Credit Rationing in the Polish Farm Sector: A Microeconometric Analysis Based on Survey Data

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ABSTRACT

The objective of this paper is to empirically detect credit rationing of Polish farms. Based on cross-sectional survey data and motivated by a microeconomic farm household model, this effort is pursued by a methodology consisting of three interrelated steps. These steps include the analysis of qualitative survey data regarding farmers' experience with bank credit, based on this an econometric estimation of internal shadow prices of credit for the credit constrained sub-sample of respondents, and finally an investigation of interdependencies between determinants of consumption and production that should be influenced by the presence of a binding credit constraint.

The results of the empirical analysis consistently suggest that among the observed randomly selected Polish farms more than 40 percent of borrowers experience pronounced credit rationing by rural banks. These farms display internal shadow prices of the credit constraint of on average 190 percent net of principal. Shadow prices are significantly different from individual effective interest rates for credit that account for loan specific transaction costs. In the group of credit constrained farms, household characteristics could be proven to have a significant effect on output supply. This is evidence for a violation of separability between production and consumption decisions and thus lends empirical support to the existence of a binding credit constraint. Overall, credit constrained farm households own less and rent more land than the average, operate with a high capital intensity with regard to land, tend to have a poor credit history, and engage intensively in intra-village conversation. Generous government support via interest subsidisation apparently contributed little to alleviate credit rationing of farms in Poland.

Keywords: agriculture credit, credit rationing, interest subsidy, microeconometrics, Poland.

1 INTRODUCTION [1]

Among the Central and Eastern Europe Candidate Countries Poland supposedly is the one where the agricultural sector poses the most difficult adjustment problems in the course of EU accession. Not only do serious structural deficiencies call the sector's international competitiveness into question (EPRICK et al. 2002). Also the gap in living standards between urban and rural groups of the Polish population gives rise to worries. It already brought about an increasingly negative attitude among rural citizens towards the whole accession process, which may well endanger social peace in the entire country. The results of the most recent parliamentary elections which strengthened extreme anti-EU positions supported by parties with a largely rural clientele bear lively testimony to this. All this will make negotiations on the agricultural chapter of the accession task scheduled for early 2002 even more complicated and politically sensitive.

Development of the Polish farm sector is thus of urgent necessity. Right from the beginning of market reforms, the Polish government introduced a number of policy measures to achieve this goal. Besides trade policy and output price support measures, interest subsidies figured prominently over recent years and accounted for about 38% of the agricultural budget in 1999 (not regarding expenses for the farmers' social insurance fund; see MRiRW 2000 and OECD 2000). These subsidies are granted both on operational and investment loans extended by commercial banks. Intervention on credit markets thus can be regarded as a major instrument of the Polish government to achieve its political objectives.

Is there an economic justification for continued government intervention in rural credit markets? In fact, it is often claimed that farm households in underdeveloped rural areas are credit rationed by formal lenders in the sense that they cannot borrow as much as needed to finance

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inputs, investment, and indispensable consumption expenditures. Contemporary contract theory argues that banks are not interested in these clients because it is particularly difficult to overcome information asymmetries and thus to screening, monitoring, and enforcement problems: clients are poor, have few assets to be realised, act in an especially risk-prone environment, and give rise to high transaction costs (BESLEY 1994). The process of transition to a market economy tends to worsen these problems (STIGLITZ and GOW 1999). Hence the question arises quite naturally whether there is any rationale for government intervention on rural credit markets in order to improve living standards and foster structural change. However, a second question is which *kind* of intervention is desirable. No conclusive policy recommendations can be derived from theory alone (BESLEY 1994). In addition, experience both from developing and OECD countries suggests that subsidies on interest rates often failed to mitigate credit rationing of rural borrowers, and that governmental credit programs frequently did not achieve their stated objectives (see e.g. the collection of articles on developing countries in ADAMS et al. 1984 and BÜMMER and LOY 2000 for a quite recent study on Germany).

A closer examination of the rural financial market in Poland appears thus to be worthwhile. In my view, the foremost step to formulate serious policy advice in the present situation is to find out (a) whether after a decade of interest subsidies Polish farmers are (still) credit rationed at all and (b) if yes, how severely this rationing affects current production outcomes. The aim of this paper is to give a methodologically sound answer to both questions. Its objective is to outline a theoretically consistent methodology to detect and analyse credit rationing of farm households and to apply this method to cross-sectional survey data of 431 Polish farms interviewed in 2000. The paper is thus also understood as an effort to bridge the observed gap in the literature (HEBS 1997) between increasing theoretical interest in market imperfections on the one hand and empirical study that puts these concepts to the test on the other.

At this stage of the research, emphasis is on credit rationing with regard to working capital loans used for the financing of current production. Only loans with a maturity of less than 12 months are regarded, and investment loans are generally not considered in the following.

The findings of this paper are based on three major indicators. The first is a qualitative one representing the *subjective experience of credit rationing* as stated by the respondents of the survey. Determinants of this credit rationing status are examined by a Probit regression. At the heart of the second indicator lies the notion of the *shadow price of the credit constraint*. This shadow price provides a measure of the marginal value of credit within a given farm household, which can be compared with an external measure of capital scarcity, e.g. the market interest rate for credit. Neo-classical theory suggests that in the absence of rationing, the marginal value of credit within the farm should equal its market price. In case the latter is significantly exceeded by the former, this is regarded as evidence for substantial market distortions and a thus prevailing credit constraint. The shadow price is calculated by estimating a reduced-form output supply equation. The third indicator looks at *violations of separability* between the household's consumption and production decisions in the presence of market failure. If there are binding constraints in credit access, production outcomes of the farm firm should be partly determined by household characteristics. This claim is subjected to an empirical test in the following.

The methodology of the subsequent analysis draws on several contributions in the literature. The most important one is FEDER et al. (1990) who examined the relation between credit and productivity in rural China. FEDER et al. were among the first to rely on specific survey data to ease the estimation of reduced-form output supply equations. Two other related papers are

CARTER (1989) and SIAL and CARTER (1996) with applications to Nicaragua and Pakistan. SIAL and CARTER to my knowledge were the first to use the notion of a 'shadow price of capital' in an econometric analysis of credit market failure. The present research attempts to learn the lessons from these papers by taking econometric problems of endogeneity and selectivity bias fully into account. Furthermore, in contrast to most of the previous contributions, flexible functional forms are employed in the estimations presented here. LOPEZ (1984) and BENJAMIN (1992) are two papers explicitly investigating the non-separability hypothesis in the household model framework, however with regard to labour markets in Canada and Indonesia. The following is an attempt to transfer their considerations to the credit market problem in Poland.

The paper proceeds in several steps. Chapter 2 outlines theoretical framework and research methodology of the analysis. In Chapter 3, the empirical strategy is presented and a number of potential problems in implementing this strategy are discussed. Chapter 4 contains the results of the econometric estimations, and Chapter 5 draws a number of conclusions.

2 THEORETICAL FRAMEWORK AND RESEARCH METHODOLOGY

This chapter theoretically examines the behaviour of a farm household facing a potential credit constraint. The model analyses household behaviour in a static fashion inspired by the literature on agricultural household modelling. In the following, I concentrate on the producer side of the household to study how the credit constraint affects production decisions, while consumption decisions are only depicted rudimentarily. However, the following can be seen as representing a subsystem of a full household model which includes consumption choices as endogenous variables. See DE SOULET and DE JANVRY (1995, pp. 149-163) for a fuller exposition of this type of models.

Consider a farm household producing one output $y \geq 0$ (with a given price p) with i inputs $x_i \geq 0$ (with given prices w_i). I assume that the farmer maximises one period's profit π, i.e. the difference between revenue and variable costs, by making decisions about the respective quantities of y and x_i. A number of fixed factors z^q are employed for production, e.g. land and machinery. Due to the seasonality of production, the farmer has a liquidity problem, since inputs have to be purchased prior to harvest. To do these purchases, the farmer can borrow external funds. These funds, however, are limited by a credit constraint $\bar{K}$, which denotes an exogenously given amount of maximum credit the household can borrow in the respective period. Due to this potentially binding credit constraint, farm production decisions compete with consumption choices of the household with respect to liquid funds. Consumption choices determined by household characteristics z^h, e.g. the size and composition of the farmer's family, require a liquidity contribution of the farm, denoted M. The contribution may principally also be negative, i.e. the household provides liquidity to finance production (e.g. as a result of public transfers). Consequently, decisions concerning the use of liquidity for both production and consumption have to be made simultaneously, though I have omitted the formal presentation of consumption choices for the sake of simplicity. The effect of this non-separability is that production decisions cannot be made independent of consumption choices under the binding credit constraint, which may or may not be binding, depending on the respective inflows and outflows of liquidity. The constrained optimisation problem is thus characterised as follows:

$$(1) \qquad \underset{x_i, y}{Max}\ \pi = py - \sum_i w_i x_i \ ,$$

subject to

(2) $g(x_i, y, z^q) = 0$, a given production technology, and

(3) $K - \sum_i w_i x_i - M(z^h) \geq 0$, the credit constraint.

The production technology is assumed to be strictly increasing in x_i and locally strongly concave in x_i. According to (3), credit may be used either for productive or consumptive purposes.

There is a rich body of theoretical literature investigating the causes of credit rationing and potential countermeasures. As noted above, the credit constraint may be due to unresolved problems of adverse selection or moral hazard as a result of information asymmetries on the credit market (STIGLITZ and WEISS 1981). The probability that (3) is binding for a given household will decrease with increasing availability of signalling and/or screening devices to overcome existing information asymmetries. Apart from a sufficient performance and satisfactorily risk exposition of the credit funded project (which is implicitly assumed to be given in the formulation of (1)), availability of collateral, individual characteristics and skills of the borrower, and a positive credit history are assumed to be among the most important devices to avoid credit rationing (for a theoretical analysis see BESTER 1987 and DIAMOND 1989). According to (3), whether the credit constraint is binding may also be due to household characteristics z^h, which in turn determine M.

The Langrangean associated with the constrained maximisation (1) to (3) is written as follows:

(4) $$L = py - \sum_i w_i x_i + \lambda g(x_i, y, z^q) + \eta\left(K - \sum_i w_i x_i - M(z^h)\right),$$

with the endogenous variables y, x_i, λ, and η. Since (3) is an inequality which may or may not be binding, I use the Kuhn-Tucker conditions for this constraint. The first-order conditions for an interior maximum are thus:

(5) $$p + \lambda \frac{\partial g}{\partial y} = 0,$$

(6) $$-w_i + \lambda \frac{\partial g}{\partial x_i} - \eta w_i = 0, \quad \text{for all } i,$$

(7) $$g(x_i, y, z^q) = 0,$$

(8a) $$\eta\left(K - \sum_i w_i x_i - M(z^h)\right) = 0,$$

(8b) $$\eta \geq 0,$$

(8c) $$K - \sum_i w_i x_i - M(z^h) \geq 0.$$

The Kuhn-Tucker conditions (8a) to (8c) allow that either the credit constraint is effective in which (8b) becomes an inequality and (8c) an equality, or the constraint is not effective, in which the reverse holds. η is the *shadow price of the credit constraint*, which is nonnegative in any case. Ceteris paribus, it denotes the marginal effect of an increase of the credit constraint on profit:

(9) $$\frac{\partial \pi}{\partial K} = \eta .$$

If binding, (3) hence represents an additional constraint of production which in turn introduces an *inefficiency* compared to the benchmark case without effective credit limit.

In reality, K is only observed if it is binding, in which case it is identical to the actual credit amount borrowed. The survey data allows the distinction between farms for which K is binding and for which it is not. This qualitative information is *first* indicator used to assess the presence of credit rationing in the sample.

The basic idea of the *second* indicator is to look whether the marginal profit increase *suffices to pay the market interest rate for credit including repayment of the principal*. Whether a given farm household is in fact credit rationed in the sense of an inefficient allocation of resources depends on the following comparison. I regard the farm household as credit rationed if:

(10) $$\eta > r ,$$

with r the interest rate for credit (including repayment of the principal).

To see how an estimate of η can be obtained, first have a look at the profit function under the binding credit constraint π^* in its fully reduced form, i.e. only depending on exogenous variables (compare the approach in SOULET and DE JANVRY 1995, p. 160):

(11) $$\pi^* = \pi^*(p, w_i, z^q, z^h, K).$$

This equation would already allow an estimation of the effect of K on π^*. However, to ease the empirical analysis, I go one step further and derive the *output supply equation* of the single output y^* under the binding credit constraint by virtue of Hotelling's lemma:

(12) $$y^* = \frac{\partial \pi^*}{\partial p} = y^*(p, w_i, z^q, z^h, K).$$

In the case of a single output, the marginal effect of an increase in K on y^* displays the marginal productivity of the credit constraint. However, in its empirical multi-product variant, y^* is total output supply of the farm aggregated by the farm-specific price vector, hence gross revenue of the farm. Product prices thus take the double function of exogenous decision variables *and* means of aggregation. In this case, $\frac{\partial y^*}{\partial K}$ equals the shadow price of the credit constraint η, since additional revenue ceteris paribus is identical to additional profit. To switch from profit to output supply has a number of advantages for empirical implementation: revenues are always positive; furthermore they are less data demanding and to a lesser extent subject to measurement error than profits. As a consequence, a greater variety of functional forms can be employed and results are less likely to be biased by attenuation.

Formulations (11) and (12) show most clearly that under the binding credit constraint, production decisions cannot be analysed in separation from the household characteristics z^h. In this case, separability of production and consumption decisions thus breaks down. An empirically significant influence of household characteristics on production outcomes consequently constitute the *third* indicator of credit rationing.

3 EMPIRICAL IMPLEMENTATION

3.1 Database

The data source for the analyses in this paper is the IAMO Poland farm survey 2000, which is a cross-sectional farm survey conducted in the boundaries of the former Szczecin, Tarnów, and Rzeszów voivodships existing prior to the administrative reform of 1. January 1999. The survey was carried out in 2000 and contains mainly data related to the economic outcomes of the year 1999.

The survey is based on a random sample of farms from the database of the official extension service. The database consists only of farms that show at least some degree of commercialisation and market integration and that account for the bulk of the traded agricultural produce in the research area. The final sample consists of 464 farms; 120 from Szczecin, 108 from Tarnów, and 236 from Rzeszów. For the subsequent analysis, 33 observations had to be excluded due to extreme leverage of outlying data points. Within the given geographic boundaries of the three voivodships, the sample is stratified in one stage. The strata are identical with administrative districts (powiat). Further details on sampling issues, organisation of data collection and a reprint of the questionnaire can be found in HIRSCHAUER (2001).

3.2 Empirical strategy for detecting credit rationing

The survey respondents were classified in borrowers and non-borrowers of working capital loans (Table 1). Approximately three quarters of respondents did not borrow any working capital at all. This does not necessarily mean that they were not active on credit markets at all, since investment loans are not considered in this study. Among the borrowers of working capital loans, 80 percent obtained a loan with subsidised interest (not shown in the table). Credit recipients were asked whether they would have liked to borrow more at the same interest rate. If so, they were classified as 'constrained', which applies to almost half of the borrowers. This is the group of interest for the analysis of the shadow price of the credit constraint, since for them the amount borrowed is identical with the credit limit, which in turn is assumed to be exogenous to the production decision.

Table 1: Importance of rationing in the sample (working capital loans)

Variable	*Observations*	*Percent*
Borrowers constrained	48	11.1
Borrowers unconstrained	67	15.6
Borrowers total	115	26.7
Non-borrowers	316	73.3
All respondents	431	100.0

Note: For definitions of subgroups see text.
Source: Own calculations.

The probability of falling in the group of constrained borrowers can be analysed by the following stochastic model:

(13) $$k_i^* = \gamma z_i + u_i.$$

In this model, k_l^* is a dichotomous (1, 0) variable indicating whether observation l is a credit constrained borrower or not, z_l represents a vector of explaining variables (such as household and production characteristics), γ is a vector of parameters, while u_l is a random error term.

For the credit constrained subgroup, the shadow price of the credit constraint is obtained by estimating (12) as a stochastic relation:

(14) $y_l^* = y_l^*(p, w_l, z^q, z^h, K) + \varepsilon_l$, with ε_l a random error term.

In the empirical model, the shadow price of the credit constraint is then given as:

(15) $\hat{\eta}_l = \dfrac{\partial E(y_l^*)}{\partial K_l}$, with $E(y_l^*)$ the expectation of y_l^*.

If the specification of $y_l^*(.)$ is sufficiently rich, $\hat{\eta}_l$ can be estimated as a function of other variables. Consequently, the value of $\hat{\eta}_l$ can be computed for each farm household and then compared with the observed interest rates. This can be done by regressing estimated shadow prices on interest rates as follows (see a similar application in FEDER et al. 1993):

(16) $\hat{\eta}_l = b_1 + b_2 r_l + e_l$, with e_l a random error term.

The statistical test of credit rationing in the sense of a market inefficiency then involves the null hypothesis $(b_1, b_2) = (0, 1)$, which can be subjected to an F-test procedure.

The above model (14) also allows to test the assumption of non-separability between production and consumption decisions in the household (see comparable studies on labour allocation by LOPEZ 1984 and BENJAMIN 1992). The strategy is straightforward: In case that the credit constraint (3) is in fact not relevant for the households in the sample, it will turn out that household characteristics z^h have no significant effect on output in (14). If, in turn, the parameters of the z^h variables are significantly different from zero (as tested by the standard t-test), separability is rejected and the credit constraint must be regarded as important.

3.3 Problems due to the non-experimental nature of the data

In empirical applications, the implementation of (14) faces a number of problems which are relevant for the specification of the model and the choice of the functional form. These problems arise as a result of the non-experimental nature of the data, in which, unlike in a laboratory experiment, environmental conditions cannot be controlled. I will discuss them in turn, together with the envisaged solutions.

First, there is the general danger of *simultaneity bias* arising from a correlation between K and ε, since one usually would regard K as an endogenous household choice similar to other input variables. However, if K is binding, it is reasonable to assume that simultaneity disappears because the amount of credit used in the farm household is exogenously imposed (FEDER et al. 1990). In this case, model (14) is correctly specified. Therefore, estimation can consistently only be done for the constrained households which I have identified by utilising the specific survey data on that issue (see Section 3.2).

Unfortunately, this sample separation does not come without a cost. It introduces a *selectivity bias*, since households will probably not randomly be selected in constrained and non-constrained ones. It is thus necessary to take the selection process as such into account. Formally, equations (13) and (14) form a system in which (14) is only observed if $k_l^* = 1$:

(17) $y_l^* = y_l^*(p, w_l, z^q, z^h, K) + \varepsilon_l$ iff $\gamma z_l + u_l > 0$.

In this system, ε_i and u_i are supposed to have a bivariate normal distribution with zero means and correlation ρ. I retain the unspecified notation of y_i^* (i) since the function may be non-linear in parameters.

A second problem concerns the availability of appropriate data for the estimations. As is frequently the case in cross sectional data, *price variation* across households *turned out to be insufficient* to produce significant estimates of parameters in the current sample. To deal with this, I dropped the price parameters and estimated a function only dependent on fixed factors and the credit constraint K_i.

3.4 Specification of the model

Equation (17) constitutes an incidentally truncated system, since (13) determines how (14) is truncated. These types of models can be conveniently estimated by a two-step procedure due to HECKMAN (1979). The first step is the estimation of (13) which already yields relevant information of its own. I estimated (13) as a Probit model which due to its non-linear transformation requires the application of Maximum Likelihood techniques. Parameters of this model are then used to calculate so-called Inverse Mills Ratios (IMR's), which are included in the second-stage linear regression of (14) as additional correction factors. To allow valid hypothesis testing, the subsequently shown p-values were modified in order to account for heteroscedasticity and the use of estimates for the IMR.

Table 2: Description of variables used in the regressions (total sample)

	Mean	*Std. Dev.*	*Minimum*	*Maximum*	*Valid observations*
Dependent variables					
Credit constrained (dummy)	.1	.3	.0	1.0	415
Aggregate output supply (ths. €)	55.2	60.3	.6	432.1	406
Independent variables					
Total land cultivated (ha)	22.4	30.2	.0	200.0	431
Total land owned (ha)	13.5	16.8	.0	142.9	431
Land rented from private persons (ha)	2.4	5.7	.0	52.5	431
Capital stock of farm net of land (ths. €)	202.6	160.0	3.3	865.0	431
Credit volume (ths. €)	2.4	7.7	.0	80.0	431
Adult males in household (no)	1.7	.9	.0	5.0	431
Adult females in household (no)	1.7	.9	.0	5.0	431
Previous loan rescheduled (dummy)	.1	.3	.0	1.0	360
Conversation with neighbour (dummy)	.7	.4	.0	1.0	429
Farm is located in northern region (dummy)	.2	.4	.0	1.0	431

Note: 4.227 ths. = 1 € in 1999.
Source: Own calculations.

The variables employed in the regression equation are shown in Table 2. A dummy variable determined by survey responses as explained above serves as dependent variable in the *first-stage Probit regression*. The following explanatory variables were chosen (expected signs are given in parentheses): Land owned (-) and land rented from private persons (+) were taken as indicators of the volume of collateralisable wealth, adult males (?) and females (?) as house-

hold characteristics, a dummy indicating a previously rescheduled loan (+) as illustrating the credit history of the borrower, and a dummy indicating the expressed habit to regularly engage in conversation with neighbours (?) as a measure of village-internal information flow. The effect of the number of adults in the household is indeterminate since a higher number of household members may both increase (via increased consumption) and decrease (via generation of unearned income) (Y). Conversation with neighbours might reduce the probability of being credit constrained due to improved information availability for the local bank. However, it may also identify the borrower as little diligent in his own business, with the result of an increased likelihood of being credit constrained.

In the *second-stage output supply equation*, the dependent variable is aggregate output supply measured in thousand DM, dropped price variables, so the dependent variables are fixed factors of production, credit, and household characteristics to test the non-separability hypothesis. These variables were operationalised as land cultivated, capital stock of farm net of land, credit volume, and adult male and female household members. The credit variable proxies the total volume of working capital loans outstanding at 30 June 1999. In addition to the presented variables, the second-stage equation also contains a dummy indicating location in the northern region and the above mentioned IMR's.

For the second stage, the question arises which functional form to select. Out of five criteria for choosing functional forms given by Uzawa et al. (1978, pp. 224-225), three are of particular importance for this study. First, the functional form should contain no more parameters than are necessary for consistency with the maintained hypothesis. Second, functional forms should be chosen in which the parameters have an intrinsic and intuitive economic interpretation, and in which functional structure is clear. Third, the chosen functional form should be well-behaved in displaying consistency with maintained hypotheses such as positive marginal products or convexity[2].

In the present case, the first criterion is of relevance due to the limited number of degrees of freedom for the second-stage regression, which is based only on a sub-sample of the entire database. This fact limits the possible number of explanatory variables as such, particularly if interaction terms as commonly used in parsimonious flexible forms should be employed. The chosen model specification should therefore concentrate on the most important variables without too much restricting the flexibility of the model. This flexibility was regarded as desirable particularly for the parameters determining the shadow price of the credit constraint, which involves the second and third criterion of Uzawa et al. My aim was to find a formulation sufficiently rich to allow the estimation of a function of the shadow price that accounts for interactions with other explanatory variables and thus to reach a maximum of economic meaningfulness. At the same time, I regarded theoretical plausibility as a decisive benchmark for specifying the model. The implication is that marginal products of credit smaller than one are implausible since they do not even allow repayment of the credit principal. Fixed factors are assumed to show positive marginal products.

In the light of the preceding discussion, I experimented with logarithmic specifications (Cobb-Douglas and Translog), but both forms failed to meet the theoretical requirements outlined above, and also led to difficulties due to zero values for explanatory variables. Two alternative specifications of the output supply equation qualified for further consideration. One is a variety of the Quadratic, the other a variety of the Generalised Leontief functional form.

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[2] The fourth and fifth criteria are computational ease and extrapolative robustness, which are both of minor importance in the present context.

Since the results of the Quadratic function were superior to those of the Leontief in terms of plausibility and explanatory power, only the former are presented in the following.

In all estimations, observations with missing values were skipped. Sample design was not taken into account, i.e. the sample was treated as if it were a simple random sample. Since stratification potentially improves the precision of estimations (DILLMAN 1997), this decision should have no negative implications.

4 RESULTS

The presentation of the empirical results follows the discussion in the preceding chapter. After displaying the estimated regression equations, I go on to show the resulting shadow price functions. Finally, I present the results of the statistical tests of credit rationing.

4.1 Probability of being credit constrained

The results of the Probit model are shown in Table 3. Three out of six explanatory variables are significant at least at the five percent level, the significance of the other three is weaker. All coefficients have the expected sign. The two indicators of collateralisable wealth suggest that collateral is of major importance as a determinant of credit rationing: less land in own property as well as higher shares of rented land imply a higher probability of being credit constrained. According to its t-value, the amount of land rented from private persons is the most important determinant of credit rationing. From the household characteristics, the number of females is significant at less than one percent. Apparently, more women in the farm household tend to tighten the credit constraint or make the farm less creditworthy for other reasons. The reverse holds for men, however less significant. The weakly significant dummy indicating a previously rescheduled loan nicely illustrates the role of the credit history. The positive sign of the dummy on village internal information flow supports the above mentioned view concerning reduced diligence of the borrower. A second explanation is that better information about farming activities of a given borrower led the bank to the impression that this borrower is in fact *not* creditworthy. He may thus have obtained less credit than expected and consequently be classified as credit constrained. The null hypothesis that all slopes of the model are zero as represented by the chi-squared statistic is clearly rejected. Overall, the percentage of

Table 3: Coefficients of Probit model: probability of being credit constrained

Variable	*Coefficient*	t-*value*	*Significance*
Total land owned (ha)	-.010	1.392	.164
Land rented from private persons (ha)	.042	3.034	.002
Adult males in household (no)	-.165	1.572	.116
Adult females in household (no)	.266	2.668	.008
Previous loan rescheduled (dummy)	.345	1.225	.221
Conversation with neighbour (dummy)	.517	2.344	.019
Chi-squared, significance	25.995		<.001
Percent correctly predicted	86.6		
Observations	350		

Note: Regression includes constant.
Source: Own calculations.

correctly predicted outcomes reveals a fairly satisfactorily fit of the model.

4.2 Output supply model: shadow prices and non-separability hypothesis

Table 4 presents the estimation results of the second-stage output supply model. In addition to the linear variables mentioned in Section 3.2, the quadratic formulation contains an interaction term land times capital, and the credit variable only appears in connection with land and capital. Significance and explanatory power of the model are satisfactory. Marginal productivity of capital and land turned out to be positive for most observations. The shadow price of the credit constraint, i.e. the marginal effect of credit on output, has the following formula:

(18) $\hat{\eta}_l = .021^{*} Capital - .051^{*} Land$, for all l.

Table 4: Coefficients of reduced-form output supply model

Variable	*Coefficient*	t-*value*	*Significance*
Total land cultivated (ha)	5.884	5.391	<.001
Capital stock of farm net of land (thz)	.097	2.532	.011
Total land cultivated * capital stock net of land	-.013	4.477	<.001
Credit volume * total land cultivated	-.051	3.408	<.001
Credit volume * capital stock net of land	.021	4.022	<.001
Adult males in household (no)	-.185	.027	.978
Adult females in household (no)	12.394	1.971	.049
Farm located in the northern region (dummy)	-57.974	2.410	.016
Inverse Mills Ratio	22.842	1.179	.239
F-*value, significance*	10.350		<.001
Adjusted R^2	.667		
Observations	43		

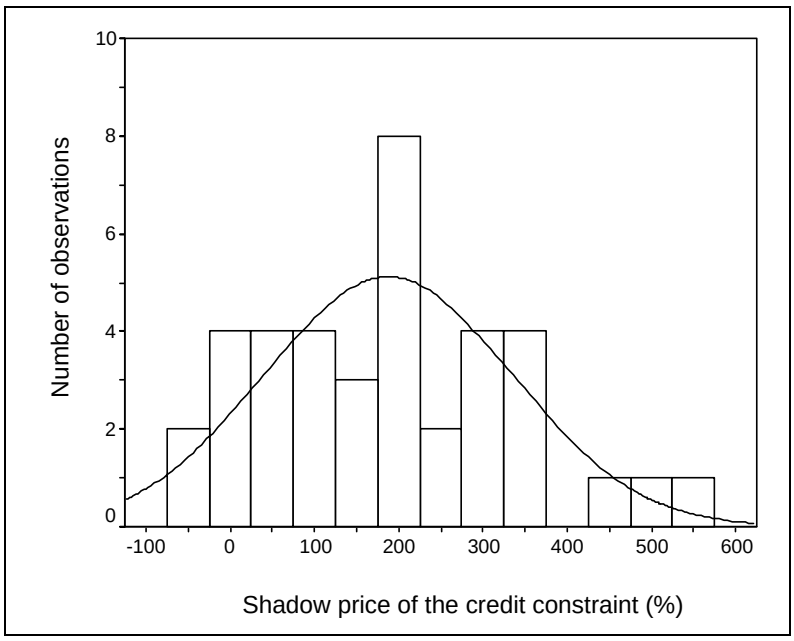
Notes: Regressions include constant. Equation was estimated using the credit constrained sub-sample. *t*-values are based on modified, heteroscedasticity-robust covariance matrix.
Source: Own calculations.

This formula demonstrates that the shadow price increases with increasing capital stock, but decreases with increasing farm size in ha, implying a ceteris paribus higher return on credit on capital intensively operating farms.

A calculation of the shadow price of the credit constraint according to (18) for all individual credit constrained farm households revealed that 90.7 percent of all values were positive and larger than one, or 100 percent, and thus consistent with theory. I rejected observations with values below minus one and above seven (five observations in total), which resulted in the distribution of shadow prices as shown in Figure 1, where they are given in percent.

The histogram shows a distribution with slightly more mass in the left tail and a mean at 187.7 percent. On average, credit constrained farm households were thus able to yield a return of on average 190 percent per annum on an extra unit of credit, with principal already deducted. Given an average nominal annual interest rate on credit of 10 percent in the sample, the presented estimations already point to substantial evidence for credit rationing. The qualitative separation examined above is thus supported and the extent of credit rationing can be quantified.

Figure 1: Distribution of shadow prices of the credit constraint



Notes: Shadow price net of principal repayment. Mean = 187.7; Std. Dev. = 147.9; N = 38. Five extreme values excluded. Solid line in figure shows a normal distribution based on mean and variance of the sample.

Source: Own calculations.

Before examining the relation between shadow price and interest rates more closely in Section 4.3, I consider the significance of the household characteristics. Table 4 shows that the effect of the number of adult females in the household is in fact significant at the five percent level. In contrast to that, an effect of the number of adult males could not be borne out empirically. Although not fully conclusive, this is additional evidence for a binding credit constraint that breaks separability of production and consumption decisions.

4.3 Comparing shadow prices and interest rates

It remains to be shown that the estimated shadow prices are in fact statistically significantly different from interest rates of credit. As described in Section 3.2, this is done by regressing shadow prices on interest rates and testing the null hypothesis of a linear relationship with the parameters $(b_1, b_2) = (0, 1)$.

To obtain a realistic picture of the actual interest rates farmers face, I use a modified effective interest rate which consists of the nominal interest rate as given in the credit contract (whether subsidised or not) plus additional transaction costs due to loan application and monitoring. Transaction costs encompass additional cash expenses fixed in the loan contract (e.g. fees, collateral insurance, etc.), cash expenses for travelling to the bank, and opportunity costs of the time spent for the loan application. I expressed them in percentage of the average loan volume and added them to the annual nominal interest rate. Effective interest rates amounted to 12.8 percent on average. Transaction costs constitute around 20 percent of effective interest rates, which underlines the necessity to account for them.

Table 5: Test of equality of shadow prices and effective interest rates

	$\hat{b}_1$	$\hat{b}_2$	F-*test*	*Signifi-cance*	*Valid ob-servations*
			for the restriction		
Interest rate equation	295.476 (5.378)	-7.139 (1.829)	33.799	<.001	39

Notes: *t*-values in parentheses. Null-hypothesis for *F*-test: $(b_1, b_2) = (0, 1)$ in equation (16).
Source: Own calculations.

The results of the parameter test are shown in Table 5. The *F*-test strongly rejects the null-hypothesis of equal shadow prices and effective interest rates. For the given sample of farm households, shadow prices of the credit constraint are thus significantly different from interest rates. The constant term is positive, large, and highly significant. This is substantial support for the thesis that credit rationing of borrowers is of major importance in the surveyed Polish regions.

5 CONCLUSIONS

The survey results show that only a minority of the observed randomly selected Polish farms borrowed working capital in the reporting period. However, the econometric analysis consistently suggests that more than 40 percent of borrowers experienced pronounced credit rationing by rural banks. For so rationed farms, credit plays a highly significant role in determining output. These farms display internal shadow prices of the credit constraint of on average 190 percent net of principal. Shadow prices increase with increasing capital intensity with regard to land. They are significantly different from individual effective interest rates for credit that account for loan specific transaction costs, which are 13 percent on average. In the group of credit constrained farms, household characteristics could be proven to have a significant effect on output supply. This is evidence for a violation of separability between production and consumption decisions and thus lends empirical support to the existence of a binding credit constraint.

A Probit regression was used to analyse the determinants of credit rationing. It underlined the crucial role of collateral availability. While a higher amount of land in own property reduces credit rationing, farms with more rented land tend to face a higher probability of being constrained. Variables indicating the credit history of the borrower and village-internal information flow turned out to be (in part weakly) significant for the rationing status of farmers. If these results are taken together with the estimated shadow price functions, the following picture of credit constrained farm households can be drawn: They own less and rent more land than the average; they operate with a high capital intensity with regard to land, tend to have a poor credit history, and engage intensively in intra-village conversation.

The policy implication of these results condenses to the statement that continuous granting of highly subsidised interest rates in Poland did not overcome credit rationing of farmers at all. Although the large majority of borrowers applied for a subsidised loan, a substantial proportion of them was not able to obtain as much credit as economically justified. On the other hand, the internal return on credit within the credit rationed sub-sample of farmers would largely suffice to pay any market oriented, commercial interest rates, which were between 15 and 25 percent in 1999. In light of the preceding analysis, a governmental subsidy on interest rates can neither be regarded as an appropriate instrument to achieve an efficient nor an equitable allocation of credit within the Polish agricultural sector.

The results suggest that the actual causes of credit rationing are related to existing information asymmetries between lender and borrower, which are not altered by any interest subsidy. There is empirical evidence that lack of appropriate collateral increases the probability of being credit constrained. In addition, risk aversion of bankers who are reluctant to lend to previously unreliable borrowers appears to play a role as well.

The resulting policy recommendations point in two directions. The first is to check the *lending technology* of Polish rural banks, i.e. the screening and enforcement procedures currently used to select and monitor creditworthy loan applicants. There might be a potential for more innovative technologies that rely less on collateral (see e.g. VON PISCHKE 1991). Furthermore, a general streamlining of banking procedures might be desirable, as the efficiency of the Polish rural banking system has recently been called into question (KOCHARKSHVILI 2000). This is a task for the banks themselves but also for policymakers who have to decide on the privatisation of the still government-owned Bank for Food Economy (Bank Gospodarki Żywnościowej; BGŻ), an important player on Polish rural credit markets.

A second direction is to consider public measures to counteract the collateral problem, e.g. by a *credit guarantee scheme* that is more extended than the existing one. However, the little available information about public credit guarantees or any similar form of risk take-over by governments suggests that these experiments often become costly for the tax payer. With few exceptions, previous programmes tended to result in severe problems of moral hazard and increasing default rates, and caused substantial administrative costs (GREEN 1998). After all, government agencies rarely possess better information about prospective borrowers than local banks. Expanding governmental credit guarantees might thus mean to substitute the bad by the worse, since default rates among Polish farmers so far have been very modest (KOCH 1998).

A final direction concerns the *effects of direct payments* Polish producers may receive after EU accession. In the light of the above results, substantial liquidity effects in terms of an expansion of production can be expected for credit constrained farms. This is in contrast to the textbook case of supposedly production neutral direct transfers and should be taken into account by those involved in the accession negotiations.

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