# A Simple Model of Farm Bankruptcies

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**Abstract**

*We devise a simple empirical model of U.S. farm bankruptcies as a function of the lagged aggregate farm sector debt-to-asset ratio. Despite its simplicity, the model has very good explanatory power. We discuss, given the the current levels of debts and assets, the potential numbers of additional bankrupticeis that would result from shocks to farm asset values. We also present data on debt-to-asset ratios by farm size and discuss the implications of our results for different sized farms.*

## I. Introduction

The determinants of U.S. farm bankruptcies have been studied very little — we find only a single published journal article, employing a data sample ending four decades ago, on this subject. Perhaps this is due to the obviousness of individual bankruptcies resulting from increasing, and eventually unsustainable, financial stress. Nonetheless, there is no recent empirical work available to support quantitative estimates of aggregate farm bankruptcies, should such estimates be needed for policy analysis. In this brief report, we devise a simple model of U.S. farm bankruptcies using current data.

Our work is most closely related to that of Shepard and Collins, who modeled the farm bankruptcy rate (bankruptcies per 100,000 farms) for 1910 through 1978 as a function of net farm income, the contemporaneous debt-to-asset ratio, farm size, general business conditions, and levels of farm program payments [1]. Their general conclusion was that all of these variables other than farm program payments were important determinants of the bankruptcy rate.

We find two other items of related work. Less directly related to our current task, Antoni, et al., modeled the determinants of farm financial condition [2]. They did not model bankruptcies or the bankruptcy rate. That is, their dependent variable(s) were closely related to one of the independent variables in Shepard and Collins and in the present work. They found that farmer's age, operations size, business structure, years of operation, and farm type were all significant determinants of financial stress levels.

Recently, Katchova and Dinterman discussed influences on farm bankruptcies, although they did not present a quantitative model. [3]. They prepared visual evidence that delinquencies on ag loans, ag land values, and farm income all covary with farm bankruptcies.

We take a slightly different approach than the works above. We acknowledge the influence of variables like farm income, asset values, and loan delinquencies on the bankruptcy rate. However, we argue that variables such as income and asset values logically result in changes to debt-to-asset ratio, and that loan delinquencies are situated laterally to this ratio — both are indicators of farm financial vulnerability. We find that the debt-to-asset ratio, viewed at an appropriate temporal shift, neatly

summarizes information sufficient to predict the bankruptcy rate with very good accuracy. Indeed, we explain variation in the bankruptcy rate with this single explanatory very nearly as well as Shepard and Collins, who employed five explanatory variables.

We argue that a constructive approach to predicting the U.S. farm bankruptcy rate is to use the simple approach presented below, and employ additional calculations or modeling to determine the influence of other variables on the overall debt-to-asset ratio. For example, a policy analyst might model the effects of a policy change on aggregate farm income, and additional modeling could then determine the subsequent effects on the debt-to-asset ratio. Similarly, the effect of a shock to asset values on the bankruptcy rate can be inferred using simple calculations of the effects of that shock on the debt-to-asset ratio.

Perhaps somewhat unusually, we describe the data we employ before describing our model, as the strong empirical regularity in the data is a critical motivation for the model specification. We then describe the current sensitivity of the bankruptcy rate to changes in the debt-to-asset ratio, and then present data on how this ratio varies by farm size and the implications of that variation.

## II. Data

Current and historical US farm sector debt and asset data are from USDA-ERS [4]. The farm bankruptcy rate per 10,000 farms for 1987 through 1991 was taken from an ERS report on bankruptcies [5]. For 1992 through 2016, the bankruptcy rate was constructed from numbers of Chapter 12 bankruptcy filings in U.S Courts [6], and numbers of farms in the US taken from the U.S. Census of Agriculture data [7], where numbers of farms in non-census years were linearly interpolated and extrapolated from the numbers in census years.

These data are presented in Figure 1. Over many instances during the sample period, we observe shocks in the debt-to-asset ratio being followed by shocks in the same direction in the bankruptcy rate the following year. This prominent regularity motivates our empirical specification described in the following section.

We acquired U.S. and state-level debt-to-asset ratios by farm size (receipts) from ERS's Agricultural Resource Management Survey (ARMS) data [8]. We do not use these latter data in estimation, but do use them to infer the likely implications of the estimation results across farm sizes in the discussion section.

## III. Model

Given the close correspondence that is evident in Figure 1, a basic starting specification is a the bankruptcy rate as a linear function of the debt-to-asset ratio lagged one year. Additionally, we reason that farms with a higher debt-to-asset ratio are in a more precarious financial situation: an 1% increment to a debt-to-asset ratio that is already at 30% is likely to result in a greater increment to the likelihood of bankruptcy than a 1% increment to a debt-to-asset ratio that is only at 10%. We are therefore motivated to include the square of the lagged debt-to-asset ratio as an additional explanatory variable. We therefore pursue the specification

$$R_t = \alpha - \beta D_{t-1} + \gamma D_{t-1}^2 + u_t$$

where $R_t$ is the bankruptcy rate (number of bankruptcies per 10,000 farms) in year $t$ and $D_{t-1}$ is the debt-to-asset ratio in year $t-1$.

We initially estimate this model using OLS. The Breusch-Gofrey LaGrange multiplier test rejects the null hypothesis of no autocorrelation in the recovered OLS residuals with a p-value of less than 0.0001. We therefore employ the Prais-Winsten iterative procedure to fit the model with AR(1) errors. This produces the following fitted model.

$$R_t = 26.8 - 463.8 D_{t-1} + 2122.1 D_{t-1}^2 + u_t$$
$$u_t = 0.621 u_{t-1} + \epsilon_t$$

Standard errors for the fitted parameters $\hat{\alpha}$, $\hat{\beta}$, and $\hat{\gamma}$ are, respectively, 7.6, 96.7, and 301.4.

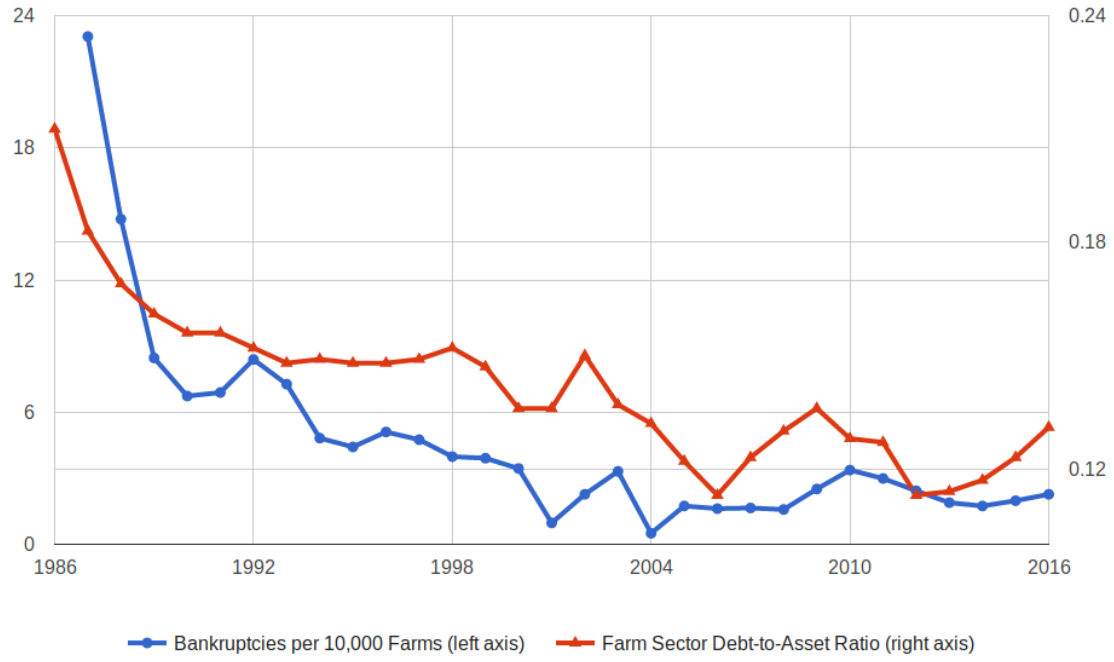


**Figure 1:** *U.S. Farm Sector Debt-to-Asset Ratio and Bankruptcies per 10,000 Farms*

All coefficients are statistically significant at the 1% level. The adjusted $R^2$ of the transformed model is 0.93. We cannot reject null hypotheses of no autorcorrelation (Breusch-Godfrey test p-value of 0.77) and no heteroskedasticiy (Breusch-Pagan p-value of 0.51) for the errors of the transformed model.

This model is intuitive and simple, minimizing the risk of over-fitting or misspecification. Given that it has very good explanatory power as is, we pursue no further embellishments. Sufficient justification exists for inclusion of dummy variables to excuse us from explaining some observations. For example, passage of the Bankruptcy Abuse Prevention and Consumer Protection Act of 2005 may have resulted in larger numbers of farm bankruptcies in 2006 and 2007 than would otherwise have occurred, due to relaxation of the requirements for Chapter 12 filings. Again, however, we prefer to keep the model simple and avoid over-fitting, rather than attempt to explain every wrinkle in the data and chase an even higher $R^2$.

## IV. Implications

Given the highly significant positive coefficient for $D^2_{t-1}$, we find that, indeed, the bankruptcy rate is increasingly sensitive to changes in the debt-to-asset ratio as leverage increases. We argue that this is a critical consideration for future policy analyses.

### i. Current Sensitivity of Bankruptcies to Asset Value Shocks

Starting from the 2016 level of the U.S. farm debt-to-asset ratio, a one percentage point increase in this value (from 13.1% to 14.1%) increases the bankruptcy rate by 1.13. This, combined with the current number of farms, implies an increase in of 231 bankruptcies. Due to the accelerating rate of bankruptcy as financial leverage increases, a 5% increase in the debt-to-asset ratio from the 2016 level is projected to increase bankruptcies by 2,016 — much greater than five times 231.

U.S. aggregate farm assets for 2016 were

**Table 1:** *Projected Increments to Farm Bankruptcies Due to Asset Value Shocks*

| Shock | Bankruptcies Increment |
|---|---|
| −1% | 26 |
| −5% | 150 |
| −10% | 364 |

$2,868 billion, while aggregate farm debt was $376 billion. Assuming various magnitudes of negative shocks to farm asset values and holding the debt level constant at the 2016 level, we project increments to farm bankruptcies (above levels that would otherwise have prevailed) that are shown in Table 1.

## ii. Implications of Results Across Farm Sizes

We do not have data for bankruptcies by farm size. However, Table 2 presents debt-to-asset ratios for U.S. farms by their size, measured in terms of gross receipts. The data clearly reveal that there is a tendency for larger farms to be more highly leveraged. The motivations for accommodating an increasing sensitivity of the bankruptcy rate to the debt-to-asset ratio as it rises in our aggregate U.S. model arises from the logic of such a phenomenon applying at the individual farm level. We therefore expect, given our results, that a change in debt-to-asset ratios that affected all farms equally would produce changes in bankruptcies that would disproportionately affect large farms.

The 2012 Survey of Agriculture identified approximately 1.86 million farms in the U.S. with receipts of less than $250,000, and about 79,000 farms with receipts of $1 million or more. These smaller farms have an average debt-to-asset ratio of less than 10%, and would likely be experience few bankruptcies as a result of an increase in the ratio. The large farms have an average ratio more than double that of the small farms.

We expect that any widespread asset price shock, such as a diffuse decline in land values, would result in large numbers of bankruptcies among the small number of large farms, particularly those with greater levels of debt. Large farms with low debt would likely be the survivors in the best position to benefit from the resulting industry consolidation.

Again relying on the 2012 Survey data, we see that states with relatively large proportions of large farms (equal to or greater than around 8% of each state's total) and small proportions of small farms include North Dakota, Nebraska, California, Arkansas, and Iowa. Again, we would expect such states to be disproportionately affected by a general increase in debt-to-asset ratios.

## References

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**Table 2:** *U.S. Farm Debt-to-asset Ratios by Farm Size*

| Receipts | Debt-to-asset Ratio (2015) | Percent of Farms (2012) |
|---|---|---|
| $1,000,000 or More | 20.4% | 3.8% |
| $500,000 to $999,999 | 15.9% | 3.6% |
| $250,000 to $499,999 | 12.0% | 4.5% |
| $100,000 to $249,999 | 10.5% | 6.6% |
| Less Than $100,000 | 7.0% | 81.6% |

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