CREDIT MARKET CONSTRAINTS AND PROFITABILITY IN

TUNISIAN AGRICULTURE

Abstract

This work provides an analytic model of dual credit markets and develops the links between credit access and agricultural productivity. Using data collected from rural Tunisia, this work provides direct estimates of credit rationing and its effects. Econometric estimates are run for agricultural profitability as a function of credit access. The investigations of credit constraints and their effects suggests that the presence of credit market constraints does impinge on farm profitability.

Jeremy Foltz

Dept. of Ag.& Applied Economics
University of Wisconsin-Madison

I. Introduction

> How can we [Tunisians] pretend to have food self-sufficiency as our objective when we invest so little and accord so little credit [in agriculture] and we exclude the vast majority of the small and medium peasantry? (Sethom, 1992, p. 154)

Agricultural credit access has particular salience in the context of Tunisian rural development. The government has as a current policy objective to improve agricultural production and exports. Recent structural adjustment loans to Tunisia from the World Bank (World Bank, 1996) have pushed the Tunisian government to reduce agricultural subsidies, price interventions, and let the private sector control marketing of agricultural products. Government investments in agriculture have been declining, with the private sector supposed to pick up the slack. If private agricultural entrepreneurs are going to increase investment levels or invest in new technologies, they will need access to credit.

While much of the literature on credit has been content to search for credit market imperfections, the work presented here seeks to push the analysis to another level. Having investigated the presence and possible causes of credit market imperfections, this work asks the question: if credit markets work imperfectly, what effect does this have on agricultural productivity? This study presents some innovations to the literature on credit market disequilibrium. It develops the links between credit access and agricultural productivity. Using data[1] from rural Tunisia, this work can directly estimate credit rationing and its effects. Direct estimates allow one to circumvent the problem of identifying empirically both the selection process of farm credit rationing and its effects on resource allocation.

II. Credit Market Literature

Recent theoretical and empirical work in economics has established that credit markets in

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[1]The data used in this paper come from a 1995 survey of irrigated farms in the Cap Bon region of Tunisia. The randomly chosen sample consisted of 142 farmers who were asked about farm production, household financial status, irrigation technology adoption, and access to credit markets. See Foltz (1998) for a description of the region and survey methodology.

developing countries work inefficiently due to a number of market imperfections.[2] This new insight has sparked a renewed interest among development economists in problems of agricultural credit. Long considered a constraint to agricultural development, economists now study credit market disequilibrium as both an optimal response to information asymmetries and a drag on productivity.

While much of the literature (Conning, 1995; Kochar, 1992; Mushinski, 1995) concentrates on the determinants of access to formal loans with the idea of valuing the benefits to a future formal loan program, here we are primarily interested in how access to capital affects agricultural profits and investment. The literature on loan programs cite a number of market imperfections which lead some potential borrowers to be rationed out of the loan market. These imperfections include: 1) interest rate ceilings usually imposed by the government, 2) monopoly power in credit markets often exercised by informal lenders (Bell et al. 1996), 3) large transaction costs incurred by borrowers in applying for loans (Key, 1997), 4) moral hazard problems (Carter, 1988). In many cases a number of these imperfections combine to ration farmers out of the loan market.

This work fits in that body of the literature which seeks to measure the degree of credit constraints directly (Jappelli, 1990; Feder et al. 1990; Mushinski 1996; Barham et al. 1996; Hauge 1997). Like that work, the analysis presented here also addresses one of the technical difficulties in the work by Carter and Olinto (1996), and Conning (1995) in using actual data on sample separation between the credit constrained and the unconstrained. By having better data, this analysis is able to dispense with a number of the shortfalls of switching regression models.

III. Credit Constraints and Agricultural Production

The literature on credit constraints (e.g. Carter, 1989; Feder et al. 1990; Hauge, 1997) suggests that they can cause a misallocation of resources in farm production. This misallocation of inputs can then

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[2]For a sampling of the recent literature see; Kochar, 1992; Conning, 1995; Mushinski, 1995; Hauge, 1997. Foltz (1998, Chapter 4) provides a formal model of the determinants of loan status and the reasons behind the imperfect operation of credit markets in Tunisia.

cause the credit rationed farmer to have lower profit levels than his unconstrained neighbor. The lower profit levels can come from a number of sources including lower investment levels and a misallocation of variable inputs.

At the beginning of a production period, farm households need to allocate their available resources between current period consumption, purchase of variable inputs for production, and investment. The household unconstrained in the capital market can separate consumption decisions from farm production decisions. Households can then choose production inputs optimally for the production process they face. In this case the levels of inputs in production and investment will not be effected by the level of credit they receive. The credit constrained household, however, will have to choose among the investments they make and the inputs they buy dependent upon the level of credit they receive. This will have a potentially detrimental impact on production with it being lower for constrained households.

IV. The Econometrics of Rationing

A farm household will be credit constrained when it demands more loans than the combination of the formal and informal markets are willing to supply. When markets do not clear fully through price adjustments, farmer credit status will be a function of factors effecting both supply and demand of credit. We assume that demand and supply of credit adjusts on the basis of farm and farmer characteristics. Let the notional demand curve of an individual be represented by $L^D(R_f, K, \theta, u_D)$ where R_f is the formal sector interest rate $(1+r_f)$, K represents farm capital, θ represents farmer ability, and u_D is a variable representing unobserved latent qualities. Define a variable G* as the reduced form excess demand for credit:

$$G^* = L^D(R_f, K, \theta, u_D) - L^S(R_f, K, \theta, u_S)$$

Since the econometrician cannot directly observe the amount of excess demand, one moves to a reduced form estimation by defining an index variable for the credit constrained. Let G take on the values of zero and one as follows:

$$G = \begin{cases} 1 & \textit{if } G^* > 0 \quad \textit{(rationing)} \\ 0 & \textit{otherwise} \quad \textit{(unrationed)} \end{cases}$$

In order to understand the determinants of credit status we are interested in characteristics of farmers and farms which influence the probability that $G^*>0$. Define Z as a vector containing observable farm and farmer characteristics influencing either supply or demand (K and θ). If G^* were observable we could write it as a function of Z in the following manner: $G^* = \gamma'Z + \epsilon$, where γ is a parameter vector to estimated and ϵ is a random disturbance term. With that formulation we can write the probability that G^* >0 in the following manner: $Prob(G^* > 0) = Prob(\gamma'Z+\epsilon>0),$

where ϵ an error term assumed to be normally distributed with mean zero and variance equal to one. The error term ϵ represents both of the unobservable latent qualities of farmers and lenders, u_s, u_D, as well as potential noise in the data.[3]

Data Implementation

The data used in here comes from a 1995 survey conducted by the author of randomly selected households engaged in irrigated farming in the Cap Bon region of northeastern Tunisia. Empirically we are interested in a measure of whether or not a household is credit rationed. Discerning this rationing is complicated by the fact that many households who do not take out loans may have zero demand for credit. Therefore one must distinguish between those who have no credit because they have no demand and those who have no credit because they received an insufficient supply. Similarly households with a positive supply of credit may not have received the full amount of credit they wanted. Thus one must

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[3]This formulation leads to a standard probit model. Under the assumption that the error ϵ is normally distributed [$\sim$N(0,1)], where Φ is the standard normal distribution evaluated at $\gamma'Z$, the log likelihood function for a probit will be $\quad \ln L = \sum_{G_i=0} \ln(1-\Phi_i) + \sum_{G_i=1} \ln\Phi_i$

partition those who received credit into those who received sufficient credit and those with excess demand who did not. Table 1 presents the measures used to determine credit rationing status.

The relevant variables in Z will specify farm fixed capital: K and farm quality measures: θ. The fixed capital measures include owned land, owned machinery, family labor per hectare, and household income. Measures of loan applicant quality will include, whether they have land title, and the education level of the farm manager. Table 2 presents variable definitions and their averages broken down by credit status. The reduced form estimation will tell us most about which factors are more important to either supply or demand. A positive estimated coefficient, γ , signifies a characteristic which increases demand more than supply.

The results from a probit estimate of the probability that a household is credit constrained are presented in Table 3. The model predicts an unspectacular 65% of the farmers correctly. This represents a small improvement over a naive model predicting all farmers as unconstrained which would be correct 55% of the time. However, the model does distribute farmers between constrained and unconstrained in approximately the right proportions, suggesting it has some applicable explanatory power.

The estimated coefficients show many of the predicted signs, with the probability of being credit constrained decreasing in household expenditure and land title. Higher household income levels, proxied by expenditure, would seem to increase credit supply more than credit demand. This fits with our intuition that a wealthier household would be more likely to receive credit, yet also be less likely to need it. Land title as predicted increases credit supply more than demand. This suggests that the benefits of land title in increasing credit supply may be stronger than the degree to which it increases the desire to

invest. Two regional dummy variables show some significant regional variations in credit status. The two regions with dummy variables are those with the greatest banking infrastructure and therefore presumably greatest supply. Their positive coefficients should be taken as evidence of a higher demand for credit in those regions. Since the highest degree of credit rationing occurs in the regions with the lowest transaction costs (at least in travel time) this suggests that transaction costs for farmers may not be the major cause of credit rationing.

V. The Effects of Credit Constraints

Let an individual farmer's expected net farm revenues for the unconstrained and the constrained be denoted as: y^n and y^c . In general the expected farm profits will be:

$$E(y_i^n|G_i=0) = \beta_y^{n'}x_i + \eta_y^{n'}P + E(v_i^{yn}|G_i=0)$$

$$E(y_i|G_i=1) = \beta_y^{c'}x_i + \eta_y^{c'}P + (\delta_y L_i^S) + E(v_i^{yc}|G_i=1)$$

where G_i is the credit constraint indicator variable, x represents observable farm and farmer characteristics including fixed assets, P represents prices, and L^S is the loan amount supplied to that individual. The random variable v represents latent qualities unobservable to the econometrician. We expect the common coefficients among these two equations to be different between the constrained and unconstrained: i.e. $\beta^n \neq \beta^c$, $\eta^n \neq \eta^c$. For the credit constrained, we also expect that net farm revenues will increase with the amount of credit they received, L^s, implying $\delta > 0$.

Econometric Considerations

In order to test the relationship between credit access and farmer profits I use an endogenous switching regression framework. Here the credit status, constrained or unconstrained, determines the

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switch between two different regimes describing the dependent variable. The analytic model of lenders and borrowers presumed that loan demand and supply were governed by farm assets and their latent productivity attributes, θ. To the extent that these latent productivity attributes are unobservable to the econometrician, they will be among the elements of the disturbance term v. For example, one would expect that greater farmer skills would decrease the probability of being credit constrained as well as the realized farm profits. If we cannot control for farmer skill with observable characteristic, e.g. education, or farming experience, our distribution term will be correlated with ϵ from the credit constraint equation.

Following Maddala (1983) for the endogenous switching model I assume two regimes with an endogenous switching equation. For any observation i the relevant structure is:

$$y_i^n = \beta^{n\prime} x_i + v_i^n \qquad \textit{iff } \gamma' Z_i + \epsilon_i \leq 0$$

$$y_i^c = \beta^{c\prime} x_i + \delta L_i^S + v_i^c \quad \textit{iff } \gamma' Z_i + \epsilon_i > 0$$

where the switching equation is the standard probit estimation of whether a household is credit constrained from the previous section. As researchers we observe only one value of Y dependent upon which regime that particular individual is in: constrained or unconstrained. The parameters of the probit equation can only be estimated up to a proportionality constant, so we assume that the variance of the random disturbance terms will be one: Var(ϵ_i) = 1. We further assume that the random disturbance terms v^n ,v^c, ϵ_i have a trivariate normal distribution, with mean vector zero. For the credit constrained the implied econometric model will be as follows:

$$E(y_i | G_i = 1) = \beta^{c\prime} x_i + \delta L_i^S + \sigma_{c\epsilon} \lambda(\alpha)$$

where $\lambda(\alpha)$ is the inverse mills ratio saved from the probit equation describing credit constraints. For the

unconstrained similar equations apply without the implied liquidity effect (L^S). The inverse mills ratio is defined as follows:

$$\lambda(\gamma'Z_i) = \frac{\phi(\gamma'Z_i)}{1 - \Phi(\gamma'Z_i)}$$

where Φ and ϕ are respectively the cumulative and probability density functions of the normal distribution. The second stage estimation for both constrained and unconstrained estimated separately, incorporates the corresponding Mills ratios into a corrected linear regression for each of the two regimes. The unconstrained case follows directly from the constrained case. second stage estimates for β^c and β^n will be consistent and asymptotically normal. The resultant variance-covariance matrix is corrected for heteroskedasticity using a procedure outlined in Maddala (1983).

VI. Estimations of the Effect of Credit Rationing

In estimating farm profits I use net revenue functions, often called pseudo-profit functions (Carter, 1989) in order to account for possible imperfections in capital, land, and labor markets. Net revenues differ from economic profits in that they do not account for depreciation costs and payments to fixed factors, which in this case includes land, family labor, and management. In an area of imperfectly operating markets farmers will not be able to rent their fixed factors out at a "market" price. The going market price for a fixed factor might well overstate the real opportunity costs of using that factor in production. Therefore, valuing profits using market prices for capital inputs would bias our results. Therefore deviations of profits will be due to differences in farmer endowments and access to markets, particularly the market for capital. Due to the imperfection of markets, farmers will make profit decisions based on the shadow values of their fixed assets, making quantity a reasonable proxy variable for the true price of those inputs.

As described above, the appropriate dependent variable describes net revenues of the farm, while the independent variables will describe farm and farmer characteristics which influence profits. The regressors for the constrained and the unconstrained are identical to each other except for a liquidity variable, total loan value, in the equation for the credit constrained.[4] Regressors common to the two equations represent farm fixed assets: owned land and capital equipment; farmer characteristics: education and wealth; whether a farmer has title to the land he owns. Since there was relatively little variation in prices among farms, I have dropped price variables from the equations. The regional dummy variables do, however, pick up some of the regional variation in prices. The dependent variable, pseudo-profits, is hypothesized to be increasing in farm fixed assets, farmer education, farmer wealth, and whether the farm has land title. The credit constrained are expected to have increasing profits in the liquidity variable.

Table 4 shows estimated coefficients for a profit function. The model produces fairly high levels of fit, R^2 equal to 0.52 and 0.74, for cross-section data with small data sets. A reasonable number of the coefficients are significant at common levels and have the expected signs. As predicted a number of the coefficients are different between the credit constrained and unconstrained equations. This difference, however, is only statistically significant in the case of the owned land variable.

The results of our estimates for a pseudo-profit function confirm the profit-liquidity hypothesis. The estimated coefficient on total debts owed is significantly large in magnitude, and in the case of the endogenous sample separation statistically significant. As might be expected under imperfectly operating

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[4]Loan value as a proxy should under-estimate the true liquidity of a household. An ideal measure would also include household savings and farm rolling capital funds from the beginning of the season. Farmers were unwilling to estimate this value in the survey.

land markets, the amount of owned land is a significant determinant of overall profits. The significantly larger coefficient on land for the credit constrained suggests that credit constrained farmers have a higher shadow price for land. These differences are statistically significant at a 5% level.[5] The increased profit (shadow value) a constrained farmer would receive from renting another hectare of land is greater than the average land rental cost, while that for the unconstrained is less than rental costs. This implies that liquidity may constrain the ability to rent or buy land, leading to the divergence of shadow prices. The estimated shadow price ($2,731 for the constrained and $422 for the unconstrained) for another hectare of owned land brackets the rental values commonly seen in Cap Bon which ranged from $500 to $3,000.

The estimations of the profit function have a number of immediate implications both for the credit market and for other markets. (1) Better access to the credit market will improve the profitability of a great number of farmers, though not necessarily the poorest. From the variable averages it is clear that the constrained are not necessarily those with the lowest profit or who are the poorest. It seems that the credit constrained might be the high quality producers who can make the best use of their capital. (2) If credit access were improved, one of the most significant effects would be in the land market. In fact many of those who claimed they would borrow when offered a loan would do so to buy or rent land. This increased demand would potentially activate the land market in the area. The corollary to this is that relaxing credit constraints may lead toward larger farm sizes rather than productivity increases: increased profitability on a per-hectare basis. Potentially if it is the young "middle class" farmer who is constrained

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[5]The lower end of the 95% confidence bound on the credit constrained coefficient is 784.5 while the upper end of the 95% confidence bound for the unconstrained is 213.3.

in the credit market, this research has shown that Tunisian farming will be less profitable and less

dynamic.

Table 1: Financial and Credit Status of Households

Financial or Credit Status	Percent of Sample Households
1) Have access to $2,000 in their extended family	**46 %**
2) Have access to $10,000 in their extended family	**12**
3) Have no access to $2,000 anywhere	**4**
4) Have no access to $10,000 anywhere	**55**
5) Have asked for a loan in the last year	**26**
6) Classified as transaction cost rationed	**12**
7) Would take a $2,000 loan at 13% interest	**62**
8) Would take a $10,000 loan at 13% interest	**52**
9) Defined as credit rationed	**45**

Table 2: Variable Means by Credit Status

Variable	Full Sample	Credit Constrained	Unconstrained
Education Level (1-5)	2.28	2.42	2.16
Family Size	6.9	6.9	6.9
Years Farming (Farm Manager)	24	21	26
Agricultural Equip. ($)	4889	5648	4273
Owned Land	2.7	1.2	4.0
Household Expenditure per month	256	209	295
Debts Owed ($)	4941	4064	5654
Land Title [0-1]	0.72	0.69	0.76
Profits ($)	11,702	13,624	10,139

Table 3: Probit Model: The Probability of Being Credit Constrained[6]

Variable	Coefficient (t-statistic)
Owned Land (Ha)	-0.0283 (-0.47)
Agricultural Equipment ($)	0.00002 (1.62)
Family Members per ha land	-0.042 (-1.05)
Household Expenditure/mo ($)	-0.0032 (-3.29)**
Education Level	0.128 (1.22)
Land Title [0-1]	-0.456 (-1.70)*
Log Likelihood	-81.43
Pct. Correctly Predicted, N=136	65%

Table 4: Pseudo-Profit Function Coefficients[7]

Variable	Credit Constrained	Unconstrained
Education	-651 (-0.28)	1255 (0.75)
Years Experience in Farming	-119 (-0.69)	-121 (-1.23)
Number of Family Members	-616 (-1.01)	-732 (-1.74)*
Agricultural Equipment	0.21 (0.75)	0.39 (1.43)
Owned Land (Ha)	2731 (2.75)**	422.3 (3.88)**
Expenditure ($/month)	66.1 (1.63)	28.7 (1.38)
Total Debts owed ($)	0.73 (2.40)**	N.A.
Title	8978 (1.62)	4316 (1.02)
Lambda	-10373 (-0.62)	-8056 (-0.69)

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[6]Estimation also includes a constant and 2 regional dummy variables. Significance at a 5% level denoted by **, the 10% level by *.

[7]The dependent variable is defined as net farm profits. Estimation also includes a constant and 3 regional dummy variables. T-statistics in parentheses

Variable	Credit Constrained	Unconstrained
R^2 [n(cons)=61, n(un)=75]	0.52	0.74

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