A CREDIT MIGRATION APPROACH IN THE EVALUATION OF THE RELATIVE

FINANCIAL STRENGTH AND ENDURANCE OF BEGINNING SMALL BUSINESS OF

YOUNG FARM OPERATORS UNDER RECESSIONARY CONDITIONS

by

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(Under the Direction of Cesar L. Escalante)

ABSTRACT

This paper examines the relative financial strength and endurance of several paired

classes of farmers according to business maturity (beginning versus mature farm businesses),

farm operators' age and experience (young versus older, more experienced farm operators), and

farm size (small versus large farm businesses) by utilizing transition probability approach and

random-effects ordered logistic regression techniques. Results show that the financial stress

resulting from the late 2000s recession did not significantly influence the financial vitality of

farms in general, regardless of the farm types. The financial strength of small farms, young farm

operators, and beginning farms during the recessionary period remained at favorable levels,

although their performances were lower to their counterparts. In addition, increasing farm size

will lead to a higher probability of class upgrades. Being a young farm operator meanwhile

decreases this probability. Positive changes in money supply and farm real estate values were

found to increase the likelihood of credit upgrades. Results also show trend reversal of credit risk

movement, where upgrades (downgrades) are more likely to be followed by downgrades

(upgrades).

INDEX WORDS: Credit risk migration, Random effects, Ordered logit regression,

Recession, Macroeconomic variables, Transition matrix

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DEDICATION

Dedicated to my parents, Vicente and Evelia, for their love and support.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

1.1 Beginning Small Farms and Consolidation

Small farms have been a vital part of the agricultural sector in the United States. Small farms, per se, constitute 92 percent of the total number of the farms in 2013. Beginning farms, on the other hand, have been the focus of government assistance efforts as there is a declining rate of business start-ups in the farm sector in recent years. The survival and growth of such farms is an important priority for the farm sector that confronts the prospect of accelerated aging of farm operators and the increasing consolidation of farm businesses.

The Economic Research Service of the U.S. Department of Agriculture (USDA-ERS) defines small commercial farms as those with a minimum gross cash farm income (GCFI) of $10,000. Farms below this income level are considered as not commercially oriented (Hoppe and Banker, 2010). The cut-off gross income level that distinguishes small and large commercial farms is $250,000, which has been recommended by the Small Farm Commission.

The number of small farms has not grown in recent years. As Figure 1 shows, the number of farms has fluctuated within a very narrow range of 146,000 to 147,000 between 2007 and 2010. Thereafter, there was a sudden decrease in the number of small farms in 2011 and 2012, but eventually the number increased in 2013.

Figure 1. Number of Small Farms through Years
(Source: USDA ARMS 2000-2012)
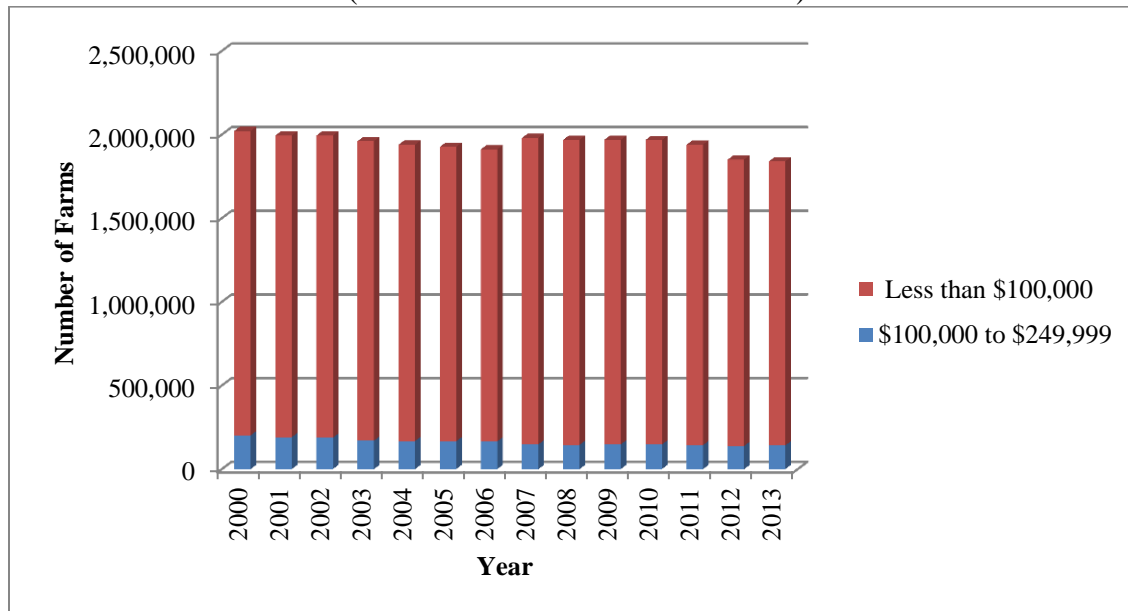
One explanation of small farms' steady growth and eventual increase in more recent years is the change in the preference of consumers in favor of fresh quality goods (Low and Vogel, 2011). It has been observed that the organic farming alternative is popular among smaller farms, especially those operated by full-time farmers. Consumers consider organic foods as healthier, fresher, and produced sustainably on small farms (O'Donoghue, 2011), that increases demand for organic products.

The economic climate in recent years is also a contributing factor to the steady growth of smaller farms. As there is high volatility in the prices of agricultural inputs and farm products, farmers are more cautious when they consider expansion plans for their farms.

While small farms have been increasing in recent years, the proportion of beginning farms to total farms in the U.S. has been decreasing for the past decade. According to the Farm Service Agency, a farm can be considered as beginning if it has been in the business for 10 years

or less. Looking at Figure 2, 30 percent of principal operators had less than 10 years of experience farming in 1997; by 2012, only 22 percent had such experience.

Figure 2. Share of Beginning and Mature Farms
(Source: USDA, Census of Agriculture 1997-2002)

In addition, beginning farms constitute only minimal amount of total production of the agricultural sector. In 2012, beginning farms constitute only 6.7 percent of the total agriculture production, which was expected as beginning farms normally hold fewer assets vis-à-vis the more established farms (Williamson, 2014). The average size of a beginning farm is smaller compared with mature farms. In 2013, the average size of a beginning farm is 135 acres, while the size of a mature farm is 436 acres. Beginning farms account for only about 6 percent of the total farmland acres operated. This is attributed to the fact that established farms usually obtain their land from relatives or by inheritance. The declining number of farm business start-ups has been an issue in the sector and support for the sector has been a priority of the government in recent years.

The average size of a U.S. crop farm has changed little during the past three decades. However, this stable structural characteristic of the U.S. farm sector does not describe the actual growth dynamics in the agricultural sector. While small farms are increasing in numbers, agriculture has been shifting predominantly to larger farms. The shifts have been large, with land and production shifting primarily from mid-size commercial farming operations going both ways – either transitioning to very small or to very large farms.

There are several key factors shaping the economic conditions of the crop agriculture industry. Four dominant forces are currently at work— growing and diversified demand; technology being used in the farm; resource availability; and societal influences (MacDonald, Korb, and Hoppe, 2013). These factors have important implications, either in isolation or combination, to the structure of crop production, including farm size, the business models used, and relationships to other parts of the industry (Bechdol, 2010).

As the larger crop farms realize better financial returns, on average, they are able to make more intensive use of their labor and capital resources, indicating that the trends are likely to continue (MacDonald, Korb, and Hoppe, 2013).

1.2 Farm Industry: An Aging Sector

While the proportion of beginning farms has been decreasing over the past decades, it has also been observed that the share of young operators is getting smaller. The average age of the principal operators has increased by 2 percent between 2007 and 2012. Among the principal operators, only 6 percent of the operators are 35 years old and below in 2012, down from 16 percent in 1982.

The downward trend in the number of young farmers reflects farm consolidation, the presence of multiple generations of operators on some farms, and the capital-intensive nature of farming. For example, land prices and startup capital requirements can make it difficult for beginning farmers to purchase or rent land (O'Donoghue, 2011). In addition, the equipment being used by farms can last more than a decade. That lowers operational costs over time and could encourage old farmers to work longer on their farms. The increased proportion of old farmers is also associated with improved health technology that enables farmers to work in their farm businesses for a longer period of time (Mishra et al., 2005).

Figure 3. Farms by Economic Class: Age (Source: USDA, Census of Agriculture 2012)
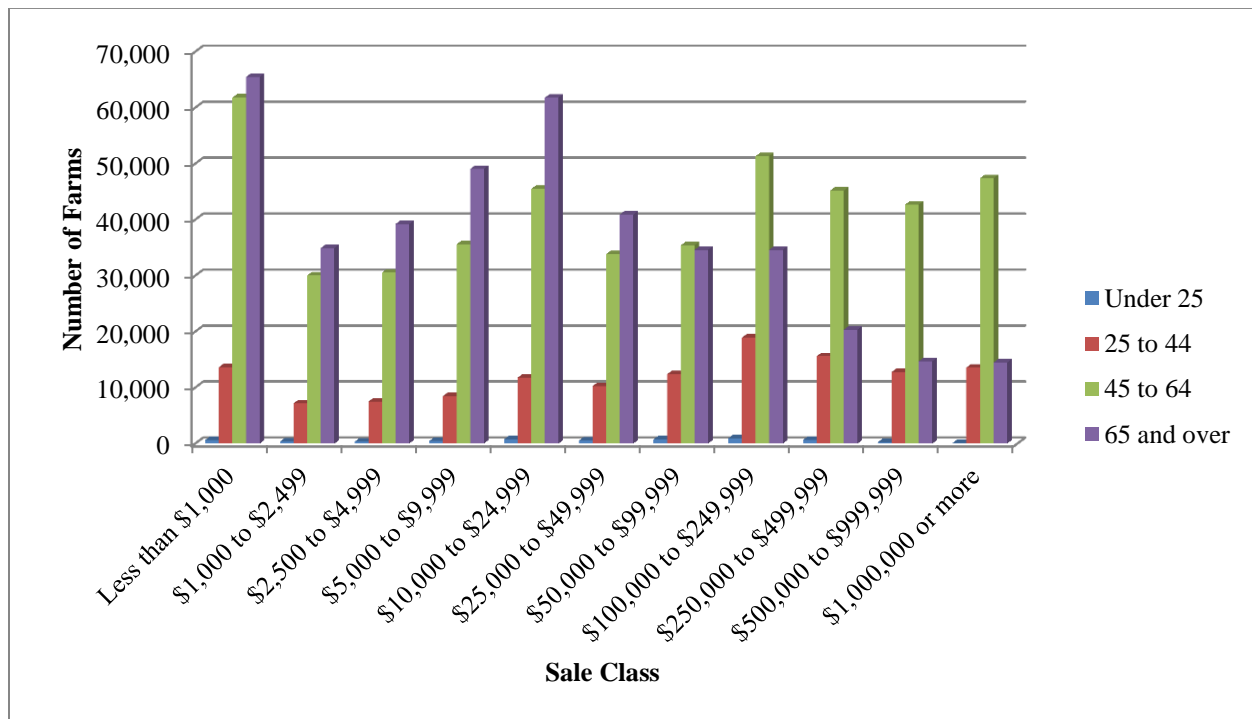
Even though the number of older farmers is increasing, their number declines with the farm revenue, reflecting the gradual withdrawal from farming of these individuals (O'Donoghue, 2011). Figure 3 shows that the number of operators who were 65 years old and above decreases

as farm revenue increases. This age category accounted for 66 percent of total farms that had sales up to $99,000. In contrast, only 25 percent of the farms had sales of $100,000 and above. The age category of 45 and 64 years old meanwhile accounted for the largest revenue share as this class accounted for 56 percent of farms that had sales of $100,000 and above. Farmers under 25 years old on the other hand accounted for a small portion of farms that had revenues of $100,000 or more (0.61 percent of farms).

The increasing number of old farmers becomes a growing concern in the farm sector as the future of agriculture is considered. In 2012, only 33 percent of U.S. farmers were at least 65 years old. The impending retirement of these older farm operators from the sector and the small number of younger farmers are among the government's concerns about the sector. Even though this is the trend in the agricultural sector, Hoppe and Banker (2010) argued that this is not as bad as it appears to be. Older operators' output only comprises 2 percent of the U.S. total farm output. In addition, most of the land owned by older operators are enrolled in land retirement programs or being rented out. Furthermore, some large farms with older operators are multiple-generation farms, with at least 20 years separating the oldest and youngest operators (O'Donoghue, 2011).

1.3 Access to Credit

Access to credit is one of the factors that enable farm businesses to take advantage of growth opportunities. Without credit, a business may opt to stay in their current level production, or worse, decide to opt out of the sector because of financial constraint. These credit issues will result to widespread declines in production and employment (Nash, 2011).

Even though smaller businesses usually borrow small amounts of money from lending institutions, these farms have higher rates of failure compared to larger businesses and are usually susceptible to business shocks (Nash, 2011). In addition, lending institutions usually employ the same scoring model regardless of the business sizes of their farm borrowers. This is a disadvantage to small farms given that they have extrinsic characteristics that the scoring model cannot take into account. For example, some institutions do not consider assigning some premium to farmers' soil enhancement investments that organic farms are practicing.

Young beginning farmers also pose greater risks to lending institution because of their usual lower farm equity infusions and the fewer assets they maintain compared with old mature farms. The lack of assets of these farms is a hindrance to meet loan requirements. Even when the loan has approved, lending institutions set higher collateral requirements to secure the loan. This is considered as one of the barriers to entry to agricultural land-ownership, as this scenario leads to higher fixed costs and cash outlays for young and beginning farmers trying to purchase land. As such, high level of land ownership is not considered a feasible model for young beginning farmers (Kauffman, 2013).

Debt is also not evenly distributed among farm operators. The share of farmers using debt is inversely related to both operator age and years on the farm (Harris, 2009). Operators that use their farm businesses as their primary source of income mostly use loans to fund and operate their businesses. Nearly three of every five farm operators who used debt used only one lender and incurred one loan to finance their business (Harris, Johnson, Dillard, Williams, and Dubman, 2009). Loans are heavily concentrated among three lender groups-- commercial banks, the Farm Credit System (FCS), and Farm Service Agency (FSA) & individuals. Commercial banks and the Farm Credit System accounted 45 and 36 percent, respectively, of the total agricultural loans in

2007. The share of farm debt of these two financial entities has been increasing while the share of loans extended by the FSA has declined in previous years. For the entire U.S. farm sector (which accounts for all stakeholders engaged in farming), these lenders accounted for 92 percent of debt owed in 2007. The other sources of loans are insurance companies and captive finance companies.

1.4 Late 2000s Recession

The financial crisis in 2008 affected the agricultural credit markets. Prices of agricultural products fell by 26 percent from 2008 to 2009. This led to lower farm incomes that created cash flow difficulties for some agricultural institutions, causing loan repayment rates to fall. The economic condition and regulatory concerns during this period made lenders impose stringent standards by raising collateral requirements. This resulted in falling incomes that drove down the repayment rates during the recession (Kauffman, 2013).

Even though the overall credit markets have been affected by the late 2000s recession, the agricultural credit markets were in better shape compared to the overall bank situation. Ellinger and Sherick (2010) associate this with the structural characteristics of farm businesses. Most agricultural banks did not put money in structured securities that lost considerable value. Agricultural institutions did not heavily lend money to the real estate industry, which was a major industry affected by the recession. In addition, a study by Li, Escalante, Epperson, and Gunter (2013) shows that during the recessionary period, delinquency rates on agricultural loans were lower compared with the overall delinquency rates in the banking industry, which confirms the relatively stronger financial health of agricultural lenders.

1.5 Objectives

This research will examine the relative financial strength and endurance of several classes of farmers paired according to business maturity (beginning versus mature farm businesses), farm operators' age/experience (young versus older, more experienced farm operators), and farm size (small versus large farm businesses). This study's time period (2005 to 2012) will allow for the comparative analyses of changes in the financial performance quality of these classes of farms before, during and after the 2008 recession.

This study will:

- Discern how these separate groups of farms fared during changing economic conditions. This will clarify the relative financial strength of those easily suspected as more vulnerable to economic adversities.
- Determine whether there are significant differences in migration rates for different types of farmers – from beginning and small farms, to mature and large farms – that translate to differences in credit quality and financial performance, especially during periods of economic shocks.
- Demonstrate how migration rates are conditioned by economic conditions and structural characteristics for each farm type.

1.6 Overview of Thesis

Chapter 2 of this research reviews related study on credit migration. This section has two sections. The first section reviews literature on how different economic variables affect credit scoring of banks/lending institutions. The second section discusses studies on the determinants of credit migration, with specific application to the agricultural sector. Chapter 3 discusses the

methodology employed in this research. This describes the concept of transition probability and random ordered logit estimation techniques. This will also describe how the model was constructed, present the justification for the choice of variables, and identify various sources from which data were obtained. This study will use farm observations from all states, except for Washington DC, Hawaii, and Alaska, for the years 2005 to 2012. Empirical results are then presented in Chapter 4. Finally, the conclusion and the policy implications are presented in Chapter 5.

CHAPTER 2

REVIEW OF RELATED LITERATURE

This section looks at previous studies on how the latest recession has affected the banking industry. The first part talks about empirical studies on how economic shocks affect the credit markets in general. The second part talks about the studies on how the economic recession has affected the performance of agricultural lenders, farms, and related institutions.

2.1 Economic Changes and the Corporate Bond Markets

Credit migration has been extensively studied in financial sector. This has been an important topic in this sector, especially for bond and bank loans. Financial institutions are always looking at the changes on the credit ratings of their portfolios. The top statistical rating organizations (NRSRO) that assign corporate bond issuers different credit ratings to reflect their creditworthiness are Standard & Poor's Rating Services (S&P) and Moody's Investor Services and Fitch Ratings. Credit risk managers pay particular attention to the ratings and transition matrices published by these NRSROs.

Credit risk measurement has evolved for the past in two decades. Altman and Saunders (1997) traced changes in credit risk measurement from 1970s. Most financial institutions in 1970s relied on the subjective analysis of banker 'expert' system using information of the borrower such as its character (reputation), capital (leverage), capacity (volatility of earnings) and collateral, which was called 4 "Cs" of credit. The expert will come to a largely subjective

judgement as to whether or not to grant credit. In recent years, meanwhile, credit worthiness of institutions by complicated models where key accounting variables are combined and weighted to produce credit risk score.

In corporate bond applications, the Markov chain approach has been used as an alternative to the traditional discrete time (cohort) method. Markov has been used to capture intra-year risk-rating changes to calculate annualized migration rates, which are then averaged across time periods to construct an overall (summary) migration matrix. Formal rating and re-ratings generally occur annually even though true changes in risk occur more frequently. The intra-year bond migration rates help to fill this information gap (Deng, Escalante, Barry, and Yu, 2007).

A time-homogenous, discrete time Markov chain has been extensively used to model the ratings migration process for corporate bonds and bond issuers. Rating transition matrices for corporate bond issuers are often based on fitting a discrete time Markov chain model to homogeneous cohorts. Literature has documented that rating migration matrices can differ considerably depending on the characteristics of the issuers in the pool used for estimation. However, it is also well known in the literature that a continuous time Markov chain gives statistically superior estimates of the rating migration process.

Wei (2003) developed a multi-factor, Markov chain model for rating migrations and credit spreads that is applicable to both sovereign and corporate debts. The model's central feature is to allow transition matrices to be time-varying and driven by rating specific latent variables which encompass economic factors like the business cycle. The model incorporates well-documented empirical properties of transition matrices such as their dependence on business/credit cycles, and it also allows for inter-rating variations in credit quality changes.

Markov chain model was also been utilized by Wozabal and Hochreiter (2012) for credit rating changes. The parameters of the model are estimated by a maximum likelihood approach using historical rating transitions and heuristic global optimization techniques. They benchmarked the model against a GLMM model in the context of bond portfolio risk management. The proposed model yields stronger dependencies and higher risks than the GLMM model. As a result, the risk optimal portfolios are more conservative than the decisions resulting from the benchmark model.

Bayesian approach has also been employed to credit ratings migration. Kadam and Lenk (2008) provided Bayesian estimates to mitigate the problem of data sparsity. The results indicate strong country and industry effects on the determination of rating migration behavior. This approach was also employed by Stefanescu, Tunaru, and Turnbull (2009) to describe the typical internal credit rating process used by banks. Using the rating transition data set from Standard and Poor's during 1981–2007 their results show that corresponding implied rating transition matrix depends on the state of the economy, and found that the effect of macroeconomic conditions is generally larger for speculative grade than for investment grade classes.

Amato and Furtine (2004) studied the influence of business risk, financial risk, and macroeconomic conditions on credit ratings. Their analysis is based on a model of ratings determination that takes into account factors that measure the business and financial risks of firms, in addition to indicators of macroeconomic conditions. The annual data on all US firms rated by Standard & Poor's from 1981 to 2001 were used in an ordered probit empirical model and the results shows that ratings do not generally exhibit excess sensitivity to the business cycle.

Feng, Gourieroux, and Jasiak (2008) proposed a factor probit model for modeling and prediction of credit rating matrices that are assumed to be stochastic and driven by a latent factor.

The filtered latent factor path reveals the effect of the economic cycle on corporate credit ratings, and provides evidence in support of the PIT (point-in-time) rating philosophy. The factor probit model also yields the estimates of cross-sectional correlations in rating transitions that are documented empirically but not fully accounted for in the literature and in the regulatory rules established by the Basel Committee.

A number of studies focus on the how different credit models accurately indicate portfolio quality. Lando and Skødeberg (2002) estimated credit rating transitions based on continuous-time observations. Using the data from S&P, they analyzed the difference between estimators based on discrete-time cohort methods and estimators based on continuous observations and applied semi-parametric regression techniques to test for two types of non-Markov effects in rating transitions. They found a significant non- Markov effects, especially for the downgrade movements. Jafry and Schuermann (2003) also introduced a testing procedure that assess statistically the differences between migration matrices such bootstrapping SVDs and L^1 and L^2 (Euclidean) distance metrics.

2.2 Analysis of Agricultural Sector Under Changing Economic Conditions

There are several studies that focus on how changes in economic conditions affect the credit scores of farms. The analyses of agricultural loan credit rating movement have not been fully explored yet in literature compared to the extensive applications made on bond transactions. Most of these studies were employed using state-level agricultural data that tend to have shorter duration and many risk-rating systems were relatively new. These risk-rating systems may not represent differences in credit qualities, with the tendency of producing high concentrations of ratings in a specific class of institution (Brady, English, and Nelson, 2008).

The transition probability approach has been employed for most research about this topic in the sector. In the study by Barry, Escalante, and Ellinger (2002), farm-level data from Illinois were used to estimate migration rates for a farmer's credit score and other performance measures under different time-averaging approaches. The credit scoring model used in that study was obtained from a joint statistical and experiential model developed from a workshop of farm lenders in the MidWest and summarized in Splett et al. (1994). Transition rates for credit scores, return on investment (ROE), and repayment capacity were derived. The results suggest greater stability in migration ratings for longer time-averaging periods, although less stable than bond migrations, and for the credit score criterion versus ROE and repayment capacity.

Research by Phillips and Kachova (2004) focused on credit score migration rates of farm businesses, testing whether migration probabilities differ across business cycles. The analysis utilized farm-level data for 1985-2002 from the Illinois Farm Business Farm Management Association. The results suggest that agricultural credit ratings are more likely to improve during expansions and deteriorate during recessions. The analysis also tests whether agricultural credit ratings depend on the previous period migration trends. The findings show that credit score ratings exhibit trend reversal where upgrades (downgrades) are more likely to be followed by downgrades (upgrades).

In the study by Gloy, LaDue, and Gunderson (2005), agricultural credit risk migration is examined using loan records from 589 lenders, which span from 1998 to 2001, to detect factors influencing downgrades. Results indicate that lender risk ratings are much more stable than ratings based on credit scores estimated from financial statements, highlighting the importance played by non-financial factors such as management capacity, character, and collateral in assessing credit risk. Additionally, the borrower's risk tier, personal characteristics, and the stage

of business life cycle provide useful information in predicting credit quality downgrades, while the primary agricultural enterprise does not impact the likelihood of a downgrade.

Behrens and Pederson (2007) examined a large data set of loan risk ratings from 1997 to 2004 from four associations in the Seventh Farm Credit District (AgriBank). These four associations represent large geographic areas in North Dakota, Wisconsin, Minnesota, and Arkansas. Using conditional migration matrices, they tested the influence of path dependence, loan size, and loan seasoning in credit movement. The results show that the magnitude of migration reported in previous credit score proxy studies overstates trend reversal in agricultural loans rated by lenders. Their results indicate that retention rates of agricultural loans risk ratings are quite high. Small loans are less likely to migrate while medium- and large-size loans and unseasoned loans are more likely to migrate than seasoned farm loans.

In 2004, Escalante, Barry, Park, and Demir employed ordered logit regression techniques on a panel data from Illinois Farm Business Farm Management (FBFM) system during the period 1992 to 2001 to identify factors affecting farm credit transition probabilities. Results indicate that most farm-specific factors do not have adequate explanatory influence on the probability of farm credit risk transition. Macroeconomic factors, meanwhile, significantly affect credit movements. Economic growth signals, such as changes in stock price indexes, were found to be significant indicators of credit upgrades. Increase in interest rates hampers the probability of upgrades.

The study of Deng, Escalante, Barry, Yu (2007) introduces the application of two Markov chain time approaches, both time-homogeneous and non-homogeneous models, for analyzing farm credit risk migration as alternatives to the traditional discrete-time (cohort) method. The Markov chain models are found to produce more accurate, reliable transition

16

probability rates using the 3x1 migration measurement method used by farm lenders. They found that substantial mean differences in singular value decomposition (SVD) are produced between farm credit risk migration matrices developed under the cohort and Markov chain models than when similar comparisons are made in corporate finance literature using bond ratings migration.

CHAPTER 3

METHODOLOGY

This chapter discusses the econometric approaches used in this research. The first part talks about the derivation and calculation of transition probabilities. The second part tackles the data sources and specification of variables used for the model. The third part discusses the theoretical foundation of the logit model used to analyze variables that affect changes in credit quality captured through the movements of credit score across different levels through time.

3.1 Transition Probability Matrices

This study will employ transition probability approach to examine credit movements over two consecutive periods. Transition probability rates are calculated by tracking the changes or movements of credit ratings from one class to another.

Figure 4. Transition Probability Matrix

Figure 4 illustrates the derivation of transition probability. Migration rates will be measured using the historical movement of credit risk classifications of farm observations. The example in figure 4 illustrates several migration possibilities for the farms' credit risk classes. As figure 4 indicates, historical rates of movements among farms might indicate class one farms could remain in class one 95 percent of the time OR migrate to class two 5 percent of the time. Class two farms, on the other hand, could remain in class two 80 percent of the time and migrate to class one 20 percent of the time.

In this analysis transition probabilities will be estimated using annual credit scores from 2005 to 2012. An average one-period transition matrix (1x1) will be created on order to analyze the overall credit score movements. The values along diagonals represent retention rate, while the off- diagonal values represent upgrades and downgrades in credit score classification.

The data will also be split in order to compare farms by farm type and period. First, farms will be divided in terms of three criteria – by farm size (small versus large), by business maturity (beginning versus mature), and by operator's age (young versus old). These categories will be useful in understanding comparative changes in credit quality among pairs of farm types.

Credit score data will also be divided by periods. Migration matrices will be created for pre-recession period (2005 – 2007), during the recession (2008 – 2009), and post-recession (2009 – 2012). This way, the overall credit score movements of farms for each period can be analyzed.

Lastly, transition matrices will be developed for each type farms for every period. With this, analysis on how migration rates are conditioned by economic conditions for each farm type will be employed.

3.1.1 Comparing Matrices

There are several ways to compare matrices to determine whether there is any significant difference between them. In this paper, L^1 distance metrics will be utilized to compare transition matrices as demonstrated by Jafry and Schuermann (2003).

L^1 distance metrics is a simple but effective way to compare distance between two matrices. Specifically, this metric is being computed as:

$$M_{L1} = \frac{\sum_{i=1}^{N}\sum_{j=1}^{N}|P_{A,i,j} - P_{B,i,j}|}{N^2} \qquad (1)$$

where P_A and P_B denote matrices being compared with $N \times N$ dimensions, where the average absolute difference between corresponding elements of the matrices are being computed. Using this metric, matrices that represent credit movements for different periods will be compared. This will also be employed to compare matrices of farm types based on farm size, business maturity, and operator's age, for each period and for the whole time span of this study. Lastly, transition matrices of different farm type farms for a certain period will be compared to other periods. This way, distance metrics can be used to compare how large each farm's migration behavior in a specific period differs to others.

3.2 Data Sources and Variable Specifications

This analysis will use data from the Farm Service Agency (FSA) compiled for its borrowers from 2005 to 2012. The FSA data set was collected as part of the loan covenants with borrowers that require the provision of periodic financial reports to monitor the borrowers' business and financial progress until their loan obligations have been paid. This study's data set

covers a national scope of farm level data on financial characteristics and past borrowing records of existing FSA clients. The analysis only includes farms that consistently maintained records over the 8-year period, which results in a sample size of 1,432 farms originating from all states (except Hawaii, Alaska, and Washington DC).

This study will follow the measurement procedures, the pre-determined weights assigned to each component of the credit-scoring model and classification intervals used by Splett, et al. for 5 credit class classification classes, which are reported in Table 3.1.

In this research, term debt coverage ratios were used as a replacement for repayment capacity with different interval ranges. The provided data for repayment capacity by FSA tend to categorize majority of the data points to class 1 using Splett's original interval ranges. This study will also extend the classification system to a 10-class rating model, with the intervals redefined between the lowest and highest possible ratings, to see if additional volatility in the transition probability ratings will be obtained. The 10-class rating class boundaries are based on the original five-class rating model where, for example, class 1 in the latter model was broken down into classes 1 and 2 of the ten-class rating model. The same trend applies to the subsequent classes in the rating models.

Aside from the data points used in the credit scoring model, the FSA data set also provides information for defining variables that capture the demographic and structural characteristics of their borrowing farms. Other economic variables at the state-level to represent local and national economic factors were drawn from the U.S. Department of Agriculture (USDA) and Bureau of Economic Analysis (BEA). The macroeconomic measures were obtained from Federal Reserve Bank of St. Louis and S&P websites. Table 3.2 shows the description of variables used in the analysis.

Table 3.1. Credit Scoring Classification Intervals (Source: Splett et al.)

Variables (Measures/Classes)	Interval Ranges	Weights
LIQUIDITY (Current Ratio)		
Class 1	> 2.00	
Class 2	1.60-2.00	
Class 3	1.25-1.60	
Class 4	1.00-1.25	
Class 5	< 1.00	___ x 0.10 =____
SOLVENCY (Equity-Asset Ratio)		
Class 1	> 0.80	
Class 2	0.70-0.80	
Class 3	0.60-0.70	
Class 4	0.50-0.60	
Class 5	< 0.50	___ x 0.35 =____
PROFITABILITY (Farm Return on Equity)		
Class 1	> 0.10	
Class 2	0.06-0.10	
Class 3	0.04-0.06	
Class 4	0.01-0.04	
Class 5	< 0.01	___ x 0.10 =____
REPAYMENT CAPACITY (Capital Debt-Repayment Margin Ratio)[a]		
Class 1	> 0.75	
Class 2	0.50-0.75	
Class 3	0.25-0.50	
Class 4	0.05-0.25	
Class 5	< 0.05	___ x 0.35 =____
FINANCIAL EFFICIENCY (Net Farm Income from Operations Ratio)		
Class 1	> 0.40	
Class 2	0.30-0.40	
Class 3	0.20-0.30	
Class 4	0.10-0.20	
Class 5	< 0.10	___ x 0.10 =____
	Total Score (Numeric)	

[a] Term debt coverage ratios were used to measure repayment capacity in this study.

Table 3.2. Summary and Definition of Variables

Variables	Definition and Coding
FSIZE	= 1 if gross revenue > $250,000; 0 otherwise
ATO	gross farm revenues divided by total farm assets
BEGFM	= 1 if farm had been in the industry for ≤ 10 years in 2005; 0 otherwise
YOUNG	= 1 if the operator is ≤ 45 years old; 0 otherwise
WESTERN	= 1 if the farm is located in western part of the US (Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, Utah, Wyoming, California, Oregon, and Washington); 0 otherwise
MIDWESTERN	= 1 if the farm is located in mid-western part of the US (Illinois, Indiana, Iowa, Missouri, Minnesota, Wisconsin, Kansas, Nebraska, North Dakota, and South Dakota); 0 otherwise
NORTHEASTERN	= 1 if the farm is located in mid-western part of the US (Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, and Vermont); 0 otherwise
SOUTHWESTERN	= 1 if the farm is located in southwestern part of the US (Arkansas, Louisiana, Mississippi, Oklahoma, and Texas); 0 otherwise
SOUTHEASTERN	= 1 if the farm is located in southeastern part of the US Kentucky, North Carolina, Tennessee, Virginia, West Virginia, Alabama, Florida, Georgia, and South Carolina); 0 otherwise
MNYSUP	Annual money supply growth (%)
SNP	Annual change in S&P 500 index (%)
REAL	Annual farmland value growth (%)

3.3 Econometric Framework

This study will utilize random-effects ordered logistic techniques for panel data to identify factors that significantly influence the probability of farm credit migration rates. The general conceptual form of the estimating equations is:

$$Y_{it}^{*} = \alpha + V_{it}'\beta_1 + W_{it}'\beta_2 + Z_{it}'\beta_3 + \mu_i + \varepsilon_{it} \qquad (2)$$

where Y_{it}, the event of interest, is an ordered, discrete migration variable, evaluated on every pair of subsequent periods, where:

$$Y_{it} = 0 \text{ for downgrade in credit classification} \qquad (3)$$

$$Y_{it} = 1 \text{ for remaining in the same class (retention)} \qquad (4)$$

$$Y_{it} = 2 \text{ for upgrade of credit classification} \qquad (5)$$

The farm's credit score will be evaluated using Year-to-Year Transition (1×1), which measures movements in credit risk ratings from one year (n) to the next (n + 1).

The V_{it}, W_{it}, and Z_{it} vectors (with their corresponding vectors of regression coefficients β_1, β_2 and β_3, respectively) are associated with three groups of independent variables representing structural/demographic, financial and macroeconomic factors that could influence the probability of class migrations; and μ_i and ε_{it} are the model's error terms, with the latter representing the stochastic unit-specific error components.

Explanatory variables include demographic, structural/ financial factors that may influence credit migration. Farm size (FSIZE), a dummy variable which is equal to 1 if farm's gross revenue is at least $250,000 is included in the model. This cut-off gross revenue is being

employed by Small Farm Commission to distinguish small and large commercial farms. Larger farms which have greater production efficiencies and economies of scale could influence the probability of upward credit migration.

Asset turnover ratio (ATO), the farm's asset acquisition decisions, is calculated by dividing gross farm revenues by total farm assets. This measure reflects the efficiency of farm's use of its assets to generate revenues. The higher the ratio, the higher revenue a farm is producing based on its assets. Therefore, a higher ratio is preferable to a lower one.

Dummy variable beginning farm (BEGFM) takes a value of 1 if the farm has been in the industry for 10 years or below in 2005. Beginning farms typically have fewer assets compared with mature ones, which could have an effect on the migration rates.

Dummy variables that indicate each farm borrower's regional affiliation (WESTERN, MIDWESTERN, NORTHEASTERN, SOUTHWESTERN, and SOUTHEASTERN) are also included in the analysis. Different U.S. regions have different weather, policies, and type of soil that would affect a farm's profitability and productivity. As such, location of the farm would have an expected effect on the credit rating of each farm. SOUTHEASTERN will be used as the base category of these variables.

Dummy variable for the age (YOUNG) will take a value of 1 if the farm operator is 45 years old or below. Empirical studies show that older farmers tend to be more risk averse (Patrick, Whitaker, and Blake, 1980). This study will look at whether this variable has significant effect on how credit scoring was determined by lending institutions.

Macroeconomic factors considered in this analysis include measures associated with economic growth, lending conditions, price level, and investor expectations. These variables are

beyond the operator's control and could affect implementation of risk-reducing and growth-enhancing business plans.

Annual growth rates of state level farm real estate values (REAL) serve as indicators of economic growth activity. Changes in real estate value reflect farm credit condition, government policies, and production risk.

The annual change in money supply (MNYSUP) reflects changes in credit availability condition. Previous studies show that business failures happen among small firms during tight money conditions as bank institutions end up lending to fewer small businesses to protect their portfolios (Altman, 2001). This economic variable may affect the credit risk quality of farms.

Annual changes in S&P 500 index (SNP) are used in the analysis to reflect the overall performance of the stock market. These changes reflect changes in the investor's demand for holding stocks, which reflects willingness to pay of investors for risky financial assets (Altman, 2001). This could have an effect on the credit risk quality of farms.

Lastly, previous period migration trend (LAGMOVE) is also included in the model to analyze whether the changes in credit risks rating from last year (upgrade, retention, or downgrade) could affect the movement of credit risk ratings in the current year. Findings by Philips and Kachova (2004) show that credit score ratings exhibit path dependence where upgrades are more likely to be followed by downgrades, and vice versa.

3.2.1 Marginal Effects

Marginal effects will be derived to estimate the extent or magnitude of the regressors' effects on the dependent variable. This will be calculated for each category of the dependent variable using the probabilities defined in the series of equations in (6):

$$\frac{\partial Prob\ (Y_{it}^* = 0)}{\partial X} = -\emptyset(\beta'X)\beta, \qquad\qquad (6)$$

$$\frac{\partial Prob\ (Y_{it}^* = 1)}{\partial X} = (\emptyset(-\beta'X)\beta - \emptyset(n - \beta'X))\beta,$$

$$\frac{\partial Prob\ (Y_{it}^* = 2)}{\partial X} = \emptyset(\beta'X)\beta,$$

The marginal effects of significant variables will be computed for 5-class and 10-class models, where the function $\emptyset$ (.) indicates a standard normal distribution, variable X is a vector that contains the three groups of regressors V_{it}, W_{it} and Z_{it}, and the vector β contains their corresponding coefficients β_1, β_2, and β_3. n is the parameter that define the range of values into which variables may fall. This parameter is estimated along with the coefficients of the explanatory variables.

CHAPTER 4

RESULTS

4.1 Transition Probability Matrices

A balanced panel dataset of 1,432 farms has been evaluated from 2005 to 2012. This does not include new entrants within this period or farms that terminated their operations during the scope of the study. The credit score migration rates for each economic period and farm type are reported in Tables 4.1 to 4.10. This section also compares the migration rates of each farm type for each economic period or episode. Summary of credit score migration rates of each farm type for each economic period are listed in the appendix of this paper.

Table 4.1. Average One-Period Transition Matrices for Credit Scores, Ten Credit Classes, 2005-2012 (Percent)

Period 1 Classes	Period 2 Classes									
	1	2	3	4	5	6	7	8	9	10
1	33.56	12.75	6.04	10.74	16.78	14.09	4.70	1.34	0.00	0.00
2	13.87	24.79	12.61	13.87	15.97	10.50	4.20	2.94	0.84	0.42
3	6.01	11.54	24.28	17.79	15.38	14.18	6.49	3.13	1.20	0.00
4	2.22	4.06	9.61	21.55	24.51	17.00	11.95	6.90	1.23	0.99
5	0.86	2.81	5.90	12.26	32.47	19.82	13.80	8.30	2.52	1.26
6	0.29	1.96	3.82	6.70	18.25	33.81	19.03	11.84	2.69	1.61
7	0.24	0.88	1.91	4.35	12.61	22.19	35.68	17.84	2.79	1.52
8	0.00	0.74	1.19	4.10	10.13	14.68	20.71	36.46	8.36	3.64
9	0.18	0.37	1.47	2.76	7.17	11.03	13.24	26.10	28.86	8.82
10	0.00	0.37	0.00	2.21	10.33	12.55	13.28	25.46	16.97	18.82

Table 4.2. Summary Transition Rates for All Farms, 2005-2012

	Summary Rates
Migration Trends: Year-to-Year	
Upgrade	35.69
Retention	32.14
Downgrade	32.16

Based on Table 4.1, retention rates range from 36.46 percent to 18.82 percent. In general, higher risk classes have higher retention rates especially Class 8, which tallies the highest retention rate. This is not line with the results of Barry, Escalante, and Ellinger (2002) and Escalante, Barry, Park, and Demir (2004) where the retention rates are highest for class 1 borrowers. The possible explanations are the difference of data samples and the difference in the time periods the studies covered. From 2005 to 2012, 35.69 percent of movements were upgrades, while retentions and downgrades comprise 32.14 percent and 32.16 percent of credit movements, respectively (Table 4.2).

4.1.2 Transition Matrices by Period

Credit scores of 1,432 farms have been divided to three economic periods or episodes (pre-recession, recession, and post-recession) in order to compare credit score movements of these farms for each period. Table 4.3 shows credits score movement for these each economic period. During the pre-recession, the highest retention rate has been observed in class 8 borrowers, which reports 40.04 percent class retention rate. This is also the case with the recession period, where class 8 also has the highest retention rate of 37.66 percent. Unlike the pre-recession, the recession period, has shown high retention rates for high classes. In the post-recession period, meanwhile, class 1 has the highest retention rate of 44.23 percent. It has also

Table 4.3. Average One-Period Transition Matrices of Periods (Pre-Recession, Recession, Post Recession) for Credit Scores, Ten Credit Classes, (Percent)

Period 1 Classes	Period 2 Classes									
	1	2	3	4	5	6	7	8	9	10
Pre-Recession										
1	19.64	7.14	3.57	12.50	19.64	26.79	7.14	3.57	0.00	0.00
2	11.54	7.69	11.54	17.31	21.15	11.54	11.54	3.85	3.85	0.00
3	4.76	7.14	15.48	19.05	23.81	19.05	5.95	2.38	2.38	0.00
4	0.99	3.45	5.91	18.23	22.17	20.69	16.26	7.88	2.46	1.97
5	0.62	1.25	4.37	10.19	30.77	21.62	17.67	8.52	3.74	1.25
6	0.18	0.88	2.46	7.04	16.55	32.04	23.77	12.15	3.17	1.76
7	0.00	0.16	1.28	3.67	8.31	22.20	37.22	22.52	2.24	2.40
8	0.00	0.19	0.96	2.68	10.15	12.84	19.92	40.04	9.39	3.83
9	0.53	0.00	0.53	3.17	5.82	11.11	15.34	25.93	29.10	8.47
10	0.00	0.00	0.00	0.00	7.23	12.05	13.25	28.92	19.28	19.28
Recession										
1	35.29	11.76	5.88	5.88	29.41	5.88	5.88	0.00	0.00	0.00
2	5.26	28.95	15.79	18.42	10.53	15.79	0.00	2.63	0.00	2.63
3	1.72	1.72	24.14	20.69	13.79	17.24	13.79	6.90	0.00	0.00
4	2.16	2.16	10.07	18.71	20.86	15.11	12.95	14.39	1.44	2.16
5	0.38	2.66	5.70	13.31	30.42	18.25	14.45	11.03	2.28	1.52
6	0.00	1.59	2.23	7.01	16.56	34.39	16.88	15.29	2.55	3.50
7	0.00	1.82	1.45	3.27	14.55	19.64	36.73	17.82	2.91	1.82
8	0.00	0.84	1.26	4.18	8.37	14.64	18.83	37.66	9.21	5.02
9	0.00	0.00	1.49	2.99	5.97	8.96	14.93	31.34	22.39	11.94
10	0.00	0.00	0.00	13.64	4.55	9.09	13.64	40.91	9.09	9.09
Post Recession										
1	44.23	19.23	3.85	11.54	15.38	3.85	1.92	0.00	0.00	0.00
2	18.18	28.28	10.10	14.14	17.17	8.08	1.01	3.03	0.00	0.00
3	7.98	19.02	32.52	14.11	11.04	8.59	5.52	0.61	0.61	0.00
4	3.00	6.01	14.16	26.18	22.32	14.59	9.44	3.43	0.43	0.43
5	0.93	5.22	7.09	11.94	33.77	18.66	11.38	8.02	1.87	1.12
6	0.53	3.54	6.02	5.66	21.24	35.93	16.46	7.26	2.12	1.24
7	0.37	1.12	2.99	4.48	13.99	24.25	33.96	14.55	3.17	1.12
8	0.00	1.97	1.75	3.73	9.43	18.42	21.49	33.77	6.80	2.63
9	0.00	0.00	2.68	2.68	9.40	10.07	10.07	23.49	34.23	7.38
10	0.00	0.00	0.00	4.00	12.00	12.00	18.67	17.33	16.00	20.00

Table 4.4. Summary Transition Rates by Period

	Pre-Recession	Recession	Post-Recession
Migration Trends: Year-to-Year			
Upgrade	32.19	32.05	39.07
Retention	31.70	31.63	33.21
Downgrade	36.10	36.31	27.72

been observed that the retention rates for higher classes are even higher compared to recession. This is an indication that overall, farms have improved after the recessionary period. This is in line with the results of Philips and Kachova (2004) study that observed improved financial status of farms after recession.

Comparing the total transitions for each period (Table 4.4), pre-recession and recession periods have almost the same percentage of migration movements. Downgrades are the highest for pre-recession and recession, which translate to 36.10 percent and 36.31 percent, respectively. This is followed by upgrades that account for 32.19 percent and 32.05 percent for pre-recession and recession. The results for these two periods suggest farms' resiliency during recession as the economic change has minimal effect in their credit score.

In the post-recession period, upgrades account for the highest percentage (39.07 percent) of movements during the period. Upgrades were followed by retentions that account for 33.21 percent, and then downgrade, which tallies 27.72 percent. Both upgrades and retentions are higher, while portion of downgrades is lower, when these migration trends are compared to the two previous periods. The higher percentage of upgrades during this period represents better financial capacity of farms in general after recession.

Table 4.5. L^1 Distance metrics Between Periods

	L^1
Comparing Periods	
Pre-recession and recession	0.034
Pre-recession and post-recession	0.039
Recession and post-recession	0.036

Table 4.5 shows that the differences between transition matrices between the three periods are small. The L^1 for the difference between the pre-recession and recession is 0.034, while the L^1 between pre-recession and post-recession is 0.039. The distance metric for recession and post-recession and post-recession meanwhile is 0.036.

4.1.3 Transition Matrices by Farm Type

Farms were also classified into different farm types. To compare the relative financial strength and endurance of several paired classes of farmers, tables have been made according to farm operators' age/experience (young versus older, more experienced farm operators), business maturity (beginning versus mature farm businesses), and farm size (small versus large farm businesses).

4.1.3.1 Young versus Old Farm Operators

Young farm operators have the highest retention rate in class 8, which translates to 36.81 percent. The retention rate for these operators ranges from 36.81 percent to 18.56 percent. Older farm operators, meanwhile, have the highest retention rate of 50.00 percent for class 1 borrowers. There is a relatively higher retention rates between classes 4 and 8, which would an implication of what kind of farm the agency caters. Old farmers' transition matrix, however, observed of

Table 4.6. Average One-Period Transition Matrices of Young and Old Farms for Credit Scores,

Ten Credit Classes, 2005-2012 (Percent)

Period 1 Classes	Period 2 Classes									
	1	2	3	4	5	6	7	8	9	10
Young										
1	32.12	11.68	5.84	11.68	16.79	15.33	5.11	1.46	0.00	0.00
2	12.61	25.23	12.61	13.51	17.12	10.36	4.50	3.15	0.45	0.45
3	6.05	11.59	24.69	17.88	15.11	13.85	6.55	3.02	1.26	0.00
4	1.79	3.85	9.62	21.28	24.87	17.31	11.79	7.18	1.28	1.03
5	0.89	2.66	5.92	12.08	32.45	19.78	13.97	8.47	2.55	1.24
6	0.30	1.93	3.70	6.80	18.21	33.89	19.08	11.87	2.54	1.67
7	0.25	0.85	1.86	4.42	12.61	21.95	35.86	17.83	2.81	1.56
8	0.00	0.76	1.16	3.90	10.25	14.21	20.85	36.81	8.39	3.67
9	0.19	0.38	1.35	2.69	7.12	10.58	13.27	26.54	28.85	9.04
10	0.00	0.38	0.00	2.27	10.61	12.88	13.26	25.38	16.67	18.56
Old										
1	50.00	25.00	8.33	0.00	16.67	0.00	0.00	0.00	0.00	0.00
2	31.25	18.75	12.50	18.75	0.00	12.50	0.00	0.00	6.25	0.00
3	5.26	10.53	15.79	15.79	21.05	21.05	5.26	5.26	0.00	0.00
4	12.50	9.38	9.38	28.13	15.63	9.38	15.63	0.00	0.00	0.00
5	0.00	7.02	5.26	17.54	33.33	21.05	8.77	3.51	1.75	1.75
6	0.00	2.74	6.85	4.11	19.18	31.51	17.81	10.96	6.85	0.00
7	0.00	1.82	3.64	1.82	12.73	30.91	29.09	18.18	1.82	0.00
8	0.00	0.00	2.44	12.20	4.88	34.15	14.63	21.95	7.32	2.44
9	0.00	0.00	4.17	4.17	8.33	20.83	12.50	16.67	29.17	4.17
10	0.00	0.00	0.00	0.00	0.00	0.00	14.29	28.57	28.57	28.57

Table 4.7. Summary Transition Rates of Young and Old Farms, 2005-2012

	Young	Old
Migration Trends: Year-to-Year		
Upgrade	35.53	40.48
Retention	32.26	28.87
Downgrade	32.22	30.65

having no value for some cells that would indicate less disperse credit score these farmer being categorized.

Comparing these two farm classes within the time line of the study, older farm operators are in a better credit position relative to younger farm operators. Upgrades account for 40.48 percent, while downgrades share 30.65 percent for old farm operators. Young farm operators have upgrades of 35.53 percent of total class transition compared to downgrades that have 32.22 percent. This means that regardless of the period, old farm operators are in better position in getting loans, which would reflect their financial stability and probable risk aversion (Patrick, Whitaker, and Blake, 1980).

Looking at L^1 distance metrics (Table 4.8), difference between the young and old farm operators is 0.043, which is the higher value obtained among the three paired comparisons. One possible explanation for this is the concentration of old farm operators on only few credit classes in the scope of the study.

Table 4.8. L^1 Distance metrics Between Farm Types

	L^1
Comparing Farm Types	
Young and old farm operators	0.043
Beginning and mature farms	0.022
Small and large farms	0.032

4.1.3.2 Beginning versus Mature Farms

Table 4.9. Average One-Period Transition Matrices of Beginning and Mature Farms for Credit

Scores, Ten Credit Classes, 2005-2012 (Percent)

Period 1 Classes	Period 2 Classes									
	1	2	3	4	5	6	7	8	9	10
Beginning Farms										
1	28.13	4.69	6.25	7.81	23.44	20.31	9.38	0.00	0.00	0.00
2	17.24	27.59	10.34	5.17	17.24	8.62	6.90	6.90	0.00	0.00
3	4.96	11.57	22.31	17.36	17.36	13.22	5.79	4.96	2.48	0.00
4	1.87	3.00	7.49	20.60	22.10	19.48	12.73	10.11	0.75	1.87
5	0.88	1.94	4.42	10.95	32.86	21.38	14.13	9.54	2.83	1.06
6	0.29	1.29	3.86	7.43	16.57	35.29	19.29	11.71	3.14	1.14
7	0.28	0.28	1.52	4.28	12.97	21.52	38.07	16.97	2.90	1.24
8	0.00	0.52	0.86	2.94	10.02	15.37	23.32	35.06	8.98	2.94
9	0.00	0.00	0.00	2.81	8.99	9.55	12.92	24.72	30.34	10.67
10	0.00	0.00	0.00	2.11	6.32	14.74	10.53	25.26	14.74	26.32
Mature Farms										
1	37.65	18.82	5.88	12.94	11.76	9.41	1.18	2.35	0.00	0.00
2	12.78	23.89	13.33	16.67	15.56	11.11	3.33	1.67	1.11	0.56
3	6.44	11.53	25.08	17.97	14.58	14.58	6.78	2.37	0.68	0.00
4	2.39	4.59	10.64	22.02	25.69	15.78	11.56	5.32	1.47	0.55
5	0.85	3.22	6.61	12.88	32.29	19.07	13.64	7.71	2.37	1.36
6	0.30	2.31	3.79	6.32	19.12	33.04	18.90	11.90	2.46	1.86
7	0.23	1.21	2.12	4.39	12.41	22.56	34.37	18.32	2.73	1.67
8	0.00	0.85	1.36	4.66	10.18	14.33	19.42	37.15	8.06	3.99
9	0.27	0.55	2.19	2.73	6.28	11.75	13.39	26.78	28.14	7.92
10	0.00	0.57	0.00	2.27	12.50	11.36	14.77	25.57	18.18	14.77

Table 4.10. Summary Transition Rates of Beginning and Mature Farms, 2005-2012

	Beginning	Mature
Migration Trends: Year-to-Year		
Upgrade	34.30	36.40
Retention	33.02	31.70
Downgrade	32.69	31.90

Table 4.9 shows the transition rates of beginning and mature farms. The retention rates of beginning farms range from a high of 38.07 percent for class 7 borrowers to a low of 20.60 percent for class 4 borrowers. Retention rates of mature farms, on the other hand, range from 37.65 percent for class 1 borrowers to a low of 14.77 percent for class 10 borrowers. Looking at the retention rate for each farm class for these farm types, mature farms have a higher rate for higher classes compared to the beginning farms. Transition matrix for mature farms behaves quite similarly with the results of the studies by Barry, Escalante, and Ellinger (2002) and Escalante, Barry, Park, and Demir (2004).

Examining Table 4.10, results show that beginning farms fare well during the scope of the study. Both beginning and mature farms have highest average transitions in upgrades that translate to 34.30 percent and 36.40 percent, respectively. Downgrades comprise the lowest for two classes of farms, which translates 32.69 percent and 31.90 percent for young and mature farms, respectively. Meanwhile, L^1 distance metrics between these two types of farm is 0.22, which is lower than the distance metrics between young and old farm operators (Table 4.8).

4.1.3.3 Small versus Large Farms

Looking at Table 4.11, the average retention rates for small farms range from 36.78 percent for class 7 borrowers to a low of 19.37 percent for class 10 borrowers. The retention rate for class 1 borrowers is relatively high, tallying 34.48 percent. For large farms, the average retention rates range from 37.14 percent for class 8 borrowers to a low of 16.33 percent for class 10 borrowers.

As both types has lowest retention rates in class 10 borrowers, this translates that for both small and large farms, majority of class 10 borrowers tend to increase their credit score for the Table

36

4.11. Average One-Period Transition Matrices of Small and Large Farms for Credit Scores, Ten

Credit Classes, 2005-2012 (Percent)

Period 1 Classes	Period 2 Classes									
	1	2	3	4	5	6	7	8	9	10
Small Farms										
1	34.48	12.41	5.52	10.34	16.55	14.48	4.83	1.38	0.00	0.00
2	14.00	25.50	13.00	11.50	16.00	11.00	4.00	3.50	1.00	0.50
3	6.85	11.61	23.21	18.45	14.58	13.99	6.85	3.27	1.19	0.00
4	2.70	3.97	9.22	22.89	24.17	16.38	11.92	6.68	1.43	0.64
5	1.01	3.18	6.60	11.72	31.21	20.89	13.59	8.15	2.56	1.09
6	0.31	1.95	3.97	6.35	16.97	35.16	18.80	12.03	2.87	1.59
7	0.30	0.91	1.64	4.38	11.81	22.78	36.78	17.05	2.86	1.46
8	0.00	0.66	1.17	4.01	9.25	14.64	21.12	36.27	9.25	3.64
9	0.21	0.42	1.27	2.54	6.14	11.65	12.71	25.21	29.87	9.96
10	0.00	0.45	0.00	2.25	9.01	11.26	13.51	25.23	18.92	19.37
Large Farms										
1	0.00	25.00	25.00	25.00	25.00	0.00	0.00	0.00	0.00	0.00
2	13.16	21.05	10.53	26.32	15.79	7.89	5.26	0.00	0.00	0.00
3	2.50	11.25	28.75	15.00	18.75	15.00	5.00	2.50	1.25	0.00
4	0.55	4.37	10.93	16.94	25.68	19.13	12.02	7.65	0.55	2.19
5	0.44	1.75	3.93	13.76	36.03	16.81	14.41	8.73	2.40	1.75
6	0.25	1.97	3.20	8.13	23.40	28.33	19.95	11.08	1.97	1.72
7	0.00	0.74	2.97	4.21	15.84	19.80	31.19	21.04	2.48	1.73
8	0.00	1.04	1.30	4.42	13.25	14.81	19.22	37.14	5.19	3.64
9	0.00	0.00	2.78	4.17	13.89	6.94	16.67	31.94	22.22	1.39
10	0.00	0.00	0.00	2.04	16.33	18.37	12.24	26.53	8.16	16.33

Table 4.12. Summary Transition Rates of Small and Large Farms, 2005-2012

	Small	Large
Migration Trends: Year-to-Year		
Upgrade	35.39	36.84
Retention	32.56	30.54
Downgrade	32.05	32.61

succeeding year and few farms tend to stay in that class. The peculiar results from large farm transition matrix are that none of these farms got class 1 classification. This would be associated with the kind of sample for this type.

Comparing the migration trends of these two farm classes, large farms have higher rate of upgrades compared to small farms, tallying 36.84 percent compared to 35.39 percent. Looking at the retention and downgrade migration trends, meanwhile, small farms showed higher values, registering 32.56 percent and 32.05 percent, respectively. This would be the case as large farms have significantly higher upgrade rates that lower the proportion of two other migration trends, which is positive for this type of farm.

Looking at L^1 distance metrics (Table 4.8), the difference between small and large farms is 0.032, a figure that is in between the two other paired classes.

4.1.4 Transition Rates of each Farm Type for Each Period

This section will examine whether there are significant differences in migration rates for different types of farms that translate to differences in credit quality especially during periods of economic shocks.

Table 4.13 shows how average migration rates for each type of farm have been affected by different economic periods.

Table 4.13. Summary Transition Rates of Paired Classes of Farmers for Each Period

Young versus Old Farm Operators						
	Upgrade		Retention		Downgrade	
	Young	Old	Young	Old	Young	Old
Pre-Recession	31.86	41.67	31.97	23.96	36.16	34.38
Recession	31.79	39.58	31.79	27.08	36.42	33.33
Post-Recession	39.16	36.46	33.09	36.46	27.75	27.08
Beginning versus Mature Farms						
	Beginning	Mature	Beginning	Mature	Beginning	Mature
Pre-Recession	30.58	33.00	31.32	31.90	38.10	35.10
Recession	30.27	32.95	32.78	31.06	36.95	35.99
Post-Recession	38.94	39.14	34.03	32.79	27.04	28.07
Small versus Large Farms						
	Small	Large	Small	Large	Small	Large
Pre-Recession	32.60	30.64	31.81	31.31	35.59	38.05
Recession	32.07	31.99	31.72	31.31	36.21	36.70
Post-Recession	38.06	42.93	34.19	29.46	27.75	27.61

Looking at the young and old farm operators, results suggest that young operators were quick to recover from economic recession. Old farm operators, meanwhile, were relatively stable during on this period. During pre-recession, old farm operators had higher percentage of upgrades of 41.67 percent, compared with 31.86 percent of young farm operators. Also in this period, 31.97 percent of total transitions of young farm operators were retentions, compared with average retention rates of old farms of 23.96 percent.

During the recession period, the percentage of each migration trends for young operators was almost the same with pre-recession. There were only a decrease for upgrades and retentions of 0.07 percent and 0.18 percent, respectively and increase for downgrades of 0.26 percent. This only shows flexibility of these farms during weak economy. After the recession, young farm operators showed improvement as it increased it upgrade percentage to 39.16 percent, which is way higher compared to its upgrade rates during recession. Curiously, upgrade percentage of old

farm operators is lower during post-recession, tallying 36.46 percent, which would be the effect

of the increased percentage of retention to 36.46 percent, which translates to 9.38 percent

difference with the retention rates during recession.

Looking at L^1 distance metrics (Table 4.14) of these two farms for different periods,

recession tallied the highest distance, registering 0.105. Pre-recession and post-recession periods,

meanwhile, show lower L^1, tallying 0.087 and 0.067, respectively. One possible explanation of

these values is the higher activity or credit movements of these farms during recession period.

Table 4.14. L^1 Distance metrics of Paired Farm Types for Each Period

Farm Types for Each Period	
	L^1
Pre-Recession	
Young and old farm operators	0.087
Beginning and mature farms	0.036
Small and large farms	0.055
Recession	
Young and old farm operators	0.105
Beginning and mature farms	0.054
Small and large farms	0.081
Post-Recession	
Young and old farm operators	0.067
Beginning and mature farms	0.037
Small and large farms	0.047

Comparing the beginning and mature farms, results imply that beginning farms managed

to survive the recession, while mature farms also show resiliency during the time period. During

the recession period, 36.95 percent of total transitions were downgrades for beginning farms, but

it decreased to 27.04 percent during the post-recession period. Upgrades for beginning farms,

meanwhile, had increased from 30.27 percent during the recession period to 38.94 percent during the post-recession period. Mature farms, on the other hand, also increased the portion of upgrades from 32.95 percent during recession to 39.14 percent during post-recession. Retention rates had almost the same portion during three periods for mature farms, as it only range from 31.90 percent to 32.79 percent.

L^1 distance metrics between beginning and mature farms show that the recession period had the highest distance of 0.054. These two farms' L^1 for pre-recession and post-recession are pretty much the same, recording 0.036 and 0.037, respectively. Results behave the same with young and old farm operators have.

Results from small and large farms suggest that these types adapt well to changing economic environment. Many of these farm classes upgraded their class ratings after recession. Upgrades of large farms comprised 42.93 percent of total transition during post-recession compared to 31.99 percent during recession. Small farms, meanwhile had 38.06 percent, which is 5.99 percent higher compared to upgrades during recession.

Retention rates were also stable during economic recession. Large farms retained the 31.31 percent retention rate during recession, but decreased its rate to 29.46 percent during post-recession. Small farms only decrease by 0.09 percent from 31.81 percent during pre-recession to 31.72 percent during recession. Retention rates for small farms had further increased during post-recession to 34.19 percent. The results suggest that small farms were a bit more stable throughout the three periods, although more large farms have better credit scores after recession.

Same with the results of the other two paired classes, recession period also tallies the highest L^1 distance metrics between small and large farms. Distance between small and large from during this period is 0.081, compared to 0.055 during pre-recession and to 0.047 of post-recession.

4.2 Random-Effects Ordered Logit Regression

The models provide interesting results on how explanatory variables affect the migration trend of farms. Table 4.15 shows the coefficients and resulting z-statistics of ordered logit models for 5-class and 10-class migration. A positive (negative) coefficient for an explanatory variable suggests increases (decreases) in the probability of a credit risk rating upgrade.

Farm size is significant for 5-class and 10-class models suggesting that larger farms have a higher probability of credit upgrade. Asset turnover ratio has a significant positive coefficient in the 5-credit class model that suggests that higher efficiency of use of assets of farms will increase the probability of credit class upgrade. Dummy variable for younger operators (YOUNG) is also found significant for the 5-class and 10-class models. This variable, however, suggests that being a young operator has a lower probability of upgrade compared with more mature farm operators, holding other variables constant.

All macroeconomic variables produced significant coefficients. Annual changes of money supply variable (MNYSUP) have positive coefficients for the 5-class and 10-class models, which is in line with the expected sign as increase in money supply could lessen credit availability constraints for farms. The positive coefficient of changes of farm real estate values, on the other hand, suggests that improving farm economy could also lead to class upgrades. Change in S&P 500 index (SNP) also has a significant effect in the 5-class and 10-class models. The sign, however, is not expected as improving stock market is anticipated to increase probability of class upgrade. This is in contrast with the results of Escalante, Barry, Park and Demir (2004), which shows S&P's positive effect on the credit score.

Table 4.15. Results of Random-effects Ordered Logit Regression

Year-to-Year Transition Random Effects Ordered Logit Model					
	5 Credit Classes			**10 Credit Classes**	
Variables	Coefficient	z-statistic		Coefficient	z-statistic
FSIZE (farm size)	**0.18485*****	4.18		**0.17785*****	4.13
ATO (asset turnover)	**0.068533****	1.97		0.052415	1.59
BEGFM (=1 if beginning farm, 0 otherwise)	-0.03466	-0.63		-0.05292	-0.99
YOUNG (=1 if 45 years old or below, 0 otherwise)	**-0.15225*****	-2.93		**-0.12618****	-2.49
WESTERN	0.09299	0.86		0.037935	0.36
MIDWESTERN	0.080746	0.9		0.048207	0.55
NORTHEASTERN	0.019513	0.17		-0.01353	-0.12
SOUTHWESTERN	-0.05977	-0.55		-0.09039	-0.85
MNYSUP (money supply growth, %)	**0.050112*****	4.75		**0.03751*****	3.64
SNP (change in S&P 500 index, %)	**-0.00523*****	-4.72		**-0.00433*****	-4.01
REAL (farmland value growth, %)	**0.007081*****	2.63		**0.009453*****	3.6
LAGMOVE (previous period migration trend)	**-1.08741*****	-34.33		**-0.74691*****	-28.9
Log likelihood	-8259.925			-8936.7666	
Wald Chi^2	1247.81***			902.58***	

*, **, *** denote significance at 10%, 5%, and 1% levels, respectively.

LAGMOVE, which is included to the model to capture the effect of previous period migration trend to the present year, also has a significant coefficient. The variable has a negative coefficient, which suggests that an upgrade in previous period decreases the probability of a credit upgrade. This is in line with the findings of previous studies on trend reversals in farm's credit scores.

Table 4.16. Marginal Effects of Significant Explanatory Variables

	Five Credit Classes		
Significant Variables	**Downgrade**	**Retention**	**Upgrade**
FSIZE (farm size)	-0.0295288	-0.0033023	0.0328311
ATO (asset turnover)	-0.0109478	-0.0012243	0.0121721
YOUNG (=1 if 45 years old or below, 0 otherwise)	0.0243215	0.00272	-0.0270414
REAL (farmland value growth, %)	-0.0011312	-0.0001265	0.0012577
MNYSUP (money supply growth, %)	-0.0080051	-0.0008952	0.0089003
SNP (change in S&P 500 index, %)	0.0008352	0.0000934	-0.0009286
LAGMOVE (previous period migration trend)	0.1737073	0.0194263	-0.1931336
	Ten Credit Classes		
FSIZE (farm size)	-0.035043	-0.0027115	0.0377545
ATO (asset turnover)			
YOUNG (=1 if 45 years old or below, 0 otherwise)	0.0248627	0.0019238	-0.0267865
REAL (farmland value growth, %)	-0.0018625	-0.0001441	0.0020067
MNYSUP (money supply growth, %)	-0.0073909	-0.0005719	0.0079628
SNP (change in S&P 500 index, %)	0.0008536	0.0000661	-0.0009197
LAGMOVE (previous period migration trend)	0.1471682	0.0113875	-0.1585557

Table 4.16 shows marginal effects of significant variables for 5-class and 10-class
models. Results show that the likelihood of an upgrade increases by a range of 0.0328 to 0.0377
if the farm's gross revenue is at least $250,000. A unit increase in ATO, meanwhile, increases
the likelihood of an upgrade by 0.0122. The variable YOUNG, on the other hand, decreases the
likelihood of an upgrade by a range of 0.0268 to 0.0270.

Two of the macroeconomic variables, REAL and MNYSUP, have negative marginal
effects on downgrade and retention probabilities, and have positive marginal effect on the
probability of upgrades. Results show that MNYSUP yields larger marginal effects on credit
class movements compared with REAL. The other significant macroeconomic variable, SNP, has

positive marginal effects in downgrade and retention probabilities, while its marginal effect on the probability of upgrades is negative. Overall, significant macroeconomic variables have weaker marginal effects on class risk movements compared with demographic and structural variables.

LAGMOVE produced the strongest marginal effects among explanatory variables. This variable decreases the likelihood of an upgrade by a range of 0.159 to 0.193. The variable's effect on downgrade probabilities is positive, which ranges from 0.147 to 0.173. The marginal effect of this variable on the probability of retention is also positive by a range of 0.0114 to 0.0194.

CHAPTER 5

IMPLICATIONS AND CONCLUSIONS

The results show that the late 2000s recession has minimal effect on farms in terms of credit rating movement, regardless of farm type. This is in line with the previous studies that show farms had relatively better financial health during economic shocks. All of the farms showed better credit scores after the recession, which shows resiliency of farm sector in general.

While the farm sector shows resiliency during the economic recession, there's no wonder that sector was affected by the changing economic conditions as reflected by higher distance metrics of each farm type during recession compared to other periods. This means that in general, there was high level of credit movements compared to pre- and post – recessionary period. In addition, the regression analysis shows that macroeconomic variables suggest that the economic activities have significant roles in credit risk movements of farms. As such the government should consider the nature and magnitude of their support for the sector especially for beginning small young farms in order for them to withstand volatile, more challenging economic conditions.

The results suggest that financial strength of small farms, young farm operators, and beginning farms during the recessionary period remained at favorable level. Although their counterpart classes were in better credit classes during and post-recession period, these farms show resiliency with a higher upgrade rate, and better or almost the same retention rates for the

higher classes. This suggests that lenders should still cater to these kinds of farms during recession as they can still manage to withstand changing economic conditions.

Regression results show that larger farm size and older farm operators have higher probabilities of credit upgrades, which is in line with the results from the migration matrices. This suggests that these kinds of farms have will most likely succeed in obtaining loans from lending institutions. Small young farms, meanwhile, may have difficulty meetings lender's requirements. Financing capital is needed by these small young farms to supplement existing funds to finance their operating infrastructure and working capital requirements. As such, these results underscore the need for lenders' better understanding of the small young farmers' operating structures and business potentials and consider the adoption of more appropriate credit risk assessment models that should more accurately capture their credit risk conditions.

Further studies can focus on the uniqueness of migration rates for agricultural loans for farm borrower from different regional affiliations. This study can also be expanded by taking into account other factors that would affect credit scores such as weather, technical change, and other structural characteristics. Employing different credit migration approach for each farm type can also be done in order to test what approach is the best indicator of farm loan portfolio quality.

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APPENDIX A. Credit Score Classes

Credit Score Classes	Interval Ranges
Five Credit Classes	
Class 1	1.00 - 1.80
Class 2	1.81 - 2.70
Class 3	2.71 - 3.60
Class 4	3.61 - 4.50
Class 5	4.51 - 5.00
Ten Credit Classes [b]	
Class 1	1.00 - 1.40
Class 2	1.41 - 1.80
Class 3	1.81 - 2.25
Class 4	2.26 - 2.70
Class 5	2.71 - 3.15
Class 6	3.16 - 3.60
Class 7	3.61 - 4.05
Class 8	4.06 - 4.50
Class 9	4.51 - 4.75
Class 10	4.76 - 5.00

[b] The ten credit classes were derived from the original five credit classes defined by Splett, et al. (1994) where class 1 in the latter classification was split into classes 1 and 2 of the new ten-class approach, and so forth.

APPENDIX B. Transition Matrices for Pre-Recession

Table B1. Average One-Period Transition Matrices of Young and Old Farm Operators for Credit
Scores, Ten Credit Classes, Pre-Recession (Percent)

Period 1 Classes	Period 2 Classes									
	1	2	3	4	5	6	7	8	9	10
Young										
1	20.37	3.70	3.70	12.96	20.37	27.78	7.41	3.70	0.00	0.00
2	10.42	8.33	12.50	16.67	22.92	10.42	12.50	4.17	2.08	0.00
3	4.94	7.41	14.81	18.52	23.46	19.75	6.17	2.47	2.47	0.00
4	1.02	3.05	5.58	18.27	22.84	20.30	16.24	8.12	2.54	2.03
5	0.64	1.07	4.49	9.83	30.98	21.37	17.95	8.76	3.63	1.28
6	0.18	0.73	2.00	7.26	16.88	32.49	23.96	12.16	2.54	1.81
7	0.00	0.16	1.31	3.78	8.37	21.84	37.44	22.33	2.30	2.46
8	0.00	0.20	0.80	2.58	10.34	12.13	20.08	40.56	9.54	3.78
9	0.56	0.00	0.56	2.81	5.62	10.11	15.73	26.97	29.21	8.43
10	0.00	0.00	0.00	0.00	7.59	12.66	12.66	29.11	20.25	17.72
Old										
1	0.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	25.00	0.00	0.00	25.00	0.00	25.00	0.00	0.00	25.00	0.00
3	0.00	0.00	33.33	33.33	33.33	0.00	0.00	0.00	0.00	0.00
4	0.00	16.67	16.67	16.67	0.00	33.33	16.67	0.00	0.00	0.00
5	0.00	7.69	0.00	23.08	23.08	30.77	7.69	0.00	7.69	0.00
6	0.00	5.88	17.65	0.00	5.88	17.65	17.65	11.76	23.53	0.00
7	0.00	0.00	0.00	0.00	5.88	35.29	29.41	29.41	0.00	0.00
8	0.00	0.00	5.26	5.26	5.26	31.58	15.79	26.32	5.26	5.26
9	0.00	0.00	0.00	9.09	9.09	27.27	9.09	9.09	27.27	9.09
10	0.00	0.00	0.00	0.00	0.00	0.00	25.00	25.00	0.00	50.00

Table B2. Summary Transition Rates of Young and Old Farm Operators, Pre-Recession

	Young	Old
Migration Trends: Year-to-Year		
Upgrade	31.86	41.67
Retention	31.97	23.96
Downgrade	36.16	34.38

Table B3. Average One-Period Transition Matrices of Beginning and Mature Farms for Credit

Scores, Ten Credit Classes, Pre-Recession (Percent)

	Period 2 Classes									
Period 1 Classes	1	2	3	4	5	6	7	8	9	10
Beginning										
1	21.21	0.00	6.06	6.06	27.27	30.30	9.09	0.00	0.00	0.00
2	16.67	5.56	11.11	11.11	16.67	11.11	22.22	5.56	0.00	0.00
3	3.57	7.14	7.14	21.43	21.43	28.57	3.57	3.57	3.57	0.00
4	2.27	2.27	4.55	20.45	17.05	20.45	18.18	11.36	1.14	2.27
5	0.60	0.60	1.80	10.78	31.14	23.95	15.57	8.98	4.79	1.80
6	0.52	0.52	3.66	11.52	14.66	31.41	23.04	8.90	3.66	2.09
7	0.00	0.00	0.00	2.39	10.53	21.05	41.15	19.62	3.83	1.44
8	0.00	0.70	1.40	3.50	12.59	11.89	21.68	35.66	11.19	1.40
9	0.00	0.00	0.00	3.57	5.36	12.50	17.86	17.86	32.14	10.71
10	0.00	0.00	0.00	0.00	8.00	24.00	4.00	24.00	20.00	20.00
Mature										
1	17.39	17.39	0.00	21.74	8.70	21.74	4.35	8.70	0.00	0.00
2	8.82	8.82	11.76	20.59	23.53	11.76	5.88	2.94	5.88	0.00
3	5.36	7.14	19.64	17.86	25.00	14.29	7.14	1.79	1.79	0.00
4	0.00	4.35	6.96	16.52	26.09	20.87	14.78	5.22	3.48	1.74
5	0.64	1.59	5.73	9.87	30.57	20.38	18.79	8.28	3.18	0.96
6	0.00	1.06	1.86	4.77	17.51	32.36	24.14	13.79	2.92	1.59
7	0.00	0.24	1.92	4.32	7.19	22.78	35.25	23.98	1.44	2.88
8	0.00	0.00	0.79	2.37	9.23	13.19	19.26	41.69	8.71	4.75
9	0.75	0.00	0.75	3.01	6.02	10.53	14.29	29.32	27.82	7.52
10	0.00	0.00	0.00	0.00	6.90	6.90	17.24	31.03	18.97	18.97

Table B4. Summary Transition Rates of Beginning and Mature Farms, Pre-Recession

	Beginning	Mature
Migration Trends: Year-to-Year		
Upgrade	30.58	33.00
Retention	31.32	31.90
Downgrade	38.10	35.10

Table B5. Average One-Period Transition Matrices of Small and Large Farms for Credit Scores,

Ten Credit Classes, Pre-Recession (Percent)

	Period 2 Classes									
Period 1 Classes	1	2	3	4	5	6	7	8	9	10
Small										
1	19.64	7.14	3.57	12.50	19.64	26.79	7.14	3.57	0.00	0.00
2	10.42	6.25	12.50	16.67	22.92	12.50	10.42	4.17	4.17	0.00
3	5.41	8.11	14.86	20.27	24.32	17.57	6.76	1.35	1.35	0.00
4	1.32	3.31	5.96	18.54	19.21	21.19	19.21	7.28	2.65	1.32
5	0.85	1.14	5.70	10.26	29.34	23.93	16.52	7.12	3.99	1.14
6	0.22	1.12	2.68	6.71	15.21	32.89	23.94	11.63	3.80	1.79
7	0.00	0.20	0.99	3.75	8.48	23.67	39.05	19.92	1.97	1.97
8	0.00	0.25	1.00	2.99	8.23	13.47	19.95	39.90	10.72	3.49
9	0.60	0.00	0.60	3.01	3.61	11.45	15.06	27.71	28.31	9.64
10	0.00	0.00	0.00	0.00	4.35	13.04	13.04	26.09	23.19	20.29
Large										
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	25.00	25.00	0.00	25.00	0.00	0.00	25.00	0.00	0.00	0.00
3	0.00	0.00	20.00	10.00	20.00	30.00	0.00	10.00	10.00	0.00
4	0.00	3.85	5.77	17.31	30.77	19.23	7.69	9.62	1.92	3.85
5	0.00	1.54	0.77	10.00	34.62	15.38	20.77	12.31	3.08	1.54
6	0.00	0.00	1.65	8.26	21.49	28.93	23.14	14.05	0.83	1.65
7	0.00	0.00	2.52	3.36	7.56	15.97	29.41	33.61	3.36	4.20
8	0.00	0.00	0.83	1.65	16.53	10.74	19.83	40.50	4.96	4.96
9	0.00	0.00	0.00	4.35	21.74	8.70	17.39	13.04	34.78	0.00
10	0.00	0.00	0.00	0.00	21.43	7.14	14.29	42.86	0.00	14.29

Table B6. Summary Transition Rates of Small and Large Farms, Pre-Recession

	Small	Large
Migration Trends: Year-to-Year		
Upgrade	32.60	30.64
Retention	31.81	31.31
Downgrade	35.59	38.05

APPENDIX C. Transition Matrices for Recession

Table C1. Average One-Period Transition Matrices of Young and Old Farm Operators for Credit

Scores, Ten Credit Classes, Recession (Percent)

Period 1 Classes	Period 2 Classes									
	1	2	3	4	5	6	7	8	9	10
Young										
1	28.57	14.29	0.00	7.14	35.71	7.14	7.14	0.00	0.00	0.00
2	5.26	28.95	15.79	18.42	10.53	15.79	0.00	2.63	0.00	2.63
3	1.85	0.00	25.93	22.22	14.81	16.67	12.96	5.56	0.00	0.00
4	2.17	2.17	10.14	18.84	21.01	14.49	13.04	14.49	1.45	2.17
5	0.40	2.78	5.56	12.70	30.16	18.65	14.29	11.51	2.38	1.59
6	0.00	1.67	2.33	7.00	17.00	34.33	16.33	15.00	2.67	3.67
7	0.00	1.87	1.12	3.36	14.55	19.03	37.31	17.91	2.99	1.87
8	0.00	0.85	1.27	3.81	8.47	14.41	19.07	37.71	9.32	5.08
9	0.00	0.00	1.59	3.17	4.76	7.94	15.87	30.16	23.81	12.70
10	0.00	0.00	0.00	14.29	4.76	9.52	14.29	38.10	9.52	9.52
Old										
1	66.67	0.00	33.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	25.00	0.00	0.00	0.00	25.00	25.00	25.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00	0.00
5	0.00	0.00	9.09	27.27	36.36	9.09	18.18	0.00	0.00	0.00
6	0.00	0.00	0.00	7.14	7.14	35.71	28.57	21.43	0.00	0.00
7	0.00	0.00	14.29	0.00	14.29	42.86	14.29	14.29	0.00	0.00
8	0.00	0.00	0.00	33.33	0.00	33.33	0.00	33.33	0.00	0.00
9	0.00	0.00	0.00	0.00	25.00	25.00	0.00	50.00	0.00	0.00
10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00	0.00

Table C2. Summary Transition Rates of Young and Old Farm Operators, Recession

	Young	Old
Migration Trends: Year-to-Year		
Upgrade	31.79	39.58
Retention	31.79	27.08
Downgrade	36.42	33.33

Table C3. Average One-Period Transition Matrices of Beginning and Mature Farms for Credit

Scores, Ten Credit Classes, Recession (Percent)

	Period 2 Classes									
Period 1 Classes	1	2	3	4	5	6	7	8	9	10
Beginning										
1	25.00	0.00	0.00	0.00	50.00	12.50	12.50	0.00	0.00	0.00
2	0.00	50.00	33.33	0.00	0.00	16.67	0.00	0.00	0.00	0.00
3	0.00	0.00	25.00	31.25	25.00	12.50	0.00	6.25	0.00	0.00
4	2.27	0.00	11.36	11.36	22.73	15.91	13.64	18.18	0.00	4.55
5	0.00	4.76	5.95	5.95	32.14	17.86	16.67	11.90	4.76	0.00
6	0.00	1.01	3.03	4.04	19.19	32.32	21.21	15.15	2.02	2.02
7	0.00	0.00	1.82	1.82	13.64	20.91	39.09	18.18	2.73	1.82
8	0.00	1.15	0.00	1.15	5.75	16.09	19.54	41.38	9.20	5.75
9	0.00	0.00	0.00	0.00	12.50	0.00	6.25	50.00	18.75	12.50
10	0.00	0.00	0.00	0.00	0.00	11.11	11.11	44.44	11.11	22.22
Mature										
1	44.44	22.22	11.11	11.11	11.11	0.00	0.00	0.00	0.00	0.00
2	6.25	25.00	12.50	21.88	12.50	15.63	0.00	3.13	0.00	3.13
3	2.38	2.38	23.81	16.67	9.52	19.05	19.05	7.14	0.00	0.00
4	2.11	3.16	9.47	22.11	20.00	14.74	12.63	12.63	2.11	1.05
5	0.56	1.68	5.59	16.76	29.61	18.44	13.41	10.61	1.12	2.23
6	0.00	1.86	1.86	8.37	15.35	35.35	14.88	15.35	2.79	4.19
7	0.00	3.03	1.21	4.24	15.15	18.79	35.15	17.58	3.03	1.82
8	0.00	0.66	1.97	5.92	9.87	13.82	18.42	35.53	9.21	4.61
9	0.00	0.00	1.96	3.92	3.92	11.76	17.65	25.49	23.53	11.76
10	0.00	0.00	0.00	23.08	7.69	7.69	15.38	38.46	7.69	0.00

Table C4. Summary Transition Rates of Beginning and Mature Farms, Recession

	Beginning	Mature
Migration Trends: Year-to-Year		
Upgrade	30.27	32.95
Retention	32.78	31.06
Downgrade	36.95	35.99

Table C5. Average One-Period Transition Matrices of Small and Large Farms for Credit Scores,

Ten Credit Classes, Recession (Percent)

	Period 2 Classes									
Period 1 Classes	1	2	3	4	5	6	7	8	9	10
Small										
1	37.50	12.50	6.25	0.00	31.25	6.25	6.25	0.00	0.00	0.00
2	6.25	28.13	18.75	15.63	6.25	18.75	0.00	3.13	0.00	3.13
3	2.27	2.27	15.91	22.73	15.91	18.18	13.64	9.09	0.00	0.00
4	2.94	1.96	7.84	18.63	24.51	13.73	12.75	14.71	1.96	0.98
5	0.51	3.06	5.10	15.31	28.57	18.37	15.31	11.22	1.53	1.02
6	0.00	1.56	2.73	7.42	14.06	35.16	18.75	14.06	3.13	3.13
7	0.00	1.78	1.78	3.56	12.44	21.33	37.78	16.00	3.56	1.78
8	0.00	0.53	1.07	4.28	7.49	13.90	19.25	39.57	10.16	3.74
9	0.00	0.00	0.00	1.79	7.14	8.93	14.29	32.14	21.43	14.29
10	0.00	0.00	0.00	14.29	0.00	9.52	14.29	42.86	9.52	9.52
Large										
1	0.00	0.00	0.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	33.33	0.00	33.33	33.33	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	50.00	14.29	7.14	14.29	14.29	0.00	0.00	0.00
4	0.00	2.70	16.22	18.92	10.81	18.92	13.51	13.51	0.00	5.41
5	0.00	1.49	7.46	7.46	35.82	17.91	11.94	10.45	4.48	2.99
6	0.00	1.72	0.00	5.17	27.59	31.03	8.62	20.69	0.00	5.17
7	0.00	2.00	0.00	2.00	24.00	12.00	32.00	26.00	0.00	2.00
8	0.00	1.92	1.92	3.85	11.54	17.31	17.31	30.77	5.77	9.62
9	0.00	0.00	9.09	9.09	0.00	9.09	18.18	27.27	27.27	0.00
10	0.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00	0.00	0.00

Table C6. Summary Transition Rates of Small and Large Farms, Recession

	Small	Large
Migration Trends: Year-to-Year		
Upgrade	32.07	31.99
Retention	31.72	31.31
Downgrade	36.21	36.70

APPENDIX D. Transition Matrices for Post-Recession

Table D1. Average One-Period Transition Matrices of Young and Old Farm Operators for Credit

Scores, Ten Credit Classes, Post-Recession (Percent)

Period 1 Classes	Period 2 Classes									
	1	2	3	4	5	6	7	8	9	10
Young										
1	42.55	19.15	4.26	12.77	14.89	4.26	2.13	0.00	0.00	0.00
2	17.58	27.47	9.89	13.19	18.68	8.79	1.10	3.30	0.00	0.00
3	8.18	18.87	33.33	13.84	10.69	8.18	5.66	0.63	0.63	0.00
4	1.83	5.96	14.22	25.69	23.39	15.60	8.72	3.67	0.46	0.46
5	0.97	4.86	7.00	12.06	34.05	18.29	11.48	8.17	1.95	1.17
6	0.55	3.64	6.00	5.64	21.27	35.45	16.91	7.09	2.18	1.27
7	0.38	1.15	3.08	4.42	14.04	24.23	33.85	14.62	3.08	1.15
8	0.00	2.00	1.78	3.34	9.58	18.26	21.60	33.85	6.90	2.67
9	0.00	0.00	2.07	2.76	9.66	10.34	9.66	24.14	33.79	7.59
10	0.00	0.00	0.00	4.00	12.00	12.00	18.67	17.33	16.00	20.00
Old										
1	60.00	20.00	0.00	0.00	20.00	0.00	0.00	0.00	0.00	0.00
2	25.00	37.50	12.50	25.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	25.00	0.00	25.00	25.00	25.00	0.00	0.00	0.00	0.00
4	20.00	6.67	13.33	33.33	6.67	0.00	20.00	0.00	0.00	0.00
5	0.00	13.64	9.09	9.09	27.27	27.27	9.09	4.55	0.00	0.00
6	0.00	0.00	6.67	6.67	20.00	53.33	0.00	13.33	0.00	0.00
7	0.00	0.00	0.00	6.25	12.50	25.00	37.50	12.50	6.25	0.00
8	0.00	0.00	0.00	28.57	0.00	28.57	14.29	28.57	0.00	0.00
9	0.00	0.00	25.00	0.00	0.00	0.00	25.00	0.00	50.00	0.00
10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table D2. Summary Transition Rates of Young and Old Farm Operators, Post-Recession

	Young	Old
Migration Trends: Year-to-Year		
Upgrade	39.16	36.46
Retention	33.09	36.46
Downgrade	27.75	27.08

Table D3. Average One-Period Transition Matrices of Beginning and Mature Farms for Credit

Scores, Ten Credit Classes, Post-Recession (Percent)

	Period 2 Classes									
Period 1 Classes	1	2	3	4	5	6	7	8	9	10
Beginning										
1	28.57	21.43	0.00	14.29	14.29	14.29	7.14	0.00	0.00	0.00
2	25.00	25.00	4.17	4.17	25.00	4.17	0.00	12.50	0.00	0.00
3	8.89	20.00	33.33	8.89	17.78	2.22	8.89	0.00	0.00	0.00
4	0.00	4.17	9.72	26.39	18.06	20.83	11.11	8.33	0.00	1.39
5	0.66	3.95	5.26	12.50	34.21	17.76	11.18	11.84	1.97	0.66
6	0.00	2.38	4.76	4.76	19.52	41.90	15.24	6.19	4.76	0.48
7	0.00	0.53	3.21	6.42	15.51	23.53	31.55	16.04	2.67	0.53
8	0.00	0.61	1.82	1.21	9.09	20.00	27.88	29.70	6.06	3.64
9	0.00	0.00	0.00	1.72	8.62	12.07	10.34	22.41	39.66	5.17
10	0.00	0.00	0.00	6.45	9.68	9.68	16.13	12.90	9.68	35.48
Mature										
1	50.00	18.42	5.26	10.53	15.79	0.00	0.00	0.00	0.00	0.00
2	16.00	29.33	12.00	17.33	14.67	9.33	1.33	0.00	0.00	0.00
3	7.63	18.64	32.20	16.10	8.47	11.02	4.24	0.85	0.85	0.00
4	4.35	6.83	16.15	26.09	24.22	11.80	8.70	1.24	0.62	0.00
5	1.04	5.73	7.81	11.72	33.59	19.01	11.46	6.51	1.82	1.30
6	0.85	4.23	6.76	6.20	22.25	32.39	17.18	7.89	0.56	1.69
7	0.57	1.43	2.87	3.44	13.18	24.64	35.24	13.75	3.44	1.43
8	0.00	2.75	1.72	5.15	9.62	17.53	17.87	36.08	7.22	2.06
9	0.00	0.00	4.40	3.30	9.89	8.79	9.89	24.18	30.77	8.79
10	0.00	0.00	0.00	2.27	13.64	13.64	20.45	20.45	20.45	9.09

Table D4. Summary Transition Rates of Beginning and Mature Farms, Post-Recession

	Beginning	Mature
Migration Trends: Year-to-Year		
Upgrade	38.94	39.14
Retention	34.03	32.79
Downgrade	27.04	28.07

Table D5. Average One-Period Transition Matrices of Small and Large Farms for Credit Scores,

Ten Credit Classes, Post-Recession (Percent)

Period 1 Classes	Period 2 Classes									
	1	2	3	4	5	6	7	8	9	10
Small										
1	46.00	18.00	4.00	12.00	14.00	4.00	2.00	0.00	0.00	0.00
2	18.75	31.25	8.75	11.25	17.50	7.50	1.25	3.75	0.00	0.00
3	9.70	19.40	32.09	13.43	8.96	9.70	5.22	0.75	0.75	0.00
4	3.24	5.95	14.05	27.57	21.08	14.59	8.65	3.78	0.54	0.54
5	0.74	5.68	6.91	10.62	34.07	19.01	11.11	8.64	2.22	0.99
6	0.45	3.17	6.35	4.54	20.41	38.32	16.10	7.71	1.59	1.36
7	0.48	1.21	2.42	4.83	12.56	24.64	33.57	15.94	3.14	1.21
8	0.00	1.63	1.63	3.00	7.90	18.80	22.34	34.33	7.36	3.00
9	0.00	0.00	2.29	3.05	9.92	11.45	8.40	19.85	37.40	7.63
10	0.00	0.00	0.00	3.17	11.11	11.11	19.05	19.05	15.87	20.63
Large										
1	0.00	50.00	0.00	0.00	50.00	0.00	0.00	0.00	0.00	0.00
2	15.79	15.79	15.79	26.32	15.79	10.53	0.00	0.00	0.00	0.00
3	0.00	17.24	34.48	17.24	20.69	3.45	6.90	0.00	0.00	0.00
4	2.08	6.25	14.58	20.83	27.08	14.58	12.50	2.08	0.00	0.00
5	1.53	3.82	7.63	16.03	32.82	17.56	12.21	6.11	0.76	1.53
6	0.81	4.84	4.84	9.68	24.19	27.42	17.74	5.65	4.03	0.81
7	0.00	0.82	4.92	3.28	18.85	22.95	35.25	9.84	3.28	0.82
8	0.00	3.37	2.25	6.74	15.73	16.85	17.98	31.46	4.49	1.12
9	0.00	0.00	5.56	0.00	5.56	0.00	22.22	50.00	11.11	5.56
10	0.00	0.00	0.00	8.33	16.67	16.67	16.67	8.33	16.67	16.67

Table D6. Summary Transition Rates of Small and Large Farms, Post-Recession

	Small	Large
Migration Trends: Year-to-Year		
Upgrade	38.06	42.93
Retention	34.19	29.46
Downgrade	27.75	27.61