OFF-FARM INCOME AND INVESTMENTS IN FARM ASSETS: A DOUBLE-HURDLE APPROACH

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Selected Paper prepared for presentation at the AAEA, CAES, and WAEA Joint Annual Meeting, Denver, Colorado, July 25-27, 2010

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Introduction

The farm household encompasses a complex set of inter-relationships between and among a variety of internal and external factors involving consumption, investment, and income-earning activities. For example, farm households today receive a substantial part of their income from non-farm sources such as wage and salary jobs and non-farm businesses. In the U.S., for example, income from off-farm sources accounted for 90% of the total income for farm households in 1999 (USDA-ERS, Mishra et al, 2002).

Other studies documenting the importance of off-farm income are Fuller (1991), Huffman (1991) and Weiss (1999). The picture remains the same if part-time farm households are defined on the basis of time spent in farming. In a study of off-farm employment in Austria, Weiss (1997) estimates that on more than 50% of farms, the husband and wife work less than 50% of their working time on the farm.

These findings may seem surprising since it is generally presumed that full-time farm operations are more efficient than part-time farms. Full-time operations have the advantage of scale efficient technology and lower costs of credit. This led Cochrane to comment, "…most [part-time farms] are going to bite the dust…cannibalized by their larger, aggressive, innovative neighbors" (Cochrane, 1987). However, there is little

evidence that this is happening. Instead, studies indicate that mid-sized farms are squeezed out as the size structure of farms settles to a bi-modal distribution where farms are either large full-time operations or small part-time activities (Weiss, 1999).

In general, off-farm work has provided a mechanism for maintaining income parity with other groups in the society (Gardner, 1992). Gardner (2005) also notes that the integration of farm and nonfarm labor markets has slowed the overall rate of decline in the number of farms. Now many people are commuting to nonfarm jobs while they remain living on the farm. Furthermore, according to Gardner, small farms are flourishing to an extent that no one guessed 20 or 30 years ago. Presumably, off-farm income has contributed to reducing the riskiness of the income stream facing the farm household. However, if part-time farms are less economically efficient, then lower rates of returns on total assets should lead to their exit if the farm is viewed as a source of income.

Related Studies

The literature on the optimal capital structure of farm businesses and households is extensive. Factors affecting optimal capital structure include depreciation, taxes, investment tax credits, economies of scale, wealth, and adjustment costs (Ahrendsen et al.; Barry et al.,2000); the cost of debt capital, asymmetric information problems, agency costs, adverse selection, moral hazard (Barry et al. 2000; Zhao, Barry, and Katchova, 2008); credit constraints (Featherstone, 2005; Bierlen et al.,1998); financing costs (Zhao, Barry, and Katchkova, 2008); lender-borrower relationships (Turvey and Weersink, 1997); consumption (Weber, 2002; Mishra, et. al., 2002); life-cycle model of the farm household (Mishra, et. al., 2002; Phimister, 1995); signaling, pecking order, and trade-off theories (Zhao, Barry and Katchova, 2008); transaction costs and risk aversion (Juiso, Jappelli, and Terlizzese, 1996; Benjamin and Phimister, 1997; Robison, Barry and Burghardt, 1987); specialization (Purdy, Langemeier, and Featherstone, 1997); tenure position

(Ellinger and Barry, 1987) and leasing (Boumtje, Barry, and Ellinger, 2001), off-farm work (Lagerkvist, Larsen, and Olson, 2007); risk balancing (Collins, 1985; Yan Yan, Katchova, and Barry, 2004); diversification, age, education, type of farm, gross farm income, amount of debt, return on assets, and government payments (Katchova, 2005).

Several off farm employment studies have been conducted. Some studies indicate a life cycle effect for off-farm employment which suggests that individuals will increase their work efforts in their younger years to accumulate wealth to draw on in later life (Huffman ,1980; Sumner 1998). Previous studies have also suggested that older farm operators may be less likely to work off farm, which may suggest differences in attitudes regarding work that are correlated with age (Mishra and Goodwin, 1998). Many researchers suggest that the larger the farm, the lower the probability that farmers work off the farm (Mishra and Goodwin, 1998). However, Mishra et al (2002) found that the operator and spouse often pursued dual careers even in households operating large farms. Hennessy and O'Brien (2005) found that farm characteristics such as system, size, and profitability are important factors affecting farm investment. However, they were led to reject the theory that income drives farm investment.

The Relationship Between Off-farm Income and Farm Investment

There are a number of economic theories as to why off-farm income may affect farm investment (O'Brien and Hennessy, 2005). The agricultural household production model suggests that it is economically rational for farmers that work off the farm to invest in farming if the farm investment allows them to maintain or increase farm output with less farm labor. In effect, farmers that work off the farm may maximize their total income by using some of their off-farm income to invest in the farm. The presence of off-farm

income may also relax the budget constraints in the farm household. Farm households that depend only on farm income have to use a larger proportion of farm profit to satisfy the consumption demands of the household. In households where additional income is present, the budgetary constraints are relaxed thereby making more of the farm profit available for reinvestment.

A number of previous studies have investigated these theories. Rosenzweig and Wolpin (1993) and Ahituv and Kimhi (2000) found that a substitution effect exists between farm labor and capital, where farmers working off-farm substitute capital for labor as capital deepening releases labor from farm production. Upton and Haworth (1987) examined the growth of farms in the UK using Farm Business Survey data. They found evidence to support a positive relationship between farm growth and off-farm income, thereby suggesting that farmers with higher levels of off-farm income were more likely to grow their farms through investment. These studies suggest that there may be a positive relationship between farm investment and off-farm income. However, the reverse can also be argued and supported with empirical evidence.

The transition from full-time to part-time farming can often be perceived as a first step out of farming and therefore farmers that work off the farm might not be expected to reinvest in farming. A number of studies, as reviewed by Hennessy and Rehman (2008), show that farmers that work off the farm typically operate more extensive and less profitable farms. Glauben et al (2003) conducted a review of studies that investigated these issues. They cite a number of studies that presented empirical evidence that farmers that work off the farm have lower expectations of continuing the farm business, are less likely to have a successor and as a consequence are less

likely to invest in their farms. It follows then that farmers that work off the farm may be less likely to reinvest in the farm business. Furthermore, a study conducted by Anderson et al (2005) using farm data from the US shows that an increase in off-farm income increases the investment in non-farm assets relative to farm assets.

It seems that there are conflicting theories about the relationship between off-farm income and farm investment. On the other hand, farmers that work off the farm may choose to substitute capital for labor thus increasing farm investment. Furthermore, the presence of off-farm income in the household, earned by either farmer or spouse, may "free-up" more capital for reinvestment in the business. On the other hand however, farmers that work off the farm seem typically to operate less profitable, less intensive farms and therefore may be less likely to reinvest in a business that may provide a poor return.

In this paper we use ARMS data to explore the contribution of off-farm income to the viability of the farm business. We focus on the link between off-farm income and farm investment and whether off-farm income drives on-farm investment.

Modelling the Investment Decision

The investment decision can be viwed as a binary one, i.e. to invest or not, and thus can be analyzed using a dichotomous choice probit model. However, farmers are also faced with the decision of how much to invest. Modelling both decisions together is more desirable since such a model would provide information about who invests and how much. Estimating just the level of investment ignores the potential extra information in the data about who actually invests. One approach is to estimate the first decision using probit and the second stage using tobit. However,

employing a choice model assumes that a farm can either choose to invest or not. A choice model is no longer appropriate if the farm has no money to invest. We apply the double-hurdle model in our analysis to minimize these problems. The first hurdle is based on whether farmers invest in their operations and the second hurdle models the decision on the amount of farm investment. The model is estimated using ARMS data for 1999 and 2008. The ARMS collects detailed information on farming activities.

The double-hurdle model, originally formulated by Cragg (1971), assumes that two hurdles are involved in the process of investment decisions, each of which can be determined by a different set of explanatory variables. In order to observe a positive level of investment, two separate hurdles must be passed. A different latent variable is used to model each decision process,

$$y_{i1}^{*} = w_i' \alpha + v_i \text{ investment decision}$$

$$y_{i2}^{*} = x_i' \beta + u_i \text{ level of investment}$$

$$y_i = xi'\beta + u_i \quad \text{if } y^{*}_{i1} > 0 \text{ and } y^{*}_{i2} > 0$$

$$y_i = 0 \quad \text{otherwise}$$

Data and Descriptive Statistics

The ARMS is a rich data source which allows the exploration of cross-sectional data over several years. Unlike most previous studies, the sample provides an accurate estimate of debt usage by farm households across all regions, farm types, and operator demographics, by year.

For this study we use two cross-sections of the USDA farm-level ARMS data -- 1999 and 2008. The descriptive statistics are shown in table 2.

Results

The estimated coefficients, the marginal effects (the effect of a unit change in each explanatory on the probability of investing) and the level of capital expenditure for the double hurdle model are shown in table 3.

Operator age was not found to significantly affect the decision to invest or the level of capital expenditures. This is surprising since previous studies cite a life cycle effect, where the probability of investment increases with age as younger farmers grow their businesses, and then declines with age as older farmers near retirement (O'Brien and Hennessy, 2005).

The results also indicate that farm size (gvsales) is a significant factor influencing both the probability of investment and the level of capital expenditures in 2008. The positive, significant value indicates that as farms increase in size, they require larger levels of capital expenditures. Education has varied effects in 2008—a college education reduces the level of capital expenditures and a postgraduate degree reduces the probability of farm investment. This might suggest that highly educated farm operators may be using higher off farm incomes to finance farm investment or substitute higher off farm income for farm income.

The level of farm diversity (entropy) is significant and positive for both the stages of the double hurdle model in 2008. The coefficient is negative and significant. As the level of diversification increases, the level of risk decreases. This reduces the level of investment since positive investment would increase overall risk. The level of vertical integration is also positive in the second stage for 2008. Higher levels of contracting create higher levels of investment since risk is reduced under contracts or is needed to continue securing contracts.

The main hypothesis being examined is the link between off farm income and farm investment. Total farm income (totofi) was significant and negative in the first stage for both 1999 and 2008. The variable was positive and insignificant in the second stage for both 1999 and 2008. Apparently, the presence of off-farm income reduces the probability of investing in the farm and does not increase the level of investment in the second stage. Therefore, we cannot conclude that off-farm income is driving farm investments.

Conclusions

The results indicate the importance of farm characteristics such as type, size, and location on the probability of investment but lead us to reject the hypothesis that off farm income is driving farm investment. Further research will be need to further unweave some of the complex relationships involved in the farm household structure.

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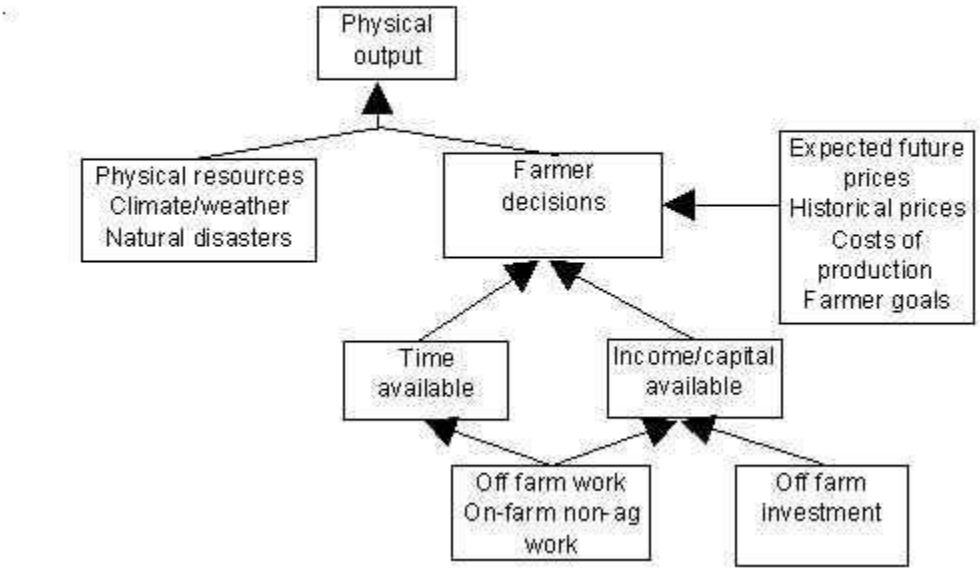
Figure 1. The relationship between off farm income and output from farming



Source: Parmiter, Irene, *Off Farm Income and Practice*, Technical Paper 97/5, Ministry Of Agriculture, New Zealand, June 1997.

Table 1. Variable Descriptions

Variable	Units	Description
Invest	1=yes; else=0	Farm capital expenditures
Expenditures	Dollars	Farm capital expenditures
College	1=college; else=0	Education (finished degree)
Postgraduate	1=postgraduate; else=0	Education (beyond four year degree)
Op_age	Years	Age of farm operator
Fowner	1=full owner; else=0	Farm ownership
Gvsales1	Thousand dollars	Gross value of farm sales
Entropy	0 to 100	Level of diversification
Getgovtpayments	1=yes; else=0	Receives government payments
Workofffarm	1=yes; else=0	Off farm employment
Totofi	Dollars	Off farm income
Ratioasst	Ratio	Ratio of farm assets to household assets
Lakestates	1= Lakestates; else=0	Region
Cornbelt	1=Corn Belt; else=0	Region
Nplains	1=Northern Plains; else=0	Region
Delta	1=Delta: else=0	Region
Mountain	1=Mountain; else=0	Region
Indexverticalintegration	Ratio of contract sales/total sales	Level of vertical integration
Dairyfarm	1=dairy farm; else=0	Type of farm

Table 2. Summary Statistics

	2008		1999	
Variable	Mean	Std. Dev	Mean	Std. Dev
Invest	0.29	0.46	0.28	0.45
Expenditures	16158.67	77361.57	15514.22	80860.31
College	0.2583	0.4377	0.2433	0.4291
Postgraduate	0.2386	0.4662	0.1358	0.3426
Op_age	57.6768	13.1719	54.7675	13.5794
Fowner	0.6573	0.4746	0.5811	0.4934
Gvsales1	120691.9	645247.7	71465.63	448119.8
Entropy	0.001662	0.0103	0.0899	0.1212
Getgovtpayments	0.3743	0.4839	0.4152	0.4928
Workofffarm	0.6652	0.4719	0.6427	0.4792
Totofi	70692.36	117452.0	57962.55	92725.46
Ratioasst	32.4388	30.5036	31.9602	197.869
Lakestates	0.1029	0.3038	0.0711	2571.0
Cornbelt	0.1816	0.3855	0.1956	0.3967
Nplains	0.0570	0.2319	0.0597	0.2369
Delta	0.0544	0.2267	0.0557	0.2294
Mountain	0.1097	0.3125	0.1036	0.3048
Indexverticalintegration	0.0905	0.3490	0.0758	0.2434
Dairyfarm	0.0264	0.1603	0.0422	0.2100

Source: Agricultural Resource Management Survey (ARMS), 2008

Table 3. Double Hurdle Results

	2008	1999
First Hurdle		
Constant	4.26***	3.72
College	1.06	-1.30
Postgrad	-0.96**	-1.22
Op_age	-0.02	-0.005
Fowner	-2.74***	-0.16
Gvsales1	0.010*	0.04
Entrophy	-36.27*	0.88
Getgovtpayments	-0.41	-0.17
Workofffarm	0.010	-2.67***
Ratioasst	-0.0001***	0.67*
Lakestates	8.07***	0.42
Cornbelt	2.89***	3.43***
Nplains	10.24***	7.50***
Delta	4.12	3.02*
Mountain	0.61	1.60
Indexverticalintegration	-0.07	0.79
Dairyfarm	6.31***	-6.82***
Totofi	-0.002***	-0.00006**
Second hurdle		
Constant	-157490.40***	-197297.90***
College	-15578.66**	-1287.32
Postgrad	-2630.75	-1180.12
Op_age	-41.27	424.99
Fowner	5739.95	6315.32
Gvsales1	7.38***	1.52
Entrophy	-1978478***	84694.54**
Getgovtpayments	23296.53***	22563.78**
Totofi	83.87	0.50
Ratioasst	1.35	1.79
Lakestates	88412.81***	-3342.64
Cornbelt	115238.80***	98991.46***
Nplains	62515.69***	64125.42***
Delta	58989.94***	51245.63***
Mountain	72196.68***	58867.88***
Indexverticalintegration	33819.83*	-22920.73*
Dairyfarm	-56613.80***	-24047.02*
Logliklihood	-80779.98	-37939.45
Sample size	19209	9348

***=99% significance; **=95% significance; *=90% significance

Table 4. Marginal effects

Variable	2008	2008	1999	1999
	Probability	Expenditure	Probability	Expenditure
College	-0.387	-11324.67**	-0.0087	-11905.24
Postgrad	-0.0278**	-12848.13	0.0083	-22415.64
Op_age	-0.0009	-371.8473	0.0010	172.3669
Fowner	0.0531***	26931.85	0.0072	25720.19
Gvsales1	0.00003*	0.8224***	0.000005	-59.4829
Entrophy	-4.5992*	-6557981***	0.1727	2549.184**
Getgovtpayments	0.0792	-5674.853***	0.0667	-8176.944**
Totofi	0.00000005***	0.0601	-0.0000003**	-0.0424
Workofffarm	-0.0148	-5430.336	-0.0280***	7251.504
Ratioasst	-0.0000004***	-3.0908	0.00001*	-0.1702
Lakestates	0.3171***	73266.54***	0.0164	733.673
Cornbelt	0.3879***	111928.2***	0.3483***	92210.74***
Nplains	0.1955***	65862.58***	0.1865***	39930.53***
Delta	0.2225	39696.24***	0.1643*	25930.24***
Mountain	0.2222	74634.88***	0.1765	33635.61***
Indexverticalintegration	0.0151	4889.443*	-0.0279	-95701.88*
Dairyfarm	-0.1336***	-78000.28***	-0.0845***	-81112.64*

***=99% significance; **=95% significance; *=90% significance
Note: Significance based on double hurdle coefficient significance.