Allocation Effects of Policy Reform:
A Micro-Simulation of Macro-Model Results for the United States

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By changing marginal prices and therefore production incentives, removal of government payments will result in a re-allocation of factors of production as farm households pursue alternative economic opportunities. At the economy-wide level these impacts are small, but closer inspection reveals that some household-level impacts will be larger and other households will be affected little if at all. The underlying heterogeneity of the agricultural sector results in variable adjustment along two dimensions. First, survey data show that payments are not evenly distributed so their removal does not have a uniform impact across the sector. Second, even if payments were evenly distributed, factor endowments are not, so that ability to enter into alternative enterprises and employment opportunities varies as well. Using micro-data from a national survey of farm households, we simulate the effects predicted by a disaggregated CGE due to removal of government payments. By bringing to the forefront the distributional character of farm and nonfarm labor income, other factor income, and tax payments, our micro-simulation approach can be a valuable tool for understanding the relationship between policy incidence and response, an issue sure to arise in implementing policy reform.

Keywords: income, labor, CGE, micro-simulation

1. Introduction

In 1996, the Federal Agriculture Improvement Reform (FAIR) Act converted most U.S. agricultural programs from a system of price-contingent and production-contingent supports to a system of non-contingent payments. Many observers heralded the new "freedom to farm" policy which conformed to a decades-long tradition of advice from economists who advocated non-contingent payments on the grounds that they don't directly change relative prices and therefore production incentives (Beard and Swinbank 2001). Non-contingent payments are not expected to influence the production decisions or induce operators to remain in agriculture instead of retiring or finding another occupation. For this reason, they were considered ideal for policy transition. The idea that producers respond differently to incentives presented by non-contingent payments than contingent payments is firmly rooted in economic models of optimal behavior. Orden, Paarlberg, and Roe (1999) as well as Schertz and Doering (1999) have studied the motivations behind the events leading up to the FAIR Act of 1996. Both studies assert that even at the time it was enacted, FAIR neither truly transitioned government out of the farm sector, nor represented a shift towards new farm constituencies. The Farm Security and Rural Investment (FSRI) Act enacted in 2002 confirmed these assertions, as the FSRI uses non-contingent payments to a lesser degree than the FAIR Act did.

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This paper will focus on production impacts from payments either introduced or continued with the FSRI, specifically direct payments, counter-cyclical payments, and marketing loan benefits. Direct payments are similar to Production Flexibility Contract (PFC) payments introduced under the 1996 farm bill; the payments are not contingent on current prices or production. Counter-cyclical payments provide price-contingent benefits for covered commodities whenever the effective price for the commodity is below its target price. Although counter-cyclical payments are contingent on prices, they are not contingent on current production of the covered commodity and therefore are not per-unit payments. Marketing loan benefits are per-unit contingent payments. Projected outlays under FSRI do not indicate a decrease in the level of government spending in agriculture compared to projected and actual outlays in 1996. Grouping FAIR-era PFC and market loss assistance payments with FSRI-era direct payments and counter-cyclical payments respectively, aggregate payments declined in 2001 and 2002 but are still above their 1996 levels (Figure 1). The rise and fall in payments over the 1998 through 2002 period is primarily from changes in the level of marketing loan benefits and market loss and disaster assistance.

Although one might conclude from the high levels of government spending in the years following FAIR enactment that farm household well-being is becoming increasingly dependent on farm prices and production in any given year, market activity of farm households indicates a divergence between farm income and farm household well-being. The chief contributor to this divergence is the continued growth in nonfarm income, shown in Figure 2 over the 1997-2002 period. The growth in nonfarm income appears to be robust even in the most recent year, when Census' Current Population Survey reported a decline in household income. As a result of increases in the incomes of farm households and decreases in the incomes of nonfarm households, the ratio of farm household income to the income earned by the average U.S. household (also shown in Figure 2) grew to 114 percent, despite the fact that government payments declined. One conclusion is that households are using labor and financial markets to increase returns to all factors of production owned by the household, increase their overall level of income, and manage risk, remedying the farm problem in ways that contingent farm programs instituted in the 1930s did not.

This paper addresses the adjustments that farm households make when policies change. Our policy scenarios are drawn from Hanson and Somwaru, who model the general equilibrium effects from removing a portion of the direct payments farm households receive, specifically the 2002-era payments received as (1) fixed, direct payment, (2) marketing loan gains, and (3) counter-cyclical payments. Environmental program payments are not included. The macro model is calibrated using Agricultural Resource Management Survey (ARMS) data on the distribution of payments received in 1999 by farm households in the form of (1) PFCs, (2) marketing loan gains, and (3) market loss assistance. We use the 1999 ARMS data to simulate impacts for all farm households using the results of Hanson and Somwaru, and add a distributional perpective to their "representative farm" findings.

2. Farm household adjustment

Farm households vary greatly with respect to the size and scope of their operations and whether or not they participate in government programs. Figure 3 shows that residential and lifestyle farms (defined by the operator's primary occupation) are by far the largest group. Overall, about a third of farm households participate in government programs, but households where the operator's primary occupation is farming as well as large farms have a much higher rate of participation in government programs. Aside from showing great variability with respect to the size of their farming operation, farm households vary in the extent to which their income streams come from non-farm sources. Figure 4 compares the contribution of off-farm income to total income across the typology, showing that although average levels of off-farm income earned are similar the relative contribution decreases in farm size for farming-occupation households.

The farm typology is useful for describing the average level of well-being of groups of farm households in the year in which a household is surveyed. The estimated averages are drawn from observations that reflect household-specific factors such as preferences, endowments, and technology as well as exogenous factors such as weather, prices, and farm and nonfarm government policies. Although the groupings are mututally exclusive given the characteristics chosen (farm size, occupation, and income level) a considerable amount of heterogeneity remains in outcomes observed, such as total household income. Figure 5 illustrates the level of heterogeneity in incomes within a farm household type by showing median household income alongside the 10th and 90th percentiles. Note that variability increases as median farm income rises both within the three groups at the top of the figure and the four groups at the bottom. Of great interest is how much of this variability stems from farm income and the degree to which payments reduce it. Also note the similarity between program participant farms and the remaining two-thirds of "typical" farms at the three points selected from the overall distribution.

General equilibrium (CGE) analysis was used by Hanson and Somwaru (2003) to show impacts on well-being across the farm typology when policies changes, namely when reform involves removal of all commodity programs. General equilibrium modeling exercises do not model policy adjustment directly but instead trace the impacts of a shock on an economy through its constituent parts from a base equilibrium to a post-shock equilibrium. Hanson and Somwaru considered household response to be distributed across the seven different household types rather than absorbed by a single representative household. We direct interested readers to Hanson and Somwaru for details of the model specification. However, it is important to note that their model of the economy is such that it does not allow for changes in the trade balance, real investment, or the government deficit to absorb the effects of the shock from removing subsidies. Instead, the closure rules used in the model imply that the economic shock affects the economy through changes to household well-being, proxied by the level of household income.

Hanson and Somwaru estimated the impacts from removing direct payments, counter-cyclical payments, and marketing loan benefits paid to farm households in the US. Removing payments decreases the levels of household income directly but also affects commodity production levels and prices. Government payments enter the model either as lump sum transfers or as per-unit payments. In effect, their analysis does not model counter-cyclical payments specifically but rather shows the effects of removing government payments equal in size to counter-cyclical payments, and modeling this alternatively as either the removal of a lump sum payment or as a price-contingent payment. Hanson and Somwaru's scenarios compare effects when 85 percent of total payments are non-contingent (Scenario 1) to removing payments when 44 percent are non-contingent (Scenario 2) and represent portfolios of payments rather than payments themselves.

Some insight on factor response to removing payments can be drawn from examination of the structure of the CGE. Note first that although removing payments to a farm household reduces their gross income, due to the "budget neutrality" closure rule implemented by the CGE all labor decisions are influenced by the reduced tax burden. Labor response at the margin, or the labor supply elasticity, is the sum of a positive component called the compensated labor supply elasticity (reflecting that people will work more if paid more per unit of work) and a negative component called the income elasticity (reflecting that people will consume more leisure if paid more for their work). These two components of the labor supply elasticity are also known as the substitution effect and the income effect, respectively. Hanson and Somwaru use a labor supply elasticity of 0.05 for the primary earner and 0.4 for the secondary earner, maintaining the assumption that the substitution effect dominates the income effect. As a result, overall labor hours increase when wages (net of taxes) increase and decrease when the net wage decreases.

Incentives to change on-farm and off-farm labor allocations can be distinguished by the type of payment as well. Because income declines under both scenarios, off-farm labor hours expand and leisure contracts. When contingent payments are removed the farm wage is affected, and farm labor hours could shift to production of another agricultural commodity as farms diversify. Alternatively, Hanson and Somwaru allow household labor hours to be shifted from farm to non-farm employment, subject to the ability of the household to supply more labor to the non-farm market. In their model, only households previously engaged in providing some off-farm labor, but not engaged full-time, will increase their off-farm labor hours. Figure 6 shows that residential and lifestyle farms have the most farms with part-time spousal employment, and therefore have the greatest capacity for labor substitution. In contrast, although many large and very large farm operators work off the farm, many of these are full-time workers, and therefore have only limited opportunities to increase off-farm labor hours to maintain household income in the face of a loss of program payments.

Not shown are Hanson and Somwaru's impacts on low-income and high-income nonfarm households. Although treatment of nonfarm households is beyond the scope of this paper, we do note that low-income non farm households were net losers and high-income nonfarm households were net gainers. Low-income nonfarm household losses were less than 2 percent of net income gains for all households. Gains for nonfarm households were derived primarily from reduced tax burdens and increased labor income. Nonfarm household losses were from lower government payment receipts earned as owners of cropland, as well as from an increase in food consumption costs.

Table 1 summarizes Hanson and Somwaru's general equilibrium effects on farm household income, farm labor income and nonfarm labor income, returns to other factors of production, and the change in taxes. Note that neither the aggregate level of payments nor its distribution (first column) changes between the two scenarios. Also unchanged between the two scenarios was the direction of the effects on household income and farm labor income (which both declined) and nonfarm labor, taxes, and returns to other farm factors of production (which all increased) in response to removing payments. Hanson and Somwaru summarized their findings by noting the following:

- The magnitude of Scenario 1 aggregate effects on value of production and prices (down $915 million and up 0.16% respectively) is smaller than Scenario 2 aggregate effects (down $2,854 million and up 1.32% respectively).
- Farm household losses are $540 million more in Scenario 1 than in Scenario 2.
- Farm households substitute off-farm labor for leisure in both simulations.
- Scenario 2 results showed greater substitution of off-farm for farm labor.
- Tax relief effects are large relative to nonfarm labor income effects.

Table 1. Effects on farm households from removal of payments

Scenario 1. CCP program modeled as lump sum payment

	Program payments	Farm labor income	Nonfarm labor income	Tax relief	Other farm factors	Household income
			billions of dollars			
All farms	-8.153	-0.651	0.266	1.087	0.558	-6.893
Limited res	-0.054	-0.009	0.002	0.01	0.004	-0.047
Retirement	-0.109	-0.074	0.009	0.042	0.007	-0.125
Residential	-0.552	-0.239	0.064	0.27	0.032	-0.425
Farm occc. ·	-1.135	-0.127	0.044	0.186	0.073	-0.959
Farm occ.-	-2.275	-0.062	0.055	0.215	0.16	-1.907
Large	-1.911	-0.041	0.042	0.16	0.143	-1.607
Very large	-2.117	-0.099	0.05	0.204	0.139	-1.823

Scenario 2. CCP program modeled as market distorting

	Program payments	Farm labor income	Nonfarm labor income	Tax relief	Other farm factors	Household income
			billions of dollars			
All farms	-8.15	-1.688	0.333	1.034	2.153	-6.318
Limited res	-0.055	-0.022	0.004	0.01	0.015	-0.048
Retirement	-0.106	-0.172	0.017	0.051	0.029	-0.181
Residential	-0.55	-0.554	0.088	0.291	0.146	-0.579
Farm occ. ·	-1.057	-0.319	0.058	0.174	0.262	-0.882
Farm occ.-	-2.194	-0.198	0.059	0.182	0.575	-1.576
Large	-1.933	-0.138	0.045	0.137	0.532	-1.357
Very large	-2.255	-0.285	0.062	0.189	0.594	-1.695

Source: Hanson and Somwaru, Tables 8 and 10

3. Micro-simulation of results

Because Table 1 presents the aggregate impact for each of the seven representative households in the US, we can then simulate an impact for each household within the ARMS data, thereby closing the "distribution gap" between the representative households shown in Table 1 and the individual households within the sector. Our objective is to introduce information contained in ARMS on the heterogeneity that still remains even after sorting households into typology groups. Micro-simulation may be especially valuable when indicators of interest to policymakers are continuous variables with a wide degree of dispersion, such as income and tax burdens.

Carrying out a micro-simulation with ARMS involves estimating an impact from policy reform for each farm household in the dataset. The following procedure was used for simulation:

1. Use the ERS farm typology definition to classify each farm in ARMS into a mutually exclusive group. Each observation will then correspond to one of the representative farm households (rows) of Table 1.
2. Transform Table 1 effects into "shock coefficients" by dividing each value within a row by the amount of program payments, found in the first column of the table.
3. Simulate shocks to farm labor income, nonfarm labor income, other factor income, and net household income by multiplying the shock coefficient by the amount of program payments (excluding environmental payments) received by farm households in 1999, using the ARMS data.

4. Simulate shocks from tax relief by multiplying the shock coefficient by estimated taxes paid for farm households. Tax payments are estimated using the reported net income of the household and the 1999 federal marginal tax brackets.

For a (hypothetical) example using the first scenario, consider a farm that received $10,000 less in government payments in 1999 as a result of policy reform. If that observation is classified as a “large” farm according to the ERS typology we simulate the changes predicted for the “large” representative farm in Table 1. The simulated change in farm labor income and nonfarm labor income is $-215 (-215 = -10,000 x (-0.041/-1.911)) and $220 (220 = -10,000 x (0.042/-1.911)) respectively. If that observation is classified as a “very large” farm according to the ERS typology we simulate the changes corresponding to the “very large” representative farm in Table 1 as $-468 (-468 = -10,000 x (-0.099 / -2.117)) and $236 (236 = -10,000 x (0.05/-2.117)) respectively. This procedure maintains the assumption that households receiving a larger payment respond more from removing it than households receiving a smaller payment, and that the response from a farm that did not receive a payment in the first place is zero. We scale the tax relief effect with estimated actual income taxes paid rather than program payments to reflect that tax relief will not benefit those who owe no taxes.

Note that these effects are general equilibrium effects, but do not represent the adjustment path itself. The general equilibrium analysis is static, and not inclusive of economic incentives to change the overall level of investment relative to current consumption or incentives to change the overall goals of the household that might include leaving the sector. Results from the micro-simulation are shown in terms of the ex-ante income distribution for farm households. The distribution of farm household income is used rather than the distribution of income from farming because the factor flows modeled in the CGE extend beyond the household’s farm business. Although effects from farm policy reform are often discussed in terms of impacts on net farm income, this is argued to be a poor policy benchmark. Net farm income excludes off-farm activities affecting household income and wealth, reveals little about the ability to service debt and gives no indication of how often farms fail (Morehart et al. 2001). It should be noted that the household income distribution is not identical to the distribution of welfare among U.S. farm households, but is merely a facet of household well-being. Mishra et al. (2001) and Roberts and Key (2003) discuss some of the pitfalls of relying on household income alone in understanding household well-being, and encourage a more integrated approach that would include household consumption and wealth levels.

The income distribution of farm households after support payments are removed is dominated by the income distribution with payments (Figure 7). The solid line is a weighted cumulative distribution function drawn directly from reported household income for the entire ARMS dataset, while the dotted line is drawn from a variable that is ex-ante household income less government payments received. Note that the dotted curve is everywhere to the left of the solid curve, indicating that the income distribution has shifted backwards as expected with the removal of payments, before households have had a chance to adjust. However, the horizontal distance between the two curves is not the same at every point, ranging from a difference in income near $2000 near the median and up to $10,000 apart at the tails. This speaks to the characteristic (seen before in Figure 5) that the tails of the large and vary large farms income are the most extreme and that larger payments going to them are driving much of the distributional impact.

Comparing the ex-ante to the ex-post distribution is useful for seeing the aggregate shift in incomes. However, because not all households receive payments and participating households receive differing amounts, the shock of removing payments not only shifts the distribution but also shuffles the ordering of households within the population. Those households participating in the program move down in the order according to the payments that have been removed, and those households not participating in the program keep their incomes but move up relative to others.

The change in incomes, holding the ranking of households fixed in their ex-ante position, can be seen in Figure 8. The horizontal axis shows the percentiles of the distribution and the vertical axis shows the absolute change in income, averaged over all farms whose income falls between the minimum and maximum value for that percentile. The curve is smoothed using locally weighted regression (Cleveland, 1979). Because the change in income is averaged over all observations within the percentile group, it is sensitive to how broadly the population is specified. To demonstrate this, we graph the change in incomes from removing payments for the entire population of farm households, the change when averaged only over participating farms, and the change when averaged only over "very large" participating farms. The (approximately) 3-fold difference between the "all farm households" and "participating farm households" holds constant the level of payments but decreases the size of the reference population. The (approximately) 4-fold difference between "participating farm households" and "very large, participating farm households" is due to the large size of the payments received by large farms.

Simulating the removal of payments shows the incidence of payments, but not the economic response of households once their payments are removed. Following the steps outlined above, we simulate the distributional incidence and response from removing payments in Figure 9, shown relative to the ex-ante income distribution. The solid lines show the results from Scenario 1 (labeled S1 in the legend) and the dashed lines show the results from Scenario 2 (labeled S2 in the legend). We want to make three general points from Figure 9 before moving to a more disaggregated explanation.

First, nearly all of the response curves have the same general shape as government payments. Because the incidence of payments is higher away from the middle of the income distribution, so is the response. This is due to the assumption that response is conditioned only on the amount of government payments received. An exception to this is the impact of tax relief. Tax relief is increasing in income because taxes themselves are progressive. Second, note that factor responses are always larger in the case of the second scenario than the first scenario. This is not due to any differences in the quantity of payments but due to the structure of payments. The predominantly-contingent set of payments modeled in Scenario 2 result in a much greater range of labor and other factor responses by households, relative to Scenario 1. Third, although labor and capital respond to net out some of the incidence of losses, most of the gains rely on the "tax dividend" gain from reducing the size of the government farm budget. In the case of households at the low end of the income distribution, they will benefit little from this, due to the fact that they are not liable for any taxes.

Figure 10 shows the difference between the "program payments" and the "household income" curve for Scenario 1 and 2 shown in Figure 9. This "response curve" represents the active adjustments made by farm households in the wake of removing payments, and range from less than $1,000 to $10,000 across the distribution, in general trending up with incomes. The response is descriptive and useful for understanding the extent to which farm households on their own may react to changing economic circumstances and incentives, a function of the "shock coefficients," the level of payments received, and income tax liabilities. Note that because the upper end of the income distribution responds more than the rest of the income distribution, one of the ultimate impacts of policy reform is to increase the overall dispersion of household incomes. This is due in part to the unequal distribution of payments as well as the tax code, which offers progressive tax relief as well as progressive taxation.

Figure 11 shows the response curve for Scenario 1 found in Figure 10, but decomposed into the seven-way farm typology. Response values along the vertical axis are calculated as an average at each percentile using only the members of each typology group. For the limited resource farms in particular, the impact on their well-being is basically identical to the loss of payments. Other types of farms make up some of the ground they lost from policy reform, by substituting off-farm work to the extent that they are currently consuming leisure. The tax relief effect is shown to be particularly strong for retirement and residential and lifestyle farms that owe taxes, exceeding the adjustment for even the largest farms receiving the most payments. The curves are useful for showing that most of the adjustment is undertaken by the large and very large farm types.

4. Summary and Conclusions

A micro-simulation of policy reform in the U.S. using data from a national survey of farm households shows that both incidence and response are heterogeneous across the sector. Key contributions of ARMS for the simulation include data on government programs, both in terms of program participation as well as levels of payment received. This allows for incidence and response to policy reform at the representative farm level in the macro model to be decomposed into incidence and response at the micro model level. Alternative simulations, such as uniform incidence and response within a farm household group, ignore this source of heterogeneity.

Households are shown to have only limited capacity to make up ground lost with policy reform through labor markets, substituting off-farm labor for leisure and substituting non-farm for farm employment. Tax relief provides some households a source of passive adjustment to policy reform and will have direct impacts on the distribution. An interesting finding from the simulation is that tax relief for many farm households can be quite large and not in proportion to the amount of payments received. Because both the macro and micro simulations are static, any incentives to households to demonstrate a positive tax liability are not included.

A more disaggregated CGE model could be easily accomodated with the methods used in this paper. Ongoing work by Hanson, Somwaru and collaborators suggests that a useful next step is to allow for more information on labor market participation to be incorporated. Breaking down representative farm households into region and commodity specialization classes would allow for factors specific to the household and region (such as demographics and off-farm wage rates) to determine adjustment. Likewise, future work will look at distributional response when we relax the assumption that the share of contingent to non-contingent payments is constant across all households. Conservation payments in particular are distributed differently across the typology, compared to commodity programs.

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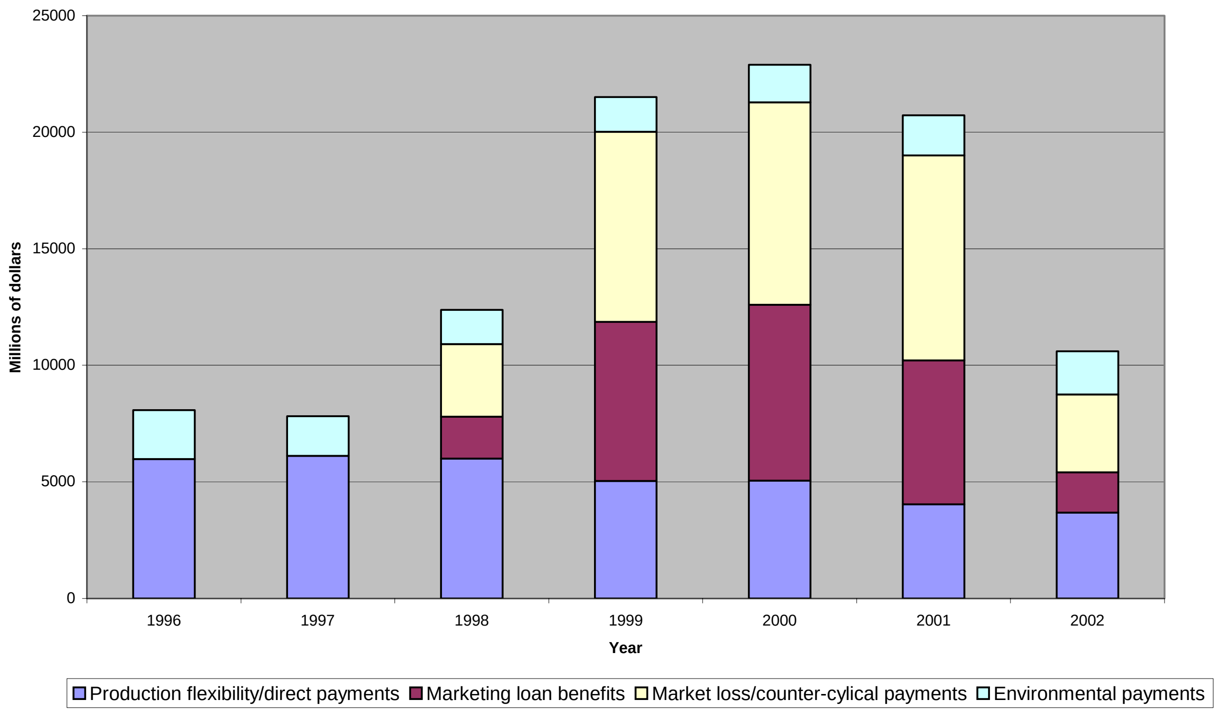


Source: 2003 data from www.ers.usda.gov/briefing/farmincome

Figure 1. Changing composition of U.S. direct payments

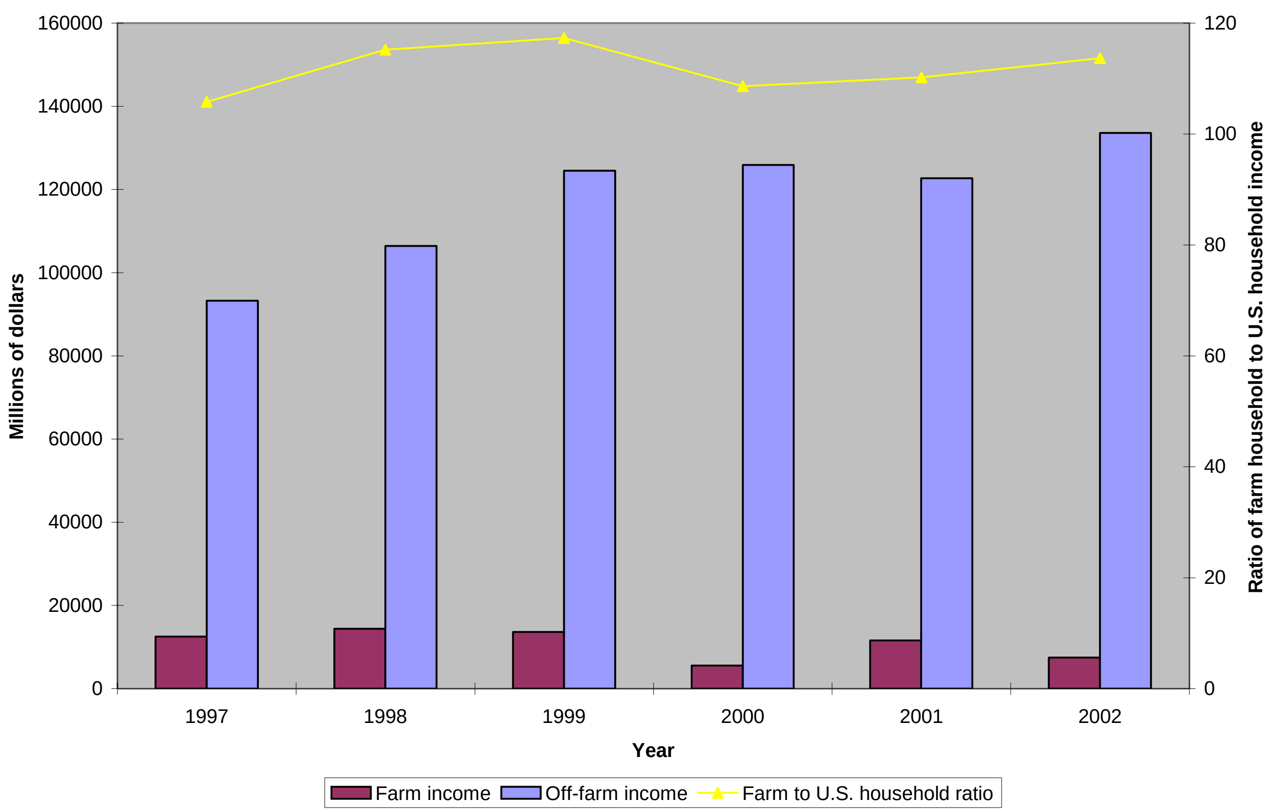


Figure 2. Off-farm income shows continued growth

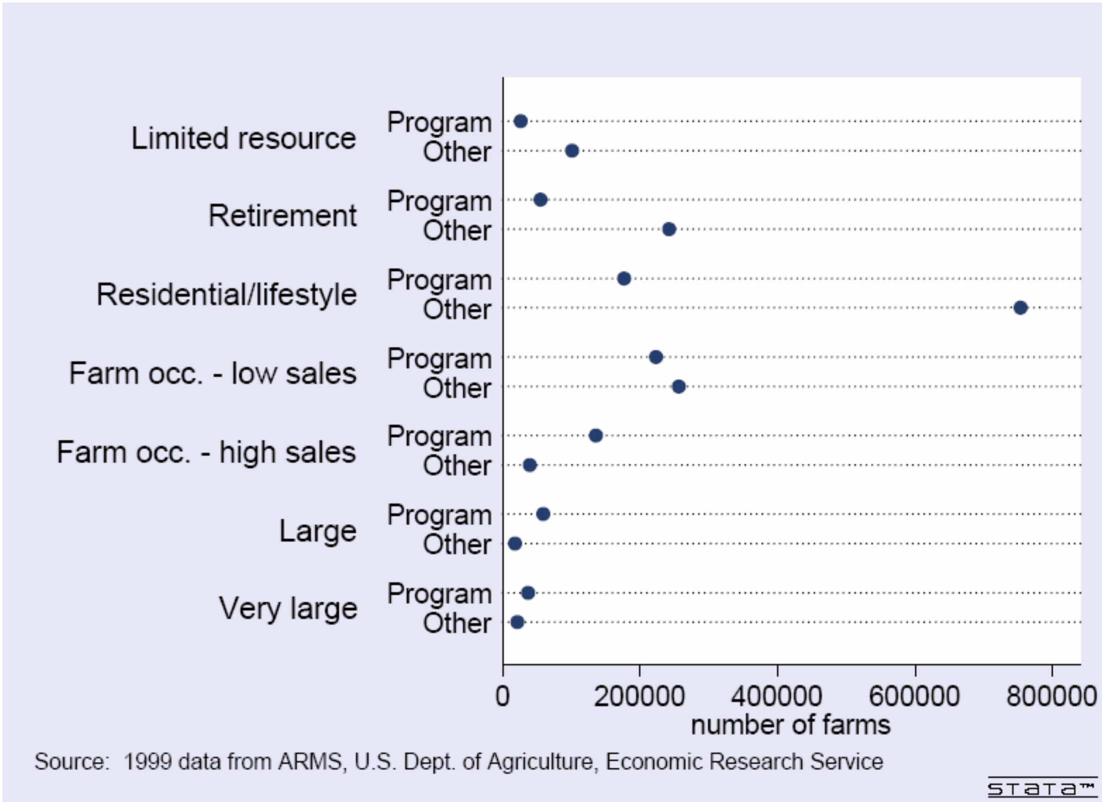


Figure 3. Distribution of Farm Types and Program Participants

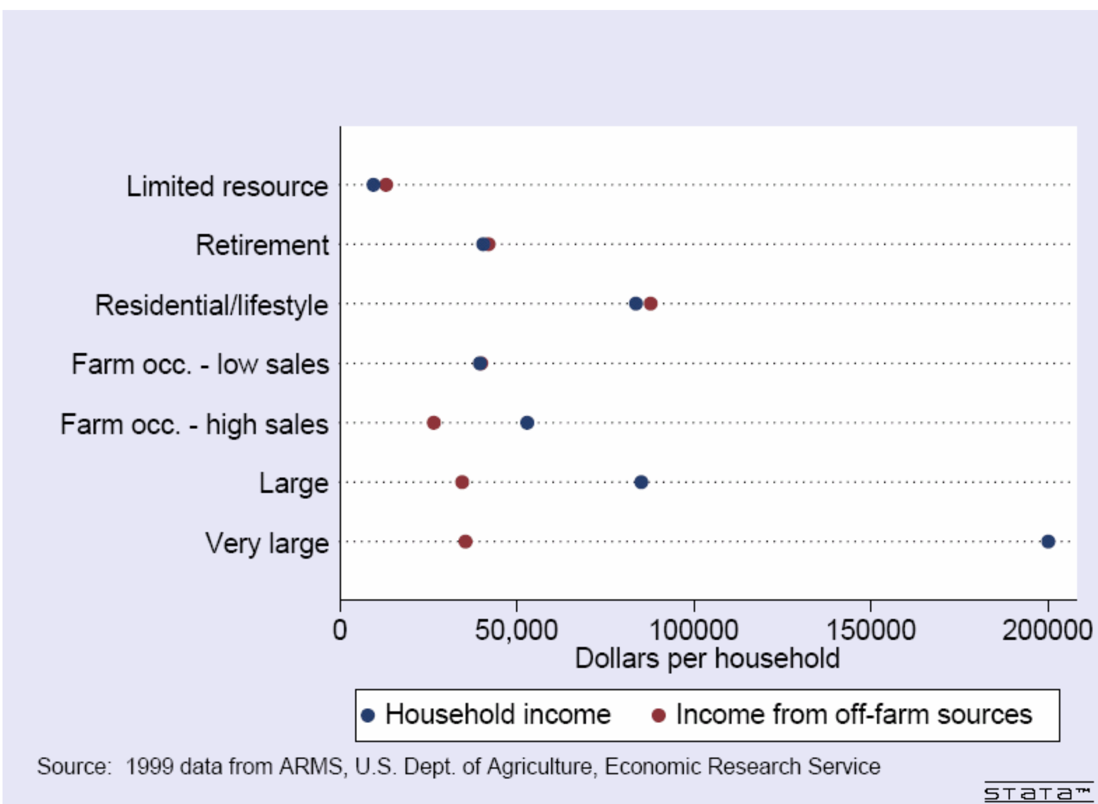


Figure 4. Off-farm contribution to Total Household Income

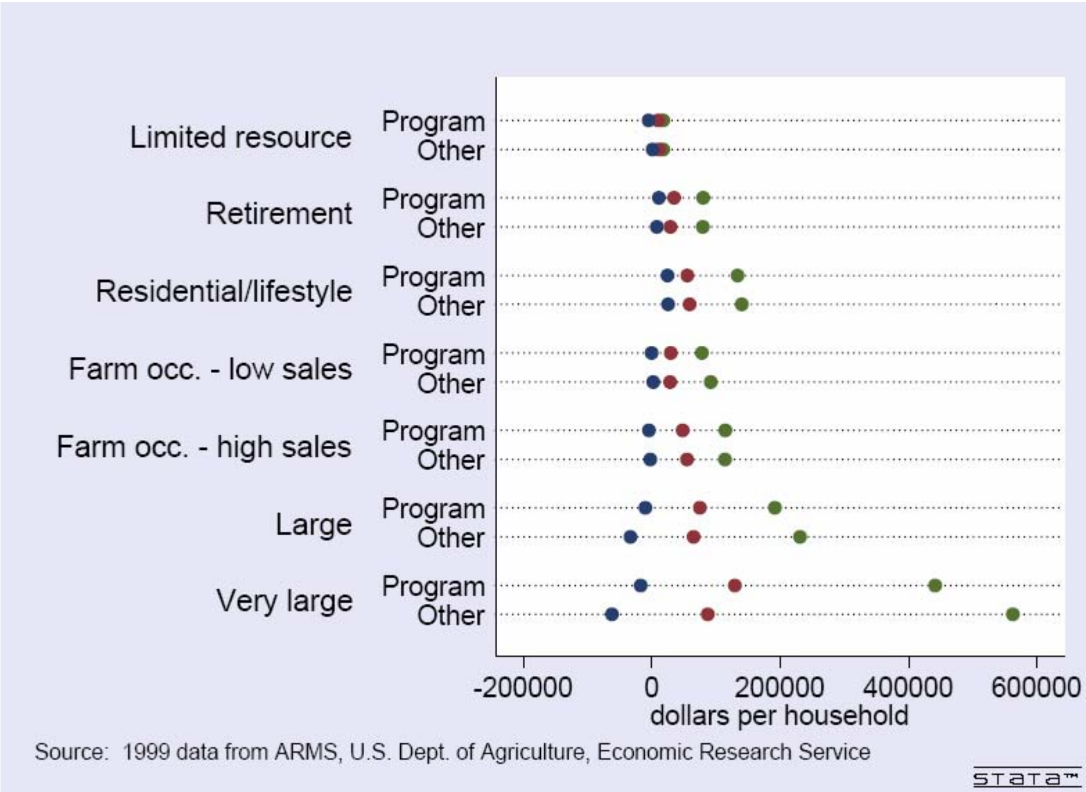


Figure 5. Median Household Income, with 10th and 90th percentiles, for program participant and typical farms.

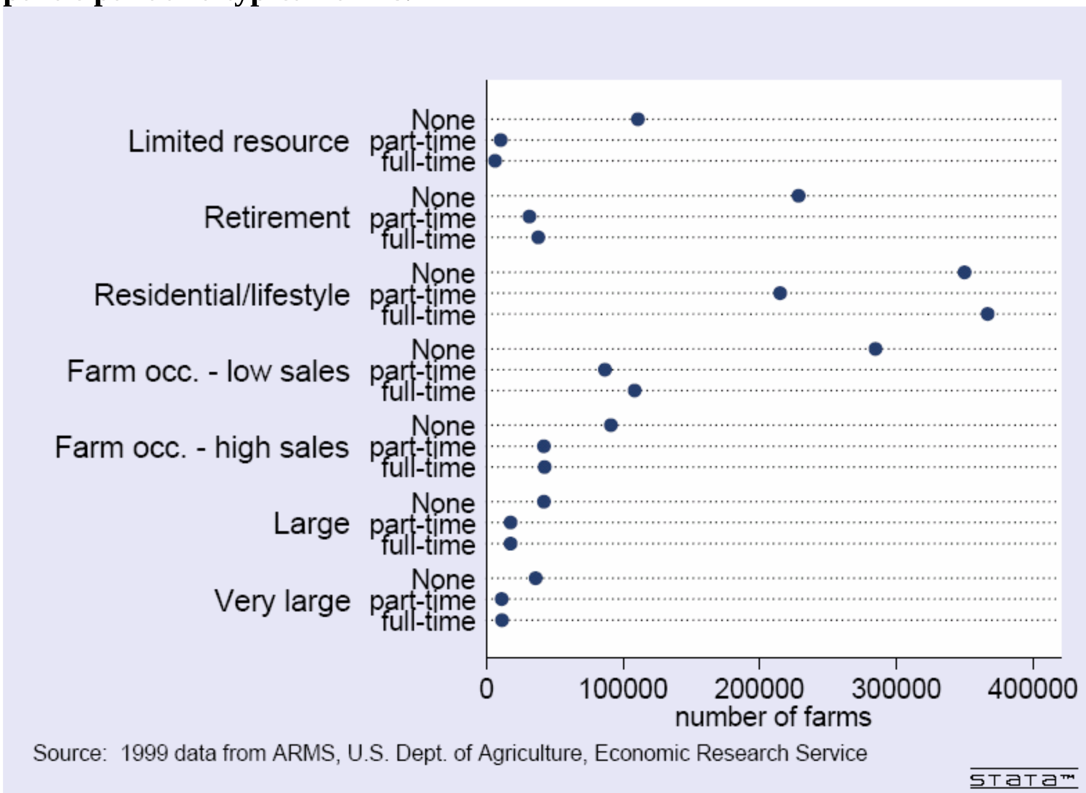
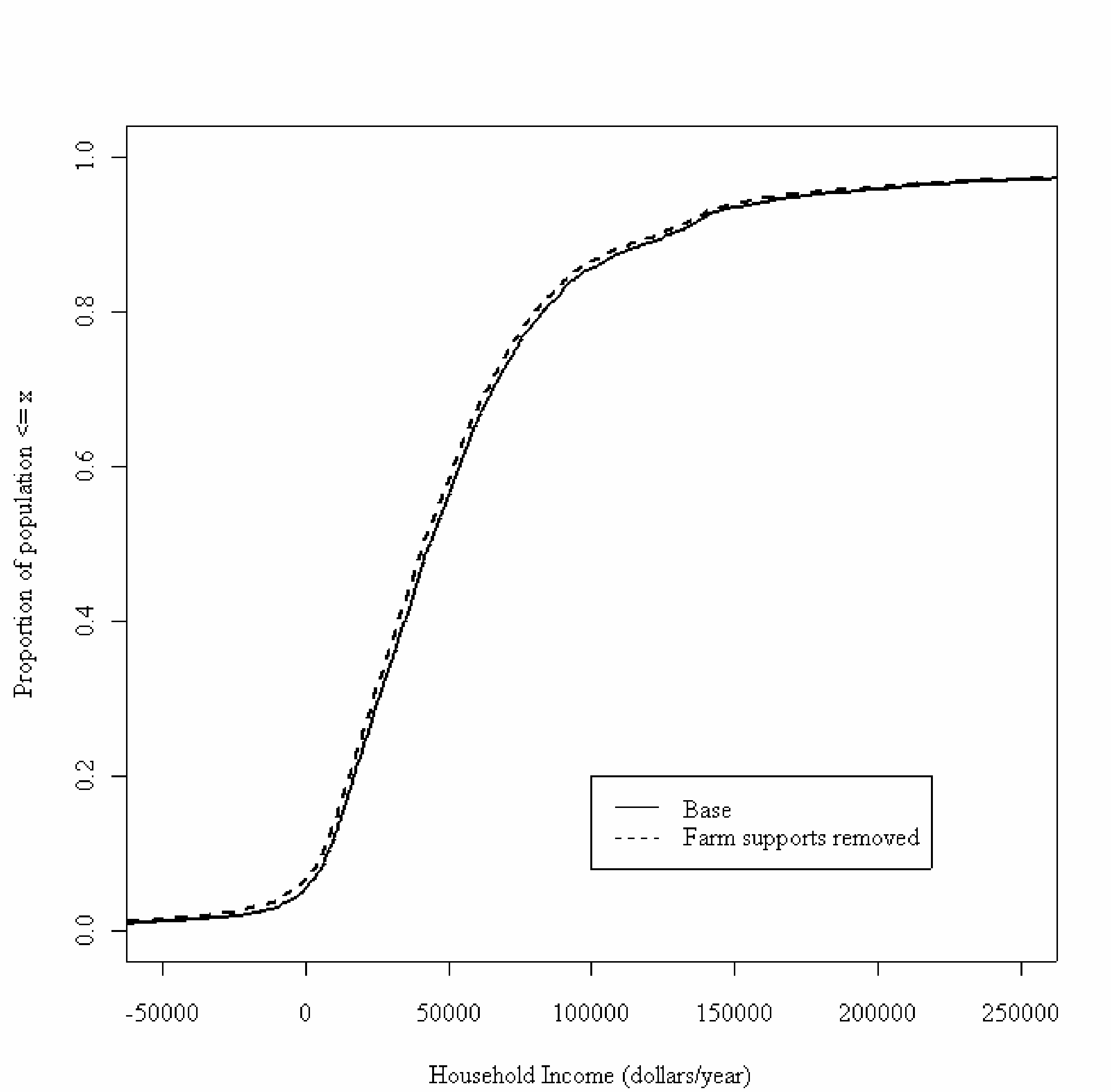
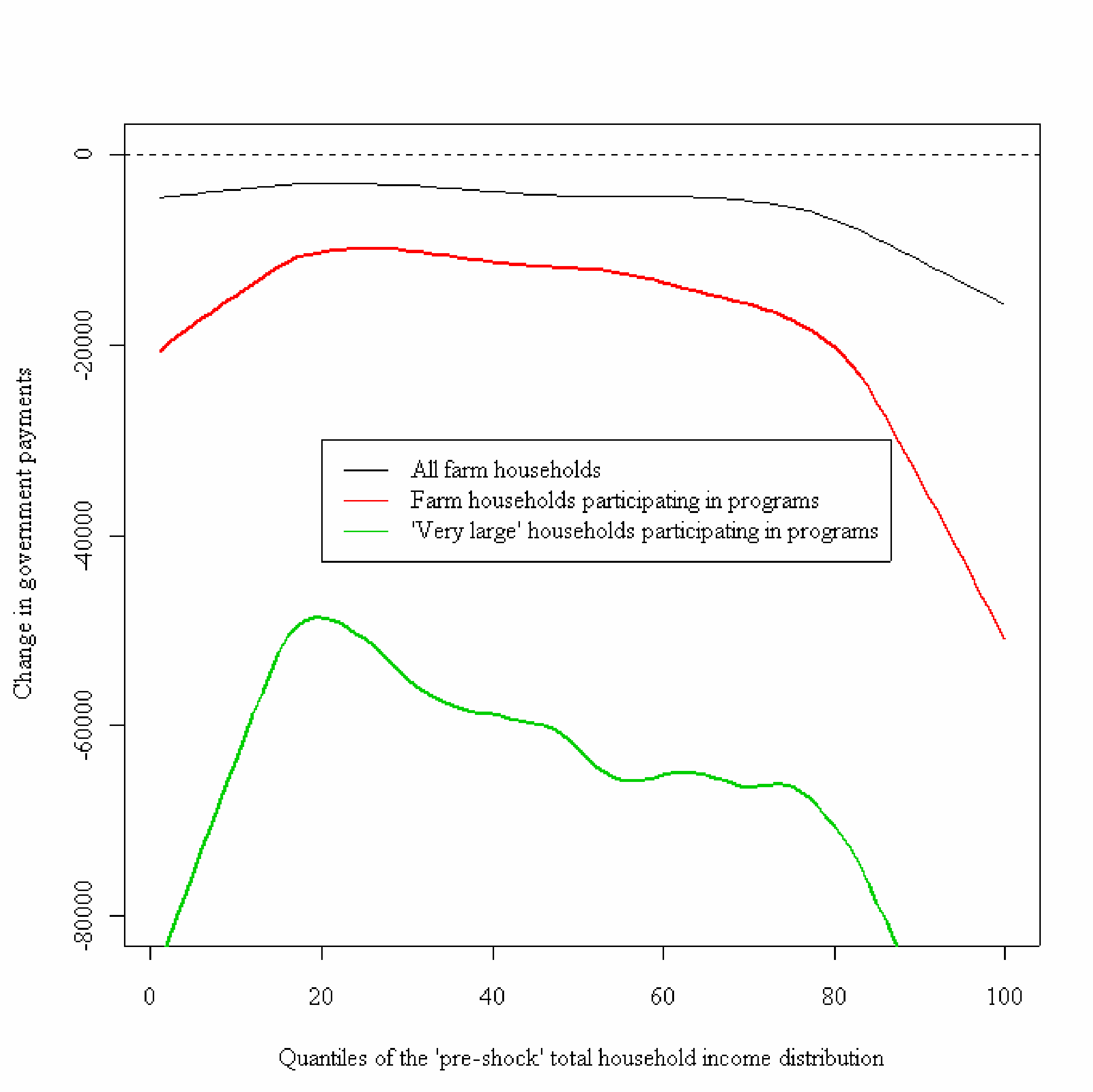


Figure 6. Number of farms on which spouse is employed off-farm.

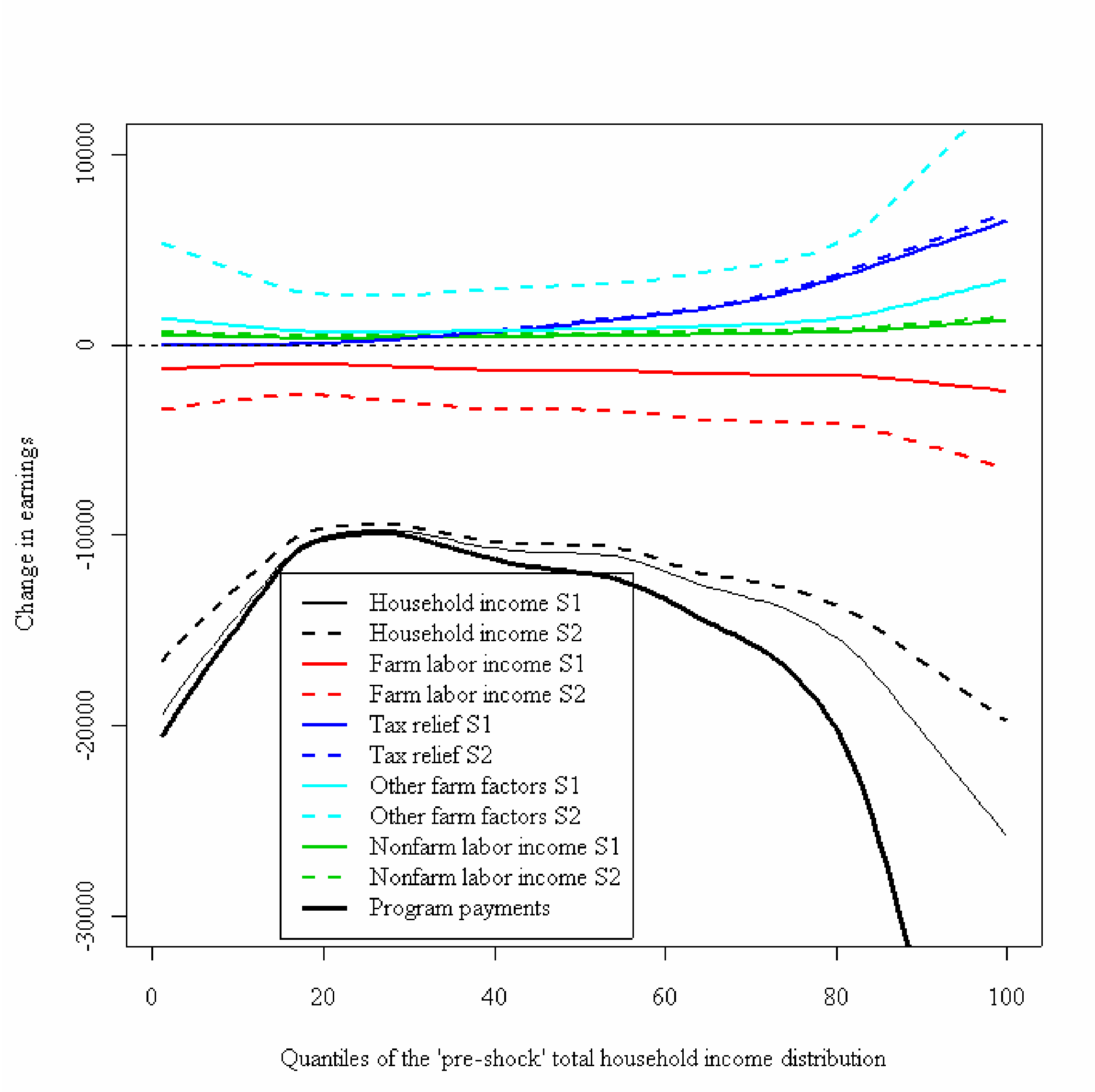


Source: 1999 data from ARMS, U.S. Dept. of Agriculture, Economic Research Service
Figure 7. Household Income, base period and after removal of supports



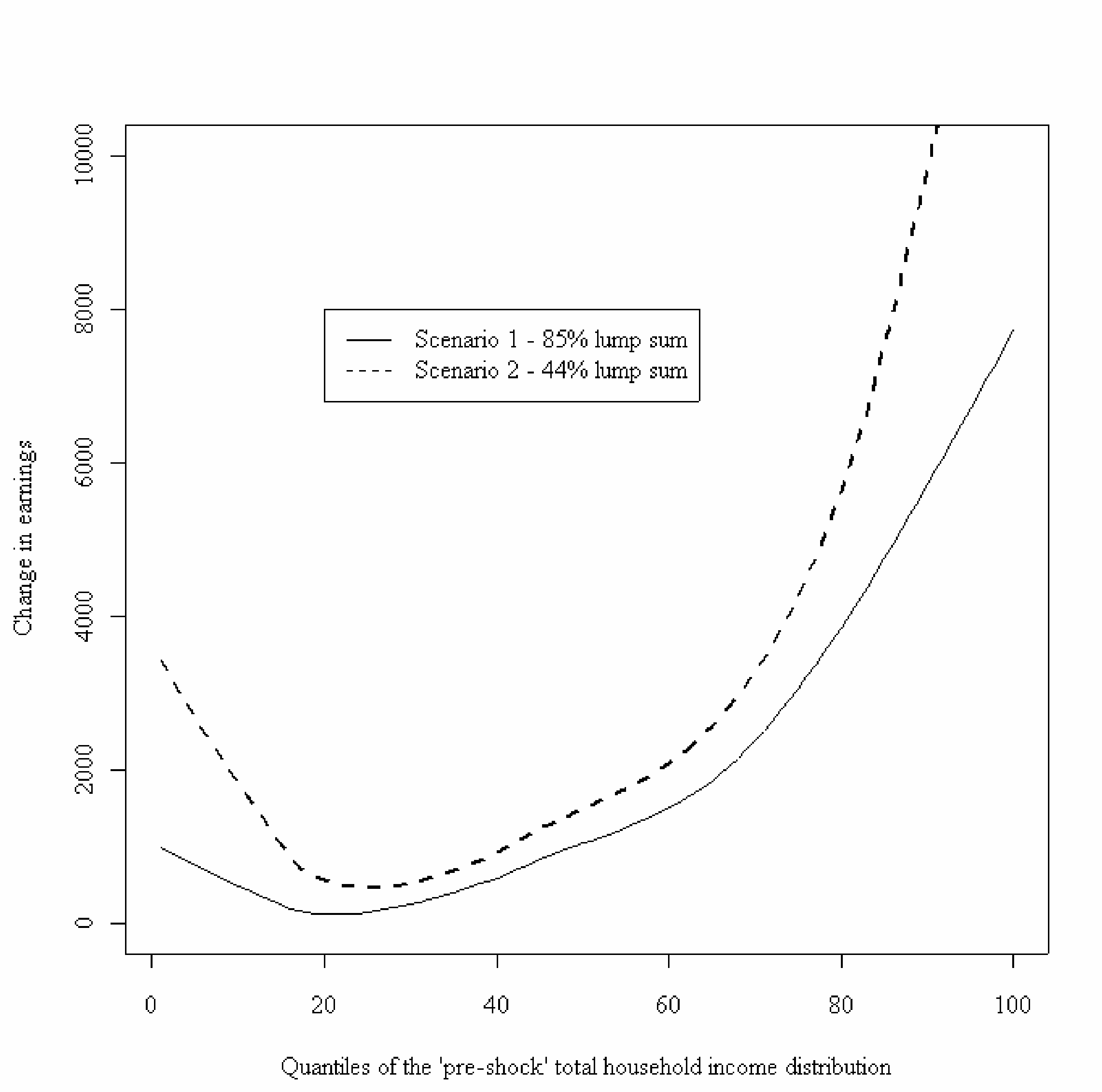
Source: Author calculations

Figure 8. Value of government payments across the income distribution



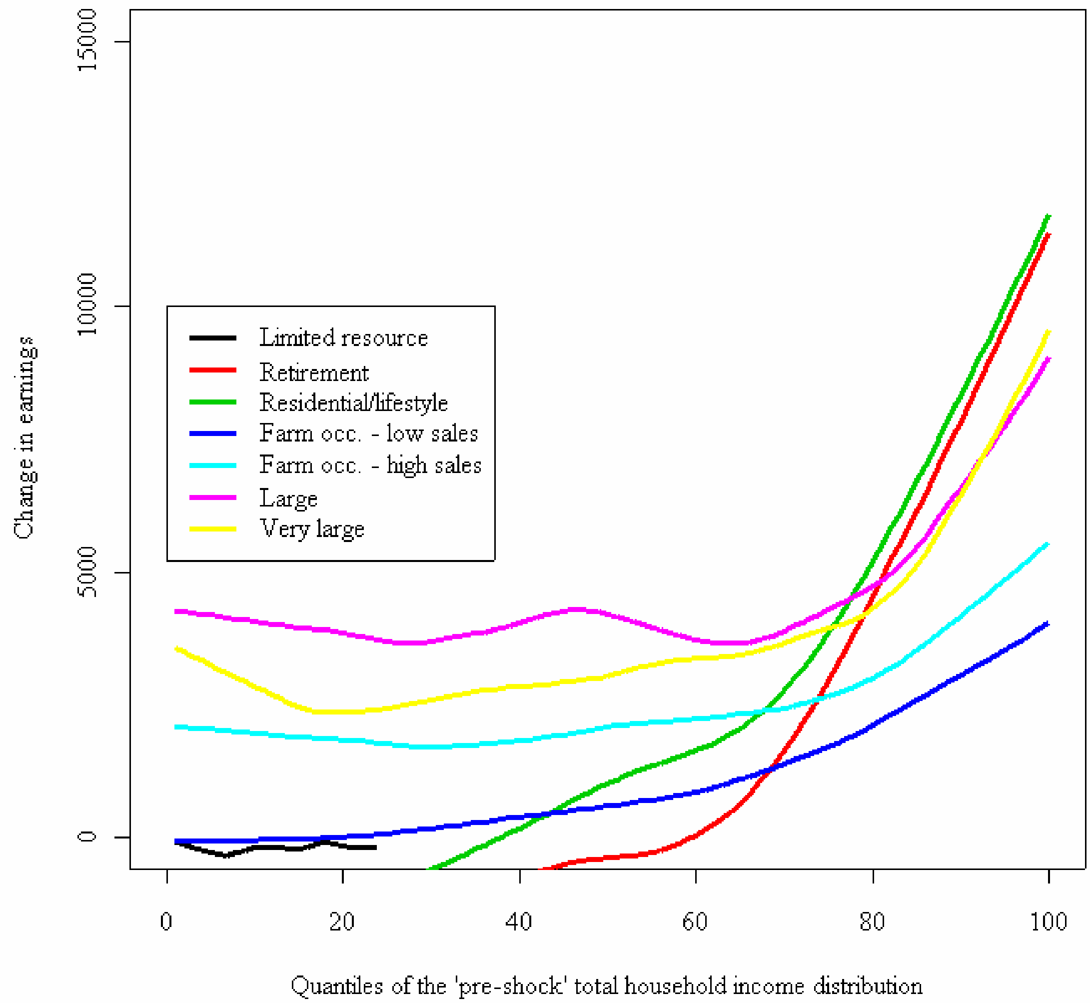
Source: Author calculations

Figure 9. Changes in income flows from policy reform, program participant farms



Source: Author calculations

Figure 10. Value of net household response from policy reform.



Source: Author calculations

Figure 11. Value of net household response from policy reform- Scenario 1