The Relation Between Farm Production Risk and Off-Farm Income

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This paper presents a model of the farm labor allocation decision based on risk and return characteristics of different activities. It is shown that off-farm employment can play an important role in the diversification of farm family income, implying that portfolio models of risk and return to farm activities should take into account the possibility of off-farm employment. A model of the labor allocation decision based on the risk and return characteristics of each activity is developed and tested using a state level cross section of the United States over the post-war period, and performs well in explaining variation in reliance on off-farm income.

Introduction

This paper presents the results of a study of the relationship between the risk-return characteristics of farm activities and the extent to which the farm population relies on off-farm sources of income. The study focuses on the 48 contiguous United States over the 1960–1986 period and uses measures of total income from farming, total income from off-farm sources and information on the size of the farm sector relative to each state as a whole to examine relationships between farm activities and off-farm income.

Figure 1 shows that the share of off-farm income in total farm income has trended upward, with increasing variation in later years due mainly to fluctuating income from on-farm sources. Disaggregate data show the share of off-farm income in total farm income to be rising or steady in all ten USDA regions. Figure 2 shows that not only is off-farm income important in all regions, but that its share varies substantially across regions.

Accordingly, the possibility that farm decisions may depend on the characteristics of off-farm income streams (or vice versa) cannot be ignored in empirical analyses of these topics. This paper shows that reliance on off-farm income has an important relationship with farm income risk, implying that omission of this linkage in studies of farm portfolio behavior or off-farm income can result in specification errors.

The relations between off-farm work and farm decision making are therefore potentially quite important, a point emphasized by previous analysts such as Ahearn et al., who conclude that off-farm income reduces income inequality in the United States. This observation is in line with the expectation that higher incomes from farm production reduce the need to look for additional income from off-farm sources.

Work participation studies have focused on various determinants of the decision to work off-farm. For example, Gould & Saupe find that various farm and farm operator characteristics are important in the decision of married farm women in Wisconsin to seek work off-farm. The demand side of the off-farm labor market, as represented by variables for regional unemployment and proximity to urban areas, was not found to be a significant determinant of off-farm work. Other studies by Huffman, Sumner, and Jensen & Salant find wages and farm income to be important in explaining off-farm income. These studies also confirm the importance of various characteristics of the demand side of the off-farm labor market.

However, most of these studies fail to incorporate directly the role of agricultural production risk in regressions designed to analyze the decision to work off the farm. Though Sumner accounted for this factor indirectly by including dummies for alternative crop mixes, no direct measure of the riskiness of farm production returns has been used in any of these analyses, with the exception of Huffman, who included the variance of farm sales in his analysis of the off-farm work decision.

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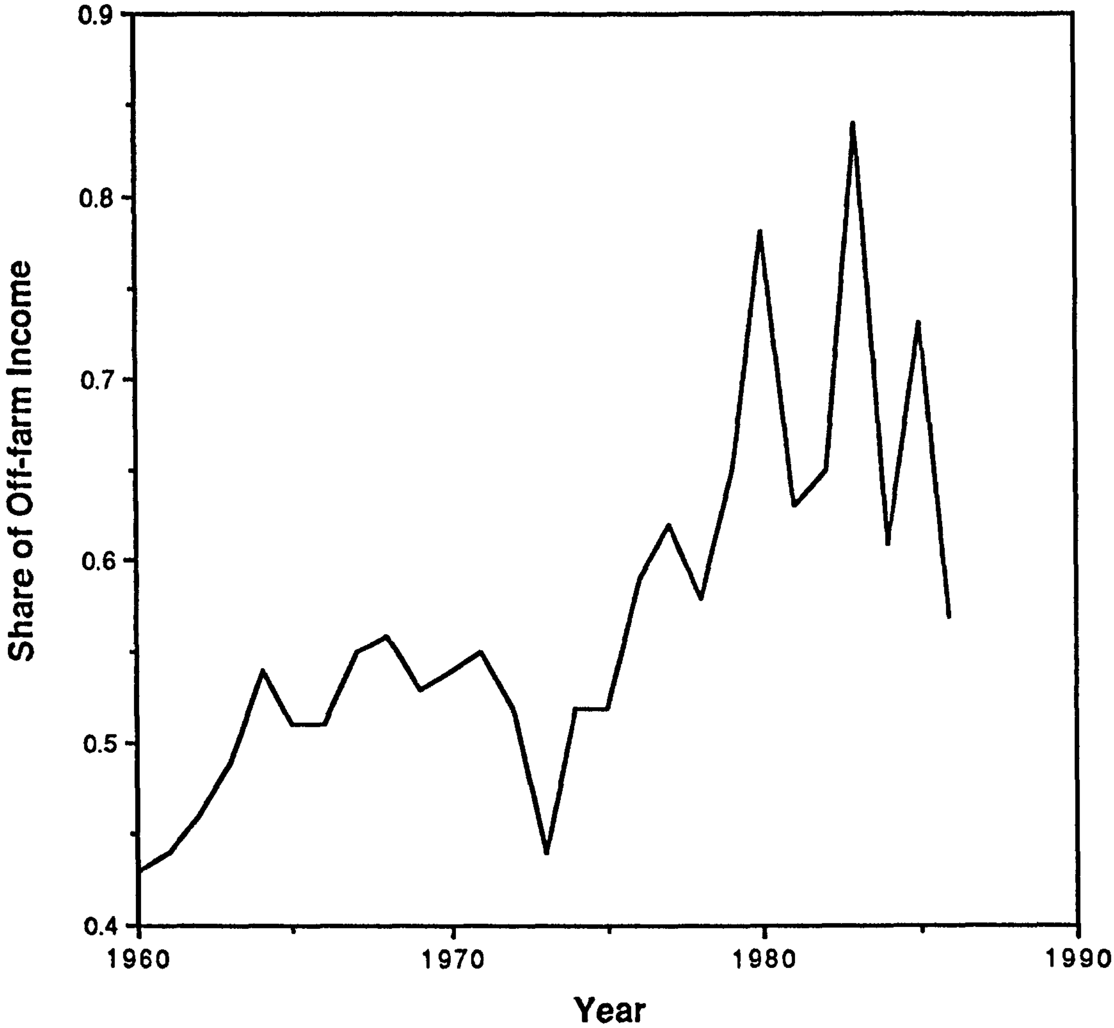
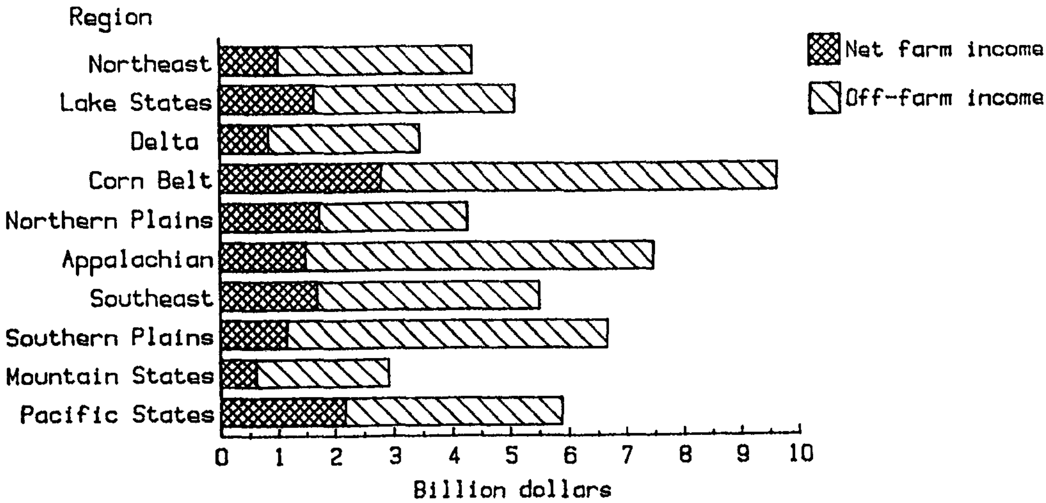


Figure 1. Average Share of Off-Farm Income in Total Income 1960–1986

This study analyzes reliance on off-farm income from a risk minimizing approach based on direct measures of production risk. Farm households are assumed to choose from among alternative investments of labor and are seen as minimizing the risks of the mix of on- and off-farm activities in an environment where the various choices have differing risk-return characteristics. Reliance on off-farm income can be viewed as a way to diversify the income stream of a farm household, since the wages from such employment are likely to be steadier and more predictable than are returns from farm production, and can exert a stabilizing influence on income. In addition, fringe benefits such as medical insurance and pension plans can play an important role in reducing risk, as shown by Jensen and Salant. We would expect to find a greater reliance on off-farm income in states where the returns to farming are riskier, as well as where returns to farming are low in an absolute sense.

Analysis of the role of risk in the decision to work off-farm is consistent with a portfolio approach to the study of risk in agricultural production. Previously there have been two distinct approaches applying portfolio theory to agriculture. The first, exemplified by Barry, applies the Capital Asset Pricing Model (CAPM) to farm real estate. This type of analysis yields estimates of the degree to which farm asset risk is related to the risk of the market portfolio, and has been conducted at both the national and regional levels. A second approach to risk analysis of agricultural activities derives from the original work of Markowitz using mean-variance (M-V) analysis to aid in actual port-



Source: Lucier, Gary, Agnes Chesley and Mary Ahearn, Farm Income Data: A Historical Perspective, USDA-ERS Statistical Bulletin No. 740, Washington, D.C., May 1986, p. 49.

Figure 2. Regional Net Farm Income and Off-Farm Income, 1984

folio management. This approach seeks to show how an individual investor can minimize the variance of a portfolio for a given level of returns.

The use of mean-variance relationships to guide decision making in agriculture has been applied mainly to planting decisions in relatively restricted areas. Numerous examples are cited in Boisvert and McCarl where the returns to crops on a state or province level are related to the returns on the farming sector in that same area. No attempt is made in these studies to relate the analysis to factors other than the risk and return characteristics of crops grown in the area of study.

One thing that all of the risk studies cited above have in common is an exclusive focus on agricultural or farming related variables in the measurement of risk and return at the farm level. As with the work participation studies, none of the applications of CAPM or M-V allow formally for the fact that farm households are integrated into the non-farm economy through their choices in allocating effort or investment in differing income sources. Thus, these studies omit an important element of farmers' menu of choices: the possibility of diversifying into non-agricultural sources of income. The need and/or ability to rely on such sources should be related to the characteristics of the on-farm income stream in a systematic way depending on the risks and returns of the alternative activities.

This paper therefore addresses two distinct gaps in previous studies: the lack of attention to risk in studies of the off-farm labor decision, and the lack of attention to off-farm income sources in portfolio models of agriculture. Utility based household models incorporating risk aversion in consumption provide theoretical support for the importance of considering production risk in labor decisions but the data requirements for such a model make a more tractable approach desirable. This study makes a first step toward the eventual integration of these various considerations, using aggregate data to address questions of risk that are generally unapproachable on the basis of micro household level data due to lack of a long enough time series for direct measurement of risk.

This last point merits added emphasis. The value added of the approach in this study is the use of a *direct* measure of the risk of farm activities. The requirement of a data set incorporating a long enough time series to estimate the relevant risk measures in practice dictates the use of aggregate data on the state level. The resulting loss of cross sectional detail, i.e., individual farm family characteristics, is the price of achieving the goal of directly measuring production risk on the basis of time series, something which studies based on cross sectional data cannot do. This analysis therefore exchanges the limitations of previous studies (no direct measures of risk) for different limitations (less cross sectional detail). Nevertheless, both types of analysis yield interesting insights, and until such time as data sets allowing simultaneous analysis of both cross sectional and time series characteristics are available, both are worthwhile in that they complement and illustrate the limitations of each other.

The next section discusses the principal factors determining the extent to which farm households rely on off-farm income, and proposes a test to evaluate the importance of these factors. This is followed by sections presenting the empirical specification and regression results. The final section presents a summary and conclusions.

A Model of the Labor Allocation Decision

The decision problem faced by farmers is to allocate their total labor time between competing activities according to their expected returns and risks. Off-farm income derived from wage labor can be viewed as a relatively less risky activity since both production risk and price risk are borne by the employer and the return to the off-farm worker is equal to the wage. Farm production income, by comparison, is derived from activities for which the farmer bears both production and price risk. Accordingly, the model is set up as a simple risk minimizing problem where the choice variables are the amount of time devoted to on- and off-farm work.[1]

$$(1) \qquad \text{Min } L_F^2\sigma_F^2 + L_O^2\sigma_O^2 + 2L_oL_F \operatorname{Cov}(R,w)$$

subject to:

$$L_F + L_o \leq L$$

$$RL_F + wL_o \geq K$$

where:

L_F = labor used in farm production
L_o = labor used in off-farm work
R = expected return per unit of labor in on-farm work ($/unit)
w = expected return per unit of labor in off-farm work ($/unit)
σ_F^2 = variance of returns to farm labor
σ_o^2 = variance of returns to off-farm labor
L = available labor
K = required expected income from all types of employment

Solution of this problem yields the following first order conditions assuming the inequalities are binding:

$$(2) \quad \partial\mathcal{L}/\partial L_F = 2L_F\sigma_F^2 + 2L_o\operatorname{Cov}(R,w) - \lambda_L - R\lambda_K = 0$$

$$(3) \quad \partial\mathcal{L}/\partial L_o = 2L_o\sigma_o^2 + 2L_F\operatorname{Cov}(R,w) - \lambda_L - w\lambda_K = 0$$

$$(4) \quad \partial\mathcal{L}/\partial\lambda_L = L - L_F - L_o = 0$$

$$(5) \quad \partial\mathcal{L}/\partial\lambda_K = K - RL_F - wL_o = 0$$

Solving (2) for the Lagrange multiplier, λ_L, and substituting into (3) yields the following expression in solving for the optimum, L_o^*:

$$L_O^* = \frac{(\lambda_K/2)(w - R) + L_F(\sigma_F^2 - \operatorname{Cov}(R,w))}{\sigma_o^2 - \operatorname{Cov}(R,w)}$$

This expression for the optimal allocation of labor to off-farm production activities can be differentiated to yield expected relationships between the share of labor income derived from off-farm sources and the right hand side variables:

$$(7) \qquad \partial L_o/\partial\sigma_O^2 < 0$$

$$(8) \qquad \partial L_o/\partial\sigma_F^2 > 0$$

$$(9) \qquad \partial L_o/\partial R < 0$$

$$(10) \qquad \partial L_o/\partial w > 0$$

$$(11) \qquad \partial L_o/\partial\lambda_K < 0$$

These results imply that the share of off-farm income in total income rises with the riskiness of agricultural production and the returns to off-farm work as shown in (7) and (10), and falls with the returns to agricultural production and the riskiness of off-farm work as shown in (8) and (9). The expression in (11) says that off-farm labor (hence off-farm income) decreases as the tradeoff between risk and return increases. This can also be seen as analogous to a risk aversion coefficient in that a more risk averse farmer is more likely to work off-farm when such work is less risky. It should be

[1] It can be shown that the formulation presented in this section yields hypotheses which are equivalent to those based on a utility maximizing formulation. Details are available on request.

noted that this model implies that the shadow values of on- and off-farm wages can differ in the presence of risk; Streeter & Saupe analyze additional factors which can cause this divergence.

In addition to these factors it is reasonable to assume that reliance on off-farm income will depend to some extent on the availability of off-farm employment opportunities. That is, for a given level of risk and return associated with on-farm activities, we would expect to observe a greater level of reliance on off-farm income the greater the opportunity to obtain such employment.

In general, off-farm employment will be easier to obtain where there is a preponderance of nonagricultural activities in the local economy. That is, the less the share of agriculture in the local economy in general, the easier it will be for a given individual to find off-farm employment to the extent desired. One way to include this consideration is to take the share of agricultural population in total population in each state as a measure of the relative availability of off-farm employment. This variable should have a negative relationship with the share of total farm income derived from off-farm sources.

A second factor of potential importance is the rate of unemployment in the off-farm labor market. It is reasonable to assume that reliance on off-farm income is sensitive both to the returns to off-farm labor and to the probability of obtaining such work as reflected by the level of unemployment. Following Harris & Todaro, this consideration can be incorporated by equating the rate of employment (i.e., one minus the unemployment rate) with the probability of obtaining a job at the going wage. This probability can then be multiplied by the wage to obtain an expected off-farm wage which can then be used as the explanatory variable. That is, the expected value of the off-farm wage rate can be calculated as [1 − unemployment rate] times the wage.

Finally, it is reasonable to assume that farm size plays an important role in the decision to seek off-farm income. Larger farms both require more labor and are better able to assure minimum income requirements. Farm size has been shown to be an important determinant of reliance on off-farm income in household level studies such as those cited above. (See, for example, Huffman.)

Empirical Specification

This discussion implies estimation of a regression of the following form:

(12)

$$\begin{aligned}\text{OFFINC} = \alpha &+ \beta_1\text{FARMRISK} + \beta_2\text{OFFRISK} \\ &+ \beta_3\text{INCPC} + \beta_4\text{OFFWAGE} \\ &+ \beta_5\text{AGSHR} + \beta_6\text{FARMSZ} + e\end{aligned}$$

where:

OFFINC = share of off-farm income in total income;
FARMRISK = coefficient of variation of farm production returns;
OFFRISK = coefficient of variation of off-farm income;
INCPC = farm income per member of farm population;
OFFWAGE = wage in off-farm employment;
AGSHR = share of farm income in total state income;
FARMSIZE = average farm size
e = error.

The analysis is based on a cross section of the United States at the state level. This means that individual farm data are aggregated to produce state level values.[2] The period from 1960–1986 is used for estimation, since that span is the longest for which information is available.

The dependent variable, the share of off-farm income in total farm income, is defined as the average over the 1960–1986 period for each state. Information on farm income and off-farm income were obtained from the USDA's Farm Income data tapes.[3]

Risk of farm activities is measured as the coefficient of variation of net farm income. Net farm

[2] Application of the proposed model to aggregated data raises the possibility of aggregation bias, as noted in the Introduction. Two observations are important in this regard. First, the need to resort to aggregate data is generated by the inability to measure risk directly in available household level data. Previous studies based on this type of data are therefore open to criticism of a different bias, that is caused by missing variables. Second, in order for aggregation to cause spurious results, it would be necessary for off-farm income and production variability to show a very particular and consistent pattern of bias within each of the 50 states. There is no evidence that this is a problem; in fact, Tauer presents circumstantial evidence to the contrary with his finding that diversity of agricultural production at the state level (measured as a Herfindahl index based on twelve commodity groups) had a near-zero correlation with the coefficient of variation of cash receipts. This indicates that aggregation of farms producing different types of commodities does not have a systematic relationship with the riskiness of cash receipts at the state level. Regressions of off-farm income share and CV of net income on the same Herfindahl index also showed a near zero correlation (details available). Thus, arguments for a spurious cross-sectional relation in equation (12) based on a supposed relation between reliance on off-farm income and diversity of farm types are unlikely to find empirical support.

[3] See Lucier et al. for a detailed description of these data series.

income is the difference between the net value of farm production and total production expenses incurred in producing that income. Income from farm production is from the USDA Farm Income data tapes, and is measured as net farm income. The coefficient of variation of this variable over the 1960–1986 period was used to obtain a measure of the risk of farm income. This measure of income approximates the net value of production whether sold for cash, placed under Commodity Credit Corporation loan, used as feed, or put into inventories. Thus, the effects of government programs in reducing the risks involved with some activities (e.g. dairy) are accounted for in the measure of risk. Capital expenses were not available on a state level, and so were excluded from the analysis.

It is important to note that farm real estate values are excluded from this definition of returns to farm activities. Thus, the focus is on variability in the income stream of the farm population, and does not take account of the variability in (unrealized) changes in net worth. It is expected that the variability of returns to farming will be positively related to the percentage share of off-farm income in total income.

The possibility that changes in returns deriving from changes in the value of farm real estate may in fact be important cannot be ignored, and is examined in the empirical analysis below. In order to accomplish this, the risk measure defined above was replaced with state level indexes of total returns to farming measured as the weighted sum of the annual holding period returns to farm real estate and the annual returns to production. The weights were computed from the shares of real estate and production expenses in the total cost of production. Information on farm real estate was obtained from the USDA's Balance Sheet of the Farming Sector.

The variable used for the return to farming activities should relate to the per capita returns, since we are interested in comparing this to off-farm income which it is reasonable to assume is principally derived from salaried or wage employment on an individual basis.[4] Therefore, returns to farming are defined as net farm income per person in the farm sector. It is expected that this variable is inversely related to the share of off-farm income in total income.

Farm income per capita was obtained by dividing real net farm income (deflated by the CPI) by total farm population as obtained from the U.S. Census.[5] Since census data are available only on a decennial basis, the intervening years were obtained by interpolation, while the years from 1980–86 were obtained by extrapolating the 1970–80 growth rate for each state. The average of this income per capita series over the 1960–86 period was used in the regressions below.

Off-farm wages are measured as average hourly earnings of production workers on manufacturing payrolls, since this information was the best available proxy for variations in wages in the non-farm sector on the state level. These figures were adjusted for unemployment (as discussed above) using state-level data from the Bureau of Labor Statistics Handbook of Labor Statistics series of Average Hourly Earnings of Workers on Manufacturing Payrolls and were deflated by the CPI. State level unemployment rates used to adjust wage data to reflect the probability of getting work were obtained from this same source and the Manpower Report of the President. The coefficient of variation of this series was used to represent the risk of off-farm income.

The share of farm income in total state income was obtained by dividing farm income (as defined above) by total state income, as reported by the U.S. Bureau of Economic Analysis. As with the previous variable, the period average was used for the regressions.

Information on farm size is from the USDA series on land values shown in USDA Handbook No. 671 on Land Values and Land Use. The average value of farms in 1986 was used to represent this variable.

Table 1 presents summary statistics for these data. It can be seen that the mean share of off-farm income (OFFINC) over the 1960–1986 period is important in all states and ranges from a low of 31% in Arizona to a high of 88% in West Virginia. The coefficient of variation of real net farm income (FARMRISK) is shown in the second column of the table where it can be seen that there is substantial variation in the C.V. of this variable across states. The third column shows real off-farm wages for each state (OFFWAGE). Wisconsin was highest while Mississippi was lowest over the period covered. Farm income per capita (INCPC) is shown in the fourth column. These figures were obtained by dividing total farm family income by total farm population and so reflect the wide variation in family incomes in different regions. Arizona registered the highest average value for this

[4] It is also reasonable to assume that the returns from off-farm income derived from wages are relatively stable because of institutional reasons such as minimum wage legislation.

[5] All other variables are expressed as ratios, eliminating the need to deflate.

Table 1. Average Values for Variables Used

	OFFINC	FARMRISK	OFFWAGE*	INCPC**	AGSHR	FARMSIZE***
Alabama	0.61	0.24	2.32	1.79	0.02	162
Arizona	0.32	0.28	2.77	7.11	0.02	1,017
Arkansas	0.47	0.38	2.02	2.38	0.07	213
California	0.37	0.24	2.99	6.25	0.01	652
Colorado	0.52	0.47	2.87	2.23	0.02	460
Connecticut	0.54	0.24	2.75	3.70	0.00	441
Delaware	0.41	0.48	2.84	2.74	0.01	326
Florida	0.38	0.19	2.29	7.31	0.02	478
Georgia	0.57	0.34	2.16	1.76	0.02	222
Idaho	0.49	0.49	2.73	1.78	0.06	385
Illinois	0.52	0.50	3.00	1.71	0.02	365
Indiana	0.65	0.55	3.08	1.07	0.02	214
Iowa	0.44	0.49	3.07	1.64	0.09	254
Kansas	0.55	0.57	2.86	1.80	0.05	258
Kentucky	0.23	0.23	2.66	0.98	0.04	126
Louisiana	0.58	0.47	2.72	1.98	0.02	286
Maine	0.53	0.67	2.20	2.12	0.02	194
Maryland	0.62	0.34	2.82	1.44	0.01	278
Massachusetts	0.56	0.31	2.54	3.35	0.00	312
Michigan	0.66	0.27	3.40	1.04	0.01	169
Minnesota	0.44	0.50	2.90	1.45	0.04	193
Mississippi	0.58	0.40	1.96	2.15	0.05	169
Missouri	0.64	0.48	2.75	1.02	0.02	222
Montana	0.79	0.89	3.08	1.61	0.06	527
Nebraska	0.42	0.46	2.66	1.86	0.08	701
Nevada	0.70	0.94	3.07	1.52	0.01	701
New Hampshire	0.67	0.39	2.27	1.17	0.00	261
New Jersey	0.57	0.29	2.80	2.55	0.00	427
New Mexico	0.53	0.35	2.25	2.73	0.03	427
New York	0.57	0.39	2.75	1.22	0.00	168
North Carolina	0.49	0.31	2.00	1.72	0.03	161
North Dakota	0.44	0.83	2.45	2.08	0.14	381
Ohio	0.69	0.37	3.16	0.92	0.01	180
Oklahoma	0.68	0.43	2.62	1.41	0.03	224
Oregon	0.61	0.32	3.07	1.60	0.02	257
Pennsylvania	0.61	0.20	2.75	1.18	0.01	217
Rhode Island	0.47	0.55	2.21	5.83	0.00	377
South Carolina	0.65	0.48	2.03	1.15	0.02	174
South Dakota	0.35	0.51	2.42	1.90	0.14	259
Tennessee	0.73	0.30	2.24	0.78	0.02	136
Texas	0.64	0.33	2.64	2.13	0.02	401
Utah	0.72	0.52	2.74	1.51	0.01	399
Vermont	0.48	0.18	2.32	1.61	0.03	270
Virginia	0.74	0.45	2.30	0.79	0.01	200
Washington	0.47	0.35	3.26	3.08	0.02	348
West Virginia	0.88	0.72	2.78	0.35	0.00	93
Wisconsin	0.47	0.22	3.98	1.35	0.03	152
Wyoming	0.86	0.98	2.83	0.85	0.03	595

*1967 dollars.
**Thousands of 1967 dollars.
***Thousands of 1986 dollars.

variable while West Virginia was lowest. The fifth column shows the share of income from farm production in total state income (AGSHR). The average value was used in the regressions. However, there is a marked downward trend over the sample period for this variable, with the maximum and minimum values representing 1960 and 1986, respectively, in almost every case. The final column shows average farm value in 1986.

Use of mean values for the explanatory variables was motivated by the fact that several of these series vary from year to year, making the choice of any single year arbitrary. Lacking a persuasive case for designating any particular year as "representative," average values were used instead. Early versions of the model were tested using both beginning and end of period observations; the main results presented here were not materially affected.

Table 2. Regression Results Dependent Variable Off-Farm Income/Total Income (absolute value of t-statistics in parentheses)

	(1)	(2)	(3)	(4)	(5)
FARMRISK	0.24	0.25	0.24	—	0.23
	(5.40)	(5.47)	(6.27)		(5.38)
TOTAL RETURNS	—	—	—	0.04	—
				(1.01)	
OFFRISK	0.34	—	—	—	0.20
	(0.67)				(0.32)
INCPC	−0.05	−0.05	−0.05	−0.05	−0.04
	(6.75)	(6.89)	(9.79)	(9.54)	(5.03)
OFFWAGE	−2.92	—	—	—	3.36
	(1.32)				(1.14)
AGSHR	−2.30	−2.23	−2.23	−1.82	−2.25
	(9.29)	(9.12)	(9.17)	(6.56)	(5.39)
FARMSIZE	0.00	−0.00	—	—	−0.00
	(0.59)	(0.02)			(0.88)
LAKE STATES					−0.05
					(1.51)
CORN BELT					−0.01
					(0.25)
NORTHERN PLAINS					0.03
					(0.57)
APPALACHIA					0.09
					(3.71)
SOUTHEAST					0.08
					(2.79)
DELTA STATES					0.06
					(1.85)
SOUTHERN PLAINS					0.11
					(3.37)
MOUNTAIN					0.06
					(1.74)
PACIFIC					0.01
					(0.31)
$\bar{R}^2$	0.70	0.70	0.70	0.58	0.77
F	38	56	75	44	22

FARMRISK = Coefficient of variation of net farm income.
TOTAL RETURNS = Barry's measure of farm asset risk (including returns to farm real estate).
INCPC = Average per capital income of farm population.
OFFWAGE = Hourly wage of manufacturing workers (adjusted for unemployment).
AGSHR = Share of farm income in total state income.
FARMSIZE = Average value of farms.

It should also be noted that use of averages is in accord with standard practice when applying portfolio models to agricultural activities, where risks and returns to particular activities or crops are represented by mean returns together with a measure of the variance of returns. See, for example, Barry (1980), Irwin et al. (1988) and Kaplan (1985).**

Results

Results for equation (12) are shown in Table 2. As can be seen from these regression results, all variables except OFFWAGE, OFFRISK, and FARMSIZE enter with the expected sign, and have a low standard error. R^2 is quite high for a cross sectional equation of this type, at 0.72, with an adjusted R^2 of 0.70. It is apparent that the variable representing the coefficient of variation of returns to farm production, FARMRISK, is important in explaining the extent of reliance on off-farm income. The partial correlation coefficient[6] of 0.42 indicates that this variable explains a substantial proportion of the residual variation in mean off-farm income remaining after accounting for the effects of other variables.

** Thanks to an anonymous reviewer for suggesting this point.

[6] The partial correlation coefficient is defined as $r^2_{yx1.x2x3}$, or the percent of the residual variance explained by x_1 after accounting for the effects of all of the other independent variables. It is calculated as $t^2/(t^2 + df)$.

Both income per capita (INCPC) and the share of farm income in total state income (AGSHR) entered with the expected signs and were very significant determinants of variation in mean off-farm income. The result for INCPC support the hypothesis that high income from farm activities lessens the need to seek income from other sources. This is in line with results obtained in previous analyses based on micro level data. See, for example, Huffman, Sumner, and Jensen & Salant.

OFFWAGE, the variable representing wage levels in the off-farm labor market, was insignificant in this regression as well as in various reformulations of the original model. Using the rate of unemployment as a separate explanatory variable rather than using it to adjust off-farm wages yielded no improvement in results. It may be that this lack of significance is due to the quality of the data available to measure this variable. Unfortunately, there are no alternative sources for comprehensive and consistently defined state level series on employment and wages.

Also, insignificant was OFFRISK, the risk associated with off-farm labor. As discussed above, the risk of layoff is proxied by using the unemployment rate to adjust real wages to obtain a direct measure of the variations in expected wages. This variable proved to have no explanatory power in any of the regressions. This can be attributed to the low variance of wages and supports the conclusion that off-farm income can provide a way to diversify farm household income streams.

Nevertheless, the importance of the demand side of the off-farm labor market is confirmed by the importance of AGSHR. This result indicates that for a given level of farm income and risk, reliance on off-farm income depends on the extent to which the local economy can provide such employment. This finding is in line with what might be expected, given the high correlation of agricultural returns across production units in a particular area. That is, given the importance of exogenous variables affecting all farmers in a given state (weather, market conditions, etc.), the need to resort to off-farm sources to maintain income is likely to arise simultaneously. The smaller the farm sector relative to the overall local economy the more easily these job seekers can be absorbed in the labor market. As noted above, institutional factors such as minimum wage legislation limit the extent to which wages can equilibrate supply and demand in this market. While a more fully specified off-farm labor market would be preferable, the aggregate nature of the data used in this study preclude the detailed approach possible with household level data.

Another experiment involved a regression in which the variable FARMRISK was replaced by the coefficient of variation of *total* returns to farming including returns to real estate. The resulting measure of risk is almost identical to that used by Barry in his original estimation of a farm sector CAPM. As can be seen in equation (4) in Table 2, this reformulation is of little use in explaining variation in the share of off-farm income, leading to the conclusion that off-farm income is used as a way to diversify sources of current income or cash flow. Thus, liquidity concerns rather than questions of net worth seem to be more important in making the decision to seek off-farm income. Another version of this model was tested in which production risk and real estate risk were used as separate explanatory variables. This regression confirmed the above results in that the coefficient for production risk remained significant and virtually unchanged in magnitude while the coefficient for real estate risk was not significantly different from zero.[7]

A final experiment, shown as equation (5) in Table 2, included dummies for the 10 USDA regions. Explanatory power is improved, with an $\bar{R}^2$ of 0.77. Three of the dummies were significant with the Appalachian, Southeastern and Southern Plains regions all showing a positive relationship (compared to the Northeastern region) with the dependent variable.

Finally, the regressions were subjected to a Goldfeld-Quandt test to ensure that there were no problems with heteroskedasticity. (See Judge et al. P. 449.) The 48 states were ranked according to farm size and partitioned into low and high value subsamples after eliminating the eight central observations. An F statistic was then calculated from the residual sums of squares of these two regressions. The value of 1.74 obtained is well below the critical 5% point of 2.48 for $F_{14,14}$. Thus the null hypothesis of no heteroskedasticity cannot be rejected.

Overall, the regressions performed quite well, with good explanatory power for cross-sectional models of this type. The importance of production risk in explaining reliance on off-farm income is clear. This result was very robust, remaining essentially unchanged in various reformulations of the original model.

Conclusions

The results presented here show that risk is an important factor in allocating efforts between on-

[7] Details available on request.

and off-farm sources of income. The analysis indicates that reliance on off-farm income by the farm population is closely related to the risk and return characteristics of farm production activities. Both the return to farm activities and the riskiness of this stream of returns were found to be important determinants of the extent of reliance on off-farm income in a cross sectional regression of the lower 48 states over the 1960–1986 period.

It is interesting to note that this result applies to the riskiness of current income streams derived from production expenses and income. The riskiness of total returns to farming including real estate values did not have any detectable relation with reliance on off-farm income in the data analyzed.

In addition, the extent to which the farm population relied on off-farm income, on average, is influenced by the relative share in the labor force accounted for by farming. This finding indicates that the decision to seek income from off-farm sources may be constrained by the ability of the local economy to generate sufficient employment opportunities. Measures of the risk and return of off-farm employment had no significant relationship with reliance on off-farm income.

In sum, it is clear that analyses of off-farm income and employment must take account of the risk and return characteristics of farm production activities. Also, it is clear that analyses of farm decision making in which differing crop alternatives are viewed in a portfolio context must take account of the fact that the existence of off-farm income sources adds an important element to the menu of choices faced by farmers.

An important policy implication of these findings relates to current proposals to eliminate farm programs in major producing nations. Insofar as removal of interventions results in greater variation in prices received, and/or lower household income due to subsidy removal, we can expect farmers to rely more and more on off-farm sources of income. In addition, this implies that farm programs will have a declining direct effect on rural populations as a greater percentage of income derives from non-farm sources.

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