Space, Government Payments, and Off-Farm Labor Response of Principal Farm Operators: *A County-Level Analysis*

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Abstract. *We examine the effects of space and government payments on off-farm employment among principal farm operators for the entire US as well as for ERS/USDA farm resource regions. Spatial dependency in off-farm employment of principal farm operators in the U.S. overall is evident; however, this is not the case for all farm resource regions. While the effects of government payments overall are significant for the U.S., important variations exist by farm program type and across ERS/USDA regions.*

Keywords: government payments, off-farm employment, off-farm labor supply, spatial dependence, ERS regions

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Introduction

Off-farm employment among U.S. farms continues to receive greater attention due to the growing share of off-farm income in total farm household income. For many farm households, off-farm work serves as insurance against adverse farm income and/or provides additional income to financially support the farm operation and farm 'way of life' (Goodwin and Bruer 2003, Kwon *et al*. 2003). For other farm households, off-farm employment is a way out of farming; Goetz and Debertin (2001) find that off-farm work is likely to encourage farmers to quit farming. Regardless of the motivation, the average hours worked off-farm for the operators has increased over time in the U.S. (Ahearn *et al.* 2002, 2004b) and off-farm income has reduced the gap between farm and nonfarm household income (El-Osta *et al.* 1995)

Simultaneously, government payments to U.S. farms in the aggregate have increased. The U.S. has historically supported farm households through government payments for several key reasons: 1) farm income is known to be highly variable and payments serve to reduce this variability, and 2) farm households have historically been believed to be economically disadvantaged relative to nonfarm households in the U.S. (Ahearn *et al.* 2002). The level of government payments paid to the agricultural production sector continues to increase in real terms. This is particularly the case following the 1996 Federal Agricultural Improvement and Reform Act, which favored farm income support through direct payments over price supports (Roberts and Key 2003). For instance, in 1996, government payments to farmers in aggregate totaled over 7 billion which escalated to over 22 billion by 2000 (USDA/ERS 2003). It is assumed that government payments as a supplementary form of farm household income have an income effect, resulting in a lower propensity for off-farm work (Mishra and Goodwin 1997, Ahearn *et al*. 2002, Goodwin and Featherstone 2003).

In contrast to expectations, both the hours and proportion of operators involved in off-farm work as well as numbers of proprietors quitting farming is not decreasing but increasing(Goetz and Debertin, 2001; Ahearn *et al.* 2002; El-Osta *et al.* 2004), even as government payments increase (USDA/ERS 2003; Ahearn et al. 2004a; Key and Roberts 2003). Hence, if the off-farm employment is shaped by government payments is a matter of scientific investigation and policy concern. Moreover, little is known about the relationship between off-farm work and government payments across different geographic locations such as the ERS farm production regions. Numerous studies have examined the relationship between government payments and off-farm employment directly or indirectly (Ahearn *et al.* 2002, Goodwin and Featherstone 2003, El-Osta *et al.* 2003). Very few studies consider aggregate county-level data, with most concentrating at the micro household level (Huffman 1980; Goodwin and Bruer 2003).

To our knowledge, no study has looked at the relationship between off-farm work behaviors of 'principal operators' and government payments while adjusting for geographical variations and spatial dependence using county-level data. Since off-farm employment is dependent on the availability of work and transaction costs, the farm's location may strongly influence off-farm work decisions (Jones 1984, Findeis *et al.* 1991). Although, traditionally, the spatial dimension has been neglected in off-farm work decision models, spatial analysis can be used here to discover if 'space' is important. Spatial analysis is important for modeling economic behavior for two major reasons. First, the economic behavior of agents in one place may not be independent of those in surrounding places due to social interaction effects such as neighborhood effects, peer effects, or spillover effects (Akerlof 1997; Anselin 1998; LeSage 1999; Jaenicke 2004). Second, the data collection process linked with the spatial units such as county may have measurement error (Anselin 1998; LeSage 1999).

For this paper, we use 2002 secondary county-level data to examine the effect of government payments and space on the off-farm response of principal farm operators in the U.S. We adjust for geographic variations including metro and non-metro county characteristics as well as ERS/USDA farm production regions. We also examine the effects of space and government payments on principal operator off-farm labor response separately by ERS farm production or resource region to determine if the observed effects differ due to regional characteristics.

Estimation Strategy

Off-farm Response Model. The off-farm response model we specify is drawn from the time allocation model based on utility theory (Rosenzweig 1980; Huffman and Lange 1989; Skoufias 1993; Ahearn *et al.* 2002; Kwon *et al.* 2003; Goodwin and Mishra 2004). Labor supply and labor participation models are generally modeled at the household level using utility theory. Huffman (1980) for the first time estimated off-farm labor supply using county-level data for Iowa, North Carolina and Oklahoma. Similarly, Goodwin and Bruer (2003) used county-level data to model off-farm work decisions for the Corn Belt states of Iowa, Illinois, Indiana, and Ohio. In our case, we estimate off-farm labor response of principal farm operators using county-level data for the entire U.S. and separately for ERS/USDA farm production or resource regions. One benefit of using county-level data is that it allows the integration of socioeconomic and demographic data with geographical reference data for all U.S. counties, to use GIS technology and also consider the spatial dimension in the analysis.

Previous studies modeled off-farm work decisions at the household level considering labor allocation of husband and wife or farm operator and spouse (Huffman and Lange 1989; Skoufias, 1993; Ahearn *et al.* 2002, Serra *et al.* 2003, 2004; El-Osta *et al.* 2003; Kwon *et al.* 2003; Goodwin and Mishra 2004). Here we are interested in the labor supply behavior of principal operators. Assume that the principal farm operator aims to maximize household utility from his/her leisure time (l^P), the leisure of other family members (l^O), and consumption of goods (C). The utility function is specified as follows.

$$U(l^P, l^O, C; \phi) \quad (1)$$

where ϕ is a vector of household attributes including the characteristics of principal operators and community characteristics. The utility function (1) is maximized subject to time and budget constraints, and production technology as specified below:

$$L = L^P + L^O + L^{FP} + L^{FO} + l^P + l^O \quad (2)$$
$$I = W^P L^P + W^O L^O - t(T^P) - t(T^O) + pQ - p_1 X + M + A = C \quad (3)$$
$$Q = f(L^{FP}, L^{FO}, X; \alpha) \quad (4)$$
$$L^P, L^O \geq 0; L^{FP}, L^{FO}, l^P, l^O X, M > 0, \quad (5)$$

Equation (2) describes the time constraints faced by the farm household. In equation (2), L is the annual total time endowment of the household. The total time endowments of the principal farm operator and other family members are allocated between off-farm work, on-farm work, and leisure (home time). The L^P and L^O are, respectively, the labor time allocated to off-farm employment by the principal farm operator (P) and others (O) within the household. Principal operators and others involved in off-farm work earn income that is spent on farming or/and consumption. L^{FP} and L^{FO} are the time allocations of the principal farm operator and other farm family members to farm work.

The budget constraint faced by the household is given in equation (3). The household total income is comprised of net income from off-farm employment, net income from farm production, exogenous income, and income from assets. The net income from off-farm employment includes the product of wages earned from off-farm employment and time allocated to off-farm work (resulting in off-farm earnings) of the principal operator (W^pL^p) and other farm household members (W^OL^O) less the transaction cost of off-farm employment for the principal operator $t(T^P)$ and others $t(T^O)$. The transaction cost for the principal operator is defined as $t(T^P) = T_0 + (L^P)*\tau$, where T_0 represents the fixed transaction cost which includes the cost of job search and logistics and τ is the variable transaction cost, which include the total cost of commuting to and from work each day (Goetz and Debertin 2001). Net farm income consists of the value of farm production (pQ) less input costs (p_1X). In the equation, M is exogenous income, A is income from assets, p is the price of agricultural output, p_1 is the vector of input prices, W^P and W^O are, respectively, the wage rates of the principal and other family members, Q is agricultural output, and α represents the characteristics of the farm and household members. Net household income is used for consumption of goods C, where the price of goods is normalized to one.

The technology for production is defined in equation (4). Since production is part of the income equation, as shown in equation (4), the value of time in farming is determined by the production function. Substituting (4) into (3), we obtain the budget constraint as follows:

$$C= W^PL^P +W^OL^O-t(T^P)-t(T^O) +pf(L^{FP}, L^{FO}, X; \alpha) - p_1X + M +A \qquad (6)$$

As specified in equation (5), we assume that time allocation to leisure and farm works, and consumption of goods, have internal solutions. However, the allocation of time to off-farm labor may have a corner solution. Hence, for the time allocation to off-farm work we specify the Kuhn-Tucker conditions. Consider λ and η to be the Lagrange multipliers, respectively, for household income and time allocation. Then, the first-order conditions for maximizing the utility function (1) with respect to set of constraints (2-6) are as follows:

$$pf'_X - p_1 \quad \text{for inputs} \quad (7)$$

$$U'_{L^P} - \eta - \lambda W^P \le 0, \left(U'_{L^P} - \eta - \lambda W^P\right) L^P = 0, L^P \ge 0 \quad \text{for off-farm labor} \quad (8)$$

$$U'_{L^{FP}} - \eta - \lambda p f'_{L^{FP}} = 0 \quad \text{for farm labor} \quad (9)$$

$$U'_{l^P} - \eta = 0 \quad \text{for leisure time} \quad (10)$$

$$U'_C - \lambda = 0 \quad \text{for consumption} \quad (11)$$

If an interior solution exists for off-farm labor of the principal farm operator, using equations (8) and (9), we can derive the following optimality relationship for the allocation of time between off-farm work and on-farm work:

$$\frac{U'_{L^P}}{U'_{L^{FP}}} = \frac{W^P}{pf'_{L^{FP}}} \quad (12)$$

$$\frac{U'_{L^P}}{W^P} = \frac{U'_{L^{FP}}}{pf'_{L^{FP}}} \quad (13)$$

Equation (12) represents the optimality condition in which the marginal rate of substitution between off-farm and farm labor allocation is equal to ratio of the off-farm wage to the value of marginal product of labor allocated to farming. Equation (12) can also be expressed as equation (13). This relationship suggests that principal operators work off-farm as opposed to working on-farm as long as the marginal utility per dollar from off-farm work outweighs the marginal utility per dollar from farm work at the margin (LHS>RHS in equation 13). In contrast, in equation (13) if LHS<RHS, an opposite decision is expected and if it is strictly equal then principal operators are indifferent between off-farm and on-farm work (El-Osta *et al.* 2004). In our study, we are interested in the effect of government payments, which is an alternative income.

Econometric Models. As we utilize data aggregated to the county level, we use the ordinary least squares technique to estimate off-farm labor response among principal operators in the U.S. The basic econometric model is specified as follows;

$$Y = X\beta + \varepsilon \qquad (14)$$

In equation (14) Y is the dependent variable vector: the county-level percentage of principal farm operators engaged in off-farm employment for 200 or more days in the last year. The X is the matrix of independent variables, including government payments and space. We modeled the effect of total government payments and also the effect of components of government payments including 1) Conservation Reserve Program and Wetland Reserve Programs (CWRP) payments, Other Federal Farm Programs (OFFP)payments, and Commodity Credit Corporation loans (CCCL). The independent variables included in the models are described in the data description that follows. Vector β is a vector of unknown parameters to be estimated and ε is the disturbances term which follows the assumption of no autocorrelation and constant variance and is independently identically distributed. This model can be estimated the usual ordinary least squares (OLS) technique.

Accounting for Spatial Dependence. One of the important assumptions of OLS estimators is that there is no autocorrelation. Traditionally, autocorrelation with respect to time is taken into account but spatial autocorrelation is generally neglected. However, more recently autocorrelation with respect to space has been increasingly of concern. This is because what occurs in one space may *depend* on what occurs in another adjoining space (Anselin 1998). That is, it may be the case that the off-farm employment choices of principal operators in one county are not independent of those in adjoining counties. Such a spatial dependence in the sample data could arise for two reasons (LeSage 1999). First, the data collection process linked with the spatial units such as county may have measurement error. This means that the spatial unit being considered does not truly reflect the nature of the sample data being generated. Second, and more importantly, the correlation could be associated with socio-economic and demographic activities that may have diffusion or spillover effects. For instance, the off-farm responses of principal farm operators in one county could have spillover effects on operators in adjoining counties. This may take place due to social networks among operators, which may well influence labor allocation decisions. In the presence of spatial

dependence, the OLS estimators will be both unbiased and inefficient if spatial dependence works through a spatially-lagged dependent variable and will be unbiased but inefficient if it works through a spatial error term (Anselin 1998). The possible presence of spatial dependence in the data can be tested using Moran's I statistic.

$$I = \frac{N}{S}\left(\frac{e'We}{e'e}\right) \tag{15}$$

where N = number of observations, S = standardization factor, which is equal to the sum of all elements in the weight matrix not normalized such that row elements sum to one, e = vector of OLS residuals and W is a spatial weight matrix.

The degree of spatial dependence at the local level can be explored by estimating significant local Moran statistics (LISA) and by identifying the clusters of spatially-dependent counties. We used Arc GIS and GeoDa (Anselin 2004a) software for these spatial exploratory analyses.

The statistical significance of the coefficient can be examined by estimating a spatial regression model and testing the lag coefficient. A suitable spatial model is dependent on the nature of spatial dependence. The spatial dependence may work through a spatial lag, suggesting for spatial lag model or through an error term, suggesting for spatial error model, or through both, suggesting for the general spatial model. The spatial lag model can be specified as:

$$Y=\rho W(Y) + X\beta+\varepsilon, \tag{16}$$
$$\varepsilon \sim N(0, \sigma^2 I_n)$$

where W is the spatial weight matrix and ρ is the spatial autoregressive parameter to be estimated. W(Y), therefore, is the spatially-weighted dependent variable.

The spatial error model can be specified as:

$$Y= X\beta+\mu, \tag{17}$$
$$\mu=\lambda W\mu +\varepsilon$$
$$\varepsilon \sim N(0, \sigma^2 I_n)$$

where μ is the error term, which is dependent on the error of adjoining units; and λ = is the scalar of spatial error coefficient. If both the spatial autoregressive parameter (ρ) and spatial error coefficient (λ) are significant, it suggests that the general spatial model that nests both spatial lag and spatial error structures is appropriate (LeSage 1999). The general spatial model is specified as follows:

$$Y = \rho W_1(Y) + X\beta + \mu, \quad (18)$$
$$\mu = \lambda W_2\mu + \varepsilon$$
$$\varepsilon \sim N(0, \sigma^2_\varepsilon)$$

For the estimation of multivariate models we used LeSage's spatial econometric tool box for MATLAB^{TM} .

Data and Variables. The data used to estimate the county-level models of off-farm labor response of principal farm operators are drawn from different sources including the Census of Agriculture 2002, the Census of Population 2000, ERS/USDA for identifying counties into different farm resource regions, and the Beadle codes for identifying the metro and non-metro counties. The variables included in the analyses are briefly described below.

P*rincipal operators' characteristics:* such as off-farm employment for 200 or more days in the last year; percentage of principal operators age < 35 years, 35 to 65 years inclusive (omitted), and > 65 years; and average number of years on present farm.

Farm characteristics: such as percentage of farms classified as grain and oil, vegetables and melon, fruits and nuts, dairy and milk producers, or other commodity producers (omitted); percentage of farms with farm size <50 acres, 50 to 500 acres (omitted), and >500 acres; percentage of farms with irrigation facilities; percentage of farms that hired labor; percentage of farm with one operator; percentage of farms that received government payments including CRRP, OFFP and CCCL; and percent farms with full ownership and partial ownership (omitted).

Geographical characteristics: such as if county lies in metro or non-metro area. We classified the county location into five categories based on 2003 rural-urban continuum (Beadle codes) such as metro area with >=250,000 population (omitted), metro with < 250,000 population, non-metro with >=2500 urban population adjacent to metro areas, non-metro with >=2500 urban population not adjacent to metro areas, and non-metro rural with <2500 urban population; county location in nine ERS farm production or resource regions such as Heartland, Northern Crescent, Northern

Great Plains, Prairie Gateway, Southern Seaboard (omitted), Eastern Uplands, Fruitful Rim, Basin and Range, and Mississippi Portal; a weighted spatial lag for county; mean commuting time to work per day for persons age 16 and above in minutes.

Socioeconomic characteristics: of counties drawn from the 2000 Population Census such as percentage of white population and other races population (omitted), percentage of males who completed high school, non completed high school, or completed bachelor or above degree (omitted); and percentage of males 16 years or above unemployed.

Total 3062 counties from the entire United States (Hawaii and Alaska excluded) were used in the analysis.

Empirical Results

Descriptive Analysis

Summary statistics for the variables included in the estimated models for the U.S. and by ERS/USDA farm resource region (FRR) are given in Table 1. Large variations in mean values are observed among FRRs. On average for U.S. counties, 38% of principal farm operators were involved in off-farm employment for 200 or more days per year in 2002, with mean values ranging between 27% (for the Northern Great Plains) to 43% (for the Eastern Uplands). Slightly over 34% of farms on a county basis in the United States had received any kind of government farm payments. It should be noted that this figure is lower than might be expected because it is on the basis on the number of farms, with many small farms being represented in many counties. Substantial variation in the percentages of farms receiving government payments across the FRRs is found, with estimates ranging from about 16% in the Eastern Uplands to 65% in the Northern Great Plains. County averages for the percent of farms receiving payments through the Conservation Reserve and Wetlands Reserve Programs (CWRP) averaged 13.3%; the participation rate was highest in the Eastern Uplands (29.7%) and lowest in the Northern Great Plains (3%). Similarly, the county average for Other Federal Farm Program (OFFP) payments was about 26%, ranging from 13% in the Fruitful Rim to 47.4% in the Northern Great Plains. In terms of acreage, larger farms are concentrated in the Northern Great Plains and Prairie Gateway farm resource

regions, while smaller farms are concentrated in the Fruitful Rim, Northern Crescent, Basin and Range and Southern Seaboard FRRs. Important variations in population density (as measured by metro and non-metro designations) are observed across regions.

Spatial Dependence of Off-farm Employment. Given the summary statistics regarding the regional variation in off-farm employment rates outlined above, it is likely that some clustering of off-farm employment among principal farm operators will be observed. In fact, clustering is apparent, as shown in Figure 1. Clustering of counties where at least half of the principal operators work off the farm for 200 or more days in 2002 can be seen in the East (Northeast and Southeast) as well as directly to the west of the Mississippi. There are also counties in the Basin and Range region where this is also the case. In contrast, many counties in the Northern Great Plains south to Texas are in clusters where the off-farm employment among principal farm operators is low. Finally, there are some regions of the country were there is a mix of high and low off-farm employment counties, although these are not as common as the clusters described above.

The degree of spatial dependence can also be measured using the Moran's I statistics. Column 1 in Table 2 presents unconditional (univariate) Moran's I statistics. As shown in Table 2, for the U.S. overall, the spatial dependence is quite high (0.45), indicating the existence of spatial dependence in the off-farm employment response of principal farm operators in a county with respect to that of surrounding counties. Across the FRRs, there are important variations in the spatial dependence of off-farm employment of principal farm operators. The spatial dependence is quite high in the Heartland, Eastern Uplands, and Mississippi Portal regions. The spatial dependence in off-farm employment is weaker in the Prairie Gateway and Northern Crescent regions, the latter region highly dependent on dairy.

The statistics presented in Table 2 do not provide the local level spatial dependency and the type of spatial dependency. However, this can be explored using LISA scatter maps. Figure 2 depicts the scatter map of counties with statistically significant local Moran's I (LISA scatter plot). In addition to significant local Moran's I statistics, the map illustrates the types of spatial association between counties. The darker shade (High-High) shows the *spatial clusters* of counties with high prevalence of principal operators' off-farm employment surrounded by similar counties and the

somewhat lighter shade (Low-Low) indicates the *spatial clusters* of counties with a low prevalence principal operators' off-farm employment surrounded by similar counties. The High-Low and Low-High shades show the *spatial outliers* (Anselin 2004b).

Figure 2 clearly documents the apparent clustering of off-farm employment, showing that the off-farm decisions of principal operators in one county are not independent of those in surrounding counties. Plausibly, the clustering could be due to social networks or spillover effects in economic decisions. The High-High spatial clustering of off-farm employment is concentrated in or near the Appalachian region; the Ozarks; in the Denver, Colorado region; and into the southern Great Lakes region encompassing Michigan, Ohio and northern Indiana. The Low-Low clustering of off-farm response is located through the Northern Great Plains southward into Texas; in a narrow band along the Mississippi; in Southern California; and in a band along the eastern coastal region where farms located in densely-populated regions are often farmed intensively. There are relatively few outliers, indicating strong spatial dependence in off-farm employment participation rates in the U.S.

The existence of a geographical pattern of spatial clustering strongly suggests consideration of the spatial dimension in modeling off-farm labor response, as well as consideration by region. We have considered these issues in the subsequent multivariate analyses.

Concentration of Government Payments. Figure 3 illustrates the concentration of government farm payments of any kind. This figure shows a high degree of match with the spatial dependence relationships in Figure 2. That is, areas where there is a Low-Low spatial relationship also tend to be those areas where farms receive low government payments while areas characterized as spatially High-High tend to be less likely to receive government farm support.

Multivariate Spatial Analysis

Models were estimated for the U.S. using both the spatial lag and spatial error structure specifications. The spatial autoregressive parameter (ρ) and spatial error coefficient (λ) were highly significant, so we estimated the general spatial model. Table 3 presents results from the estimation of OLS and general spatial regression models. The effect of government payments are

examined in total and by the separate payment components (i.e., CCCL payments, CRWP payments, and OFFP payments). In Table 3, Model-I reports the results including the effect of government payments; Model-II, Model-III and Model-IV provide the results including the effects of CRWP payments, OFFP payments, and CCCL, respectively.

The estimated coefficients for both ρ and λ are highly significant in Model-I through Model–III. But the estimated coefficient of the lag error structure is not significant in Model-IV. For all counties in the U.S., results show that 'space' has a significant positive effect on county-level off-farm employment rates, suggesting that off-farm decisions of principal farm operators in one county are significantly dependent on off-farm decisions of principal operators in surrounding counties. The differences in R-squared values show that 4% of the variations in county-level off-farm employment rates are explained by spatial dependence.

Model results reported in Table 3 also show that government payments had significant negative effects on the principal farm operators' off-farm employment for 200 or more days annually. This provides evidence of an income effect of government payments on off-farm work decisions. The significant coefficient for the spatial model suggests that inferences based on the OLS specification inflate the effect of government payments on county-level off-farm employment. Hence, the OLS model without spatial parameters appears to be not valid for drawing inferences regarding the county-level off-farm employment response among principal farm operators in the U.S. The signs of the estimated coefficients for the effect of CWRP payments and CCCL are as expected and are highly significant. However, the sign of the OFFP payments is positive, but not significant. The results show that when the effects of CWRP payments and CCCL are estimated (separately), these programs have income effects on off-farm employment response. However, the magnitude of the effect for CCCL program is the largest, followed by the CWRP payments.

Regional Analysis

The results from the U.S. models in Table 3 provide evidence of regional variations in the off-farm employment of principal farm operators. However, these results do not provide information about variations in the effects of space and government payments within farm resource regions. Therefore, additional models were estimated for each of the nine ERS/USDA farm resource

regions, using the same set of explanatory variables as used for the U.S. models. Tables 6 through 14 in the appendix provide the regional results.

For the overall U.S. model, the general spatial model that nests both spatial lag and spatial error structures was found to be appropriate to describe the data; however in the regional models, the spatial dependence worked either through the spatial error structure or the spatial lag structure. Table 4 reports the conditional Moran's I statistics (adjusting for the effects of the explanatory variables) for off-farm employment of principal farm operators for each of the regions. Results show considerable variation in the spatial dependence of off-farm employment of principal operators across ERS/USDA farm resource regions. In regions such as Northern Great Plains, Eastern Uplands, and Mississippi Portal, the county-level off-farm employment of principal farm operators were not statistically influenced by the off-farm employment patterns in neighboring counties. However, spatial dependence in off-farm employment was significant in the other six regions. The effect was stronger in the Heartland, Prairie Gateway, and Basin and Range regions than in other regions. The results suggest that estimation of off-farm employment rates using OLS without considering spatial dependence is inefficient for farm resource regions other than the Northern Great Plains, Eastern Upland and Mississippi Portal regions.

The results of the effects of government payments in the regional analyses are summarized in Table 5. The income effect of government payments on the off-farm employment of principal operators is found to vary across farm resource regions and also vary by the types of payments. When the effects of government payments are estimated overall, the effect are negative and significant only in the Southern Seaboard, Mississippi Portal and marginally significant in the Northern Great Plains. However, when government payments are disaggregated by type and the effects are estimated separately, the results are interestingly different. The effects of CWRP were significant only in the Heartland, Prairie Gateway, Southern Seaboard and Mississippi Portal regions. On the other hand, the effects of OFP on off-farm employment are mixed. In the Mississippi Portal region, the effect was as expected showing a negative effect, while in the Northern Crescent and Eastern Uplands, in contrast to our expectation, the effect was positive and significant. The CCCL had a negative significant effect on off-farm employment rates of principal farm operators only in the Prairie Gateway region.

Overall, the CWRP was found to have a greater impact on the off-farm employment of principal operators (>= 200 days annually) compared to the other two forms of government payments. The results suggest that, regional analyses without disaggregating the types of government payments may mislead the notion of an income effect of government payments on the county-level off-farm employment of principal operators.

Conclusions

Using 2002 county-level data, we examined for the U.S. as a whole and for each of nine ERS/USDA farm resource regions if the off-farm employment of the principal farm operator (>= 200 days a year) is spatially dependent and shaped by government payments. The effects of government payments are examined in total and by payment type including payments related to the Conservation and Wetland Reserve Programs, Commodity Credit Corporation loans, and other federal farm program payments.

The exploratory spatial analyses clearly show apparent clustering of off-farm employment of principal farm operators in the U.S. This result is well substantiated by the multivariate results, in which the estimated coefficients for spatial dependence are positive and highly significant. This implies that the off-farm decisions of principal farm operators in one county are not statistically independent of those in surrounding counties. The separate analyses by ERS regions also yield similar results except for the Northern Great Plains, Eastern Uplands and Mississippi Portal regions.

As expected, for U.S. overall, total government payments have a significant negative relationship with the off-farm employment rate of principal farm operators, providing evidence of an income effect of government payments on off-farm decisions of principal farm operators. However, when the effects of government payments are examined by type of payment, the effects of Conservation and Wetland Reserve Program payments and CCC loans are consistent in terms of signs and significance while the effect of other federal farm program payments is not. The ERS region-specific analyses show that the effects of government payments, in total and by type, on the off-farm employment rates of the principal farm operator vary across ERS resource regions. In terms

of coverage of the impacts, the Conservation and Wetland Reserve Program payments are found to have greater impacts across the regions than those of the other two programs.

Overall, results suggest that estimating county-level off-farm employment response using OLS while ignoring spatial dependence seems to yield invalid estimates, suggesting a spatial econometric approach to the analysis. Similarly, estimating the effects of government payments without considering its type may mislead the notion of income effect of government payments on the off-farm employment of principal operators in the U.S. Variations in the regional results suggest that the income effect of government payments is specific to region and type of payment.

Table 1: Summary Statistics of Variables Used in Models by ERS/USDA Farm Resource Region in the U.S.

Variables	Heartland		Northern Crescent		Northern Great Plains		Prairie Gateway		Eastern Uplands		Southern Seaboard		Fruitful Rim		Basin and Range		Mississippi Portal		U.S.	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
% principal operators with >= 200 days off-farm	38.95	6.57	39.09	7.16	27.66	6.50	36.45	7.24	43.13	5.79	38.54	6.39	36.63	6.93	36.39	8.84	37.63	7.69	38.04	7.61
% farm receiving government payment	56.81	16.09	24.95	17.05	64.59	17.57	47.64	25.25	15.78	9.55	26.62	17.05	16.65	15.31	21.53	16.91	35.13	18.06	34.44	23.92
% farm receiving conservation/wetland reserve payment	23.82	13.14	7.84	9.17	29.73	17.78	20.12	18.28	3.06	3.90	10.31	9.66	5.35	8.63	5.83	11.39	14.36	11.32	13.27	14.56
% farm receiving other federal program payment	42.21	12.29	19.09	11.69	47.42	10.71	35.75	17.88	13.77	8.38	18.49	12.51	12.87	11.64	18.28	12.83	23.85	15.38	25.82	17.41
% farm receiving commodity credit corporation loans	12.14	7.60	2.94	3.33	7.81	5.27	6.10	5.58	0.87	1.92	2.97	4.44	1.80	3.09	1.47	3.00	7.29	9.35	5.03	6.50
% farm with size 1-49 acres	28.15	11.30	40.21	18.92	9.26	8.65	18.78	14.27	34.92	12.63	37.23	13.40	49.88	21.42	37.37	19.91	30.31	14.50	32.50	18.17
% farm with size >500 acres	20.65	10.70	7.15	4.67	58.10	15.50	36.14	18.14	5.91	4.39	11.01	8.45	16.64	16.82	28.11	18.32	18.73	15.62	19.51	18.40
% principal operators age <35 years	6.74	2.30	5.28	2.86	7.15	2.41	6.34	2.61	5.28	2.11	4.61	2.91	4.55	3.89	4.21	2.74	5.65	2.85	5.56	2.88
% principal operators age >65 years	24.69	4.60	22.08	5.04	26.08	4.82	30.97	5.57	26.72	4.67	28.58	5.30	27.14	6.30	25.06	7.90	27.51	6.47	26.50	6.03
Average years of principal operators on present farm	22.94	1.81	20.82	2.08	23.97	2.41	21.43	3.11	20.21	1.68	20.14	2.01	18.57	2.22	18.90	2.74	19.86	2.10	20.89	2.68
% farm with full ownership	60.12	12.31	69.62	7.89	50.58	9.41	59.62	10.61	72.62	6.73	69.91	9.56	73.72	10.44	69.41	10.81	62.89	15.19	65.98	12.12
% farm with one operator	65.83	4.80	56.92	7.19	62.14	8.84	63.96	6.33	63.66	5.33	67.08	6.93	59.19	9.21	51.66	8.61	68.38	5.79	62.69	8.16
% farm hired labor	26.78	8.74	25.12	9.40	33.40	9.22	27.03	9.78	22.01	8.35	26.26	10.09	31.40	12.36	29.65	10.18	28.86	14.56	26.97	10.42
%farm classified as grain and oil producers	41.67	19.81	12.03	12.41	25.70	18.74	18.87	18.57	3.45	5.05	7.78	11.09	4.58	6.95	5.22	9.29	17.67	20.20	16.35	19.65
%farm classified as vegetables producers	0.73	1.01	4.28	4.90	0.29	0.64	0.41	0.75	1.33	1.53	2.85	3.10	2.95	3.12	1.60	3.01	1.58	2.59	1.86	2.99
%farm classified as fruit and nuts producers	0.65	0.76	4.34	6.30	0.07	0.23	1.54	4.28	1.34	2.91	3.57	4.12	13.17	17.23	3.55	7.61	2.03	4.40	3.18	7.43
%farm classified as dairy and milk producers	2.09	3.01	9.90	9.28	1.16	1.84	0.65	0.97	2.08	3.12	1.04	1.68	1.73	3.50	1.04	2.03	0.59	1.97	2.58	5.09
%farm with irrigation facilities	4.81	10.20	10.90	12.54	13.10	17.53	16.95	18.89	3.72	3.84	9.42	7.67	36.83	27.27	54.31	23.61	14.50	18.47	14.86	20.52
Mean per day commuting time	21.99	4.56	23.57	4.57	17.25	3.40	20.57	5.28	26.79	4.86	27.08	5.10	24.09	4.74	21.23	5.07	25.83	4.94	23.53	5.55
% male unemployment	4.80	1.93	6.10	2.43	5.55	4.95	4.28	2.22	6.12	2.65	5.35	2.26	6.69	3.10	7.36	3.94	7.24	3.14	5.69	2.92
% white population	94.43	6.39	91.73	9.55	89.36	18.95	86.00	10.15	92.67	8.24	68.59	16.37	78.22	13.15	87.47	12.90	66.65	20.94	85.00	15.82
% male high school completed	39.47	6.64	36.13	7.22	34.59	5.57	33.30	6.46	37.04	5.96	33.15	5.40	28.62	6.84	29.96	6.41	33.95	5.80	34.73	7.11
% male high school not comp.	19.59	6.13	17.82	4.86	20.04	6.29	22.39	8.18	30.14	9.29	28.79	7.87	24.91	10.90	16.97	7.08	33.61	7.76	23.65	9.26
Metro < 250,000 population	0.12	0.32	0.10	0.30	0.06	0.23	0.07	0.26	0.12	0.32	0.15	0.36	0.15	0.36	0.09	0.28	0.10	0.30	0.11	0.32
Non-metro 2,500 + urban adjacent to metro	0.29	0.45	0.27	0.45	0.06	0.24	0.22	0.41	0.28	0.45	0.31	0.46	0.32	0.47	0.25	0.43	0.30	0.46	0.27	0.44
Non-metro 2,500 + urban non - adjacent to metro	0.22	0.41	0.14	0.35	0.22	0.41	0.25	0.44	0.13	0.34	0.09	0.28	0.10	0.30	0.29	0.46	0.27	0.45	0.18	0.38
Non-metro rural < 2,500 urban	0.17	0.38	0.12	0.32	0.65	0.48	0.32	0.47	0.22	0.41	0.18	0.38	0.08	0.28	0.26	0.44	0.13	0.34	0.21	0.41
Number of counties	543		420		179		394		410		477		279		195		165		3062	

Table 2: Univariate Global Moran's I Statistics by ERS Farm Resource Region.

Region	Moran's I
U.S. (total)	0.454
Heartland	0.566
Northern Crescent	0.152
Northern Great Plains	0.300
Prairie Gateway	0.062
Eastern Uplands	0.537
Southern Seaboard	0.317
Fruitful Rim	0.231
Basin and Range	0.274
Mississippi Portal	0.443

Table 3: County-Level Off-Farm Employment Rates of Principal Farm Operators in 2002, U.S. (n = 3062)

Variable	*Model-I*		*Model-II*		*Model-III*		*Model-IV*	
	OLS	Spatial	OLS	Spatial	OLS	Spatial	OLS	Spatial
Constant	56.902***	43.785***	55.285***	43.102***	57.653***	44.111***	58.467***	45.025***
% farm receiving government payment	-0.026**	-0.019*						
% farm receiving conservation/wetland reserve payment			-0.042***	-0.026**				
% farm receiving other federal program payment					0.014	0.010		
% farm receiving commodity credit corporation loans							-0.154***	-0.107***
% farm with size 1-49 acres	-0.067***	-0.052***	-0.065***	-0.050***	-0.058***	-0.045***	-0.063***	-0.049***
% farm with size >500 acres	-0.188***	-0.141***	-0.187***	-0.142***	-0.199***	-0.148***	-0.194***	-0.146***
% principal operators age <35 years	0.108**	0.105**	0.108**	0.104**	0.099*	0.099**	0.114**	0.109**
% principal operators age >65 years	-0.246***	-0.246***	-0.242***	-0.243***	-0.241***	-0.242***	-0.250***	-0.249***
Average years of principal operators on present farm	-0.248***	-0.225***	-0.244***	-0.227***	-0.289***	-0.254***	-0.271***	-0.242***
% farm with full ownership	0.065***	0.053***	0.079***	0.061***	0.059***	0.048***	0.044**	0.038**
% farm with one operator	0.016	0.02	0.021	0.024	0.000	0.011	0.012	0.019
% farm hired labor	-0.157***	-0.144***	-0.159***	-0.145***	-0.160***	-0.145***	-0.149***	-0.138***
%farm classified as grain and oil producers	-0.034**	-0.032**	-0.035***	-0.034***	-0.051***	-0.044***	-0.019+	-0.022*
%farm classified as vegetables producers	-0.246***	-0.212***	-0.240***	-0.209***	-0.245***	-0.211***	-0.253***	-0.218***
%farm classified as fruit and nuts producers	-0.052**	-0.031*	-0.051**	-0.031+	-0.050**	-0.029+	-0.048**	-0.028+
%farm classified as dairy and milk producers	-0.303***	-0.274***	-0.306***	-0.278***	-0.320***	-0.285***	-0.313***	-0.281***
%farm with irrigation facilities	-0.016*	-0.013+	-0.019*	-0.015*	-0.017*	-0.013+	-0.012	-0.010
Mean per day commuting time	-0.094***	-0.092***	-0.096***	-0.092***	-0.083**	-0.085***	-0.095***	-0.092***
% male unemployment	-0.111***	-0.080*	-0.108*	-0.077+	-0.093*	-0.066+	-0.111**	-0.080*
% white population	-0.014	-0.012	-0.014	-0.012	-0.013	-0.011	-0.014	-0.012
% male high school completed	0.094***	0.063***	0.088***	0.060**	0.091***	0.061**	0.094***	0.063***
% male high school not completed	-0.006	-0.010	-0.008	-0.011	-0.006	-0.010	-0.007	-0.011
ERS Region: Heartland	2.621***	1.913***	2.596***	1.890***	2.404***	1.747***	2.662**	1.943***
ERS Region: North Crescent	1.422**	1.118*	1.449**	1.144*	1.504**	1.172*	1.372**	1.088*
ERS Region: North Great Plains	-0.511	0.287	-0.394	0.326	-0.690	0.169	-1.046	-0.101
ERS Region: Prairie Gateway	2.978***	2.451***	3.011***	2.468***	2.848***	2.348***	2.720***	2.271***
ERS Region: Eastern Uplands	1.630***	0.791*	1.581***	0.792+	1.815***	0.912*	1.703***	0.857*
ERS Region: Fruitful Rim	1.010*	0.836*	1.097*	0.896+	1.093*	0.892+	0.950+	0.796
ERS Region: Basin and Range	1.368*	0.939	1.501*	1.027	1.420*	0.968	1.085	0.744
ERS Region: Mississippi Portal	0.674	0.533	0.775	0.594	0.666	0.524	0.843+	0.651
Metro < 250,000 population	0.537	0.492	0.547	0.497	0.530	0.486	0.549	0.500
Non-metro 2,500 + urban adjacent to metro	0.011	0.000	0.037	0.013	-0.007	-0.012	0.020	0.005
Non-metro 2,500 + urban non- adjacent to metro	-0.564	-0.365	-0.521	-0.342	-0.557	-0.357	-0.525	-0.340
Non-metro rural < 2,500 urban	-1.414***	-1.230***	-1.312**	-1.177**	-1.478***	-1.275***	-1.458***	-1.266**
ρ		0.311***		0.306***		0.316***		0.308***
λ		0.012***		0.013***		0.011***		0.011
R-squared	0.512	0.553	0.513	0.553	0.512	0.552	0.512	0.554

+ = p < 0.1; * = p < 0.05; ** = p < 0.01; *** = p < 0.001

Table 4: Measures of Conditional Moran's I Statistics for Principal Farm Operator's Off-Farm Employment (>= 200 Days) in 2002 by Farm Resource Region, U.S.

Regions	Model-I	Model-II	Model-III	Model-IV	Spatial Coef.	Appropriate Model
Heartland	0.115***	0.122***	0.119***	0.103***	λ	Spatial Error
Northern Crescent	0.063**	0.066**	0.061**	0.064**	λ	Spatial Error
Northern Great Plains	0.044	0.039	0.052	0.044	λ	OLS
Prairie Gateway	0.091***	0.087***	0.086***	0.089***	ρ	Spatial Lag
Eastern Uplands	-0.02	-0.011	-0.025	-0.015	ρ	OLS
Southern Seaboard	0.05*	0.049*	0.053**	0.052*	ρ	Spatial Lag
Fruitful Rim	0.067**	0.068**	0.067**	0.064*	ρ	Spatial Lag
Basin and Range	0.108***	0.111***	0.101***	0.121***	ρ	Spatial Lag
Mississippi Portal	-0.025	-0.029	-0.023	-0.024	ρ	OLS

* = p < 0.05;** = p < 0.01;*** = p < 0.001

Table 5: Effect of Government Payments on Principal Operator's Off-farm Employment (>= 200 Days) in 2002 by Farm Resource Region, U.S.

Regions	**GP**	**CRWR**	**OFP**	**CCCL**	**Model**
Heartland	-0.023	-0.046**	0.039	0.001	Spatial Error
Northern Crescent	0.005	-0.058	0.111*	0.237	Spatial Error
Northern Great Plains	-0.073+	-0.020	-0.078	-0.075	OLS
Prairie Gateway	-0.023	-0.047**	-0.005	-0.171*	Spatial Lag
Eastern Uplands	0.047	0.079	0.085*	0.079	OLS
Southern Seaboard	-0.064**	-0.078**	-0.005	-0.114	Spatial Lag
Fruitful Rim	0.002	-0.014	-0.013	-0.120	Spatial Lag
Basin and Range	-0.046	0.114	0.109	-0.013	Spatial Lag
Mississippi Portal	-0.138**	-0.169***	-0.138***	-0.024	OLS

* = p < 0.05;** = p < 0.01; *** = p < 0.001

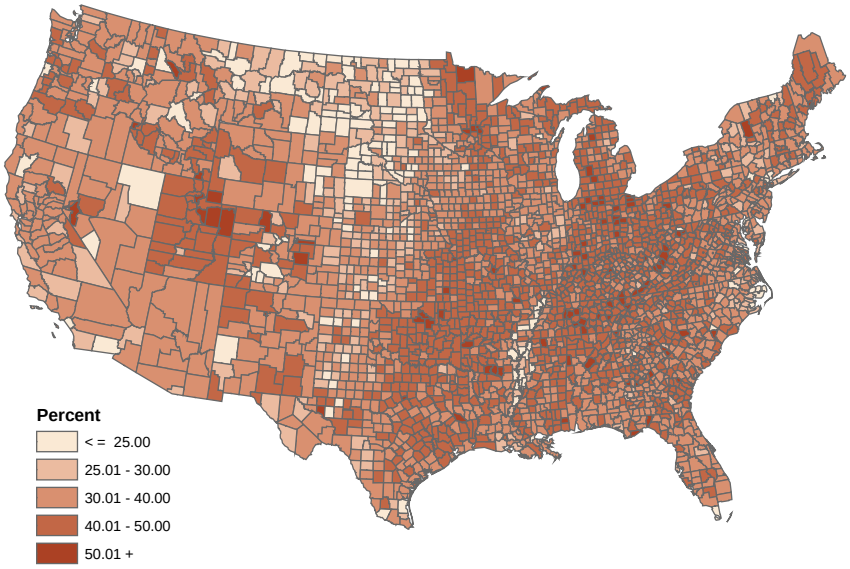

Figure 1: Percentage Distribution of Off-farm Employment Among Principal Farm Operators (>= 200 days per year) by County, U.S.

Source: 2002 Census of Agriculture, U.S.

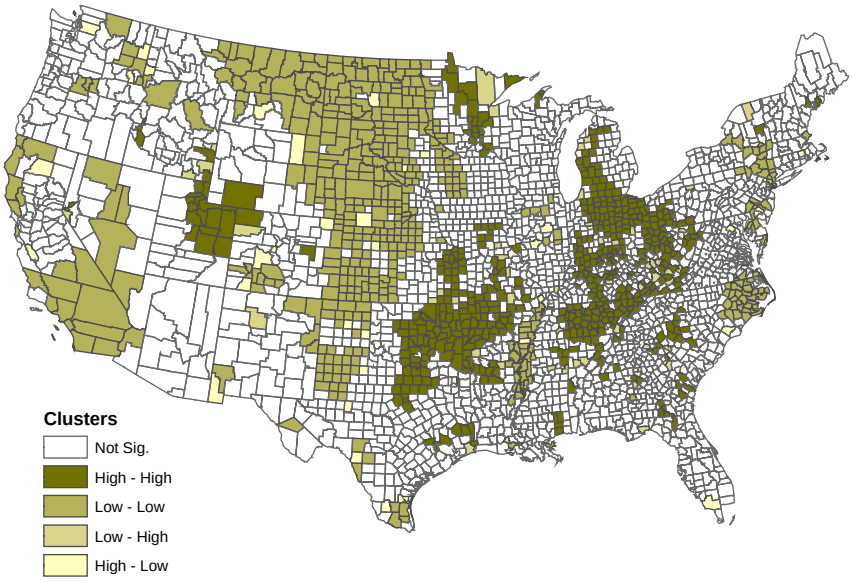

Figure 2: Scatter Plot Indicating Local Spatial Dependence, U.S.

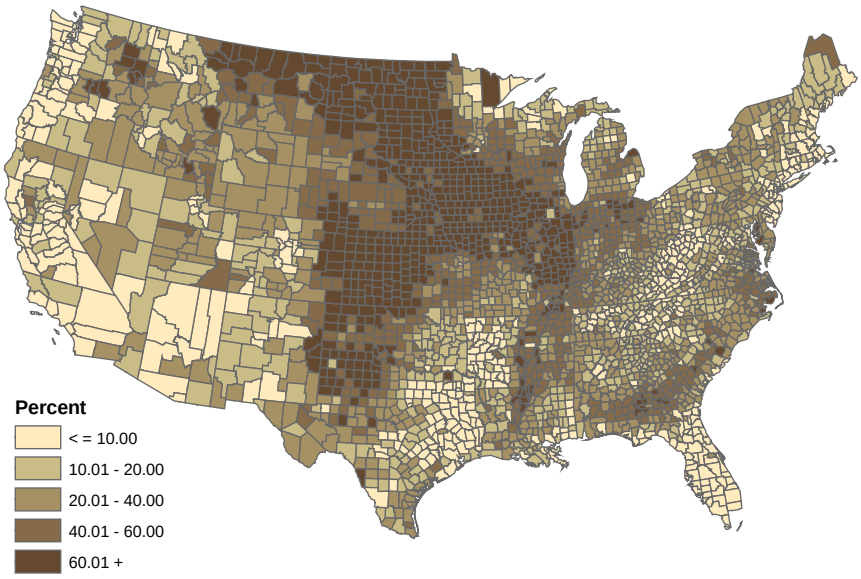

Figure 3: Percentage Distribution of Government Payment Recipient Farms, U.S.

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Appendix

Table 6: County-Level Off-Farm Supply Response of Principal Operators in 2002, Heartland Farm Resource Region, U.S. (n =543)

Variables	Model-I		Model-II		Model-III		Model-IV	
	OLS	Spatial	OLS	Spatial	OLS	Spatial	OLS	Spatial
Constant	65.898***	66.546***	63.899**	63.309**	68.411***	67.378***	69.241***	68.222***
% farm receiving government payment	-0.032	-0.023						
% farm receiving conservation/wetland reserve payment			-0.038*	-0.046**				
% farm receiving other federal program payment					0.007	0.039		
% farm receiving commodity credit corporation loans							-0.086+	0.001
% farm with size 1-49 acres	-0.027	-0.040	-0.026	-0.043	-0.017	-0.028	-0.020	-0.034
% farm with size >500 acres	-0.313***	-0.286***	-0.314***	-0.285***	-0.321***	-0.295***	-0.318***	-0.290***
% principal operators age <35 years	0.033	-0.033	0.020	-0.042	0.020	-0.054	0.025	-0.045
% principal operators age >65 years	-0.361***	-0.402***	-0.360***	-0.404***	-0.370***	-0.411***	-0.376***	-0.407***
Average years of principal operators on present farm	-0.374*	-0.514***	-0.393*	-0.513***	-0.445**	-0.593***	-0.427**	-0.562***
% farm with full ownership	0.171***	0.165***	0.187***	0.188***	0.163***	0.168***	0.141***	0.157***
% farm with one operator	-0.069	-0.016	-0.061	0.009	-0.099*	-0.030	-0.090+	-0.031
% farm hired labor	-0.133***	-0.090***	-0.133***	-0.089***	-0.137***	-0.092***	-0.121***	-0.090***
%farm classified as grain and oil producers	0.050**	0.028	0.049**	0.029	0.038+	0.010	0.046*	0.019
%farm classified as vegetables producers	-0.169	-0.087	-0.148	-0.075	-0.122	-0.034	-0.114	-0.059
%farm classified as fruit and nuts producers	0.324	0.372	0.323	0.360	0.349	0.396+	0.326	0.390
%farm classified as dairy and milk producers	-0.304***	-0.328***	-0.307***	-0.329***	-0.327***	-0.343***	-0.315***	-0.335***
%farm with irrigation facilities	-0.035+	-0.068**	-0.040*	-0.075***	-0.032+	-0.066**	-0.035+	-0.067**
Mean per day commuting time to work (minutes)	-0.181**	-0.186***	-0.185***	-0.190***	-0.180**	-0.186***	-0.194***	-0.186***
% male unemployed	-0.165	-0.167+	-0.159	-0.160+	-0.156	-0.148	-0.181+	-0.162+
% white population	-0.047	-0.024	-0.046	-0.022	-0.047	-0.025	-0.041	-0.023
% male high school completed	0.189***	0.138***	0.189***	0.136***	0.189***	0.133***	0.191***	0.136***
% male high school not completed	-0.130***	-0.117***	-0.127***	-0.114**	-0.121***	-0.110**	-0.126***	-0.113**
Metro<250,000 population	0.816	0.283	0.847	0.285	0.828	0.204	0.844	0.255
Non-metro 2500+Urban adjacent to metro	0.653	0.149	0.657	0.136	0.617	0.050	0.615	0.095
Non-metro 2500+Urban non adjacent to metro	0.026	-0.375	0.062	-0.308	-0.108	-0.544	0.050	-0.483
Non-metro Rural <2500 urban population	-0.589	-0.755	-0.491	-0.601	-0.724	-0.868	-0.652	-0.846
λ		0.407***		0.421***		0.432***		0.421***
R_Squared	0.705	0.729	0.707	0.732		0.730		0.729

+ p<0.1 *=p<0.05 **=p<0.01 ***=p<0.001

Table 7: County-Level Off-Farm Supply Response of Principal Operators in 2002, Northern Crescent Farm Resource Region, U.S. (n =420)

Variables	Model-I		Model-II		Model-III		Model-IV	
	OLS	Spatial	OLS	Spatial	OLS	Spatial	OLS	Spatial
Constant	50.875***	45.522***	48.958***	43.831***	52.535***	47.016***	52.710***	47.326***
% farm receiving government payment	0.014	0.005						
% farm receiving conservation/wetland reserve payment			-0.050	-0.058				
% farm receiving other federal program payment					0.117*	0.111*		
% farm receiving commodity credit corporation loans							0.239	0.237
% farm with size 1-49 acres	-0.111**	-0.117**	-0.117**	-0.122**	-0.105**	-0.110**	-0.116**	-0.121**
% farm with size >500 acres	-0.188+	-0.191+	-0.177+	-0.187+	-0.236*	-0.239*	-0.215*	-0.222*
% principal operators age <35 years	-0.089	-0.082	-0.098	-0.083	-0.041	-0.042	-0.093	-0.084
% principal operators age >65 years	-0.360***	-0.339***	-0.351***	-0.330***	-0.353***	-0.334***	-0.354***	-0.334***
Average years of principal operators on present farm	-0.165	-0.219	-0.156	-0.216	-0.200	-0.252	-0.179	-0.237
% farm with full ownership	0.172**	0.171***	0.190***	0.184***	0.170***	0.172****	0.167**	0.167***
% farm with one operator	-0.051	-0.004	-0.043	0.006	-0.049	-0.005	-0.051	-0.006
% farm hired labor	-0.001	0.017	0.007	0.023	-0.009	0.005	-0.009	0.008
%farm classified as grain and oil producers	0.056	0.049*	0.092*	0.076+	0.007	0.000	0.025	0.013
%farm classified as vegetables producers	-0.500***	-0.513***	-0.494***	-0.512***	-0.503***	-0.514***	-0.505***	-0.518***
%farm classified as fruit and nuts producers	-0.197***	-0.191***	-0.205***	-0.198***	-0.202***	-0.194***	-0.193***	-0.187***
%farm classified as dairy and milk producers	-0.443***	-0.450***	-0.420***	-0.438***	-0.497***	-0.500***	-0.449***	-0.460***
%farm with irrigation facilities	0.056	0.066	0.053	0.063	0.065	0.075	0.060	0.071
Mean per day commuting time to work (minutes)	-0.208*	-0.200*	-0.207*	-0.196*	-0.219**	-0.212*	-0.209**	-0.201*
% male unemployed	-0.115	-0.095	-0.131	-0.106	-0.116	-0.093	-0.108	-0.086
% white population	0.074	0.112*	0.076	0.114*	0.059	0.097*	0.064	0.102*
% male high school completed	0.028	0.007	0.028	0.007	0.022	0.001	0.024	0.003
% male high school not completed	0.035	0.069	0.025	0.062	0.033	0.066	0.050	0.082
Metro<250,000 population	-0.107	-0.473	-0.107	-0.523	-0.115	-0.438	-0.092	-0.414
Non-metro 2500+Urban adjacent to metro	0.138	0.195	0.249	0.305	0.240	0.287	0.240	0.306
Non-metro 2500+Urban non adjacent to metro	-1.280	-1.733	-1.222	-1.715	-1.080	-1.483	-1.130	-1.547
Non-metro Rural <2500 urban population	-1.187	-1.084	-1.109	-1.052	-0.986	-0.863	-1.163	-1.026
λ		0.234**		0.250***		0.226**		0.231**
R_Squared	0.385	0.401	0.387	0.404	0.392	0.407	0.389	0.404

+ p<0.1 *=p<0.05 **=p<0.01 ***=p<0.001

Table 8: County-Level Off-Farm Supply Response of Principal Operators in 2002, Northern Great Plains Farm Resource Region, U.S. (n =179)

Variables	Model-I	Model-II	Model-III		Model-IV
	OLS	OLS	OLS	Spatial	OLS
Constant	64.823***	64.823***	68.488***	70.248***	65.892***
% farm receiving government payment	-0.073+				
% farm receiving conservation/wetland reserve payment		-0.020			
% farm receiving other federal program payment			-0.078	-0.094+	
% farm receiving commodity credit corporation loans					-0.075
% farm with size 1-49 acres	-0.128	-0.088	-0.101	-0.108	-0.081
% farm with size >500 acres	-0.259***	-0.264***	-0.257***	-0.270***	-0.271***
% principal operators age <35 years	-0.292*	-0.320*	-0.289*	-0.277*	-0.312*
% principal operators age >65 years	-0.196*	-0.183+	-0.193*	-0.202*	-0.184*
Average years of principal operators on present farm	-0.404	-0.480+	-0.476+	-0.473+	-0.495+
% farm with full ownership	0.032	0.024	-0.007	-0.014	-0.001
% farm with one operator	0.035	0.012	0.007	0.027	0.009
% farm hired labor	-0.165***	-0.167***	-0.154***	-0.138***	-0.160***
%farm classified as grain and oil producers	-0.002	-0.022	-0.010	-0.016	-0.016
%farm classified as vegetables producers	-0.877+	-0.851	-0.944	-0.862+	-0.921+
%farm classified as fruit and nuts producers	-0.557	-0.229	-0.235	-0.371	-0.106
%farm classified as dairy and milk producers	-0.012	0.014	0.027	-0.001	0.014
%farm with irrigation facilities	0.003	0.006	0.009	0.002	0.010
Mean per day commuting time to work (minutes)	-0.007	-0.001	0.003	-0.041	0.012
% male unemployed	-0.066	-0.061	-0.089	-0.084	-0.071
% white population	-0.045	-0.052	-0.053	-0.051+	-0.052
% male high school completed	0.217**	0.219**	0.220**	0.193**	0.230**
% male high school not completed	-0.087	-0.106	-0.093	-0.119+	-0.098
Metro<250,000 population	3.917	4.332	4.493	4.708	4.314
Non-metro 2500+Urban adjacent to metro	0.938	1.557	1.617	2.178	1.472
Non-metro 2500+Urban non adjacent to metro	3.200	3.798	3.950	4.449	3.738
Non-metro Rural <2500 urban population	0.738	1.392	1.461	2.276	1.285
λ				0.220+	
R_Squared	0.731	0.726	0.729	0.734	0.726

+ p<0.1 *=p<0.05 **=p<0.01 ***=p<0.001

Table 9: County-Level Off-Farm Supply Response of Principal Operators in 2002, Prairie Gateway Farm Resource Region, U.S. (n=394)

Variables	Model-I		Model-II		Model-III		Model-IV	
	OLS	Spatial	OLS	Spatial	OLS	Spatial	OLS	Spatial
Constant	72.306***	62.313***	67.064***	59.633***	74.547***	63.850***	73.844***	63.885***
% farm receiving government payment	-0.029	-0.023						
% farm receiving conservation/wetland reserve payment			-0.058**	-0.047**				
% farm receiving other federal program payment					-0.001	-0.005		
% farm receiving commodity credit corporation loans							-0.196*	-0.171*
% farm with size 1-49 acres	-0.069+	-0.067*	-0.065+	-0.064+	-0.058	-0.060+	-0.068+	-0.067*
% farm with size >500 acres	-0.107***	-0.079**	-0.094***	-0.073**	-0.115***	-0.084**	-0.128***	-0.097***
% principal operators age <35 years	-0.029	-0.029	-0.007	-0.012	-0.047	-0.042	-0.019	-0.019
% principal operators age >65 years	-0.368***	-0.352***	-0.360***	-0.348***	-0.366***	-0.351***	-0.379***	-0.362***
Average years of principal operators on present farm	-0.080	-0.115	-0.025	-0.066	-0.145	-0.163	-0.107	-0.133
% farm with full ownership	0.033	0.047	0.077+	0.080*	0.025	0.040	-0.003	0.016
% farm with one operator	-0.154**	-0.138**	-0.124*	-0.117*	-0.185***	-0.161***	-0.157**	-0.139**
% farm hired labor	-0.135***	-0.146***	-0.145***	-0.152***	-0.134***	-0.145***	-0.121***	-0.133***
%farm classified as grain and oil producers	-0.032	-0.024	-0.032	-0.025	-0.036	-0.026	-0.019	-0.012
%farm classified as vegetables producers	0.447	0.407	0.445	0.411	0.415	0.386	0.418	0.385
%farm classified as fruit and nuts producers	0.156*	0.132	0.141*	0.123*	0.170**	0.142*	0.165**	0.139*
%farm classified as dairy and milk producers	0.074	-0.014	0.059	-0.014	0.066	-0.022	0.009	-0.067
%farm with irrigation facilities	-0.151***	-0.128***	-0.152***	-0.133***	-0.155***	-0.130***	-0.142***	-0.121***
Mean per day commuting time to work (minutes)	-0.152*	-0.174**	-0.157*	-0.174**	-0.131*	-0.159*	-0.150*	-0.172**
% male unemployed	0.013	0.025	-0.005	0.008	0.014	0.027	0.055	0.061
% white population	-0.016	-0.011	-0.026	-0.020	-0.019	-0.012	-0.003	0.000
% male high school completed	0.105*	0.099*	0.101*	0.097*	0.105*	0.099*	0.102*	0.097*
% male high school not completed	-0.031	-0.025	-0.035	-0.029	-0.027	-0.022	-0.016	-0.012
Metro<250,000 population	2.404*	2.246*	2.330*	2.210*	2.449*	2.267*	2.148*	2.026*
Non-metro 2500+Urban adjacent to metro	-0.012	-0.201	-0.159	-0.287	0.198	-0.056	-0.157	-0.334
Non-metro 2500+Urban non adjacent to metro	0.055	0.025	-0.075	-0.070	0.294	0.195	-0.243	-0.248
Non-metro Rural <2500 urban population	-0.891	-0.880	-0.839	-0.835	-0.702	-0.749	-1.177	-1.140
ρ		0.191**		0.162**		0.196***		0.184**
R-Squared	0.719	0.719	0.725	0.724	0.718	0.719	0.723	0.722

+ p<0.1 *=p<0.05 **=p<0.01 ***=p<0.001

Table 10: County-Level Off-Farm Supply Response of Principal Operators in 2002, Eastern Uplands Farm Resource Region, U.S. (n =410)

Variables	Model-I OLS	Model-II OLS	Model-III OLS	Model-IV OLS
Constant	71.912***	72.230***	72.543***	72.331***
% farm receiving government payment	0.047			
% farm receiving conservation/wetland reserve payment		0.079		
% farm receiving other federal program payment			0.085*	
% farm receiving commodity credit corporation loans				0.079
% farm with size 1-49 acres	0.044	0.047	0.039	0.042
% farm with size >500 acres	-0.159+	-0.148+	-0.189*	-0.151+
% principal operators age <35 years	0.324*	0.330*	0.288*	0.320*
% principal operators age >65 years	-0.356***	-0.355***	-0.358***	-0.358***
Average years of principal operators on present farm	-0.377*	-0.364+	-0.383*	-0.365+
% farm with full ownership	-0.168***	-0.171***	-0.177***	-0.167***
% farm with one operator	0.057	0.052	0.063	0.059
% farm hired labor	-0.179***	-0.171***	-0.184***	-0.170***
%farm classified as grain and oil producers	-0.183**	-0.158**	-0.171**	-0.135*
%farm classified as vegetables producers	-0.473*	-0.519**	-0.507**	-0.486*
%farm classified as fruit and nuts producers	-0.230*	-0.228*	-0.214*	-0.222*
%farm classified as dairy and milk producers	-0.412***	-0.402***	-0.427***	-0.397***
%farm with irrigation facilities	-0.096	-0.099	-0.084	-0.117
Mean per day commuting time to work (minutes)	-0.130+	-0.132+	-0.127+	-0.128+
% male unemployed	0.228+	0.210+	0.232*	0.187
% white population	-0.008	-0.009	-0.011	-0.012
% male high school completed	0.130*	0.136*	0.136*	0.131*
% male high school not completed	-0.016	-0.013	-0.014	-0.013
Metro<250,000 population	-2.021*	-2.052*	-1.988*	-1.976*
Non-metro 2500+Urban adjacent to metro	-0.304	-0.265	-0.331	-0.206
Non-metro 2500+Urban non adjacent to metro	-1.332	-1.321	-1.376	-1.329
Non-metro Rural <2500 urban population	-2.045*	-1.994*	-2.082*	-1.923*
R_Square	0.337	0.336	0.344	0.334

+ p<0.1 *=p<0.05 **=p<0.01 ***=p<0.001

Table 11: County-Level Off-Farm Supply Response of Principal Operators in 2002, Southern Seaboard Farm Resource Region, U.S. (n =477)

Variable	Model-I		Model-II		Model-III		Model-IV	
	OLS	Spatial	OLS	Spatial	OLS	Spatial	OLS	Spatial
Constant	53.105***	48.044***	52.382***	47.578***	55.957***	50.213***	56.134***	50.580***
% farm receiving government payment	-0.068**	-0.064**						
% farm receiving conservation/wetland reserve payment			-0.086**	-0.078**				
% farm receiving other federal program payment					-0.008	-0.005		
% farm receiving commodity credit corporation loans							-0.132+	-0.114
% farm with size 1-49 acres	-0.105***	-0.096***	-0.094**	-0.085**	-0.089**	-0.080**	-0.082**	-0.075**
% farm with size >500 acres	-0.101+	-0.087+	-0.10*8	-0.095+	-0.153**	-0.136**	-0.128*	-0.113*
% principal operators age <35 years	0.193*	0.194*	0.188*	0.189*	0.182*	0.184*	0.190*	0.191*
% principal operators age >65 years	-0.241***	-0.247***	-0.228***	-0.235***	-0.240***	-0.247***	-0.241***	-0.248***
Average years of principal operators on present farm	-0.236	-0.200	-0.276+	-0.239+	-0.269+	-0.229	-0.275+	-0.235
% farm with full ownership	0.061+	0.053	0.087*	0.075*	0.040	0.032	0.025	0.019
% farm with one operator	0.085*	0.074+	0.065	0.055	0.050	0.040	0.057	0.047
% farm hired labor	-0.196***	-0.188***	-0.194***	-0.186***	-0.201***	-0.191***	-0.194***	-0.186***
%farm classified as grain and oil producers	-0.076**	-0.065*	-0.091**	-0.079**	-0.100***	-0.086**	-0.100***	-0.086**
%farm classified as vegetables producers	0.162+	0.159+	0.169*	0.166*	0.178*	0.174*	0.169*	0.167*
%farm classified as fruit and nuts producers	0.144*	0.129*	0.117+	0.105	0.154*	0.136*	0.158*	0.141*
%farm classified as dairy and milk producers	-0.058	-0.070	-0.056	-0.068	-0.055	-0.069	-0.071	-0.082
%farm with irrigation facilities	-0.107*	-0.099*	-0.120**	-0.112**	-0.133**	-0.123**	-0.120**	-0.112**
Mean per day commuting time to work (minutes)	-0.133*	-0.132*	-0.135*	-0.133*	-0.135*	-0.134*	-0.130*	-0.129*
% male unemployed	0.098	0.076	0.105	0.085	0.157	0.129	0.146	0.121
% white population	0.009	0.006	0.008	0.005	0.012	0.009	0.013	0.009
% male high school completed	0.032	0.033	0.028	0.030	0.036	0.037	0.034	0.036
% male high school not completed	0.053	0.045	0.044	0.037	0.045	0.037	0.039	0.033
Metro<250,000 population	-0.486	-0.329	-0.396	-0.248	-0.424	-0.255	-0.350	-0.197
Non-metro 2500+Urban adjacent to metro	-1.848*	-1.664*	-1.698*	-1.533*	-1.868*	-1.668*	-1.761*	-1.581**
Non-metro 2500+Urban non adjacent to metro	-3.309**	-3.121**	-3.092**	-2.920**	-3.093**	-2.900**	-2.913**	-2.751+
Non-metro Rural <2500 urban population	-1.717*	-1.511+	-1.525+	-1.339+	-1.655*	-1.434+	-1.579*	-1.376*
ρ		0.138*		0.135*		0.152*		0.146*
R-squared	0.460	0.461	0.459	0.460	0.449	0.452	0.453	0.454

+ p<0.1 *=p<0.05 **=p<0.01 ***=p<0.001

Table 12: County-Level Off-Farm Supply Response of Principal Operators in 2002, Fruitful Rims Farm Resource Region, U.S. (n =279)

Variable	Model-I		Model-II		Model-III		Model-IV	
	OLS	Spatial	OLS	Spatial	OLS	Spatial	OLS	Spatial
Constant	48.811***	41.862***	48.550***	41.386***	48.792***	42.030***	49.553***	42.493***
% farm receiving government payment	0.008	0.002						
% farm receiving conservation/wetland reserve payment			-0.008	-0.014				
% farm receiving other federal program payment					0.001	-0.013		
% farm receiving commodity credit corporation loans							-0.108	-0.120
% farm with size 1-49 acres	-0.107*	-0.097*	-0.110*	-0.099*	-0.109*	-0.100*	-0.112**	-0.101*
% farm with size >500 acres	-0.045	-0.037	-0.044	-0.036	-0.045	-0.036	-0.047	-0.039
% principal operators age <35 years	0.392***	0.372***	0.397***	0.375***	0.396***	0.376****	0.402***	0.379***
% principal operators age >65 years	-0.270**	-0.254**	-0.272**	-0.256**	-0.271**	-0.257**	-0.276**	-0.259**
Average years of principal operators on present farm	0.255	0.205	0.266	0.213	0.262	0.211	0.266	0.210
% farm with full ownership	0.075	0.058	0.078	0.063	0.075	0.058	0.072	0.054
% farm with one operator	-0.114*	-0.123*	-0.111*	-0.120*	-0.112*	-0.122*	-0.114*	-0.125**
% farm hired labor	-0.230***	-0.223***	-0.231***	-0.224***	-0.231***	-0.223***	-0.232***	-0.225***
%farm classified as grain and oil producers	-0.104	-0.089	-0.094	-0.080	-0.098	-0.080	-0.067	-0.053
%farm classified as vegetables producers	0.060	0.054	0.067	0.062	0.063	0.054	0.062	0.053
%farm classified as fruit and nuts producers	0.042	0.056+	0.041	0.056+	0.041	0.055+	0.042	0.057+
%farm classified as dairy and milk producers	-0.253*	-0.244*	-0.251*	-0.243*	-0.252*	-0.242*	-0.255*	-0.248*
%farm with irrigation facilities	0.010	0.007	0.011	0.007	0.011	0.009	0.014	0.010
Mean per day commuting time to work (minutes)	-0.006	0.011	-0.009	0.009	-0.008	0.007	-0.012	0.006
% male unemployed	-0.230	-0.174	-0.225	-0.169	-0.228	-0.175	-0.238	-0.183
% white population	-0.007	-0.003	-0.007	-0.003	-0.007	-0.002	-0.007	-0.002
% male high school completed	0.210**	0.167**	0.210**	0.167**	0.210**	0.168**	0.207**	0.162*
% male high school not completed	-0.012	0.001	-0.014	-0.001	-0.013	0.002	-0.010	0.004
Metro<250,000 population	0.627	0.489	0.625	0.487	0.624	0.473	0.597	0.453
Non-metro 2500+Urban adjacent to metro	-0.786	-0.675	-0.790	-0.675	-0.790	-0.688	-0.796	-0.680
Non-metro 2500+Urban non adjacent to metro	-1.644	-1.494	-1.597	-1.467	-1.607	-1.473	-1.661	-1.540
Non-metro Rural <2500 urban population	-4.133*	-3.992*	-4.084*	-3.944*	-4.107*	-3.970*	-4.162*	-4.043*
ρ		0.224**		0.226**		0.225**		0.231**
R_Squared	0.370	0.375	0.369	0.375	0.369	0.375	0.370	0.377

+ p<0.1 *=p<0.05 **=p<0.01 ***=p<0.001

Table 13: County-Level Off-Farm Supply Response of Principal Operators in 2002, Basin and Range Farm Resource Region, U.S. (n =195)

Variables	Model-I		Model-II		Model-III		Model-IV	
	OLS	Spatial	OLS	Spatial	OLS	Spatial	OLS	Spatial
Constant	52.741***	44.341***	54.505***	46.011***	51.919***	44.017***	52.119***	43.797***
% farm receiving government payment	0.064	0.046						
% farm receiving conservation/wetland reserve payment			0.125	0.114				
% farm receiving other federal program payment					0.134+	0.109		
% farm receiving commodity credit corporation loans							-0.073	-0.013
% farm with size 1-49 acres	0.070	0.043	0.056	0.032	0.075	0.049	0.065	0.039
% farm with size >500 acres	-0.135*	-0.110+	-0.139*	-0.117+	-0.144*	-0.120*	-0.117+	-0.097+
% principal operators age <35 years	0.540*	0.542**	0.541*	0.538**	0.534*	0.535**	0.571*	0.561**
% principal operators age >65 years	-0.024	-0.018	-0.035	-0.023	-0.014	-0.007	-0.058	-0.040
Average years of principal operators on present farm	-0.766*	-0.900**	-0.733*	-0.881**	-0.788*	-0.918**	-0.708*	-0.862**
% farm with full ownership	-0.082	-0.076	-0.093	-0.084	-0.072	-0.067	-0.090	-0.081
% farm with one operator	0.068	0.068	0.077	0.075	0.061	0.061	0.079	0.076
% farm hired labor	-0.045	-0.069	-0.043	-0.065	-0.045	-0.067	-0.053	-0.075
%farm classified as grain and oil producers	-0.102	-0.077	-0.152	-0.133	-0.117	-0.094	-0.026	-0.033
%farm classified as vegetables producers	-0.189	-0.114	-0.144	-0.076	-0.228	-0.150	-0.171	-0.103
%farm classified as fruit and nuts producers	-0.270**	-0.226**	-0.273**	-0.229**	-0.268**	-0.226**	-0.273**	-0.228**
%farm classified as dairy and milk producers	-0.194	-0.172	-0.184	-0.169	-0.211	-0.189	-0.159	-0.149
%farm with irrigation facilities	0.047	0.029	0.055+	0.036	0.044	0.027	0.048	0.029
Mean per day commuting time to work (minutes)	0.153	0.134	0.131	0.116	0.175	0.153	0.139	0.123
% male unemployed	-0.040	-0.030	-0.055	-0.038	-0.011	-0.004	-0.064	-0.047
% white population	-0.008	-0.005	-0.016	-0.015	-0.004	-0.003	0.004	0.003
% male high school completed	-0.057	-0.065	-0.024	-0.037	-0.091	-0.094	-0.043	-0.057
% male high school not completed	-0.074	-0.055	-0.094	-0.078	-0.071	-0.056	-0.050	-0.037
Metro<250,000 population	1.212	1.725	1.134	1.660	1.097	1.615	1.167	1.715
Non-metro 2500+Urban adjacent to metro	1.467	1.562	1.390	1.497	1.544	1.624	1.433	1.543
Non-metro 2500+Urban non adjacent to metro	-0.577	-0.222	-0.752	-0.323	-0.497	-0.144	-0.899	-0.430
Non-metro Rural <2500 urban population	-1.793	-1.690	-2.037	-1.888	-1.824	-1.709	-1.904	-1.767
ρ		0.333***		0.334***		0.321***		0.340***
R_Squared	0.379	0.391	0.382	0.394	0.386	0.400	0.375	0.384

+ p<0.1 *=p<0.05 **=p<0.01 ***=p<0.001

Table 14: County-Level Off-Farm Supply Response of Principal Operators in 2002, Mississippi Portal Farm Resource Region, U.S. (n =165)

Variables	Model-I OLS	Model-II OLS	Model-III OLS	Model-IV OLS
Constant	48.465***	48.050***	54.295***	54.396***
% farm receiving government payment	-0.138***			
% farm receiving conservation/wetland reserve payment		-0.169***		
% farm receiving other federal program payment			-0.138**	
% farm receiving commodity credit corporation loans				-0.024
% farm with size 1-49 acres	-0.144***	-0.161***	-0.132**	-0.130**
% farm with size >500 acres	-0.092	-0.126+	-0.132+	-0.158*
% principal operators age <35 years	-0.299*	-0.372**	-0.321*	-0.382**
% principal operators age >65 years	-0.324***	-0.311***	-0.323***	-0.323***
Average years of principal operators on present farm	-0.094	-0.164	-0.085	-0.097
% farm with full ownership	0.156**	0.179***	0.092+	0.096+
% farm with one operator	0.122	0.130	0.051	0.043
% farm hired labor	-0.158**	-0.150**	-0.153**	-0.158**
%farm classified as grain and oil producers	0.030	-0.031	0.021	-0.036
%farm classified as vegetables producers	-0.270+	-0.231	-0.335*	-0.316*
%farm classified as fruit and nuts producers	-0.154+	-0.149+	-0.140	-0.127
%farm classified as dairy and milk producers	-0.258	-0.347*	-0.271	-0.353+
%farm with irrigation facilities	-0.089**	-0.089*	-0.072*	-0.068+
Mean per day commuting time to work (minutes)	-0.241*	-0.238*	-0.214*	-0.205*
% male unemployed	-0.109	-0.105	-0.075	-0.052
% white population	0.033	0.037	0.040	0.044
% male high school completed	0.135+	0.109	0.165*	0.143+
% male high school not completed	0.090	0.085	0.077	0.059
Metro<250,000 population	-2.210+	-2.442+	-2.476+	-2.357+
Non-metro 2500+Urban adjacent to metro	-3.047**	-2.952**	-3.307**	-3.458**
Non-metro 2500+Urban non adjacent to metro	-2.206+	-1.912	-2.828*	-2.896*
Non-metro Rural <2500 urban population	-3.348*	-3.433*	-3.847**	-4.212**
R_Squared	0.792	0.788	0.777	0.766

+ p<0.1 *=p<0.05 **=p<0.01 ***=p<0.001