Land Price Forecasts with a Capital Asset Valuation Model

Robert W. Dubman, Gregory Hanson, and Utpal Vasavada

Proceedings of
Regional Research Committee NC-161

FINANCING AGRICULTURE IN A CHANGING ENVIRONMENT: MACRO, MARKET, POLICY AND MANAGEMENT ISSUES

Denver, Colorado
October 6-7
1987

Department of Agricultural and Applied Economics
University of Minnesota
St. Paul, MN 55108
March 1988

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FOREWORD

This study offers results that are preliminary in nature. Initial treatments of this topic (Gabriel; Hanson, 1986) succeeded in generating discussion. The objective of this report is to further clarify both the problems and potential advantages of the "simple" asset capitalization model.

INTRODUCTION

Forecasting the direction of land prices changes is an important activity in an agricultural sector with real estate comprising nearly three quarters of all farm business assets in 1987. An accurate forecast ability in 1970 would have enabled an astute investor to handsomely share in the 300 percent increase in farmland values between 1970 and 1981 (from $180 to $730 billion, USDA, Economic Indicators of the Farm Sector). Conversely, a high degree of forecast precision would potentially have shielded the astute investor from the 30 percent decline in land values between 1981 and 1986.

For farm lenders, the importance of reliable forecast techniques can be as critical as it is to the farmer relying on agriculture as a major or sole source of income. Farm lenders are likely to experience farm debt write-offs of about $20 billion between 1984 and the end of the 1980's (Hanson, 1987). A substantial share of these losses could have been avoided had the underlying, long-run collateral value of land been projected with improved accuracy. In addition to the thousands of farmers that have suffered foreclosure because they were unable to service debt on "high-priced" late 1970's farm land purchases, large numbers of agricultural banks have also lost their capital base and been forced to merge on cease operations. The cooperative Farm Credit System is now desperately struggling to reorganize in order to survive multi-billion dollar loan losses and a $35 billion decline in its farm loan portfolio.

In spite of the fundamental importance of reliable land value forecasts to producers, investors and lenders, it is not apparent that our modeling efforts significantly advanced our econometric ability to sort out land price forecast issues prior to the early 1980's land market collapse. Several recent studies, notable for

Agricultural Economist, Section Leader, and Visiting Economist, U.S.D.A., Economic Research Service, Washington, D.C.

their creative approach to the issue, as well as for their thorough statistical treatments, may do so (Barry, Burt, and Featherstone and Baker). This study offers a modest, more limited approach to the issue based on an interesting statistical relationship and the perspective that data limitations are perhaps more of a problem in estimation than is often perceived.

THE ASSET CAPITALIZATION RELATIONSHIP

In a riskless taxless stationary state equilibrium, it can be shown that the ratio of debt (D) to assets (A) would equal the ratio of interest (Int) to Income before interest (Inc):

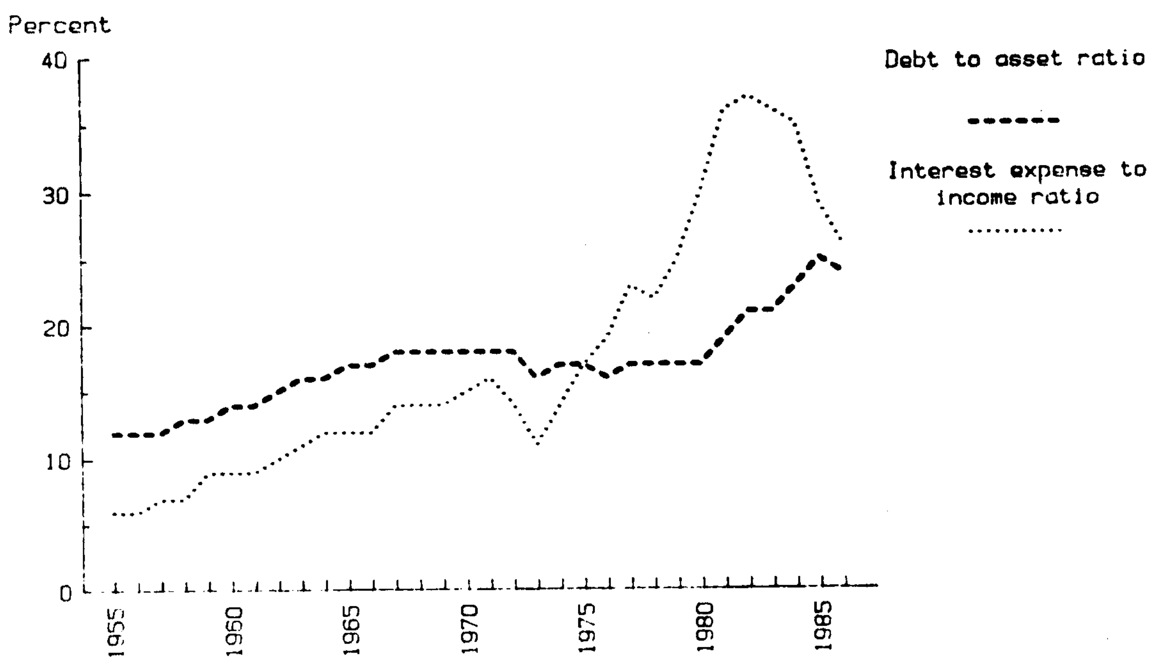
(1) $A = \frac{Inc}{r}$ (r=interest rate or returns rate)

(2) $\frac{A}{D} = \frac{Inc}{Int}$ (multipying by 1/D)

(3) $\frac{D}{A} = \frac{Int}{Inc}$ (inverting)

Gabriel observed that an overlay of the trend in debt to assets against interest to income suggests a long-run correlation does exist between these two series (figure 1).

Figure 1. Debt/asset and interest expense/income ratios, 1955-1986

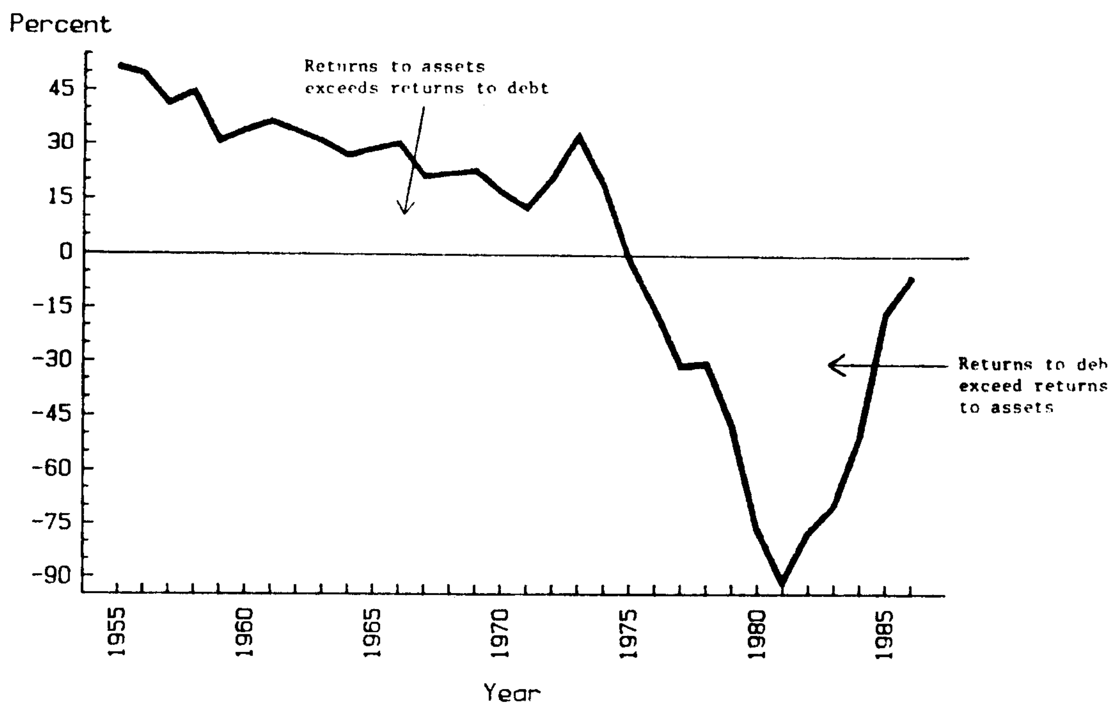


Another way to view this relation is that should the rate of return to assets exceed the the interest rate, more debt capital would be demanded by producers recognizing the benefit of financial leverage:

$$(4) \quad \frac{Inc}{A} = \frac{Int}{D}$$

This process would eventually ensure that the rate of interest would approximate the rate of return to assets as diminishing marginal returns to capital use occurs, or as the marginal cost of capital is bid up through the supply/demand process. Between 1955 and 1975 this equilibruum adustment process seemed to be occurring (figure 2).

Figure 2. Percent differences in debt/asset and interest/income ratios, 1955-1986.



Percent differences are the sum of debt-to-asset ratio less the interest-to-income ratio divided by the debt-to-asset ratio.

THEORY AND DATA ISSUES IN THE SIMPLE CAPITALIZATION APPROACH

Melichar has pointed out how several major adjustments to the income series would be necessary before it can be viewed to adequately represent a key component of the asset capitalization process. For example, the opportunity cost of unpaid labor and management ought to be deducted from net income. Inventory adjustments, depreciation, and adjustment for the net rental income of non-operating landlords ought also to be factored into the income series. Other imputations, such as a return to equity in operator dwellings, could also be made.

However, these estimates, imputations and adjustments can typically be complex. For example, determining the true economic rate of depreciation and appropriate discount factors to use in deflating data series, can be very difficult. The data available to use in this adjustment process may also be less than ideal. This can be illustrated with unpaid operator hours. Enterprise budgets would suggest about 3 billion hours of such labor would be consistent with sector production levels. Two large surveys (USDA and BLS) suggest about 6 billion hours are used. Sorting this issue through, in a Sector where two of every three producers tends to be part-time (or of noncommercial size), is not an easy task. While it would be comforting to assume that each economic data series emmanating from USDA is highly accurate, that is a luxury that at this time cannot be justified. Those of us that participate in the income estimation process continue to be very concerned about the quality of our estimates and the data bases that comprise the foundation for our many economic series.

A CASE FOR A SIMPLIFIED APPROACH TO THE CAPITALIZATION PROCESS

A capitalization formula that is theoretically robust would include a risk premium parameter, be on an after-tax basis, and be operationalized with observable data. These data would be available for the subset of commerical size farms in the Sector which would tend to display more homogeneous behavior. Other factors that could explicitly be represented in the formula would be credit rationing behavior of lenders, and changes in institutional policies of FmHA, FCS and bank regulations (Regulation Q). Technological change, farm size, savings rates, the availability of off-farm income and flexibility of loan terms (variable interest rates, lines of credit, etc.) would also be candidates for the econometric estimation process.

This study pursues an alternative estimation approach based on the following core components: use of the most elemetary capitalization model, employment of a very limited number of data series, and use of the vector autoregression model which permits a less "structured" approach to the estimation process. One can briefly summarize this approach as follows:

- The correspondence between the trends in debt to assets and interest to income sugeest an underlying statistical relationship that is not spurius. The asset capitalization forumla provides a theoretical underpinning for these series.

- Explicit modeling of the actual capitalization process is notably difficult due to the complexities of taxes, discount factors, changing attitudes toward use of debt and savings, technological changes, the increasing use of purchased inputs, increasing farm size, changes in the behavior of credit and regulatory institutions increased reliance on off-farm income, etc.

- Deductions in financial data bases available in agriculture, and the concerns regarding the precision of imputations for unpaid operator inputs, depreciation, etc., suggest use of an estimation process based on a bare minimum of observable data.

- Use of a small number of data series in a less structured system (high reduced form equations) may be consistent with vector autoregression estimation techniques.

METHODOLOGY

The major goal of this technique is to provide a method of forecasting the value of farm assets. Vector autoregression (VAR) methods were developed to defer specification problems inherent in most macro models (Sims). The VAR model consists of each endogenous variable regressed against all other variables lagged for all periods. In this way spurious restrictions on the model needed for identification are avoided. An example of such a restriction might be the omission of a independent variable from one but not all of the equations. Estimation of the VAR model is relatively simple, involving ordinary least squares on each equation.

A two equation VAR model was estimated along with a standard autoregressive model for the asset equation. The form of the VAR model was:

$$[1-a_{11}L-a_{21}L^2...-a_{n1}L^n](DEBT/ASSET)_t+[b_{11}+b_{21}L^2... +b_{n1}L^n](INTEREST/INCOME)_t=e_{t1}$$

$$[a_{12}L+a_{22}L^2...-a_{n2}L^n](DEBT/ASSET)_t+[1-b_{12}+b_{22}L^2... +b_{n2}L^n](INTEREST/INCOME)_t=e_{t2}$$

where L is a lag operator, n was four years, e_{ti} were error terms, and a_{ii} and b_{ii} were the parameters to estimate.

For comparison, alternative models were estimated using traditional atuoregressive models. In these models the difference between the DEBT/ASSET ratio and the INTEREST/INCOME ratio was the dependent variable. This difference is termed the disturbance factor and represents all factors that separate the two ratios. The factors include growth over time, farm size, increased production efficiency, risk, and other factors that influence asset values. Another variable was included which represents the proportion of installment credit used by consumers. This variable is an attempt to measure the increasing sophistication in consumer credit terms. Increasing credit creativity has been noticed in the consumer market. For example, variable interest rates have become more common lately.

One model was autoregressive in the independent variables such that:

$$DF_t = a + \sum_{n=1}^{4} a_n(\text{DEBT/ASSETS})_{t-n} + \sum_{n=1}^{4} b_n(\text{INTEREST/INCOME})_{t-n} + \sum_{n=1}^{4} c_n(\text{CREDIT})_{t-n} + e_t$$

The final model was autoregressive in the error term such that:

$$DF_t = a + a(\text{DEBT/ASSETS})_{t-1} + b(\text{INTEREST/INCOME})_{t-1} + c(\text{CREDIT})_{t-1} + e_t$$

and $e_t = f(e_{t-1}, e_{t-2}, e_{t-3})$. In both models above a, b, and c are the parameters to estimate.

RESULTS

Several parameter hypothesis tests are necessary for the estimation and interpretation of a vector autoregression model. As a preliminary step the finite lag length must be determined to have an estimatable model. A sequential series of tests starting with the longest plausible lag length and decreasing to shorter lengths was used in this study. Limited observations are the major empirical constraint. The terminal lag length for the DEBT/ASSET equation was determined to be four years. This was the longest length for both equations. Thus, the lag length for the entire model was set at years. Extending the lag length for the remaining equations kept the observations equal between equations. Extending a lag length is preferable to shortening the length which may introduce bias into the estimates.

An interesting occurence in the VAR model (table 1) is that the effect of some variables lagged four years was significant while a shorter length was not. A possible explanation for this may be found in Featherstone and Baker. They found that asset values are influenced in a delayed fashion with shorter lags possibly having a less significant influence than longer lags. Thus, a "bubble" effect may be present in the determination of asset values.

Causality tests are also possible on the VAR model to determine the simultaneity of the system (Harvey). In particular F tests on each equation were calculated to determine if lagged values of DEBT/ASSETS predict INTEREST/INCOME and if the reverse also holds. The F test value that DEBT/ASSETS causes INTEREST/INCOME was $F_{4,19}$= 17.401. This value was significant at the .05 level indicating statistical support for the hypothesis. The reverse that INTEREST/INCOME causes DEBT/ASSETS was also significant at the .05 level with $F_{4,19}$= 4.094.

A further test of the independence of the two ratios was achieved with a cross equation F test. This resulted in an $F_{8,38}$= 3.601 which was again significant at .05 level. Thus, the two ratios might be jointly dependent.

The DEBT/ASSET ratio was estimated more precisely than the INTEREST/INCOME ratio as judged by the R-squared and the root mean squared error (RMSE). As shown in figure 1, the INTEREST/INCOME ratio was voltile over time while the DEBT/ASSET ratio showed a steady increase. Thus, the INTEREST/INCOME ratio may have the stronger influence on asset values.

Table 1. Vector autoregressive results with debt to assets and interest to income ratios as dependent variables.

Variable	DEBT/ASSET	INTEREST/INCOME
INTERCEPT	0.035*	0.099
DEBT/ASSET-1	-1.822*	0.736
DEBT/ASSET-2	0.765	0.284
DEBT/ASSET-3	-0.449	0.272
DEBT/ASSET-4	0.877*	-0.588
INTEREST/INCOME-1	1.154*	0.097
INTEREST/INCOME-2	-0.077	-0.085
INTEREST/INCOME-3	0.086	-0.048
INTEREST/INCOME-4	-0.015*	0.146
R-SQUARE	0.971	0.957
RMSE	0.00614	0.02388

The two single equation autoregressive models also suggested good predictive behavior (table 2). The autoregressive in variables model was a more precise predictor of the disturbance factor. The disturbance factor roughly corresponds to figure 2. Thus, the VAR models and the two autoregressive models were not directly comparable.

Table 2. Two autoregressive models with the disturbance factor as the dependent variable: one autoregressive in the variables and one autoregressive in the error term.

Variable	Autoregressive In Variables	Autoregressive In Error Term
INTERCEPT	0.803*	0.307*
DEBT/ASSET-1	-1.086*	1.741*
DEBT/ASSET-2	0.705	
DEBT/ASSET-3	-0.823	
DEBT/ASSET-4	0.242*	
INTEREST/INCOME-1	-0.591*	-0.774*
INTEREST/INCOME-2	-0.114	
INTEREST/INCOME-3	-0.062	
INTEREST/INCOME-4	-0.304*	
CREDIT-1	-0.791	-0.723*
CREDIT-2	-0.843	
CREDIT-3	-0.701	
CREDIT-4	-0.194	
R-SQUARE	0.965	0.943
RMSE	0.01814	0.01908

Conclusions

The purpose of this project was to investigate a relatively simple method of forecasting land prices based on a minimal amount of data imputations. Vector autoregressive techniques were applied to keep in the same spirit of simplicity of assumptions. The relationship between the debt to asset ratio and interest to income ratios over time has been empirically observed to correspond to asset values. This is strikingly noticeable for the period after 1975 when asset values declined and for 1986 when asset value appear to be increasing. These ratios should mathematically be equal at equilibrium; however factors in the economy have separated them over time. This disequilibrium was used to explain the change in asset values over time.

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