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AN EMPIRICAL INVESTIGATION OF THE EFFECT OF RISK IN AGRICULTURE ON THE INTEREST RATE ON FARM CREDIT SYSTEMS BONDS

by

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Abstract

This study investigates whether projected returns to agricultural assets and the variability of such returns affect the yield spread between Farm Credit System bonds and comparable Treasury issues. Results based on a dynamic two-equation system linking measures of profitability in the agricultural sector to risk premia on FCS bonds indicate that the capital market does not take into account variations in agricultural returns.

Key words: risk premia, Farm Credit System bonds, autoregressive conditional heteroskedasticity.

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Increased levels of capital use in agriculture during this century offer a popular stylized fact in agricultural economics. During the post war era, real capital investment in physical assets has increased from 446.9 billion 1988 dollars in 1945 to 706.8 billion 1988 dollars in 1987. A high of 1,401.7 billion 1988 dollars was attained in 1980 (USDA). The equity to support this expansion has come from several sources: such as, retained earnings, equity investments from outside the sector, and borrowing. Agricultural debt shows a similar pattern of expansion along with the growth in physical capital. Agricultural debt on December 31, 1945 stood at 47.1 billion 1988 dollars. The debt had risen to 258.4 billion 1988 dollars in 1980 and has declined to 160.6 billion dollars in 1987.

A large share of that debt, especially during the 1970s and 1980s, has been provided by the Farm Credit System (FCS). In 1987, the FCS accounted for 27.4 percent of total agricultural debt (Walraven and Rosine), down from a peak of 34.1 percent in 1982. The FCS's share is larger for real estate debt, 47.3 percent, then for non-real-estate debt, 17.0 percent. However, the share of real estate lending by the FCS has declined steadily over the past two decades.

The FCS is an input cooperative that sells bonds on the capital market to raise funds for the farm sector. FCS bonds are sold on the federal agency market even though these issues are not explicitly guaranteed by the federal government. However, the federal agency status of the FCS may lead many investors to perceive an implicit guarantee on FCS bonds by the federal government. The existence or non existence of this perception is a primary focus in this study. If investors behave in a way that is consistent with a guarantee, an implicit transfer of wealth may occur between the general economy and the farm sector. If investors act as if the government guarantees the bonds issued by the FCS, then the interest rate on FCS bonds will be lower than a corporation with the same riskiness. Thus, agriculture will receive an indirect transfer through this reduced cost of capital. The cost of this transfer is paid by the investor if the government fails to step in when adversity occurs in the farm sector. Alternatively, in the recent past, the cost of the transfer fell on the taxpayer as the federal government intervened to support the FCS.

The purpose of this study is to examine whether risk in agriculture affects the price spread between FCS bonds and other federal debentures. If the study finds no evidence of the effect of risk in agriculture on FCS bond prices, then evidence exists that the market perceives an implicit guarantee on FCS bonds. The next section presents a theoretical model linking expected agricultural returns and their riskiness with the premium on FCS bonds. Following this discussion the study describes the empirical

model, the data used, and the empirical results. Conclusions based on the findings are then presented with a brief discussion of implications.

Theory

In Hick's Value and Capital, he recognized the relative riskiness of an investment as a potential reason for different interest rates in the economy:

> The money rates of interest paid for different loans at the same date differ for two main reasons: (1) because of differences in the length of time for which the loans are to run, and in the way the repayment is distributed over time; (2) because of differences in the risk of default of the borrower.... When a borrower's credit is poor, people will not be prepared to pay the same price for his promise to pay certain sums in the future as they would do if the credit were good. (pp. 142-143).

Thus, according to Hicks, the value of a debenture issued by a poor credit risk is lower than the value of a similar instrument offered by a good credit risk. Another way to state the proposition is that a risky borrower pays a higher interest rate than a safe borrower, all other things held constant.

In theory, the linkage between risk and price is fairly well developed. Assets yielding the same return but possessing a different perceived risk provide different levels of economic well-being to consumers. Specifically, if an economic agent possesses a concave preference function, then that agent is risk averse, or prefers less risk to more risk. At this broad level most risk theorists, even those who question certain assumptions of the von Neumann-Morgenstern framework,

would agree. If two assets yield the same expected return, but different levels of risk, the consumer derives less economic well-being from the riskier investment. Alternatively, the marginal value of the riskier investment to the economic agent, and hence the maximum "bid" or offer price, would be lower.

Given that investors demand a higher return from bonds they believe have a higher probability of default, what determines the risk of default on FCS bonds? The FCS is a financial intermediary which raises money through bond sales and uses it to make loans to agriculture. The FCS is a single industry lender; it does not make loans to heavy industry, urban housing,[1] or other activities. Thus, the risk of bankruptcy or repayment problems for the FCS is related to the riskiness of domestic agriculture. Specifically, the repayment risk on FCS bonds should be a monotonically decreasing function of income in agriculture, and a monotonically increasing function of the variance of returns in agriculture.[2]

Other factors may also affect the riskiness of FCS bonds. The FCS is not simply a "pass through" for farm debt. It maintains a capital surplus account of its own. However, since its capital is invested in agriculture along with the debt it borrows, the value of its capital remains highly correlated with the riskiness of the farm sector. In addition, the FCS has control over the spread between its cost of capital and the interest rate at which it lends. Thus, the FCS may be able to enact a risk premium on its lending to remove some of the system's riskiness.

Therefore, according to the aforementioned factors, the interest rate for FCS bonds should be directly related to the riskiness of agriculture and inversely related to the profitability of agriculture. Two possible explanations would then exist for the lack of effect of the riskiness of agriculture on the interest rate: (1) superior management in the FCS limits the effect of agricultural variations on the system's repayment capacity, or (2) investors perceive that the federal government implicitly guarantees FCS liabilities. If the interest rate on FCS bonds is not related to risk in agriculture because of superior management, no economic transfer between the general economy and agriculture is implied. However, if the interest rate is not related to risk in the farm sector because of a perceived government guarantee, then agriculture is being subsidized by the general economy.

Procedure

The empirical procedure used to estimate the effect of risk in agriculture on FCS bonds is similar to the procedure used by Shonkwiler et al. Specifically, this study uses an Autoregressive Conditional Hetcroscedasticity (ARCH) model proposed by Engel to estimate the conditional variance of projected agricultural returns. The projected variance is then used as the measure of risk in an equation to estimate the spread between the interest rate on FCS bonds and comparable maturity Treasury bonds.

Several measures of risk are presented in the literature. In the Capital Asset Pricing Models of Sharpe and Lintner the covariance of a particular investment normalized by the variance of the market portfolio, or the "beta", is used as a measure of risk. In Fruend's programming model, the variance of a particular investment is used as a measure of risk consistent with Markowitz's portfolio model. This study uses expected variance as a measure of risk. However, we recognize that others have proposed more complete measures such as Roll and Ross' risk factors used in the empirical version of the arbitrage pricing model.

The model estimated in this study can, therefore, be written,

$$(1) \qquad r_t^P = f(V_t^*, R_t^*)$$

$$V_t^* = P_v(\xi_{t-1}, \xi_{t-2}, \cdots \xi_{t-p})$$

$$R_t^* = P_R(R_{t-1}, R_{t-2}, \cdots R_{t-q})$$

$$\xi_t = R_t^* - R_t$$

where r_t^P is the risk premium on FCS bonds V_t^* is the projected variance of returns in agriculture, R_t^* is the projected returns in agriculture, P_v is the projection mechanism for variance described by Engle, ξ_t is the error in projection of R_t, and R_t is the actual return to agriculture in period t. Adapting a linear time series form of the model in equation 1, this study estimates

$$(2) \qquad r_t^P = \gamma_0 + \gamma_1 R_t^* + \gamma_2 V_t^* + \gamma_3 r_{t-1}^P$$

$$V_t^* = \alpha_0 + \alpha_1 \xi_{t-1}^2 + \alpha_2 \xi_{t-2}^2 + \alpha_3 \xi_{t-3}^2 + \cdots$$

$$R_t^* = \beta_0 + \beta_1 R_{t-1} + \beta_2 R_{t-2} + \beta_3 R_{t-3} + \cdots \xi_t.$$

Our discussion suggests that $\alpha_1 < 0$, and $\alpha_2 > 0$. Further, we are concerned with the stationarity of V_t^*.

If the process determining the rate of return in agriculture displays ARCH disturbances, it is possible to determine if risk in agriculture matters in determining the interest rate spread. Thus, if the hypothesis $\alpha_1 = \alpha_2 = \cdots = 0$ is rejected then the projected variance changes over time. If $\alpha_1 = \alpha_2 = \cdots = 0$ is not rejected, the effect of the variance in agricultural assets could collapse into the intercept term, α_0. Past results indicate that the rate of returns in agriculture do follow an ARCH process (Shonkwiler et al.). Further a test of $\gamma_1 = \gamma_2 = 0$ implies that the first two moments of expected agricultural returns have no affect on the FCS risk premia.

Data

The spreads between FCS bonds and government securities were derived from the Wall Street Journal. Specifically, the data were computed by the yield on the longest maturity FCS bond less the yield on a Treasury bond of equal maturity. The exact spread used was based on Federal Land Bank

Bonds from 1957 to 1979 and then switching to the system consolidated bonds until 1987. Since both FCS bonds and Treasury securities are equally affected by inflation no adjustment for inflation was made to the interest rate spread. The bond yields were collected for the fifteenth day of every month and aggregated into an average spread for each calendar year.

The rates of return to farm assets are computed from USDA data. The rate of return to agricultural assets results from cash income and capital gains on physical assets. Cash gains from each year and real assets were converted into 1987 dollars using the Personal Consumption Expenditures Component of the Implicit Gross National Product Deflator (PCE) from the United States Department of Commerce. Dividing cash income by total assets yielded the rate of operating income. Taking the logarithmic changes in the total value of real estate adjusted for inflation yielded the real rate of capital gains.[3] Adding the rate of operating income to the capital gains rate for real estate yields the total rate of income to assets.

Results

Standard time series techniques were first used to fit an autoregressive model to the agricultural returns series, R_t. An AR(1) model was identified using data from 1954 through 1987 and its squared residuals were analyzed to determine whether they followed an ARCH

process. A Lagrange multiplier test (Engle) that $\alpha_1=\alpha_2=\alpha_3=0$ was rejected at the .05 level, thus, suggesting a third order ARCH process.

This specification of the returns equation as AR(1) with ARCH(3) disturbances was estimated jointly with the risk premia equation (2) using full information maximum likelihood over the period 1957 through 1987. Maximum likelihood estimation yields consistent estimates of the standard errors of the calculated R_t^* and V_t^* in the risk premia equation, unlike two-step estimation methods (Pagan; Pagan and Ullah). Table 1 displays the results of the estimated model. Note that α_2 has a value of zero. This results from restricting all α_i to be greater than or equal to zero. The resulting α_i implies that the ARCH process is regular and covariance stationary. The Wald test for $\alpha_1=\alpha_3=0$ is rejected at a significance level of 15%. Thus, the variance or riskiness of the rate of return to agricultural assets is not constant over time is subject to some doubt.

The results indicate that the effect of expected rate of return on agricultural assets and projected variance of the rate of return on agricultural assets are not statistically significant in determining the spread between FCS bonds and the interest rate on treasury notes. The Wald test of the hypothesis $\gamma_1=\gamma_2=0$ yields a value of 2.396 with two degrees of freedom. Further, while the effect of expected returns on the interest rate spread has the expected sign, the estimated coefficient for the effect of variance on the interest rate spread does not have the anticipated sign. The only statistically significant slope parameter in the spread equation is lagged spread. Ignoring the returns measures, the

results suggests that the long run steady state solution for the spread is .6514, i.e. about a 65 basis point difference between FCS and comparable Treasury yields.

Conclusions

Since the results of this study indicate that the price on FCS bonds is not affected by variations in the riskiness of agriculture, we are left with the two possibilities. Either the management of the FCS is capable of removing the risk implicit in the sector, or investors believe in an implicit government guarantee. Recent history would suggest that the previous explanation is unlikely. Therefore, our results suggest that investors believe that an implicit guarantee on FCS bonds exists.

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Endnotes

[1]The FCS does make loans for rural housing, but its primary charter and the bulk of its lending activities remain commercial agriculture. However, for the purpose of this study the rural housing component is not a problem because the risk of lending for rural housing may be positively correlated to risk in agriculture.

[2]For example, assume that real returns in agriculture are normally distributed with mean μ and variance σ^2. The probability of the sector earning a return smaller than b can be computed

$$P[b|\mu,\sigma^2] = \int_{-\infty}^{b} f(X|\mu,\sigma^2)\, dX$$

where $f(\cdot)$ is the normal probability density function. Taking the derivative of this probability function indicates that

$$\frac{\partial P[b|\mu,\sigma^2]}{\partial \mu} < 0$$

$$\frac{\partial P[b|\mu,\sigma^2]}{\partial \sigma^2} > 0.$$

Therefore, defining b as that income where agriculture defaults on FCS bonds, the risk on FCS bonds declines with an increase in the mean and increases with an increase in the variance.

[3]Real assets were used to mitigate the problem of additional investments in non real assets.

Table 1. Estimated Coefficients of the Effect of Agricultural Returns on Interest Rate Spread.

Parameter	Coefficient	Std. Error
	Return to Agriculture	
β_0	0.0225	0.0102
β_1	0.7669	0.0959
	Variance of Returns to Agriculture	
α_0	0.0006	0.0003
α_1	0.1673	0.2101
α_2	0.0000	0.0000
α_3	0.6659	0.3961
	Interest Rate Spread	
γ_0	0.2270	0.0873
γ_1	-0.7096	0.4891
γ_2	-11.9430	13.2177
γ_3	0.6515	0.1729