Farm Financial Stress in a Changing Economic Environment:

Simulating Credit Risk with New Imputed ARMS Data on Farm Debt

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Abstract

Current USDA forecasts indicate that US farms are entering a period of lower net farm income, following historical highs in 2012 and 2013. A sustained period of lower net farm income may lead to lower farmland values as returns to farmland decline, raising questions about whether specific sectors of the U.S. farm economy will become financially stressed in this environment. Using USDA's 2013 Agricultural Resource Management Survey data (ARMS) with new imputed farm debt data we assess financial stress for both borrowers and lenders under scenarios of lower net farm income and land values. To accomplish this, we use both financial ratio analysis and a synthetic credit rating model. We then examine scenarios of a 25% drop in net farm income, and a 35% drop in land values. Our results suggest that the overall financial health of the U.S. farm economy is relatively strong, however some sectors remain vulnerable. We find that a drop of 35% in farmland values will negatively impact specific sectors, including: peanut, tobacco, and poultry farms; highly leveraged farms, farms with gross sales over 1 million dollars, and farmers who rent a majority of their farmland.

JEL codes: Q14, Q15, D14

Keywords: financial stress, farmland values, net farm income

Net farm income reached a record high of $129 billion in 2013, but dropped 16% to $108 billion in 2014, and is forecast to drop another 32% to $74 billion in 2015 (ERS 2015). Farmland values also reached record highs in 2013, largely driven by both record net farm income and historically low interest rates. Current land value surveys indicate slowing land appreciation, with declining land values in parts of the Corn Belt, Lake States, and Northern Plains, largely caused by falling commodity prices for corn and soybeans (Wall Street Journal 2014). Because farmland is most farms' largest asset, worth $2.31 trillion and accounting for 83% of farm assets in 2013 (ERS 2015), the financial health of U.S. farms is strongly tied to the value of land. An environment of falling land values and net farm income could lead to significant financial stress for certain sectors of the U.S. farm economy, limiting the ability of farms to meet debt service requirements. This could have implications for government policy, farm lending organizations, and private decision makers.

This study explores how changing land values and net farm income could increase financial stress for the U.S. agricultural sector. In this analysis we focus on farm businesses, defined as farm operations where the primary operator's primary occupation is farming. These include both crop and livestock farm businesses. We use the 2013 Agricultural Resource Management Survey data (ARMS) to estimate financial stress using two separate financial measures: 1) financial ratios and 2) a synthetic credit rating model. After examining traditional measures like the debt-to-asset ratio, we explore how the probability of default changes under different scenarios based on a synthetic credit rating model. The synthetic credit rating model provides a way for lenders to assess default risk for potential borrowers.

Next, we use the 2013 ARMS data and USDA-ERS forecasts for cash rents and net farm income to examine two scenarios: 1) a 25% drop in net farm income and 2) a 35% drop in land values.[2] These scenarios are chosen based on current income forecasts, and "worst-case" scenarios for land values. Our results find that the overall financial health of the US farm economy is in good shape and will not likely be significantly negatively affected. However some sectors remain vulnerable, especially if net farm income remains below the historical average for several consecutive years. Our results find vulnerable sectors include: peanut, tobacco, and poultry farms; highly leveraged farms, farms with gross sales over 1 million dollars, and farmers who rent a majority of their farmland

This study also makes use of updated farm debt estimates, the result of a new methodology for imputing debt in ARMS. ERS has recently moved to a multivariate imputation methodology for imputing missing data in the farm debt section of ARMS. Prior to 2012, missing data on farm debt were imputed using a cell mean approach (i.e. weighted conditional mean). ERS currently employs a multivariate imputation method called Sequential Regression Multivariate Imputation (SRMI) (Raghunathan et al. 2001), which can be implemented with SAS 9.3 (SAS Institute) and

[2] We also considered a scenario with both a 25% decline in net farm income and a 35% decline in land values, and the results under this scenario were qualitatively similar to the scenario with a 35% drop in land values.

the SAS IVEware package. A recent study by Morehart, Milkove and Xu (2014) using data from the 2012 ARMS showed that total farm debt would be $27 billion higher using this methodology, as compared with the conditional mean imputation. This suggests that the baseline distribution of financial stress might change significantly under the new imputation methodology.

The rest of the paper proceeds as follows; we first describe some approaches to analyzing farm financial stress and then we analyze how the new imputed debt estimates for ARMS would change the incidence of financial stress for farm businesses. Next, we examine the intensity of financial stress by looking at debt concentration. We then discuss possible scenarios under which farm income and land values will decline. Following that, we describe results from these scenarios using both financial ratio analysis and a synthetic credit rating model approach. We conclude by discussing whether current policies are adequate for mitigating increased financial stress in a challenging economic environment for the US farm sector.

Analyzing farm stress

Numerous studies in both the finance and agricultural economics literatures have examined the process of predicting and analyzing financial stress[3]. Methods continue to evolve into conceptually richer and more accurate approaches. Researchers and practitioners use these methods for a range of purposes including monitoring financial solvency, assessment of loan security, and the measurement of portfolio risk.

Briggeman (2010) defines financial stress as the inability to meet debt service payments, including principal and interest. He evaluates farm financial stress under scenarios of higher interest rates and lower net farm income using debt repayment capacity utilization (DRCU)[4] with ARMS data from 2008. He finds that younger farmers and livestock producers are most susceptible to rising levels of financial stress in these scenarios.

Reflecting on the farm crisis of the mid 1980's, Jolly et al. (1985) stated that "financial stress occurs when the capacity of an individual or firm or a specific sector of the economy to adjust to the forces causing stress is exceeded." They note that some financial stress is essential for efficiency and growth. It can lead to reallocation of scarce resources to more productive uses. However, too much financial stress can lead to misallocation of resources, which in turn can lead to loss of economic and human capital.

The 1980's farm crisis arose from the combination of low commodity prices, highly leveraged farms and high interest rates. Perhaps the most comprehensive analysis of the impact of these

[3] We note that financial stress is a latent variable which is imperfectly measured by financial ratios and credit rating models. There are numerous approaches to measuring financial stress, including creating a composite index using weighted economic variables, as shown by Moss and Shonkwiler (1993).

[4] Debt repayment capacity (utilization) uses income to determine the maximum feasible debt that can be supported by the farm business. Utilization is expressed by comparing the amount of debt with the maximum feasible debt that a farm business can borrow (see Harris et al, 2009).

factors on the financial crisis in the 1980's is a study by Featherstone and Boessen (1994). One of their findings indicates that the original loan balance, based on defaulted loans originated by Equitable Agribusiness, a division of The Equitable, exceeded $161 million. The average origination loan-to-value ratio was over 60%.

Except for declining net farm income, the current farm economy does not resemble the 1980's. Currently the U.S. farm economy has record low debt-to-asset ratios and interest rates remain historically low in nominal terms. Despite this vastly different financial landscape, there is still concern that a prolonged period of lower net farm income will leave certain sectors financially stressed.

Farm financial stress can be measured by examining characteristics of the farm business, including; profitability, liquidity, solvency, and debt repayment capacity. Each of these measures represents one dimension of a farm's financial performance. Profitability measures the financial performance of the farm over a period of time, usually a year. Both return on assets and return on equity are widely reported measures of profitability. Liquidity measures the ability of the farm business to generate enough cash to pay farm expenses and debt payments as they become due. Solvency measures the ability of the business to pay all debt if all assets were liquidated. Repayment capacity measures the farm's ability to repay debt with farm and non-farm income (Moss 2014).

Agricultural economists have employed several methods to look at financial stress. The Farm Financial Standards Council (FFSC) has established benchmarks for financial stress for all dimensions of farm financial performance. The three color system (i.e. green, yellow, red) indicates whether a farm is in good, fair or poor financial health (FFSC 2011). For example, a farm with a debt-to-asset ratio of between 30-55% is considered in fair condition, while a ratio of greater than 55% is considered financially stressed. However, as noted by Harris et al. (2010) financial stress is not just a result of being highly leveraged (high debt-to-asset ratio) or having low or negative income. Instead the multiple dimensions of financial stress require looking at several measures. They use a Venn diagram approach to financial stress, examining how many dimensions exceed a critical threshold for stress. The intersection of these financial performance measures can be very informative, and give a more detailed understanding of whether a farm will be able to meet debt service payments and avoid becoming insolvent.

One measure of farm financial performance long used by ERS (Ifft et al. 2012; Harris et al., 2009) categorizes the farm operation's financial position into four categories, based on net farm income and the debt-to-asset ratio. A farm with positive net farm income and a debt-to-asset ratio less than 40% is put into the highest category, or favorable financial position. Farms that have a debt-to-asset ratio greater than 40% and negative net farm income are put in the most vulnerable category. These farms would be considered to be financially stressed.

Because no one financial measure can unambiguously determine financial stress, we make use of several different measures. For example, declining land values will affect farm assets, resulting in lower farm operator solvency. Falling net farm income will affect operators' ability to repay debt and result in lower liquidity. We also use a credit scoring model to examine the creditworthiness of farm operations, as a proxy for the lender's perspective on farms' financial strength (or lack thereof).

Credit scoring models can be used to assess the credit risk of farm operations, giving financial institutions a measure of potential default. These models are widely used in the farm lending industry to price loans and assess a potential borrower's credit risk (Goodwin and Mishra 2000). One credit scoring model that has been used in the agricultural finance literature is the synthetic credit rating model.

The synthetic credit rating model (Featherstone, Roessler and Barry 2006) uses three dimensions of financial performance to predict a farm operation's probability of default. The three measures used in the model are: owner equity percentage (solvency), working capital percentage (liquidity) and debt repayment capacity. The parameter estimates for the model are derived from an analysis of farm loan defaults from the seventh farm credit district's loan accounting data base, from 1995-2002. More recently this model was used to estimate the probability of default for the U.S. agricultural sector using ARMS data from 1996-2010 (Brewer et al. 2012). The authors found that the livestock sector showed financial distress, and that the probability of default increased monotonically with sales class.

Evaluating the impact of new debt imputations on stress measures

Each year USDA collects detailed information on farm operator loans through the Agricultural Resource Management Survey (ARMS). This information includes interest rates, loan term, origination date, type of loan, purpose of loan and type of financing. The data is then used to estimate the farm sector balance sheet, which gives policymakers information on key financial statistics such as debt-to-asset ratios, debt repayment capacity and liquidity. Information on debt is subject to non-response. To deal with this issue, ARMS has historically used a generalized cell mean imputation for missing debt (Morehart, Milkove and Xu 2014). This method has two main drawbacks from a statistical standpoint, specifically it biases the variance of the imputed variable downward, and it distorts multivariate relationships between the imputed variable and other variables the data (Rubin 2002). In addition, a recent external review of ARMS (National Research Council 2007) highlighted the need to explore new imputation methodology. Other studies have identified differences between ARMS estimates of debt and administrative data (Briggeman et al. 2012), motivating a need for better estimates of total debt.

To address the imputation issues, ERS implemented a multivariate imputation methodology in 2012. This was implemented using the SAS (SAS Institute, Cary NC) callable imputation program IVEware (Raghunathan, 2002). Models for imputation were built using economic

theory and included variables such as operator age, acres, government payments, property taxes and region. This approach incorporates more information about missing farm debt by imputing by lender category.

The resulting estimates added $27 billion of farm debt in 2012, when compared to the conditional mean imputation estimates. In 2013, it added $31 billion to bring total farm debt to $196 billion, an increase of approximately 19% over what the old method would have produced. The additional $31 billion was broken down into $16 billion for non-current liabilities and $15 billion in current liabilities. This new methodology significantly increased both total farm debt and the number of farms that fall in the "vulnerable" and "marginal solvency" categories of financial strength.

Given the significant changes[5] in total farm debt, we first compare several important financial indicators using both debt estimates, as shown in table 1. The first two measures we report are debt repayment capacity utilization (DRCU) and debt-to-asset percentage (D/A). DRCU is defined as the maximum amount of debt that can be supported by net cash income available for loan repayment (ERS 2009). A DRCU ratio less than 100 means that an operator has more than sufficient income to cover his/her current debt. ERS has traditionally used a DRCU of 120 as a threshold for farms that are unable to meet debt service obligations with their current income. Both DRCU and D/A increase under the new imputation, with average DRCU increasing by more than 100%. Both financial ratios are statistically greater with the new imputed debt at the 1% level of significance. Additionally, as shown in figures 1, 2, and 3, the new imputation method captured more farms in the red zone (< 55%) for farms of all production categories, sizes (by sales), and regions.

The figures show that significantly more corn and cattle farm businesses are found in the red zone for solvency under the new debt imputation. These changes can also be seen on a regional level, with significantly more farm businesses in the Corn Belt, Northern Plains, and Southern Plains in the red zone for solvency.

We also report a financial position measure which uses a combination of the D/A percentage and net farm income to classify a farm's financial position. The four categories are explained in table 2. A farm that falls into the "vulnerable" category, with both a D/A ratio greater than 40% and negative net farm income, would be considered financially stressed.

Our results show significant differences in financial stress for the US agriculture sector under the new imputed debt numbers. The additional $31 billion in total farm debt reveals that significantly more farms are financially stressed. Approximately 84,000 more farms fall in the "vulnerable" financial category and 105,000 additional farms fall into the "marginal solvency" category under the new imputed debt estimates.

[5] A simple paired t-test for difference in total farm debt reveals the new imputed debt is statistically greater at the 1% level.

Synthetic Credit Rating Model

The synthetic credit rating model allows us to understand how a drop in net farm income or land values will be viewed on the lender side. This model uses a binary logistic regression to calculate the probability of default based on three criteria: capital debt repayment capacity (CDRC), owner equity as a percentage of assets (OE), and working capital as a percentage of assets (WC). CDRC measures the ability of the borrower to repay principal and interest payments. OE measures a borrower's solvency, and WC measures a firm's liquidity position as it relates to its revenue. Estimates for the model parameters were derived from data on 157,853 loans in the Seventh Farm Credit District in Featherstone, Roesseler and Barry (2006).

The synthetic credit rating model treats each farm in the ARMS sample as a potential borrower and assigns a credit rating based on the predicted probability of default, given by the model. This approach falls into the class of latent variable models, since we do not observe whether a sampled ARMS farm operator actually defaults on a loan. The ARMS data does not allow us to determine if a farm has actually defaulted on a loan. The synthetic credit rating gives a probability of default, which we map to the corresponding S&P credit rating. A farm with a probability of default that is above a certain threshold is then considered more likely to default.

The resulting probability of default is mapped to a credit rating, using cutoffs similar to well-known benchmarks used by Standard and Poor's (S&P). These credit ratings are designed to provide relative rankings of the creditworthiness of potential borrowers. Following work by Brewer et al. (2012) we estimate the probability of default using 2013 ARMS data, including the new imputed farm debt data.

Using the 2013 ARMS data we calculate financial ratios for owner equity percentage (OE), working capital percentage (WC), and capital debt repayment capacity (CDRC) for each farm. CDRC is calculated by dividing repayment capacity by the sum of annual principal and interest payments on term loans, working capital deficiency and capital asset replacement. Repayment capacity is defined as:

Repayment capacity = net farm income + non-farm income+ term interest+ depreciation – income taxes – living expenses – non-farm expenses

OE is calculated as the ratio of net worth to total assets. WC is calculated by dividing working capital by adjusted gross income. Working capital is the difference between current assets and current liabilities. Adjusted gross income is the difference between gross receipts and purchases for resale. We show the mean estimates of OE, WC and CDRC for farm businesses in the 2013 ARMS data in table 3.

Based on previous work by Featherstone, Roessler and Barry (2006), we then predict the probability of default. The predicted probability of default for farm i is calculated as

$$\log_e\left(\frac{p_i}{1-p_i}\right) = -2.3643 - 0.00135 * CDRC_i - 0.2017 * OE_i - 0.00399 * WC_i$$

where p_i is the probability of default , which can take values between 0 and 1. As the sign on the coefficients in the model indicate, an increase in either the CDRC, OE or WC will decrease the probability of default, all else constant. The synthetic credit ratings in this paper are modeled after S&P's ratings, which are broken into tiers based on the quality of a government or corporate bond. These ratings range from AAA, which is considered to be a prime investment grade bond, to D, which represents a bond that is in default. We summarize these credit rating tiers by examining the number of farms in three distinct categories, using the S&P credit rating, shown in table 4.

A farm with a credit rating of BBB- or higher is considered investment grade, between BB+ and B- is considered a non-investment grade, and a credit rating of less than CCC+ is considered a substantial risk.

Comparing the Synthetic Credit Ratings by Debt Imputation

The distribution of credit ratings for all farm businesses can be seen in Figure 4, where the height of the bar is the proportion of farm businesses that falls into each credit rating. The distribution has fatter tails under the new debt estimates, reflecting a greater number of farm businesses with lower credit ratings.

As shown in table 5, using the new imputed debt numbers, the number of farm businesses considered to be a substantial credit risk increases by almost 10,000. Additionally, about 7,000 fewer farm businesses are considered to be investment grade because the new imputed debt numbers negatively affect their solvency. This finding is important because it means lenders perception of the financial strength of U.S. farm businesses will change under the new imputed debt numbers. Investors may also make different decisions with this new debt information, particularly if certain sectors look more vulnerable than before.

It is important to note that none of the farm businesses fall into the ratings categories of AAA to A-, visually cutting off the high end of the credit ratings scale in the figures throughout this section. In most of the credit ratings figures presented throughout this paper, the largest percentages of farms fall into the low end of "investment grade" (specifically, BBB-) and the high end of the "non-investment grade" (specifically, BB+ to BB, although smaller percentages do fall into the lower end of this category).

Summarizing Financial Health of US Farm Businesses under new debt imputation methodology

In this section we summarize the current financial health of the US farm businesses, representing about 935,000 farms where the primary occupation of the operator is farming. We focus on farm businesses because they account for over 90% of total value of US agricultural production (Ifft et al. 2012). We break down the D/A, DRCU, and financial position indicators by livestock, crop, net land owners and net land renters. A net land owner is defined as an operator that owns 50% or more of the land they operate, while a net land renter is an operator who owns less than 50%.

We chose to focus on land tenure because changing land values will likely have differing effects for operators who rent the majority of their land and operators who own a majority of their land. Net land owners may be in a better position with falling land values, due to higher levels of equity. Net land renters could see their profits squeezed as commodity prices fall while their operating expenses remain high. If cash rents are "sticky" and adjust more slowly as farmland returns decline, there could be substantial stress put on net land renters. Because cash rents are typically the largest expense for net land renters then falling income could squeeze their profit margins substantially.

Table 6 summarizes the differences between net land owners and net land renters. Compared with net land renters, net land owners on average have smaller farms as measured in acres, lower D/A ratios, older operators, and lower net farm income. Because younger farmers and larger farms tend to rent more of their land, net land renters are a very heterogeneous group.

As shown in table 7, in 2013 certain livestock farms and net land renters are more financially stressed than crop and net land owners. In 2013, 13% of livestock farms and 19.7% of net land owners had a D/A ratio greater than 40%. These two sectors also have the smallest percentage of farms in the "favorable" category. Looking DRCU measure, 2.5% of net land renters are considered to be in a financially stressed category (e.g. have a DRCU > 120). 5.6% of net land renters fall into the "vulnerable category", the lowest of four financial stress categories.

Concentration of debt

One method for measuring the intensity of financial stress is to look at the concentration of debt. We look specifically at the level of debt concentration among farm businesses and particularly leveraged farm businesses (i.e. debt-to-asset ratio > 55%). In 2013, farm businesses held 85.7% of the total debt in the US agriculture sector. Highly leveraged farm businesses, represented approximately 7.3% of farm businesses and held approximately 35.5% of total farm business debt.

A regional analysis shows that several regions have higher debt concentration than others. Figure 5 reveals that the Southern Plains region is most concentrated in debt, with approximately 57% of total debt concentrated in farm businesses with debt-to-asset ratios greater than 55%. This region contains many cattle and wheat operations. The Southeast, Delta and Mountain regions also show high debt concentration, at 52%, 53% and 51% of total debt on highly leveraged farms respectively.

Figure 6 shows a breakdown of debt concentration by value of production. In 2013, tobacco, peanut, poultry and nursery farm businesses are most concentrated in debt. Highly leveraged peanut farm businesses have almost 67% of the total debt among all peanut farm businesses. Tobacco, poultry and nursery farms have debt concentration percentages of 58%, 65% and 56% respectively. Dairy operations also have high debt concentration, with 50% of total dairy debt belonging to leveraged dairy farm businesses.

Next, we break down the debt concentration by net land owner status and value of production, as shown in Figures 7 and 8. Overall, debt concentration is much higher for net land renters than net land owners. Leveraged net land renters that specialize in tobacco, peanuts and poultry have more than 70% of the total debt in their respective specialties. Dairy and fruit farm businesses net land renters also show higher levels of debt concentration, at around 60%. Among net land owners, tobacco farm businesses show the highest debt concentration by a large margin, with leveraged operations holding over 90% of total debt.

Land Value Trends

Trends in land values can be used as an aggregate measure of farm financial stress (Jolly et al. 1985). The last decade has seen historically high levels of farmland appreciation, driven largely by record net farm income and low interest rates. This period of rapid land appreciation allowed land owners to borrow against their land and expand their operations (Weber and Key 2014; 2015). It should be noted that the appreciation in farmland values was not uniform. Figure 9 shows how cropland appreciation changed significantly between the periods of 2003-2008 and 2008-2013. From 2003-2008, every region in the country saw significant land appreciation. From 2008-2013 the Northern Plains, Corn Belt, Lake States, and Delta experienced the highest levels of land appreciation, while most other regions saw little to no appreciation. Regions such as the Mountain states, Northeast, and Southeast saw decreases in real land values over this later time period.

In 2014, the Northern Plains and heartland regions saw their first drop in land values in more than a decade. The 2014 Iowa State University land value survey reported an 8.9% decrease in farmland values, the largest decrease since 1986. In addition, 94% of survey respondents indicated that lower commodity prices are a major negative factor on farmland values (Iowa State University 2015). The 2014 Kansas State University Agricultural Lender Survey found that 95% of respondents expected interest rates to go up in the next 2-5 years. The majority of respondents also expected land values to decline in the short run (1 year) and long run (2-5 years). The overall picture suggests that farmland values, particularly in the Heartland, are slowly moving into a period of decline. Farmland that lies closer to urban areas may not see the same changes as alternative use values may be a larger factor.

Additional factors that may contribute to a drop in farmland values include the end of direct and countercyclical payments. The Agricultural Act of 2014 ended direct commodity and

countercyclical payments, and expanded crop insurance programs for a number of commodities. The expanded role of crop insurance may mitigate the effect of the ending of direct payments. Studies have indicated that publicly-subsidized insurance programs are capitalized into farmland values (Ifft, Wu and Keuthe 2014).

Future farmland prices will likely depend on interest rates and profitability. While the likelihood of a large drop in land values in the near term is low, there is certainly room to suggest that a farmland price correction is underway. However, given that farm mortgage underwriting has been conservative and the current low interest rate environment, the odds of a 1980's style bust in farmland values seems highly unlikely (Gabriel 2014).

Scenarios for Declining Land Values

Economic models for farmland typically calculate their value as the sum of their discounted future returns (Schnitkey and Sherrick 2011). Present value models use levels of current farmland returns (e.g. cash rents) and a discount factor (e.g. interest rate) to estimate these values. While this model does not take into account expectations about future returns or non-agricultural land value factors, such as proximity to urban areas, they are widely used to understand how economic factors will impact future values. The net present value of farmland is then calculated as

$$\text{Capitalized Land Value} = \frac{cash\ rent}{interest\ rate\ on\ 10\ year\ treasury\ note}$$

By manipulating the cash rent and interest rates on a 10 year t-note we can look at different scenarios. To calculate the baseline for capitalized land values, we use 2014 average cropland cash rent of $141 dollars an acre (ERS 2015), and the January 2014 ten-year Treasury note yield of 3%. This gives an average U.S. capitalized cropland value of $4,700, or about $600 more than actual average value per acre.

Using the net present value model, we then look at a drop in farmland returns on 5-15% and an increase in the interest rate (measured in basis points in table 8) of between 100 to 150 basis points. Table 8 displays a matrix of capitalized values (Gabriel 2014) for U.S. cropland under different scenarios of interest rates (e.g. 100 BP = 1% increase) and cash rents. Under a 5-15% drop in average cash rents and a 100 to 150 basis point increase in interest rates, average U.S. cropland values would fall between 18-35%. Similar decreases in cropland values are found using average cash rents for different regions of the US, such as the Corn Belt and Southern Plains. Under this scenario, the largest drop that most regions would see is approximately 35%.

Our estimates for land value drop can be considered a worst case, though not completely out of line with other forecasts. Some economists have recently stated that should interest rates increase 1-2% in the next year, combined with several consecutive years of corn prices around $4 a

bushel and soybeans at $10 a bushel, this could lead to a 25-30% drop in land values (Grebner 2014) in parts of the Heartland.

Our results shown below reflect several important economic assumptions. First, we assume that farms do not change production decisions under these scenarios. Second, we assume that the drop in land values and net farm income does not result in operations taking on additional debt.

For farms that rent farmland, we also assume land rental rates remain constant in our scenarios for land values and net farm income declines. While it is unlikely that cash rents would not eventually adjust as returns to farmlands decline, there is ample evidence that they are "sticky" and tend to lag behind changes in farmland returns (Schnitkey 2014). Cash rental agreements be for multiple years, meaning that some operations will be stuck with rental rates in the short-term. This is particularly important for farmers who rent the majority of their land. A more comprehensive model would incorporate the dynamic effects of changing interest rates and net farm income on land values, cash rents, and production decisions. We acknowledge the limitations of this method, while still believing it can help shed light on which sectors may be most vulnerable to these scenarios.

The question of how a 35% drop in land values would affect farm financial stress is complicated. We begin by looking at D/A measures and then examine how many farm businesses would change financial categories under this scenario. Next we examine the lender side of the equation by using the synthetic credit rating model.

Financial Ratio Results: Measuring Financial Stress under a 35% drop in Land Values using Ratio Analysis

Under a 35% drop in land values we revisit the financial measures for farm businesses, shown in table 9. In this scenario the mean D/A ratio for all farm businesses increases from 10.6% to 11.9%. While this does not represent a large change in average leverage, the mean does capture changes in the tail of the distribution, specifically farm businesses on the threshold of being highly leveraged. We find that some groups show more stress than others.

Almost one quarter of net land renters would now be considered highly leveraged. They also show the highest mean D/A ratio, at 20.4%, and the highest proportion in the vulnerable category, at 6.4%. This represents about 17,000 farm businesses that are net land renters. Although livestock farms show a higher D/A ratio than crop farms, the percentage of crop farms considered vulnerable is larger at 4.1%. This represents about 19,000 crop farm businesses.

Figures 10, 11, and 12 show the percentage or proportion of farm businesses in the red zone (Debt/Asset < 0.55) for solvency under the current 2013 baseline and a 35% drop in land values.

Figure 10 shows that the percentage of farm businesses in the red zone increases monotonically with sales class. Farm businesses with more than $1 million in sales are most likely to be vulnerable.

Figure 11 shows a commodity specialization analysis for debt/asset ratios. This reflects the change in the percentage of farms in the red zone for the Debt/Asset ratio in the presence of a 35% fall in land values. The 17.4% of tobacco farms is unchanged after a 35% decrease in land values, while the percentage of peanut farms increases from 24.2% to 26.4%, poultry farms' percentage increases from 17.1% to 19.3%, and hogs increase from 11.3% to 13.3%.

Figure 12 breaks down solvency by region. The Mountain, Northern Plains, and Southern Plains have the highest percentages of farms with the Debt/Asset ratio greater than 0.55, with 6.94%, 6.42%, and 6.25% respectively.

Synthetic Credit Rating Model Results

Next, we examine the lender side of the financial stress by using the synthetic credit rating model. To analyze how a 35% drop in land values will impact credit ratings, we reduce the value of assets associated with farmland and recalculate owner equity (OE). To analyze a 25% drop in net farm income, we reduce farm business net farm income, a component of the debt repayment capacity (CDRC) variable in the credit rating model. In each scenario, we classify a farm business into one of three categories based on the resulting probability of default. Table 4 explains the credit ratings that are associated with these three categories: investment grade (AAA to BBB-), non-investment grade (BB+ to B-) and substantial risk (CCC+ or lower).

Effect of 25% drop in net farm income for all farm businesses

The credit rating distribution for all farm businesses under a 25% drop in net farm income is shown in figure 13. Given the record net farm income of the last several years, it's not surprising that the credit risk profile does not change much under this scenario. Under this scenario we see approximately 1,500 farm businesses move out of investment grade category into non-investment grade. About 400 additional farm businesses are rated as a substantial risk.

Effect of 35% drop in land values for all farm businesses

We examine a scenario of a 35% drop in land values on farm businesses. Figure 14 shows the distribution for all farm businesses ranges from a BBB+ to D. Under a 35% drop in land values, the number of farm businesses in the substantial risk category increases by 6,364, to a total of 24,307. This represents about 2.6% of all farm businesses. The drop in asset values due to the decline in land values has a much more negative impact than the 25% drop in net farm income. Still, the overall picture does not change substantially. Most farm businesses are shown to have a cushion for such a drop in assets.

Land Owners and Renters under a 35% drop in Land Values

Breaking down farm businesses further into net land owners and renters—differentiated by owning more than 50% vs. less than 50%, respectively, of the land farmed by one's operation—we see they are affected differently by changes in land values. In figures 15 and 16 we show that the average credit ratings for net land owners are stronger than for net land renters.

Under a 35% drop in land values, net land owners add about 3,000 farm businesses to the substantial risk category, bringing the total to 11,580. This represents about 1.7% of all net land owners.

As seen in table 13, under a 35% drop in land values, net land renters add about 3,400 farm business to the substantial risk category. The percentage of net land renters in the substantial risk category represents about 4.8% of all net land renters under this scenario. Again, we assume that land rental rates do not change under this scenario. This effectively makes this a "worst case" analysis, as farm operators will seek to renegotiate their rental contracts as returns to farmland decline.

Effect of 35% drop in land values by Commodity Specialization and Region

Figure 17 also shows that under a 35% drop in land values, the percentage of tobacco farms that are in the substantial risk category increases from 3% to 17%, and for peanut farms it increases from 19% to 20%. Tobacco farms have lowest mean current ratios and owner equity percentages among all the sectors. However, we should note that there are only about 3800 tobacco farms and a little over 1,000 peanut farm businesses. The percentage of cattle farms in the substantial risk category increases from 0.6% to 1.3%, dairy increases from 0.5% to 3.3%, and cotton increases from 0.5% to 1.7%.

For most commodity specializations, a 35% drop in land values only slightly increases the percentage of farms with low credit ratings, but the total number of farms that are stressed is lower in the synthetic credit rating results than in the Debt/Asset results. Note that the thresholds for the credit scoring model and Debt/Asset ratio are not necessarily the same.

Figure 18 displays similar regional patterns to figure 12, in that Southern Plains, Northern Plains, and Mountain had the highest percentages of farms at financial risk. In figure 18, the risk was captured by a "substantial risk" rating and in figure 12 by a Debt/Asset ratio in the red zone. However, the percentages were slightly lower in figure 18. This also was the case for the percentages in figure 17 vs. 11.

Next we look at farms that fall into either the red or yellow categories for the Debt/Asset ratio, with Debt/Asset > 30% accounting for farms that are both highly leveraged and moderately highly leveraged. Figure 19 and table 14 show the impact on these farms of a 35% decline in

land values. Note that the high end of the distribution shown in figure 19 is lower than in the other graphs, at BBB- instead of BBB+, with a larger percentage of farms represented in the "substantial risk" category of CCC+ or lower.

Under a 35% decline in land values, the number of highly and moderately highly leveraged farms in the substantial risk category increases from approximately 18,000 to 24,000. Almost no farm businesses with a Debt/Asset > .3 are considered investment grade.

High-sales farm businesses

We now turn our attention to farms of different sizes, as measured by sales. Figure 20 shows the impact of a 35% decline in land values on the percentage of farms that would have synthetic credit ratings in the "substantial risk" category. The percentage increases within every sales category. In order to further focus on small farms vs. larger farms, Figure 21, 22, and 23 separate the farms into sales categories of less than $250,000, $250,000 to $1 million, and over $1 million. The two higher-sales categories exhibit similar patterns in reaction to a 35% decline in land values: a slight rightward shifting of the distribution as the percentage of farms with higher credit ratings falls slightly and the percentage of farms with lower credit ratings increase slightly. Both before and after the 35% drop in land values, farms with $1 million or more in sales are also more concentrated in the lower credit rating categories as compared to farms in the lower sales categories.

Conclusion

While much of the U.S. agricultural economy has seen record growth in farmland values over the last decade there are signs that we may be entering a period of declining farmland values, as net farm income falls and interest rates are poised to increase. This study examines the current financial health of U.S. farm businesses and analyzes how financial stress would impact specific sectors under two scenarios, a 25% drop in net farm income, and a 35% drop in land values. These scenarios are based on recent estimates for net farm income from the USDA, as well as new imputed farm debt numbers.

Because financial stress is a latent variable which can only be imperfectly measured, we examine several different financial measures in this study. To get a more complete picture we analyze these scenarios with two measures of financial stress: 1) a measure that categorizes a farm's financial position using net farm income and debt-asset ratio, and 2) a synthetic credit rating model that predicts the probability of default under these scenarios. The synthetic credit rating model is used because it combines three financial dimensions, solvency, debt repayment capacity and liquidity. It also allows us to examine these scenarios from a lender's perspective.

Our results show that while the overall financial condition of U.S. farm businesses is strong, certain sectors remain vulnerable to an extended downturn in net farm income and land values. Peanut, tobacco and poultry farms are vulnerable because many are already highly leveraged. A further decline in land values will only increase their leveraged positions. Farm businesses with debt-to-asset ratios over 40% are more vulnerable, especially when combined with lower liquidity. Many tobacco farms fall into this category. In addition, using the synthetic credit rating we find that the new debt imputation methodology adds almost 10,000 more farm businesses to the substantial risk category. These new debt numbers reveal that lenders may be less willing to lend or will increase borrowing requirements for more farm businesses than previously estimated.

We also find that larger farms (e.g. farms with sales over one million dollars) are more vulnerable to a downturn in land values. These farms tend to have higher debt-to-asset ratios, and rent the majority of their land. Along those lines, we find, somewhat surprisingly, that net land renters are more vulnerable under a 35% drop in land values. This group has higher leverage, and is more susceptible to large swings in asset values. Because net land renters tend to be younger farmers or large farms that rent a majority of their land, these groups may require additional access to credit markets if net farm income remains low for an extended period (i.e. more than a few years). Additionally, our synthetic credit rating analysis suggests that lenders may be less willing to offer credit to these groups.

The results from this study will prove useful for policymakers, farm lenders, and researchers. The vast majority of U.S. farm businesses look well positioned to weather a drop in land values and net farm income. The current economic environment does not resemble 1980's, with mean debt-to-asset ratios at record lows and a low interest rate environment. Additionally, changes in lending practices make it unlikely that we will see large changes in financial stress for lenders or borrowers in the short-term. There are questions about how new insurance programs will help or hurt farm businesses in this challenging environment. The efficacy of these programs will be scrutinized as farm businesses attempt to cope with economic challenges in a new policy environment.

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Tables

Table 1. Financial Characteristics of all farm operations by debt imputation methods, 2013 ARMS*

	Conditional mean debt imputation	Multivariate debt imputation	Difference (all farms)
Number of Farms (thousands)	2095.5	2095.5	
Total Farm Debt ($ Billions)	165	196	31
Mean Farm Sector D/A (%)	7.3	8.6	1.3
D/A > 55% (# farms)	51366	66535	15169
Mean Farm Sector DRCU (7.5% interest rate) (%)	21.6	25.9	4.3
DRCU >120 (# farms)	10995	18606	7611
Financial position (%)			**(# farms, % farms)**
Favorable	59.1	58.6	(-104774, -0.5%)
Marginal Income	36.4	36.0	(-83819, -0.4%)
Marginal Solvency	2.1	2.6	(104774, +0.5%)
Vulnerable	2.4	2.8	(83819, +0.4%)

Table 2. ERS Financial Position Categories

Financial Position	Net Farm Income	Debt-to-asset
Favorable	positive	<40%
Marginal Income	negative	<40%
Marginal Solvency	positive	>40%
Vulnerable	negative	>40%

Table 3. OE, WC and CDRC for Farm Businesses and certain Farm Business Sectors

	Farm Business	Livestock	Crop	Net land own	Net land renter
Owner Equity (%)	90.5	91.4	90.0	93.6	82.8
Working Capital (%)	49.2	54.2	45.7	50.5	45.7
CDRC (%)	162.6	154.7	168.0	172.7	136.8

Table 4. Rating descriptions

S&P Rating	Rating Description
AAA to BBB-	Investment Grade
BB+ to B-	Non-investment Grade
CCC+ or lower	Substantial Risk

Table 5. Number of farm businesses in each major credit category

	Conditional mean imputed debt	Multivariate imputed debt	Difference
Investment grade	206354	199061	-7293
Non-investment grade	720509	717984	-2525
Substantial risk	8069	17943	9874

Table 6. Mean characteristics of net land owners and renters (Farm Businesses), 2013 ARMS

	Net land owners	Net land renters
Net Farm Income	60399	201704
Acres Operated	503	1475
Total Assets	1721003	1835597
Debt-to-Asset Ratio	6.8	20.0
Operator Age	61	54

Table 7. Financial Characteristics of US Farm Businesses using new imputed debt numbers, ARMS 2013

	Farm Businesses	Livestock	Crop	Net Land Owner	Net Land Renter
Number of Farms (thousands)	934.9	466.7	373.7	672.5	262.5
Mean debt-to-asset ratio (%)	10.6	9.7	11.8	6.8	20.4
Farms with D/A > 55% (%)	4.3	3.9	4.3	2.5	8.7
Mean DRCU (7.5% interest rate)	110.8	45.0	62.1	33.4	152.3
Farms with DRCU >120 (%)	1.2	0.7	1.6	1.8	2.5
Financial position (% of farms)					
Favorable	60.9	58.7	64.3	61.9	58.1
Marginal Income	31.7	33.6	28.9	33.8	26.3
Marginal Solvency	4.4	4.7	3.9	2.4	9.5
Vulnerable	3.0	3.0	3.0	1.9	5.6

Table 8. Capitalized Values for US Average Cropland under Different Scenarios of Cash Rents and Interest Rates

	change in avg cash rent					
interest rate BP	**0**	**-5%**	**-10%**	**-15%**	**-20%**	**-25%**
0	4700	4465	4230	3995	3760	3525
25	4338	4122	3688	3688	3471	3254
50	4029	3827	3626	3424	3223	3021
75	3760	3572	3196	3196	3008	2820
100	3525	**3349**	**3173**	**2996**	2820	2644
125	3318	**3152**	**2820**	**2820**	2654	2488
150	3133	**2977**	**2820**	**2663**	2507	2350
175	2968	2820	2523	2523	2375	2226
200	2820	2679	2538	2397	2256	2115

Table 9. Characterizing the US Farm Business Sector under a 35% drop in land values

	Farm Businesses	Livestock	Crop	Net Land Owner	Net Land Renter
Number of Farms (thousands)	934.9	466.7	373.7	672.5	262.5
Mean debt-to-asset ratio (%)	11.9	9.7	11.8	6.8	20.4
Farms with D/A > 55% (%)	5.0	4.7	5.0	3.2	9.7
Financial position (% of farms)					
Favorable	59.8	56.8	62.9	60.7	57.4
Marginal Income	31.0	34.2	27.8	33.1	25.6
Marginal Solvency	5.5	5.7	5.2	3.5	10.6
Vulnerable	3.7	3.3	4.1	2.7	6.4

Table 10. Synthetic credit ratings: baseline vs. 25% drop in net farm income

	2013 Baseline	25% drop in net farm income	Difference
Investment grade	199061	197378	-1683
Non-invest grade	717984	719387	1403
Substantial Risk	17943	18317	374

Table 11: Number of Farm Businesses in Credit Rating Categories

	2013 Baseline	35% drop in land values	Difference
Investment grade	199061	197097	-1964
Non-invest grade	717984	713683	-4301
Substantial Risk	17943	24307	6364

Table 12: Net Land Owners Credit Rating Categories

	2013 Baseline	35% drop in land values	Difference
Investment grade	156155	154608	-1547
Non-invest grade	507603	506325	-1278
Substantial Risk	8581	11580	2999

Table 13: Net Land Renters Credit Rating Categories

	2013 Baseline	35% drop in land values	Difference
Investment grade	42893	42499	-394
Non-invest grade	210394	207401	-2993
Substantial Risk	9261	12600	3339

Table 14. Leveraged Farms Credit Rating Categories

	Baseline	35% drop in land values	Difference
Investment grade	14	14	0
Non-invest grade	85026	78746	-6280
Substantial Risk	17913	24179	6266

Table 15. Credit Rating Categories: Farms with $1 million + in sales

	baseline	35% drop in land values	Difference
Investment grade	6299	6263	-36
Non-invest grade	80654	80162	-492
Substantial Risk	2531	3053	522

Figures

Figure 1. Debt/Asset > 0.55, New vs. Old Imputation Method, by Production Category

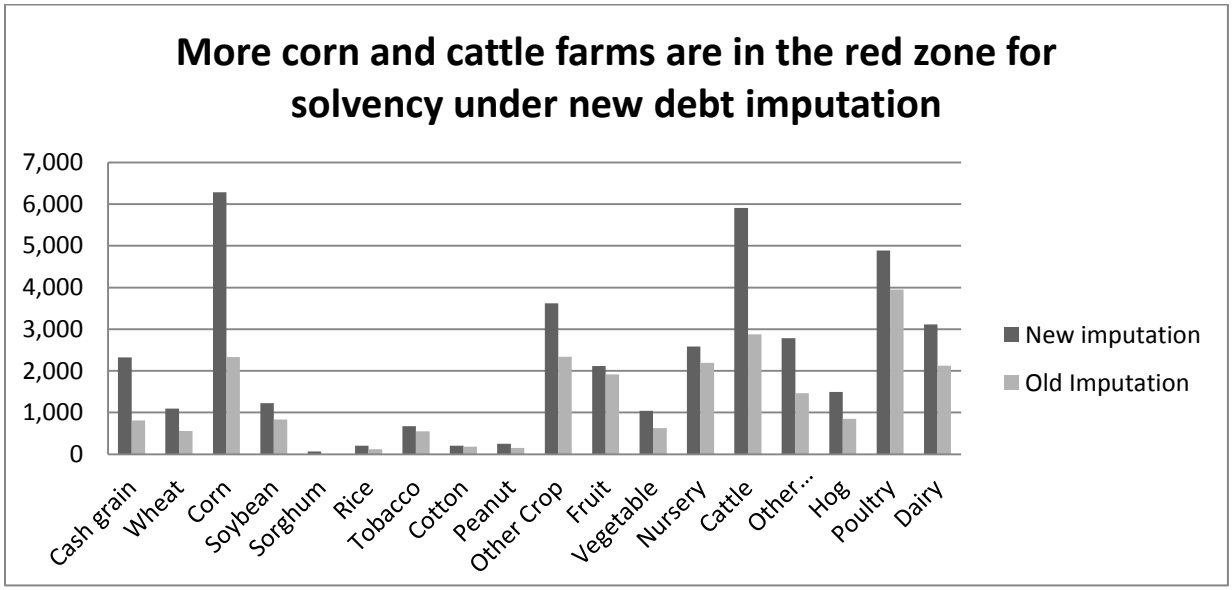


Figure 2. Debt/Asset > 0.55, New vs. Old Imputation Method, by Sales Category

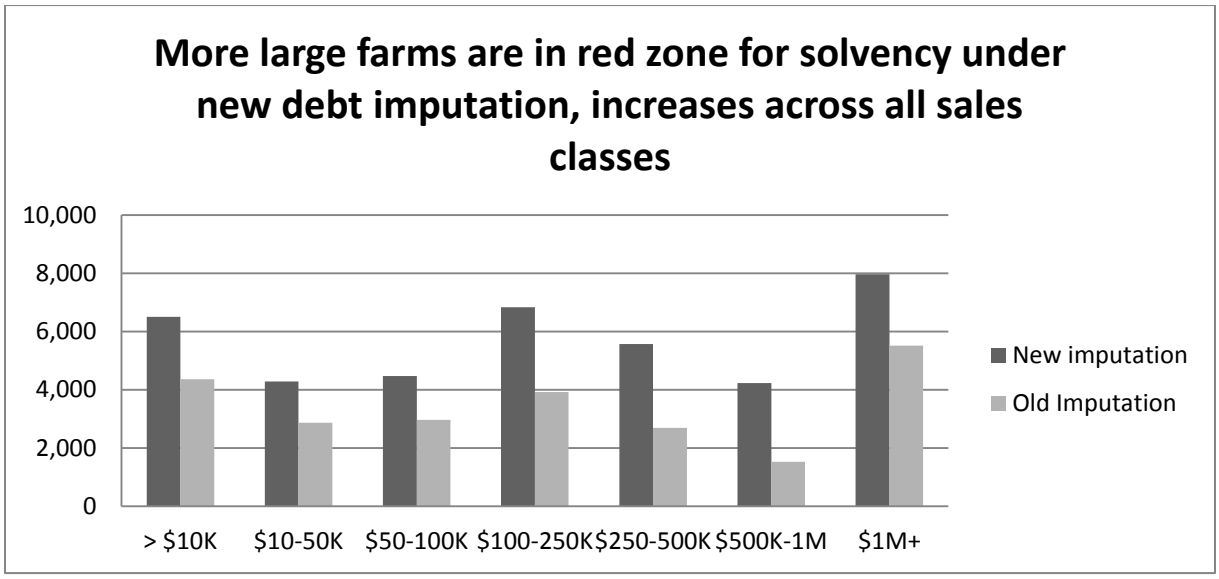


Figure 3. Debt/Asset > 0.55, New vs. Old Imputation Method, by Region

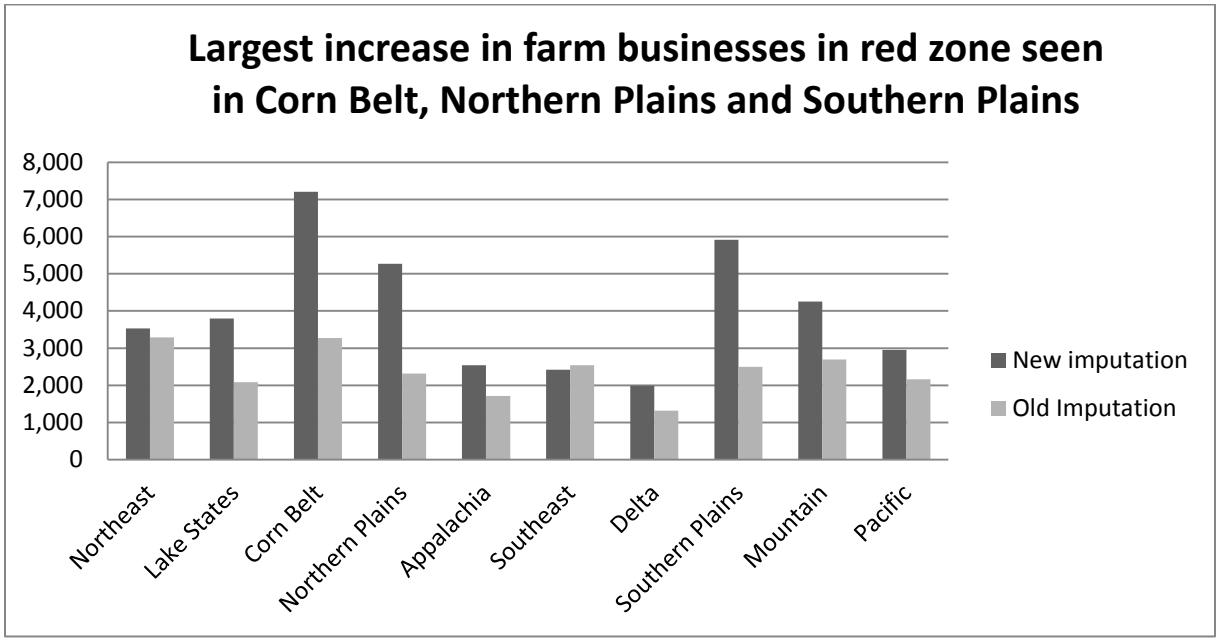
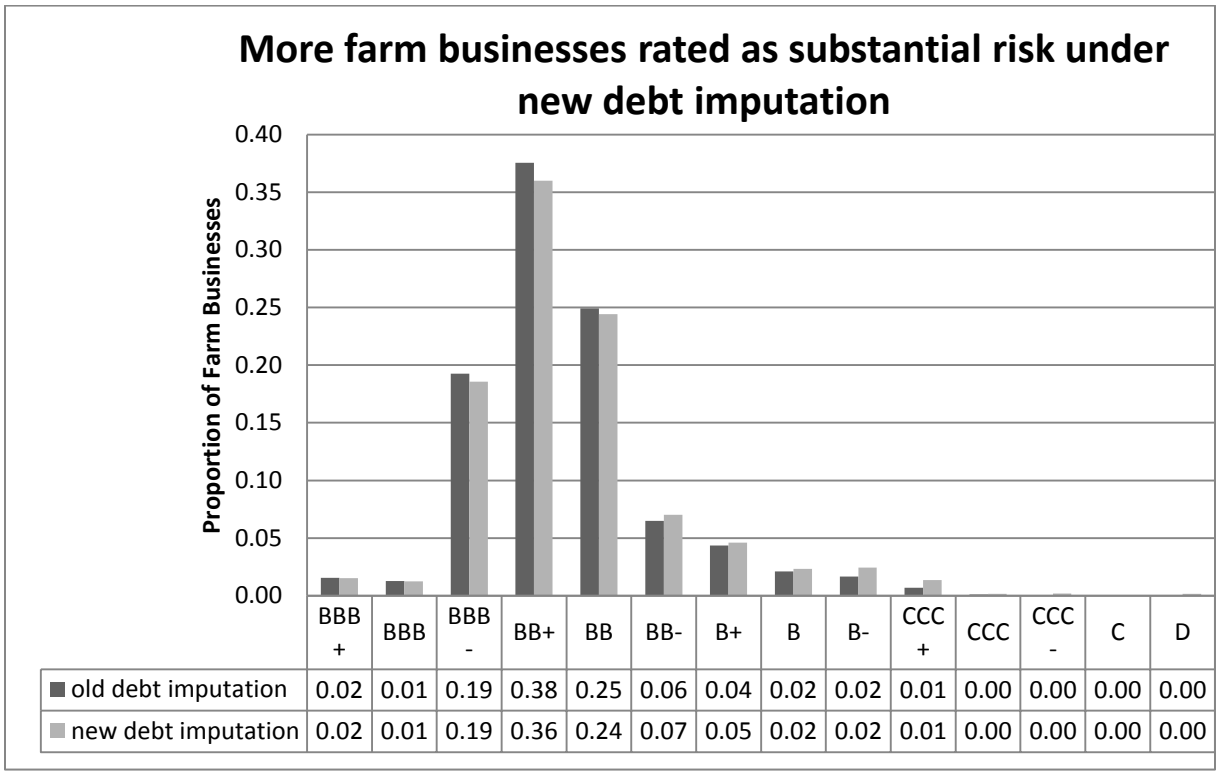


Figure 4. Synthetic Credit Rating Distribution by debt imputation method



	BBB+	BBB	BBB-	BB+	BB	BB-	B+	B	B-	CCC+	CCC	CCC-	C	D
old debt imputation	0.02	0.01	0.19	0.38	0.25	0.06	0.04	0.02	0.02	0.01	0.00	0.00	0.00	0.00
new debt imputation	0.02	0.01	0.19	0.36	0.24	0.07	0.05	0.02	0.02	0.01	0.00	0.00	0.00	0.00

Figure 5. Concentration of Debt on Leveraged Farm Businesses by Production Region

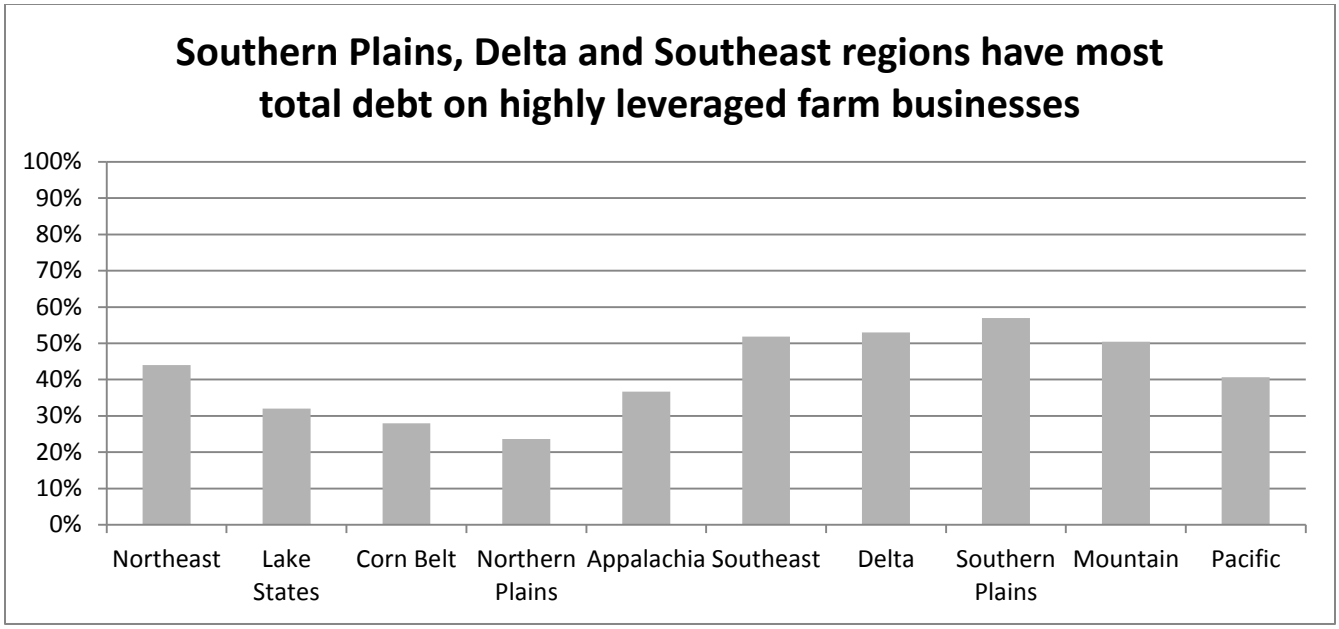


Figure 6. Concentration of Debt by Value of Production

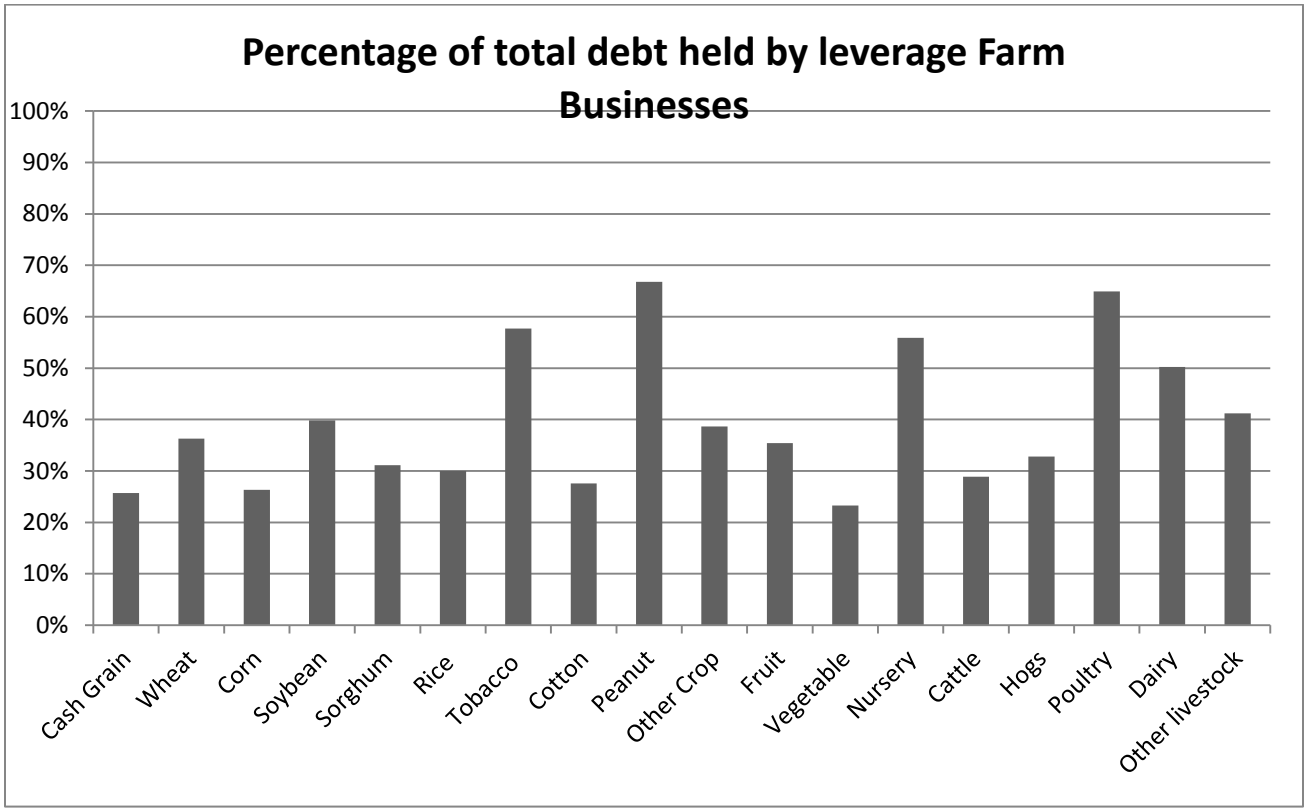


Figure 7. Concentration of Debt (Leveraged Net Land Owners), by Value of Production

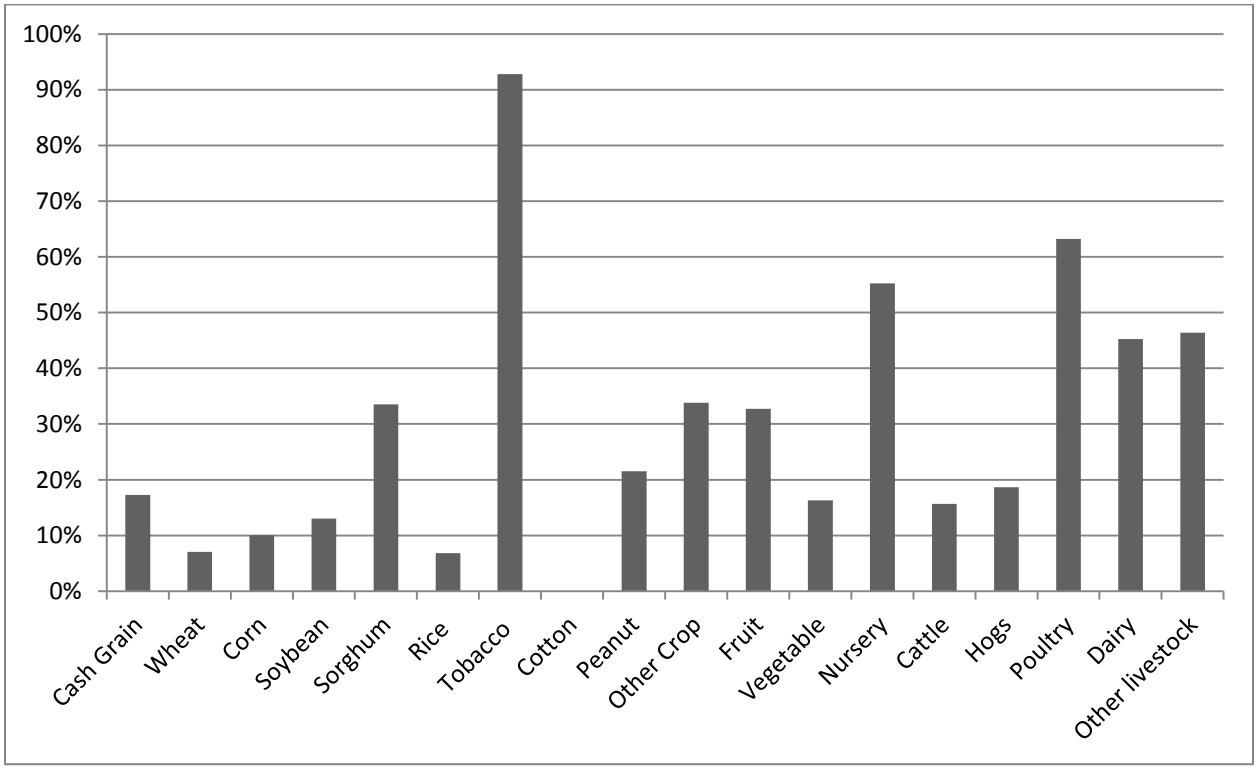


Figure 8. Concentration of Debt (Leveraged Net Land Renters), by Value of Production

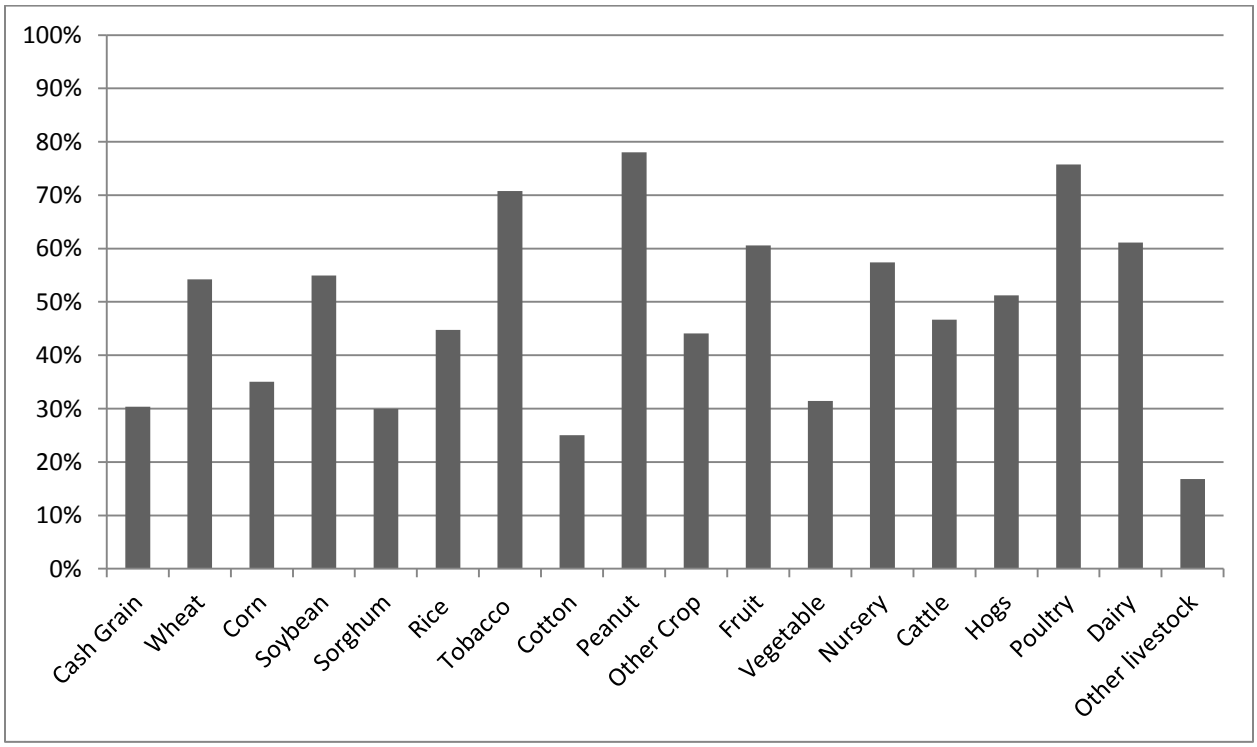


Figure 9. Changes in land appreciation (nominal) by region, 2003-2013[6]

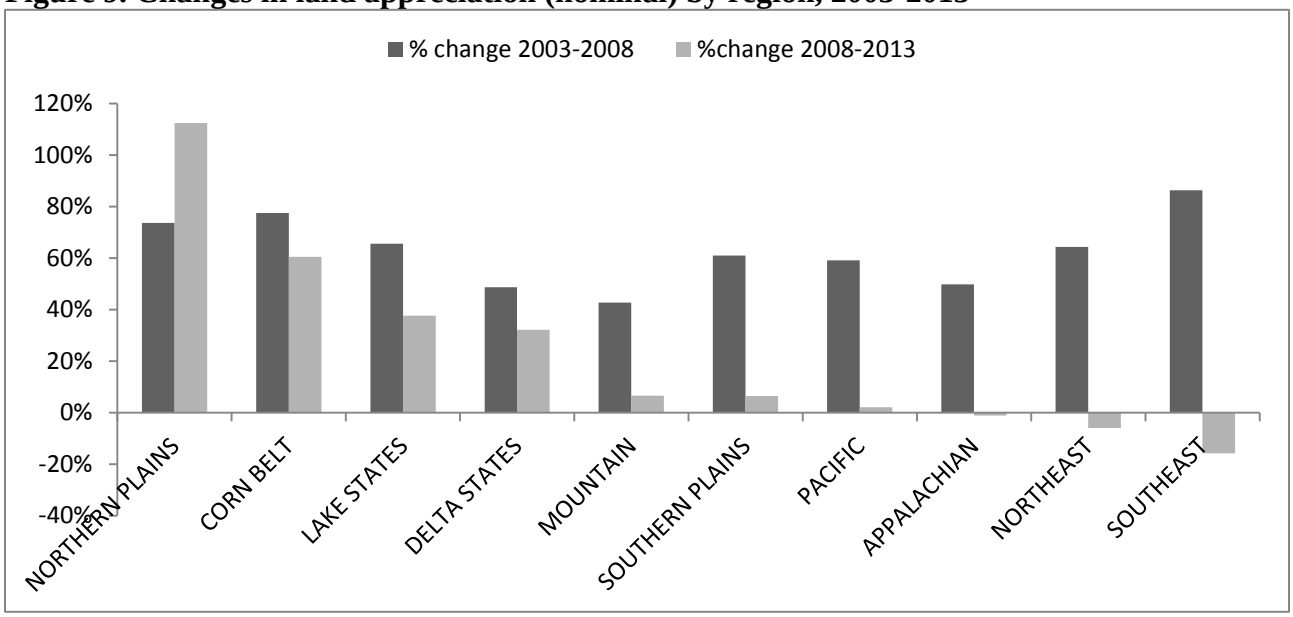
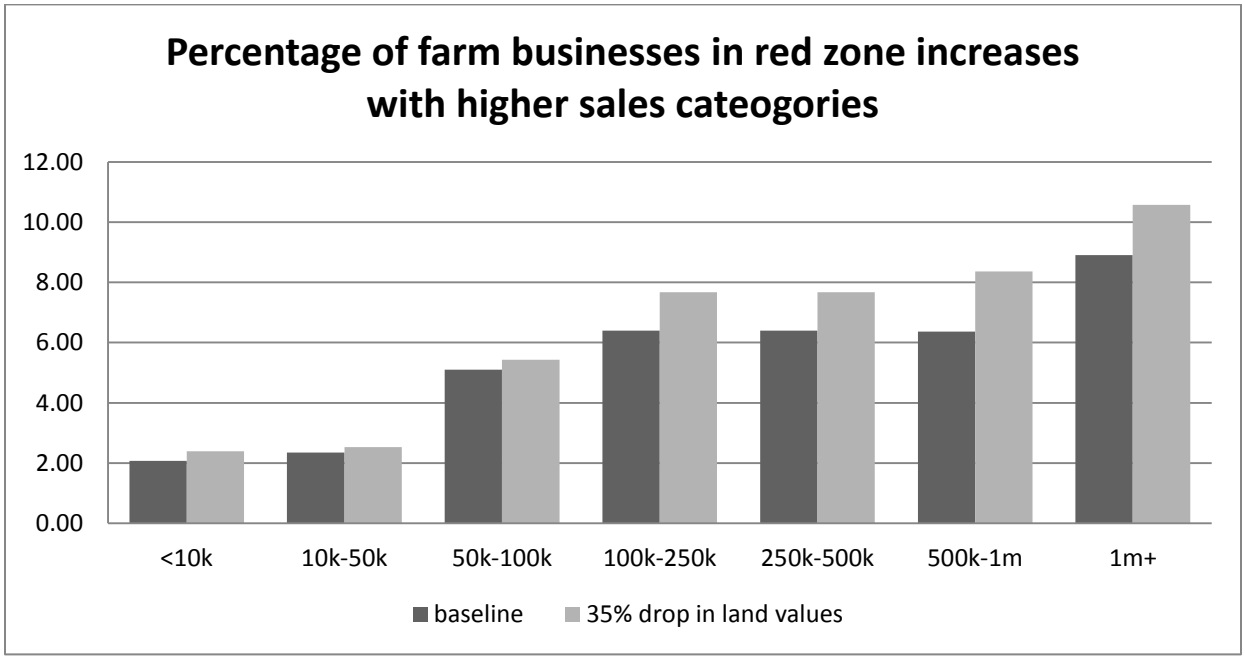


Figure 10. Percentage of Farm Businesses with Debt/Asset > 0.55 (red zone), by sales



[6] Note: Figure depicts changes in nominal cropland values. Source: USDA, Economic Research Service and National Agricultural Statistics Service

Figure 11. Percentage of Farm Businesses with Debt/Asset > 0.55 (red zone), by Production Category

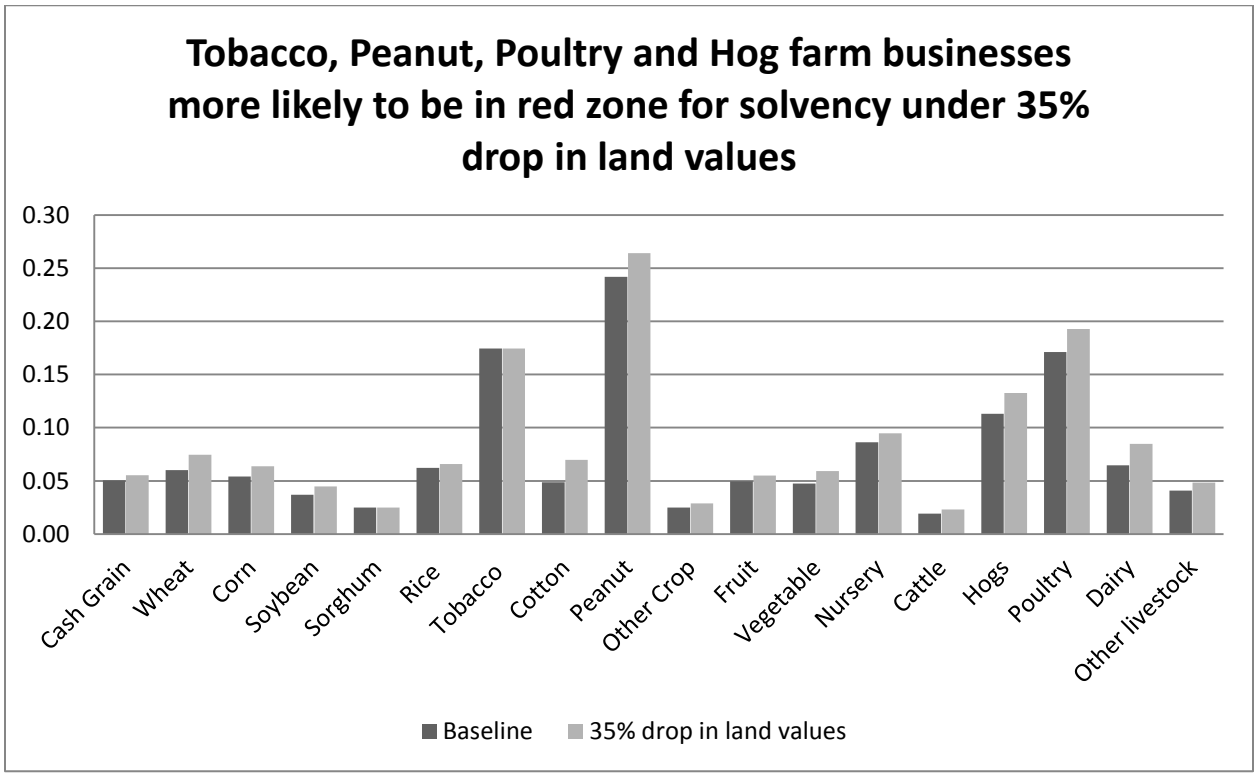


Figure 12. Proportion of Farm Businesses with Debt/Asset > 0.55 (red zone), by Region

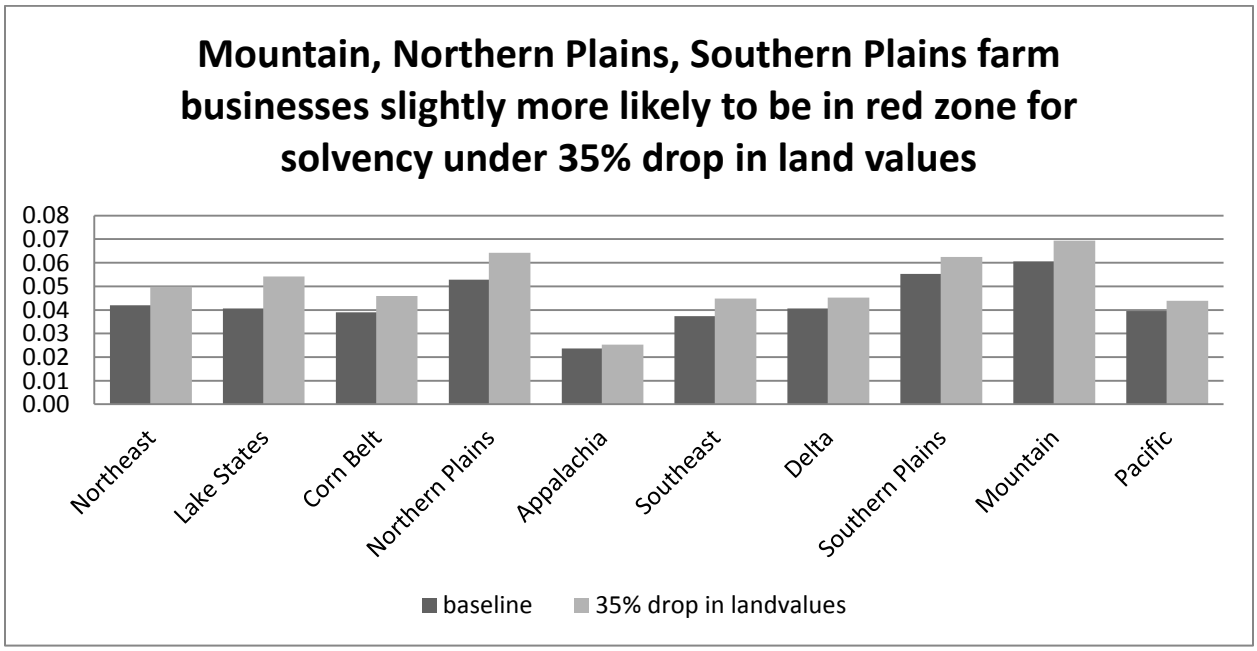


Figure 13. Synthetic Credit Ratings: Baseline vs. 25% Drop in Net Farm Income

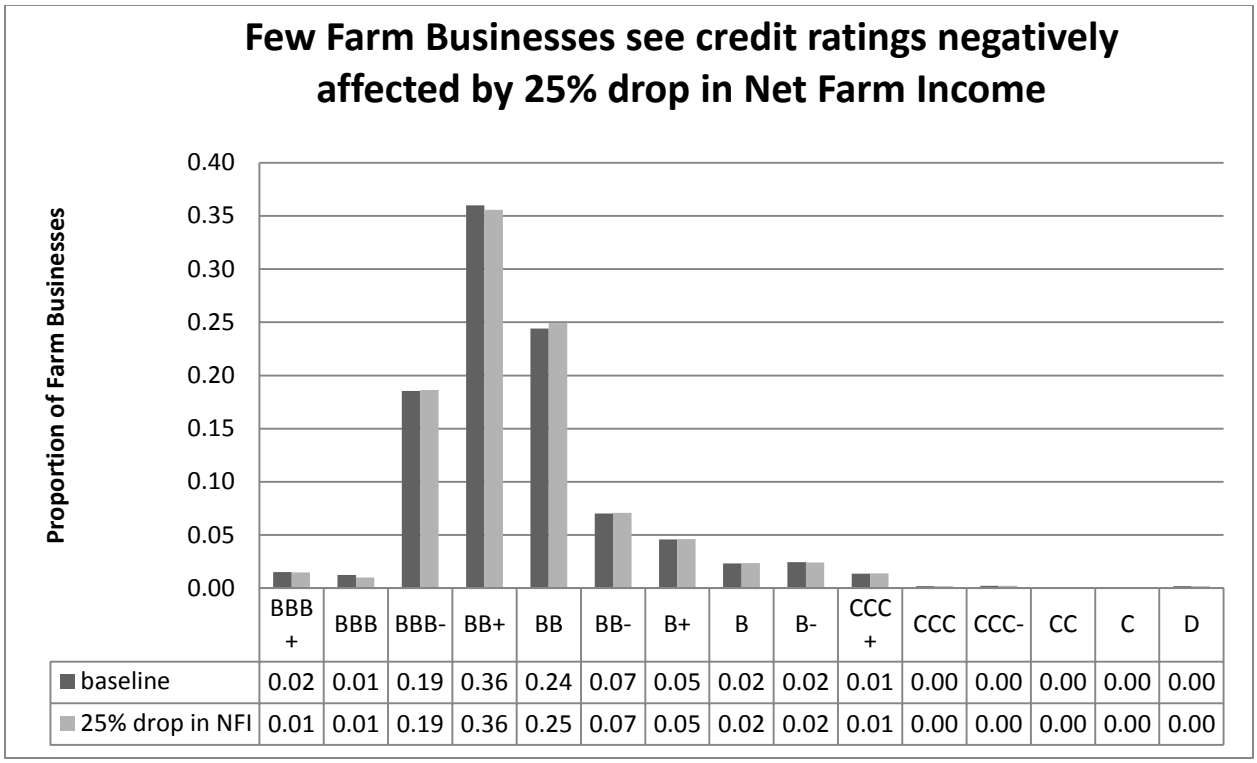


Figure 14. Synthetic Credit Ratings: Baseline vs. 35% Drop in Land Values

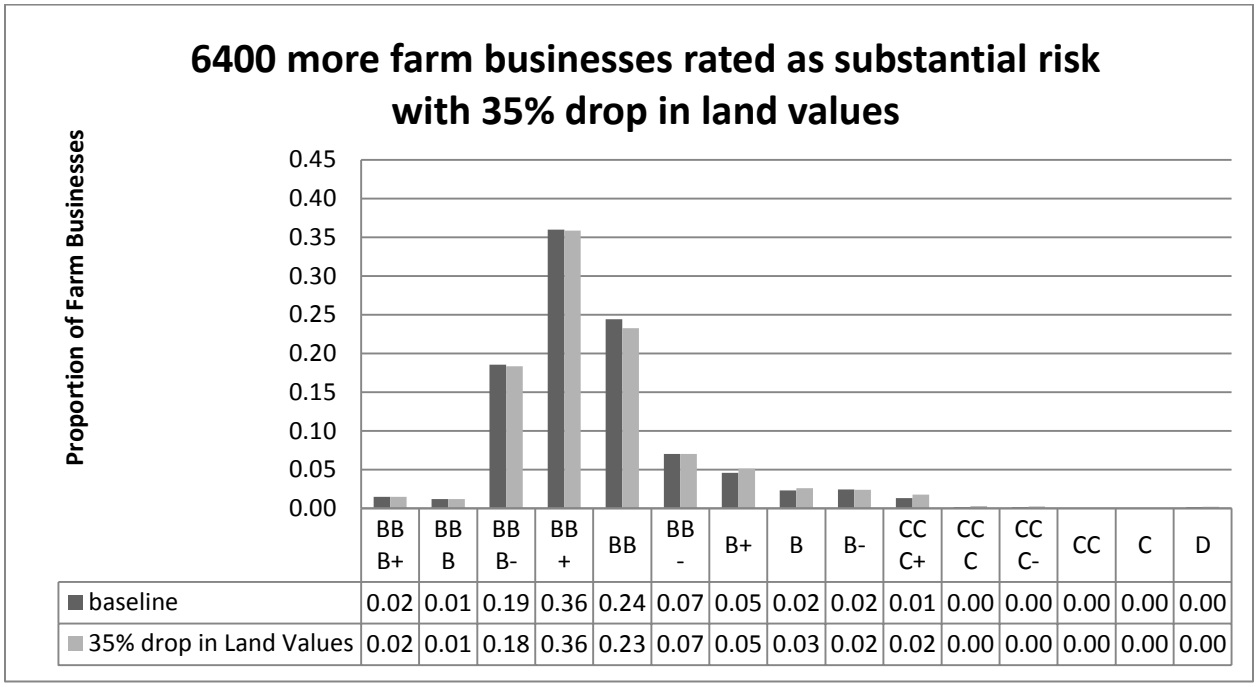
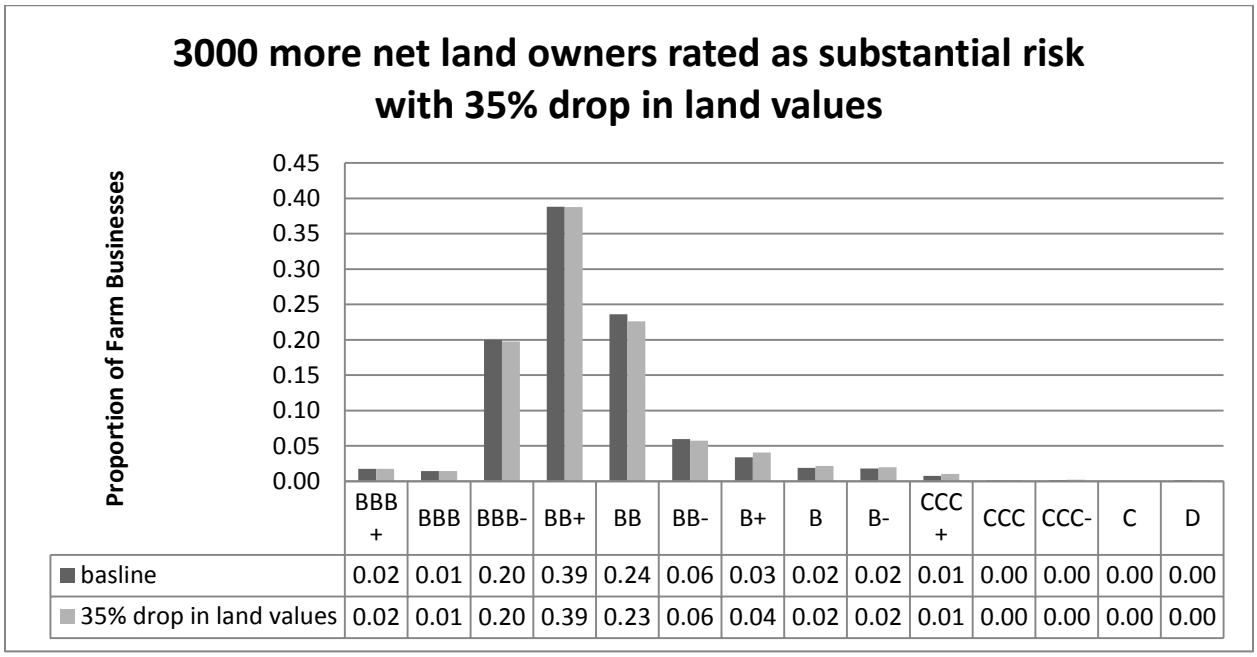
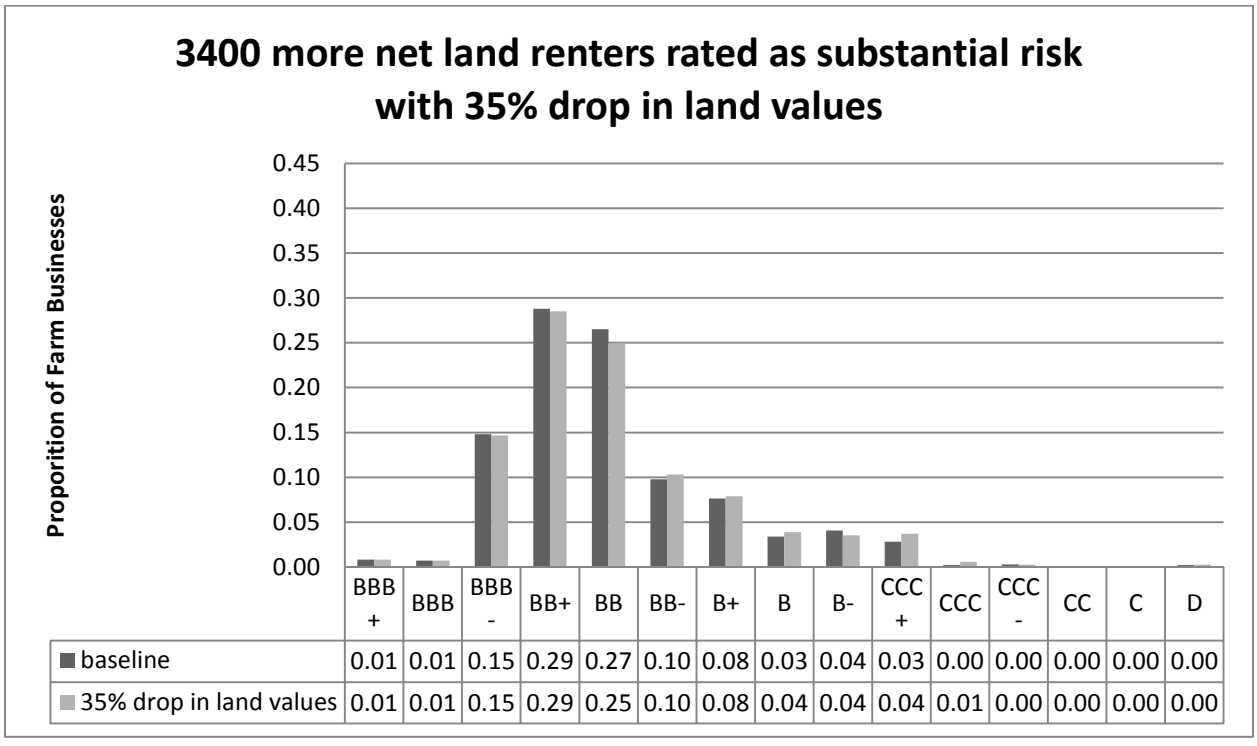


Figure 15. Synthetic Credit Ratings (Net Land Owners): Baseline vs. 35% Drop in Land Values



	BBB+	BBB	BBB-	BB+	BB	BB-	B+	B	B-	CCC+	CCC	CCC-	C	D
basline	0.02	0.01	0.20	0.39	0.24	0.06	0.03	0.02	0.02	0.01	0.00	0.00	0.00	0.00
35% drop in land values	0.02	0.01	0.20	0.39	0.23	0.06	0.04	0.02	0.02	0.01	0.00	0.00	0.00	0.00

Figure 16. Synthetic Credit Ratings (Net Land Renters): Baseline vs. 35% Drop in Land Values



	BBB+	BBB	BBB-	BB+	BB	BB-	B+	B	B-	CCC+	CCC	CCC-	CC	C	D
baseline	0.01	0.01	0.15	0.29	0.27	0.10	0.08	0.03	0.04	0.03	0.00	0.00	0.00	0.00	0.00
35% drop in land values	0.01	0.01	0.15	0.29	0.25	0.10	0.08	0.04	0.04	0.04	0.01	0.00	0.00	0.00	0.00

Figure 17. Percentage of Farm Businesses Rated "Substantial Risk", Baseline vs. 35% drop in Land Values, by Value of Production

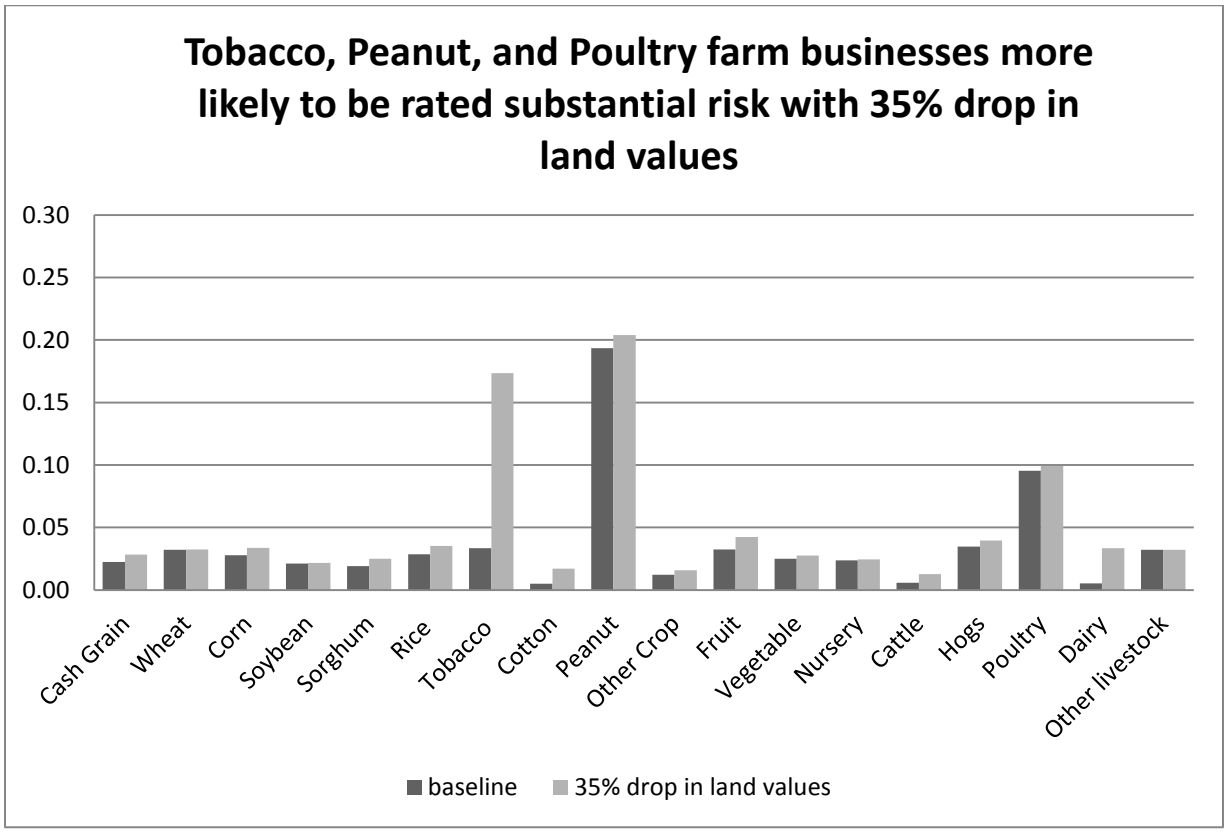


Figure 18. Percentage of Farm Businesses Rated "Substantial Risk", Baseline vs. 35% drop in Land Values, by Region

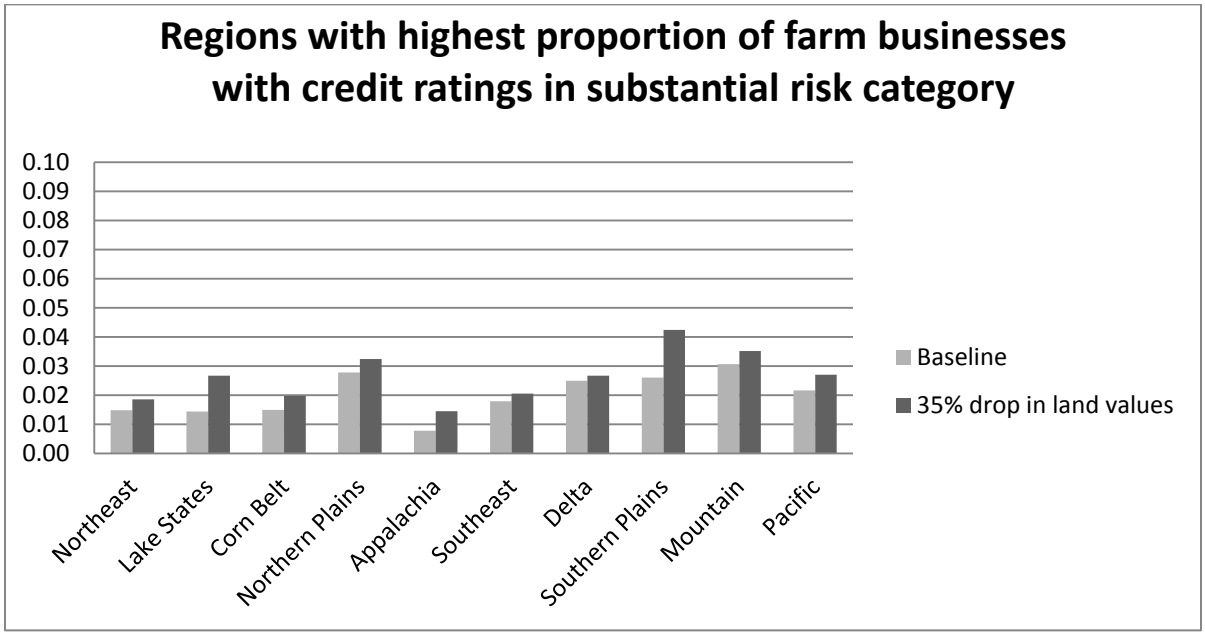
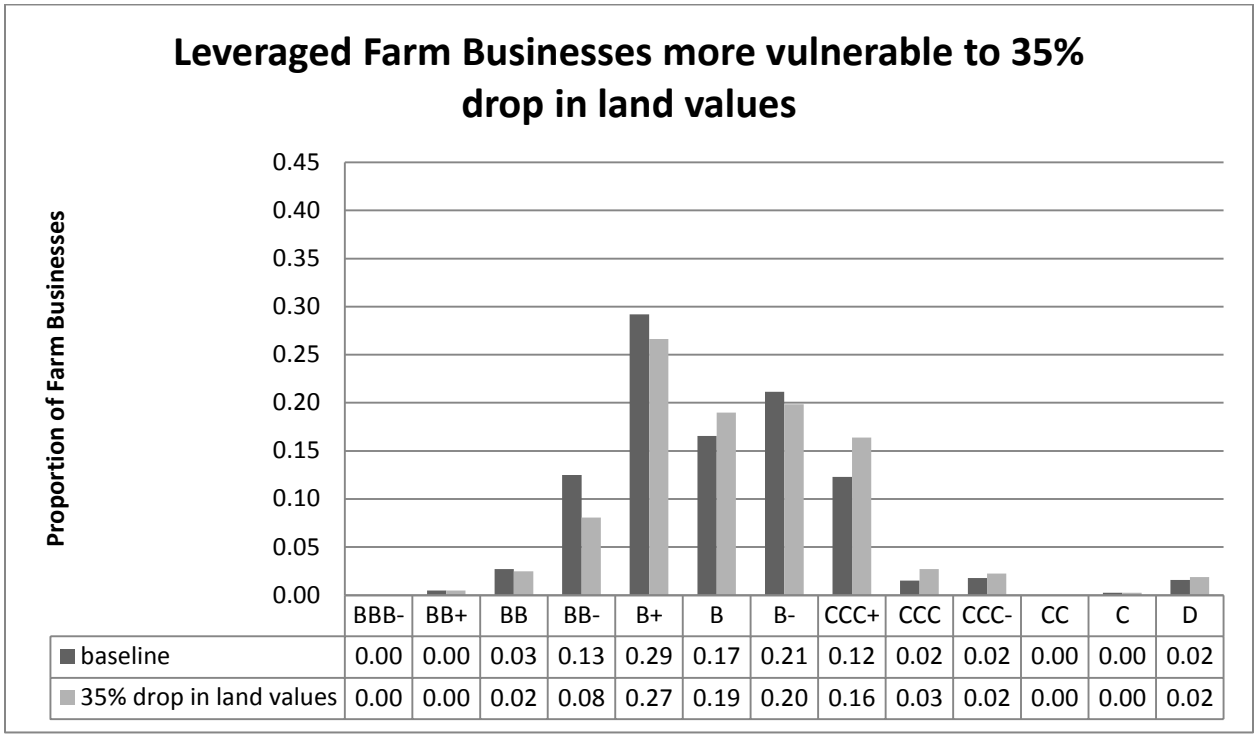
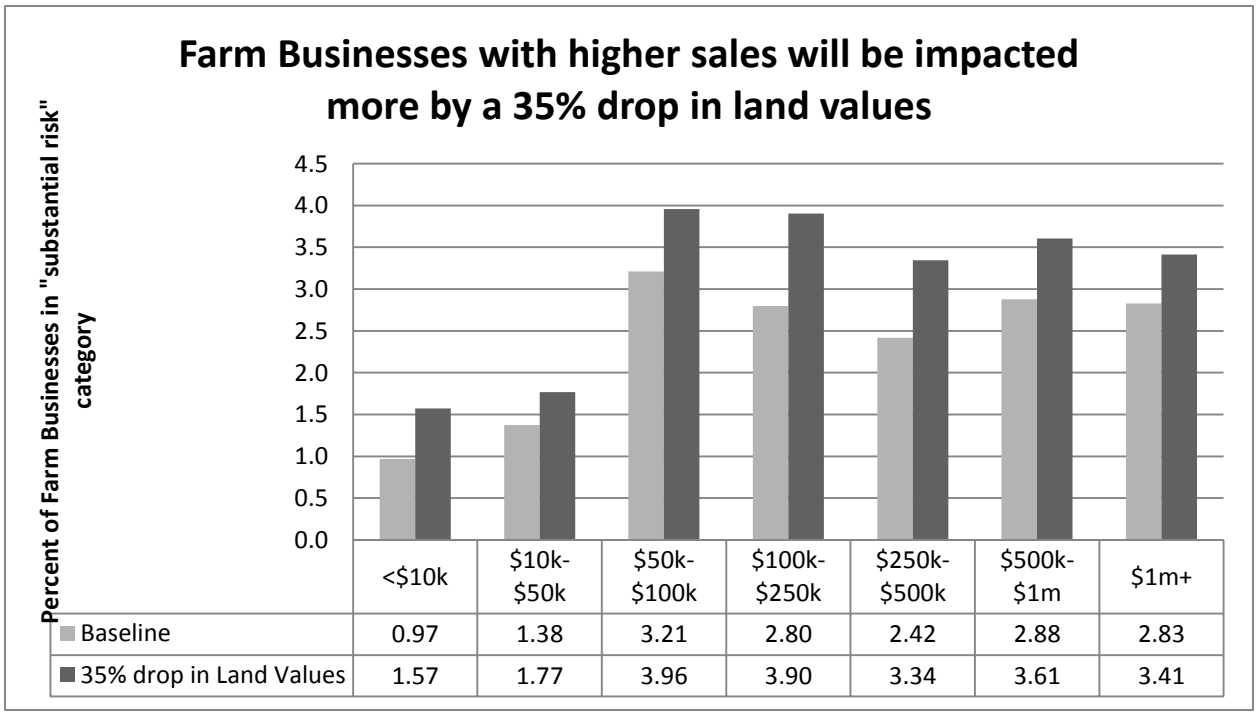


Figure 19: Farm Businesses with Debt/Asset > 30%, Baseline vs. 35% drop in land values



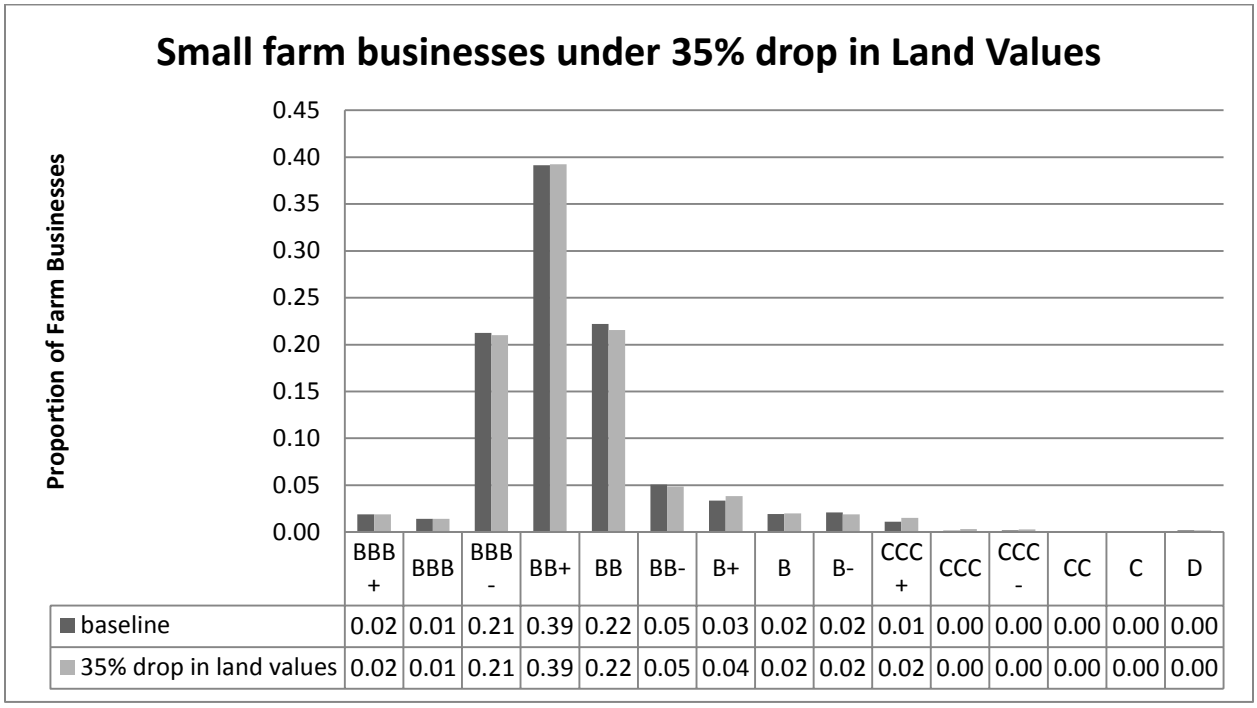
	BBB-	BB+	BB	BB-	B+	B	B-	CCC+	CCC	CCC-	CC	C	D
baseline	0.00	0.00	0.03	0.13	0.29	0.17	0.21	0.12	0.02	0.02	0.00	0.00	0.02
35% drop in land values	0.00	0.00	0.02	0.08	0.27	0.19	0.20	0.16	0.03	0.02	0.00	0.00	0.02

Figure 20: Percent of Farm Businesses with "Substantial Risk" Synthetic Credit Ratings: Baseline vs. 35% Drop in Land Values, by Sales



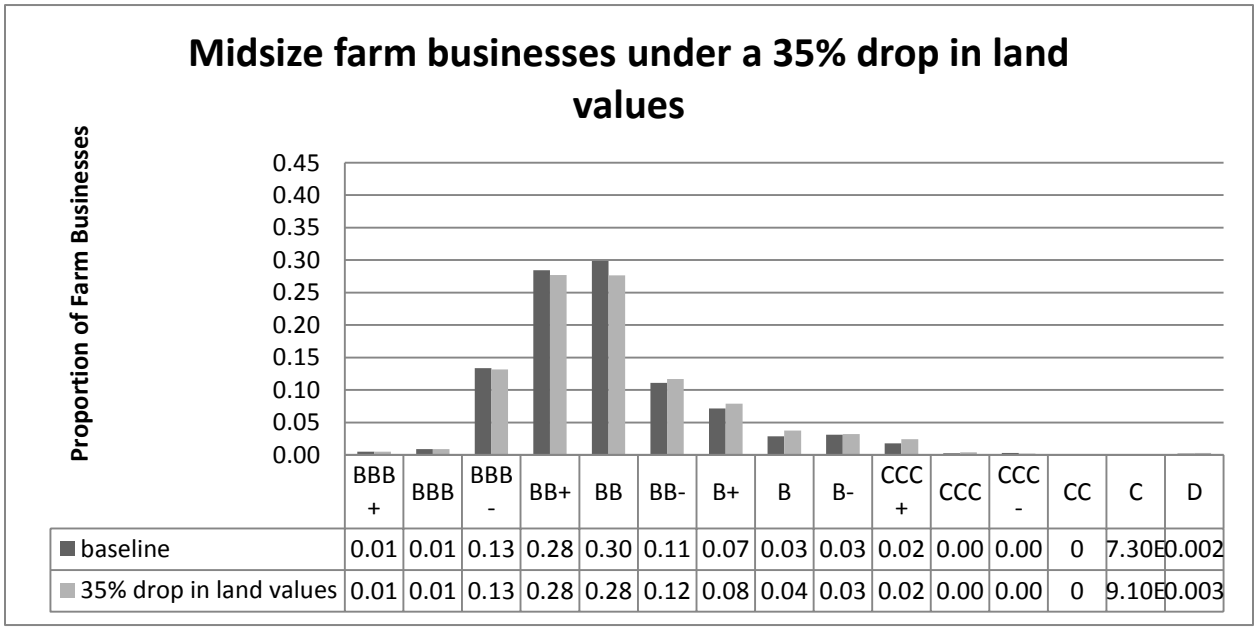
	<$10k	$10k-$50k	$50k-$100k	$100k-$250k	$250k-$500k	$500k-$1m	$1m+
Baseline	0.97	1.38	3.21	2.80	2.42	2.88	2.83
35% drop in Land Values	1.57	1.77	3.96	3.90	3.34	3.61	3.41

Figure 21: Farm Businesses with Sales < $250,000, Baseline vs. 35%Drop in Land Values



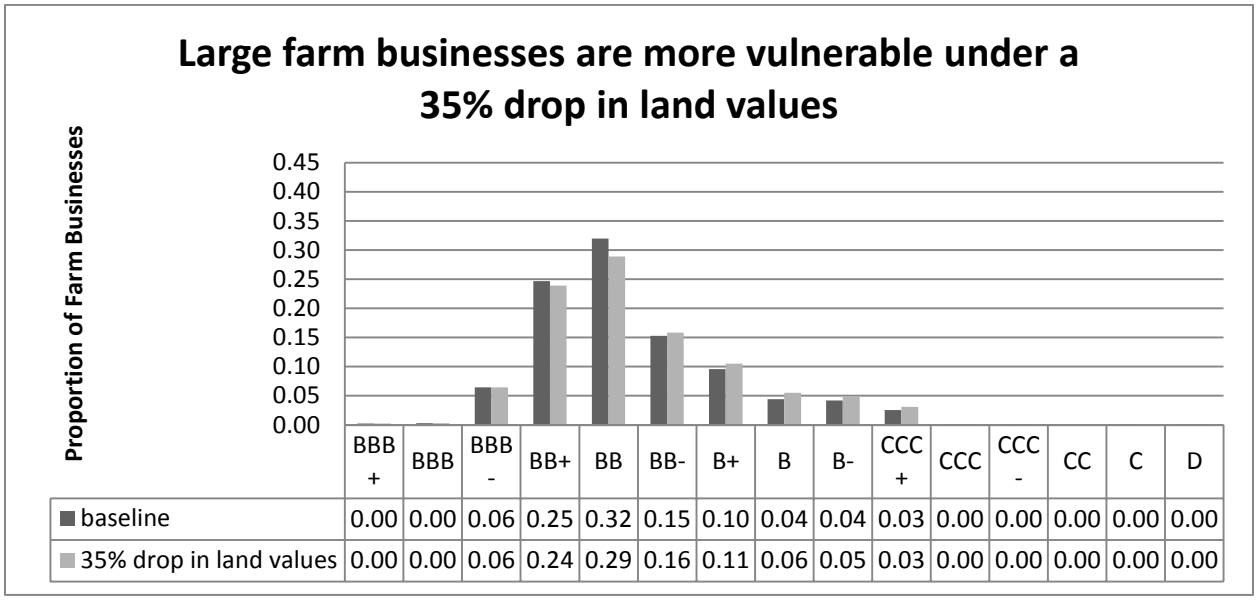
	BBB+	BBB	BBB-	BB+	BB	BB-	B+	B	B-	CCC+	CCC	CCC-	CC	C	D
baseline	0.02	0.01	0.21	0.39	0.22	0.05	0.03	0.02	0.02	0.01	0.00	0.00	0.00	0.00	0.00
35% drop in land values	0.02	0.01	0.21	0.39	0.22	0.05	0.04	0.02	0.02	0.02	0.00	0.00	0.00	0.00	0.00

Figure 21: Farm Businesses with Sales $250,000 - $1 million, Baseline vs. 35%Drop in Land Values



	BBB+	BBB	BBB-	BB+	BB	BB-	B+	B	B-	CCC+	CCC	CCC-	CC	C	D
baseline	0.01	0.01	0.13	0.28	0.30	0.11	0.07	0.03	0.03	0.02	0.00	0.00	0	7.30E	0.002
35% drop in land values	0.01	0.01	0.13	0.28	0.28	0.12	0.08	0.04	0.03	0.02	0.00	0.00	0	9.10E	0.003

Figure 22: Farm Businesses with Sales > $1 million, Baseline vs. 35%Drop in Land Values



	BBB+	BBB	BBB-	BB+	BB	BB-	B+	B	B-	CCC+	CCC	CCC-	CC	C	D
baseline	0.00	0.00	0.06	0.25	0.32	0.15	0.10	0.04	0.04	0.03	0.00	0.00	0.00	0.00	0.00
35% drop in land values	0.00	0.00	0.06	0.24	0.29	0.16	0.11	0.06	0.05	0.03	0.00	0.00	0.00	0.00	0.00