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# Distributional Impact of U.S. Farm Commodity Programs: Accounting for Alternative Farm Household Typologies

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Selected Paper prepared for presentation at the American Agricultural Economics Association Annual Meetings in Portland, OR, July 29-August 1, 2007

**Abstract:** Agricultural households adjust to policy changes through market mechanisms by altering: their production mix, labor input, and on- and off-farm investments. Because of the significant heterogeneity among farms in the US agricultural sector, various types of farm households respond to the same policy change in significantly different ways. The parameters used to classify farm households into different typologies may also play a significant role in the interpretation of observed effects of policy changes. This paper, using a highly disaggregated U.S. Computable General Equilibrium (CGE) model, analyzes the distributional impacts of policy changes involving price-contingent government payments on *alternative* U.S. farm household typologies. We find that farm households do vary their responses to an elimination of price-contingent support based on location, production specialty, and farm categorization.

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## I. Introduction

Farm production decisions are made at the business level in conjunction with farm household decisions. There is significant heterogeneity among U.S farm households with respect to their farm and non-farm activities, such as production revenues, farm and off-farm labor allocation, income from various sources, and financial asset portfolio allocation. This heterogeneity in the sources of farm household income can exist even between farms in the same region that produce the same commodities. As a result, adjustments to policy changes may vary significantly not only by region and production specialty, but by farm typology as well. Further, how these parameters are used to classify farms into different typologies may affect how we interpret their responses to policy changes. Classifying farms by value of farm production only may lead to different policy prescriptions than if they are classified by farm asset values or levels of off-farm income as well. We use a highly disaggregated U.S. Computable General Equilibrium (CGE) model for the year 2002 to analyze the distributional impacts of policy changes involving price-contingent and lump sum government payments on two *alternative* U.S. farm household typologies. Results indicate that farm production responses to national level policy changes vary widely by region, production specialty, and farm categories within each typology.

The first typology classification system we use was developed at the US Department of Agriculture's Economic Research Service (ERS) (Hoppe, Perry, and Banker 2000). The ERS typology divides family farm operations into two groups, those that have sales less than $250,000 and those that have sales of $250,000 or greater. These two groups are further subdivided for a total of seven family farm *categories*: Limited-Resource, Retirement, Residential/Lifestyle, Farming Occupation: Lower Sales, Farming Occupation: Higher Sales,

Large, and Very Large.[1] Of the seven, only one uses asset levels and farm household income from all sources as classification parameters.[2] The remaining categories are based on the principal occupation of the farm operator (retired, non-farming, or farming) and total farm sales.

The ERS typology largely omits important farm household characteristics, such as off-farm income earned by a spouse or the level of farm and non-farm assets, which could be used as classification parameters because they can be adjusted in response to changes in farm policy. Briggeman and Gray (2006) developed an alternative farm household classification system using a cluster analysis. The Briggeman-Gray (BG) typology contains six *family farm* categories differentiated by combinations of farm income, off-farm income, farm and non-farm assets, and labor allocation. The categories are Single Income Rurlapolitan, Double Income Ruralpolitan, Active Seniors, Farm Operator with Spouse Working Off Farm, Traditional Farm, and Commercial Farm. For both ERS and BG typology definitions, we simulate the elimination of price-contingent subsidies to farms and make both within-typology and between-typology comparisons of how farm production income is affected for different types of farm households.

There are several types of price-contingent U.S. government subsidies to agriculture, including marketing loan gains (MLG), milk income loss contracts (MILC), counter-cyclical payments (CCP), and crop insurance guarantees.[3] Marketing loans allow farm operators to take a government loan using their crop as collateral. If per unit market prices are lower than the per unit loan rate, farmers can forfeit the crop and keep the loan as payment, or in some cases, repay the loan at a rate that is lower than the initial loan rate. A more popular alternative, called a Loan Deficiency Payment (LDP) is for farm operations to forego the loan process and simply collect

[1] There is an eighth category for nonfamily farms.
[2] These farms are referred to as "limited-resource" farms and must have farm assets less than $150,000 and total household income of less than $20,000.
[3] See the ERS briefing room on farm policy found at http://www.ers.usda.gov/Briefing/FarmPolicy. Data on crop insurance payments were obtained from USDA's Risk Management Agency (RMA).

the difference between the marketing loan rate and the market price for their commodity. Farmers are then free to sell their commodity in the market after taking the payment. With either the marketing loan or the LDP, the loan rate effectively serves as a commodity price floor. Milk income loss contract payments are made directly to a dairy producer when milk prices fall below a specified target rate. These payments have a strict cap that limits the amount paid to each dairy farm. This leads MILC payments to account for a smaller percentage of total revenues for larger dairy operations. Counter-cyclical payments as a subsidy have both price-dependent and price-independent characteristics. They are paid when commodity prices fall below a specified target, but only to producers who own and operate certain land that has a history of crop production. It remains unclear from the literature how coupled CCP's are to production decisions.[4]

We use a single-country CGE model of the 2002 U.S. economy that disaggregates agricultural producers by region, production specialty, and farm category to simulate the impact that an elimination of price-contingent subsidies has on farm households. The basic framework of the model builds on traditional static single-country models, such as those developed by Benjamin, Devarajan, and Weiner (1989); Robinson, Kilkenny, and Hanson (1990), and Lofgren, Harris, and Robinson (2002). It is then disaggregated regionally, similar to Diao, Roe, and Doukkali (2002).

A disaggregated CGE model has several advantages for policy analysis in the agricultural sector over more aggregated CGE models. Most domestic support for agricultural commodities is determined at the national level, but the production of these commodities varies significantly by geographic location. A common policy may lead to widely different responses across regions. Unlike producers in other industries, farm households can be very heterogeneous, even

[4] See, for example, Lin and Disumkes 2007; Westcott 2005; Anton and Le Mouel 2004; Miller, Barnett, and Coble 2003; and Sumner 2003.

within a region and production specialty. They vary in their production quantities, asset levels, farm revenues, and non-farm sources of income. A disaggregated model allows for the simulation of varying responses to policy changes according to these farm household heterogeneities.

Another advantage of the disaggregated CGE model is its ability to simulate farm specific effects on both agricultural and non-agricultural activities. While farm households are heterogeneous, they are largely interconnected across production specialties and size. Commodities are often substitutes and are even used as inputs in the production of other agricultural commodities. For example, policy changes that affect corn production would also have an effect on livestock production as well as the production of other feed grains. Policy changes in agriculture may also affect nonagricultural sectors of the economy, such as the food processing, energy, and textile industries.

The U.S. is divided into ten so called "production" regions as defined by USDA's National Agricultural Statistics Service (NASS): Northeast, Lake States, Corn Belt, Northern Plains, Appalachia, Southeast, Delta, Southern Plains, Mountain, and Pacific.[5] Farms also fall into one of 14 production categories: Wheat, Corn, Soybeans, Rice, Tobacco, Cotton, Peanuts, Specialty Crops, General Crops, Beef, Hogs, Poultry, Dairy, and General Livestock. Because farm operations often produce multiple commodities, their area of specialization is defined by the commodity that accounts for 50 percent or more of their total value of production. The ERS and BG typologies are collapsed into three farm household categories each, allowing for a more consistent comparison of the two typologies. Table 1 shows the seven ERS and six BG farm types and how they are combined. Classifying farms by region, production specialty, and farm

[5] The regions used in this paper are the NASS crop reporting regions and not the ERS farm resource regions. See the ERS briefing room on ARMS resource regions at http://www.ers.usda.gov/Briefing/ARMS/resourceregions/resourceregions.htm

typology yields a total of 420 (14 x 3 x 10) sectors for the CGE analysis in addition to the 16 national-level non-farm sectors. This paper represents an introduction of the Farm Household CGE Model and it should be viewed as a stylized, or prototype, of farm household differentiation that can be improved or altered depending on research needs. Indeed disaggregating can occur by any farm operation or household characteristics to create any number of typologies or categories within a typology.

National data are taken from the Bureau of Economic Analysis (BEA) while farm household data are compiled from the USDA's Agricultural Resource Management Survey (ARMS).[6] This annual survey contains rich data on various aspects of U.S. farm household activities. Information on farm production, farm and non-farm assets, farm and non-farm income, government payments, and other important farm household information is readily available. We incorporate the heterogeneity among farm households sampled in the survey into our CGE framework, allowing us to investigate the distributional impacts of policy changes on different types of farm households.

**II. Results**

Analyzing the results from 10 regions, 14 production specialties, and 3 farm categories classified using two separate typologies is beyond the scope of this paper. In this paper, we instead focus our attention on the responses of farm households from three production specialties and three regions, looking at corn, dairy, and beef producers in the Corn Belt, Lake States, and Northeast regions of the U.S. Depending on market conditions, corn producers receive substantial MLG and CCP payments and may also receive indemnity payments from crop insurance programs. Corn production is most prevalent in the Corn Belt region of the U.S. A moderate amount is produced in the Lake States region while relatively little corn is produced in

[6] See the ERS briefing room on ARMS found at http://www.ers.usda.gov/Briefing/ARMS.

the Northeast. Dairy producers receive MILC payments and may also receive some commodity payments if they are producing corn, either for grain or as silage, or other program crops in addition to their dairy production. Dairy is prevalent in the Lake States and Northeast regions of the U.S. It is produced to a lesser degree in the Corn Belt region. Livestock producers do not receive price-contingent support for the production of beef, but they do use corn and other feed grains in the production of cattle and are therefore affected by the production of those commodities. Livestock production takes place in all three regions, but to a greater degree in the Corn Belt region.[7]

We simulate an elimination of price-contingent subsidies to U.S. farm households to investigate their effects on farm value-added income. Farm *value-added income*, referred to hereafter simply as farm income, is defined as the income from the factors used in farm production (or returns to land, operator labor, hired labor, and capital) and excludes off-farm earned and unearned income. We then make comparisons of farm household responses to the policy change on three different levels. First, comparisons are made across regions for farm categories within the ERS typology. Second, we compare responses across ERS typology farm categories within a region. Third, comparisons are made between ERS and BG typologies. We then discuss how farm household responses to the policy change are motivated by their production specialty and level of diversification.

Table 2 lists the percentage changes in farm income in response to the removal of price-contingent subsidies. Because the absolute changes in payments are policy-relevant, levels of farm income prior to the policy change (or base year's values) are given underneath in parentheses. These values are given in millions of dollars and are rounded to the nearest

[7] See the ERS briefing rooms on individual crop and livestock products at http://www.ers.usda.gov/Briefing.

millionth dollar. The initial level of farm income also shows how prevalent the production of each commodity is in each region.

*Comparisons by Region*

The results indicate that farm household responses to policy changes can vary significantly across regions. Using the ERS typology, Rural Residence corn producers in the Corn Belt region experienced a 4.8 percent decrease in farm income with an elimination of price-contingent support. Rural Residence corn producers in the Lake States region experienced 2.4 percent increase in farm income. In the Northeast region, however, Rural Residence corn farmers showed a decrease in farm income of 60.3 percent, though from a relatively low initial base level. This regional variation in adjustments underlines differences in production diversification across regions. According to the 2002 ARMS data, Rural Residence corn farms in the Northeast are primarily specialized in corn production and lack virtually any livestock or other non-program commodity production. On the other hand, Rural Residence corn farms in the Lake States region had a significant amount of livestock production in addition to the production of corn and other program crops. With the policy change, Rural Residence corn farms in this region would reallocate resources away from subsidized farm activities and intensify the production of non-subsidized livestock activities. Moreover, the change in income due to the removal of subsidies captures the differential adjustment across regions and indicates the vulnerability of farm households' well-being from agricultural production.

Regional variation in farm responses to policy changes also occurs in the Dairy sector. Again using the ERS typology, Intermediate dairy farms in the Corn Belt experience a 0.8 percent decline in farm income with the removal of price-contingent subsidies. In the Lake States region, where dairy production and subsidization are more prevalent, Intermediate dairy

farms show a 16.1 percent decline in farm income. The decline in farm income for Intermediate dairy farms in the Northeast, where dairy production is also prevalent, is 4.7 percent. This adjustment of Intermediate farms to the policy change underlines the prevalence of a U-shaped distribution of US farms. Intermediate farms, unlike Rural and Commercial farms, are unable to adjust their resources and are declining in numbers overtime. In the meantime, Rural and Commercial farms increasingly dominate farm activities.

*Comparisons by Farm Category within the ERS Typology*

The results show that within the ERS typology, farm households respond differently to the elimination of price-contingent subsidies according to their classification. In the Lake States region, Rural Residence corn operations show an increase in farm income due to the policy change. Commercial corn operations in the same region respond with a decline in farm income. This is due to the larger role the subsidies play in Commercial farm income relative to Rural Residence farm income and the increased production diversification activities by Rural Residence farms relative to Commercial farms.

The Dairy industry is also characterized by different responses to policy changes by Rural Residence and Commercial farm operations. In the Corn Belt region, Rural Residence dairy farms show a 9.8 percent increase in farm income while Commercial dairy farms show a 6.8 percent decrease in farm income. This pattern is repeated in the Lake States region where Rural Residence dairy farms experience no change in farm income with the policy shock while Commercial dairy farms experience a 3.9 percent decrease. The change in policy causes Rural Residence farms to reallocate resources and produce more feed on the farm rather than purchase feed for their operations. On the other hand Commercial farm operations depending on purchased feed would experience income reductions due to higher prices.

*Comparisons between ERS and BG Typologies*

When making comparisons between typologies, it is important to note that each farm household will fall into one ERS category as well as one BG category. A farm operation that is classified as Rural Residence under the ERS typology may be classified into any of the three categories under the BG typology. Results, however, indicate that Commercial and Farming farm types are similar in their responses as are Rural Residence and Ruralpolitan farm types. This suggests that farm income, though other parameters are used to classify farm households under the BG typology, plays a dominant role in determining responses to policy changes regarding price-contingent subsidies.

There are only a few cases where the ERS and BG typologies break from this pattern. In the Lake States regions, Intermediate corn farmers under the ERS typology show a 2.3 percent increase in farm income while Senior/Spouse corn farmers show a 2.1 percent decrease in farm income. While the Intermediate farms show an initial farm income of $873 million, the Senior/Spouse farms show a much smaller initial farm income of $177 million. It is likely that a significant number of farm operations classified as Intermediate under the ERS typology are classified as either Ruralpolitan or Farming under the BG typology. In the Northeast region, discrepancies in farm income in response to the policy change between the two typologies exist for Commercial and Farming corn operations for Rural Residence and Ruralpolitan dairy operations.

*Why Do Production Intensity and Diversification Matter?*

In 2002, dairy farmers' main support comes in the form of MILC payments while MLG and CCP payments are the main source of support for corn farmers. Farmers do not receive any price-contingent support for producing livestock. Because of the heterogeneity in program

payments, producers of different commodities within a region react differently to a national-level policy change. Differential impacts on farm income due to changes in policy raise the question: what factors determine the role of price-contingent subsidies in farm income?

One answer is production diversification. Recall that a farm operation is classified according to which commodity accounts for more than half of the operation's total value of production. A farm operation in which 90% of its total value of production comes from subsidized corn would be more affected by an elimination of price-contingent support to corn than a farm operation in which only 51% of its total value of production comes from subsidized corn. In other words, diversification matters. In the short- or medium- run, farm operations that are highly specialized in the production of a subsidized commodity cannot reallocate their resources to the production of alternative commodities in the event of an adverse policy change relative to farm operations that are already well diversified.

Adjustments to policy vary by region and typology category. In the Corn Belt region, Rural Residence corn operations experience a 4.8 percent decrease in farm income with the removal of price-contingent subsidies while Rural Residence dairy operations experience a 9.8 percent increase in income. Rural Residence dairy farms in the Corn Belt region produce food and feed grains in addition to dairy products. With the policy change, Rural Residence dairy operations move resources towards their non-subsidized activities. Rural Residence corn farms in the same region, on the other hand, tend to specialize in the production of food and feed grains with relatively little livestock production. They would experience a reduction in income until they moved production resources to non-subsidized production activities.

The opposite holds true for the Lake States region where Rural Residence dairy farms showed no change in farm income while Rural Residence corn farms experienced a 2.4 percent

increase in farm income. Rural Residence corn farms in the Lake States region are more diverse in their production than Rural Residence corn farms in the Corn Belt region, producing feed grains that are used as inputs in their own dairy and livestock production. In the Northeast region, Rural Residence corn operations produced program crops almost exclusively making it difficult for them to respond to a policy change through product diversification. This led to a 60 percent decline in production among their Rural Residence corn farms.

Diversification also varies with farm typology categories. For corn operations in the Corn Belt, Commercial farms experience the largest decrease in farm income for all farm categories. They are also the least diverse, with high production intensity of subsidized crops and producing similar levels of livestock to Rural Residence corn farms in the same region. Because products other than food or feed grains make up a relatively small percentage of their total production, Commercial corn farms are affected to a greater degree than their Rural Residence counterparts. For dairy operations in the Lake States region, it is Intermediate farms that experience the largest decline in income. These results reflect the nature of the payment systems. Dairy operations receive MILC payments, which have a smaller and more stringent cap on the amount of payments that can be made relative to MLG and CCP payments. These limits are reached with intermediate levels of production, making MILC payments a smaller percentage of larger dairy producers' revenues. Commercial dairy operations are therefore less affected by an elimination of MILC payments than Intermediate dairy operations.

Beef producing operations show only slight variation across regions, within typologies, and between typologies, in their alteration of farm income in response to an elimination of price-contingent subsidies. Declines for the ERS typology range from -0.6% for Rural Residence farms in the Northeast region to -4.1% for Commercial farms in the Corn Belt region. Under the

BG typology, the declines range from -0.5% for Rural Residence farms in the Northeast region to -3.3% for Farming farms in the Corn Belt Region. This reduction in farm income for livestock producers is likely due to increased production costs, specifically from higher priced feed grains. The higher costs result from the decline in production due to the elimination of price-contingent subsidies.

*How Farm Household Utility is Affected by the Policy Change*

To highlight the versatility of the disaggregated Farm Household CGE model, we capture the impacts of the policy change on farm household utility (figures 1 and 2). Figure 1 focuses on comparing changes in utility for corn farm households for two regions (Corn Belt and Lake States), within typologies, and between typologies. Figure 2 focuses on the same comparisons for dairy farm households.

For corn and dairy farms in the Corn Belt region, the larger the farm operation, the larger the decrease in farm household utility due to the policy change. In the Lake States region, however, it is Intermediate corn and dairy farm households that show the largest decline in utility rather than larger Commercial farms. These differences highlight the varying effects a single policy change can have on a diverse group of farm household welfare.

There are some noticeable differences between the ERS and BG typology responses. For corn farms in the Lake States Region, ERS typology Rural Residence farms have the lowest percentage decline in farm household utility while Intermediate farms have the highest. Under the BG typology, it is the Ruralpolitan farm households that show the largest reduction in farm household utility while Retired/Spouse farms show the smallest decrease. For dairy farms in the same region, the pattern is the same for ERS typology farms with Rural Residence dairy farms showing the lowest decline and Intermediate dairy farms the largest. Under the BG typology, it

is Farming dairy operations that show the largest decline with Retired/Spouse farms showing the smallest decline in welfare.

## III. Conclusions

We use a highly disaggregated Computable General Equilibrium (CGE) model to investigate the effects of farm policy shocks at the farm household level. Simulating an elimination of price-contingent subsidies, we show that farm household changes in farm income vary by region, production specialty, and farm category. We compare two typologies that use different parameters to group farm households. The ERS typology, which relies mainly on total value of production and the main occupation of the principal operator, is compared to the BG typology, which uses labor allocation, farm and non-farm income, and asset levels to create more of a farm household categorization system rather than a farm operation categorization system. Results show that farm household responses do vary by region, production specialty, and farm classification within a typology. Only in certain instances do responses vary substantially between typologies, suggesting that the farm income effect is the most influential factor in determining policy responses for both farm household groupings.

Farm household responses to the policy change generally follow three patterns. First, as expected, those farms that receive a higher proportion of subsidies also show a larger percentage change in farm income. Second, some farm operations can increase their farm income in response to the elimination of price-contingent subsidies by reallocating resources away from the production of subsidized commodities. The ability to adapt to a policy adjustment lies in production diversification. Those farms that have alternative production capabilities in place can adapt effectively to an adverse policy change by shifting resources into the production of unsubsidized commodities. This can lead to increased farm income. Third, livestock producers,

who generally do not receive price-contingent support, experience similar reductions in farm income across all farm categories, regions, and between typologies due to increases in feed cost.[8] Variations in responses across regions, production specialties, and farm categories are driven by the role that price-contingent subsidies play in overall farm income. Income variability and consequently income volatility varies by farm typology and production specialization.

In this paper, we explore how removing price-contingent subsidies affects farm income. From this simple analysis, we can compare farm household responses by region, by production specialty, by farm category, and even between competing farm typologies. The farm household CGE model, however, can capture the impact of various policy changes on an equally diverse group of farm household indicators. For instance, we show welfare changes by farm specialization, region and typology. Moreover, the model can simulate the effects of price-independent subsidies on total farm household income, which includes off-farm sources of income. We can analyze how a policy change might affect farm or non-farm assets, and how responses vary by region, production specialty, and farm category. In addition, we can simulate the effects that a commodity or region specific policy change might have on down-stream non-agricultural industries, such as energy or food-processing industries. This type of disaggregated model can be especially useful in capturing variations in farm household responses to the pressures and policies of biofuels production. With little modification, this model can show the varying effects on differentiated farm households of taxes and policies in the non-agricultural energy sector. This is important because biofuels have the potential to radically change the landscape of agriculture. Because farm households vary their responses to policy changes based on location, production specialty, and farm categorization, it is important to both researchers and policy makers to understand the distributional effects of competing policy alternatives.

[8] Responses do vary, however, by livestock production specialty (beef, hogs, poultry).

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**Table 1 - Collapsing the ERS and BG Typologies**

| ERS Typology | | BG Typology | |
|---|---|---|---|
| Limited-Resource | Rural Residence | Single Income Ruralpolitan | Ruralpolitan |
| Retirement | | Double Income Ruralpolitan | |
| Residential/Lifestyle | | | |
| Farming Occupation: Lower-Sales | Intermediate | Active Seniors | Senior/Spouse |
| Farming Occupation: Higher-Sales | | Farm Operator with Spouse Working Off Farm | |
| Large | Commercial | Traditional Farm | Farming |
| Very Large | | Commercial Farm | |

**Table 2. The Effects of Eliminating Price-Contingent Support on Value-Added Income**

| Production | Corn Belt | | Lake States | | Northeast | |
|---|---|---|---|---|---|---|
| | ERS | BG | ERS | BG | ERS | BG |
| **Corn** | | | | | | |
| Rural/Ruralpolitan[a] | -4.8% | -4.5% | 2.4% | 2.1% | -60.3% | -100.0% |
| | (560) | (862) | (291) | (440) | (10) | (0)[b] |
| Intermediate/Senior | -1.3% | -4.8% | 2.3% | -2.1% | -54.0% | -42.8% |
| | (2,384) | (2,740) | (873) | (177) | (53) | (40) |
| Commercial/Farming | -9.6% | -8.5% | -6.3% | -4.9% | 5.5% | -6.0% |
| | (2,562) | (2,449) | (726) | (936) | (98) | (118) |
| **Dairy** | | | | | | |
| Rural/Ruralpolitan | 9.8% | 18.4% | 0.0% | 3.5% | 1.0% | -6.3% |
| | (17) | (6) | (60) | (61) | (20) | (15) |
| Intermediate/Senior | -0.8% | -1.3% | -16.1% | -9.8% | -4.7% | -6.1% |
| | (276) | (102) | (413) | (294) | (518) | (209) |
| Commercial/Farming | -6.8% | -4.7% | -3.9% | -8.6% | -4.6% | -3.5% |
| | (212) | (386) | (669) | (725) | (319) | (661) |
| **Beef** | | | | | | |
| Rural/Ruralpolitan | -1.1% | -2.5% | -1.1% | -2.3% | -0.6% | -0.5% |
| | (109) | (344) | (109) | (89) | (118) | (186) |
| Intermediate/Senior | -1.7% | -2.0% | -2.8% | -1.0% | -1.6% | -1.4% |
| | (420) | (391) | (105) | (93) | (17) | (27) |
| Commercial/Farming | -4.1% | -3.3% | -2.5% | -1.7% | -0.8% | -0.6% |
| | (136) | (354) | (94) | (146) | (25) | (83) |

a. Under each production specialty (corn, dairy, and beef), an ERS farm type is given followed by a forward slash and a BG farm type.

b. Initial levels of farm income in millions of dollars, rounded to the nearest million, are given in parentheses. Because of rounding, an initial level of zero implies a positive level of income below $500,000.

Figure 1. The Effects of Removing Price-Contingent Subsidies on Corn Farm Household Utility.

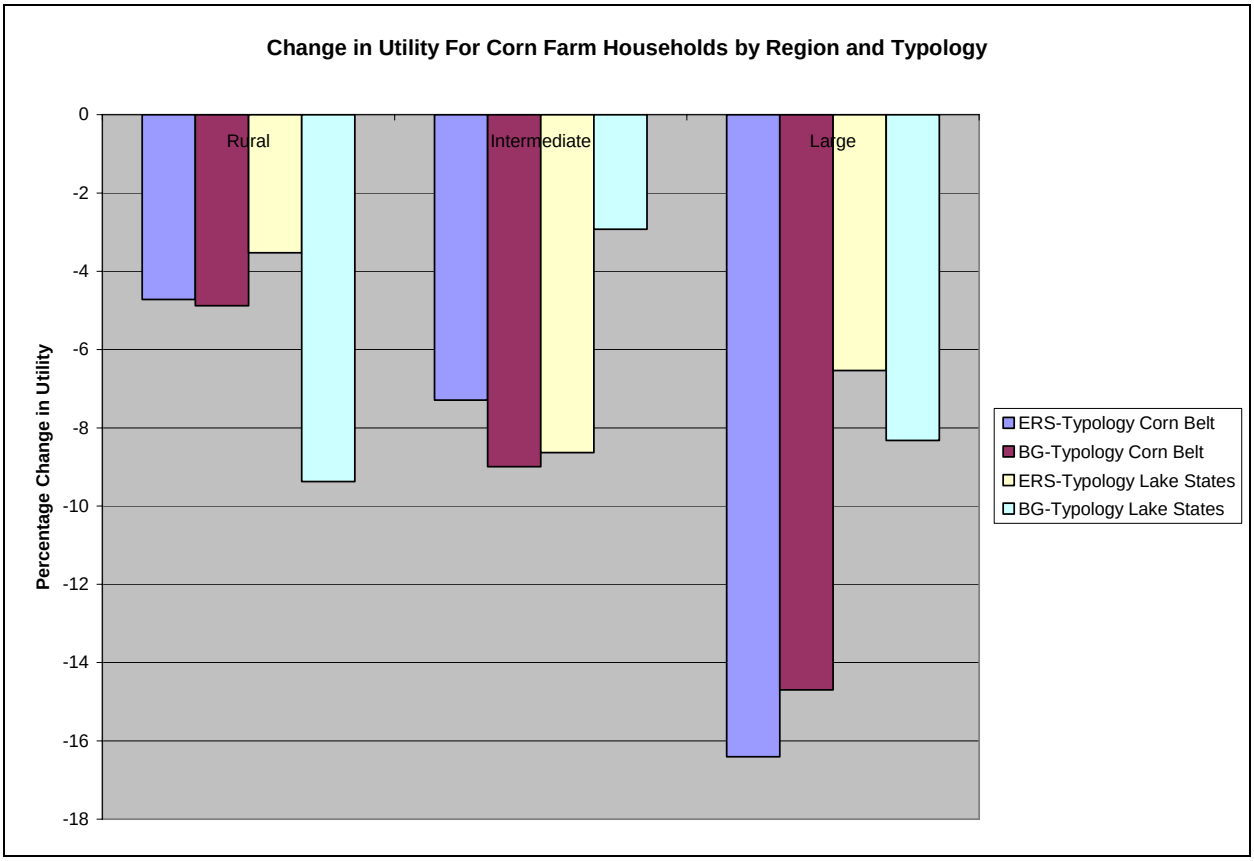
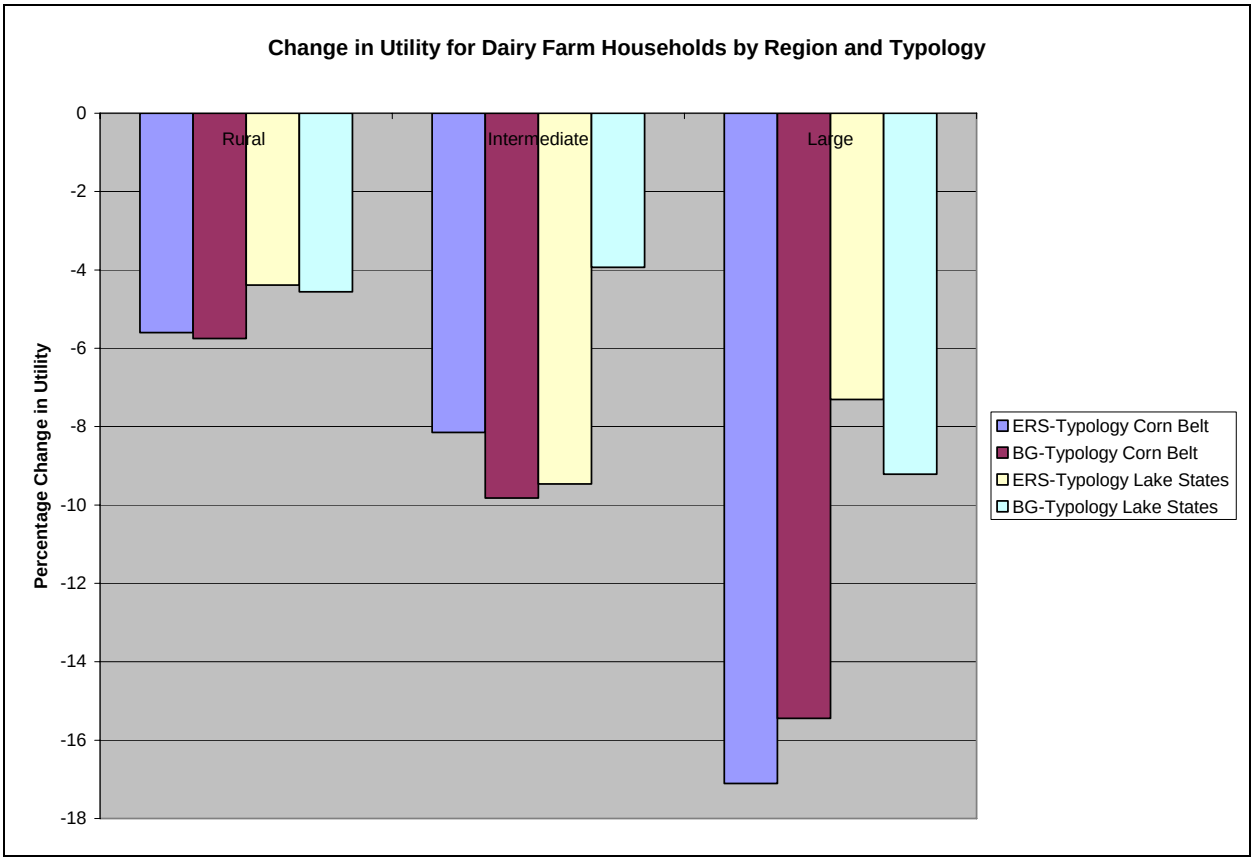
Figure 2. The Effects of Removing Price-Contingent Subsidies on Dairy Farm Household Utility.