Factors Affecting Demand and Supply of Agricultural Real Estate Debt

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A market share analysis is undertaken to determine the contribution of the size of market effect, the distribution effect, and the competitive effect to gains for the five major farm real estate lenders. Results are used as a basis for selection of variables for a demand-supply analysis. Separate demand and supply equations for new farm real estate debt over the 1951–81 period are estimated by three-stage least squares for three major lending groups. The results are used as a basis for simulation of Federal Land Bank supply response to selected policy changes. If current market conditions continue through 1990, FLB market share is expected to decrease 12.34 percent over the 1987–90 period. Higher FLB interest rates would decrease FLB new loans sharply.

Key words: agricultural debt, financial institutions, market shares, real estate, supply/demand system.

Agriculture has become increasingly reliant on external sources of credit, in part because of the continued substitution of capital for labor and the need to finance larger amounts of capital. Outstanding farm real estate debt has increased dramatically in recent years. Market shares of the major lenders supplying this debt have changed considerably. Individuals and others have traditionally held the largest share of this market; however, over the last several years, the Federal Land Bank (FLB) has become the leading supplier of farm real estate credit. The purpose of this paper is to determine factors affecting net changes in farm real estate debt owed to the major lenders.

Previous research on the farm mortgage (real estate) loan market has focused on the simultaneous determination of supply and demand within the context of a single market. This analysis considers simultaneity resulting from interactions among lending institutions. The overall objective of the paper is to analyze the demand and supply of agricultural real estate debt associated with the major lenders—Federal Land Bank, banks and life insurance companies, Farmers' Home Administration (FmHA), individuals and others. Supply and demand relationships will be estimated using recent historical data and then used to project future market shares under selected scenarios.

The paper integrates three research efforts—market share analysis, econometric demand and supply analysis, and policy analysis. Therefore, a description of the paper's organization is warranted. In the next section, market share analysis is used to determine components of gains in farm real estate debt held by major lenders over selected periods. Results from the market share analysis are very informative by themselves, but they are further used to select variables to be included in the econometric demand and supply analysis. The second major section, which analyzes the demand and supply for farm real estate debt, includes three components—conceptual framework, data and estimation procedure, and estimation results. The third section uses these estimated demand and supply relationships to analyze a proposed policy change affecting the Federal Land Bank's lending authority. The final section contains a summary and discusses conclusions drawn from the analysis.

Market Share Analysis

Several studies have utilized market share analysis to explain how markets have changed

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through time (Richardson; Rigaux; Sirhan and Johnson; Sprott). Market share analysis shows whether a gain or loss in a market was due primarily to a size-of-market effect (resulting from a change over time in the size of the market), a distribution effect (showing a gain or loss in the overall market when shares in individual markets remain constant), or a competitive effect (revealing gains or losses in individual markets).

The effects for a particular lender are calculated using total amount of debt held by a lender in the beginning and end of each period and two different measures of potential debt held by a lender at the end of a given period. The first measure of potential debt assumes the same overall market share held at the beginning of the period, while the second measure assumes market shares in each region are equal to those prevailing at the beginning of the period (constant market shares). The size of market effect (SME) for a particular lender is calculated as follows:

$$(1) \qquad SME = \frac{L_{us}^{t}}{TD_{us}^{t}}(TD_{us}^{t+1}) - L_{us}^{t},$$

where L_{us} is actual debt held by a lender in the United States, TD_{us} is total debt of all lenders in the United States, t is the first year of the decade, and $t + 1$ is the last year of the decade. The first term in (1) is potential debt held by a lender at the end of the period, assuming the lender maintains a constant portion of total debt in the United States. The second term in (1) is actual debt held by the lender at the beginning of the period. The difference between these terms is the change in debt due to the change in the size of the overall market. The distribution effect (DE) is expressed as

$$(2) \qquad DE = \sum_{i=1}^{n} \frac{L_i^t}{TD_i^t}(TD_i^{t+1}) - \frac{L_{us}^{t}}{TD_{us}^{t}}(TD_{us}^{t+1}),$$

where L_i is actual debt for a lender in region i, TD_i is total debt in region i, and the other terms are defined as above. The first term in (2) is potential debt at the end of the period, assuming constant market shares in all regions; the second term, which is potential debt assuming constant overall market shares, is identical to the first term in (1). The differences between the terms shows the change in debt due to differences in regional growth rates and the original market share in each region. The competitive effect (CE) is

$$(3) \qquad CE = L_{us}^{t+1} - \sum_{i=1}^{n} \frac{L_i^t}{TD_i^t}(TD_i^{t+1}),$$

where the first term is total actual debt for a particular lender at the end of the period; and the second term, which is potential debt assuming constant market shares in all regions, is identical to the first term in (2). This effect is due to differences in the competitiveness of the institutions. The effects may be positive or negative but when summed reflect the actual gain in debt for each lender over the period considered. This gain, as expressed by the sum of the three effects, is as follows:

$$(4) \qquad L_{us}^{t+1} - L_{us}^{t} = SME + DE + CE.$$

Data on farm real estate debt outstanding (by lender, 1 Jan.) was obtained for the forty-eight contiguous states for three decades over the 1951–81 period (USDA 1952, 1976; Farm Credit Administration 1981). State-level data are separated into three regional groups and aggregated to get totals for the West, North, and South. The western region includes the Pacific and mountain farm production regions; the northern plains, lake states, Corn Belt, and northeast compose the northern region; and the southern region contains the southern plains, delta states, Appalachian, and southeast farm production regions.

Components of gains for the major lenders over the three time periods are presented in table 1. These effects were calculated using deflated dollar values. The dominant effect in all three periods is the size of market effect. FLB and FmHA also experienced gains from competitive effect in all three periods, while other lenders generally experienced losses in the market because of this effect, especially in the final period. The distribution effect had relatively smaller impacts on actual gains (or losses) in all periods. This indicates that the differences in regional debt growth rates were relatively small given the original market share of the lenders in each region. Taking all three effects into account, each lender had actual gains in all three periods. The greatest gains occurred in debt held by individuals and others in the first two periods and FLB in the final period. This increase in market share for FLB coincides with the changes in the lending authority granted the FLB by the 1971 Farm Credit Act which increased the credit FLB can extend from 65% to 85% of real estate market value. The large gain by FLB caused by the

Table 1. Components of Gains in Farm Real Estate Debt Held, by Lender, Selected Periods, 1951–81

Components of Gain	Federal Land Banks	Farmers Home Administration	Life Insurance Companies	All Banks	Individuals and Others	Total
	($ Million)[a]					
1951–61						
Size of market	1,158.4	250.1	1,566.5	1,178.2	2,655.8	6,809
Distribution	−16.9	−3.3	−31.8	−56.2	108.3	0
Competitive	417.2	282.2	62.0	−647.2	−114.2	0
Actual gain	1,558.7	529.0	1,596.7	474.8	2,649.9	6,809
1961–71						
Size of market	2,119.3	601.5	2,483.5	1,324.7	4,167.8	10,697
Distribution	20.6	19.4	24.7	65.8	−130.5	0
Competitive	903.6	584.3	−1,204.6	−54.6	−228.7	0
Actual gain	3,043.5	1,205.2	1,303.6	1,335.9	3,808.6	10,697
1971–81						
Size of market	2,054.1	702.4	1,616.1	1,085.9	3,278.7	8,737
Distribution	−10.7	7.3	−57.3	26.0	34.7	0
Competitive	5,247.5	106.6	−1,447.1	−1,010.0	−2.897.0	0
Actual gain	7,290.9	816.3	111.7	101.9	416.4	8,737

[a] All dollar values are deflated by the CPI.

competitive effect suggests that FLB did respond to the increased lending authority.

In order to determine the importance of factors behind the size-of-market effect and the competitive effect, a demand-supply analysis is conducted. It is expected that own price (interest rate) and the interest rates offered by alternative lenders affect the change in farm real estate debt demanded from each lender. Because the distribution effect contributed relatively little to gains (or losses) for the lenders, regional variables are not included in the analysis.

Demand and Supply Analysis

Conceptual Framework

Demand and supply for farm real estate debt are analyzed in terms of factor-market equilibrium (see Henderson and Quandt). The criterion is to maximize the present value of the firm, defined as the integral of discounted future revenues less discounted future outlays. Levels of output and input are constrained by a production function relating flows of output to flows of input. Optimally, the firm should then maximize profit at each point of time in the usual way. The resulting long-run demand functions result in the same marginal productivity conditions for input and output as those obtained from profit maximization (see Jorgenson and Stephenson). The demand for an input is then a function of its price, the prices of all other inputs, and the price of output.[1] This is a derived demand because it depends on the price of output and is therefore derived indirectly from the demand for the output. The profit-maximizing price-quantity combination for an input must satisfy the condition that the value of the marginal product (VMP, or price of output multiplied by the partial derivative of the production function with respect to the input quantity) equals the price of the input. This analysis deals with a produced input rather than a primary input. Therefore, the supply function is the aggregate supply function of the firms producing the input. Market equilibrium is obtained when the quantity demanded equals the quantity supplied. The equilibrium price-quantity combination must also satisfy the profit maximization conditions where VMP equals price.

Demand and supply relationships are estimated for three groups of major lenders: (*a*)

[1] Since all interest rate and price data are deflated by the prices paid for production items index (*PPI*), the demand equations are normalized on prices of all other production inputs not included in the model.

Federal Land Bank (*FLB*), (*b*) banks and life insurance companies (*BLIC*), and (*c*) individuals and others (*IO*). The supply and demand for FmHA funds is not estimated because the quantity of FmHA direct loans is primarily determined by congressional appropriations and thus is unrelated to market forces. However, FmHA lending activities are accounted for through the use of exogenous variables.

Gross flows of aggregate farm mortgage debt have been analyzed (Hesser and Schuh 1962, 1963), as have net flows for selected lenders (Lins; Robison and Love). In this study net flows rather than gross flows are used to account for refinancing of existing debt. The dependent variable in the demand equation for each major lender is the annual net change in farm real estate debt outstanding on 1 January (including farm households). It is expected that the change in debt and interest rate are simultaneously determined, resulting in a positively sloping supply curve (see Hesser and Schuh 1962, 1963). Therefore, average interest rate on new farm real estate loans by each respective major lender and interest rates of the alternative major lenders are included in each demand equation as endogenous variables. The farm real estate market for credit is also affected by general economic/political conditions. These conditions are assumed to be captured in the model by including exogenous variables for industrial bond yield and inflation as measured by changes in the consumer price index (*CPI*). Other exogenous variables are price of output, the respective quantity of new loans lagged one year, quantity of new debt owed to FmHA, the stock of time deposits held by the farm sector, the value of farm real estate assets, and annual investments made by life insurance companies.

Restrictions are imposed on the demand equations to reduce the number of parameters to be estimated, thus conserving degrees of freedom and reducing multicollinearity problems. The restrictions are (*a*) the homogeneity condition, and (*b*) the Slutsky condition (also called the symmetry relation). These restrictions are derived from the input demand functions and specify relationships among demand elasticities. The homogeneity for the models may be stated,

$$(5)\quad E_{ii} + \sum_{j} E_{ij} + E_{io} = 0 \qquad [i = 1, 2, 3; j = i],$$

where E_{ii} is own-price elasticity, the E_{ij}'s are cross-price elasticities, and E_{io} is output price elasticity. This means that the substitution effect of an own-price change must be consistent with the cross- and output-price elasticities. Since the demand equations are normalized on all other production inputs not included in the model, the homogeneity condition is automatically maintained, and thus not applied directly on the system of equations. The Slutsky condition, which indicates the interrelationships among the cross elasticities, is written as

$$(6)\quad E_{ij} = \frac{R_j}{R_i} E_{ji},$$

where R_i and R_j represent the average expenditure on debt owed to sources i or j as a proportion of average total expenditure on debt owed to all sources, and E_{ij} and E_{ji} are cross elasticities.

The dependent variable in the supply equations, except for *FLB*, is the annual net change in farm real estate debt outstanding for the respective leaders. Interest rates in the supply equations for *BLIC* and *IO* are expressed in real terms as the ratio between the contract rates and the percentage change in the *CPI*. The supply equations for *BLIC* and *IO* include the respective quantity of new loans lagged one year, and the ratio between the yield on industrial bonds and the percentage change in the *CPI*. Including these variables on industrial bond yields and changes in the *CPI* reflects the macroeconomic variables generally believed to be important in determining interest rates. The stock of time deposits held by the farm sector, 1 January, and annual investments made by life insurance companies (*LIC*) are included as factors affecting the amount of loanable funds available to *BLIC*. The value of farm real estate assets (including farm households, 1 January) is expected to affect available funds for *IO* loans.

According to Robison and Love, the *FLB* supply curve can be considered perfectly elastic for given bond costs. This model specification assumes that *FLB* increases (decreases) new loan rates when bond rates increase (decrease). The dependent variable in the *FLB* supply equation is the average interest rate on new *FLB* farm real estate loans and is considered to be a function of the rate on industrial bonds, as expressed in the other two supply equations.

Two identities are needed to link interest

rates in the demand equations with those in the supply equations and complete the system. The identities provide feedback information on the jointly determined variables and express the basic structural relationships among the endogenous interest ratios and other variables in the system. These identities are:

$$r_t^{BLIC} = i_t^{BLIC} + \%CPI - PPI, \quad (7)$$

and

$$r_t^{IO} = i_t^{IO} + \%CPI - PPI, \quad (8)$$

where r_t^{BLIC} and r_t^{IO} are endogenous demand interest rates, i_t^{BLIC} and i_t^{IO} are supply interest rates, and *CPI* and *PPI* are the consumer price and prices paid for production items indexes, respectively. Because the model is in log-linear form, the identities take the form of (7) and (8), and all variables are expressed in logarithmic terms. The model, which includes six behavioral equations and two identities, is estimated simultaneously, with all interest rates and quantities, as measured by changes in farm real estate debt, being endogenous to the system.

Data and Estimation Procedure

The econometric demand and supply analysis covers the years 1951 through 1981 and relies on annual data for the United States. Data for the analysis were from American Council on Life Insurance, Robison and Leatham; USDA 1952, 1982, 1983 *Balance Sheet of the Farm Sector*; U.S. Department of Commerce *Statistical Abstract of the U.S., Survey of Current Business*; and unpublished ERS data. All figures are deflated to constant values using the *CPI* except production data (interest rates and output prices) which are deflated by the prices paid for production items index (*PPI*) which includes taxes and wages.

Interest rates in the demand equations are contract rates on new loans for the respective lenders. Interest rates in the supply equations for *BLIC* and *IO* are expressed as the ratio between the contract rates (endogenous variable) and the percentage change in the *CPI* (exogenous to the system). This formulation is adapted from a supply and demand model for U.S. agriculture presented by Yeh. The index of prices received by farmers for all commodities (*PRI*) is used as a proxy for output price. Time deposits held by the farm sector, investments made by *LIC*, and the value of farm real estate assets are included in the supply equations as measures of the quantity of loanable funds available.

Three-stage least squares (3SLS) estimation is applied to the system of demand and supply equations. This technique is used in order to account for the correlation between disturbances in the demand and supply equations. Each equation is specified as a linear relationship between logarithms with each endogenous and exogenous variable expressed in logarithmic terms. This specification provides for straightforward estimation of elasticities.

Estimation Results for Demand and Supply

Three-stage least squares estimation results for the restricted model are shown in table 2. All variables in the system have the theoretically correct signs except for the output price elasticity for *FLB*. The existence of multicollinearity among the interest rates resulted in large standard errors for some of these coefficients. Most of the parameters have standard errors less than the estimated coefficient, though they are not statistically significant at the .10 level or better.

The own-price (interest) elasticities of demand reported in table 2 indicate elastic demands for all loans with respect to own price (−2.8994, −3.3283, and −1.3093, respectively). All of the cross-price (interest) elasticities are positive. This positive relationship suggests that if one lender raises its interest rate then quantity of loans demanded from the other lenders increases as substitutes for the higher priced loans. A binary variable, to reflect the effects of the 1971 Farm Credit Act, was considered; however, inclusion of this variable did not improve results.

The industrial bond rate is significant only in the *FLB* equation. The *FLB* increases (decreases) new loan rates when bond rates increase (decrease). However, as bond rates increase (decrease) relative to own price (interest) for *BLIC* and *IO*, the supply of these loans decreases (increases). Estimated supply elasticities for *BLIC* and *IO* were not statistically significant, although both coefficients have the correct sign. Time deposits held by the farm sector and investments made by *LIC* were expected to have positive coefficients in the supply equation for *BLIC*. Time deposits enable banks to shift funds from investments in liquid

Table 2. Results for a System of Demand and Supply Equations for Farm Real Estate Debt, by Lender, 1951–81

	Estimated Coefficients		
	FLB	*BLIC*	*IO*
Demand:			
Constant	−.0179	4.6738***[b]	4.0794***
	(1.2228)[a]	(1.4319)	(1.0587)
Own price (interest)	−2.8994*	−3.3283*	−1.3093*
	(1.5522)	(1.3455)	(.6411)
Output price	−.3025	.2592	.2217
	(.7035)	(1.1322)	(.5111)
Quantity lagged	.9164***	.4506***	.4328***
	(.0919)	(.1365)	(.1265)
FLB cross price (interest)		1.9302*	.0543
		(1.0491)	(.5009)
BLIC cross price (interest)	2.9700*		.5661
	(1.6142)		(.6459)
IO cross price (interest)	.0849	.5744	
	(.7820)	(.6554)	
Annual change in quantity owed to FmHA	.0340	.0612	.1188**
	(.0745)	(.1289)	(.0515)
Supply:			
Constant	.9853***	.3532	−1.7074
	(.2935)	(1.6890)	(1.8198)
Industrial bond rate	.1317**	−1.4901	−.4113
	(.0561)	(.9954)	(.4097)
Own price (interest)		1.5421	.3607
		(.9877)	(.3965)
Time deposits held by farm sector		.3224	
		(.4613)	
LIC investments		.3695	
		(.2212)	
Value of farm real estate assets			1.1008***
			(.3718)
Quantity lagged		.5376***	.4034***
		(.1243)	(.1448)
Weighted *R*-square for system = .8586			

Note: All variables are deflated and are expressed in logarithms.
[a] Numbers in parentheses are standard errors.
[b] Single asterisk indicates significant at the .10 level; double asterisk indicates significant at the .05 level; triple asterisk indicates significant at the .01 level.

government securities to loans which are less liquid (Penson and Lins, p. 439). Funds acquired by *LIC* through life insurance policies are long-term commitments and are available to finance long-term investments, which include farm real estate loans (Penson and Lins, p. 491). These variables have the expected positive relationship with quantity of new loans supplied by *BLIC*, although the coefficients are not statistically significant. Individuals acquire farm mortgage loan funds from farmland sales under seller mortgages and land contracts (Lins). Therefore, as the value of farm real estate assets increases, so does farm real estate credit supplied by individuals. This relationship is reflected by the positive and significant coefficient on this variable. The estimated demand and supply relationships presented in this section will be used in the next section to analyze a proposed policy change.

Policy Analysis

The Farm Credit System (FCS) is a borrower cooperative, now supervised by the Farm

Table 3. Federal Land Bank Market Shares of Farm Real Estate Debt, 1986–90

Year	Continuation of Current Conditions	Raise FLB Interest Rates by 10%
	(%)	
1987	42.29	42.22
1988	40.55	40.35
1989	38.78	38.45
1990	37.07	36.62

Note: Exogenous variables are specified at 1985 conditions, with FLB interest rates set first at 1985 levels and then raised 10%.

Credit Administration (FCA), an independent government agency. The Federal Land Banks are the main organization in the FCS supplying long-term real estate loans to agriculture. Through congressional action, FmHA has been granted the authority to guarantee against default certain types of these loans. Federal Land Banks have the authority to make loans of up to 85% of the value of property taken as security; however, they can make loans of up to 97% of the value if guaranteed by a government unit, such as FmHA or a state government (Farm Credit Administration 1982, p. 26). The history and current supervision of *FLB* have led investors to believe that bonds sold by *FLB* are backed by the integrity of the federal government. Past public policies and the "quasi-public image of FLB" (see Robison and Love, p. 22) or "agency status" have helped keep interest rates low on *FLB* farm loans. With mounting deficits, the federal government is considering alternatives that would reduce the level of debt for which it is responsible. One possibility is to eliminate the authority of FmHA to guarantee FLB and certain other loans against default. Elimination of this authority and/or the "agency status" of *FLB* could result in fewer *FLB* loans to farmers (see Garcia) and higher interest rates on new *FLB* loans.

The demand and supply relationships presented in table 2 are used to simulate the responsiveness of *FLB* market shares to this proposed change in lending authority for the 1987–90 period.[2] Although it is uncertain exactly what the FLB supply response would be, it is possible to model the supply response over a range of values, as a means of sensitivity analysis.

Counterfactual simulation, which employs exogenous data not corresponding to actual data or model coefficients different from those obtained from empirical estimates, is used in this analysis. The supply-demand relationships are simulated over the 1987–90 period under two alternatives: (*a*) continuation of 1985 conditions and (*b*) increase FLB interest rates 10% above 1985 levels with other variables set at 1986 levels. Robison and Love used a similar approach in a study of changes in market shares held by *FLB*s and *LIC*s.

FLB market shares of farm real estate debt are simulated over the 1987–90 period for two levels of *FLB* interest rates. All other variables in the demand and supply model are held at their actual values for 1985. Under those conditions the model was simulated from 1986 through 1990 with allowances made for adjustments in lagged endogenous variables. Simulation results reported in table 3 indicate that under current conditions *FLB*'s market share of farm real estate debt is projected to decline 12.34% over the 1987–90 period. If *FLB* interest rates are increased 10% above current rates, then *FLB*'s share of new loans will decline sharply; however its share of total real estate debt will decline only moderately in the short run. With the 10% higher interest rates *FLB*'s market share of farm real estate debt would decline 13.41% over the 1987–90 period. This effect would likely be more pronounced over a longer period of time.

Summary and Conclusions

This paper has examined the role of major lenders in the market for farm real estate loans. Attention was focused on the Federal Land Bank, commercial banks, life insurance companies, and individuals and others in the United States. A market share analysis was reported as a means of describing recent changes in the market. Econometric demand and supply results indicated how this market operates. Then the econometric results were utilized as the basis for policy analysis of changes in the lending authority of *FLB*.

The market share analysis indicated that the size of market effect was the dominant com-

[2] Results presented in table 2 indicate the presence of multicollinearity, especially among the interest rates. However, an estimated model may predict well, despite the presence of multicollinearity (see Judge et al., p. 619). Since the purpose of the simulation is prediction, multicollinearity would not be expected to present a problem.

ponent of gain for all lenders over the 1951–81 period. The greatest actual gain for a lender was experienced by *FLB* in the 1971–81 period. This suggestion that *FLB* did respond to the increased lending authority granted by the 1971 Farm Credit Act. The market share analysis helped identify demand-related variables in the demand-supply analysis. Econometric results from the demand and supply model indicated that the interest elasticity of demand for own interest rates were −2.90 for *FLB*, −3.33 for banks and life insurance companies, and −1.31 for individuals and others. The lower interest elasticity value for *IO* indicated that *IO* borrowers were less responsive to changes in interest rates than borrowers from banks and life insurance companies or *FLB*. All cross-price (interest) elasticities among major lenders were positive as expected. The low level of statistical significance on some variables could be explained by multicollinearity problems, but this problem should not affect the simulation results of the policy analysis.

Possible impacts of changing the *FLB* lending authority by eliminating the "quasi-public image of *FLB*" were analyzed through simulation with an application of the estimated demand and supply model. Alternative *FLB* interest rates were included in the policy analysis to estimate the effects of the policy change on market shares of major lenders. These simulation results indicated the *FLB*'s market share is projected to decline 12.34% over the 1987–90 period with no change in interest rates. If *FLB*'s interest rates increase by 10%, then the decline in its market share over the 1987–90 period will be 13.41%.

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