specialized. On the other hand, Figure 3 shows that the Northeast and Appalachian regions were largely unaffected by the farm financial crisis of 1980's. One possible reason could be that farms in these regions are generally small and diversified. Equity values in the Southern Plains (Figure 4) did not recover as quickly as equity in the U.S. as a whole. However, recovery in equity started a year earlier for farms in the Southeast region.

Theil's Measure of Inequality (TMI)

The use of entropy in statistics has its origin in information theory. Shannon's (1948) measure of uncertainty was introduced as a measure of dispersion. Theil's measure of inequality (TMI) expands the basic concept of information by using Shannon's[1] third requirement, additivity of

[1] Shannon developed a measure of statistical information based on entropy. In developing this measure, Shannon set out three requirements: (1) the entropy measure should be continuos on p_i, (2) that the measure be a monotonically

the information index. To obtain the dispersion index for a distribution, we use class frequencies or probabilities.

Theil's inequality is a statistical measure of dispersion or entropy where entropy is the expected information in a message or signal. Let p be the probability, 0#p#1, of an event E. Suppose that a signal is received that E did occur. The information contained in that signal is inversely related to p. If an event is unlikely (has a smaller p) then that E occurred has more information than an event occurring that is more likely (has a large p). For example, if the probability is 0.95 and information is received that the event occurred then that information carries little information. But is the probability were 0.05 then the information that the event did indeed occur would contain a great deal of information.

Assume a set of n mutually exclusive events E_1, E_2,……. E_n with initial probabilities p_1, p_2,…… p_n and a second set of probabilities, probabilities q_1, q_2,…… q_n, that are analogous to the posterior probabilities from Bayesian statistics. Given two set of probabilities, the TMI (Theil 1967) is

$$I(p,q) = \sum_{i=1}^{N} p_i \ln\left(\frac{p_i}{q_i}\right) \qquad (1)$$

Intuitively, TMI captures the expected value of the information in the second signal. If the first and second probabilities are equal for all events, then $I(p,q)=0$. This implies that there is no information in the second signal not contained in the first. As the two probabilities diverge, the natural log of their ratios becomes different from zero. If the initial probability is large relative to

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increasing function of n, and (3) if the uncertainty could be broken down into two successive probabilities (p_i, q_i), then the overall measure of the entropy should be the weighted average of the two successive events.

the second probability, $p_i > q_i$, then the natural log of the ratio is positive. Alternatively, if the first probability is smaller than the second probability, $p_i < q_i$, then the natural log of the ratio is negative. However, due to the concavity of $\ln(X)$ the TMI has a lower bound at zero and no upper bound.

The TMI is consistent with basic income inequality measures, such as the Lorenz measure. As Foster points out, a measure of inequality must satisfy certain basic properties. First, the inequality measure must increase when wealth is transferred from poor to rich. Also, the measure should be symmetric and homogeneous of degree zero. The TMI satisfies these basic criteria. Other dispersion measures, such as the coefficient of variation or the variance of logarithms, fail to satisfy all of the criteria. In addition, the decomposability property of TMI makes the TMI unique among all measures that satisfy the basic criteria.

The application of TMI in the current situation follows the basic inequality studies of Theil, Gao *et al*., Moss and Mulkey, and others. The p_i is the probability that a farm is from a given state, measured simply as the number of farms in that state divided by the total number of farms in the country. The q_i is the probability that a dollar of equity[2] is from a given state, which is the dollars of equity from that state divided by the national amount of farm equity. If the probability based on the farm numbers is close to the probability based on farm equity, then there is little additional information and the TMI is small. Finally, a small inequality means that the distribution of farm wealth is uniform across states and vice versa. Further, additivity of the measure allows for the analysis of inequality between regions of the country. This study focuses on the national, regional, and average within region inequality.

Regional Decomposition

The basic notion of decomposition of the inequality measure (TMI) is that the total inequality can be decomposed into inequality between regions and the average inequality within each region. Specifically, define P_f and Q_f to be

$$P_f = \sum_{i \in f} p_i \text{ and } Q_f = \sum_{i \in f} q_i \tag{2}$$

where P_f is the probability of farm numbers and Q_f is the probability of farm equity for a given region, that is, the state within the farming regions. Additionally, inequality across regions can be defined from equation 1 as

$$I_R = \sum_{f=1}^{F} P_f \ln\left(\frac{P_f}{Q_f}\right) \tag{3}$$

The measure of inequality within each farming region can then be defined as

$$I_f = \sum_{i \in f}\left(\frac{p_i}{P_f}\right)\ln\left(\left(\frac{p_i}{P_f}\right)\Big/\left(\frac{q_i}{Q_f}\right)\right) \tag{4}$$

Finally, overall inequality in equation 1 can be decomposed as: $I = I_R + I_A$ where $I_A = \sum P_f I_f$ is the average inequality within regions. There are two major advantages of TMI over other measures of inequality. First, the TMI provides a descriptive measure of the distribution of farm wealth that measures inequality of equity per farm weighted by the farm population. This is particularly important given structural changes in the agricultural sector. Second, a major advantage of the TMI is its empirical decomposition of national-level inequality. The measures of between-regions inequality, I_R, and the average-within region inequality, I_A, indicate whether the national

[2] The nominal and real informational inequality are identical if inflation is the same across regions.

inequality in the distribution of farm wealth is due to variation between states, within regions or between the individual regions.

Results

In interpreting the results it is important to note that there have been considerable changes in the composition of farms, including in the size distribution of farms (Erickson, *et al.*). Furthermore, there have also been important changes in products/commodities produced, in methods of production (e.g., machinery, equipment, buildings and other capital assets like nursery and animal production facilities, and in the allocation of operator and family labor among different employment activities). Therefore, a dollar of equity may have been generated by a considerably different set of asset and debt instruments than in the 1990s. Furthermore, the number and distribution of farms by state and region have changed significantly over this period. So in interpreting these results, based as they are on within- and between-region changes in equity per farm and in the number of farms, we must consider the impacts of these structural changes.

In general, the results indicate that farm equity in the U.S. has changed. Now its distribution by state is more consistent with the distribution of farms by state. Most dramatic convergence occurred between 1950 and 1975. During this period steadily rising farm incomes, particularly in areas with supported commodities like cash grains and dairy, resulted to a more equal distribution of wealth, both nationally and regionally. Growing farm exports and accommodating farm credit policies also contributed to this convergence. From 1976-1999 changes in inequality were minimal. An increasing number of small farms with minimal debt and increased off-farm incomes also brought outside equity into agriculture.

The estimates of (TMI) of wealth inequality nationally (I), regionally (I_R), and the average within-regions (I_A) are presented in Figure 5. The highest levels of the national inequality measure, 0.196 was in 1962. Over the next three decades, the measure of national inequality fell to 0.066 in 1992, a reduction of 0.13, or 68 percent. However, starting 1993 there has been an increase in national inequality. During 1993-1999 the national inequality has increased 0.087 in 1993 to 0.174 in 1999. Most of this increased inequality can be attributed to the average within-region inequality (as seen in figure 5) increases. Variations by states within regions, where states tend to be more homogeneous, tend to reflect microeconomic conditions, whereas variations between regions tend to reflect inherent macroeconomic differences, such as farm structural changes (changes in size distribution of farms, changes in production methods, etc.) and government price support and credit programs. Over the same period (1962-1992) average within-region (I_A) inequality reduced from 0.089 in 1962 to 0.025, down 0.064. Consequently, of the 0.13 reduction in national inequality, 0.07, or 41 percent, was due to a reduction in inequality within-regions. But most of the reduction in national inequality (60%) was due to a reduction in between-regions in inequality.

Between-region inequality (I_R) decreased steadily from a high 0.129 in 1950 to 0.041 in 1992 (Figure 5). However, between-region inequality increased from the low, 0.041 in 1992 to 0.057 in 1993. Since then between-region inequality has remained steady, with little reduction in inequality in 1998 and 1999. The ratio of the between-region measure to the national measure averaged 60 percent during 1962-1992 period. However, the ratio of the between-region measure to the national measure decreased from 66 percent in 1995 to 29 percent in 1999. In 1986 and

1987 for two consecutive years national inequality was almost equally divided between the regions (I_R) and within-region (I_A) inequality.

During the 1962-1992 period, agriculture in the U.S. went through significant structural changes. The number of farms declined and the average size of farm increased (through consolidation). These changes were partly due to a more open and globalized world economy, to greater mobility of capital and labor, and to deregulation of capital markets. This expansion/consolidation of agriculture resulted in a more even distribution of wealth across the states relative to the number of farms in each state. The between-region results show the major part of this increased equality as a between-region move toward equality rather than within-region. This also demonstrates that regions that were losing their share of farms relative to other regions were maintaining or even increasing their share of equity.

The national inequality of equity increased from its lowest level (2.4%) in 1993 to 17.4% in 1999. Much of this inequality can be attributed to within-region inequality. Within-region inequality of equity increased from 2.4% in 1993 to 12.4% in 1999. Also, it is worth noting that the share of land in total farm business assets increased from 74% to 77% during the same period (Mishra, Moss, and Erickson). On the other hand, between-region inequality of equity increased from 4.1% in 1993 to 5.7% in 1994. Since then between-region inequality of equity has averaged around 5.5%.

Within-Region Inequality

Estimates of within-region inequality of equity, I_f (equation 4) for 10 regions are presented in Figure 6, 7, and 8. Figure 6 presents three main farming regions (Lake States, Cornbelt, and Northern Plains). For the initial year, 1950, the Cornbelt region (Figure 6) displayed the highest level of inequality between the states (7.0%). The inequality in the Cornbelt region trended downward for two decades. Starting in 1972 (the lowest level of inequality, 3.3%) we see a rise in inequality of equity between states in the Cornbelt region. This could be attributed to the 1970s and early 1980s expansion and consolidation phase in agriculture. Further, the inequality in the Cornbelt region reached its highest level, 7.4% in 1976. The inequality in the regions nearly matched its lowest level at the end of the farm crisis period (1986). Since 1986 the inequality of equity in the Cornbelt region has been increasing. Figure 6 also shows more equality in wealth within the states in the Lake States and Northern Great Plains region. Additionally, like the Cornbelt region we see a similar increase in inequality of equity starting in the 1970s and ending at the end of the farm crisis period (1986). However, from 1972 to 1987 the inequality of equity in the Northern Great Plains region rose steadily.

During 1950-1963 inequality of equity in states within the Southern Plains and Delta regions (Figure 7) increased by more than in any other region. This could be because of the growth of large farms. The inequality of equity in the Southeast region increased from 0.055 to 0.18 in the first decade (1950-1960) and then decreased 0.095 in 1971. After 1971 inequality of equity was around 0.100 (or 10%) until 1987 when it decreased and reached its lowest level of 0.034 in 1997. The inequality in the Southern Plains increased from 0.023 in 1980 to 0.165 in 1998 as number of farms increased in the region. Primarily it was the result of increased equity share

experienced in Oklahoma. In all three regions (Southeast, Southern Plains, and Delta) inequality in equality has been rising since 1997. Recent data shows that number of small farms and poultry contracting increased in the Delta and Southeast. Further, farms in the Southeast region have substantial amount of income off the farm.

Finally, Figure 8 presents the inequality in equality estimates for Northeast, Appalachian, Mountain, and Pacific regions of the United States. The Northeast and Appalachian regions show the least inequality in equity over the last five decades. Farms in these regions tend to be small and labor intensive. Beginning in 1997 there was a rise in the inequality estimate for the Northeast. This could be partly due the growth in farmland values and equity relative to number of farms. Additionally, equity increased as a result on increased non-farm income (suburban employment opportunity) and urban demand for land development. Pacific and Mountain regions show a very different pattern than other regions. The inequality of equity in Pacific regions increased from 0.044 in 1950 to its highest level 0.191 in 1964 and finally reached to its minimum level 0.016 in 1976. Farms in California, Oregon, and Washington saw their share of equity rise because of increased foreign and domestic demand for grains, fruits, and vegetables. During 1977-1992 California's share of equity rose steadily, reflecting the state's expanding agricultural sector. The Mountain states (Figure 8) show a sharp jump in inequality of equity starting in 1992. In 1992 the National Agricultural Statistics Service (NASS) of U.S. Department of Agriculture readjusted the value of agricultural land in Arizona, Nevada, Utah, and New Mexico by excluding Native American Land. NASS did this because there is no precise measure of farmland value for Native American Land as it is not traded and full market value is not realized. Farmland value jumped from $310 per acre in 1991 to $810 per acre in 1992. This

resulted in a greater inequality in equity in Arizona, Nevada, Utah, New Mexico, and the Mountain region as a whole. Inequality of equity increased from 4.1% in 1992 to 18.7% in 1993 and almost 30% in 1999.

Summary and Conclusions

Over the past five decades **e**conomic well-being of agriculture has varied significantly. In the 1950s and early part of 1960s farmers benefited from rising prices and incomes. The 1970s saw unprecedented growth in the world and domestic demand for farm products. However, agriculture also recorded significant losses in equity during the farm crisis period (1979-1984) and a major reduction in farm numbers in past several decades. A change in farm equity is related to changes in farm assets and debts. Farm policies, production controls, subsidized credit, and income transfers affect the level of farm assets and debts. This study analyzed changes in farm wealth that have occurred across states and regions within the U.S. between 1950 and 1999. Specifically, it applied Theil's measure of income inequality to state-level farm equity data to measure the variation in wealth across states and production regions.

Results from this study show that the largest inequalities were in early 1950's and early 1960's. Further, the largest convergence in farm equity occurred from 1960 to 1992. A reduction in interregional variations contributed to this convergence. In general, more recently reduction in number of farms slowed down and data show an increase in the number o f small farms. Net worth (farm and non-farm) in all regions increased. Farms in Midwest regions recovered all their lost equity. Starting in 1993 we observe a small rise in the inequality of wealth, both at the national and regional level (within-region inequality has been stable). Further, changes in the

farm numbers appeared well matched to changes in equity. During this period (1993-1999) the sector recorded highest incomes (1994, 1996, 1997) while government support payments were reduced for many commodities. However, in recent years non-farm equity, such as increase in number of small farms with no debt, and increased off-farm income have produced a stable wealth structure in the agricultural sector.

Although this decomposition of variation in farm wealth is helpful in explaining the extent to which microeconomic (within-regions) and macroeconomic (structural and government program-related) factors underlie changes in the distribution of farm wealth over time. Further, analysis is needed to understand how farm structure, government programs, and microeconomic forces interact to affect farm sector wealth and well-being. Farm-level data, such as that provided by the Agricultural Resources Management Survey (ARMS) may be useful in further explaining these changes. The ARMS gathers data not only on the farm business sector, but also on the financial well-being of the farm households. Because this survey collects data on farms by type of farm, by size class, by tenure arrangement, and by other important structural characteristics, it may be used to further explain changes not only in farm business wealth, but also in farm household wealth.

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Figure 1: Average Equity Per Farm, U.S. (1950-1998)

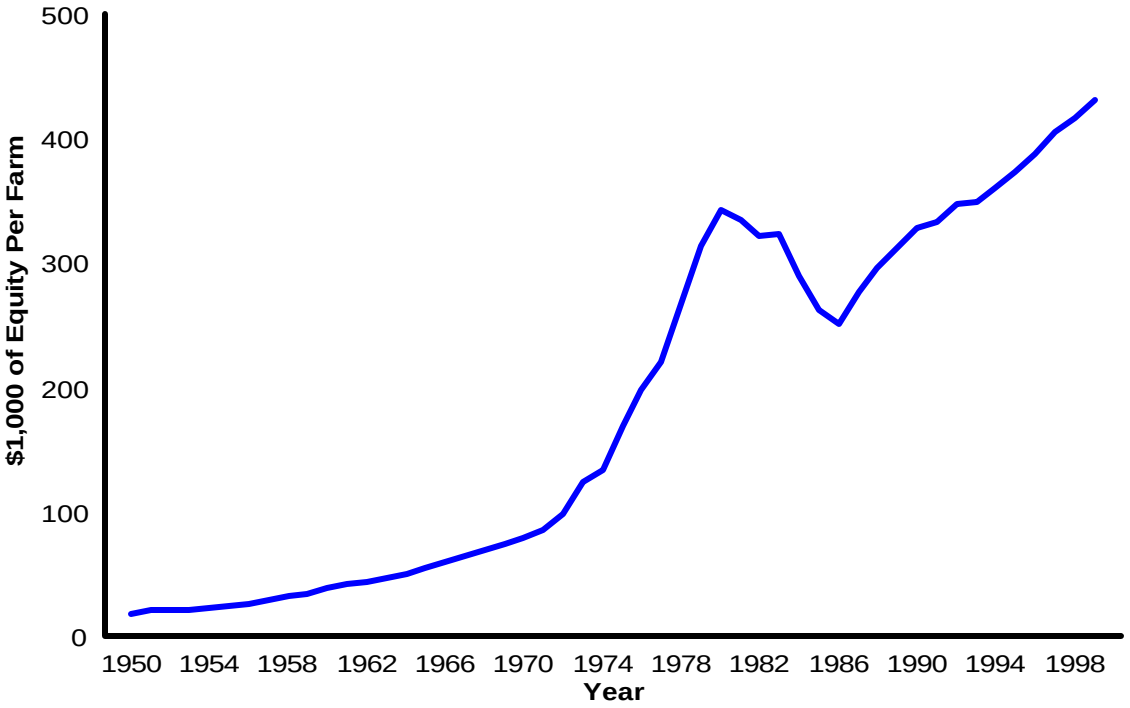


Figure 2: Average Equity Per Farm, for Selected Regions (1950-1998)

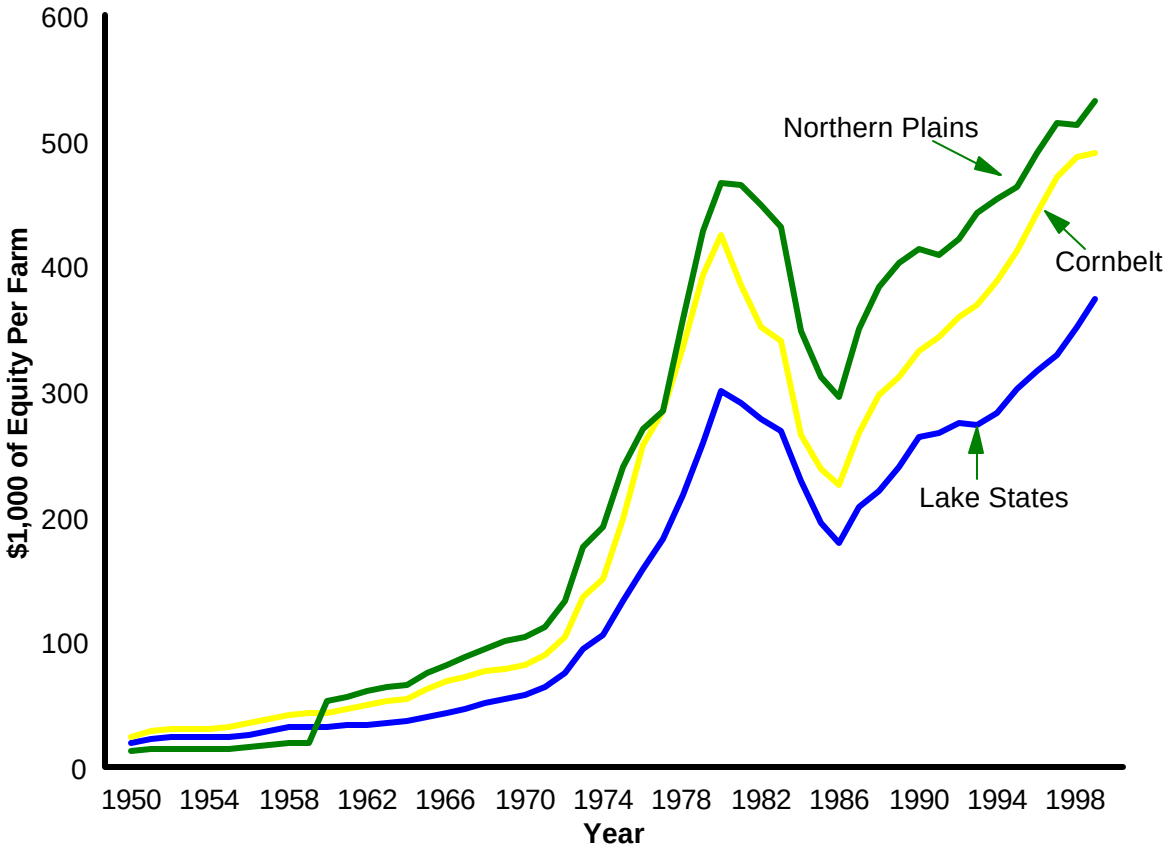


Figure 3: Average Equity Per Farm, for Selected Regions (1950-1998)

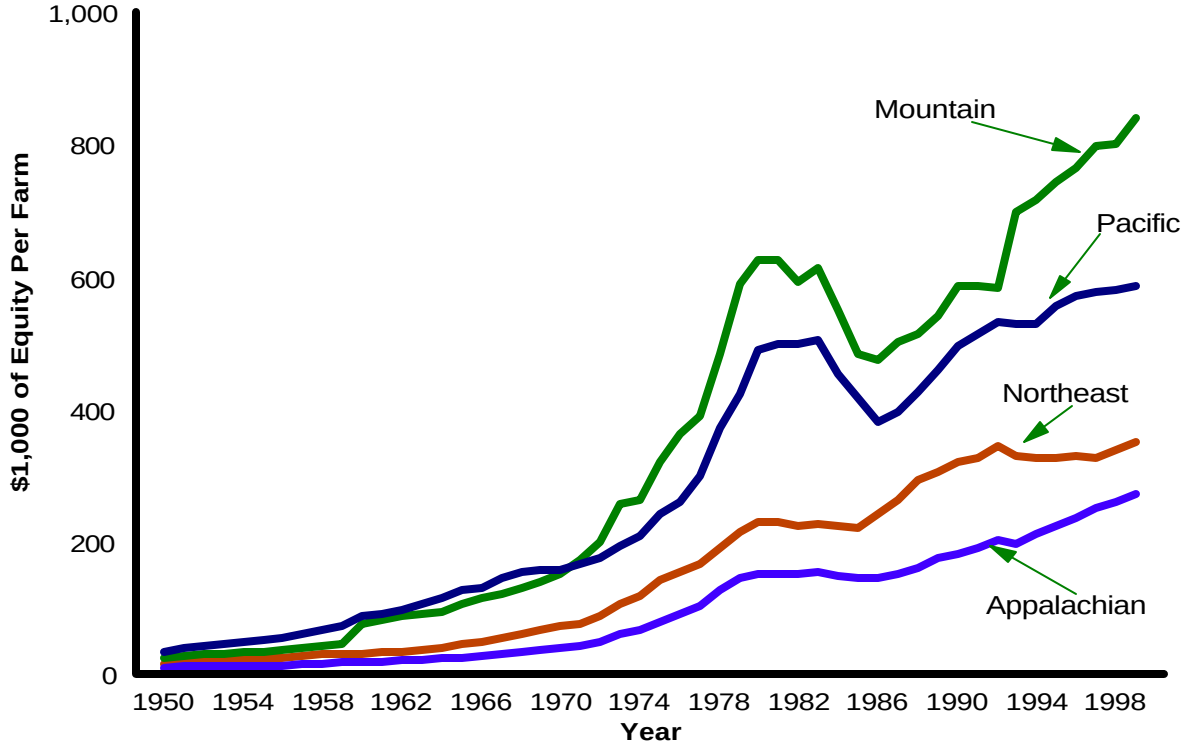
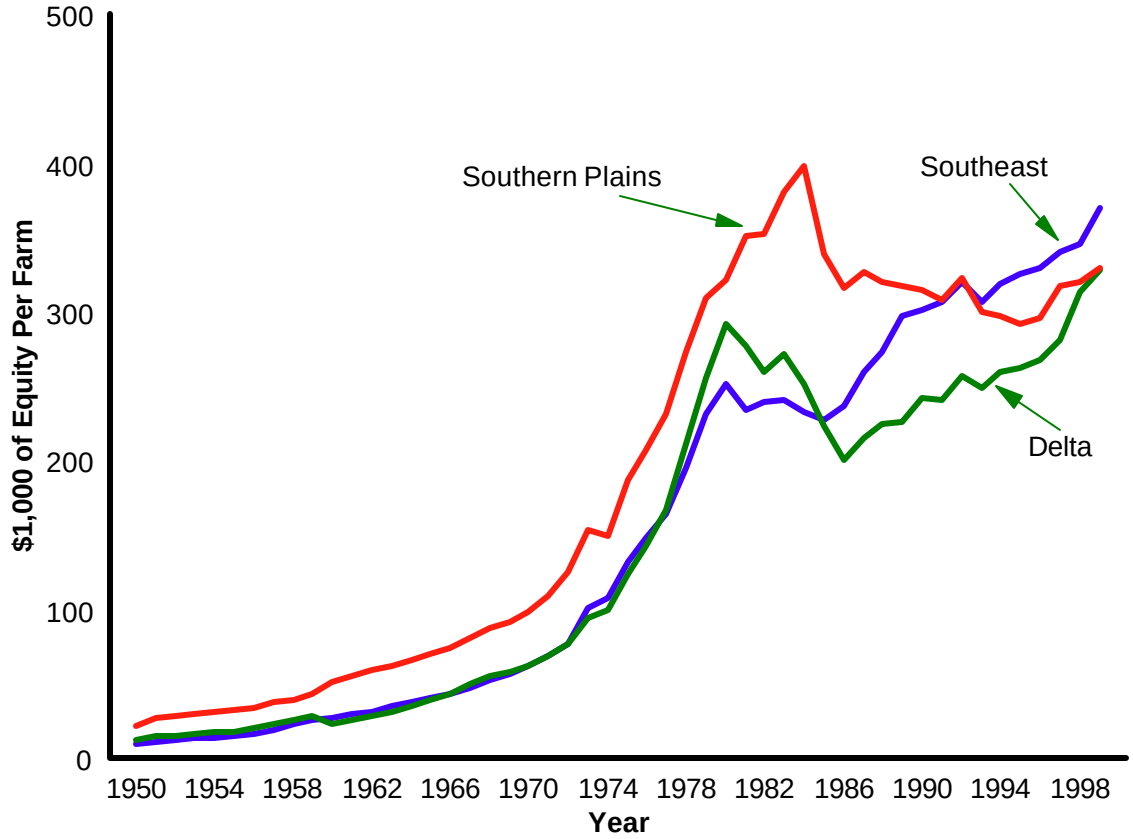


Figure 4: Average Equity Per Farm, for Selected Regions (1950-1998)



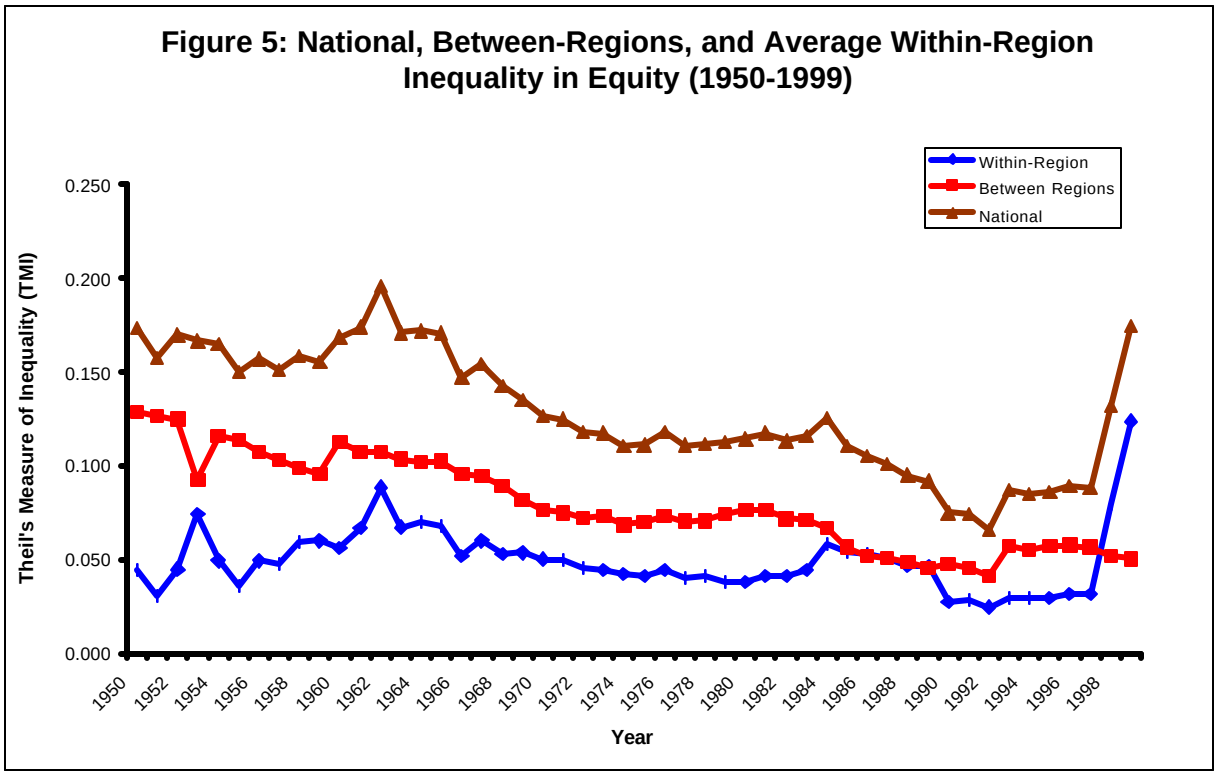


Figure 5: National, Between-Regions, and Average Within-Region Inequality in Equity (1950-1999)
Within-Region
Between Regions
National
Theil's Measure of Inequality (TMI)
0.250
0.200
0.150
0.100
0.050
0.000
1950
1952
1954
1956
1958
1960
1962
1964
1966
1968
1970
1972
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1992
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1996
1998
Year

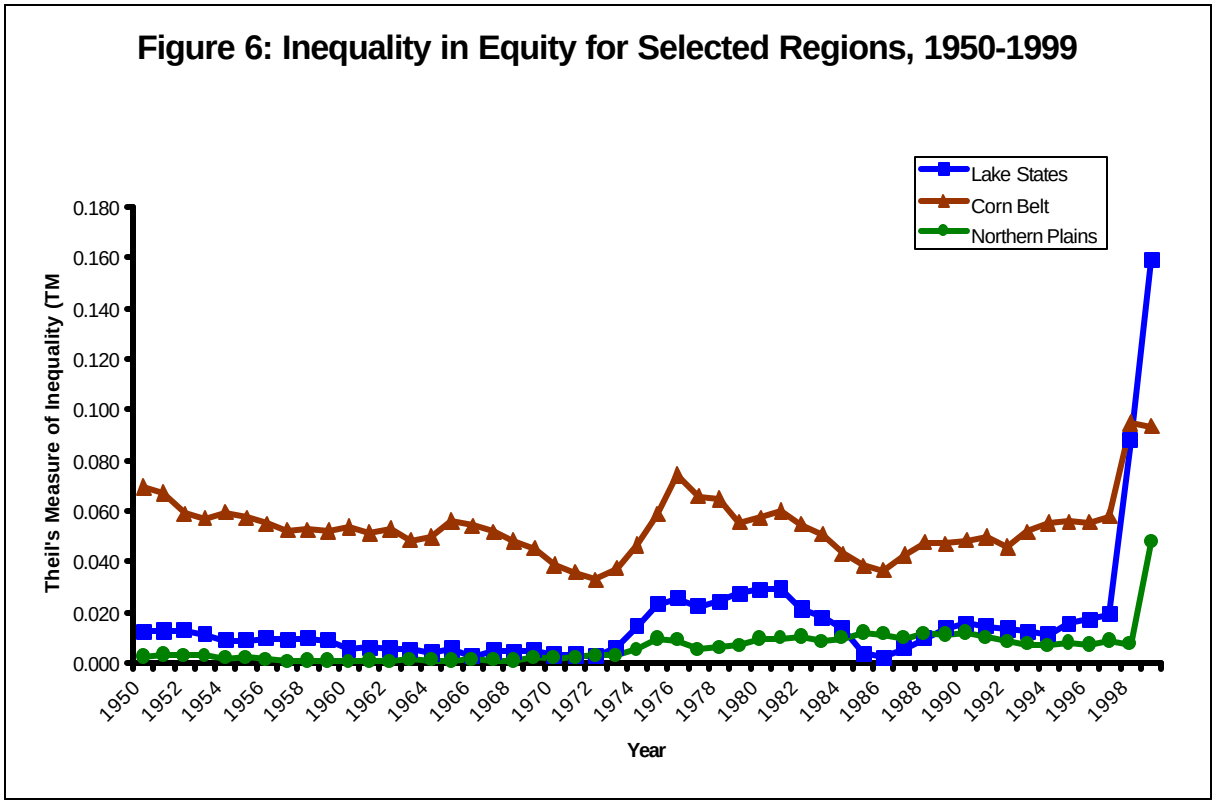
Figure 6: Inequality in Equity for Selected Regions, 1950-1999
Lake States
Corn Belt
Northern Plains
Theil's Measure of Inequality (TM
0.180
0.160
0.140
0.120
0.100
0.080
0.060
0.040
0.020
0.000
1950
1952
1954
1956
1958
1960
1962
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1968
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Figure 7: Inequality in Equity for Selected Regions, 1950-1999

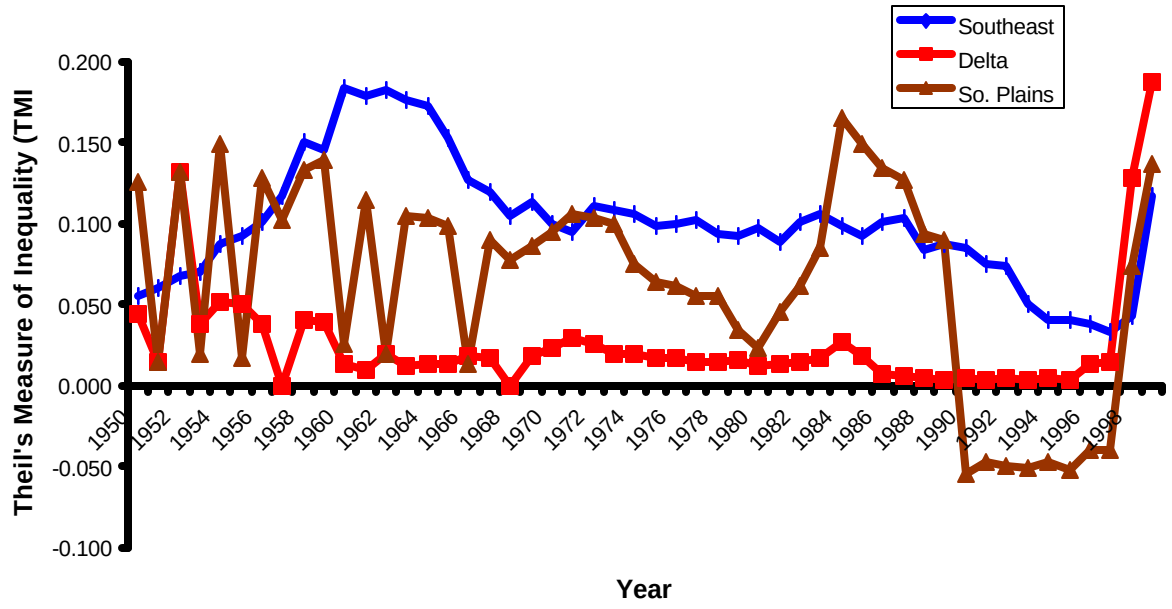

Figure 8: Inequality in Equity for Selected Regions, 1950-1999