An Empirical Analysis of Farm Structure and Off-Farm Work Decisions

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Introduction

The years since World War II have brought rampant change to the structure of agriculture throughout most developed countries. The United States has seen a dramatic decrease in the number of farms as well as production acres. A combination of productivity enhancing technology and an influx of production from developing countries has resulted in an over saturation in commodity markets and left many U.S. farmers with empty bank accounts. Multiple measures have been taken by farmers and policymakers to combat these phenomena and ensure survival. This study will consider the decision made by farmers to shift from full-time to part-time farming and the structural variables and constraints associated with such decisions.

With empirical research regarding part-time farming beginning as early as Fugitt's 1959 study, it is obvious that the current interest in the movement toward part-time farming, as well as the phenomenon itself, is far from novel. The significance of part-time farming, however, has become increasingly evident as the majority share of total household income generation is now a result of off-farm labor for farming households (Goodwin and Jones, 1986). For the nearly forty-year period of 1954 to 1992 farmers reporting off-farm labor in excess of 100 days annually jumped by almost 20% from 62 to 83 percent (US Census of Agriculture). As the movement to part-time farming has escalated, its impetus has been of great interest. The stimulus for off-farm work has frequently been thought to be a result of "small-farm operators struggling to continue a way of life and [being] forced by declining farm income or changing economic conditions to get off-farm work." (Barlett, 1986). Barlett further suggests that part-time farming was not merely a second-best alternative, but rather "the best of both worlds" in which farmers could avoid the risk associated with farming, but were not forced out of the occupation entirely. Fuller and Mage (1976) concluded that a key reason for farmers participating in off-farm work is as a means of deceasing income risk via the distribution of income sources over two or more source of employment. The ability of a farmer to acquire such work, however, is dependent upon the farm's size and structure, as well as the availability of off-farm labor (Evenson and Huffman, 2001).

Throughout the studies to date, farm characteristics and structure have been considered important determinants of off-farm labor. In these studies, farm attributes are

considered to be evaluated outside of the off-farm labor supply decision. We, however, hypothesize that such decisions as farm size and diversification of livestock and crop production are not exogenous, but dependent upon off-farm labor attributes. By examining off-farm work availability, the volatility of income on and off the farm, and wages associated with both types of labor effort, we will analyze the endogeneity (endogenous sources) of off-farm work and farm structure.

Empirical Application

The focus of our analysis is on four important Corn Belt states—Iowa, Illinois, Indiana, and Ohio. Our analysis utilizes county-level data collected from two sources. Information on off-farm labor effort and the structure and characteristics of farms was taken from the 1987, 1992, and 1997 Agricultural Censuses. Detailed wage and income information was taken from the U.S. Department of Commerce's Regional Economic Information Service (REIS). All monetary figures were converted to 1997 terms using the producer price index.

A number of variables are conceptually relevant to off-farm labor supply decisions. In particular, variables representing the relative wages or implied productivity in alternative labor supply situations are relevant to how a farmer tends to allocate his or her time. We measure such opportunity costs using implied farm wages (total farm income divided by number of farm proprietors) and the average earnings per job in the county. Goodwin and Mishra demonstrated that risk averse agents may respond to differences in the level of income risk across alternative earning sources by adjusting their labor supplies. In this light, we calculated a measure of the relative risk of income from agriculture and from employment off the farm. Specifically, we utilized annual data from the REIS dataset to calculate a coefficient of variation (CV) over the 10 years preceding each of the census years included in our study. Age may also be relevant to an individual's tastes and preferences regarding working off the farm. We include the average age of farmers in each county as an explanatory factor.

Our primary interest in this study is on structural farm characteristics and their influence on (and by) off-farm labor supply decisions. We consider three important variables relating to the structure of farms. First, we utilized sales data from the Agricultural Census to calculate shares of total sales accounted for by various crop and livestock commodities. Using these shares, we calculated a Herfindahl index as a measure of the diversification of farming in each county. In order to facilitate interpretation, our measure of diversification is 1-H, where H is the Herfindahl index. Thus, a larger value corresponds to more diversification. It is well-accepted that crop producers may have greater off-farm employment opportunities because of the seasonal nature of production whereas livestock product producers have relatively fewer opportunities for off-farm employment due to the fact that livestock operations generally run year-round. Finally, the scale of agriculture would be expected to influence off-farm labor supply. Producers on larger farms are less likely to pursue employment off the farm in that the on-farm effort required to operate a farm is most certainly influenced by the scale of the operation.

In addition to evaluating the extent to which these factors affect off-farm labor supply decision in the four Corn Belt states under consideration here, a primary goal of our analysis involves an evaluation of the extent to which farm structure may be endogenous or jointly determined along with off-farm labor supply decisions. For example, is off-farm employment another way of diversifying the overall income flow for an individual farm? If so, one might expect that our measure of farm diversification is influenced by the extent to which farmers are working off the farm. Likewise, one might expect that the extent of diversification between crops and livestock undertaken by individual farms may be dependent upon whether the farmers are engaged in off-farm labor activities. Finally, the size of an operation might be influenced by whether a farmer is engaged in off-farm employment activities. A farmer that is working outside of the farm may be less likely to expand an operation.

These structural factors are always assumed to be exogenous in studies of off-farm labor supply. Such an assumption is generally justified on the grounds that these structural factors are relatively fixed in the short-run and thus are exogenous to labor

supply decisions. The usual approach to modeling off-farm labor supply involves estimation of a labor supply equation of the form:

$$y_i = f(w_i^f, w_i^o, C_i, X_i)$$

where w_i^f represents the farm wage, w_i^o, represents the off-farm wage, C_i represents farm and operator characteristics relevant to labor decisions, and X_i represents other exogenous factors relevant to off-farm work. Empirical applications typically make use of individual data (e.g., from surveys) and thus y, representing the degree of participation in off-farm labor markets, is often censored at zero (for individuals not working off the farm) or, in some cases, completely censored (when only the discrete work decisions can β_0 be observed). In our example, we utilize census data aggregated to the county level, such that ordinary least squares regression techniques are appropriate.

We have argued that farm characteristics may be endogenous to off-farm employment decisions. To address such concerns, we adopt conventional two-stage least squares (2SLS). Instrumental variables included values of the farm characteristics from the preceding Census (five years previous), the lagged wage variables, and the other exogenous factors included in the regression model. Some method of evaluating the statistical significance of the differences between OLS and 2SLS estimate is needed. We utilize a standard Wu-Hausman test for this purpose. Under the null hypothesis that the OLS estimates are correctly specified, the Wu-Hausman test statistics, given by

$$q = (\beta_0 - \beta_1)'\left[V(\beta_1) - V(\beta_0)\right]^{-1}(\beta_0 - \beta_1)$$

is distributed as a chi-square random variable with degrees of freedom given by the number of variables being tested. Note that β_0 represents the OLS estimates and β_1 represents the 2SLS estimates and V(.) is the appropriate covariance matrix.

Variable definitions and summary statistics are presented in table 1. Two alternative measures of off-farm labor supply are considered. The first considers the proportion of farmers in a county reporting 150 days or more of work off the farm during the preceding year. This variable represents a high degree of involvement in the off-farm labor market (i.e., a level of involvement approaching full-time work). The second measure is constructed by taking a weighted average of days worked off the farm. The Census collects off-farm work effort data by specifying particular categories of effort—

for example, work between 0-49 days per year, 50-99 days per year, and so forth. We use the midpoint of each range as the implied days worked and construct the weighted average of days worked accordingly.[1] In our sample, the average farmer worked about 77 days per year off the farm. About 32% of the farmers worked more than 150 days per year off the farm.

Parameter estimates and summary statistics for the estimated off-farm labor supply equations are presented in Table 2. The estimates are, in most cases, highly significant. An informal comparison of the OLS and the 2SLS estimates suggests that the values are very similar to one another. Indeed, in both cases, a Hausman test fails to reject the null hypothesis that the OLS estimates are properly specified. The results suggest that operators of more highly diversified farms tend to be more likely to pursue off-farm employment. The parameter estimates are statistically significant in every case. This may reflect the fact that off-farm employment is yet another way of diversifying the income stream for a farmer. As expected, a greater concentration of sales in livestock commodities is associated with a lower degree of off-farm labor market participation, though the effect is only significant in the 2SLS models. This is consistent with expectations and the results of other studies that have determined that the nature of livestock production generally implies fewer opportunities for off-farm employment by livestock producers.

The age of producers is not significantly correlated with off-farm employment decisions. This may reflect the rather limited variation in this aggregated measure in our data. Off-farm labor supply is negatively affected by the size of farming operations. Larger farms imply less off-farm employment. Again, this is consistent with expectations that operators of larger farms generally have fewer opportunities for off-farm employment. The level and volatility of labor market wages and implied farm proprietor wages tend to have statistically significant influences on labor supply decisions. Counties with a higher degree of volatility in off-farm wages tend to have less off-farm labor market participation, though the effect is only significant in the case of the OLS estimates using the first (proportional) measure of off-farm work. Conversely, on-farm earnings variability does not appear to be significantly related to off-farm labor market

[1] Of course, such a construct is subject to measurement error.

participation. This result is somewhat counter to the results obtained by Goodwin and Mishra(1998) though our result is obtained for aggregate data and for a different sample of states and years.

Finally, as would be expected, the relative level of wages in each respective sector tends to have a very strong influence on off-farm labor market decisions. Higher off-farm wages in the preceding year tend to encourage more off-farm employment. The effect is statistically significant in every case. Conversely, higher on-farm wages tend to be associated with less off-farm employment. These effects are what would be expected since higher wages in one sector will encourage agents to reallocate their labor supplies in favor of that sector.

Central to our analysis is the question of whether farm structure is endogenous to off-farm employment decisions. Wu-Hausman tests of the OLS specification were considered for each of the alternative measures of off-farm labor supply. In each case, the chi-square statistics and associated p-values support the OLS estimates and suggest that, at least for these data, there is little evidence that farm structure is endogenous to off-farm labor supply decisions. This supports the typical specification adopted in the rather extensive literature that has considered models of the off-farm supply of labor. For our sample of states and years, it would appear that farm structure is exogenous to labor supply decisions.

Concluding Remarks

The chief objective of this study is to investigate the extent to which farm structure is endogenous to off-farm labor supply decisions. It is our initial hypothesis that farm structure and off-farm work decisions are jointly made. The results of the Wu-Hausman test, however, proved the hypothesis incorrect and the assumptions of previous economists accurate – the decision to work off the farm is made exogenously to farm structure.

Furthermore, the effect of three important farm structure variables on the off-farm work decision is examined. All three variables –diversification, crop or livestock specialization and farm scale were found to have a significant effect on part-time

farming. It appears that the more risk averse the producer, the more diversified he is. As a result of his risk aversion, he chooses to further diversify his income through off-farm labor endeavors. Results found on livestock and crop specialization are consistent with those found by Evenson and Huffman (2001). It seems that those farmers highly engaged in livestock production are more likely not to seek off-farm work, largely due to the constant on-site labor demand. On the other hand, those producers focused on crop production are more likely to engage in off-farm work, because of the seasonality of such farming activities. Finally, the study found a negative correlation between farm size and off-farm work. It was determined that the greater the scale of production, the less likely the farmer was to be "part-time."

The effect of wage volatility on the decision to engage in off-farm labor was found to be significant in most cases. The greater the variability in off-farm wages the less likely farmers are to hold work off the farm. On-farm income variability, however, does not lead to an increase in off-farm work. It was consistently found that higher wages in previous periods, on-farm or off-farm, resulted in a rise in the job market with the increased wage.

Table 1. Variable Definitions and Summary Statistics

Variable	Definition	Mean	Std. Dev.
Proportion Working >150 Days	Proportion of farmers working more than 150 days per year	0.3248	0.1443
Average Days Worked	Weighted average of days worked off farm	76.7361	28.6542
Diversification	Herfindahl index of diversification (1-H)	0.7452	0.0836
Livestock Sales	Livestock sales as a proportion of total farm sales	0.4071	0.1974
Age	Average farmer age	51.1897	2.1968
Average Size	Average farm size (acres)	293.1445	99.6106
Volatility Off-Farm Earnings	CV of average off-farm earnings per job	7.4766	4.9997
Volatility of Farm Income	CV of average farm earnings per proprietor	74.5487	348.7540
Off-Farm Wages per Job (t-1)	Average earnings per job	22.7296	4.1810
Farm Income per Proprietor (t-1)	Average income per farm proprietor	0.0157	0.0172

Table 2. Parameter Estimates of Off-Farm Labor Participation Models

Variable	OLS Parameter Estimate	OLS Standard Error	2SLS Parameter Estimate	2SLS Standard Error
Proportion Working More than 150 Days Off-Farm				
Intercept	0.0730	0.1414	0.1320	0.1479
Diversification	0.2280	0.0646 *	0.2208	0.0708 *
Livestock Sales	-0.0420	0.0276	-0.0495	0.0290 *
Age	0.0023	0.0023	0.0021	0.0023
Average Size	-0.0002	0.0000 *	-0.0004	0.0001 *
Volatility Off-Farm Earnings	-0.0023	0.0014 *	-0.0016	0.0014
Volatility of Farm Income	0.0000	0.0000	0.0000	0.0000
Off-Farm Wages per Job (t-1)	0.0038	0.0013 *	0.0034	0.0014 *
Farm Income per Proprietor (t-1)	-0.6817	0.2769 *	-0.5070	0.2888 *
Hausman Test	7.30	[0.6061]		
Average Days Worked Off-Farm				
Intercept	44.1262	28.0525	54.2964	29.3067 *
Diversification	32.6207	12.8166 *	32.6822	14.0392 *
Livestock Sales	-7.8926	5.4814	-9.9538	5.7550 *
Age	0.2683	0.4556	0.2293	0.4586
Average Size	-0.0425	0.0095 *	-0.0654	0.0146 *
Volatility Off-Farm Earnings	-0.4265	0.2745	-0.3109	0.2805
Volatility of Farm Income	0.0018	0.0021	0.0020	0.0022
Off-Farm Wages per Job (t-1)	0.7815	0.2646 *	0.7103	0.2694 *
Farm Income per Proprietor (t-1)	-188.1390	54.9515 *	-156.6090	57.2429 *
Hausman Test	5.03	[0.8315]		

An asterisk indicates statistical significance at the .10 or smaller level. Numbers in brackets are chi-square probabilities.

References

Barlett, P.F. (1986). Part-time farming: saving the farm or saving the lifestyle? *Rural Sociology*, 51(3), 289-313.

Bureau of the Census, (1997) *Census of Agriculture, State and Country Data*, Washington, DC.

Fuguitt, G.V. (1959). Part-time farming and the push-pull hypothesis. *American Journal of Sociology,* 64(4), 375-79.

Fuller, A.M., and Mage J.A. (1976) Part-time farming: problem or resource in rural devolpment. Norwich, England, *GeoAbstract* Limited for the University of Guelph.

Goodwin, H.L.J., and Jones L.L. The importance of off-farm income in the United States. *The Rural Sociologist,* 6(4), 272-279.

Hausman, J.A. (1978) Specification tests in econometrics, *Econometrica*, 46 (November) 1251-1272.

Huffman, W.E., and Evenson, R.E. (2001). Structural and productivity change in US agriculture, 950-1982. *Agricultural Economics*, 24, 127-147.

Mishra, A.K. and Goodwin, B.K. (1998). Income risk and allocation of labour time: an empirical investigation. *Applied Economics*, 30, 1549-1555.

US Department of Commerce (1969-1997) Bureau of Economic Analysis, Regional Economic Measurement Division, *Regional Economic Information System,* Washington DC.