KY

41

Determinants of Variation in Average Farm Acreage in Kentucky Counties

Sylvie Marzin, Angelos Pagoulatos, and David L. Debertin

Agricultural Economics Research Report 41
August 1985

University of Kentucky • College of Agriculture • Agricultural Experiment Station
Department of Agricultural Economics • Lexington, Kentucky 40546-0215

Determinants of Variation in Average Farm Acreage in Kentucky Counties

by

Sylvie Marzin, Angelos Pagoulatos and David L. Debertin*

Research Report # 41

*Marzin is a Graduate Research Assistant; Pagoulatos and Debertin are Professors of Agricultural Economics, University of Kentucky.

Determinants of Variation in Average Farm Acreage in Kentucky Counties

One of the key characteristics of American agriculture is enormous variation in average acreages of farms, but reasons for this variation and sources of variation have not been extensively examined. Factors influencing average farm acreages have been attributed to both socioeconomic and technical forces in agriculture (Gardner and Pope, Krause and Kyle, Madden and Partenheimer, and Raup). Population characteristics of the region, the stage of development, and the degree of diversification have also been shown to have impacts on farm size (Bachman and Christensen, Pope and Prescott, and Heady and Sonka). These studies did not necessarily rely on acreage as the measure of farm size, but also used measures such as cultivated land area, output measures, or farm income (Carlin and Crecink). Huang reported on determinants of average farm acreages for 53 countries, but these results are not strictly applicable to the U.S.

The aim of this paper is to examine the determinants of variation in average farm acreages in Kentucky and test the importance of some socioeconomic factors. A model is estimated with cross sectional data for Kentucky counties. Kentucky is an ideal state in which to conduct such a study because of the variety in the types of farming from one section of the state to another. The variation ranges from commercial grain farms to beef and dairy operations on rolling land not suited to row crops, to labor intensive tobacco and horticultural crops, to mixed subsistence farming in some of the lowest income agricultural areas within the United States.

The Conceptual Model

The average acreage in farms is measured by dividing the total agricultural land area in acres by the total number of farms. This variable, although linked to the concept of farm size, does not reflect the magnitude of output for livestock farms, commercial grain farms, horticultural operations and subsistence farms, because these enterprises are very different in their land requirements.

If agriculture is homogeneous, the variation in acreages should be attributed only to variation in land prices. Land price differences should reflect variation in the productivity of the land. Several socioeconomic variables, including farm income, age of the farm, operator, tenancy, and days worked off-farm have been suggested by researchers as leading to variation in average farm acreages, even if the agriculture itself is very homogeneous (Carlin and Crecink).

Carlin and Crecink examined the 1975 Farm Production Expenditures Survey (E.S.C.S, U.S.D.A.) and found little variation in the age distribution of three groups of small farm operators. They found that low income farmers tend not to be part time farmers. As output increases, Flinn and Buttel found that the proportion of hired to total labor increases, and the concentration of land ownership increases. In Kentucky, much tobacco and horticultural production is dependent on seasonal hired labor, and substantial variation exists across the state in the availability of this labor. Thus, variation in wages for hired labor may be an important factor.

The impact of the tobacco industry on the state's economy and in particular on specific economic groups is being debated in anticipation of possible changes in the quota system (Mattas) for burley tobacco in Kentucky. It is of interest to know the importance of tobacco cultivation and wages as average farm size and diversification changes. Farms are classified by the census data into three major categories, grain (G), tobacco (T), and livestock (L). By calculating for each county the percent of the total farms that produce grain, tobacco, and livestock, changes in the relative importance of grain, tobacco and livestock enterprises can be observed among counties with differing average acreage in farms or returns per acre or percentage of land in farms.

Few firm hypotheses regarding price of land, farm income, type of cultivation, organizational farm and other factors can be derived from theory. The price of land should be negatively correlated to average acreage in farms. The type of cultivation (grain, tobacco and livestock) farm income, tenancy, off farm work and age are suggested as important elements in the decisions to expand average farm acreage.

The Herfindahl (H) equation (1) and Entropy (E) equation (2) indices of diversification were calculated for each of three sorts of the average acreage for farm among Kentucky counties (Tables 1, 3):

(1) $$H = \sum_{i=1}^{n} p_i^2$$

(2) $$E = \sum_{i=1}^{n} p_i \ln \frac{1}{p_i}$$

where p_i is the proportion of acreage in each crop i ($p_i = A_i / \sum_{i=1}^{8} A_i$) and A_i is total farm acreage in corn, wheat, tobacco, soybeans, sweet potatoes, hay, vegetables and pasture. The H index decreases with increasing diversification, ranging from zero to one as complete specialization occurs. The E index increases with increasing diversification, reaches a maximum when $p_i = 1/n$, and approaches zero with complete specialization.

The calculation of these indexes (Tables 1 - 3) reveals that diversification decreases slightly as average farm acreage increases and that there is more specialization where returns per acre are higher. Furthermore, counties with a higher proportion of their land in farms tend to be also less diversified. The indices are consistent and confirm the results obtained by Pope and Prescott in California.

Postulating an aggregate agricultural production function at the county level with two variable inputs (only the price of land and wage rates are assumed to vary across counties) and assuming a Cobb-Douglas production technology, the demand for land acreage under profit maximization is given by:

$$(3) \qquad X_{Lt} = P_t^{(1-\alpha_L)(\alpha_L+\alpha_W-1)^{-1}} \; W_t^{\alpha_W(\alpha_L+\alpha_W-1)^{-1}} \; (\alpha_L P_O A)^{-(\alpha_L+\alpha_W-1)^{-1}}$$

where X_L is the acreage of farmland in county t, p_t is the price of farmland in county t, w_t is the wage rate in county t and p_o is the price of output. The constants α_L, α_W and A are, respectively, output elasticities for land and labor and a technological parameter. Dividing both sides of equation (3) by the number of farms (N) and expressing A/N as a function of the socioeconomic variables to be tested in this study a relationship for the average acreage per farm among Kentucky counties is obtained. The log-linear form of the relationship is:

$$(4)\quad \ln S_t^i = \alpha_0^i + \alpha_1^i \ln P_t + \alpha_2^i \ln V_t + \alpha_3^i \ln W_t \qquad t = 1, \ldots, 115$$

$$+ \alpha_4^i \ln D_t + \alpha_5^i \ln A_t + \alpha_6^i \ln Ten_t + \alpha_7^i \ln PT \qquad i = 1, \ldots, 9$$

$$+ \ln\varepsilon_t \quad (0,\sigma^2),\ E(\varepsilon_t\ \varepsilon_s') = 0 \quad \text{for } t \neq s$$

where:

S_t^i is the ith measure of average acreage per farm in Kentucky county t.

P_t is the value of land and buildings per acre for each county ($1,000)

W_t is the expense for one hired worker (+150 days) per year for each county ($)

D_t is a vector representing cultivation

D_{1t} is the percentage of farms growing grain for each county

D_{2t} is the percentage of farms growing tobacco for each county

D_{3t} is the percentage of farms raising livestock for each county

A_t is the average age of operator for each county (years)

Ten_t is percent of tenancy for each county

PT_t is percent of operators for each county working more than 200 days off-farm

V_t is total value of product sold, per farm, for each county.

The model is estimated with cross sectional data for 115 counties. Five counties that had less than 8 percent of their land in farms were not used in the analysis (Letcher, Knott, Perry, Harlan and Pike). Because the price vector for output is constant across counties, V represents the net effect in variation of output.

Data

Average acreage per farm among Kentucky counties varies from 76 acres to 429 acres with a mean of 147.30 acres, an extremely skewed distribution. Therefore, to accurately test the significance of socioeconomic variables, the counties are sorted in three different ways. The first sorting divides the data into three samples with approximately the same number of observations based on average acreage. In the same banner, the data were separated into three groups by percent of total land in farms to measure of the "agricultural" vocation of the counties. The less "agricultural" counties (less than 50% of total land in farms) were deleted. Thus, the two groups of interest were the counties with 50 to 78 percent of land in farms and the group of counties with more than 78 percent of land in farms (agricultural counties). Nonagricultural counties (such as the Eastern Kentucky coal counties) were not included in the analysis.

The variation in average gross returns per acre should be affecting average acreage on farms and total average returns per farm from county to county. The state is thus divided into three approximately equal groups. The first group has average gross returns per acre of less than $65/acre, the second group between $66 and $140/acre and the third group more than $140/acre.

The state model contains all counties which are subsequently sorted by three categories of average acreage, two categories of percent of land in farms in each county and three categories of average gross returns per farm.

All Kentucky county data are from the U.S.D.A. Agr. Census, Kentucky, 1978. Since the model was estimated in double log form, the coefficients can be directly interpreted as elasticities. Correlations between variables were very low with only a few above .50. Hired labor wages and average acreage in farms had a correlation coefficient of .76 and total value of product sold had a correlation coefficient of .75 with average acreage in farms.

Empirical Results

Ordinary least squares regression results for all models are presented in Tables 1-3. The results of the state model reveal that the coefficients of hired labor wages, age, tenancy and gross farm income are positively related to average acreage of farms in Kentucky (Table 1). The price of land coefficient is significant and inversely related to the average acreage as expected. In general, tobacco is more dominant in counties with smaller average acreage in farms. Moreover, the percentage of land in grain increases as the average acreage in farms increases.

When observations are placed into three separate groups according to acreage, the price of land, farm income and tobacco production remain significant determinants of farm acreage within each group. Farm income and tobacco production are always significant determinants of average acreage variation (Table 1). Tobacco production is most important on the smallest farms within each group. This result suggests that tobacco cultivation is predominant on small, diversified farms as measured by the H and E indices (Table 1).

For the large farm group, grain production and acreage are positively related. This was as expected since most grain is produced on the commercial farms of Western Kentucky, not the part time and subsistence farms in the central and eastern part of the state.

The price of hired labor is significant on both the medium and large farm groups. Within the large farm group, off-farm work decreases as the average acreage in farms increases. Tenancy is significant for the medium acreage group. However, the age variable was insignificant in all three groups.

The sample was then divided into two groups based on the percent of land in farms, 50 to 78 percent of the total land in farms, and over 78 per cent of the total land in farms, and separate regressions were constructed for the two groups. For both subgroups, the price of land and farm income variable remain significant determinants of average acreage variation (Table 2). Tobacco production also remains a significant variable, with a strongly negative coefficient in the group with more than 78 percent of the total land in farms.

For counties with 50 to 78 percent of land in farms, off-farm work is significant and positively related to average acreage in farms, thus giving a result consistent with the findings of Carlin and Crecink. Off-farm work is positively related with farm acreage expansion; especially for the medium groups, contribution of farm income is at its lowest level (0.21, Table 2). The coefficient of off-farm work in the more agricultural counties is insignificant since not much off-farm work would be available in these counties and agriculture is the main economic sector.

The sample was then divided into three groups based on the average gross return per acre in the county. Gross returns for the first group were less than $65 per acre. The second group included counties in which the average gross returns per acre were over $65 but less than $140 per acre. The third group included counties with farms earning an average of more than $140 per acre.

Perhaps surprisingly, farms with the largest acreages were those in the middle group with respect to returns per acre. The mean farm size for this group was 160.85 acres. Farms with the highest returns per acre tended to be the most diversified. Raup suggested that the largest farms may be less able to bear risk than some smaller and more diversified operations. Diversification increases as average acreage in farms increases and gross returns per acre increase (Tables 1 and 3).

Evidence presented in Table 1 is consistent with that reported by Pope and Prescott using California data. They found that diversification increases as the acreage of farms increased. However, in our study diversification and acreage do not necessarily lead to the greatest gross returns per acre.

A stronger relationship exists between age and gross returns than between age and acreage. Younger farmers tend to be more specialized. This is also consistent with the Pope and Prescott results. The percentage of farmers with off-farm work increases as the average acreage in farms decreases, and returns per acre are low (Table 3). Tenancy is most important for the group with medium gross returns per acre, and for farms with the largest average acreage.

Conclusions

The price of land was found to be a major determinant of farm acreage throughout Kentucky and was the main limiting factor in farm expansion. Only a slight increase in diversification occurs as the average farm size increases. The higher the proportion of land in farms, the more diversification and the larger the average acreage. For Kentucky, as diversification increases, farm income per acre increases substantially. However, counties with the greatest gross returns per acre do not necessarily have the largest farms.

Grain production is associated with large farms and high returns per acre. Livestock production is not linked to any particular farm size. Tobacco production, although present in nearly all agricultural counties, is of greater importance for small acreage farms. Surprisingly, the tobacco producers are found in counties where the farms tend to be less diversified and have lower returns per acre than the average for the state as a whole.

Farm income and off-farm work behaved consistently in this analysis. Off-farm income has a less important impact on farm size than the level of farm output for the group of counties with more than 78 percent of their land in farms. The renting of additional land is a main determinant of acreage expansion for farms of medium acreage. Older farmers do not necessarily have larger acreages, but do frequently have larger gross returns per acre than do younger farmers.

As with other cross sectional studies, a diverse array of causal forces influence each variable. Therefore, caution must be exercised in the interpretation of results. Nevertheless, evidence supports the contention that diversification and average acreages are positively, not negatively, related. Small farms are not necessarily more diversified than large farms.

REFERENCES

Bachman, K.L. and R.P. Christensen. "The Economics of Farm Size." in Agricultural Development and Economic Growth. eds., Herman M. Southworth and Bruce Johnston, Ithaca, Cornell University Press, 1967: 234-357.

Carlin, T.A. and J. Crecink. "Small Farm Definition and Public Policy." American Journal of Agricultural Economics, 61(1979): 933-939.

Doering, O.C., "Appropriate Technology for U.S. Agriculture: Are Small Farms the Common Thing? Introductory Comments." American Journal of Agricultural Economics, 62 (1980): 946-953.

Flinn, W.L. and F.H. Buttel, "Sociological Aspects of Farm Size: Idéological and Social Consequences of Scale in Agriculture." American Journal of Agricultural Economics, 62(1980): 946-953.

Gardner, B.D. and R.D. Pope. "How is Scale and Structure Determined in Agriculture." American Journal of Agricultural Economics, 60(1978): 296-302.

Heady, E.O. and S.T. Sonka. "Farm Size, Rural Community Income and Consumer Welfare." American Journal of Agricultural Economics, 56 (1974): 534-542.

Huang, Y., "On Some Determinants of Farm Size Across Counties." American Journal of Agricultural Economics, 55 (1973): 89-92.

Krause, K.R. and L.R. Kyle. "Economic Factors Underlying the Incidence of Large Farming Units: The Current Situation and Probable Trends." American Journal of Agricultural Economics, 52 (1970): 748-761.

Madden, J.P. and E.J. Partenheimer. "Evidence of Economies and Diseconomies of Farm Size." In Size, Structure and Future of Farms, eds., A. Gordon Ball and Earl O. Heady, Ames, Iowa State University Press, 1972.

Mattas, K. Interdependencies in a State Economy: A Nonsurvey I-O Model for the State of Kentucky, Ph.D. Dissertation, University of Kentucky, Lexington, 1984.

Pope, R.D. and R. Prescott. "Diversification in Relation to Farm Size and Other Socioeconomic Characteristics." American Journal of Agricultural Economics, 62 (1980): 554-559.

Raup, P.M., "Economies and Diseconomies of Large Scale Agriculture." American Journal of Agricultural Economics, 51 (1969): 1274-1283.

U.S. Bureau of the Census. U.S. Census of Agriculture 1978, U.S. Government Printing Office, Washington, D.C.

White, T. and G. Irwin. "Farm Size and Specialization." Size, Structure and Future of Farms, eds. G. Bolland, E. Heady. Ames: Iowa State University Press, 1972.

TABLE 1
Average Acreage in Kentucky Counties Sorted by Average Acreage Level

Variable	Coefficients: State Model	Less Than 120 Acres	Between 120 & 147 Acres	More Than 147 Acres
Price of Land (P_1)	-0.388 (0.052)[a]	-0.310 (0.77)	-0.148 (0.050)	-0.225 (0.134)
Hired Labor Wage (W)	0.150 (0.047)	0.064 (0.096)	0.047 (0.039)	0.098 (0.081)
Farm Income (V)	0.266 (0.047)	0.153 (0.056)	0.104 (0.050)	0.230 (0.134)
Percent Grain (D_1)	0.062 (0.023)	0.001 (0.034)	-0.030 (0.020)	0.068 (0.038)
Percent Tobacco (D_2)	-0.086 (0.017)	-0.058 (0.046)	-0.069 (0.030)	-0.069 (0.019)
Percent Livestock (D_3)	0.001 (0.035)	0.025 (0.033)	-0.054 (0.055)	-0.017 (0.149)
Age (A)	0.865 (0.563)	0.451 (1.211)	-0.063 (0.386)	-0.112 (1.152)
Percent Tenancy (Ten)	0.093 (0.024)	0.058 (0.602)	0.041 (0.028)	-0.042 (0.090)
Percent Off Farm Work (PT)	0.025 (0.081)	0.111 (0.110)	0.028 (0.073)	-0.214 (0.127)
Constant	0.563 (2.351)	2.794 (4.491)	5.278 (1.682)	5.232 (4.703)
DF	105	27	26	32
F	47.15	2.42	2.35	18.17
R2	.8017	.4461	.4484	.8363
Mean Acreage	147.30	106.73	133.69	194.69
Mean & Land in Farm	62.47	48.25	65.27	72.50
Mean Average return/acre	109.96	88.87	112.02	126.78
Mean Herfindahl Index	0.4093	.4274	.4191	.3850
Mean Entropy Index	1.1108	1.0216	1.1062	1.1934

[a] Values in parentheses are standard errors.

TABLE 2
Average Acreage In Farms In Kentucky by County
Percent of Land in Farm Groups

	Between 50 to 78% of Land in Farms		More than 78% of Land In Farms	
Price of Land (P_1)	-0.548	(0.119)	-0.536	(0.113)
Hired Labor Wage (W)	0.309	(0.888)	0.084	(0.099)
Farm Income (V)	0.210	(0.125)	0.491	(0.143)
Percent Grain (D_1)	0.070	(0.051)	-0.028	(0.039)
Percent Tobacco (D_2)	-0.040	(0.022)	-0.148	(0.036)
Percent Livestock (D_3)	-0.246	(0.182)	-0.295	(0.181)
Age (A)	1.975	(1.071)	-0.937	(1.187)
Percent Tenancy (Ten)	0.241	(0.098)	0.125	(0.079)
Percent Off Farm Work (PT)	0.370	(0.145)	0.130	(0.141)
Intercept	-3.903	(4.083)	8.132	(4.776)
DF	28		30	
F	26.46		21.12	
R2	.8948		.8637	
Mean Acreage	159.97		159.30	
Mean & Land in Farm	67.77		86.14	
Mean Average return/acre	129.16		154.70	
Mean Herfindahl Index	.3749		.4348	
Mean Entropy Index	1.2054		1.0747	

TABLE 3
Average Acreage in Farms in Kentucky by Average
Gross Returns/Acre Groups

Variable	Coefficient					
	Less Than 65$/Acre		Between 65 and 140/Acre		More Than 140$/Acre	
Price of Land (P_1)	-0.349	(0.076)[a]	-0.429	(0.084)	-0.530	(0.128)
Hired Labor Wage (W)	0.043	(0.065)	0.236	(0.089)	0.041	(0.095)
Farm Income (V)	0.281	(0.064)	0.457	(0.124)	0.526	(0.117)
Percent Grain (D_1)	0.040	(0.043)	-0.027	(0.035)	0.073	(0.043)
Percent Tobacco (D_2)	-0.076	(0.025)	-0.036	(0.036)	-0.427	(0.160)
Percent Livestock (D_3)	0.050	(0.037)	0.118	(0.153)	-0.149	(0.164)
Age (A)	1.203	(0.805)	-2.153	(1.186)	2.811	(1.019)
Percent Tenancy (Ten)	0.084	(0.033)	0.149	(0.077)	0.109	(0.083)
Percent Off Farm Work (PT)	-0.174	(0.120)	0.058	(0.126)	0.180	(0.182)
Constant	0.086	(3.384)	9.607	(4.716)	-6.576	(3.777)
DF	27		29		28	
F	21.67		34.37		17.06	
R2	.8784		.9143		.8458	
Mean Acreage	137.03		160.85		142.47	
Mean & Land in Farm	38.44		69.02		78.93	
Mean Average return/acre	27.78		93.06		208.50	
Mean Herfindahl Index	.4341		.4041		.3940	
Mean Entropy Index	1.0297		1.1354		1.1579	

[a] Values in parentheses are standard errors.

400—8-85