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Household Time Allocation and Endogenous Farm Structure: Implications for the Design of Agricultural Policies

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Abstract

We evaluate relationships among time allocation decisions for farm operators and their spouses and endogenous farm structure. We consider two aspects of farm structure–farm scale, represented by acreage operated and harvested, and farm scope, which is represented by an index of diversification. We are particularly interested in the role of policy expectations as a factor influencing labor decisions and farm structure. Our results indicate that farm structure and household time allocations are significantly related to one another. Operators on larger and more diversified farms tend to work less off the farm. Size may be endogenous to off-farm work decisions in that farms tend to be smaller when farmers pursue off-farm work opportunities, though the converse is true for the operators' spouses. Direct (decoupled) payments tend to be associated with less off-farm work by spouses, a smaller scale of production, and more diversification. This result has relevance to the ongoing debate over the production neutrality of decoupled payments. Coupled payments tend to be associated with more off-farm work by spouses and larger farms, thus suggesting a positive effect on farm labor.

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Household Time Allocation and Endogenous Farm Structure: Implications for the Design of Agricultural Policies

The design of mechanisms intended to transfer benefits from government treasuries to agricultural households has long been an important topic of debate. This debate has centered on the extent to which transfers intended to benefit select producers of a particular commodity have effects on other producers, especially those producers in other countries. Much of this debate has been framed within the context of the extent to which program benefits are "decoupled" from production decisions and market prices. Much recent policy has been designed and implemented on the basis of this notion of "decoupling." In particular, payments that do not have direct, contemporaneous production requirements (such as the U.S. fixed, direct payments) have been assumed to be fully decoupled and production-neutral. Under current WTO guidelines, such benefits have been designated as "Green-Box" payments and have been exempted from negotiated reductions in agricultural support.

The production-neutrality of such Green-Box policies has recently been challenged in trade negotiations and in academic research. For example, Chau and de Gorter (2000) found that direct payments may bring about significant production effects by easing credit constraints and changing producers' attitudes toward risk. Goodwin and Mishra (2006) discussed these mechanisms in detail and found little evidence that would support arguments in favor of large production effects from decoupled payments. The argument is far from settled and the issue has continued to arise in international trade negotiations (see, for example, the recent U.S.-Brazil cotton dispute).

Although a number of arguments (and an equally impressive volume of empirical results) have addressed this issue, the existing empirical literature has taken a rather narrow approach to the problem. In particular, existing theoretical and empirical research addressing the effects of farm policy has largely focused on the *farm business* as the relevant unit of analysis rather than the *farm household*. Indeed, this myopic view has characterized many dimensions of the farm policy discussion. The decision-making framework may become much more complex and thus the implications more clouded when one broadens the consideration of policy impacts to include those impacts on the nonagricultural segments of the farm sector. It is, of course, the farm household that is the relevant decision-making unit and thus considerations of the effects of farm policies or other exogenous shocks must consider the household as a whole rather than focusing only on the farm business. An important exception to this general ignorance of the relationship between farm policy and time-allocation is in the work of Ooms and Hall (2005), who considered the impact of decoupled payments on the labor supply of Dutch dairy farmers. Their results indicated that decoupled payments had a negative effect on labor supply but that their economic significance was limited.

It is widely recognized that a substantial share (the majority for most farms) of farm household income comes from off-farm sources. Off-farm labor earnings are an important component of the typical farm household's total income. To the extent that wealth and income changes affect an individual's labor decisions, one avenue by which direct income transfers, a common component of "decoupled" farm programs, may influence agricultural production is through their effects on the allocation of time among on-farm labor, off-farm labor, and leisure. An understanding of farm household labor allocation decisions is central to any consideration of the effects of farm policies on the overall structure of the agricultural sector. Further, many of the current arguments and debates about the effects of farm policies on the competitive structure of agriculture are incomplete in that they ignore the relevance of time allocation and the off-farm labor market to farm household production decisions.

The importance of off-farm labor markets and time allocation decisions of farm operators and their spouses has also been given substantial attention in applied research. Following the typical approach to a consideration of labor supply at a household level, applied research has established that farm household members allocate their work effort in accordance with their returns to alternative activities—including farming and participation in the non-farm labor market. In addition, exogenous shocks to wealth, such as those implied by direct payments, may imply important time allocation effects, as individuals adjust their work effort and their consumption of leisure.

The objective of this paper is to undertake a broader consideration of the implications of farm policy for the structure and competitive standing of U.S. agriculture. To this end, we endogenize farm-level labor allocations and examine the effects of exogenous policy variables on off-farm labor supplies. We also consider the effects of certain agricultural policy variables on farm structure. In particular, we examine two important aspects of farm structure—the scale (or utilization) of farm resources and the scope of the farm enterprise. We hypothesize that policy shocks may impact time allocation decisions by altering the relative returns between farm and non-farm labor activities. In addition, important wealth and income shocks may be implied by policy benefits, which are often substantial for farm operators in developed countries. The structure of a farm may also be affected by policies—which may directly impact the returns to specific agricultural enterprises as well as affecting the allocation of time to farm and non-farm activities. For example, the direct income transfers which are implied by decoupled payments may lead to greater consumption of leisure, which would imply a diminished effort in both off-farm and on-farm work activities. In the latter case, important structural changes involving the scale and scope of a farm's structure may result. Of course, changes in the scale and scope of farm structure typically imply long-run adjustments. Thus, we focus on long-run *expected* values of farm policy benefits.

The outline of our paper is as follows. In the next section, we provide an overview of the current U.S. policy environment. A number of issues are germane to this discussion in that the U.S. Congress is currently debating the next farm bill. We also discuss the broader implications of domestic U.S. farm policy for international policy discussions. We are particularly concerned with U.S. obligations under the Uruguay Round of the WTO and the ongoing debate of liberalization of domestic protection measures. We then provide a brief summary of issues relevant to farm time allocation decisions and, in particular, participation in the off-farm labor market by U.S. farmers and their spouses. We next undertake an empirical analysis of the interrelationships between exogenous policy expectations, farm household time allocation decisions, and structural considerations involving U.S. farms. Our empirical analysis makes use of farm-level data collected from over 12,000 U.S. farms in 2003 and 2004. The final section of our paper provides a summary of the results and offers concluding remarks.

The U.S. Farm Policy Environment

The period following the 1996 U.S. Farm Bill (the Food and Agricultural Improvement and Reform—or FAIR Act) has been a study in contrasts and contradictions. Many observers of farm policy believed that the FAIR Act represented a significant departure from the previous sixty years of farm policies. In particular, the declared intent of the legislation was to evoke a "transition" to the market, with a policy environment characterized by a diminishing role for the government (and treasury) in supporting U.S. agriculture. This intent was backed up by Congressional rhetoric that emphasized the reforms to be brought about by the new farm legislation.

Several specific provisions of the 1996 FAIR Act brought about significant changes in U.S. agricultural policy. Perhaps the most significant change involved the elimination of production constraints (and acreage base requirements) and the concomitant movement toward direct support that was not tied (or "coupled") to production decisions. In theory, such decoupled support was believed to be less distorting to markets in that there was no production requirement to be eligible for the payments. The intended "transition to the market" was reflected in a series of direct payments, which were based upon historical production and were not tied to market conditions or current production. In a manner that reflected their supposed role in policy reform, these payments were referred to as "Agricultural Market Transition Act" or AMTA payments. A schedule of payments was established for each program crop and the payment rates were set to decline each year through the end of the legislation in 2002.

A full appreciation of the policy environment of the time as well as that which followed requires consideration of the general state of agricultural markets and the U.S. agricultural economy as the FAIR Act was being deliberated and implemented. Figure 1 illustrates the development of real ($2005 terms) net farm income less total direct government payments—a measure of net returns from the market (with an adjustment having been made for government payment receipts).[1] Note that, in the early 1990s, despite a degree of year-to-year volatility, net income remained strong and robust. Figure 1 also presents total direct government payments as a proportion of net farm income from the market. The diagram also illustrates the fact that government payments, as a percentage of total farm income, remained relatively low in the years leading up to the 1996 FAIR Act.

Of course, reforms are easy to contemplate and painless to implement when markets are strong.[2] Export markets for U.S. agricultural products were strong throughout the early 1990s and exports actually climbed in 1996. The overall state of the agricultural economy in 1995-96 was strong and thus debate favored policy reforms and a transition away from strong government involvement in markets.

Several events in the latter half of the decade brought about some rather significant changes in the views of U.S. agricultural policymakers. Demand for U.S. agricultural exports fell significantly over the latter part of the decade, due in part to the Asian financial crisis and relatively strong growing conditions elsewhere in the world. The U.S. agricultural trade balance fell from $26.8 billion in 1996 to only $10.7 billion in 1999.[3] This balance has fallen further, to only $7.4 billion in 2004. This general collapse of agricultural markets and overall malaise in the U.S. agricultural economy made the reform rhetoric of just a few years previous much less palatable to U.S. policymakers. New rhetoric by policymakers referred to the FAIR Act's "freedom to farm" provisions as instead implying a "freedom to fail."[4] Regardless of legislators' actual intent, Congress quickly retreated from the market reforms

[1] The statistics presented in Figure 1 were taken from the *Economic Report of the President, 2006*.

[2] The Uruguay Round Agreement of the WTO serves to illustrate this point. Due to a careful (and deliberate) choice of a base period characterized by low prices and high support, the actual reforms needed to satisfy the terms of the Agreement were modest at most.

[3] Unpublished data taken from USDA sources.

[4] The elimination of base acreage requirements for coupled payment eligibility led many to refer to the 1996 legislation as the "Freedom to Farm" Act. For examples of Congressional rhetoric critical of the FAIR Act, see floor statements by Representative Mike Ross, who stated that "the Freedom to Farm law . . . should've been called 'Freedom to Fail' (April 17, 2002) and Senator Paul Wellstone, who argued that ". . . thanks to the Freedom to Farm, or as I call it the Freedom to Fail Act, tens of thousands of farm families are in jeopardy of losing their livelihoods and life savings (March 28, 2000).

implied by the 1996 legislation and instituted a number of ad-hoc measures intended to direct funds to U.S. farmers. Much of this support was conveyed through "market loss assistance" payments, which were ad-hoc, direct payments made to producers as compensation for the financial losses brought about by weak markets. Figure 1 illustrates the substantial increases in government support for U.S. farmers in the latter part of the 1990s. Between 1997 and 1999, the ratio of payments to net market income rose from under 0.10 to over 0.45. Some debate ensued as to the extent to which these ad-hoc payments were decoupled. Market loss assistance payments were based upon the decoupled market transition payments and thus did not require current production in order to be eligible. However, the payments were deemed to have been triggered by low market prices and thus, under the terms of the Uruguay Round WTO Agreement, were considered to be tied to markets and thus "amber-box" support.

The extent to which the FAIR Act actually constituted a change in U.S. farm policy became especially questionable with the implementation of the 2002 Farm Bill. The 2002 Farm Bill, which was signed into law on May 13, 2002, provided generous increases in support and extended the fixed, decoupled AMTA-type payments for another six years. Not only were the payments extended under the 2002 Act, producers were also given the opportunity to update their base acreage and yields which determine the payments and, perhaps more important, to include historical soybean acreage in their base. Provisions for updating this historical base led many to question the extent to which fixed, direct payments are actually decoupled. In the end, the 2002 Farm Bill provided generous support, which was scored by the Congressional Budget Office at over $190 billion for the ten-year period which follows the Act. The 2002 Act, which currently governs U.S. farm policies, provided three primary mechanisms for support—fixed, direct (decoupled) payments; counter-cyclical payments (which are largely analogous to the ad-hoc market loss assistance payments which preceded the 2002 Act); and loan-deficiency (coupled) payments, which are paid on a per-unit basis and thus are directly tied to production.

In short, government support for U.S. farmers appears to be as strong as ever and any ambitions of a transition to the market with limited government involvement appear to have been transitory. Debate over the upcoming 2007 Farm Bill is ongoing and the flavor of the policy deliberations has been shaped by partisan politics and the recent change in Congressional leadership. A number of topics not directly relevant to the analysis presented in this paper are being debated, including the imposition of binding limits on total payments for an individual and the consistency of domestic U.S. policy with WTO obligations. The degree of reforms and extent to which the 2007 legislation will resemble the 1996 Act or the 2002 Act remains unclear. Congressional support for U.S. agriculture does appear to remain sound and the flavor of any new legislation will likely be shaped by the strength of the U.S. agricultural economy as well as overall budget considerations.

Time Allocation and Farm Structure: Conceptual Issues

An extensive literature has addressed issues pertaining to the time allocation decisions of farm households. This line of research has taken on new importance in recent years in light of an increasing focus on the economic status of the entire farm household and the ever-increasing dependence of farm households on non-farm employment opportunities. The general line of inquiry undertaken in these studies parallels that which characterizes the wide body of research evaluating the determinants of labor supply. Individuals choose to allocate their time among competing work and leisure activities according to the relative returns offered by each activity. These returns, in turn, are determined by an individual's talents and abilities. An individual's time allocation decisions will reflect these returns and will be made on the basis of an individual's preferences, wealth, risk attitudes, and other factors pertinent to utility maximization choices. Of course, when one considers choices among multiple job opportunities, more time spent in one activity usually implies less time available for others. In the case of agricultural households, more time spent working off the farm or in consuming leisure generally will imply that less time will be spent in farming.

This shift in time (and potentially other) resources away from farming may have important implications for structural aspects of any individual farm. For example, the gradual shift in population and labor out of the farm sector has corresponded to a concomitant increase in average farm sizes and greater specialization in farm enterprises.

A number of studies have considered the relationship of individual farm and operator factors to the allocation of time by farm households. Schultz (1990) noted that off-farm employment was an important mechanism by which farm households could diversify their income. Mishra and Goodwin (1997) confirmed this role and found that farmers with significant farm income risk were more likely to pursue off-farm employment opportunities. A number of studies have considered various demographic factors that are relevant to the time allocation decisions of farm operators and their spouses. Factors such as age, farm and non-farm work experience, education, and household size have been found to be significantly related to the extent of off-farm work (see, for example, Mishra and Goodwin (1997), Goodwin and Mishra (2004), Kimhi (1996), Goodwin and Holt (2002), Furtan, Van-Kooten, and Thompson (1985), Huffman and Lange (1989), Lass and Gempesaw (1992), and Sumner (1982)). In addition, a number of farm characteristics have been demonstrated to be significantly related to off-farm work decisions. Factors such as farm size, tenancy, enterprise choice, diversification, and financial leverage have all been found to be related to time allocations decisions.

The potential for farm structure and other characteristics of farming operations to be endogenous to off-farm labor decisions has received considerably less attention in the empirical literature. Goodwin and Mishra (2004) considered the possibility that farming "efficiency" could be endogenous to the off-farm labor choice. Although they acknowledged the difficulties associated with measuring farming efficiency, they found that farms with operators that tended to devote considerable time to off-farm work also tended to be "less-efficient," where efficiency was measured using a ratio of revenues to costs. Ahituv and Kimhi (2006) found that farm activity and non-farm work effort were jointly determined and that farmers that had increased the scale of their operation have tended to work less off the farm. In contrast, farms that had downsized the scale of their farm operation had tended to work more off the farm. Ahituv and Kimhi (2002) found that the capital holdings of farmers tended to be endogenous to their off-farm work decisions. McNamara and Weiss (2005) found that farm enterprise diversification and the diversification of on-farm and off-farm earnings for a sample of Austrian farmers tended to be affected by the same general household, farm, and operator characteristics. This implies that the diversification of a farm could be jointly determined with labor allocation decisions. Fernandez-Cornejo, Gempesaw, Elterich, and Stefanou (1992) investigated scope and scale economies for a sample of German dairy farms and found that the scale of land and other inputs tended to be important determinants of economies of scale and scope. Their analysis, however, stopped short of considering the relationship of scale and scope with time and labor allocation decisions.

It is not our intent to develop a detailed conceptual framework relating farm structure to time allocation decisions. However, there is value in giving a more formal consideration to the joint decision-making framework that characterizes the relationships among farm structure variables and labor supply. A fundamental point is that adjustments to the underlying structure of U.S. farms are likely to be of a long-run nature. Thus, any decisions underlying such structural adjustments should be of a life-cycle nature and rational farm operators will be forward-looking in making decisions.

We assume that agents maximize the expected value of a discounted (at a rate of δ) sum of a household-level utility function having a single consumption good q and leisure L as arguments:

$$\sum_{j=0}^{T} \delta^{t+j} U(q_{t+j}, L_{t+j}). \tag{1}$$

Income is generated by farming (by supplying F units of labor to the farm enterprise) and off-farm employment (by supplying O units of labor). Thus, if we normalize the amount of labor available to each household to 1 unit per period, the utility of a household in each period is governed by the following income constraint:

$$w_t + p_{ft}(M_t, G_t) Q_f(X_t, F_t, Z_t, V) - TC_t(X_t, F_t, Z_t, V) - P_{qt} q_t - w_t L_t + W_t, \tag{2}$$

where X_t represents variable factors of production, Z_t represents production inputs that are fixed in the short-run but variable in the long-run, V represents factors that are fixed over all time periods (e.g., factors related to location such as climate, etc.), $TC(\cdot)$ reflects total production costs, W_t represents non-labor income available for consumption in period t, and $p_{ft}(M_t, G_t)$ represents farm product prices, which may be influenced by government policies (G_t) and exogenous market factors (M_t). Wages will be influenced by a number of operator characteristics, such as education and experience. In that our empirical evaluation is limited to current farm operators and their spouses, we assume that variables representing human capital and other wage factors are predetermined and thus define a standard wage equation to relate wages for a household to exogenous operator and spouse characteristics z_t:

$$w_t = w(z_t). \tag{3}$$

Finally, equations that describe the adjustment process of those factors that are fixed in the short-run would take the general form of:

$$Z_{t+1} = Z_t + \gamma(\hat{Z}_t(V) - Z_t), \tag{4}$$

where $\hat{Z}_t$ represents the optimal long run level of those semi-fixed factors. Equation (4) could be adjusted to reflect labor or other factors required for adjustment. In the long-run, individuals choose those values of O_t, F_t, X_t, and Z_t in order to maximize the long-run sum of the expected utility of profits. We do not directly observe farm labor but instead use our measures of farm structure to represent the effects of adjustments in farm labor—changes in farm labor will be reflected in changes in the scale and scope of the farm operation.[5] Likewise, we do not directly observe the farm structure variables represented by Z_t. However, we are able to construct observable metrics representing farm structure (scale and scope), wage factors, and exogenous factors that are related to farm structure. In that we are interested in examining the interrelationships among farm structure and time allocation decisions, we define a structural empirical model that relates farm structure to off-farm labor supply and vice versa. In the end, this implies estimable equations of the following form:

$$\tilde{Z}_{it} = f(O_{it}, V_i, G_{it}, W_{it}, M_{it}) \tag{5}$$

[5]Of course, this ignores many important issues related to the substitutability of farm labor for other inputs—an important topic for future research.

where $\tilde{Z}_{it}$ is a measure of farm structure and

$$O_{it} = g(\tilde{Z}_{it}, G_{it}, z_{it}, W_{it}, M_{it}), \quad (6)$$

which relates off-farm labor supply to farm endogenous farm structure and other relevant explanatory factors.[6]

Empirical Analysis and Results

Our analysis is conducted using individual farm data collected under the Agricultural Resource Management Survey (ARMS) project by the Economic Research Service and the National Agricultural Statistics Service of the USDA. The ARMS data are collected annually by means of a survey of individual farmers. The ARMS data represent the USDA's primary source of information about U.S. agricultural production conditions, marketing practices, resource use, and economic well-being of farm households. We focus on data taken from 2003 and 2004. These two years were characterized by a common policy environment—the 2002 Farm Bill. In addition, the ARMS surveys collected detailed data regarding off-farm employment by farmers and their spouses, as well as many operator characteristics conceptually related to off-farm work. Although the ARMS data provide a rich and valuable set of detailed farm household data, the database does have an important limitation—the lack of repeated sampling on individual farms. That is, the sample is taken randomly each year and it is thus impossible to observe the same farm in more than a single year. This implies an important reliance on cross-sectional variability and prevents one from conditioning observed events on the preceding year's experience or on fixed farm effects. In addition, identification issues may be complicated by an inability to condition on variables that are clearly predetermined (i.e., observed in previous time periods).

A variety of other sources were used to collect data pertinent to farm structure and labor market conditions. County-level unemployment rates were collected from the Bureau

[6]Note that we are implicitly assuming that wealth is reflected in our scale variables in the empirical analysis. This approach is justified by the fact that farm assets, which determine scale, comprise a significant proportion of most farm households' total wealth. We do not model wealth directly because of a lack of appropriate instruments in the ARMS survey. This remains a topic of current research.

of Labor Statistics (BLS). Opportunities for off-farm employment will be reflected in this measure of local labor market conditions. We collected annual, county-level measures of total farm sales (cash receipts from marketings) and total production expenses from the Bureau of Economic Analysis (BEA) Regional Economic Information System (REIS). From these data, we calculated implied market rates of return to farming (measured as the log of the ratio of the sum of gross sales to the sum of total costs) for the period covering 1990-2002. We also calculated the standard deviation of this measure of farming returns over the 1970-2002 period and used this to represent the inherent volatility (and riskiness) of agriculture in the county.

A key focus of our analysis involves the role of government policy on farm structure and off-farm labor supplies. We collected farm program payment data for each county from unpublished Farm Service Agency (FSA) sources for the period covering 1990-2002. We grouped the payment data into three aggregated categories—coupled payments, direct (decoupled) payments, and all other payments. Coupled payments included deficiency and loan deficiency payments and marketing loan gains. Direct payments included AMTA payments, direct payments, and ad-hoc market loss assistance payments—all of which have no direct, contemporaneous production requirements for eligibility. Finally, all other farm program payments including disaster relief were grouped in a residual category. It is important to acknowledge that payments made under some programs may be difficult to classify. For example, market loss assistance and counter-cyclical payments are decoupled in that they do not have production requirements but are of a coupled nature because they are triggered by low market prices.

Our intent is to capture payment expectations—which should be the primary factor influencing producer decisions. In that realized farm program payments vary substantially from year-to-year, receipts in any single year may not be representative of the expected value of payments. We sum payment receipts in each category over the 1990-2002 period and then use farm acreage for the county reported in the 2002 *Agricultural Census* to place the payments on a per-acre basis.

We use the 1997 and 2002 *Agricultural Census* data to construct a number of county-level measures representing the aggregate structure of the agricultural sector in each county. This included shares of the total value of production for various commodity groups, the scale of agriculture (in terms of the total value of sales) in the county, and changes in the structure of agriculture in the county from 1997 to 2002. All financial values are converted to real terms by dividing by the consumer price index.

A number of important econometric issues underlie our empirical analysis. An important characteristic of the ARMS data relates to the stratified nature of the sampling used to collect the data. Two estimation approaches have been suggested for problems such as this involving stratification. The simplest involves a jacknife procedure, where the estimation data are split into a fixed number of subsamples and the estimation is repeated with each subsample omitted. An alternative approach involves repeated sampling from the estimation data in a bootstrapping scheme. Ideally, rather than random sampling from the entire estimation sample, an appropriate approach to obtaining unbiased and efficient estimation results involves random sampling from individual strata (see, for example, Deaton (1997)). In the ARMS data, however, this is not possible since the strata are not identified. The database does, however, contain a population weighting factor, representing the number of farms in the population (i.e., all U.S. farms) represented by each individual observation. This can be used in a probability-weighted sampling scheme whereby the likelihood of being selected in any given replication is proportional to the number of observations in the population represented by each individual ARMS observation. We utilize a probability-weighted bootstrapping procedure.

The specific estimation approach involves selecting N observations (where N is the size of the survey sample) from the sample data. The data are sampled with replacement according to the probability rule described above.[7] The models are estimated using the pseudo sample

[7] To be precise, if observation i represents n_i farms out of the total of M farms in the population, the likelihood that observation i is drawn on any given draw is n_i/M. It should be acknowledged that our approach may result in less efficient estimates than would be the case were sampling from individual strata possible. This could occur in cases where inferences are being made about variables used in designing the stratification scheme in that such information is being ignored by not drawing from individual strata. To the extent that this is relevant to our analysis, the t-ratios reported below represent conservative estimates.

of data. This process is repeated a large number of times and estimates of the parameters and their variances are given by the mean and variance of the replicated estimates.[8]

An important econometric issue also involves the fact that a censoring issue underlies several of the individual equations to be estimated in our analysis. In particular, our measure of farm scope—an index of diversification—is censored at zero for single-enterprise farms. In addition, off-farm labor supply is censored at zero for individuals who do not work off the farm. Procedures for estimating simultaneous equation models with censored endogenous variables have been proposed by Amemiya (1979), Nelson and Olson (1978), Lee, Maddala, and Trost (1980), Newey (1987), and Vella (1993). Nelson and Olson (1978) suggested a simple two-stage procedure where the endogenous right-hand side variables are replaced by the $X\beta$ index implied by standard maximum likelihood Tobit estimates of a first-stage regression of the censored variable on an instrument set. However, Nelson and Olson's estimator understates the true variance associated with the second-stage parameter estimates in that it ignores the uncertainty associated with estimation of the first-stage. Maddala (1983) notes that an analytical solution for the exact covariance matrices of the second stage estimates may be very complex. We instead utilize our probability-weighted bootstrapping procedures to derive covariance estimates of the second stage parameter estimates.

Our specific empirical analysis consists of a four-equation simultaneous equations system. The first two equations represent off-farm labor supply decisions for farm operators and their spouses. Note that our analysis was limited to only those farm households with both an operator and a spouse. We hypothesize that off-farm labor supply is related to education, age, farming experience, local labor market conditions (unemployment), the mean and standard deviation of returns to agricultural production, household size, farm program payments, and the size and scope of the agricultural operation.[9] Size and scope are the structural variables which we allow to be endogenous to one another and to off-farm labor supplies. We also allow the farm operator's off-farm labor supply to be endogenous to the spouse's

[8] We utilize 2,500 replications in the applications which follow.

[9] Note that the reporting of age for spouses was incomplete and thus we use the operator's age in both the operator and spouse equations.

labor decisions and vice versa. We measure the overall scope of a farming operation in terms of its diversification across alternative crop and livestock enterprises. In particular, we adopt a Herfindahl-based index of diversification, given by

$$H_i = 1 - \sum_{j=1}^{J} w_{ij}^2, \tag{7}$$

where w_{ij} is the share of the total value of output accounted for by enterprise j on farm i. For a farm of a single enterprise, H_i will be zero. However, H_i approaches one for very diversified farms. Note that this measure of scope is censored from below at zero and thus also requires estimators that recognize such censoring. We assume that farm scope for an individual farm will reflect government program payments at the county level, a measure of the overall diversification of agriculture in the county (which represents environmental and local market conditions that influence the potential and profitability of diversification on a farm), and the overall production patterns (represented by shares of production value accounted for by certain commodity categories at the county level).

As a measure of farm scale, we utilize the total acres operated on the farm. We are assuming that total land holdings will be adjusted in response to changes in the relative returns to alternative agricultural and non-agricultural enterprises. In light of the substantial prevalence of rental arrangements in U.S. agriculture, farm size is likely to be frequently adjusted in response to changes in policies and other exogenous factors.[10] It is also possible however, that total farm size is relatively fixed in the short-run and that farm owners and operators may choose simply to idle land and other resources. In addition, the ARMS survey considers land that is enrolled in conservation set-aside programs and land that is otherwise idled to still be part of a farm operation. Finally, acreage operated may not be an ideal measure of the overall scale of a farm operation for some farms—especially in the case of livestock operations, which utilize land resources in ways that differ from crop farms.

As an alternative, we also consider a second analysis that is limited only to crop farms. Farms are classified according to the value of their production as being primarily crop or

[10]The 2002 *Agricultural Economics and Land Owners Survey* determined that approximately 45% of U.S. farmland is operated by a tenant.

livestock operations. Of our sample of 12,935 farms, 6,809 were defined as crop farms. We utilized the number of crop acres *harvested* in each year as a second measure of scale. This provides a more direct representation of the short-run scale of an individual operation. In addition, whereas holdings of farm acreage may be relatively hard to adjust in the short-run, crop acreage can be easily idled in response to market conditions, policies, or non-farm alternatives. We assume that farm scale is influenced by factors pertinent to the profitability of agriculture in the county (both mean and standard deviation), the average scale of farms in the county, output per acre in the county, farm program payments, farm diversification, and off-farm labor supply by operators and their spouses.

Analysis of All Farms and Total Acreage

Table 1 presents variable definitions and summary statistics for the complete sample, which consists of 12,935 farm households consisting of a farm operator and a spouse. The sample was selected from the wider ARMS sample on the basis of the completeness of survey responses. In particular, a limiting factor for many surveys involved incomplete responses for characteristics of the spouse. The average farm in our sample consists of 464 acres and the average operator was 55 years of age, with 24 years of farming experience, and came from a household with 3 family members. Both the farm operator and the spouse worked an average of about 1,000 hours in off-farm employment activities over a year. About 54% of farm operators reported some off-farm work over the space of a year while nearly 60% of their spouses reported having worked off the farm.

Table 2 presents bootstrapped parameter estimates and summary statistics for the off-farm labor supply equations for farm operators and spouses taken from all farm types and the entire sample. In most cases, the estimates are highly significant and conform to expectations. In both the operator and spouse cases, off-farm work by one individual tends to be correlated with an increased off-farm work effort by the other individual. This is consistent with expectations in that spouses tend to share similar attitudes, opportunities, and constraints regarding off-farm employment. The degree of participation in off-farm labor markets appears to exhibit a quadratic age effect, with off-farm work rising with age to a point and then diminishing thereafter. The implied relationship between age and off-farm work is illustrated for farm operators and spouses in Figure 2. Note that participation appears to peak at about 37 years of age for operators and at 41 years of age for spouses. Also note a generally higher level of off-farm work at each age level for spouses, all other things constant, than for farm operators.

Off-farm work is positively related to education, reflecting the improved opportunities and higher wages available to individuals with more education. The education variables, which represent different categories of increasing levels of education, show that off-farm work rises with each level of education, with the highest levels of off-farm employment being realized for farm operators and spouses with graduate degrees. The effect of education appears to be substantially stronger for spouses than is the case for farm operators in that the education coefficients are substantially larger.[11] The unemployment rate in the county has a significantly negative effect on the degree of participation in off-farm labor markets by spouses. In contrast, farm operators' off-farm work efforts are not significantly affected by the county-level unemployment rate. This suggests that spouses' labor supply may be more volatile in response to the diminished work opportunities implied by higher rates of unemployment. Spouses from larger households are work less off the farm, a result that likely reflects the child care obligations that typically are more substantial in larger farm households. Household size does not appear to have a significant impact on farm operators' participation in off-farm labor markets. More farming experience, a factor that would be expected to be correlated with returns to farming, is associated with less work off the farm.

The results reveal several interesting findings in relation to the effects of agricultural market conditions on labor supply. A higher rate of return to farming appears to significantly diminish farm operators' participation in off-farm labor markets—a finding consistent with the fact that such a condition raises the relative returns to on-farm work. In contrast,

[11] Note that an adequate approximation for marginal effects at the mean values of the data in a Tobit model can be derived by scaling the parameter estimates by the proportion of noncensored values in the data—0.54 for operators and 0.60 for spouses. The similarity of these proportions suggests that direct comparisons of the coefficients across the equations will not be misleading.

spouses' off-farm work decisions do not appear to be significantly affected by the average rates of return to agricultural activities. In contrast, farmers facing a riskier agricultural environment, as reflected in the standard deviation of farm rates of return, appear to supply less labor to off-farm markets while the opposite is true for their spouses. In particular, a higher degree of farm earnings risk significantly increases the off-farm work effort of spouses. This is a different result than that which was obtained in a similar analysis by Mishra and Goodwin (1997), although their measure of risk applied directly to the farm and not to the aggregate farm economy (i.e., the county) in which the farm operated. In their case, higher farm risk was correlated with more off-farm work by the farm operator.

Perhaps of greatest interest are the effects of farm program payments on the labor allocation decisions of farm households. In the case of farm operators, off-farm labor is affected by direct payments and by the "all other payments" category. In both cases, more payments are correlated with less off-farm work. This may reflect the wealth effects that are associated with farm program benefits, especially in the case of decoupled direct payments. In the case of spouses, more coupled payments tend to lead to more off-farm work while more direct, decoupled payments tend to be associated with less off-farm employment. Again, the wealth transfers implied by direct payments may lead to a diminished work effort and the consumption of more leisure. At first glance, the positive relationship between coupled payments and the off-farm labor supply of spouses is harder to explain. However, it is important to recognize that we are conditioning off-farm labor supplies on our farm structure variables which represent size and scope. We expect that increased coupled payments will increase farm size (discussed below) and thus potentially decrease off-farm labor supplies (as more labor is directed to the farm). This additional effect on off-farm labor supplies may represent increased specialization within the household, as spouses allocate more effort off the farm.

The results also reveal interesting results for the effects of farm structure on off-farm labor efforts. In the case of the farm operator, larger and more diversified farms tend to lower the extent of participation in off-farm labor markets. This is not surprising in that the labor demands associated with farms of increased size and scope should result in an allocation of the farm operator's labor away from off-farm work. In the case of spouses' off-farm work, farm size does not have a significant influence on the work decision. In contrast, increased diversification tends to be associated with more work off the farm by spouses. This may reflect the fact that off-farm work by spouses is an additional diversification measure that may be undertaken, along with diversification of the farm enterprise, to better manage farm risk. Thus, it is not surprising to find such diversification through off-farm employment occurring on farms that are also highly diversified in terms of farm output.

Table 3 presents bootstrapped parameter estimates and summary statistics for our two farm structure measures—size (acres operated) and scope (diversification). In the case of farm size, we find reinforcement for the relationship between labor allocation and scale in the off-farm labor supply equations. More acreage tends to be operated for farms having operators that work less off the farm. In contrast, off-farm work by the spouses of farm operators tends to be associated with larger farms. Farms in counties with a considerable amount of livestock production tend to be larger, reflecting the land demands often associated with grazing. In contrast, counties specializing in producing crops that are "high-value," in terms of having a greater value of output per acre, tend to be smaller. Farms in counties with highly variable returns to agriculture tend to be larger.

Farm program payments also tend to have important impacts on farm structure. Direct payments tend to be associated with less acreage being operated. This may reflect the presence of important wealth effects, implying that less effort is directed to farm labor (and thus farm scale) as more leisure is consumed in response to greater wealth. As expected, coupled payments are correlated with larger farms. Payments tied directly to production raise farm returns and thus would be expected to lead to larger farms and more intensive production. Other types of farm program payments, largely representing disaster relief, are correlated with smaller farms. More highly diversified farms tend to be larger, possibly reflecting greater land demands associated with diversified production. A similar result was obtained by Kimhi and Rekah (2006), whose structural model estimates implied that diversification increased farm size but that larger farms were not necessarily more diversified.

Table 3 also contains parameter estimates for the farm diversification equation. Diversification does not appear to be affected by off-farm labor supplies. In both cases, the off-farm work effort of farm operators and their spouses does not appear to affect the scope of a farming enterprise. Again, larger farms appear to be more highly diversified. As expected, coupled payments tend to be associated with less diversification. In contrast, farms in counties receiving a large amount of direct and other types of farm program payments tend to be more highly diversified. Characteristics of agriculture in the farm's county, as measured by the distribution of crops within the county and by a county-level measure of diversification, tend to be significantly related to farm diversification.

In short, the results demonstrate that there are important interrelationships among farm structure, farm households' time allocation decisions, and farm payments. Direct farm payments tend to be associated with less off-farm work and less acreage being operated. This may suggest that, in contrast to arguments in favor of substantial production effects, decoupled farm program payments tend to be associated with a smaller work effort both on the farm and in off-farm markets. This may reflect a wealth effect that corresponds to an increased consumption of leisure in response to policy-driven wealth transfers. Coupled payments directly influence the returns to farming and thus are expected to be positively correlated with the size of farms and negatively correlated with off-farm labor supplies—at least for farm operators. Our results are consistent with these expectations and also suggest that payments tied to production are correlated with larger, more specialized farms.

Analysis of Crop Farms and Harvested Acreage

As we have noted above, the preceding analysis assumed that farm size was endogenous to time allocation decisions, farm scope, and a number of other important variables including farm program payments. The preceding analysis considered total farm acreage (the total of all acres operated). It is possible that total acreage holdings may not be entirely flexible due to various fixities that constrain acreage adjustment. In addition, aggregation across all farms (crops and livestock) may not give the most accurate picture of how land use may be affected by labor supply decisions and farm policies. In particular, land is used for very different purposes on crop farms than is the case for livestock operations. To consider the extent to which the utilization of farm acreage on crop farms may be affected by labor allocations, farm scope, and policies, we considered an alternative analysis based upon a subset of farms in our sample which are primarily crop-producing operations. A subsample of 6,809 crop farms was used in an alternative analysis that considered the utilization of crop acreage (measured as total harvested acres) as a measure of farm scale.

Tables 4 and 5 present bootstrapped parameter estimates and summary statistics for the sample of crop farms. In Table 4, we repeat the analysis of off-farm labor supply for farm operators and their spouses. The results are largely consistent with those obtained for the complete sample. Similar quadratic relationships between age and hours worked are revealed. More labor is devoted to the non-farm market for agents with more education. Direct farm program payments are associated once again with less work by the spouse, but have no effect on the off-farm labor supplies of farmers. Higher rates of return to agriculture result in less participation in off-farm labor markets. Results are again similar for the variability of farm earnings, with spouses facing greater variability tending to work less off the farm. However, the parameter narrowly misses being statistically significant at the 10% level. Again, spouses from large households tend to work less off the farm. In contrast to the findings for the sample of all farms, crop farm operators from larger households appear to supply more labor to non-farm markets.

Table 5 presents parameter estimates and summary statistics for indicators of farm structure. In this case, the scale of an operation is measured in terms of total crop acres harvested. Again, direct payments appear to be negatively correlated with the intensity of land usage and scale of farms. In contrast, coupled payments are naturally associated with more acreage being harvested. Acreage scale again varies inversely with the participation of farmers in non-farm labor markets but directly with the off-farm work of spouses. Crop farms that are more highly diversified tend to be larger. In contrast to the analysis of all farms, crop farms in counties with a substantial share of livestock production tend to be smaller. This is consistent with expectations in that crop farms in areas dominated by livestock production would be expected to be of a smaller scale.

Large crop farms, as reflected in their use of acreage in growing crops, tend to be more diversified. Again, this reflects the fact that multiple crop enterprises may require substantial fixed resources and thus a larger scale of operation. Crop farm scope, as represented by diversification, is not affected by farm program payments. An exception occurs for the all other payments category, which is positively associated with increased diversification. Characteristics of the agricultural economy in the county in which the farm is located tend to be strongly associated with the degree of diversification on crop farms. Again, the degree of diversification at the county level tends to be significantly correlated with diversification at the farm level.

In short, results for the subsample of crop farms tend to be similar to those obtained when all farms are considered together. Labor supply equations confirm that the allocation of labor to the non-farm market tends to respond to factors associated with work opportunities, such as education. In both cases, payments tied to production tend to decrease off-farm work by farmers. Likewise, decoupled payments tend to lower the off-farm work effort of spouses but have no effect on farmers' off-farm work decisions. Direct payments are associated with smaller farms, both in terms of overall acreage and in terms of harvested acreage on crop farms. However, direct payments do not affect the diversification of crop farms where, in the case of all farms, more direct payments tended to imply more diversification. Coupled payments tend to lead to less diversification when one considers all farms. However, when inferences are limited to crop farms, coupled payments do not appear to significantly affect diversification. This may reflect the fact that less diversification is a natural consequence of focusing on less diversified farms (i.e., only crop farms). Crop farm households are more likely to be recipients of farm program payments since such payments are based on crops or, in the case of decoupled payments, were originally established on the basis of crop production.

Policy Implications

Our analysis suggests yet another mechanism by which decoupled payments might impact agricultural production—through the effects on time allocation decisions. If leisure is a normal good, positive wealth transfers would be expected to increase the consumption of leisure and thus decrease the supply of labor hours. In a result that is consistent with this expectation, direct (decoupled) payments tend to be associated with less off-farm work by spouses. In addition, direct payments are associated with a smaller scale of production, a result that is consistent with a decrease in farm labor, and more diversification. This result has relevance to the ongoing debate over the production neutrality of decoupled payments. In particular, our results suggest an additional avenue for agricultural production effects—through changes in the work effort of farmers (at least on the farm) and spouses (both on- and off-farm). On-farm labor effects are indirectly captured through the effects on farm scale and the utilization of farm acreage. Coupled payments tend to be associated with more off-farm work by spouses and larger farms, thus suggesting a positive effect on farm labor (at least to the extent that larger farms demand more labor from an operator).

The parameter estimates presented above do not permit an overall evaluation of the effects of policy benefits on farm structure and time allocation in that they do not necessarily capture the full effect of policy shocks operating through the structural model. In particular, a policy shock can have a direct impact on an endogenous variable through the structural parameter corresponding to the policy variable but also an indirect impact through other endogenous right hand side variables. To assess these overall effects, one must consider system multipliers, which capture the overall impact of a shock in an exogenous factor as it affects each of the endogenous variables in the system. To this end, we calculated system multiplier elasticities for each of the policy variables. Table 6 presents these multiplier elasticities for the two alternative models.

Perhaps of greatest interest are the farm scale impacts from changes in direct payments. In the model of all farm types, a one-percent increase in direct payments is associated with a 0.72 percent decrease in farm scale. In the case of crop farms, the direct payment elasticity is -0.39, suggesting that a one-percent increase in direct payments would decrease harvested acres by 0.39 percent. Again, these results are consistent with scale effects which operate through a reallocation of labor effort toward increased consumption of leisure in response to wealth increases. The system multipliers again suggest that wealth transfers through direct payments lower spouses' off-farm labor supply. The elasticities for spouses off-farm labor supply range from -0.08 to -0.14, suggesting inelastic responses of labor supply to direct payment shocks. The farm scope elasticity for direct payments is positive and statistically significant in the model of all farm types but is not significant for crop farms. This again suggests that direct payment shocks may increase diversification.

In the case of coupled payments, the farm scale elasticities are statistically significant and range from 0.41 to 0.48, suggesting that increases in payments tied to production would tend to increase the scale of farming. This is consistent with expectations that benefits that are tied directly to production tend to increase output. It is again the case that coupled payments appear to be tied to increased off-farm work by spouses but are not associated with off-farm work efforts of farm operators.

Concluding Remarks

Our analysis has considered relationships among time allocation for farm operators and their spouses and endogenous farm structure. We considered two aspects of farm structure—farm scale and farm scope. In the case of scale, we consider two alternative measures. The first considers total acreage under operation for all farm types while the second focuses on harvested acreage for crop farms. Several important conclusions emerge from our analysis.

First, it is clear that farm structure and household time allocations are significantly related to one another. In general, operators on larger and more diversified farms tend to work less off the farm. Size may be endogenous to off-farm work decisions in that farms tend to also be smaller when farmers pursue off-farm work opportunities. The converse is true for the operators' spouses. Farms with spouses that spend considerable effort working off the farm tend to actually be of a larger scale.

Perhaps of greatest significance are our results linking policy expectations (measured through long-run averages of payments at the county level) with farm structure and time allocation decisions. Direct (decoupled) payments tend to be associated with less off-farm work by spouses, a smaller scale of production, and more diversification, suggesting yet another avenue for agricultural production effects from decoupled payments—through changes in the work effort of farm operators and their spouses. Coupled payments are associated with a greater off-farm work effort by spouses. As one would expect, coupled payments are also positively correlated with farm size and total crop acreage. Increases in policy benefits that are directly tied to production would be expected to increase farm acreage and total output.

The results of this analysis add to the ongoing debate over the effects of decoupled farm program payments on agricultural production. In contrast to most arguments, our results suggest that decoupled payments may actually decrease farm output once the relationships between policy benefits and time allocation decisions are recognized. Wealth transfers may increase the consumption of leisure and thus lower on-farm and off-farm work efforts. The responses of work effort to decoupled payments are quite inelastic, suggesting that most policy changes would have small impacts on production. The results reinforce the importance of considering the farm household as a whole when evaluating policy changes.

Table 1. Variable Definitions and Summary Statistics[a]

Variable	Definition	Mean	Standard Deviation
Household Size	Number of household members	2.9983	16.6278
Hours Operator	Annual total of hours of off-farm work (hundreds)	10.7343	126.1386
Hours Spouse	Annual total of hours of off-farm work (hundreds)	10.9177	112.8940
Acres Operated (thousands)	Total number of farm acres operated (in thousands)	0.4636	20.9829
Acres Harvested	Number of acres harvested on subsample of crop farms	313.9654	6476.0400
Farm Scope	1 - Herfindahl index of farm diversificaiton, defined by values of output	0.1515	2.4526
Operator Farming Experience	Years of farming experience of operator	23.9743	169.6206
Spouse Farming Experience	Years of farming experience of spouse	6.4457	137.6302
Operator Age	Age of operator	55.3399	141.8775
Operator Education_2	High school education or equivalent	0.4239	5.4248
Operator Education_3	Some college	0.2470	4.7339
Operator Education_4	College degree	0.1457	3.8731
Operator Education_5	Graduate degree	0.0575	2.5547
Spouse Education_2	High school education or equivalent	0.5153	5.4862
Spouse Education_3	Some college	0.2150	4.5100
Spouse Education_4	College degree	0.1494	3.9135
Spouse Education_5	Graduate degree	0.0546	2.4950
Mean Market Returns	Average agricultural rate of return 1990-2002, given by ln(revenues/costs)	−0.0029	1.8641
Std. Deviation Market Returns	Standard deviation of agricultural rate of return, 1970-2002	0.1601	0.6737
Total County Output Value 2002	Total value of agricultural output in the county, 2002 ($million)	0.0932	2.3036
County Average Output per Farm	Average value ($) of output per farm acre, 2002	8.1692	111.7016
County Share of Grains	County-level share of market value of agricultural sales: grains and oilseeds	0.1749	2.4446

[a]Number of observations is 12,935. Summary statistics weighted by population sampling weights.

Table 1. (continued)[a]

Variable	Definition	Mean	Standard Deviation
County Share of Tobacco	County-level share of market value of agricultural sales: tobacco	0.0256	0.9320
County Share of Cotton	County-level share of market value of agricultural sales: cotton and cottonseed	0.0173	0.7834
County Share of Vegetables	County-level share of market value of agricultural sales: vegetables	0.0297	0.7730
County Share of Fruit	County-level share of market value of agricultural sales: fruits	0.0235	0.9450
County Share of Nursery Products	County-level share of market value of agricultural sales: nursery products	0.0661	1.4291
County Share of Poultry	County-level share of market value of agricultural sales: poultry and eggs	0.1074	2.5768
County Share of Cattle	County-level share of market value of agricultural sales: cattle	0.2552	2.5900
County Share of Dairy	County-level share of market value of agricultural sales: dairy products	0.1075	1.8285
County Share of Hogs	County-level share of market value of agricultural sales: hogs	0.0374	0.8995
County Share of Livestock	County-level share of market value of agricultural sales: all livestock	0.5844	2.8990
County Diversification	1 - County-level Herfindahl index of diversification of agricultural sales	0.5757	1.9298
Change in Total County Output	Change in total agricultural county output, 1997-2002	−0.1424	2.4432
Change in Output per Farm	Change in agricultural output per farm	−0.1052	2.4918
Unemployment Rate	County-level unemployment rate	5.8327	18.8754
County Average Output per Acre	County-level value of output per acre in 2002	0.3281	4.6449
Coupled Payments	County average ($) per farm acre for payments tied to production	59.2351	847.1372
Direct Payments	County average ($) per farm acre for payments not tied to production	64.1064	744.7397
All Other Payments	County average ($) per farm acre for all other government payments	48.2320	423.1720

[a]Number of observations is 12,935. Summary statistics weighted by population sampling weights.

Table 2. Off-Farm Labor Supply Equation Estimates: All Farm Types

Variable	Parameter Estimate	Standard Error	t Ratio[a]
Farm Operator			
Intercept	−8.3417	6.0744	−1.37
Spouse Hours	0.2620	0.0701	3.74*
Age	1.0969	0.2505	4.38*
Age^2	−0.0150	0.0026	−5.80*
$Education_2$	4.1480	0.8329	4.98*
$Education_3$	4.2171	0.8540	4.94*
$Education_4$	4.9393	0.9158	5.39*
$Education_5$	7.9213	1.0682	7.42*
Acres Operated	−2.6912	0.6664	−4.04*
Farming Experience	−0.0575	0.0246	−2.34*
Farm Scope	−3.1697	1.7406	−1.82*
Unemployment Rate	0.0862	0.1254	0.69
Mean Market Returns	−5.8173	1.2782	−4.55*
Std. Deviation Market Returns	−12.5164	3.3773	−3.71*
Direct Payments	−0.0192	0.0113	−1.69*
Coupled Payments	0.0094	0.0091	1.04
All Other Payments	−0.0162	0.0045	−3.58*
Household Size	−0.1920	0.1918	−1.00
σ	16.5493	0.1466	112.92*
Spouse			
Intercept	−16.1714	4.1406	−3.91*
Operator Hours	0.2333	0.0494	4.72*
Age	1.2752	0.1624	7.85*
Age^2	−0.0156	0.0017	−9.10*
$Education_2$	5.8758	0.9446	6.22*
$Education_3$	9.8179	0.9965	9.85*
$Education_4$	9.5973	0.9929	9.67*
$Education_5$	13.1489	1.0112	13.00*
Acres Operated	0.3592	0.3848	0.93
Farming Experience	−0.0276	0.0124	−2.22*
Farm Scope	2.0863	0.9824	2.12*
Unemployment Rate	−0.6019	0.0873	−6.90*
Mean Market Returns	0.8024	1.0131	0.79
Std. Deviation Market Returns	12.8587	2.6940	4.77*
Direct Payments	−0.0198	0.0087	−2.29*
Coupled Payments	0.0166	0.0071	2.35*
All Other Payments	0.0023	0.0038	0.60
Household Size	−1.4056	0.1680	−8.36*
σ	13.3083	0.1186	112.26*

[a]An "*" indicates statistical significance at the $\alpha = .10$ or smaller level.

Table 3. Farm Structure Equation Estimates: All Farm Types

Variable	Parameter Estimate	Standard Error	t Ratio[a]
.... Farm Size (Acres Operated)			
Intercept	0.1082	0.1028	1.05
Mean Market Returns	−0.1702	0.1272	−1.34
Std. Deviation Market Returns	1.9369	0.4367	4.44*
Farm Scope	0.3831	0.0898	4.27*
Direct Payments	−0.0053	0.0008	−7.01*
Coupled Payments	0.0029	0.0005	5.41*
All Other Payments	−0.0007	0.0004	−1.83*
Operator Hours	−0.0177	0.0043	−4.09*
Spouse Hours	0.0212	0.0050	4.21*
County Average Output per Farm	0.0320	0.0045	7.13*
Change in Output per Farm	−0.0778	0.1162	−0.67
Total County Output Value 2002	−0.2135	0.0945	−2.26*
County Average Output per Acre	−0.4960	0.0533	−9.30*
County Share of Livestock	0.2354	0.0899	2.62*
.... Farm Scope (Index of Diversification)			
Intercept	−0.4776	0.0409	−11.68*
Acres Operated	0.2154	0.0361	5.96*
Coupled Payments	−0.0009	0.0003	−3.17*
Direct Payments	0.0022	0.0003	6.83*
All Other Payments	0.0006	0.0001	4.02*
Operator Hours	0.0009	0.0018	0.49
Spouse Hours	−0.0002	0.0021	−0.11
County Diversification	0.3369	0.0551	6.12*
Change in Total County Output	−0.0089	0.0373	−0.24
County Share of Grains	0.2352	0.0425	5.54*
County Share of Tobacco	0.2886	0.0642	4.50*
County Share of Cotton	−1.0417	0.1308	−7.96*
County Share of Vegetables	0.0018	0.0983	0.02
County Share of Fruit	−0.5832	0.0833	−7.00*
County Share of Nursery Products	−0.1639	0.0587	−2.79*
County Share of Poultry	−0.0831	0.0360	−2.31*
County Share of Cattle	−0.3119	0.0561	−5.56*
County Share of Dairy	0.2022	0.0413	4.89*
County Share of Hogs	0.4077	0.0658	6.19*
σ	0.4254	0.0037	115.54*

[a]An "*" indicates statistical significance at the $\alpha = .10$ or smaller level.

Table 4. Off-Farm Labor Supply Equation Estimates: Crop Farms

Variable	Parameter Estimate	Standard Error	t Ratio[a]
	Farm Operator		
Intercept	−7.4167	9.3630	−0.79
Spouse Hours	0.4891	0.1144	4.27*
Age	0.7720	0.3678	2.10*
Age^2	−0.0099	0.0036	−2.74*
$Education_2$	3.0234	1.5780	1.92*
$Education_3$	2.7837	1.7277	1.61
$Education_4$	5.5871	1.6779	3.33*
$Education_5$	6.2541	1.9390	3.23*
Acres Operated	−0.0116	0.0020	−5.75*
Farming Experience	−0.1538	0.0422	−3.65*
Farm Scope	7.9953	2.9135	2.74*
Unemployment Rate	−0.1971	0.1846	−1.07
Mean Market Returns	−3.7135	2.1894	−1.70*
Std. Deviation Market Returns	−6.9570	4.4370	−1.57
Direct Payments	−0.0173	0.0150	−1.16
Coupled Payments	0.0052	0.0126	0.41
All Other Payments	−0.0214	0.0064	−3.32*
Household Size	0.6378	0.2621	2.43*
σ	17.4018	0.2089	83.29*
	Spouse		
Intercept	−13.1465	5.5295	−2.38*
Operator Hours	0.3227	0.0496	6.50*
Age	0.9715	0.1916	5.07*
Age^2	−0.0114	0.0019	−5.96*
$Education_2$	2.9178	1.2609	2.31*
$Education_3$	6.6245	1.3429	4.93*
$Education_4$	7.6161	1.3879	5.49*
$Education_5$	9.6904	1.3701	7.07*
Acres Operated	0.0015	0.0013	1.16
Farming Experience	−0.0665	0.0153	−4.33*
Farm Scope	5.0007	1.3623	3.67*
Unemployment Rate	−0.1005	0.1207	−0.83
Mean Market Returns	−3.8643	1.7029	−2.27*
Std. Deviation Market Returns	4.3596	3.4501	1.26
Direct Payments	−0.0175	0.0106	−1.66*
Coupled Payments	0.0127	0.0088	1.43
All Other Payments	0.0046	0.0045	1.02
Household Size	−0.8524	0.2113	−4.03*
σ	12.7531	0.1419	89.89*

[a] An "*" indicates statistical significance at the $\alpha = .10$ or smaller level.

Table 5. Farm Structure Equation Estimates: Crop Farms

Variable	Parameter Estimate	Standard Error	t Ratio[a]
.... Farm Size (Crop Acres Harvested)			
Intercept	115.0568	41.3598	2.78*
Mean Market Returns	169.8800	56.1081	3.03*
Std. Deviation Market Returns	664.6729	181.1238	3.67*
Farm Scope	501.3853	43.8944	11.42*
Direct Payments	−0.8697	0.4889	−1.78*
Coupled Payments	0.9171	0.3908	2.35*
All Other Payments	0.3542	0.2117	1.67*
Operator Hours	−6.3060	2.2341	−2.82*
Spouse Hours	12.3088	2.7317	4.51*
County Average Output per Farm	10.6940	1.5646	6.83*
Change in Output per Farm	70.4139	43.4594	1.62
Total County Output Value 2002	−52.9085	42.3100	−1.25
County Average Output per Acre	−123.4447	23.4613	−5.26*
County Share of Livestock	−216.0609	39.3376	−5.49*
.... Farm Scope (Index of Diversification)			
Intercept	−0.2816	0.0485	−5.81*
Acres Operated	0.0006	0.0001	7.59*
Coupled Payments	0.0002	0.0003	0.69
Direct Payments	0.0002	0.0003	0.72
All Other Payments	0.0004	0.0002	2.35*
Operator Hours	0.0018	0.0022	0.80
Spouse Hours	−0.0019	0.0030	−0.65
County Diversification	0.2340	0.0495	4.72*
Change in Total County Output	−0.0989	0.0308	−3.21*
County Share of Grains	0.0573	0.0598	0.96
County Share of Tobacco	0.2297	0.0653	3.52*
County Share of Cotton	−0.9797	0.1252	−7.82*
County Share of Vegetables	0.0983	0.0988	0.99
County Share of Fruit	−0.7146	0.0934	−7.65*
County Share of Nursery Products	−0.1631	0.0635	−2.57*
County Share of Poultry	−0.0518	0.0528	−0.98
County Share of Cattle	−0.0437	0.0472	−0.92
County Share of Dairy	0.1362	0.0540	2.52*
County Share of Hogs	0.5385	0.0720	7.48*
σ	0.3611	0.0041	87.23*

[a]An "*" indicates statistical significance at the $\alpha = .10$ or smaller level.

Table 6. System Multiplier Elasticities for Policy Variables[a]

Dependent Variable	Direct Payments	Coupled Payments	Other Payments
.... All Farm Types			
Operator Off-Farm Work Hours	−0.0484	0.0200	−0.0438
	(0.0354)	(0.0274)	(0.0115)*
Spouse Off-Farm Work Hours	−0.0815	0.0624	−0.0021
	(0.0304)*	(0.0235)*	(0.0101)
Farm Scale	−0.7225	0.4050	−0.0183
	(0.0978)*	(0.0659)*	(0.0379)
Farm Scope	0.1778	−0.0278	0.0686
	(0.0565)*	(0.0443)	(0.0182)*
.... Crop Farms			
Operator Off-Farm Work Hours	−0.0911	0.0244	−0.0672
	(0.0683)	(0.0540)	(0.0176)*
Spouse Off-Farm Work Hours	−0.1439	0.1115	0.0086
	(0.0529)*	(0.0418)*	(0.0132)
Farm Scale	−0.3857	0.4798	0.1699
	(0.1522)*	(0.1204)*	(0.0367)*
Farm Scope	−0.1014	0.2212	0.1078
	(0.0678)	(0.0589)*	(0.0188)*

[a]Numbers in parentheses are standard errors. An "*" indicates statistical significance at the $\alpha = .10$ or smaller level. Elasticities are evaluated at the sample means calculated for all observations, including zeros for the censored dependent variables. For censored dependent variables (hours worked and farm scope), elasticities are given by $F(X\beta)\frac{\partial Y}{\partial X}\frac{X}{Y}$, where $F(X\beta)$ is the probability that the dependent variable is non-censored, which is represented using the proportion of non-censored observations.

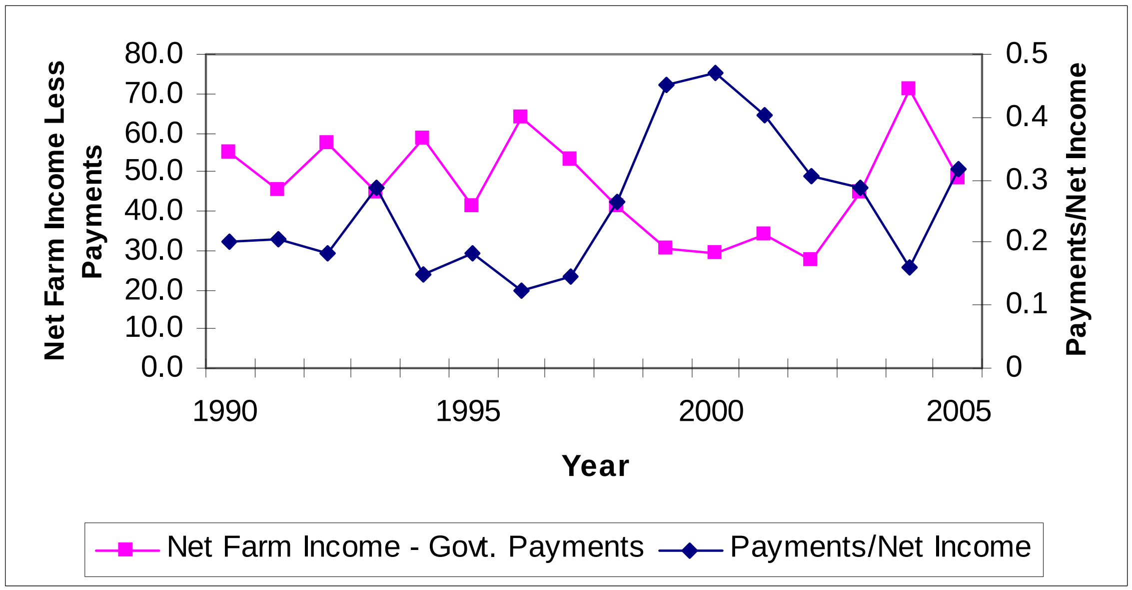

Figure 1: Net Farm Income Less Government Payments and Ratio of Payments to Non-Payment Net Farm Income

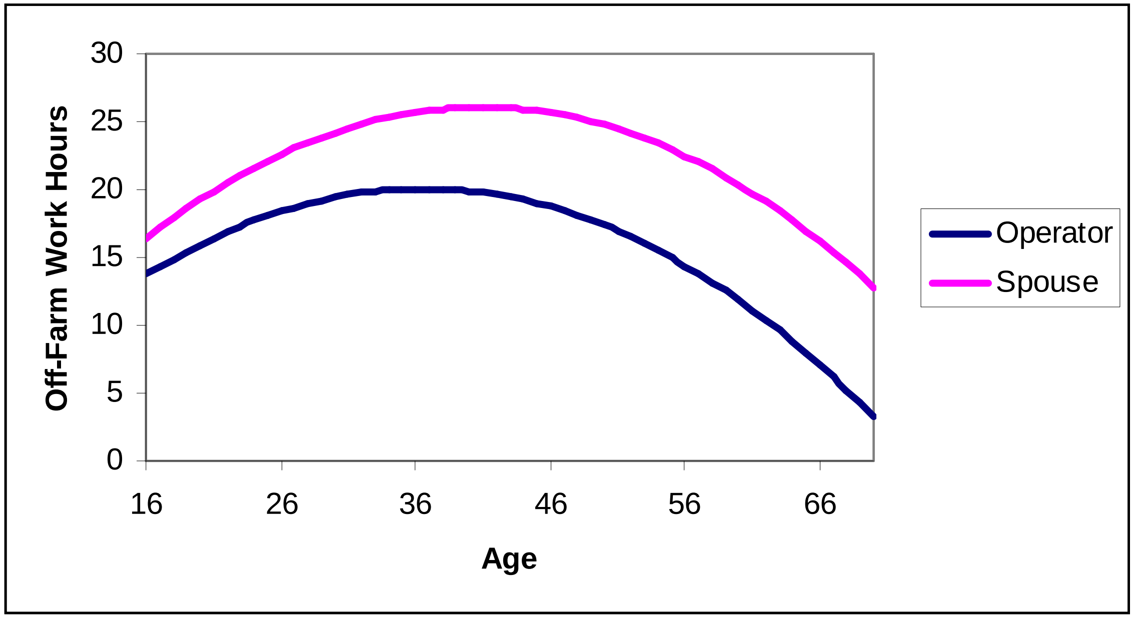

Figure 2: Age Effect on Off-Farm Employment by Farm Operators and Spouses

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