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by

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Introduction

A recent report by Ahearn and Newton (2009) provides a timely summary of the obstacles that beginning and low-resource farmers continue to face as they attempt to enter U.S. agriculture. They find that, "beginning farmers and ranchers face two primary obstacles: high startup costs and a lack of available land for purchase or rent. Beginning farmers are less likely than established farmers to rent farmland. They are just as likely as established farmers to own all of the land they operate - although they own smaller acreage and are more likely to carry debt on their land. The most common way beginning farmers acquire land is to purchase it from a nonrelative, rather than inherit it or receive it as a gift" (pp. iii-iv). While the USDA has developed programs to assist beginning and low-resource farmers, some states have also enacted legislation that provides financial assistance to these farmers for the purpose of acquiring production assets.

The Rural Finance Authority (RFA) was established by Minnesota state law in 1986 to administer a program where state bonds are issued and their proceeds used to develop Minnesota's agricultural resources (Rural Finance Authority). Initially, the RFA was designed to help lenders and borrowers restructure loans that had become unsecured. However, since 1987, the RFA funds have been extended to assist beginning and low-resource farmers to acquire real estate. As farm land values have continued to increase, these higher prices have made it difficult for many beginning farmers to finance real estate purchases using significant proportions of debt financing, based on the net cash flow generated just by the land. Thus, farmers and lenders identified debt financing of land purchases as a potential "barrier to entry" for new farmers and an obstacle to the transfer of land from one generation of farmers to the next.

Two RFA loan programs have focused on the credit needs of beginning and low-resource farmers, the Basic Farmer Loan Program and the Seller-Assisted Loan Program. Under the Seller Assisted program the seller of a farm property funds a portion of the financing necessary for the sale. Due to the similarities of these two programs the RFA refers to the joint programs as the Basic/Seller-Assisted Loan (BSAL) Program. Through its involvement in rural credit markets, the RFA aims to improve access to credit among credit-constrained farmers. Since its inception, the BSAL has assisted 1,573 Minnesota farmers and provided about $87 million in loan funds.

The objective of this study is to investigate what effect this credit market intervention has on the performance and investment behavior of participating farmers, some of whom are credit constrained. No previous attempt has been made to rigorously evaluate the farm-level effects of the BSAL program.

Loan Program Characteristics

The RFA acquires a stake up to 45% of the total loan amount needed to finance the real estate investment at an interest rate below that of the primary lender, reducing the cost of borrowing and helping farmers to "cash flow" their operations. Through 2008, the maximum BSAL financing has been set at $200,000 with the cumulative effect that the borrower can borrow up to $440,000 when combining loans from both the RFA and a private lending institution. More than one loan could be acquired from the RFA as long as the total amount borrowed does not exceed $200,000 and the applicant stays within the selection criteria.

The BSAL program targets farmers who aim to become full time farmers. The application selection criteria used by the program excludes speculators and investors looking for tax advantages. These selection criteria are in place to avoid an over extension of credit or an extension of credit to entities that do not meet the State credit assistance eligibility guidelines.

The BSAL interest rate is determined by Minnesota's 10-year bond rate at the time the loan is issued. RFA program costs are funded through an interest rate deferential between the State bond rate and the farmer loan rate. With a low $50 application fee and farm lenders screening their clients for eligibility, nearly all BSAL applicants tend to qualify. The amortization period is flexible with 15, 20, 25, 30 and 35-year amortization periods. The RFA loan matures in 10 years after which the borrower is required to pay the remainder of the RFA loan (a 10-year balloon payment is required). The Minnesota bond is then repaid with the proceeds of the loan.

The BSAL program is the RFA's highest priority portfolio, and the RFA has in the past moved funds appropriated for other programs to the BSAL program. A limited number of loans have defaulted during 1995-2003 and in most cases the RFA recovered the full loan amount through the sale of the property. The RFA has established also a reserve fund to help it meet its responsibilities in times of high default rates.

According to RFA rules of eligibility a participant must:

- have a minimum down payment of 10%;
- be an individual who is a resident of Minnesota, a domestic family farm corporation, or a family farm partnership;
- have sufficient education, training or experience to succeed in the type of farming that they intend to practice;
- have a total net worth of less than $398,000 (2008 limit) indexed for inflation including the assets and liabilities of their spouse and dependents;
- have the financial need for a loan and the ability to repay the loan;
- agree to be the principal operator of the farm to be purchased and intend to make farming their principal future occupation;

- agree to consult with a local adult farm management instructor and enroll in a farm business management program approved by the Minnesota Commissioner of Agriculture for at least the first three years of the loan, if an approved program is available within 45 miles from the borrower's residence;
- agree to consult with a local Board of Water and Soil Resources office or the county Natural Resources Conservation Service; and
- agree to carry credit life insurance for the amount of the loan.

By reducing the exposure of the private lender to 55%, the RFA lowers the risk to the lender and makes it easier for the lender to approve the loan. A lender's decision to join the RFA program is voluntary and all lenders who are active in Minnesota are eligible to take part in the program. Lenders determine their own terms and conditions for their part of the BSAL contract and the RFA negotiates terms and conditions with each lender separately. The lender's part of the loan is financed with a higher interest rate and can have an interest rate of more that 4% above the RFA rate. Also, the lender has the option to increase the down payment percentage.

Credit constraints and rationing

Much of the previous economic literature on credit rationing has focused on the problem of identifying the factors that restrict access to formal sources of credit. Some research has discussed the negative effect of credit rationing on income and consumption levels (Zeller *et al.*, 2001) and others have evaluated the impacts on a farmer's ability to optimize profits and investments (Foltz, 2002). Most of these studies have been implemented using data from developing countries.

In the case of an investment Petrick (2005) identifies credit as "a means to enable investment by solving a liquidity problem" (p. 192). Thus, a credit constraint (presumably due to credit rationing by a lender) becomes a reason for observed underinvestment. We can also think of a potential borrower as being externally credit rationed if the borrower's demand for credit exceeds the available supply of credit at the market rate of interest. Thus, while a *credit constraint* is a capital resource limitation that a farmer faces and external *credit rationing* is the result of a lending decision, the impact on a farmer without adequate liquidity is the same - they both serve as impediments to capital formation.

Foltz (2002) suggests that credit constraints can have potentially two effects. A credit constraint (or reduced access to credit) restricts liquidity leading a farmer to use inputs only up to the level of available capital. The resulting suboptimal allocation of production inputs reduces profitability and produces a "profit-liquidity effect." Alternatively, a credit constraint can also limit the level of investment in capital assets and land. Forgoing these long term investments leads to an eventual decline in farm profitability and an "investment demand effect" is observed. Foltz finds evidence for the liquidity effect of credit access on farm profitability among Tunisian farmers, due to a suboptimal allocation of inputs. There is no observed effect of credit rationing on investment demand among these farmers, although there is a difference between the investment behavior of credit rationed and nonrationed farmers.

Lenders ultimately decide which clients will receive credit and how much they will receive. In each case the lending decision is based on the application of a set of rules or underwriting guidelines. These rules may take into consideration information about variables such as farm capital and/or farmer characteristics. Although some of these variables are unobserved, this approach helps us structure an empirical analysis of the credit rationing problem in the case of Minnesota's BSAL farmer participants. Farmers who participate in the BSAL program are selected using criteria that suggest they may have been credit rationed and/or they face credit constraints that prohibit capital investments. An implication is that, if BSAL participants receive sufficient credit to alleviate their credit constraint problem, an improvement will be made in their liquidity status sufficient to undertake the investment and they will be able to achieve higher levels of productivity and profitability.

Credit Rationing Model

The underlying hypothesis of interest in this study is suggested by Foltz. If a farmer is initially credit rationed, the opportunity to borrow will produce a switch between the rationed and the nonrationed credit regimes. If we measure the differences in the parameters of the estimated equations that predict the performance of the two types of farmers (rationed and nonrationed), we can assess the implied costs of credit rationing. The measures of performance might include farm profits (or revenues) or the level of farm investments undertaken. For example, with regard to farm productivity and profitability, we expect that credit rationed farmers will generate relatively larger increases in both if the credit constraint is alleviated.

Further, Foltz suggests that there are potentially two switching models. In the exogenous switching model we assume that any unobserved factors (e.g., farmer ability, farm assets) that influence profitability are also independent of the unobserved credit rationing effect. The alternative is an endogenous switching model where the unobserved characteristics of farm assets and farmer ability influence both the likelihood of being credit rationed and the increase in profitability that occurs once the credit constraint is alleviated. In this latter case, the problem is that endogeneity confounds the observed output effects with the effects of improving credit access. If one does not control for this form of endogeneity, the effects of removing the credit constraint will be overstated.

Using this approach Foltz defines a model where L^d( ) represents the farmer's loan demand function and L^s( ) represents the farmer's available loan supply function. Further, L^f ( ) is the formal loan supply function (loans from formal credit institutions) and L^i ( ) is the informal loan supply function (loans from moneylenders, family and friends). Using Foltz's notation (p. 231), we write

$L^d (R_f, K, \theta, u_d)$ loan demand function (1)

$L^s (R_f, K, \theta, u_s) = L^f (R_f, K, \theta, u_s) + L^i (R_f, K, \theta, u_s)$ loan supply function (2)

where R_f represents the formal credit market interest rate, K represents farm capital, and θ represents various observed farm/farmer quality characteristics. The u_d and u_s terms capture all latent (unobserved) qualities for the demand and supply functions, respectively. Since loan demand equals loan supply under credit market clearing conditions, we can write G* as the equilibrium excess demand for credit (where G is equal to loan demand minus loan supply).

$$G^* = L^d (R_f, K, \theta, u_d) - L^s (R_f, K, \theta, u_s) \quad (3)$$

Credit rationing occurs when credit supply is less than credit demand. Since G* is not directly observed we need a proxy for credit rationing. So, we define a binary variable G and set G=1 when G* > 0 (the farmer is credit rationed), but set G=0 when G* = 0 (the farmer is not credit rationed).

A linear equation can be written as $G^* = \gamma' Z + \varepsilon$, where Z represents a vector containing observations of farmer qualities which might be influencing credit availability and γ is a vector of underlying parameters. Then the probability of being credit rationed can be written as

$$\text{Prob}(G^* > 0) = \text{Prob}(\gamma' Z + \varepsilon > 0). \quad (4)$$

Here the random disturbance term (ε) is assumed to be normally distributed with mean zero and variance one. It represents the effects captured by the latent unobserved qualities (u) for demand and supply, respectively, and the random noise in the data. In (4) the probability that G*>0 (being credit-rationed) is modeled using a standard probit model. The probit estimation of credit rationing has a cumulative normal S-shaped distribution (Φ) when evaluated using the independent variables in Z. Given the underlying distributional assumptions the log likelihood function is written as

$$\text{Ln } G^* = \Sigma_{Gi=1} \text{Ln } \Phi_i + \Sigma_{Gi=0} \text{Ln } (1-\Phi_i). \quad (5)$$

The coefficients in the estimated probit equation measure the effects of the Z vector variables on the cumulative normal distribution and, thus, the effects of the underlying dependent variables on the probability that G=1 (the farmer is credit rationed).

Switching Regression Models

Following Foltz, let us denote the profit equations for the nonrationed and rationed groups as y^n and y^c, respectively. Then the expected farm profit equations can be written

$$E(y_i^c | G_i=1) = \beta'^c_y X_i + \eta'^c_y P_i + \delta^c_y L_i^s + E(\upsilon_i^{yc} | G_i = 1) \quad \text{credit rationed} \quad (6)$$

$$E(y_i^n | G_i=0) = \beta'^n_y X_i + \eta'^n_y P_i + \delta^n_y L_i^s + E(\upsilon_i^{yn} | G_i = 0) \quad \text{not credit rationed.} \quad (7)$$

In (6) and (7), G is the credit rationing indicator variable, X_i is a vector of farm/farmer qualities, and P_i and L_i represent the price and credit supply vectors, respectively. The term υ is a random variable that describes latent qualities of the farm and farmer that are not observed by the econometrician (Foltz). The effect of credit rationing is measured by comparing the estimated coefficients of the credit rationed group and the nonrationed group. The expectation is that the coefficients will be nonzero and $\beta^n \neq \beta^c$ and $\eta^n \neq \eta^c$. In this second-stage regression equation y represents the dependent variable as measured by profits, revenues, or investments.

Exogenous switching model

In the exogenous switching regression model we assume that all the independent variables are exogenous. Therefore,

$$E(\nu^c | G=0) = E(\nu^n | G=1) = 0 \quad (8)$$

where ν^c and ν^n are the random disturbance terms which are assumed to be uncorrelated with each other and with the error term. From this assumption Foltz shows that one can derive the exogenous switching regression model in (9) and (10)

$$y_i^c = \beta'^c X_i + \delta_y^c L_i^s + \nu_i^c \quad \text{credit rationed} \quad (9)$$

$$y_i^n = \beta'^n X_i + \delta_y^n L_i^s + \nu_i^n \quad \text{not credit rationed} \quad (10)$$

where X_i and L_i^s are as defined earlier, and the error terms (ν^c,ν^n) are assumed to be uncorrelated.

In this second stage regression the estimated β and δ coefficients are the marginal effects and they can be compared across the two credit regimes. The coefficient comparison establishes the effect of credit rationing where β_i^n - β_i^c equals the effect of credit rationing associated with the i^{th} variable and δ^n - δ^c equals the liquidity effect on profitability due to credit rationing, where it is expected that δ^n=0 for nonrationed farmers and δ^c >0 for credit rationed farmers.

Endogenous switching model

From an econometric perspective, endogeneity occurs when the latent unobserved effects are included in the random disturbance term (ν). These unaccounted-for effects cause ν^c and ν^n to be correlated with ε (the error term in the credit rationing probit estimation). This will result in inconsistent estimates of the independent variable coefficients. In order to account for these latent effects the assumption of exogenous independent variables is relaxed. As recommended by Maddala (1983) and shown in Foltz, the structure of the econometric model is analogous to the exogenous switching model but when compared to the exogenous model in (9) and (10) it includes an additional term to the correct for endogeneity.

$$E(y_i^c| G_i =1) = \beta'^c X_i + \delta^c L_i^s + E(\nu_i^c|\varepsilon_i > - \gamma' Z_i)\ E(y_i^c| G_i = 1)$$
$$= \beta'^c X_i + \delta^c L_i^s + \sigma_{c\varepsilon} \sigma_c \lambda(\alpha). \qquad \text{credit rationed} \qquad (11)$$

$$E(y_i^n| G_i =0) = \beta'^n X_i + \delta^n L_i^s + E(\nu_i^n|\varepsilon_i \leq - \gamma' Z_i)\ E(y_i^n| G_i = 0)$$
$$= \beta'^n X_i + \delta^n L_i^s + \sigma_{n\varepsilon} \sigma_n \lambda(\alpha) \qquad \text{not credit rationed} \qquad (12)$$

Thus, to account for endogeneity, the inverse Mill's ratio $\lambda(\alpha)$ is derived from the credit rationing probit equation. In (12) we expect ε_i to be ≤ 0 leading to an equation similar to the credit rationed model. The inverse Mills ratio $\lambda(\alpha)$ is included in both of the second stage OLS models (11) and (12) and the resulting models are expected to produce asymptotically normal estimates for the β^c and β^n vectors.

Due to the interrelationships of the underlying farm resource and farmer characteristics, endogeneity may be present in the regression analysis. Therefore, the switching regression model is expected to have inconsistent estimated coefficients. In a small sample application such as this (with less than 250 observations) a correction for heteroscedasticity is recommended

(Long and Erven, 1998). We use the HC3 method recommended by Long and Erven to correct for this inconsistency.

Data

In order to implement the econometric analysis, farmer mail survey data is used (Nel, 2006). The farmer survey was conducted among 838 farmers who participated in the BSAL during 1987-2004. Surveys that were returned with a signed disclosure agreement permitted access to additional borrower financial data in the RFA applicant files. One hundred and eighteen farmers released their RFA file data for this study and 82 farmers completed the survey. This represents a response rate of 9.7% (n=82) for completed surveys and 14% (n=118) for access to RFA file information. Although the whole population of BSAL recipients was surveyed, and the sample is not random, the survey respondents are found to be representative of all BSAL recipients according to their farm type (crop, dairy, hogs, and cattle) and location in Minnesota. To compile a consistent financial data set, farmers were asked for information from their IRS Form 1040 and the associated Schedule-F tax form. We included survey questions that identify farm capital assets, farmer characteristics, and credit rationing status at the time of the loan application.

Credit rationing proxy variable

This study modifies the methodology suggested by Foltz to be applicable to Minnesota farmers and the BSAL program. We define credit rationing similar to Foltz. Credit rationing occurs when a borrower does not receive the required operating and capital investment loans and has a willingness to pay a higher interest rate to obtain the required financing. Unlike the analysis developed by Foltz, where some Tunisian farmers may not have a demand for credit, the Minnesota farmers who participated in the BSAL all have an expressed demand for credit. Thus, we concentrate on three possible scenarios at the time an eligible farmer makes the BSAL loan application: 1) the farmer has insufficient operating and investment credit to enter farming, 2) the farmer has sufficient operating capital but lacks sufficient investment credit to expand, 3) the farmer has sufficient capital for the expansion investment, but is seeking better loan terms.

Therefore, to classify farmers entering the BSAL program into “credit constrained” and “not credit constrained,” a survey was conducted in which farmer participants were asked: “Could you have financed your real estate purchase in the year prior to your application, if the RFA program was not available?” The answer to this question signals the farmer’s perception of having sufficient credit available to make the real estate investment without the BSAL at the time of application. Thus, the farmer’s answer is used as a proxy for credit rationing, because it describes the farmer's ability to finance the real estate investment through commercial credit institutions without State assistance. Answering "no" indicates that the farmer could not acquire the necessary investment credit and, therefore, is credit rationed. In this case the credit rationed farmer is given a proxy variable RFN = 1, otherwise the nonrationed farmer is given RFN = 0.

This approach captures all three applicant scenarios and includes farmers who are eligible for the RFA program, but may have adequate capital for the planned investment. About 50% of the surveyed farmers indicated that they required the BSAL to acquire the real estate assets at the time they applied. This type of self-reporting of credit status is subjective and has the potential for upward measurement bias, as farmers may respond in a way that justifies their application decision. We do not attempt to measure the degree of this measurement bias.

There are various reasons why farmers may feel that they would not have been able to obtain the desired financing without the BSAL. Some possible reasons include; the farmer was discouraged by previous attempts to acquire debt financing from other lender sources, the local banker may have told the farmer that they would not be able to acquire the necessary financing without the BSAL loan, or the farmer may have determined that the investment was not feasible without the lower interest rate offered by the BSAL.

(insert Table 1 here)

Credit rationing model variables

As suggested by Foltz, the independent variables that might be used to predict credit rationing can be divided into two classes – farm fixed capital (K) and farm/farmer qualities (θ). These two classes of variables are regularly used by loan officers to make credit decisions and we assume that they have an influence on the farmer's probability of being credit rationed. The variables used in the empirical analysis are reported in Table 1 by credit status. The farm capital variables include: owned farmland, owned farm machinery, and net worth. Farm/farmer quality variables include: family living expenses, farmer post-high school education, farming arrangement with family members, length of loan amortization, proportion of off-farm income, and having a loan from a lender.

The unconditional means of the sample data are reported in Table 1. Farmers who are not credit constrained have lower total farm liabilities and higher net worth levels and less invested in machinery and equipment. Farmers who are credit rationed report generally higher average farm sales and profit levels, although these may not represent significant differences between the two groups of farmers. Unexpectedly, farmers who indicate that they are credit constrained also report more owned farm land and higher family living expenses. Foltz finds similar patterns among

Tunisian farmers, but he finds that credit constrained farmers have smaller farms and lower living expenditure levels on average. These comparisons are for the unconditional means and none of the differences we observe between the variable means are statistically significant given the large standard deviations in the sample data. In the estimation and analysis that follows we control for several important variables as we investigate the multivariate relationship between credit rationing and several of these variables. Thus, we will develop a better understanding of which factors explain credit rationing and the effects that credit rationing exerts on farm performance and farmer investment behavior.

Using the probability framework, historical farm level data in the BSAL applicant file and the farmer survey allows us to determine the likelihood of being credit-rationed at the time of the loan application. The signs of the coefficients in the estimated probit equation indicate increases in demand or supply, respectively. For example, a coefficient with a negative sign indicates that an increase in the variable will likely increase credit supply more than credit demand and reduce the likelihood of being credit rationed. Conversely, a positive coefficient indicates that demand is likely to be increased relative to supply, and credit-rationing is more likely to occur.

(insert Table 2 here)

Probit Model Results

Initially, we apply a reduced version of the model reported by Foltz to the Minnesota BSAL data set (see Table 2). Since we exclude the family size, loan default, and titled land variables (which Foltz included in his model), this specification is not intended as a test of Foltz's model. Rather, it is used to establish the fact that there is good consistency between the estimation results that we generate for several variables that are in common with those analyzed by Foltz. We estimate also an extended BSAL model with additional variables from the same Minnesota BSAL data set to provide a set of comparative results. We find that the two models produce quite consistent results (e.g., coefficient signs and magnitudes) for the common set of variables. The BSAL model provides a reasonably good fit to the data and predicts correctly the credit status for 62% of the farmers in the sample.

In the BASL model we add variables such as farming arrangement, farmer net worth, off-farm income, and loan amortization period. Factors that tend to increase significantly the likelihood of being credit rationed include: owned farm land, owned farm machinery, post-high school education, and the loan amortization period. Increasing the farm acreage owned significantly increases the likelihood of a farmer being credit rationed. A large initial investment in real estate in the years prior to applying to the BSAL appears to decrease the farmer's ability to obtain financing for additional farm expansion projects. Similarly, farm machinery owned has a positive effect on the likelihood of being credit rationed. Post-high school education is significant and the estimated model produces a positive sign, so that credit demand is increased more than supply by increasing the level of post-high school education. While unexpected this sign may be an indication that more highly educated farmers rely more on programs like the BSAL to enter farming. The amortization period of the BSAL loan has a positive effect on being credit rationed. Farmers who are credit-rationed may need an extended amortization period to be able to make the additional loan payments required by the expansion of real estate debt.

Two factors significantly reduce the likelihood of being credit rationed. They include the farmer's net worth position and the existence of a farming arrangement at the time the BSAL application is made. It is logical that farmer net worth would be used by the participating lender to make the credit decision, since it represents available collateral that a farmer may use to secure additional credit. The family farming arrangement variable in effect decreases the capital requirements needed to farm and as expected it tends to reduce the likelihood of being credit rationed.

Switching Models

In the switching regressions for farm profits and farm investments, we identify the liquidity effects of credit rationing and evaluate the implicit costs of credit rationing that are associated with measurable farm and farmer characteristics. The cost of credit rationing is expected to be the difference between the estimated coefficients of the independent variables across the two credit regimes. For the purpose of estimating the switching regression models we identify some additional variables that represent the capital resources of the farms and the farm/farmer qualities that influence profitability and investment decisions of participants in the BSAL.

Total farm debt (liabilities) is a key variable in this switching regression framework, since it instruments the liquidity effect of credit rationing. Total farm debt is defined as the sum of current and long-term liabilities, as reported on the farmer balance sheet. Logically, a *ceteris paribus* increase in total farm debt implies a decrease in farm financial liquidity. Thus, we expect that a significant positive coefficient on the total farm debt variable in the credit rationed farmer profit equation indicates there is a liquidity effect on farm profits. We expect that, conditional on being credit rationed, farmers who gain access to BSAL loans will improve their liquidity and ability to invest. It is expected that these investments will generate significant increases in farm productivity due to a more optimal allocation of inputs and the ability to achieve increased economies of size.

Analogously, the total farm debt variable is used also to identify a liquidity effect in the farm investment equation where a significant positive coefficient on the total farm debt variable in the credit rationed farmer investment equation indicates there is a liquidity effect on farm investment behavior.

(insert Table 3 here)

Farm sales equation

In Table 3 we report the results from both the exogenous and endogenous models for the ordinary least squares regression with the average level of farm sales (during the three years prior to loan application) as the dependent variable. The sales variable is used as an indicator of the overall level of farm productivity. We also investigated several other measures of farm productivity (gross farm income) and profitability (net farm income and net cash farm income). Farm sales and gross farm income are the most comparable measures of farm productivity, yet farm sales is a better measure of the impact of credit on farm operations, since gross farm income also includes income from several nonfarm and nonoperating sources of income which are not related to farming operations. The farm profitability measures have relatively large variances (probably due to a high level of variability in farm expenses) and the excessive noise in those two measures make them less useful for evaluating the impact of credit. The farm sales variable is highly correlated with gross farm income (correlation coefficient = 0.95) and slightly less correlated with each of the farm profitability measures (the correlation coefficient with net cash farm income = 0.65 and with net farm income = 0.36). Thus, we expect that the regression results for farm sales will reflect the impact of the BSAL loan program on overall farm profitability as well.

Both the endogenous and exogenous regression models have F-statistic values that indicate the estimated models are significant at the 1% level. However, the Mills ratio variable is not significant in the endogenous separation model, suggesting that there is no significant endogeneity effect in the survey data and the exogenous separation model is an adequate representation of the role that credit rationing plays in determining farm productivity differences. Although all regressions are significant, it is interesting to note that the equations for farmers who are not credit rationed tend to be slightly better predictors of the effects of credit rationing status on farm sales than the equations for the credit rationed farmers.

As expected, there is a measurable liquidity effect present among farmers who face a credit constraint. The positive coefficient on the total debt variable in the credit rationed farmer equation indicates that a liquidity effect exists as the funds provided by the BSAL program would significantly increase sales. A comparison of the estimated coefficients in the two exogenous model equations implies that for each $1 increase in credit received the credit rationed farmers increase their sales by about $0.27 more than the nonrationed group of farmers. The average amount of credit extended to the credit rationed farmers in our sample was $149,557. This implies that the average increase in farm sales would be about $40,380 due to improved liquidity. This finding confirms the presence of a liquidity effect of credit access on farm productivity among credit rationed farmers in the sample. We find similar evidence of a liquidity effect when the farm sales variable is replaced with a measure of farm profitability as the dependent variable.

In Table 3 we see that there is no relationship between household living expenses and farm sales among the credit rationed group of farmers, but these expenses significantly increase with the level of sales and productivity of farmers who are not credit rationed. This contrasts with the opposite findings of Foltz in Tunisia where household expenditures increase with the profitability of credit constrained farmers, but no such effect is present among farmers who are not credit constrained. Foltz suggests that the level of living expenses is a proxy for the permanent income level of the household and that such a positive effect on farm profits is expected. Logically, higher consumption expenditures imply lower savings at any given level of expected income and, therefore, a positive relationship might be expected between profits and living expenses. But that relationship should hold regardless of credit status. We find evidence of such a positive and significant relationship among the Minnesota farmers who are not credit constrained, but it is not significant among those who report facing an external credit constraint.

When we look at the effect of off-farm income on farm sales we see a strong negative impact of off-farm income on the level of farm sales among the farmers who are not credit rationed. Among the credit rationed group of farmers we see a similar (but insignificant) effect on farm sales. Clearly, there is a trade-off between farm and nonfarm work for both groups of farmers, yet the farmers who are credit rationed face a lower opportunity cost when pursuing off-farm income.

Two other variables are of interest even though they are not significant predictors of overall farm productivity. We find that owned farm land is not a significant variable in the farm sales equation. In contrast Foltz finds that owned farm land has a positive effect on farm profits for both the credit rationed and not credit rationed farmer groups, and the effect is greater for the credit rationed farmers. Our results imply that there is no significant divergence of the shadow prices of farm land among farmers in our sample. One interpretation is that farm real estate markets in Minnesota operate more like competitive markets, so there should not be any differences in the shadow prices of farm land among these farmers. Finally, higher education levels do not tend to increase farm sales among either the credit rationed group or the not credit rationed group. Foltz finds a similar pattern for the education variable when predicting profitability among Tunisian farmers. These results imply that the “cost of education” among credit rationed farmers is not significantly different from that of farmers who do not face a credit constraint. The lack of significance in our analysis may be due to the fact that the sample data do not reveal large differences between the education levels of these two groups.

(insert Table 4 here)

Farm investment equation

Average annual depreciation expense during the three years following the BSAL loan application is used as the dependent variable in the farm investment equation. Depreciation expense is a reasonable proxy for changes in the level of investments subsequent to receiving the BSAL loan, as farmers have an incentive to use depreciation as a tax shield as it has the effect of reducing pre-tax earnings and tax liability. Thus, as farmers use improved access to credit to acquire more assets, they also increase their average annual levels of depreciation expense.

In Table 4 we summarize the exogenous and endogenous OLS regression models for farm investments. The Mills ratio variable is again not significant in the endogenous separation model, which suggests that there is no endogenous effect in the survey data and the exogenous separation model is an adequate representation of the role that credit rationing plays in determining differences in farm investment behavior.

The estimated investment demand equations show that the expected liquidity effect is present among the credit rationed group of farmers. The significant positive coefficient on the total farm liabilities variable in the exogenous model for the rationed farmers indicates that they increased investments in depreciable assets as a result of obtaining the BSAL loan, while farmers who are not credit rationed do not exhibit an investment demand response. Thus, the BSAL loan appears to mitigate the liquidity constraint that credit rationed farmers face.

Farmers who identify themselves as being credit rationed and who had attained higher levels of education appear to have a positive demand for increasing their investment levels. In comparison farmers who are not credit rationed but also achieved higher education levels do not exhibit a positive investment response as a result of participating in the BSAL program. One interpretation is that this latter group of farmers participates in the program primarily to obtain more favorable credit terms. The effect of education on investment demand in this study contrasts with that reported by Foltz, where education actually had a negative impact on investment demand conditional on receiving access to credit. Our results appear to be more consistent with the expected relationship.

The presence of a formal farming arrangement between the beginning farmer and family members has a negative effect on the demand for farm investments. This result is consistent with the general view that these farming arrangements provide access to machinery and equipment that would otherwise have required purchase with credit (making the credit constraint more severe). Thus, among credit rationed farmers the use of farming arrangements relaxes the credit constraint so that investments might be made in other capital assets such as farm land.

Similarly, we find that the level of off-farm income has the effect of reducing the demand for farm investments conditional on being credit rationed. Farmers who are not credit rationed do not change their investment behavior as off-farm income varies while credit rationed farmers significantly reduce their investments in farm capital assets when off-farm activities increase the level of household income. We suggest that off-farm income tends to have the effect of reducing the severity of the credit constraint. However, an underlying labor allocation choice may also be influencing the investment behavior of the credit rationed group of farmers. It is plausible that investments in farm capital assets might be used to substitute for farm operator labor time, thus increasing the demand for farm capital assets. Yet, with more time spent off the farm to earn income, these farmers may be revealing a preference to grow more slowly, and that depresses the demand for farm production assets. In addition off-farm employment may provide for additional benefits such as health insurance coverage which may be motivating these farmers to continue their off-farm income activities, even though the credit constraint is made less severe by participation in the BSAL loan program.

The estimated negative coefficient on the owned farm land variable is not highly significant, yet it raises an interesting point about the effect of owned capital assets in the investment demands of these beginning and low-resource farmers. It suggests that a credit rationed farmer who initially owns more farm land would choose to invest less in depreciable production assets. A similar farmer who is not credit rationed would have no such investment response. This difference across the two credit regimes is present in both the exogenous and endogenous models. It is a result that merits further research with a more complete panel data set.

Conclusions

Our primary objective has been to use data from participants in the Minnesota Basic and Seller Assisted Loan program (BSAL) during 1995-2003 to estimate the beneficial effects that credit rationed farmers realize compared to those who are not credit rationed. Only farmers who received BSAL loans are analyzed. Thus, we do not compare these farmers with other beginning or low-resource farmers who did not apply for BSAL loans or with farmers whose loan applications were rejected by the Rural Finance Authority. For this reason the results of our study are not strictly comparable with those of other studies where the data set includes farmers who do not receive loans.

We find that there are liquidity effects of credit rationing present for a significant share of the beginning and low-resource farmers who participated in the program. This finding serves as an economic argument for the BSAL program. The program improves access to farm real estate credit and, thus, promotes a more optimal allocation of farm inputs and increases in farm investments for those farmers who are credit constrained. The analysis produces empirical evidence that credit rationing has a liquidity effect for farm productivity and profitability and for investments in farm capital assets. The general findings of this study are quite consistent with earlier research on the effects of credit constraints on farmers in developing countries.

There are also differences between the findings of this study and those of prior studies, differences that may be attributable to structural and competitive differences that may exist between factor markets for land, labor and capital in developing and developed countries. Two such examples are the role of off-farm income and owned farm land in determining the effect of program participation on the severity of the credit constraint. We find evidence that there is a trade-off between farm and off-farm work for both credit constrained farmers and those who are not credit constrained. Yet, farmers who are credit constrained appear to face a lower opportunity cost when pursuing off-farm income activities. They also may be attracted to off-farm employment due to the availability of health insurance benefits which are increasingly important to self-employed farmers. These and other off-farm employment benefits may also alleviate the liquidity constraint that they face. We also find that owned farmland is not a significant factor in determining the effect of credit access on farm productivity and profitability. Specifically, there is no observed divergence of the shadow prices of land among the two farmer groups in our sample of beginning and low-resource farmers. This implies that when farm real estate markets operate more competitively, programs that are designed to improve access to farm real estate credit in developed countries may have a less distorting effect on land prices than what might be found in developing countries where imperfections in the land market are more severe.

Table 1. Summary Statistics of Variables by Farmer Credit Status

	All Farmers			Not Credit Rationed			Credit Rationed		
Variable	N	Mean	Std. Dev.	N	Mean	Std. Dev.	N	Mean	Std. Dev.
Owned farm land (acres)	114	67	140	57	51	88	57	83	176
Owned farm machinery ($)	116	63,842	56,479	58	57,357	50,339	58	70,326	61,774
Farming arrangement (0,1)	113	0.60	0.51	54	0.69	0.51	59	0.53	0.50
Living expenses ($)	115	24,794	11,957	58	23,352	11,364	57	26,262	12,460
Net worth ($)	117	145,242	77,219	58	150,295	78,568	59	140,274	76,214
Total farm liabilities ($)	116	158,806	154,104	57	137,945	113,215	59	178,960	184,040
Post-high school education (years)	116	2.45	1.32	58	2.28	1.32	58	2.62	1.31
Pre-existing loan (0,1)	117	0.82	0.39	58	0.79	0.41	59	0.85	0.36
Loan amortization period (years)	116	21.16	4.45	58	20.16	4.79	58	22.17	3.87
Principal farm manager (years)	109	7.98	7.57	50	6.84	6.80	59	8.95	8.10
Off farm income (% total income	116	0.30	0.20	58	0.32	0.21	58	0.28	0.18
Farm sales ($)	114	69,647	74,071	56	65,452	68,101	58	73,698	79,798
Gross farm income ($)	114	93,861	90,098	56	91,238	86,782	58	96,393	93,875
Cash farm income ($)	114	15,410	27,305	56	16,350	22,383	58	14,503	31,511
Net farm income ($)	114	2,171	21,728	56	1,377	27,606	58	2,993	13,373

Table 2. Probit Regression Results for Probability of Being Credit Rationed (dependent variable: credit rationed =1, otherwise =0)

Variable	Foltz model	BSAL model
Owned farmland	0.001 (0.001)	0.005*** (0.002)
Owned farm machinery	0.004 (0.002)	0.008*** (0.003)
Living expenses	0.006 (0.012)	0.014 (0.014)
Pre-existing loan	-0.072 (0.357)	-0.152 (0.450)
Post-high school education	0.186* (0.102)	0.318*** (0.122)
Farming arrangement		-0.784** (0.305)
Net worth		-0.008*** (0.003)
Off-farm income		-1.467** (0.927)
Loan amortization period		0.135*** (0.035)
Constant	- 0.894** (0.425)	-2.645*** (0.944)
Log pseudo-likelihood	-72.99	-55.69
Number of observations	111	106
Wald Chi-square(11)	8.36	34.86***
Percent correctly predicted		62%
Pseudo R-square statistic	0.05	0.24

*** Significant at the 1% level, ** Significant at the 5% level, * Significant at the 10% level

Table 3. Switching Regression Results for Farm Productivity (dependent variable: annual average farm sales)

	Exogenous Model		Endogenous Model	
Variables	Not Credit Rationed	Credit Rationed	Not Credit Rationed	Credit Rationed
Total farm liabilities	-0.004	0.267**	0.006	0.299**
	(0.146) a/	(0.110)	(0.142)	(0.121)
Higher education	-4,981	12,923	2,835	38,540
	(18,053)	(37,258)	(22,700)	(34,090)
Principal farm manager	1,082	706	1,137	592
	(1,890)	(1,656)	(2,128)	1,742
Owned farm machinery	342	245	324	217
	(234)	(274)	(252)	(276)
Owned farmland	175	-195	189	-208
	(163)	(122)	(167)	(145)
Living expenses	2,217**	319	2,257**	0.828
	(1,073)	(762)	(1,135)	(747)
Farming arrangement (0,1)	4,096	-26,630	1,918	-30,217
	(20,629)	(20,706)	(20,963)	(21,105)
Off-farm income	-126,486**	-81,596	-139,395**	-97,679
	(55,321)	(64,102)	(62,733)	(67,870)
Mill's ratio			-21,430	-11,420
			(35,277)	(24,119)
Constant	16,405	31,210	27,022	11,006
	(27,180)	(45,145)	(36,231)	(48,942)
F-statistic	5.31***	3.77***	4.43***	3.12***
N	46	55	46	53
R-square statistic	0.52	0.49	NA	NA

a/ Standard errors in parentheses
*** Significant at the 1% level; ** Significant at the 5% level; * Significant at the 10% level

Table 4. Switching Regression Results for Farm Investments (dependent variable: annual average depreciation expense)

	Exogenous Model		Endogenous Model	
Variables	Not credit rationed	Credit rationed	Not credit rationed	Credit rationed
Total farm liabilities	0.020	0.042**	0.022	0.036*
	(0.078) a/	(0.019)	(0.077)	(0.019)
Principal farm manager	783	-34.3	774	-72.4
	(1,153)	(483.3)	(1,189)	(460.6)
Owned farm land	10.6	-56.6*	14.8	-59.4*
	(58.9)	(32.5)	(66.8)	(31.9)
Higher education	1,158	16,199**	2,639	10,527
	(6,215)	(7,093)	(8,015)	(6,674)
Living expenses	470	313*	496	274
	(424)	(188)	(461)	(212)
Farming arrangement (0,1)	5,663	-12,264**	5,392	-10,626*
	(11,848)	(5,431)	(12,560)	(5,839)
Off-farm income	2,217	-38,888**	-1,331	-32,348*
	(36,705)	(16,597)	(38,441)	(17,308)
Mill's ratio			-5,073	13,912
			(16,370)	(9,111)
Constant	-2,804	13,353	-647	27,066***
	(16,408)	(8,757)	(18,274)	(9,443)
F-statistic	1.98*	3.68***	1.23	3.74***
N	30	46	30	45
R-square statistic	0.23	0.45	NA	NA

a/ Standard errors in parentheses
*** Significant at the 1% level; ** Significant at the 5% level; * Significant at the 10% level

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