Permanent Income and the Importance of Precautionary Savings: An Instrumental Variable Approach

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1. Introduction

Farm households in the United States face high income risks due to weather and price shocks, as a result they try to manage these risks through either the use of crop insurance, futures and option markets or by participating in government commodity programs that are designed to lower the variability of the farm income (Mishra et al. 2002). They can also lower their income risk by increasing their savings during good time and use these savings to smooth their consumption when times are bad (Newbery and Stiglitz (1981)). Using Savings as a buffer against income shocks is the main hypothesis of precautionary saving theory. This theory states that individuals (farm household in this case) who face high level of income uncertainty save more and accumulate more wealth in order to smooth their future consumptions (Lusardi, 1997). Unfortunately, the empirical studies investigating the importance of precautionary saving are still inconclusive. For example, some studies find that precautionary saving accounts for a large percentage of wealth accumulation by households (Dardanoni ,1991; Kazarosian,1997; Carroll and Samwick,1998). Others find that precautionary savings account only for a small fraction of wealth accumulation by households (Guiso et al.,1992; Arrondel, 2002; Jensen and Pope, 2004; Kennickell and Lusardi, 2005). Because of the difficulty associated with obtaining good measures of permanent income and income uncertainty using cross sectional data, only few studies have tried to quantify the importance of precautionary saving using cross sectional data (Skinner,1988; Dardanoni,1991; Guiso et al., 1992; Lusardi, 1997; Arrondel, 2002). To the best of our knowledge, this is the first study that quantifies the importance of precautionary savings of U.S. farm households using large cross sectional data. This is very important and it will have strong policy implication (Paxson, 1992). For example, if the magnitude of these savings are great, then farm income variation will not lead to serious decline in the well-being of the U.S farm households. On the other hand, if the magnitude of these precautionary savings is small, then the farm household will be susceptible to the fluctuation in their farm income (Paxson, 1992). Furthermore, Precautionary savings could be used as a tool to self-insure against income risk, thereby reducing government's expenditures on farm program payments.

The main objective of this paper is to investigate the presence of precautionary savings among farm households in the United States. A secondary objective of this paper is to estimate a permanent income model for the U.S farm households. Due to the potential endogeneity of the income uncertainty in the model, estimation of precautionary savings model using OLS can be misleading; therefore we use an instrumental variable approach to obtain consistent parameter estimates. The rest of the paper is organized as follows: in section 2, we present a literature review of the past empirical studies on precautionary savings. The economic model is presented in section 3. Section 4 describes the empirical model and estimation procedure. A summary of the data is presented in the next section. In section 6, we present the results -of our analysis. Finally, section 7 presents the conclusion of our main finding.

2. Literature review

The literature has plenty of studies that investigate the presence of precautionary savings. Empirical findings of these papers can be grouped into two sets: the first set of empirical studies found that precautionary savings accounts for a zero or very little proportion of households' wealth accumulation. Skinner (1988) investigated the presence of precautionary savings using data from 1972-73 consumer expenditure survey (CES). The author used occupation as proxy for income uncertainty. The study finds no evidence that households in riskier occupations (farmers, self-employed non-farmers, and salespersons) save more than households in less risky occupations. On the other hand, Guiso et al. (1992) test presence of precautionary savings in Italian households using 1989 Italian household income and wealth survey. The authors measure income uncertainty using the subjective variance of the household's next year income. The study found that households have precautionary savings but it only accounts for 2% of the household total net wealth. Similarly, Lusardi (1997, 1998) found that precautionary savings accounted for about 3 to 5% of the total wealth accumulation. In more recent paper, Arrondel (2002) used subjective earning variance to explain wealth accumulation by French households. He found that precautionary savings is important reason for savings but it account for only 5% of the accumulated wealth accumulation.

The second set of papers found that precautionary savings accounts for a large percentage of wealth accumulation by individuals and households. For example, Kazarosian (1997) found a strong evidence of precautionary savings using panel data from National longitudinal Survey. In addition, he found that farm households exhibit high precautionary saving motives compared to households in other occupation groups. Dardanoni (1991) analyzed precautionary savings using cross sectional data for British households and found that approximately 60% of total savings of individuals can be explained by precautionary savings. Carroll and Samwick (1998) estimated that up to 50% of wealth accumulation of a household can be explained by precautionary savings. Using an approach similar to Dardanoni (1991), Zhou (2003) analyzed precautionary saving of Japanese households and found that precautionary savings attribute approximately 64% of the wealth accumulation for agricultural, forestry, fisheries and self-employed households.

Even though, results from all of these studies are mixed regarding the magnitude of precautionary savings, the majority of them point out that precautionary savings represent a large percentage of wealth accumulation among farmers and self employed households. To the best of our knowledge, only one study by Jensen and Pope (2004) measures precautionary savings by farmers. Using panel data (1973-1999) from Kansas, the authors tested for the presence of precautionary saving motive among Kansas farm households. They found clear evidence of precautionary saving hypothesis. However, the magnitude of this savings is very small. One drawback of Jensen and Pope (2004) is that farms and farm families in their study were from a limited area (Kansas) and the majority of them specialized in wheat farming. Further, farm families faced limited off-farm job opportunities compared to farms in other regions of the U.S. Unlike previous studies, the analysis here is conducted on a national farm-level data with the unique feature of a larger sample than previously reported, comprising farms of different economic sizes and in different regions of the United States.

3. The Theoretical Model

In this section, we briefly layout a theoretical foundation of the precautionary saving model used in this paper. Assume that the household takes a decision in a discrete time and have time-separable utility function u. Assume also that the household labor income can be characterized by the following stochastic process:

$$Y_t = \gamma Y_{t-1} + (1-\gamma)\hat{Y} + \varepsilon_t \qquad (1)$$

The household maximizes the expected discounted utilities of the consumption streams subject to its budget constraint. More specifically, the household consumption optimization problem can be written as follow:

$$\max_{C_t} \; E \sum_{t=1}^{\infty} B^{t-1} u(C_t) \quad (2)$$

subject to

$$W_t = \; R\, W_{t-1} + Y_t - C_t; \; Y_t = \gamma Y_{t-1} + (1-\gamma)\hat{Y} + \varepsilon_t \quad (3)$$

where E denotes expectation, C_t denotes consumption at time t, $B = \frac{1}{1+\delta}$ is the discount factor where δ is discount rate. W_t is total assets (nonhuman wealth) at time t, u is the expected utility function, and $R = 1 + r$ is the gross interest rate.

Solving the above optimization consumption function is very difficult task because it doesn't have a closed form solution under general forms of the utility function and income distribution Some simplified assumptions about both the distribution of the income and the shape of the utility function has to be made to overcome this difficulty (Dardanoni, 1991). Caballero (1991) derived a closed form solution of the above consumption optimization problem assuming that labor income follows a random walk distribution and the utility function to display constant absolute risk aversion(exponential utility function). He found that optimal consumption at time t is a function of permanent income and variance of consumption. Following Jensen and Pope (2004) consumption is a function of permanent income and adjustment in consumption due to uncertainty. Sppecifically:

$$C_t = Y_t^p - \alpha B\left(\sum_{i=1}^{\infty} \alpha^i \left[\sum_{j=1}^{i} E_t \left(\sigma_{vt+1}^2\right)\right]\right) \quad (4)$$

The first term in equation 4 is associated with the permanent income and the second term is the income uncertainty component. Since savings and wealth are linked through the intertemporal budget constraint, investigating the impact of uncertainty on saving or consumption should be equivalent to investigating the impact of income uncertainty on the wealth accumulation for individuals. With wealth data being relatively more readily available and more accurate than say saving data. Proponents of precautionary saving hypothesis have focused on studying the relationship between wealth and income uncertainty (Guiso et al.(1992);Jensen and Pope (2004)). The majority of precautionary saving studies have estimated the following reduce form equation

$$\frac{W_h}{y_h^p} = f(AGE, X_h, \sigma_h^2) \qquad (5)$$

The response variable is wealth divided by the estimated permanent income of the household h, as a function of age of the household, and X_h is a vector of observable variables which influence the age wealth profile relationship,. The vector X should include permanent income if the households' preferences are non-homothetic. σ_h^2 is a measure of income uncertainty of household h. The above specification function is a direct extension for the life-cycle hypothesis model (King and Dicks-Mireaux, 1982). The precautionary saving model added the income uncertainty as a new determinant for the wealth accumulation in addition to the permanent income. The expected sign on income uncertainty is positive meaning that the higher the income uncertainty, the higher is the wealth accumulation (Lusardi, 1998);

4. The Empirical Model

The impact of precautionary savings on the U.S farm household wealth accumulation is estimated using the same functional form adopted by Carroll and Samwick (1997, 1998). The model is expressed as follows:

$$ln(w_i) = \alpha_0 + \alpha_1 OpAGE_i + \alpha_1 OpAGESQ_i + \alpha_5 \ln(y_i^p) + \alpha_2 Nkids + \alpha_3 Hsize + \alpha_6 \sigma_i^2 + \varepsilon_i \qquad (6)$$

Where $ln(w_i)$ is the total wealth (net worth) for the ith farm household (in natural log); $OpAGE_i$ represent age of the farm operator; $OpAGESQ$ is operator age squared, $\ln(y_i^p)$ is the natural logarithm of the permanent income of the ith farm household; *Nkids* is the numbers of children under 13; $Hsize$ is the household size, σ_i^2 is a measure of the income uncertainty for the ith farm household; and ε_i denotes the error term.

In order to estimate the impact of the income uncertainty on the wealth accumulation using equation (3), we need the estimates of permanent income, y_i^p, and household income uncertainty, σ_i^2. The precautionary saving model (equation 3) is estimated using by a two-step procedure. Specifically, in the first step we estimate the permanent income and the income uncertainty of the farm household. In the second step we the precautionary savings of the farm households using a instrumental variable approach.

Estimation of permanent income and income uncertainty

The specification function for the permanent income model is grounded in conventional human capital theory. The theory states that earnings of an individual should be primarily determined by the level of education of the individual, occupation, and the experience in the labor market as it is approximated by age (Ben-Porath, 1967; King and Dicks-Mireaux, 1982). Musgrove (1979) used age, education and occupation to estimate permanent income model using cross sectional dataset for South American households. Wang (1995) used a cross sectional data to estimate the permanent income for Chinese households. In addition to age, education and occupation, he included the type of employer and regional dummies in the specification function of the model. Jensen and Pope (2004) estimated the permanent income for the U.S. Kansas farmers using a stochastic specification function. In their model specification function, they include the number of acres operated, a time trend variable, an interaction between the time trend variable and age, and a lagged observed income in the model.

In this paper, permanent income model is estimated using the following model specification:

$$ln(y_{it}) = Z_i\beta + g(A_{it}) + R_i\delta + \ln(y_{it-1}) + \mu_{it} \quad (7)$$

Where $\ln(y_{it})$ is the natural log of the observed annual household income at time t, Z_i is a vector of observable variables for an individual operator i. This vector includes education of the farm operator, occupation, number of kids, household size, and farm size as it is represented by the number of acres operated. β is a vector of associated parameter estimates, $g(A_{it})$ is the age-income profile (quadratic age function), and R_i is a vector of dummy variables to capture the influence of region-specific effect such as the weather variability and the location advantages of the farm (Paxson (1992)). $\ln(y_{it-1})$ is the natural log of the observed household income in the previous year. Finally μ_{it} denotes the error term at time t. We estimate equation 5 using ordinary least square (OLS) and the predicted values of this model was used as an estimate for the permanent income, and the income uncertainty was approximated by the squared residuals from this model.

5. Data and Estimation Procedures

Data for the analysis were taken from the 2005 Agricultural Resource Management Study (ARMS). The ARMS is conducted annually by the Economic Research Service and the National Agricultural Statistics Service. The survey collects data to measure the financial condition (farm income, expenses, assets, and debts) and operating characteristics of farm businesses, the cost of producing agricultural commodities, and the well-being of farm operator households.

The target population of the survey is operators associated with farm businesses representing agricultural production in the 48 contiguous states. A farm is defined as an establishment that sold or normally would have sold at least $1,000 of agricultural products during the year. Farms can be organized as proprietorships, partnerships, family corporations, nonfamily corporations, or cooperatives. Data are collected from one operator per farm, the senior farm operator. A senior farm operator is the operator who makes most of the day-to-day management decisions. For the purpose of this study, operator households organized as nonfamily corporations or cooperatives and farms run by hired managers were excluded.

The 2005 ARMS collected information on farm households in addition to farm economic data collected through the regular survey. It also collected detailed information on off-farm hours worked by spouses and farm operators, the amount of income received from off-farm work, net cash income from operating another farm/ranch, net cash income from operating another business, and net income from share renting. Furthermore, income received from other sources, such as disability, social security, and unemployment payments, and gross income from interest and dividends was also counted. In this study we only include farm operators between ages 20 and 65. The age limitation is consistent with other studies (Lusardi, 1997; Kazarosian,1997; Guiso et al., 1992) that estimate permanent income and precautionary savings of households. Summary statistics and description of the variables used in analysis is presented in Table 1. Finally, wealth (or net worth) of the farm household is defined as the sum of farm wealth (farm assets-farm debt) and nonfarm wealth (total nonfarm assets-nonfarm debt).

Estimation Procedures

The permanent income model is estimated using Ordinary Least Squares (OLS). The predicted value of the response variable in this model is then used as a measure for the permanent income, and the squared of the residuals associated with this income is used as a measure of income uncertainty. This measure of income uncertainty will be subject to serious measurement error. First, there is an inherit measurement errors in the construction of income of the household using a survey data. Second, our measure of the income uncertainty involves only one two income observations. Each farm operator household was squired on their total income in the survey year 2005 and year 2004. As a result, estimating the precautionary saving model using OLS will lead to problems in the standard errors of the variable. In fact, the OLS estimates will be biased toward zero with the magnitude of bias proportional to the variance of the measurement error for the household (Samwick (1997, 1998); Lusardi (1997)). To account for the bias in the construction of the household income variability (square residuals), we used the instrumental variable estimation procedure to estimate the precautionary wealth equation. The instruments used include education level of the farm household, a dummy variable for occupation, whether the farm household received government payment, and whether the head of the farm household and/or his spouse is working off farm. The validity of these instruments is tested and is reported in the result section.

6. Results

Permanent Income Estimation

Table 1 shows the OLS estimates of the permanent income model. Model results show that age and education level of the head of household (operator) are significant determinant of the permanent income. The findings are consistent with human capital theory. The coefficient of the education variable is positive and highly significant indicating that higher the educational level of the operator, the higher the income of the operator household. The coefficient estimate implies that an extra year of schooling will increases the total income of the household by approximately 10 percent. Also results support a quadratic relationship between the age of the operator and total household income, implying that earnings of the household peak at age 50. The coefficient on the occupation dummy was positive and significant, indicating that operators who reported farming as their main occupation have more income. In percentage terms, they make 26% more income than the operators with occupation. The coefficient of numbers of acres (proxy for farm size) is positive and highly significant indicating that economies of scale. Specifically, results show that larger the farm size the more income the household generates. Result in table 2 shows that last year's total income of farm household is a significant determinant of permanent income of farm households. Specifically, results indicate that 1 percent increase in lagged total household income increases current year income (permanent income) by approximately 0.5 percent.

The majority of the regional dummies were insignificant with the exception of the three regions (Eastern Upland, Fruitful Rim, and Basin and Range regions). Relative to farm household in Mississippi Portal region, households with the same characteristic in the Eastern Upland and Basin and Range regions make approximately 19% less in annual income after holding other factors constant. On the other hand, households in the Fruitful Rim region make approximately 20% more income after holding all other factors constant.

Precautionary Savings Estimation

Table 3 presents the two stage least squares (2SLS) estimates of the precautionary savings model. The results reveal a strong effect of income uncertainty on the wealth accumulation of U.S. farm households. The coefficient of income uncertainty is positive and statistically significant at the 1% level of significance. This finding is consistent with precautionary saving theory--farm households that face high income risks appear to save more and accumulate more wealth. The magnitude of this precautionary saving is large, but within the range: at the sample mean, precautionary saving accounted for 49% percentage of the total wealth accumulation of U.S farm households. In their study of self-employed individuals in the U.S. Carroll and Samwick (1998) found precautionary savings accounted for 46 percent of the total wealth accumulation. This result is consistent with the findings of other studies that precautionary saving account for a large percentage of the wealth accumulation of individuals with high income risks (Dardanoni, 1991; Kazarosian,1997; Carroll and Samwick,1998).

As theoretically expected, the results show that age of the farm operator has a strong positive effect on the wealth accumulation. The coefficient on age is positive and statistically significant at the 5 percent level of significance. The results suggest that an additional year in operator age increases farm household wealth by 5 percent. However, the variable age square was not significant. Model results do not support a quadratic relationship between age and wealth accumulation. Jensen and Pope (2004) report similar finding in their precautionary savings study for a sample of Kansas wheat farmers. They attributed it to the fact that the majority of farmers stay active in farming way after the retirement age. Similarly, Guiso et al., (1992) modelled precautionary saving as a linear function of age, after excluding all households with age greater than 65. Therefore, our finding is consistent with the findings of Jensen and Pope (2004) and Guiso et al., (1992). The impact of permanent income on wealth accumulation is positive and significant at the 1 percent level of significance. Results indicate that, on average, farm households with more permanent income accumulate more wealth. Findings here show that 1 percent increase in permanent income increases wealth accumulation by 0.69 percent. Our findings are consistent with those obtained by Lusardi (1997); Arrondel (2002); Carroll and Samwick (1997 and 1998) and Jensen and Pope (2004).

We performed a series of battery tests to test the validity of the instruments we used in the wealth accumulation model. The over identification test did not reject the model specification and the chosen instruments. The p-value of the over-identification test is equal to 0.109. The second test is for the predicted power of the instruments, we used an F-test to test the joint significance of the parameters of the excluded instruments. The value of this test is 67.86 indicating that the instruments used in the model are well correlated with the variance of the income. This confirms the validity of the chosen instruments.

7. Conclusion

The main objective of this paper was to assess the importance of precautionary saving of the U.S. farm households. Following precautionary saving literature, we specify wealth as a function of age, permanent income, income uncertainty, and other socioeconomic factors that influence the age-wealth profile. The precautionary wealth model is applied to cross sectional data for the U.S. farm households in 2005. Estimating the precautionary saving model with OLS can be misleading due to the large measurement errors in the construction of the income variance. Hence, the empirical model is estimated using the instrumental variable approach. Consistent with findings in the literature, our study found that precautionary savings is powerful determinant of wealth accumulation of the U.S. farm households. The coefficient of the income variance was positive and highly significant in the model--higher the income variation the higher the wealth accumulated by the U.S. farm households. At the sample mean, we found that precautionary saving account for as much as 49% of the wealth accumulation by the U.S. farm households. This result is very important because it indicates that random shocks to the incomes of the U.S farm households will not have serious consequences on the well-being of U.S. farm households. This implies that the government policies that reduce the income variations of the U.S. farm households might have some unintended consequences. They might in fact lower the wealth accumulation of the U.S farm households and make them more susceptible to future farm income variation. In addition, we found that age is very important determinant of wealth of individuals, however, the results of the model did not support a quadratic relationship between wealth and age variable given the age restriction we imposed on the sample. Furthermore, there was no evidence that number of kids and family size are important factors that determine the wealth accumulation of individual household.

Finally, we need to stress the importance of using instrumental variable approach to estimate the importance of precautionary saving, especially when income uncertainty is subject to some measurement errors. This can be the case when the income uncertainty is estimated using a cross sectional survey. The OLS estimation of the extent of precautionary saving when the variance of income is subject to a measurement error will be biased downward. As a result, we will under estimate the extent of precautionary saving.

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Table1: Definitions and summary statistics of variables used in the analysis

Variable	Descriptions	Mean	Std Dev
VAR_INCOME	Estimated income variance	0.83	1.37
P_INCOME	Estimated permanent income($)	97,203	76,646
HH_NETW	net worth of farm operator household (includes both farm and nonfarm net worth, $)	1,401,918	2,612,978
FARMING	=1 if a operator's job is farming; 0 otherwise	0.683	0.465
OP_EDUC	Operator education level	12.39	1.20
HH_SIZE	Farm household size	3.10	1.61
N_CHILD	Number of children under 13	0.52	1.20
OP_AGE	Age of farm operator	50.51	9.16
T_ACRES	Total acres owned	1,155	3,521
FR_HEART	=1 if farm is located in the Heartland region; 0 otherwise	0.14	0.35
FR_NORTHC	=1 if farm is located in the North Crescent region; 0 otherwise	0.17	0.37
FR_NORTHGP	=1 if farm is located in the North Great Plains region; 0 otherwise	0.05	0.22
FR_PGATE	=1 if farm is located in the Prairie Gateway region; 0 otherwise	0.12	0.32
FR_EUPLAND	=1 if farm is located in the Eastern Uplands region; 0 otherwise	0.11	0.31
FR_SSBOARD	=1 if farm is located in the Southern Seaboard region; 0 otherwise	0.13	0.34
FR_FRIM	=1 if farm is located in the Fruitful Rim region, 0 otherwise	0.16	0.36
FR_BASINR	=1 if farm is located in the Basin and Range region, 0 otherwise	0.05	0.23
FR_MPORTAL	=1 if farm is located in the Mississippi Portal region, 0 otherwise	0.08	0.26
Total number of observations		4,428	

Source: 2005 Agricultural Resource Management Survey (ARMS).

Table 2: Parameter estimates of permanent income model

Variable	Estimate	Robust Std. Err.
Intercept	3.349***	0.373
Farming occupation	0.262***	0.027
Operator Age/10	0.516***	0.140
Operator agesquare/100	-0.052***	0.015
Operator's education	0.096***	0.012
Number of kids under age 13	-0.016	0.020
Family size	0.005	0.014
Total acres operated/1000	0.023***	0.006
Lagged income (in natural log)	0.484***	0.015
Heartland region	0.033	0.063
Northern Crescent region	-0.086	0.062
Northern Great Plains region	-0.070	0.081
Prairie Gateway region	0.006	0.068
Eastern Upland region	-0.189***	0.065
Southern Seaboard region	-0.071	0.062
Fruitful Rim region	0.206***	0.064
Basing and Range region	-0.185**	0.078
Number of observations	4,463	
Adj.R^2	0.33	

*, **, and *** denotes that the parameter is significance at 10, 5 and 1% level of significance

Source: Authors calculations

Table 3: Parameter estimates of savings equation
Dependent variable = ln(wealth)

Variable	Parameter Estimate	Robust Std. Error
Intercept	3.044***	0.573
Income variance	0.829***	0.064
Permanent income	0.693***	0.038
Family size	0.017	0.022
Number of kids under age 13	0.045	0.030
Operator age	0.513**	0.221
Operator age squared	-0.025	0.023
No. of Observation	4,428	
Overidentification test	6.052 (p=0.1091)	

*, **, and *** denotes that the parameter is significance at 10, 5 and 1% level of significance
Source: Authors calculations