Effects of U.S. Farm Policy on Equity and Efficiency

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Abstract

This paper provides a framework to determine what tradeoffs are present between equity and efficiency in farm policy. In terms of equity, we are concerned with the implications of policies on the distribution of income. For efficiency we consider how the profitability of farms is impacted by the same government policies. Specifically of interest will be the relative contributions of direct payments, commodity payments, and conservation payments to each of these measures. Results show that relative to direct payments commodity payments are more efficient (in terms of increasing average farm profitability) but less equitable (large farmers dominate the income gains). Conservation payments are found to be both less equitable and efficient relative to direct payments. We identify segmentation of the farm household population as a limitation of the analysis with respect to measuring impacts of conservation payments.

Keywords: U.S. Farm Policy, Equity, Efficiency

1. Introduction

As pressure to pass a farm bill under tighter funding constraints persists, evaluating equity and efficiency measures becomes essential to understanding how changes in policy will affect the farming population in the next five years. When evaluating equity, we think in terms of measuring the impacts of policy on the distribution of household income in the farm population, while efficiency can be evaluated by quantifying the impact of those same policies on the profitability of farms. Specifically of interest are the tradeoffs inherent between making the agricultural sector more competitive in global markets while preserving family farms, two common goals of U.S. farm policy. Farm legislation continues to be scrutinized for allocating a large portion of total payments to the largest farms (see e.g. analysis by the Environmental Working Group). With expectations of payment caps and tighter eligibility criteria, evaluating growth and distributional changes resulting from farm programs stands out as a critical knowledge gap. In addition to domestic implications, the distorting nature of farm subsidies and their relative impacts on global markets continue to be a source of international agitation.

Examination of the relationship between equity and efficiency of different government programs promises to enhance both our understanding of the interaction between policy mechanisms as well as our evaluations of program efficacy.

2. Hypothesized Tradeoff Relationships

Figure 1 below represents a hypothesized relationship between equity (Eq_i) and efficiency (Ef_i) and the tradeoff across different types of government payments. The hypothesized relationship serves as a conceptual null from which to analyze our empirical results. The placement of the three broad payment types on the graph is determined by the producer's ability to influence payment levels through farm business decisions and size of the operation. Small farms that have lower farm net worth and derive more income off the farm could choose to enroll their land in conservation programs and receive payments. Likewise, larger, higher asset farms are more likely to put their land in production to produce greater profits, therefore influencing the level of payments through production and marketing in line with specific government programs. Commodity programs are assumed to be located in the northwest portion of the equity efficiency curve because of the relationship between levels of payments and production. These payments are more likely to be concentrated on larger efficient farms, contributing positively to farm profitability. The negative contribution to inequality arises from concentration of the payments (assuming large farming is correlated with high household income). Conservation payments are placed in the southeast corner since they restrict land use for agricultural production and are less concentrated among farms with higher farm assets.

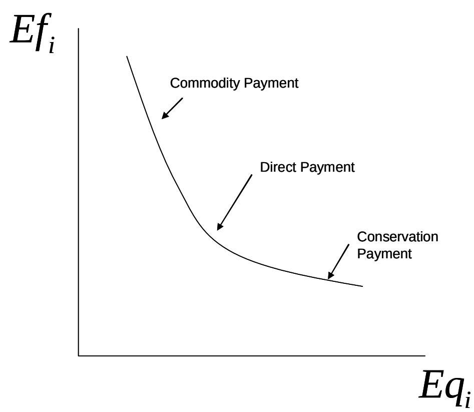

Figure 1: Conceptual Model of Equity Efficiency Tradeoff

Empirically representing this graph requires estimation of equity and efficiency measures. Using a Gini decomposition method to measure inequality, Gini elasticities can be generated to quantify the individual and relative effect of increases in individual government payment types. For example, Gini elasticity estimates will show which types of government payments have the largest impact on reducing inequality. Efficiency estimates will also show the impact government payments have in increasing or reducing the profitability (i.e. efficiency) of farms. These estimates enable comparisons to be made within an equity efficiency tradeoff context.

3. Data and Empirical Approach

Conducting analysis of the farm household population's response to changing government programs requires data that captures distinguishing features between U.S. farm households as well as considerable detail on earnings sources. Current government policies address these sources of differentiation among farming households in only a limited fashion and therefore understanding the objectives and intended beneficiaries of programs becomes imperative. The importance of different sources of income received by farm households varies across farms, making the policy objectives of income support extremely complicated. An additional complication is the use of aggregate data in policy analysis that fails to consider differences in farm structure and income components. Evaluating agricultural policy impacts with national aggregate measures can overlook the distribution of both benefits and costs between regions and across farms that are differentially oriented between farm and non-farm earnings. Therefore, it is essential to perform the analysis with data that represent these differences.

The Agricultural Resource Management Survey (ARMS) is conducted on an annual basis by the USDA's National Agricultural Statistics Service and the Economic Research Service. This survey is administered to farm and ranch operators and is used by decisions makers in the political and industrial sectors as a tool to evaluate alternative policies that affect farm households. The survey provides important data on production practices, resource use, and the economic well-being of farm households. Using the ARMS data is attractive for equity and efficiency analysis because of the information provided for individual farm accounts and structure. The data include farm participation in government programs and the unit of observation allows for analysis of the distribution of payments. This information is specifically of interest as it will enable evaluation of policy impacts on family farm households. Also, the ARMS data provides information on off-farm income which allows for evaluation of the role of this source of heterogeneity among farming households when comparing policy impacts.

The ARMS cross sectional data will be used to identify equity and efficiency measures for separate years (1998, 2001, 2004) allowing comparisons to be made between estimates of each year evaluated. Inequality and efficiency measures will be estimated over different farm bill years in order to better understand the impacts of changes in policy on farm incomes.

3.1. Modeling Inequality

Lerman and Yitzhaki (1985) develop a method for Gini decomposition that uses the covariance between ranks of total and component sources of income within specified income groups. Assume Y is household income, F(Y) represents the cumulative density function of income, and μ is the mean of income. Equation (1) represents the Gini index of Lorenz inequality. Decomposition of this index requires inclusion of an additive element to the equation that will take into consideration the different components of income, and the role those components play in overall inequality. The variable Y is household income and is the sum of K income components represented by Y_1, Y_2… Y_K. Equation (2) stresses the additive properties of (1) as K indexes different household income components. The final decomposition required in equation (3) is established by substituting (2) into (1) and multiplying by the mean of the K^{th} source of income (μ_k) and dividing each component K by the covariance of Y_K and F_K.

(1) $$G = 2 \times \text{cov}[Y, F(Y)] / \mu$$

(2) $$\text{cov}[Y, F(Y)] = \sum_{k=1}^{K} \text{cov}[Y_K, F(Y)]$$

(3) $$G = \sum_{k=1}^{K} \frac{\text{cov}(Y_K, F)}{\text{cov}(Y_K, F_K)} \times \frac{2\,\text{cov}(Y, F_K)}{\mu_K} \times \frac{\mu_K}{\mu}$$

Equation (3) can be rewritten as:

(4) $$G = \sum_{k=1}^{K} R_K G_K S_K$$

where R_K is the Gini correlation between component income rankings and total income, G_K is the Gini coefficient of component income, and S_K is the K^{th} share of income in total income.

Using the ARMS database, a data set is constructed for a reference year and is restricted to U.S. family farms[1] only. These family farms are then categorized into income groups based on the individual observation's total household income. Using frequency tables, household groups are created for every two percent of the frequency distribution, resulting in a total of fifty representative household groups linked by total household income[2].

Using the representative household groups, means are calculated for each variable needed to calculate the Gini coefficients in its decomposed form. Variables are created for total household income, total farm income and total off-farm income with the first being the sum of the latter two variables. Total farm income is broken down into a variable for total government payments and a variable for other farm income. These variables are summarized in Table 1.

Table 1: Income Variables

Variable	Variable Name	Variable Description
Total Household Income	thi	tfi + toi
Total Farm Income	tfi	igovt + ofi
Total Off-farm Income	toi	
Total Government Payments	igovt	
Other Farm Income	ofi	

Disaggregating the components of income to establish the significance of each income source in determining the Gini coefficient requires utilizing the additive component in equation (2) to solve equation (3). In order to make this calculation, representative households are re-ranked by income component in order from lowest to highest. Each component is sorted based

[1] Starting in 2005, "family farm" is defined as any farm where the majority of the business is owned by the operator and individuals related to the operator by blood, marriage, or adoption. Under the previous definition, family farms were farms organized as sole proprietorships, legal partnerships, or family corporations. The previous definition also excluded any business operated by a hired manager. The current definition recognizes that hired managers may have an ownership interest in the business. (USDA)

[2] This will deal with the problem of unequal observation weights.

on rank and Gini coefficients are calculated. The Gini coefficients calculated for all components are summed to reach the total household income Gini.

The focus of this investigation will be the impact of government payments on the total household income Gini coefficient. This income category is decomposed into individual payments in order to establish the impact these programs have on the overall Gini coefficient. The total government payment variable includes all government payment types listed within the ARMS database. For the purpose of simplifying the analysis, the different types of payments are categorized in groups based on the nature of the payments. These groups can be seen in Table 2. The total government payment variable is the sum of production flexibility payments[3], production and marketing payments and conservation oriented payments. The types of payments categorized as commodity and marketing are traditionally tied to production and/or prices and are grouped to simplify the analysis. Conservation payments are placed in the other group (conservation oriented payments). The variable for production and marketing payments in 2004 includes additional payments compared to the previous years to reflect changes in the sugar, peanut and dairy assistance programs.

[3] Production Flexibility Payments were replaced by Direct Payments in the 2002 Farm Bill.

Table 2: Total Government Payment Variables by Year

1998	2001	2004
Production Flexibility Payments	Production Flexibility Payments	Direct Payments
Production and Marketing Payments LDP Agricultural Disaster Other Federal or State	Production and Marketing Payments LDP Agricultural Disaster Other Federal or State	Production and Marketing Payments CCP LDP MLG Net Value Commodity Certificates Cooperative Government Peanut Quota Buyout Milk Income Loss Contract Payments Agricultural Disaster Other Fed., State, Local
Conservation Oriented Payments CRP WRP EQIP	Conservation Oriented Payments CRP WRP EQIP	Conservation Oriented Payments CRP WRP EQIP

The same procedure mentioned earlier is utilized to calculate the impacts of each of these types of payments in the overall Gini for total household income. Total farm income is separated into total government payments and other farm income (see Table 1). Total government payments are further decomposed into direct payments, production and marketing payments, and conservation oriented payments. These components are individually ranked and Gini coefficients are calculated for each component. Equation (3) again is utilized to sum the individual components to reach the overall Gini for total household income. The individual Gini's for the three types of government payments are summed to reach the Gini for total government payments. That Gini is added to the Gini calculated for other farm income to reach the Gini for total farm income. Finally, the Gini for total farm income is added to the off-farm income Gini to reach the total household income Gini coefficient.

With the calculation of individual income component Gini coefficients, elasticities can be calculated to determine how changes in income sources will affect the inequality measure. Specifically, this will show how a percentage change in an income source will change the Gini coefficient (percent change). To calculate elasticities, a quantity is needed that represents the concentration of an income source across households ranked with corresponding income received. From equation (4), the concentration measure is represented as $R_K \times G_K$ and is denoted as C_K. As derived by Lerman and Yitzhaki, their equation for the elasticity identity is:

$$(5) \qquad \eta_K = 1/G[\mu_K/\mu(C_K - G)].$$

This calculation is important as it shows how inequality is impacted with changes in income sources, specifically government payments.

3.2. Modeling Efficiency

Pairing the chosen equity/inequality measure with an efficiency measurement requires the same ARMS data and thus a comparable cross-section approach. Utilizing the ARMS data specifically for structural components of individual farms enables estimation of efficiency measurements that will determine the impact of government payments on profitability of family farms. We derive our analysis of efficiency from a model used to estimate economies of size in family farms, previously implemented on the ARMS data. In conjunction with the equity analysis, the main element of this model will be determining the relationship between government payments and profitability of individual farms.

Following the model developed by Tweeten and Hopkins (2003), an equation for estimating (logged) costs as a share of revenue is given in (6). S is the farm size in total sales, and U represents the error, such that the estimate of b represents the impact of farm size on farm costs (relative to sales).

(6) $\ln(C) = \ln(a) + b \ln(S) + \ln(U)$.

Restricting the analysis to U.S. family cash grain farms, a revenue cost ratio is estimated for cash grain farms similar to that of (6), as detailed in table 3. The variable (RC) is the ratio of revenue to cost, and the focus of this analysis is on the impact of government payments. The variables representing the same three government payment groups used in the equity analysis will be used on the right hand side of the estimation (DP =Direct Payments, PMP = Production and Marketing Payments, COP = Conservation Oriented Payments). We also separate agricultural disaster payments (ADP) and in post 2002 data their replacement counter-cyclical payments. Variable definitions are given in table 4.

Table 3: Modified Efficiency Regression

Tweeten and Hopkins Regression	Modified Regression
$\ln(C) = \ln(a) + b\ln(S) + \ln(U)$	$\ln(RC) = \ln(a) + b_1 DP + b_2 PMP + b_3 COP + b_4 ADP$

Table 4: Efficiency Regression Variables

Variable	Variable Description
RC	Revenue cost ratio (Value of production / Resource costs)
DP	Direct Payments (in 1000s)
PMP	Production and Marketing Payments (in 1000s) see Table 2
COP	Conservation Oriented Payments (in 1000s) see Table 2
ADP	Agricultural Disaster Payments (in 1000s)
CCP	Counter Cyclical Payments (in 1000s)

This approach allows the relative impacts on efficiency (i.e. profitability) to be estimated with respect to the same government payment variables investigated for inequality. In line with the inequality measures, the focus here is also placed on estimating these impacts on efficiency with respect to the specified groups of government payments. As a result, conclusions can be drawn about the relative impact on efficiency of farm program types under different policy regimes.

4. Results

4.1 Inequality Response to Government Payments

The Lorenz curve graphically represents the Gini coefficient that is used as our inequality measurement. The Gini coefficient is a ratio between 0 and 1 and is the area between the 45 degree line (representing equally distributed income) and the Lorenz curve divided by the area below the 45 degree line. A Gini coefficient of 0 corresponds to perfect equality and a coefficient of 1 represents perfect inequality. Therefore, the lower the coefficient, the more equal the distribution.

Lorenz curves are presented to show differences between years and income components. Using Lerman and Yitzhaki's decomposition, Gini coefficients are also calculated to highlight the quantitative differences between the same years and income components. Figure 2 represents the Lorenz curves for 1998, 2001, and 2004. These curves enable visual identification of inequality among income component distributions. The three groups of government payments are displayed in addition to total household income. One Lorenz curve would "dominate" another if it is closer to the equidistribution line over the [0,1] domain.

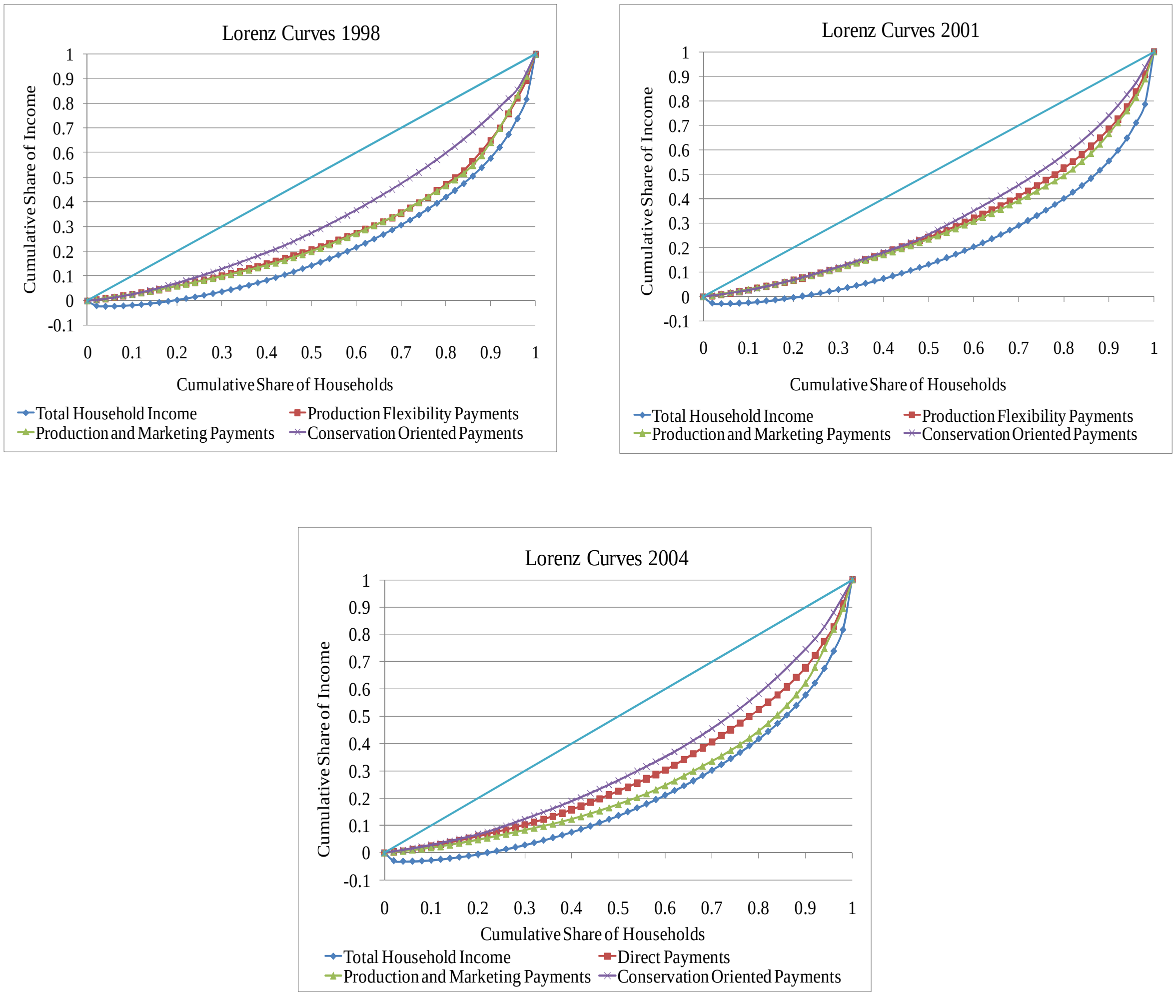

Figure 2: Lorenz Curves for 1998, 2001, and 2004

In comparing the three groups of government payments, conservation oriented payments are visually the most equally distributed income component followed by production flexibility payments and production and marketing payments, the latter two components having practically identical distributions with the exception of 2004. As 1998 and 2001 fall under the same farm bill (1996 FAIR Act), differences in the distribution will result from the activation of different farm programs in response to changes in the agricultural economy (i.e. crop prices). The Lorenz curves for 2004 reflect changes legislated in the 2002 Farm Bill and continue to show an unequal distribution for each of the component sources, with clearly defined differences between the payment groups. Unlike the previous two years presented, production and marketing payments and direct payments show different distributions in part due to the replacement of production flexibility payments with direct payments in addition to lower levels of loan deficiency payments. Of the three groups, production and marketing payments are the most unequally distributed. In addition, conservation oriented payments seem to be the most equally distributed income component in all three years evaluated.

Table 5 shows the decomposed Gini calculations for each year evaluated. Total household income has a Gini coefficient of 0.579, 0.615, and 0.592 in 1998, 2001, and 2004 respectively. In comparison to the scale between zero (perfect equality) and one (perfect inequality), these Gini coefficients represent a fairly unequal distributions. Disaggregating the total Gini into component sources indicates that off farm income contributes more to inequality compared to farm income in all three years. This is explained by its large contribution (Sk) to total income compared to all other income components. Of the three groups of government payments, conservation oriented payments contribute the least to inequality in all years, supporting our visual indication of this being the most equally distributed government payment group.

Table 5: Gini Coefficients for 1998, 2001, and 2004

	1998		2001		2004	
Total Household Income	0.579		0.615		0.592	
Off-Farm Income	0.336	(0.80)	0.380	(0.85)	0.354	(0.84)
Farm Income	0.243	(0.20)	0.234	(0.15)	0.238	(0.16)
Other Farm Income	0.213	(0.13)	0.192	(0.05)	0.211	(0.10)
Government Payments	0.029	(0.07)	0.042	(0.10)	0.027	(0.06)
Production Flexibility Payments (Direct Payments)	0.016	(0.04)	0.011	(0.03)	0.010	(0.02)
Production and Marketing Payments	0.011	(0.02)	0.027	(0.07)	0.014	(0.03)
Conservation Oriented Payments	0.003	(0.01)	0.004	(0.01)	0.003	(0.01)

Share (Sk) of each component in total household income is in parenthesis.

Comparing the government payment Gini coefficients for each year shows significant changes that can be attributed to different farm programs being triggered in response to what was occurring in agricultural markets from 1998 to 2001. Throughout the life of the 1996 FAIR act, production flexibility payments continued to be a relatively important component of the total government payments Gini. This undoubtedly is a reflection of the nature of the production flexibility payments program under the FAIR Act. Despite being decoupled from current production, this lump sum payment was based on historical production. Because of a high correlation between farm size and payment levels, the largest producing farms received the most payments.

However, in 2001, because of depressed crop prices, the government paid out additional funds in the form of loan deficiency payments. As highlighted by the Gini coefficient in 1998, production flexibility contract payments contributed the most to overall inequality as this payment group held the largest share of total government outlays. However, when Congress authorized additional loan deficiency payments in 2001, the total share of government payments became largely concentrated among production and marketing payments. As a result, the contribution of production and marketing payments to the total government payment Gini became more influential. This group, particularly marketing loans and agricultural disaster payments that were tied to current prices and/or production, affected the distribution of payments. Conservation payments categorized in conservation oriented payments show little variability (almost none) between 1998 and 2001 in large part due to the decoupled nature of the payment group.

As the 1996 FAIR Act concluded its tenure, policies aimed at paving a new direction in farm policy were brought to fruition in 2002 with the passage of a new farm bill. The 2002 Farm bill was crafted in light of the circumstances surrounding high government outlays and the status of agricultural markets. Commodity prices started to increase from 2002-2004 and in response there was a lower contribution of government payments to overall household income in 2004 (comparable to levels in 1998). The introduction of counter cyclical payments to stabilize market price volatility in the market can also be assumed to contribute to less dependence on agricultural disaster payments.

From Table 5, we can see that the Gini coefficients in 2001 stand out in comparison to other years with a higher overall household income Gini in addition to the higher contribution of total government payments. This gives an indication of how farm households are impacted by policies that respond to changing market conditions. Off farm income remained the most consistent source of inequality throughout the three years. Off farm income may play a more pivotal role in the determination of farm policy in the future, especially in light of the current debate surrounding payment limits and who is most deserving of farm payments. Conservation oriented payments were consistently the most equally distributed income component and the calculation of elasticities later on in the analysis will provide interesting insights into how this program influences the distribution of household income.

4.2 Efficiency Response to Government Payments

Estimating farm efficiency in respect to the same government payment groups utilized in the equity analysis enables comparisons to be made between both equity and efficiency. Using regression analysis, estimated coefficients for each respective government payment group can be compared to elasticities calculated from the Gini coefficients. With both of these measures, tradeoffs can be established to determine the impacts the three government payment groups have on overall equity and efficiency.

Modifying the framework derived by Tweeten and Hopkins, cash grain farms[4] are evaluated in terms of the same government payment groups established in the equity section. As cash grain farms receive the largest portion of total government payments, these farm observations from the ARMS database will serve as the basis of the analysis. Altering Tweeten and Hopkins approach, profitability ratios (revenue over cost) are estimated in the place of total cost over total output. The same three years are evaluated to provide adequate comparisons to the equity measures.

The regression used to present the efficiency impact of government payments estimates the profitability ratio in terms of three different groups of government payments: Production flexibility payments (direct payments), production and marketing payments, and conservation oriented payments. In addition, agricultural disaster payments in 1998 and 2001 and counter-cyclical payments in 2004 (new program established by the 2002 farm bill) will be separated from their respective group and regressed separately in attempt to understand the impacts of these specific programs. The regression restated from chapter 3 is:

$$\ln(RC) = \ln(a) + \beta_1 DP + \beta_2 PMP + \beta_3 COP + \beta_4 ADP \text{ (or CCP)},$$

where ln(RC) is the natural log of the ratio of revenue (total value of production) over cost (resource costs)[5]. A farm becomes profitable when the revenue cost ratio surpasses 1. For the purpose of this analysis, the impact of the specified groups of payments on the profitability ratio will be established. The overall affect (i.e. the sign of the coefficient), not necessarily the magnitude of the effect, will be the basis for comparison between policy years. As the ARMS

[4] Further segmenting cash grain farms into wheat, corn, soybeans, etc. would provide additional insight into how government payments affect the efficiency of individual types of farms.
[5] Please refer to Tables 3 and 4 for variable descriptions and regression equation modification.

data used represents all cash grain farms and is therefore rather large, the magnitude of the effects will be minimal due to the composition of the sample.

Table 6 summarizes the estimated regression coefficients for 1998. Significance at the five percent level is reached for all variable coefficients except agricultural disaster payments. Both production flexibility payments and production and marketing payments positively contribute to farm profitability. Conservation oriented payments primarily consist of CRP payments concentrated among smaller farms that earn high off farm income. As these farms, comparative to large family farm, are not as concerned with farm profits, this coefficient shows negative impacts on efficiency. A noticeably low R^2 value for the model can be explained by the cross sectional nature of the data and the fact that government payments constitute a small portion of revenue and therefore will contribute little to the variability in the model.

Table 6: Regression 1998

Variable	Parameter Estimate	Standard Error	T-statistic
Intercept	-0.449	0.038	-11.91
Production Flexibility Payments	0.004	0.001	4.27
Production and Marketing Payments	0.006	0.001	5.46
Conservation Oriented Payments	-0.008	0.003	-2.83
Agricultural Disaster Payments	0.004	0.004	0.99

Estimates are statistically significant at the 0.05 significance level with t-statistics of 2.13 and at the 0.10 significance level at 1.53. $R^2 = 0.028$. 1998 ARMS data used with 2081 observations weighted to represent all U.S. cash grain family farm households.

In comparison to 1998, the regression output for 2001 holds similar parameter estimations but pale in comparison in terms of statistical significance (Table 7). Production flexibility payments are the only significant variable at the ten percent level. Production and marketing payments and conservation oriented payments are not significantly different from zero and therefore will not affect profitability. As 1998 and 2001 fall under the same farm bill, similar parameter estimates can be assumed, taking into consideration changes in production and marketing payments as a result of market volatility.

Table 7: Regression 2001

Variable	Parameter Estimate	Standard Error	T-statistic
Intercept	-0.770	0.082	-9.44
Production Flexibility Payments	0.007	0.003	1.99
Production and Marketing Payments	0.001	0.005	0.14
Conservation Oriented Payments	-0.009	0.008	-1.11
Agricultural Disaster Payments	0.002	0.002	0.70

$R^2 = 0.037$. 2001 ARMS data used with 1695 observations weighted to represent all cash grain U.S. family farm households.

Coefficients estimated for the 2004 data (Table 8) again show consistent positive or negative impacts corresponding to 1998. Direct payments and conservation oriented payments are significant at the five percent level with production and marketing payments being significant at the ten percent level. The last category of payments unique to the 2002 farm bill (counter cyclical payments) is not significant. Conservation oriented payments, relatively, show a larger (negative) impact on profitability compared to previous years. This could be a reflection of additional acres being authorized under the 2002 farm bill, in addition to more of the same farm types taking advantage of CRP payments. In comparison, each of the other coefficients has the same magnitude as in 1998.

Table 8: Regression 2004

Variable	Parameter Estimate	Standard Error	T-statistic
Intercept	-0.420	0.069	-6.08
Direct Payments	0.004	0.003	1.53
Production and Marketing Payments	0.006	0.002	2.68
Conservation Oriented Payments	-0.021	0.007	-3.06
Counter Cyclical Payments	0.004	0.003	1.36

R^2 = 0.040. 2004 ARMS data used with 1631 observations weighted to represent all cash grain U.S. family farm households.

With the Gini elasticities calculated for each government payment group, the profitability regression coefficients estimated for the same government payment groups can be used to show the impacts on the tradeoffs between equity and efficiency for each of the three years evaluated.

4.3. Elasticities and Tradeoffs

To better understand the relationship between equity and efficiency in response to government programs, tradeoffs can be presented to highlight the results of both the equity and efficiency measures. To establish whether tradeoffs are present, elasticities for the equity measure will be compared to the coefficients estimated for efficiency. The Gini elasticities show the percentage change in overall inequality due to a percent change in government payments, and therefore are comparable to our estimated profitability coefficients as they show the percentage change in profitability due to a percentage change in government payments. Since the equity elasticities are presented in terms of how the measures will respond to percentage changes in mean sources of income, the magnitude of the change will be minimal. However, we are concerned with determining how income components contribute to overall equity and efficiency, whether they increase or decrease the measures, and not particularly with the magnitude of the change.

From the Gini coefficients, elasticities can be calculated to show how proportionate changes in a component source of income impacts overall inequality. These changes can be characterized as inequality reducing or inequality increasing. Table 9 summarizes the Gini elasticities for 1998, 2001 and 2004. These elasticity identities show the percentage change in the Gini coefficient as a result of a one percent change in the mean of a certain income source.

Table 9: Equity Elasticities by Income Component for 1998, 2001, and 2004

Elasticities	1998	2001	2004
Total Household Income			
Off-Farm Income	-0.221	-0.228	-0.243
Farm Income	0.221	0.228	0.243
Other Farm Income	0.238	0.264	0.260
Government Payments	-0.017	-0.036	-0.016
Direct Payments	-0.008	-0.010	-0.007
Production and Marketing Payments	-0.005	-0.021	-0.005
Conservation Oriented Payments	-0.004	-0.004	-0.004

Elasticity Equation: $\eta_k = 1/G \times [\mu_k/\mu \times (C_k\text{-}G)]$

Elasticities from each of the three years show that off farm income has inequality reducing tendencies and of all the component sources of income, contributes the most to reducing overall inequality. Using the interpretation mentioned earlier, a one percent change in the mean of off farm income will reduce the Gini coefficient (i.e. inequality) by 0.22 percent in 1998. Despite contributing to a large portion of farm heterogeneity, off farm income stabilizes household income for farms producing negative farm profit and serves as a source of supplemental income to other farms. As this income category constitutes the largest share of total income in comparison to all other components, it will have the most impact in reducing inequality. Farm income increases inequality as many farms capture negative incomes, in addition to a disproportionate share of farm income being in the hands of a relatively small group of households in the upper distribution of households. Separating farm income into components, total government payments show inequality reducing tendencies despite being overshadowed by other farm income, the component that exemplifies the dispersion of income from farming between the lower and upper distribution of households.

Government payments consistently contribute to decreasing inequality in each of the three years evaluated. The degree to which they contribute is a reflection of farm policy and market conditions already specified. Table 10 shows total government payments to farmers from 1996 to 2005. Government outlays in the form of production and marketing payments peaked in 2000 and remained very high in 2001 compared to both 1998 and 2004. These payments worked to truncate low incomes at the low end of the distribution, thus reducing inequality. Total government payments in 2001 had more than double the impact on inequality compared to both 1998 and 2004. Looking at the three groups of payments for 2001, production and marketing payments reduce inequality by 0.02 percent, a value that would reduce inequality four times more than it would in either 1998 or 2004. Other than in 2001, direct payments contribute the most to reducing inequality. Conservation oriented payments are consistent in magnitude and decrease inequality by 0.004 percent.

Table 10: Government Payments to Farm Households 1996-2005

	Production Flexibility Contract Payments (PFC)/ Direct Payments*	Production and Marketing Payments	Conservation Oriented Payments
1996	$5,973,002.03	$172,368.77	$1,845,110.93
1997	$6,119,813.78	$189,081.28	$1,739,730.10
1998	$6,000,580.27	$4,838,745.79	$1,546,313.96
1999	$5,045,690.47	$14,765,968.15	$1,568,772.06
2000	$5,048,840.45	$16,175,298.87	$1,662,088.78
2001	$4,040,448.54	$14,710,673.33	$1,903,436.91
2002	$3,499,757.13	$3,311,432.78	$1,965,843.88
2003	$6,703,601.20	$3,917,802.90	$2,167,302.40
2004	$5,238,134.10	$3,578,678.10	$2,319,561.80
2005	$5,197,831.00	$8,617,860.50	$2,767,463.80

*PFC authorized under 1996 Farm Bill and Direct Payments under 2002 Farm Bill

Source: ERS 2008

Determination of tradeoffs between equity and efficient requires putting the measures in the proper context. Using elasticities calculated from the Gini coefficients and the efficiency coefficients resulting from the regression analysis enables each of the government payment groups to be evaluated on an elasticity scale. The tradeoffs will be presented by illustrating the level of effect one payment group has on inequality or efficiency relative to another payment group.

Table 11 summarizes the tradeoffs between government payment groups relative to direct payments. From the elasticities calculated above (see Table 9), direct payments do not fluctuate in response to market conditions as in the case of production and marketing payments. Therefore this group will serve as the benchmark for evaluating tradeoffs. Since the profitability regression results for 2001 show insignificant coefficients, tradeoffs for that year are not presented. Relative to direct payments, there is a tradeoff present as production and marketing payments are less equitable but more efficient in both 1998 and 2004. Conservation oriented payments are less equitable and less efficient in both years and therefore no tradeoffs are apparent. The degree to which conservation payments are less efficient is reflected in the negative values relative to direct payments.

Table 11: Tradeoff Effects Relative to Direct Payments

	1998		2004	
	Equity	Efficiency	Equity	Efficiency
Direct Payments	1.00	1.00	1.00	1.00
Production and Marketing Payments	0.64	1.64	0.68	1.43
Conservation Oriented Payments	0.48	-2.13	0.56	-5.22

Figure 3 plots the tradeoffs calculated in Table 11. As stated above, tradeoffs will be presented with direct payments serving as the point of reference. We expected production and marketing payments to be the more efficient and less equitable than direct payments as these types of payments are characterized by the relationship between the level of payment and production. Larger farms with higher assets that are more concerned with profit are more likely to receive these types of payments. As previously discussed these payments are less equitable because of their tie to production and prices. Conservation oriented payments are expected to be more equitable but less efficient compared to direct payments as land is taken out of production and because this type of payment is less concentrated among high asset farms. The tradeoffs depicted in our graph follow expectations (see Figure 1), save for conservation oriented conservation payments.

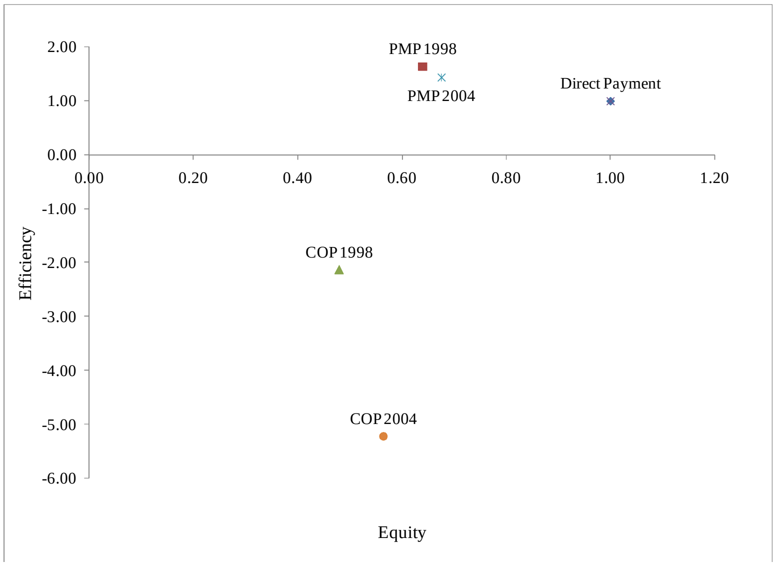

Figure 3: Equity Efficiency Tradeoff for 1998 and 2004

The tradeoff depicted for both 1998 and 2004 is intuitive as production and marketing payments (PMP) show equity being sacrificed in place of efficiency when compared to direct payments. Production and marketing payments are traditionally more important to larger farms and because of their relation to market prices, farm income is more sensitive to market volatility. Interpretation of the results for conservation oriented payments (COP) relies on understanding who receives these types of payments. As the data used in the analysis is not segmented but is representative of all cash grain farms, the tradeoff predicted is not supported (we expected conservation oriented payments to be less efficient and more equitable compared to direct payments). In addition, the negative values (depicted by the conservation oriented programs below the horizontal axis) represent the severe dispersion of this payment group within the distribution of farms. It is likely that a large portion of households receiving conservation payments obtain high off farm incomes and earn little from the farm but prefer living in rural areas. Therefore, these households receive conservation payments that contribute more to lifestyle choices rather than actual need. Segmenting the farm population into farm typologies (Briggeman et. al 2007) would provide a better indication of which portion of the farm population receives these payments and how dependent their incomes are on government support.

5. Conclusions

This analysis has shown the relationship between equity and efficiency of different government programs by determining tradeoffs. Using the Gini decomposition approach derived by Lerman and Yitzhaki, the impact of government payments (direct payments, production and marketing payments, and conservation oriented payments) on inequality is quantified using Gini coefficients. In comparison, efficiency is represented by estimating the impact of the same government payments on the profitability of farms. With the calculation of elasticities from Gini coefficients, tradeoffs are determined by comparing equity elasticities to the efficiency coefficients relative to direct payments. Equity efficiency tradeoffs are found for both 1998 and 2004 as production and marketing payments are less equitable but more efficient than direct payments. Due to non-segmentation of cash grain farms into better representative household groups, conservation oriented payments are both less equitable and efficient compared to direct payments due to the concentration of this payment group not being considered in the analysis.

As this approach has brought the evaluation of policy down to the household level, results show that further segmentation of family farms can provide an even clearer picture of how policy influences households. Using the farm typology groups developed by Briggeman et al. (2007), Gray and Keeney evaluate the incidence of farm policy using specific farm household typologies. This type of analysis further segments the population to show how government payments are distributed across specific farm types. Their analysis sheds some light onto the tradeoffs determined in this analysis. This study has built upon previous works completed in both equity and efficiency analysis. As these methods have already been established and successfully utilized, the road to future analysis is already paved. With the continued use of disaggregated household data from sources such as ARMS, the next steps involve determining how to utilize the data in a way that paints the most detailed picture of the family farming population.

This work has demonstrated that with the proliferation of data, we are able to examine distributional issues when evaluating policy. This analysis is more rigorous than other analyses that critique the distribution of payments by citing a few large recipients. With agriculture constantly changing and farm policy continuing to be complicated with the intersection of trade and energy policies, this framework represents a standard to be adopted when discussing the distributional impact of farm programs.

References

Briggeman, B., A. Gray, M. Morehart. (2007). "A New U.S. Household Typology: Implications for Agricultural Policy," *Review of Agricultural Economics*.

Economic Research Service (2008). Data Sets: Farm Income Data Files. Washington D.C., United States Department of Agriculture. http://www.ers.usda.gov/data/FarmIncome/finfidmuxls.htm#payments.

Economic Research Service. (2008). Briefing Room: Agricultural Resource Management Survey (ARMS). Washington D.C., United States Department of Agriculture. http://www.ers.usda.gov/Briefing/ARMS/.

Environmental Working Group. (2007). "Concentration of Crop Subsidies." Environmental Working Group, http://farm.ewg.org/sites/farmbill2007/, 14 January, 2008.

Gray, Allan W., Roman Keeney. (2007). "Incidence of Government Subsidies and U.S. Farm Households." Perspectives on 21st Century Agriculture: A Tribute to Walter J. Armbruster. Ronald D. Knutson, Sharron D. Knutson and David P. Ernstes. Farm Foundation, 167-174.

Hopkins, J., and Tweeten, L. (2003). "Economies of Farm Size, Government Payments, and Land Costs." Government Policy and Farmland Markets. Charles B. Moss and Andrew Schmitz. Iowa State Press, 141-156.

Lerman, R.I., and S. Yitzhaki. (1985). "Income Inequality Effects by Income Source." *Review of Economics and Statistics* 67: 151-156.