CHANGES IN DEBT PATTERNS AND FINANCIAL STRUCTURE OF FARM BUSINESSES: A DOUBLE HURDLE APPROACH[1]

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Introduction

Income and wealth gains have resulted in unparalleled financial outcomes for U.S. agriculture this decade. Both producers of crop and livestock commodities and owners of farm assets, particularly farmland, have benefited. Even agriculture's generation of 'on-again, off-again' record level profits pales in comparison to the sustained rise in asset values that stretches for over two decades from the end of the last major financial crisis. Just since 2000, farm asset values have nearly doubled in nominal terms, rising by over a trillion dollars from 2000 to 2008, figure 1. Debt levels have continued to rise, but the increase in asset values has been so pronounced that farm equity has doubled, figure 2. Despite overall rising debt levels, the percent of farms that use agricultural credit has decreased from 60 percent in 1986 to 31 percent in 2007, figure 3. In 2008, U.S. agriculture as a whole will use less debt relative to its asset and equity base than at any time since USDA began developing estimates of the Farm Balance Sheet.

Against a backdrop of a high level of sector-wide financial performance, questions are arising about the possibility that U.S. agriculture may encounter financial stresses resembling those of the 1980's. Regardless of the probability of occurrence, the financial structure of U.S. farm businesses has changed considerably since the 1980s. Increased competition in agricultural commodity markets, increased opportunities for off-farm income, and increased nonagricultural sources of demand for farmland have caused farm households to become more diverse in their sources of income (Blank et

al., 2009). Furthermore, recent research is now recognizing that farmers and ranchers are making consumption and production decisions based on total household wealth, not just on-farm production profitability (Carriker et al.1993; Mishra, 2002;).

Finance studies have also examined whether gaps or distortions between a firm's costs of internal funds and external sources of investment funds stemming from capital market imperfections influence its investment behavior and funding preferences (Hubbard, 1998; Gertler, 1988). Capital market distortions may arise from asymmetric information between borrower and lender, from adverse selection, or moral hazard. Barry et al. (2000) note that the approach of business studies in general is to demonstrate that the investment decisions of firms operating in imperfect financial markets are sensitive to the availability of internal funds.

Barry et al. note that determining whether farm businesses experience similar funding preferences in their financial structure is important because of several salient characteristics. First, farm businesses are typically small in size, capital intensive, high risk, and make extensive use of debt capital and leasing of farm real estate while utilizing little outside equity capital. Second, they are also subject to periods of financial stress, as occurred in the 1980s. These rather unique structural and financial characteristics of farm households vis-à-vis non-farm businesses and non-farm households further motivate this study.

Objectives

The objective of this paper is to help explain one aspect of the changing capital structure of U.S. production agriculture – the increase in the number of debt free farms (figure 3). We consider the farm operator's decision to borrow outside funds as a "two-step" process. First, we discuss some

related studies, conceptual framework, and the econometric approach. We follow with some preliminary results and conclusions..

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).

Conceptual Framework

Farmers borrow funds (capital inputs) at a specified interest rate when the expected rate of return in the production process is greater than the cost of the borrowed funds. Basically, this process is simply an extension of the risk-balancing hypothesis (Katchova, 2005). According to the hypothesis, farmers maximize their expected utility when an increase in financial leverage leads to a decrease in financial risk. Since interest rates and profitability are important factors in terms of

credit use, we include these factors in our analysis of credit use along with other farm and financial characteristics.

Stiglitz and Weiss (1981) also incorporated capital markets with imperfect information into their analysis of credit use. Their approach acknowledges that the debt market consists of both demand (borrowers) and supply (lenders). Lenders are concerned about interest rates charged and the risks of default. They further talk about the effect of interest rates on the borrowers' pool due to the problems of moral hazard and adverse selection problems. Basically, they showed that credit rationing may exist due to informational problems between lenders and borrowers.

Berger and Udell (2002) further provide a basis for including financial measures (factors) that influence the use of debt capital. Availability of credit small businesses (and farms) may be limited due to disequilibrium in credit markets. Loans to farms can be categorized into four loan categories: 1) loans based on the balance sheet and income statement data; 2) loans based on collateral (assets); 3) loans based on credit scoring models and models of creditworthiness, and 4) loans based on personal interaction (these are face-to-face transactions between borrowers and lenders). Because financial factors are an important part of the process of borrowing and lending, these factors are included in our empirical analysis.

In developing a framework for our paper, we must also consider the agricultural credit market. In essence, loan markets have at least five characteristics: 1) observed debt depends on both demand by borrowers and supply by lenders; 2) loan markets, even in equilibrium, are rationed due to disequilibrium, default (potential creditworthiness), or unfavorable rates or terms; 3) lenders and borrowers both have veto power, either may ration the other; 4) two forms of rationing may exist, either loan rationing or amount rationing; and, 5) creditworthy borrowers may not wish to hold debt

at all times or even at all (Schreiner, et. al., 1996). Any econometric model that analyzes debt should address these factors, if possible.

Credit decisions are inherently joint decisions between the lender and the borrowers. However, this paper examines cross-sectional differences in the current structure of debt regardless of whether they are credit constrained or not. We estimate models for two cross sections (1997 and 2006). We then compare result between the twp time periods.

Econometric Models

Conventional models of the demand for credit use information from those farm businesses that have used credit and not from those who have not borrowed. Omitting the non-borrowers distorts the properties of an original sample of farms. Furthermore, ignoring the initial decision to borrow or not to borrow can lead to biased estimates. We apply the double-hurdle model in our analysis to minimize the problems listed above. The model has been used in economics to analyze a wide variety of individual demand and labor supply behavior plus consumer issues. Since we are unable to observe supply or demand of debt capital, these considerations lead to the specification of our double hurdle model, which incorporates a partial observability model at each of the two hurdles. The first hurdle is based on whether a loan occurs or not and the second hurdle is the amount of the loan. Each hurdle is itself a partial observability model in which the observed outcome is the minimum of unobserved supply and demand (Fair and Jaffee, 1972).

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

$$y_{i1}^{*} = w_i{}'\alpha + v_i \text{ transaction (lending/debt) decision}$$

$$y_{i2}^{*} = x_i{}'\beta + u_i \text{ loan amount demanded/supplied}$$

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

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

Data and Descriptive Statistics

The ARMS is a rich data source which allows for the exploration of cross-sectional data for 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 for 1997 and 2006. The descriptive statistics are shown in appendix table 2.

Here the dependent variable under analysis shows a strong skew, figure 4. In this situation it is tempting to apply the logarithmic transformation. However, the model we are estimating is dependent on the assumption of normality in the error terms. Without normality, the property of consistency of the maximum likelihood estimator fails to hold. However, the logarithmic transformation is clearly inappropriate due to the presence of the zero observations in the sample. Instead we use the Box-Cox transformation, which is defined as:

$$y^{T} = \frac{y^{\lambda} - 1}{\lambda} \qquad 0 < \lambda \leq 1$$

When applied to the dependent variable in the double hurdle model, we obtain the Box-Cox double hurdle model, defined as follows (where the latent variables d* and y** are defined as:

first hurdle:

$$d_i = 1 \; if \;\; d_i^* > 0$$
$$d_i = 0 \; if \;\; d_i^* \leq 0$$

second hurdle:

$$y_i^{*T} = \max\left(y_i^{**T}, -\frac{1}{\lambda} \right)$$

Observed y^T :

$$y_i^T = y_i^{*T} \; if \;\; d_i = 1$$
$$y_i^T = -\frac{1}{\lambda} \; if \;\; d_i = 0$$

Note that the lower limit of the transformed variable is -1/λ rather than zero.

Results

The double hurdle model is used to examine the effects of farm typology and financial characteristics on both farm credit use and indebtedness. The results (appendix table 3) show that the debt service variable has the largest effect on credit use. This variable is a ratio which measures the amount of cash available relative to principal, interest, and lease payments. This result, along with the very small impact of the value of farm assets suggests that income may be more important to the credit use decision than the value of assets. However, it seems to be less important in 2006 than in 1997.

The operator age variable is negative and significant in both years. This finding is consistent with life-cycle effects described in economic theory. Farmers generally pay off their debt as they age and older operators are likely to have less debt since they are more risk averse.

Other farm typological and financial variables were significant but had small and mixed effects. Education was found to have small but positive effects coupled with mixed regional effects. Larger

farms (as measured in gross sales) were also found to use agricultural credit less than farms with lower gross sales. Farmers that us various strategies, such as contracts, to reduce risk, were found to be slightly more likely to use debt (borrow). However, this effect is very small.

In the second stage, we look at indebtedness and the factors which influence the distribution of debt. These results reflect the effects of farm typology and financial characteristics on the degree of indebtedness. Farm size (gross sales) had a large impact on the degree of indebtedness in both 1997 and 2007. However, the effects were much smaller in 2006. The debt service ratio variable was also significant and small in 1997 and insignificant in 2006 coupled with a total assets variable which also had very small values but was significant. Larger farms with higher sales (gross incomes) and potentially higher profits may be practicing the risk-balancing hypothesis and are more inclined to finance their projects with debt.

The stage two effects of education and regional effects were again, mixed. However, some noticeable differences in the degree of indebtedness exist between regions.

Conclusions

This study uses farm-level data to examine the farm and personal characteristics affecting the use of credit and the degree of indebtedness. Although our model and results are tentative, they do identify a few common trends among farm businesses by farm typology and financial characteristics.

Our findings suggest that nonfinancial factors, such as operator age, region, risk aversion, and financial factors such as debt service ability and the cost of capital play significant roles in distinguishing borrowers from non-borrowers.

Future research will consider other potentially key explanatory variables and explore alternative econometric methods of modeling farm household credit use.

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Figure 1--Farm Business Debt, 1970-2009f

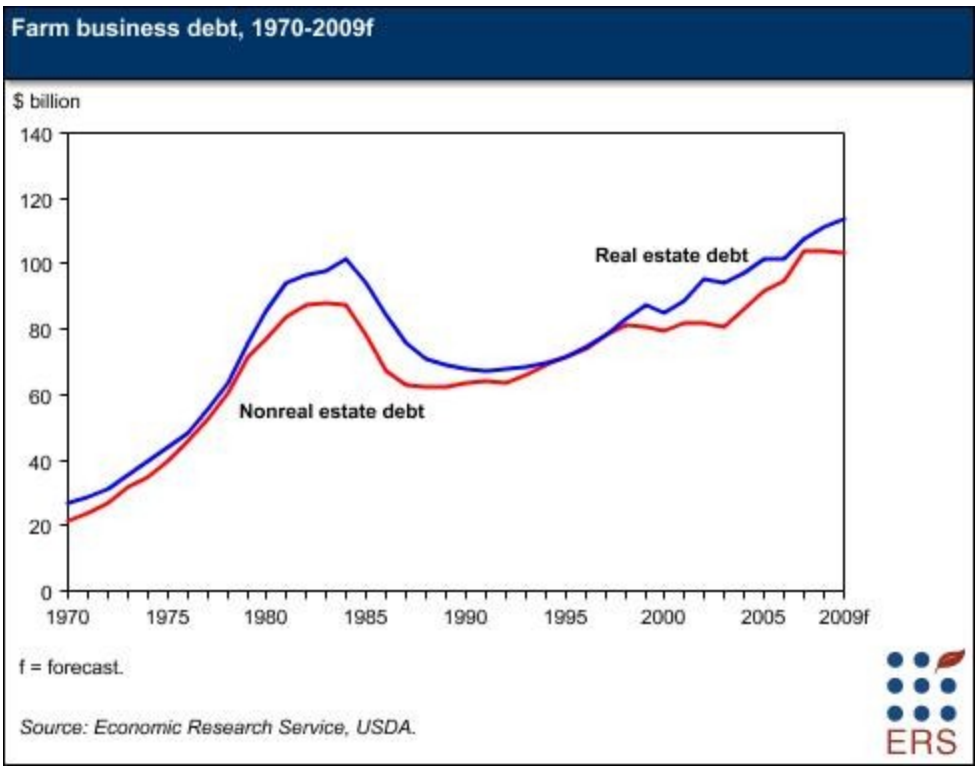


Figure 2—Debt-to-equity ratio of farmers, 1970-2009f

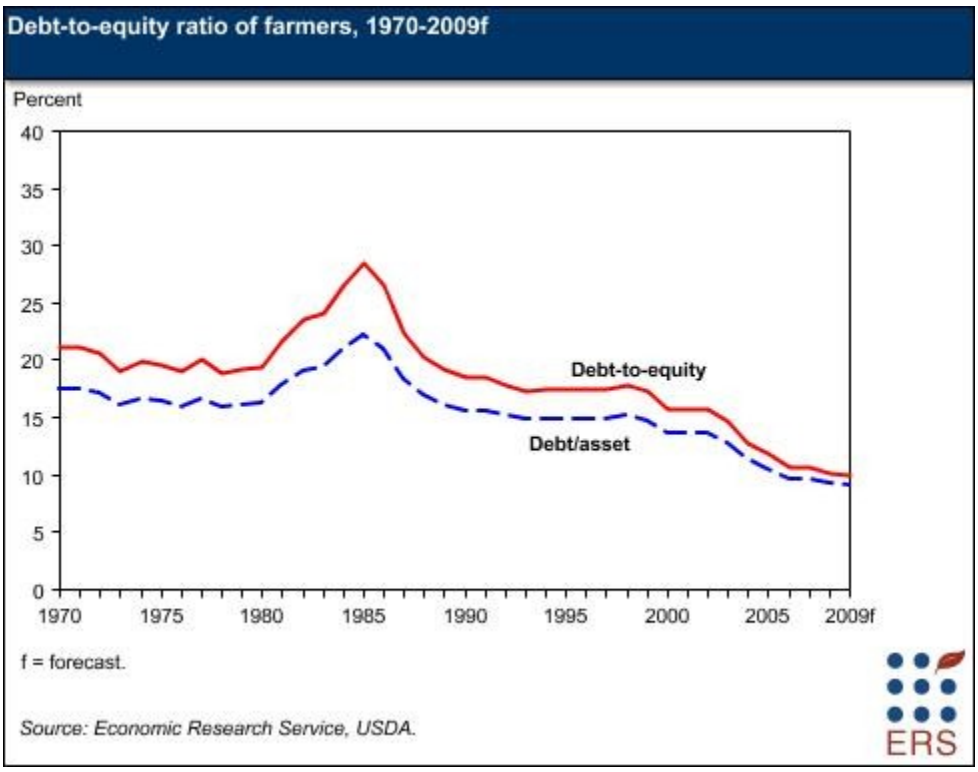
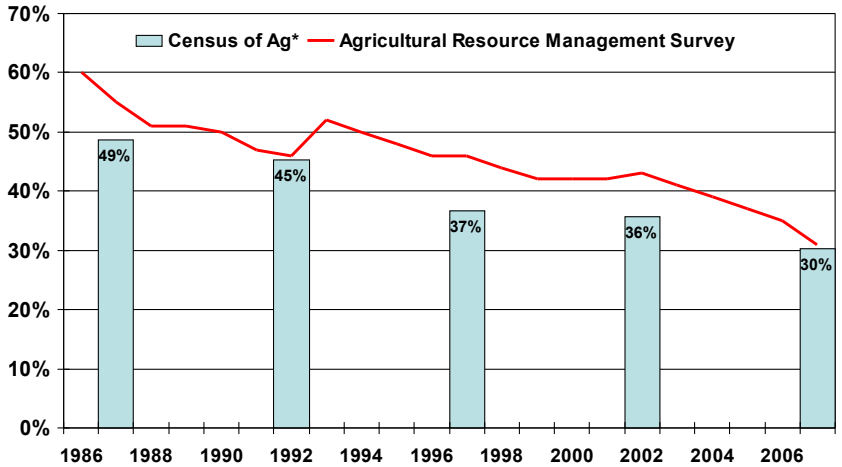


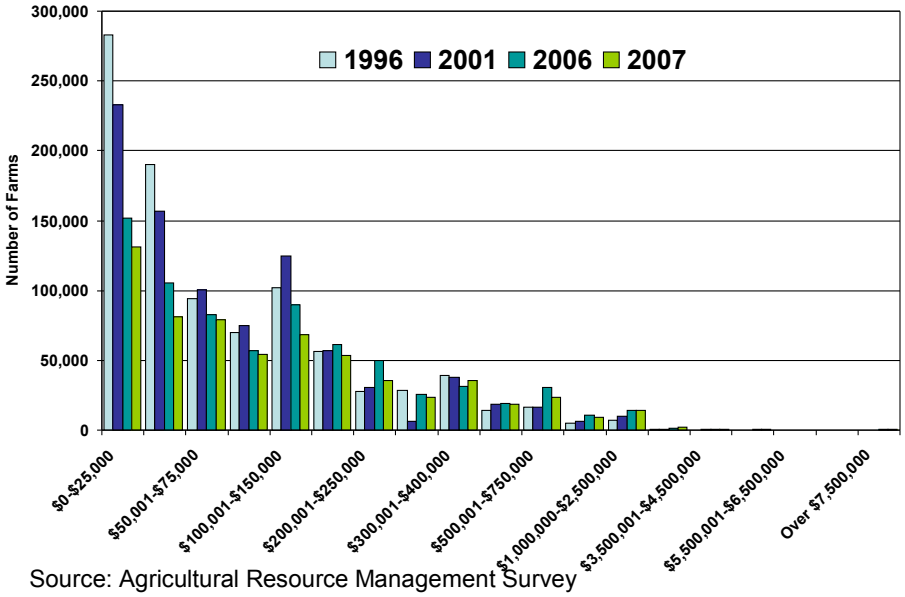
Figure 3. Percent of Farms with Debt



*Operation paid interest

1

Figure 4. Debt distribution



Source: Agricultural Resource Management Survey

Appendix table 1. Variable Descriptions

Variable	Units	Description
Tdebt	Dollars	Total debt (real estate, non-real estate, and operating debt
Debt	1=borrows; else=0	Farm HH borrows in year t
Lths	1=less than high school; else=0	Education (base)
HS	1=high school; else=0	Education
College	1=college; else=0	Education
Postgrad	1=post graduate; else=0	Education
Op_age	Years	Age of principal operator
Tenant	1=tenant; else=0	Ownership (base)
Powner	1=part owner; else=0	Ownership
Fowner	1=owner; else=0	Ownership
Crop farm	1=crop farm; else=0	Farm type (base)
Livestock farm	1= livestock; else=0	Farm type
Sales1	Base	Less than $250k gross sales
Sales2	1=$250-500K sales; else=0	$250 to $500K gross sales
Sales3	1=$500-1mil sales: else=0	$500 to $1 million gross sales
Sales4	1=>$1mil sales; else=0	>$1 million gross sales
CostCapital	Percent	Interest rate
Totofi	Dollars	Off-farm income
Debtserv	Ratio	Debt service ratio
Vprodct	Dollars	Value of contract production
Northeast	1=Northeast; else=0	Dummy variable
Lake states	1=Lake States; else=0	Dummy variable
Cornbelt	1=Corn Belt; else=0	Dummy variable
Nplains	1=Northern Plains; else=0	Dummy variable
Appalachia	1=Appalachia; else=0	Dummy variable
Delta	1= Delta; else=0	Dummy variable
Splains	1= Southern Plains; else=0	Dummy variable
Mountain	1=Mountain; else=0	Dummy variable
Pacific	1=Pacific; else=0	Dummy variable

Appendix Table 2: Summary Statistics

	1997		2006	
Variable	Mean	Std. Dev	Mean	Std. Dev
Tdebt	179131.3	449833	249431	1122130
Debt	0.6802362	0.4664058	0.5516737	0.4973361
Lths	0.1062897	0.3082218	0.0761564	0.2652554
Hs	0.4170171	0.4930878	0.4019608	0.4903074
College	0.2682294	0.4430575	0.2578811	0.43748
Postgrad	0.1653395	0.3715033	0.2640017	0.4408121
Tenant	0.1441353	0.3512426	0.1039974	0.3052654
Op_age	52.28675	12.89319	55.63747	12.31241
Powner	0.5684889	0.4953092	0.4815838	0.4996743
Fowner	0.2873759	0.4525586	0.4144188	0.4926348
Crop	0.6023083	0.489443	0.5063373	0.4999734
Livestock	0.3976917	0.489443	0.4936627	0.4999734
Sales1	0.000000	0.000000	0.0157079	0.1243464
Sales2	0.0356088	0.1853211	0.0344491	0.1823848
Sales3	0.0386508	0.1927699	0.0423031	0.2012852
Sales4	0.0525186	0.2230803	0.0541653	0.2263497
CostCapital	9.078546	3.177247	7.125016	2.594244
Totofi	39417.59	99725.31	63416.94	126071.4
Debtserv	0.5023066	5.973762	1.620444	157.8507
Vprodct	173,527.2	1,095,341	311,374.3	1,165,376
NE	0.0722018	0.2588334	0.038349	0.1920427
Lake states	0.1077212	0.3100419	0.1036724	0.3048434
Cornbelt	0.1749128	0.3799095	0.1965659	0.397412
Nplains	0.1129999	0.3166069	0.1019391	0.3025764
Appalachia	0.1147893	0.3187818	0.0986892	0.2982523
SE	0.0830276	0.2759363	0.1317842	0.3382652
Delta	0.0682652	0.2522117	0.1122847	0.3157249
Splains	0.0950166	0.2932509	0.0827104	0.2754515
Mountain	0.0908115	0.2873537	0.0250244	0.1562033
Pacific	0.0802541	0.2716983	0.1089806	0.3116233
Farmincome-x	-0.2652301	21.23939	-0.0632951	4.869974

Appendix Table 3: Box-Cox Double Hurdle Results

First hurdle	1997	2006
Constant	0.5686513(0.111)**	0.1970259(0.076)**
College	0.1254139(0.044)**	0.0801176(0.029)**
Postgrad	0.0605064(0.050)	0.0764788(0.029)**
Op_age	-0.0163294(0.001)**	-0.0113566(0.001)**
Fowner	-0.3745153(0.042)**	-0.3212739(0.026)**
Livestock	0.108302(0.039)**	0.1366905(0.025)**
Sales2	-1.174971(0.139)**	-1.007878(0.100)**
Sales3	-0.935163(0.118)**	-1.252973(0.098)**
Sales4	-1.138873(0.108)**	-1.122609(0.073)**
ATOT	9.92e-09(4.86e-09)*	3.05e-09(2.06e-09)
Costcapital	0.0002003(0.006)	-0.0030802(0.004)
Totofi	-5.93e-07(1.79e-07)**	-6.39e-07(1.02e-07)**
Debtserv	10.53938(0.236)**	4.824229(0.108)**
Vproduct	6.76e-08(1.91e-08)**	1.02e-07(1.33e-08)**
Lakestates	0.0902667(0.073)	0.1807666(0.048)**
Cornbelt	-0.0678969(0.062)	0.1434579(0.040)**
Nplains	0.0433106(0.075)	0.0447594(0.048)
Appalachia	-0.1731881(0.066)**	-0.0674506(0.047)
Delta	-0.2907577(0.075)**	-0.1090852(0.045)*
Splains	-0.2553024(0.078)**	-0.1393241(0.052)**
Mountain	-0.189406(0.077)*	0.1281405(0.085)
Pacific	0.0448(0.075)	-0.0944538(0.047)*
Second hurdle		
Constant	64.21677(1.121)**	22.91949(0.250)**
College	1.532336(0.440)**	0.4520439(0.097)**
Postgrad	2.306623(0.532)**	0.7366856(0.099)**
Op_age	-0.1549374(0.017)**	-0.0363124(0.004)**
Fowner	-2.550379(0.487)**	-0.4641973(0.089)**
Livestock	1.513098(0.402)**	0.2266426(0.085)**
Sales2	-16.99043(1.389)**	-3.2573474(0.330)**
Sales3	-16.3505(1.389)**	-3.175322(0.291)**
Sales4	-15.53485(1.249)**	-3.126756(0.268)**
ATOT	6.10e-06(1.21e-07)**	1.97e-07(8.90e-09)**
Costcapital	-0.4387041(0.050)**	-0.1133829(0.012)**
Totofi	-3.87e06(2.05e-06)	5.14e-07(3.64e-07)
Debtserv	0.0595236(0.026)	-4.10e-06(0.000)
Vproduct	1.28e-06(1.59e-07)**	3.67e-07(3.07e-08)**
Lakestates	2.751693(0.745)**	0.5257132(0.158)**
Cornbelt	0.3547146(0.674)	0.0805961(0.138)
Nplains	1.049171(0.731)	-0.0065381(0.160)
Appalachia	-1.298872(0.786)	-0.226315(0.171)
Delta	0.2408077(0.926)	0.4391439(0.160)**
Splains	2.078743(0.792)**	0.3532785(0.177)*
Mountain	1.628875(0.790)*	0.2991877(0.261)
Pacific	3.377129(0.837)**	1.227666(0.168)**
Farmincome-x	0.0030551(0.007)	-0.0003828(0.010)
δ	16.28056(0.135)	3.975882(0.031)
Sample Size	11,117	18,384
LogL	-35,115.50	-35,887.25
* 5% Confidence level	** 10% Confidence level	