Measuring the Financial Health of U.S. Production Agriculture

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Abstract

With farm income at record, or near record levels, the overall agricultural production sector has fared well. However, in the current economic climate, instability and volatility in certain agricultural input markets caused by the U.S. macro-economy has put increased pressure on some sub-sectors of the agricultural economy. This paper analyzes the probability of default for USDA Agriculture Resource Management Survey (ARMS) farm operator households over time using a synthetic credit rating model. The probability of default was estimated for each ARMS farm sampled. The farms are classified according to farm type, gross sales class and by region to assess the financial health of each sector. Results indicate that the financial sector at the end of 2010 was exceptionally strong, although there are still certain farms that are vulnerable.

Introduction

With a strong agricultural economy, the overall financial health of U.S. production agriculture has been excellent for the past few years. According to the 2011 USDA ERS Agricultural Income and Finance Outlook report (Park et al., 2011), net farm income was forecast to be $100.9 billion in 2011, a 50 percent increase over the 10-year average from the years 2001 to 2010. This increase in income for production agriculture is occurring during the largest recession that the U.S. economy has experienced since the Great Depression of the 1930s. While the overall agricultural sector has fared well in the current economic climate, the instability of prices of some agricultural inputs caused by volatility in the larger economy has put increased pressure on several agricultural sectors; such as the livestock sector as prices for livestock and dairy products decreased faster than the respective feed input prices (Park, et al. 2010). This leads to the question, "How has each sector of production agriculture fared in today's global economic climate?"

The objective of this paper is to analyze the probability of default for USDA Agriculture Resource Management Survey (ARMS) farms over time. A synthetic credit rating model is used to predict the probability of default for each ARMS farm sampled. The farms are classified according to farm type, gross sales class and by region to assess the financial health of each sector. Results of these analyses provide insights into which farms may be under financial stress and whether those farms under stress have common characteristics.






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Methods and Data

The data were obtained through the USDA Agriculture Resource Management Survey (ARMS)[1]. Data are farm-level data and are pooled for 1996-2010. The range of farm observations for the study was 9,573 in 1996 to 21,578 in 2010. The largest number of farm observations was in 2005 at 22,843 and the smallest number of observations was in 1996. The ARMS survey is a stratified statistically drawn sample to be representative of U.S. farms. Larger farms are sampled at a heavier rate to ensure representativeness can be determined when the data are presented by group, farm type, or sales class. Each farm observation is individually analyzed in this study. The results are summarized on a national level using farms of different types and economic sizes across different ERS farm production regions of the United States. Individual farms were grouped into three categories for analysis: farm type, gross sales amount, and by region of the United States. All categories are according to USDA ARMS classification. The farm type sub-categories include: cash grain, other crops, high value crops, cattle, hogs, poultry, dairy and other livestock. The sales class sub-categories include: gross sales under $10,000; gross sales between $10,000 and $100,000; gross sales between $100,000 and $500,000; gross sales between $500,000 and $1,000,000; gross sales between $1,000,000 and $5,000,000; and gross sales above $5,000,000. The sub-categories for region include: Northeast, Lake States, Corn Belt, North Plains, Appalachia, Southeast, Delta, South Plains, Mountain States, and Pacific. Table 1 provides the specific states in each of the regions.

In this study, each farm in the ARMS data is viewed as a new potential borrower whether they currently borrow or not. The synthetic credit score model estimated from a sample of performing and defaulted actual farm loans by Featherstone, Roessler, and Barry (2006) was estimated using a similar assumption. This allows one to assess the probability that a loan will enter default status. By using this model to assess the risks of each loan and assigning an appropriate credit rating to each farm, we will be able to determine the riskiness of the sector by aggregating the individual farms by farm type and geographical region.

One way to think of credit models is to relate them to a well-known benchmark such as Standard and Poor's (S&P) credit ratings. The S&P credit ratings are designed to provide relative rankings of creditworthiness including default likelihood, payment priority, recovery, and credit stability. The S&P basic ratings range from excellent (AAA) to poor (C). Debtors classified in the C rating classes are substantial risks and generally depend on positive economic conditions to meet financial commitments. A rating of D indicates payment default. Relating a farm's creditworthiness to the rating classes used by S&P benefits the research in several ways. The S&P model is established, used, and validated in the marketplace and the use of its classes provides a consistency in the marketplace. This consistency allows one to compare results across studies. Since the S&P model is commonly used, policymakers may have a better grasp of what the ratings indicate.

The farm record data used for this study were adjusted to provide an accurate representation of the financial data received by a lender from a potential borrower. These data were obtained from the ARMS and used to calculate the probability of default and the corresponding credit rating for each farm[2]. The probability of default for each loan in the sample was calculated from an equation derived from a binary logit regression using actual loan origination data. The equation for calculating probability of default is as follows:

$$Ln(\text{probability of default}/[1-\text{probability of default}]) = -2.3643 - 0.00135(\text{Repayment Capacity Percentage}) - 0.0217(\text{Owner Equity Percentage}) - 0.00399(\text{Working Capital Percentage}).$$

This equation was estimated by Featherstone, Roessler, and Barry (2006) using 157,853 loans from the Seventh Farm Credit District portfolio to determine the ability of financial performance ratios to predict the probability of default for customers of the Seventh Farm Credit District using loan origination data. ARMS farm-level data were used to calculate yearly financial ratios (Owner Equity Percentage, Working Capital Percentage, and Capital Debt Repayment Capacity) for each farm. These ratios were used to find the probability of default for the individual ARMS farms by calculating the probability of default in the equation above. Each farm was then assigned a credit rating based upon its probability of default for each year.

Estimates of the probabilities of default by S&P rating were determined by Lopez (2002), who used KMV, a company that creates and provides software to Moody's and S&P to determine the probabilities of default of their portfolios. The KMV methodology determines the estimated default frequency and categorizes it based on that company's individual risk classes. The data used to construct the grid were year-end 2001 data.

Definition of Variables

The probability of default is a function of three key financial variables: Capital Debt Repayment Capacity (CDRC), Owner Equity Percentage (OE), and Working Capital Percentage (WC).

Capital Debt Repayment Capacity (CDRC) is used to determine repayment capacity. It measures the ability of the borrower to repay principal and interest on term loans by comparing their cash flow to their debt requirements. The larger the ratio, the greater their ability to meet repayment needs. CDRC is calculated by dividing repayment capacity by the sum of annual principal and interest payments on term loans, working capital deficiency (WCD) and capital asset replacement (CAR). Repayment Capacity is the result of net farm income from operations plus non-farm income plus term interest plus depreciation minus income taxes minus family living expenses minus non-farm expenses.

Owner Equity Percentage (OE) provides a measure of a borrower's solvency. This ratio is calculated by dividing net worth by total assets. In this analysis, the OE will be restricted between zero and 100 percent.

Working Capital Percentage (WC) measures a firm's liquidity position as it relates to its revenue. It is calculated by dividing working capital by the adjusted gross income. Working capital is the result of current assets minus current liabilities. Adjusted gross income is gross receipts minus purchases for resale.

Health of Individual Agricultural Sectors

The average Working Capital, Owners Equity, and Capital Debt Repayment Capacity for the ARMS farms from 1996 through 2010 are illustrated in Figure 1. Generally the debt repayment and the equity to assets ratios have increased over time.[3] The debt repayment ratio was 149 percent in 1996 and ended at 165 percent in 2010. The equity to assets ratio began at 87 percent in 1996 and has increased to 91 percent in 2010. The working capital ratio decreased from 1996 (66%) through 2002 (39%) and has trended upwards since then with a large increase in 2010 to 102 percent.[4]

The individual ratios of each farm were then used to calculate the probability of default and aggregated using the appropriate ARMS sampling weights to determine the probability of default for the sector. Generally the probability of default has trended downwards over the time frame decreasing from 1.18 in 1996 to 0.92 in 2010 (Figure 2)[5]. The highest probability of default occurred in 2002 (1.44%) and the lowest probability of default occurred in 2010 (0.92%).

There is considerable variation in the average probability of default and synthetic credit ratings among farms (Figure 3). The distribution is provided for 1996, 2002, and 2010 reporting the S&P classification system on the horizontal axis. The mode of the distribution was in the BB+ category for each of the years. B category ratings generally suggest that firms have the capacity to meet financial obligations but uncertainties in economic and business conditions may impair the ability to meet commitments. Firms in the higher B categories are in better financial shape than those in lower B categories. The distribution was a bit more skewed to the right (lower quality ratings) in 2002 than in either 1996 or 2010.

Results by Farm Type

Figure 4 shows the probability of default for farms by farm type. The probability of default has generally decreased over time for each of the farm types. The decrease in probability of default was statistically significant at the 95 percent confidence level[6] for all the farm types except other livestock and high value crops. When categorized by farm type, the classification that had the highest average probability of default for farms that have debt was poultry farms with a probability of default of 2.31 percent (Table 2). Hog farms had the second highest average probability of default for farms that have debt at 1.97 percent. Cattle farms had the lowest average probability of default for farms that have debt at 1.39 percent. For farms without debt, the highest probability of default was in the other livestock category with a rate of 0.75 percent followed by other crops at 0.73 percent. For farms with debt, the livestock categories generally had a higher probability of default than the crops categories.

Several categories had large variability in the probability of default (Figure 4). The largest range for a farm type with debt was poultry with a range of 0.99 percent between its maximum probability of default of 2.46 percent in 1996 and its minimum of 1.47 percent in 2010. To provide the magnitude of this range, roughly 1 in 40 poultry farms were susceptible to default in 1996 and roughly 1 in 70 farms in 2010. The second largest range for farm type categories was in hog farms with a range of 0.66 percent from its highest probability of default of 1.82 percent for farms in 2001 to its lowest of 1.16 percent in 2010. For the most recent years of data, 2009 to 2010, the probability of default declined for all of the farm types but other livestock.

Results by Region

Figure 5 shows the probability of default for farms by region. The probability of default has generally decreased for each of the regions. The decrease in probability of default has been statistically significant for the Lake States, Corn Belt, Northern Plains, and the Southeast. Table 1 provides the states included in each region.

The Delta region has the highest average probability of default at 2.04 percent for farms with debt for the years measured while the Corn Belt region had the lowest average probability of default of all regions at 1.47 percent (Table 3). For farms without debt, the Pacific region had the highest probability of default at 0.73 percent while the Corn Belt region had the lowest probability of default at 0.58 percent.

From 2009 to 2010, all of the regions experienced a decline in the probability of default (Figure 5). The most significant decrease from 2009 to 2010 occurred in the Delta States with a decrease of 0.39 percent. The second largest decrease was in the Southern Plains with a decrease of 0.20 percent.

The range of the probability of default of farms also varied significantly when categorized by region (Figure 5). The Delta region had the largest range with a 0.81 percent difference from its maximum probability of default of 1.77 percent to its minimum of 0.96 percent. The Southern Plains region had the smallest range with a 0.49 percent difference between the maximum probability of default of 1.30 percent and the minimum probability of default of 0.81 percent.

Results by Sales Class

Figure 6 shows the probability of default for all ARMS farms by sales class. The probability of default has generally decreased for each of the sales classes except for those farms with sales of more than $5 million which increased slightly. The decrease in probability of default has been statistically significant for the farms with sales between $10,000 to $100,000; $100,000 to $500,000; $500,000 to $1 million; and $1 million to $5 million.

The gross sales class with the highest probability of default for farms with debt is farms with sales above $5 million with an average of 2.31 percent over the years surveyed (Table 4). Farms with sales between $10,000 and $100,000 had the lowest average probability of default at 1.44 percent. When farms are grouped according to gross sales amount, a general trend of having a higher probability of default for a higher gross sales classification emerges. Thus, while the general trend in the agricultural sector has been a decrease in the probability of default, those farms in larger sales classes have a higher probability of default than those in lower sales classes.[7]

From 2009 to 2010, all sales classes exhibited a decrease in the probability of default (Figure 6). Farms with sales over $5 million had the highest decrease in the probability of default from 2009 to 2010 with a decrease of 0.28 percent. Farms with sales between $100,000 and $500,000 had the smallest decrease in probability of default from 2009 to 2010 with a decrease of 0.10 percent.

For all but the smallest gross sales classes (Sales Under $10,000), the percentage of farms with debt exceeds the percentage of farms without debt (Table 4). When categorized by sales class, larger farms have a higher percentage of farms with debt, and they have a higher probability of default.

Figures 7 through 12 examine the difference in the probability of default by sales class in more depth. Each of the figures compares the probability of default for those farms that have debt with those that do not have debt in addition to the percentage of farms that have debt and those that do not. These figures help to determine whether the results that appear in Figure 6 where those farms with more sales are more likely to default is simply due to differences in the proportion of farms that have debt versus those that do not among sales class. The percent of farms with debt is roughly 29 percent for farms with sales less than $10,000, 52 percent for those in the $10,000 to $100,000 sales class, 71 percent for those in the $100,000 to $500,000 sales class, 76 percent in the $500,000 to $1,000,000 sales class, 79 percent for those farms with sales from $1 million to $5 million, and 75 percent for those farms with sales greater than $5 million. Certainly weighing the percentages of farms with debt by a higher probability of default could affect the overall probability of default depicted in Figure 6.

Figure 13 displays the trend in probability of default for only those farms that have debt from 1996 to 2010. While the difference is not as pronounced as those depicted in Figure 6, those farms that have sales more than $1,000,000 generally have a larger probability of default than those with smaller sales. The trend is downwards in the probability of default for farms with sales between $10,000 and $5,000,000. The trend is statistically significant for farms with sales between $100,000 and $5,000,000. The trend is upwards for farms with less than $10,000 in sales and more than $5,000,000 in sales but

not statistically significant from zero. The farms that had the largest trend improvement in the financial situation from 1996 to 2010 are those between $500,000 and $5,000,000 in sales.

Several implications can be drawn from these sales class results. First, those farms with debt that are very large (more than $5 million in sales) are the most vulnerable to a financial downturn in the agricultural economy. This suggests that these farms would be the first farms lenders should be concerned with when the agricultural economy begins to suffer. Second, those farms from $500,000 to $5,000,000 in sales have significantly improved their financial situation since 1996. While overall the probability of default for these sales classes is higher than other smaller sales classes, these farms may continue improving their position in a positive agricultural economy. Finally, the very small farms with debt (less than $10,000 in gross sales), while generally being the safest, have not become safer during the recent years. Small farms have not benefited as much from a strong agricultural economy as have larger farms.

Concluding Comments

This paper used farm-level data from the USDA's annual Agriculture Resource Management Survey (ARMS) to analyze the probability of default for USDA ARMS farms from 1996 to 2010. The paper used a synthetic credit rating model to predict the probability of default for each farm sampled. The probability of default is a function of three key financial variables: Capital Debt Repayment Capacity (CDRC), Owner Equity Percentage (OE), and Working Capital Percentage (WC). For each year from 1996 through 2010, the ARMS farms were classified according to farm type, gross sales class and by region to assess the financial health of each sector.

Results of the study indicate several trends. Generally the debt repayment and the equity to assets ratios have increased over time. Generally the probability of default has decreased over the time frame. The highest probability of default during the study period occurred in 2002 (1.44%) and the lowest probability of default occurred in 2010 (0.92%). There is considerable variation in the average probability of default among farms; the mode of the distribution was in the BB+ category for each of the three years examined. Because of the wide variability in the financial situation of farms, lenders and others interested in the financial situation need to focus on the variability of financial situation across farms in addition to the average situation.
The probability of default has generally decreased over time for each of the farm types. For farms with debt, the livestock categories generally had a higher probability of default than the crops categories. Many farm types experienced their lowest probability of default during the time period examined in 2010. For the most recent years of data, 2009 to 2010, the probability of default declined for all of the farm types but other livestock. Based upon the preliminary income forecasts for 2011, it is likely that the probability of default will be lower at the end of 2011 than it was at the end of 2010.

The probability of default has generally decreased for each of the regions. The decrease in probability of default has been statistically significant for the Lake States, Corn Belt, Northern Plains, and the Southeast. The Delta region has the highest average probability of default at 2.04 percent for farms with debt for the years measured while the Corn Belt region had the lowest average probability of default of all regions at 1.47 percent. When looking at 2011, it is likely that all regions but the Southern Plains will see another drop in the probability of default.

The probability of default has generally decreased for each of the sales classes except for farms with sales of more than $5 million which increased slightly. The gross sales class with the highest probability of default for farms with debt is farms with sales above $5 million with an average of 2.31 percent over the years surveyed. While the general trend in the agricultural sector has been a decrease in the probability of default, those farms in larger sales classes have a higher probability of default than those in lower sales classes. From 2009 to 2010, all sales classes exhibited a decrease in the probability of default. Those farms that have sales more than $1,000,000 generally have a larger probability of default than those with smaller sales.

When the agricultural sector begins to face a downturn, it will be important to track the farms with gross sales of more than $1 million. In addition, farms with livestock have generally had a higher probability of default than those that are primarily cropping enterprises. Thus, large livestock farms are likely to become vulnerable first unless an agricultural downturn would coincide with a decrease in land values. If that occurs, the financial situation of cropping farms could deteriorate very quickly.

While the overall agricultural sector has fared well in the current economic climate, the volatility of prices of some agricultural inputs caused by volatility in the macro-economy has put increased pressure on several agricultural sectors. Results of this study indicate that while subsectors of agricultural production may have previously

experienced times of greater financial stress, the trends in most variables of financial health have been positive for agricultural production. The agricultural production sector was generally in excellent financial shape at the end of 2010. From 2009 to 2010, many subsectors saw declines in the probability of default suggesting less risk associated with these than in the past. The agricultural economy has been strong during the recession in the macro-economy. Farm size as determined by sales is an important measure to watch as changes occur in the agricultural economy. Farms with debt that are very large (more than $5 million in sales) are the most vulnerable to a financial downturn in the agricultural economy. Farms from $500,000 to $5,000,000 in sales have significantly improved their financial situation since 1996, while very small farms with debt (less than $10,000 in gross sales), while generally being the safest, have not become safer during the recent years.

Endnotes

1 For information on ARMS, see http://www.ers.usda.gov/data/arms/GlobalAbout.htm.

2 The income statements used are not accrual adjusted. The farm real estate values used are market values. Given these data constraints, market influences from market value land changes may mask any negative changes in cash-flow from earnings.

3 This upward trend was statistically significant for the debt and equity to assets ratios.

4 There was not a statistically significant trend in the working capital ratio.

5 This trend was statistically significant over the period.

6 All statistical significance levels in the paper are at the 95% level.

7 The trend is true for farms with debt with the exception of the category of farms with gross sales under $10,000. The trend is generally true for farms without debt with the exception of the categories of farms with gross sales under $10,000 and above $5,000,000.

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Table 1. Regions and states in each region

Region	States Included in Region
Northeast	Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont
Lake States	Michigan, Minnesota, Wisconsin
Corn Belt	Illinois, Indiana, Iowa, Missouri, Ohio
Northern Plains	Kansas, Nebraska, North Dakota, South Dakota
Appalachia	Kentucky, North Carolina, Tennessee, Virginia, West Virginia
Southeast	Alabama, Florida, Georgia, South Carolina
Delta	Arkansas, Louisiana, Mississippi
Southern Plains	Oklahoma, Texas
Mountain States	Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, Utah, Wyoming
Pacific	California, Oregon, Washington

Table 2. Debt and probability of default for USDA ARMS farms by farm type: 1996-2010

Farm Type	Average Probability of Default for Farms with Debt	Average Probability of Default for Farms Without Debt	Percentage of Farms with Debt	Percentage Without Debt
Poultry	2.31%	0.66%	77.13%	22.87%
Hogs	1.97%	0.60%	78.47%	21.53%
High Value	1.78%	0.63%	56.77%	43.23%
Dairy	1.70%	0.59%	80.20%	19.80%
Other Crops	1.61%	0.73%	59.89%	40.11%
Cash Grain	1.51%	0.60%	70.35%	29.65%
Other Livestock	1.42%	0.75%	54.81%	45.19%
Cattle	1.39%	0.60%	55.84%	44.16%

Table 3. Debt and probability of default for USDA ARMS farms by region: 1996-2010

Region	Average Probability of Default for Farms with Debt	Average Probability of Default for Farms Without Debt	Percentage of Farms with Debt	Percentage of Farms without Debt
Delta	2.04%	0.69%	60.79%	39.21%
Pacific	1.77%	0.73%	61.58%	38.42%
Northeast	1.71%	0.64%	69.24%	30.76%
Southeast	1.69%	0.71%	57.05%	42.95%
Northern Plains	1.58%	0.60%	74.82%	25.18%
Southern Plains	1.56%	0.69%	60.89%	39.11%
Lake States	1.55%	0.65%	76.14%	23.86%
Mountain states	1.54%	0.64%	70.30%	29.70%
Appalachia	1.49%	0.61%	58.17%	41.83%
Corn Belt	1.47%	0.58%	71.98%	28.02%

Table 4. Debt and probability of default for USDA ARMS farms by sales class: 1996-2010

Sales Class Category	Average Probability of Default for Farms with Debt	Average Probability of Default for Farms without Debt	Percentage of Farms with Debt	Percentage of Farms without Debt
Gross Sales Under $10,000	1.48%	0.70%	28.93%	71.07%
Gross Sales Between $10,000 & $100,000	1.44%	0.60%	51.85%	48.15%
Gross Sales Between $100,000 & $500,000	1.62%	0.60%	70.64%	29.36%
Gross Sales Between $500,000 & $1,000,000	1.85%	0.65%	76.26%	23.74%
Gross Sales Between $1,000,000 & $5,000,000	2.06%	0.74%	78.97%	21.03%
Gross Sales Above $5,000,000	2.31%	0.71%	75.25%	24.75%

Figure 1. Working capital, equity to asset, and debt repayment capacity ratios for ARMS farms: 1996-2010

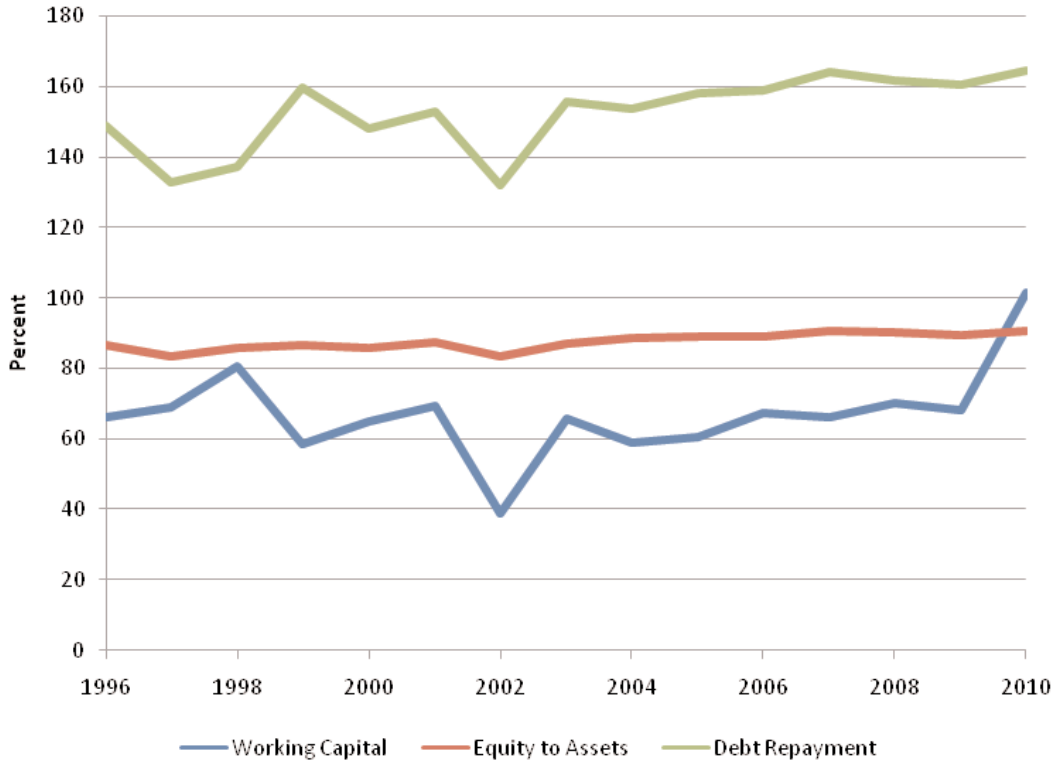

Figure 2. Average probability of default for ARMS farms: 1996-2010

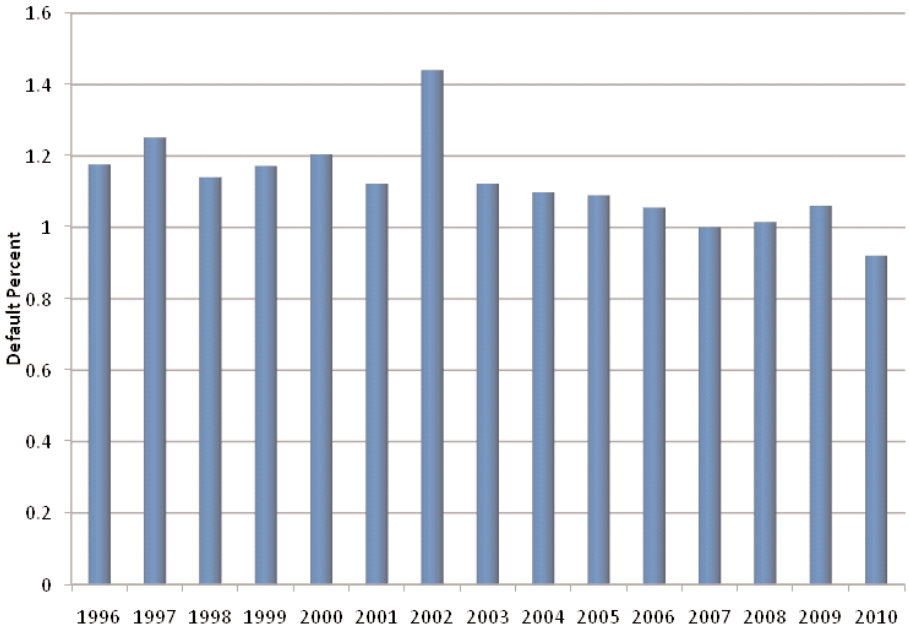

Figure 3. Synthetic S&P credit ratings for ARMS farms: 1996, 2002, and 2010

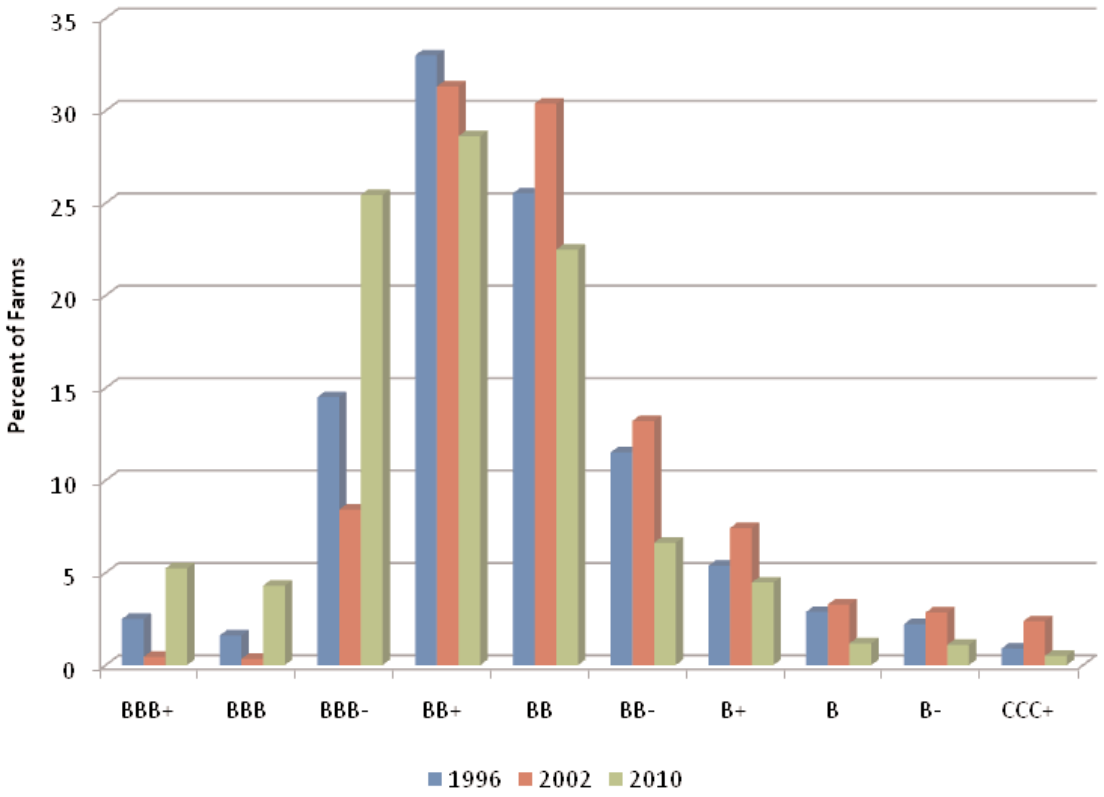

Figure 4. Average probability of default for ARMS farms by farm type: 1996 – 2010

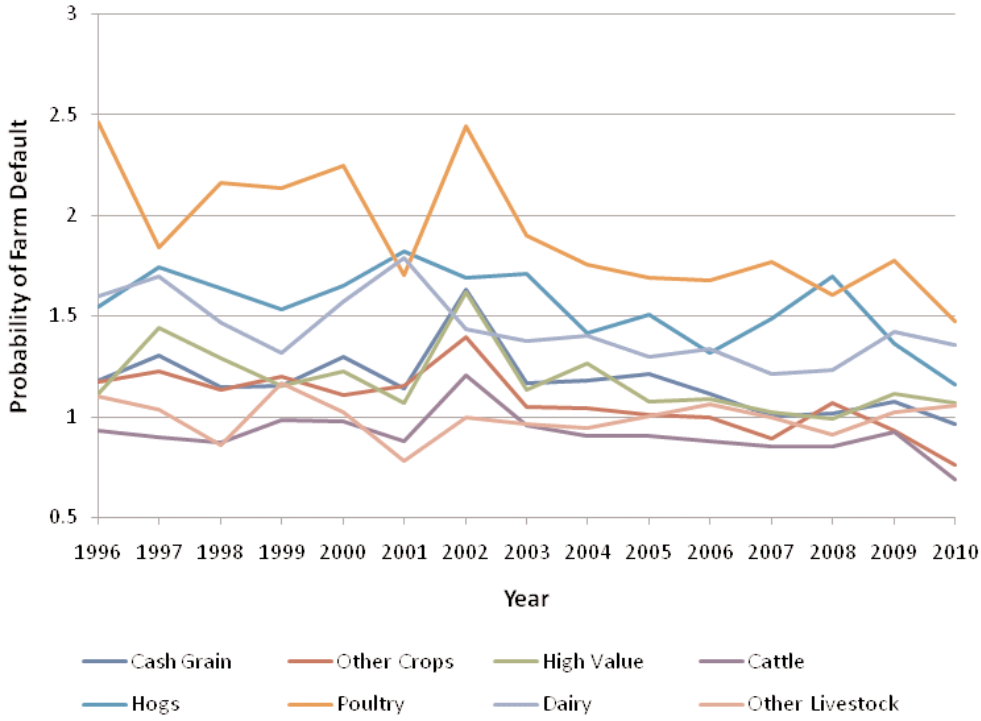

Figure 5. Average probability of default for ARMS farms by region: 1996 – 2010

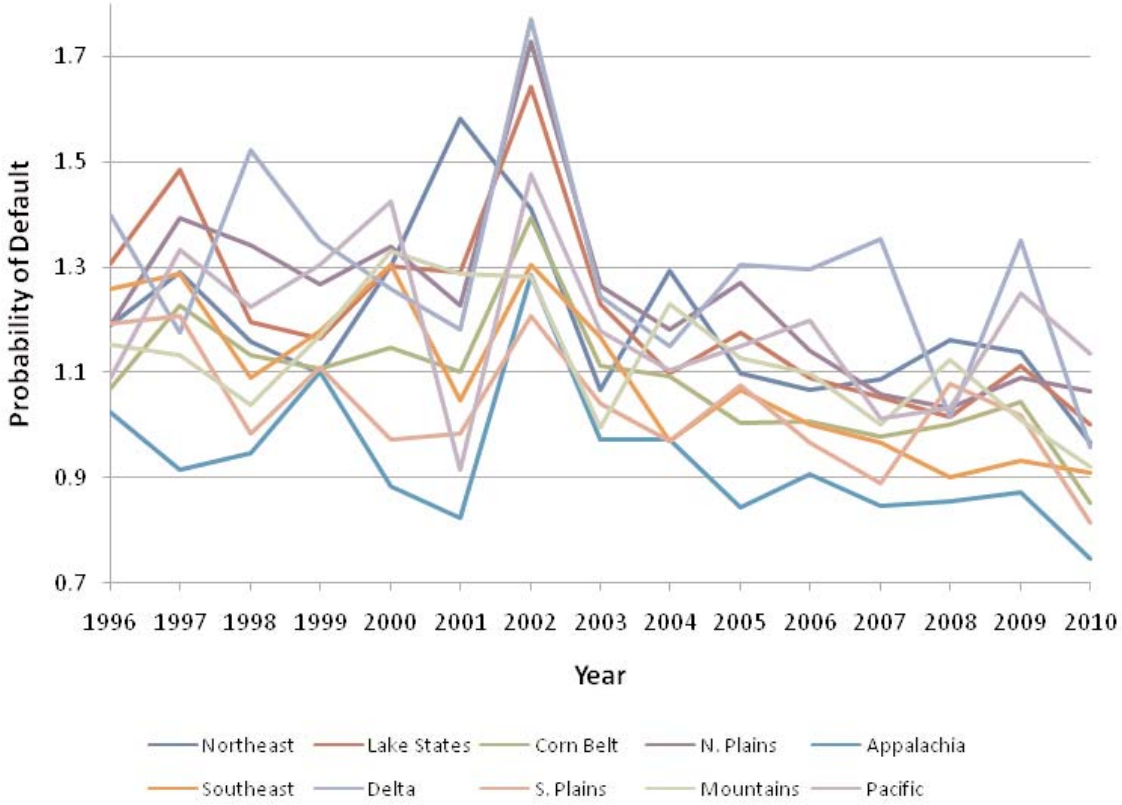

Figure 6. Average probability of default for ARMS farms by sales class: 1996 – 2010

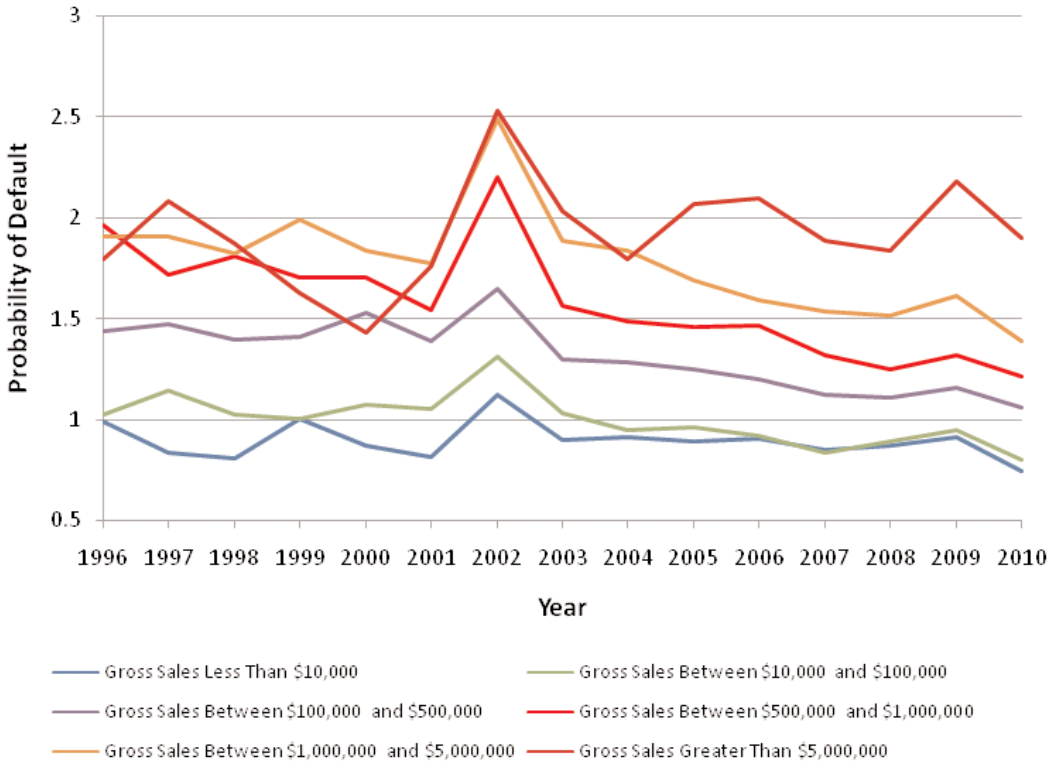

Figure 7. Average probability of default for ARMS farms with gross sales under $10,000: 1996 – 2010

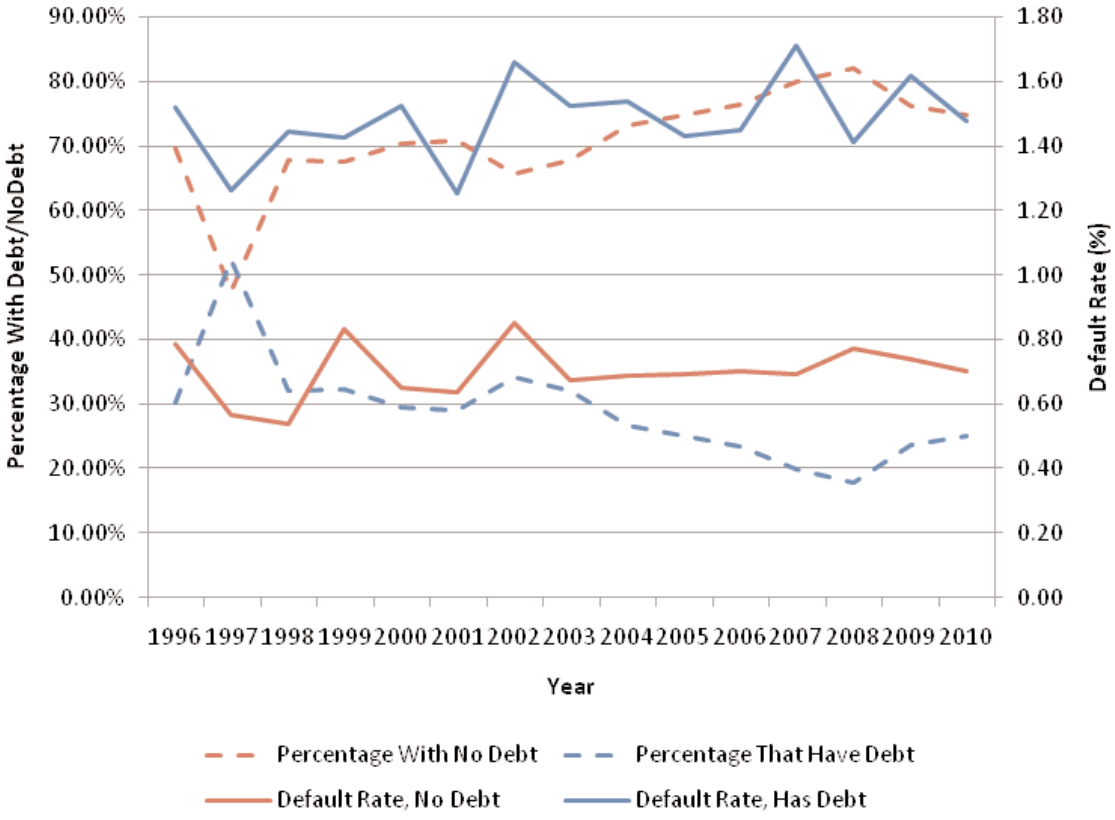

Figure 8. Average probability of default for ARMS farms with gross sales between $10,000 and $100,000: 1996 – 2010

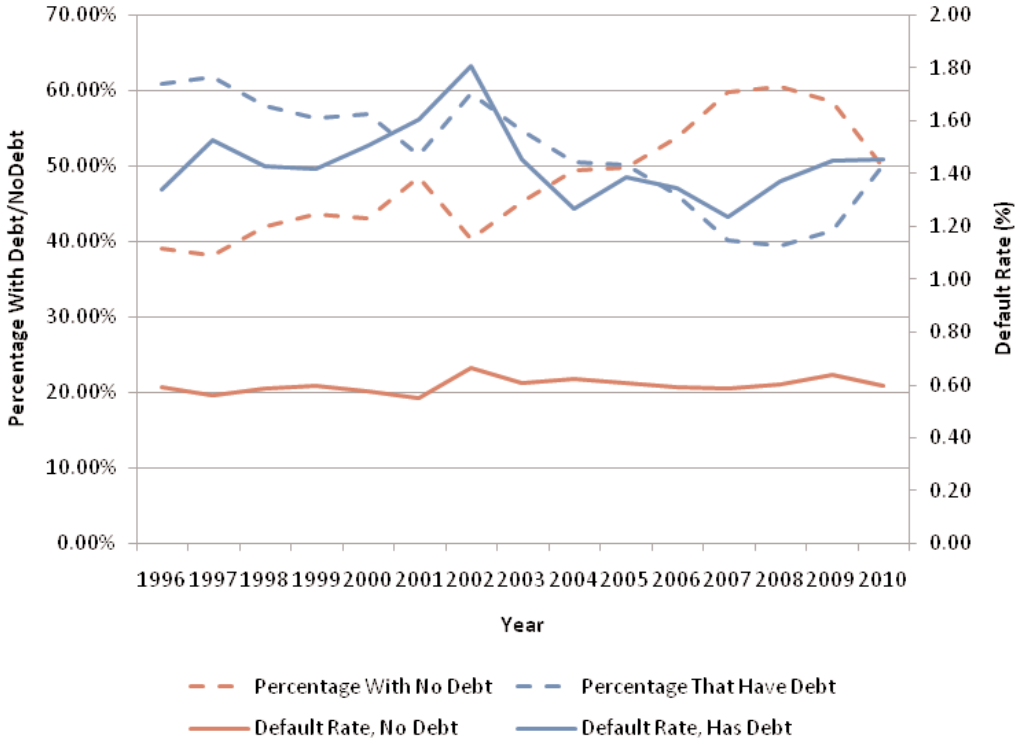

Figure 9. Average probability of default for ARMS farms with gross sales between $100,000 and $500,000: 1996 – 2010

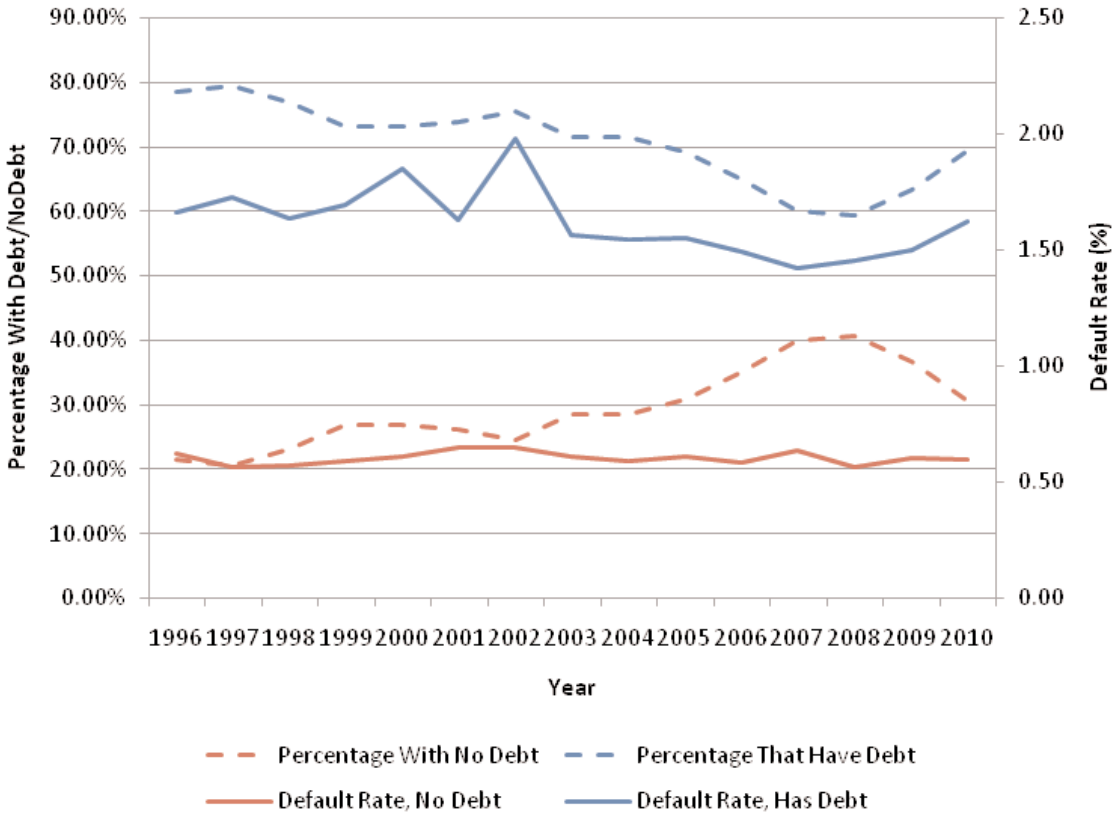

Figure 10. Average probability of default for ARMS farms with gross between $500,000 and $1,000,000: 1996 – 2010

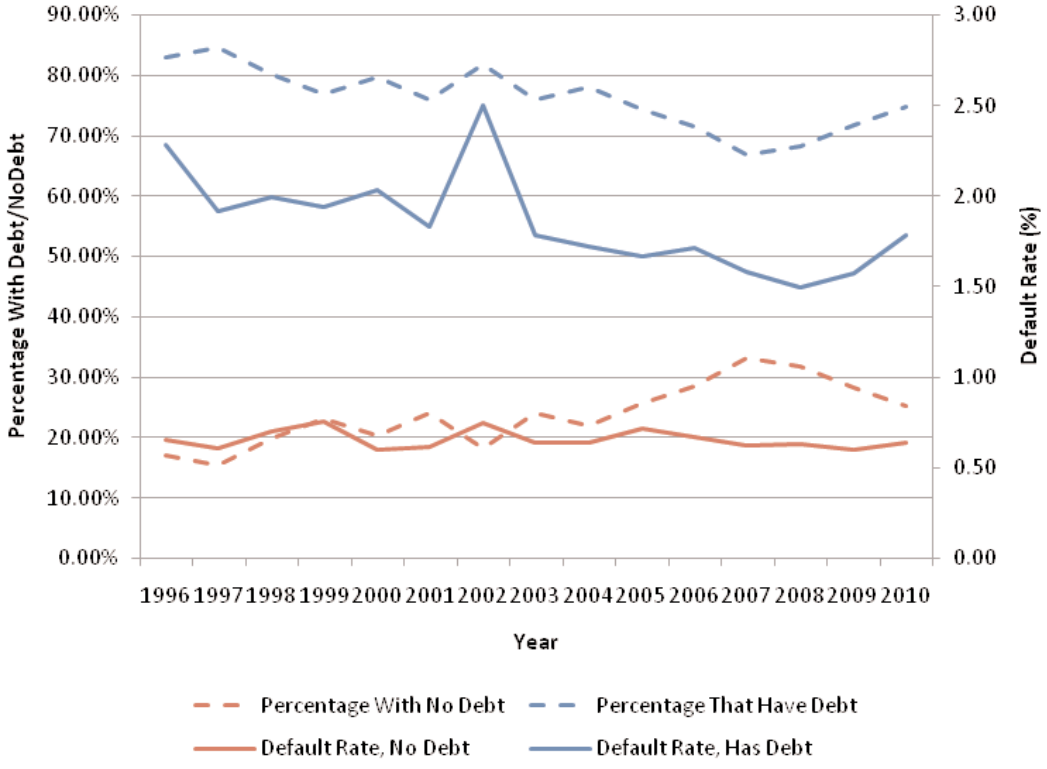

Figure 11. Average probability of default for ARMS farms with gross between $1,000,000 and $5,000,000: 1996 – 2010

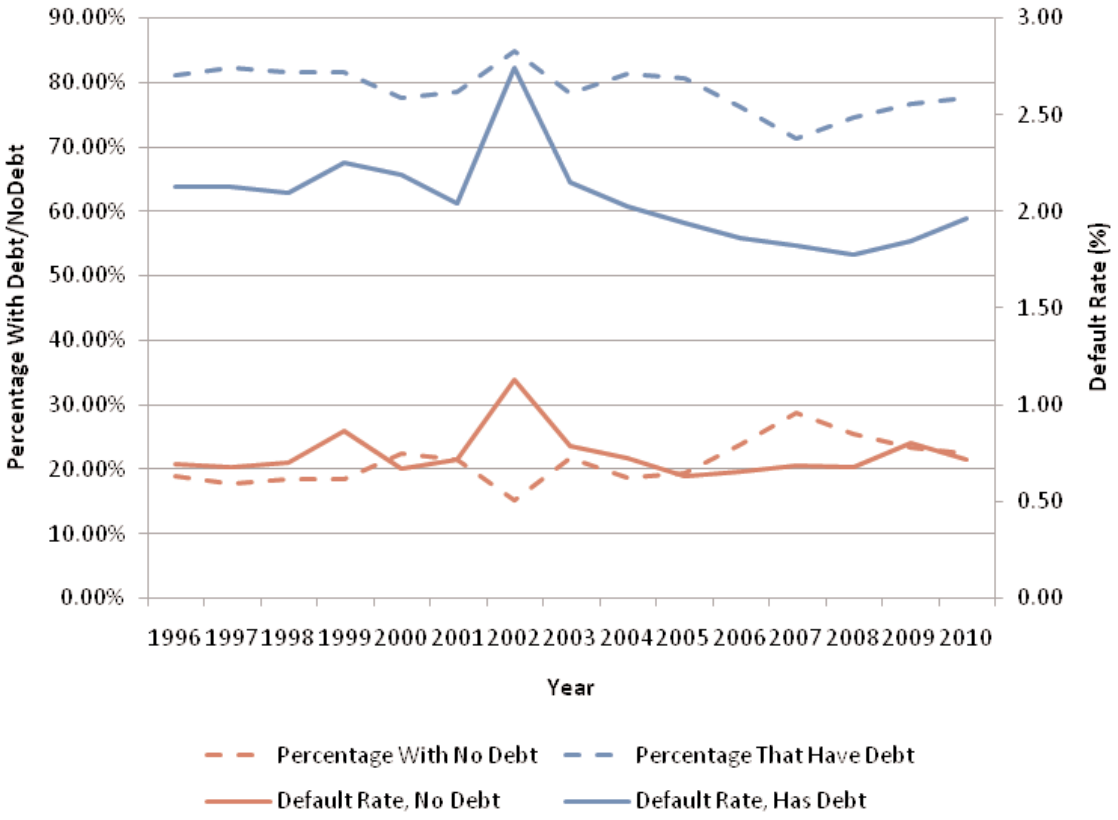

Figure 12. Average probability of default for ARMS farms with gross above $5,000,000: 1996 – 2010

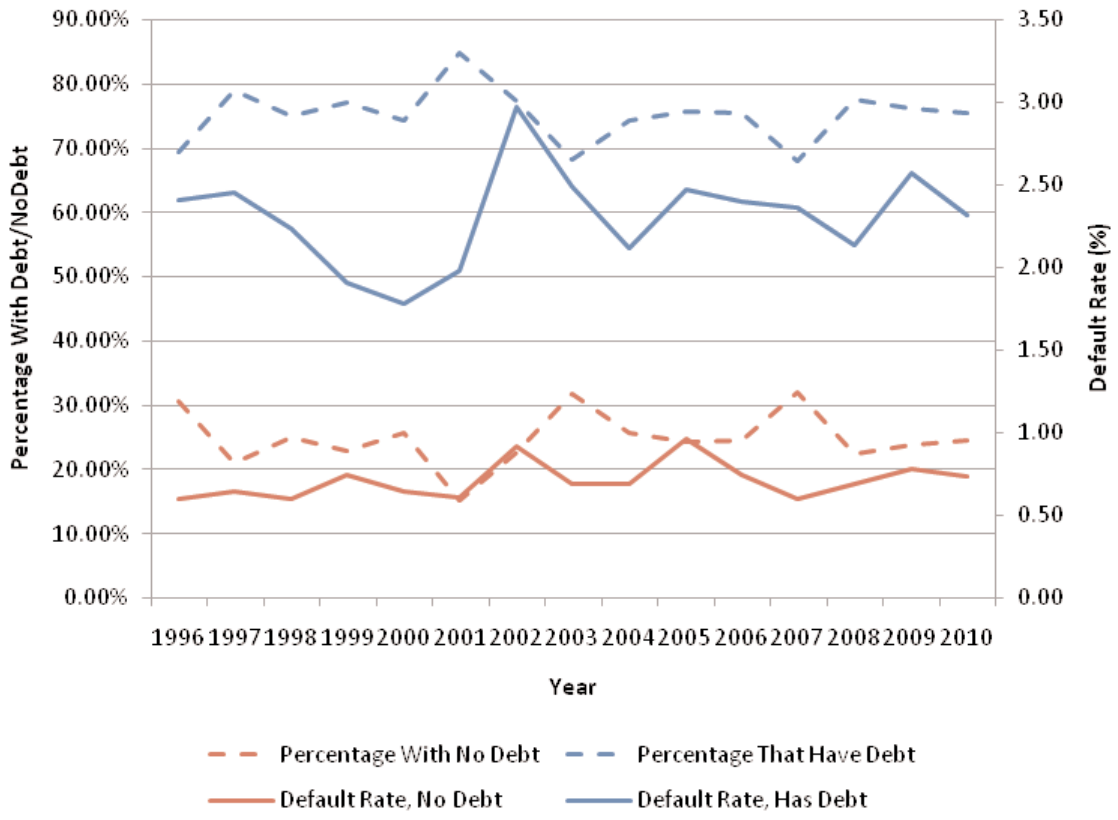

Figure 13. Average probability of default for ARMS farms with debt by sales class: 1996 – 2010