Credit Rationing Under Asymmetric Information and The Fund of Guarantees for Agriculture and Forestry

Karel Janda[1]

August 1994

Abstract

There exist many different programs for government support of agricultural credit around the world. Many of these programs are specified for special purposes such as the support of environmentally friendly farming, or for the support of young farmers. But a great proportion of the government money for the support of agricultural credit goes to general programs aimed just at financing agricultural activities.

In a majority of these general purpose programs of government support for agricultural and small business credit in the U.S.A. and Western European countries, there is the condition that these programs are intended for borrowers who do not qualify for ordinary commercial loans. In some of these programs the applicant for the subsidized loan has to show that his loan application was rejected by a commercial bank. The government support for agriculture is in this way strictly targeted toward the most disadvantaged farmers.

The Czech programs administered by the Fund of Guarantees for Agriculture and Forestry (Fund of Guarantees) are in sharp contrast with this approach of targeting credit support. Of course, there exist a number of conditions to determine the eligibility of a farmer for support by the Fund of Guarantees. Primarily, in order to be considered for support, the agricultural enterprise has to have settled all the restitution and transformation liabilities, and there are further conditions elaborated in the program guidelines 'Pokyny pro poskytovani garance a dotace prostrednictvim', PGRLF (1994). However, there is no special emphasis on targeting the support towards a special group of farmers, who are rejected by commercial banks.

The aim of this paper is to provide the possible theoretical rationale and justification of such a nondiscriminating policy and of the credit guarantee approach to government support of agricultural credit markets.

Abstrakt

Ve světě existuje mnoho různých programů vládní podpory úvěrů v zemědělství. Řada z nich je zaměřena na konkrétní cíle, jakými jsou podpora ekologického hospodaření nebo podpora mladých farmářů. Velká část vládních prostředků na podporu úvěrů v zemědělství je však určena na obecné programy, jejichž cílem je právě jenom financování zemědělských aktivit. U většiny těchto obecně zaměřených programů vládní podpory úvěrů v zemědělství a drobném

[1] This paper was written during the author's stay at the Department of Applied Economics, University of Cambridge. The author thanks J. Edwards, W. Perraudin, and I. Sturgess for helpful comments and suggestions.

podnikání v USA a v západoevropských zemích je podmínka, že tyto programy jsou určeny pro zájemce, kteří nesplňují podmínky pro poskytnutí běžné komerční půjčky. V některých případech musí zájemce o dotovanou půjčku prokázat, že jeho žádost o půjčku byla komerční bankou zamítnuta. Vládní podpora zemědělství je tímto způsobem zaměřena výhradně na nejvíce znevýhodněné farmáře.

Přímým opakem tohoto přístupu k cílené podpoře úvěrů jsou české programy spravované Garančním fondem zemědělství a lesnictví (Garanční fond). Je zde samozřejmě řada podmínek, na jejichž základě Garanční fond posuzuje vhodnost zemědělce pro poskytnutí podpory. K tomu, aby zemědělskému družstvu mohla být poskytnuta podpora, musí mít předně vypořádány všechny restituční a transformační závazky. Další podmínky jsou uvedeny v programové příručce "Pokyny pro poskytování garance a dotace prostřednictvím PGRLF",(1994). Avšak není zde kladen zvláštní důraz na cílenou podporu konkrétní skupině farmářů, kteří byli odmítnuti komerčními bankami.

Cílem této práce je podat možné teoretické zdůvodnění a ospravedlnění takové nediskriminační politiky a přístupu vlády k poskytování úvěrových garancí v zemědělství.

CONTENTS

1. Introduction

There exist many different programs for government support of agricultural credit around the world. Many of these programs are specified for special purposes such as the support of environmentally friendly farming, or for the support of young farmers. But a great proportion of the government money for the support of agricultural credit goes to general programs aimed just at financing agricultural activities.

In a majority of these general purpose programs of government support for agricultural and small business credit in the U.S.A. and Western European countries, there is the condition that these programs are intended for borrowers who do not qualify for ordinary commercial loans. In some of these programs the applicant for the subsidized loan has to show that his loan application was rejected by a commercial bank. The government support for agriculture is in this way strictly targeted toward the most disadvantaged farmers.

The Czech programs administered by the Fund of Guarantees for Agriculture and Forestry (Fund of Guarantees) are in sharp contrast with this approach of targeting credit support. Of course, there exist a number of conditions to determine the eligibility of a farmer for support by the Fund of Guarantees. Primarily, in order to be considered for support, the agricultural enterprise has to have settled all the restitution and transformation liabilities, and there are further conditions elaborated in the program guidelines ‘Pokyny pro poskytovani garance a dotace prostrednictvim’, PGRLF (1994). However, there is no special emphasis on targeting the support towards a special group of farmers, who are rejected by commercial banks.

The nondiscriminatory character of the Czech program is emphasized in part A.3.2. of the program guidelines [Pokyny pro poskytovani garance a dotace prostrednictvim PGRLF(1994, p.9)] by stating that the only reason for not providing assistance, under the condition that all required eligibility requirements are satisfied, is a shortage of money in the Fund of Guarantees budget.

Another question of interest connected with government interventions in the agricultural credit markets is the form which these interventions should take. One of the range of possible choices is a provision of credit guarantees. The support of the farm credit by credit guarantees recently became one of the preferred choices both in established market economies (Luttrell (1989)) and in economies in transition (Sturgess (1993, 1994)). It also forms a substantial part of a Czech programs of the Fund of Guarantees.

The aim of this paper is to provide the possible theoretical rationale and justification of such a nondiscriminating policy and of the credit guarantee approach to government support of agricultural credit markets.

2. The Outline of a Theoretical Approach

The model used for an explanation of the welfare effects of the non-targeted approach of the Czech Fund of Guarantees is based on the Smith and Stutzer (1988, 1989) approach which belongs to a large family of credit rationing models initiated by a Stiglitz and Weiss (1981) paper.

The underlying problem in agricultural credit markets is a difference in opinion about the viability of agricultural enterprises between banks and farmers. On a basis of their private information about markets and about their own entrepreneurial ability, many farmers consider their investment projects to be potentially profitable and economically viable. Banks are often of a different opinion and reject the financing of agricultural projects which could be socially efficient.

In their seminal 1981 paper, Stiglitz and Weiss offered a rigorous theoretical explanation of the existence of credit rationing in which some applicants obtain loans and some of them are rejected, even if they would be willing to pay higher interest rates. The Stiglitz and Weiss explanation is based on a game theoretical argument of informational asymmetry between a borrower and a lender: the individual borrowers know more about their chances of success in their enterprise than a bank knows. There are also asymmetries in the impact of the possible failure of a business project on a farm and on a bank. Generally we can say that, because of limited liability, the bankruptcy of a farm has a worse effect on the expected payoff of a bank than on the expected payoff of the farmer.

Because of this asymmetry, there exists an adverse selection effect, when the farmers with worse projects purport to have good ones, and are willing to pay a higher interest rate. Adverse selection in this context means that, when the bank offers a high interest rate, the agents who respond to this offer (who are selected by this offer) are the ones with the most risky projects, not the ones with the least risky projects. In this situation there can exist an optimal interest rate for the bank, which maximises its profits, and the bank is not willing to extend loans at an interest rate higher than this optimal interest rate. This means that the standard market mechanism, in which we would expect the interest rate to equate demand and supply for credit on a Pareto efficient level, breaks down.

This question of inefficiency of the credit market under asymmetric information was addressed by a family of models of Gale (1990, 1991) and Innes (1990,1991), which also comprises a simple Smith and Stutzer (1989) model, on which the theoretical argument of this paper is based. These models generally investigate government interventions into the credit markets and their welfare effects.

The main game-theoretical technical tool used in these models is a self-selection mechanism which is used to overcome informational asymmetry by sorting farmers into groups according to the riskiness of their projects. There always has to be a sorting criterion with variable parameters in these models. Each farmer chooses a value of a parameter and consequently reveals to the lender to which risk category he belongs. The major problem in constructing such a sorting mechanism is to overcome the natural tendency of a particular risk-type group of farmers to pretend that they belong to a different risk-type group, possibly in order to obtain more favorable treatment which would otherwise be reserved for members of the other group. The approach used to stop this disguising of one group of farmers as members of another group is to make the loan contracts of the other group less favorable, so that each farmer finds it advantageous to stick to his own contract. (The underlying concept of Nash equilibrium is mentioned below in section 3.1.3.). The measure used in this paper's model to decrease the attraction of some contracts is a statement by a lender that he will grant only some of the loan application and that he will ration credit with some given probability of satisfying the loan application.

Besides a large family of Stiglitz-Weiss based models, there also exists a continuous-time finance approach based on Merton (1990) applications of a standard Black and Scholes (1973) model. A non-technical intuitive exposition to this type of models is contained in Janda (1994).

3. The Model

3.1. The Basic Description of the Model

The model is a standard two-period model, with periods indexed by t = 1, 2. There exist two groups of economic agents in a Smith and Stutzer model: lenders and farmers.

3.1.1. Lenders

The utility function of lenders is described as a sum of their consumption in both periods. Letting c_t denote period t consumption, the lenders utility function is $U = c_1 + c_2$. Each lender is endowed with one unit of funds at t = 1, which can be either loaned out or consumed by a lender. This one unit of funds serves as a numerary in our model. The number of homogeneous lenders is N_1.

3.1.2. Farmers

There are $N_2 \leq N_1$ farmers in the model. All farmers are endowed with only one unit of their effort to expend at t=1 and have no further funds of their own. Each farmer has access to an investment project. These projects are indivisible - their realization requires one unit of financial funds (which the farmer has to borrow from a lender) at t=1 and one unit of effort. Additional inputs of funds or an effort would have no effect on a project output.

At t=2, each project is either a "success" or a "failure". A successful project returns y>0 at t=2, while an unsuccessful project produces zero.

In order to induce a source of information asymmetry needed for a functioning of this type of a model, we suppose that the farmers are not homogeneous. The farmers can be divided into two types, with type indexed by i= H, L. A type i farmer has a probability P_i of operating a successful project. The values P_i satisfy $P_H < P_L$, so type H farmers are "high (default) risk" farmers.

Each farmer knows his own type, but not that of the others. This means that there exists information asymmetry between a farmer and lender.

Again letting c_2 denote date 2 consumption, type i farmers have utility functions given by

$$U_i = c_2 + \beta_i, \qquad (1)$$

where β_i is a sure net return which is brought by an alternative employment opportunity for a farmer. It is just an opportunity cost of using the farmer's effort endowment.

It is common knowledge to all farmers and all lenders that the fraction of farmers of type H is θ, such that $0<\theta<1$.

3.1.3. Financial Contracts and a Game

We assume that $N_1>1$, so there is a competition among lenders. Each lender offers a loan contract consisting of a pair (R_i, π_i), where R_i is the gross interest rate charged to a farmer of a type i and π_i is the probability that a loan to a farmer of type i will be granted. The gross interest rate is paid by a farmer in the second period after a random return of a project becomes known. From a limited liability of a farmer it follows, that in case of failure, his payment to a lender is zero.

The probability of granting a loan is incorporated into a loan contract offer because it enables lenders to separate the farmers using the self-selection mechanism mentioned in part 2 of this paper. If the contract were to consist only of the interest rate there would be no way for a lender to distinguish between the two types of farmers; all farmers would apply for the same interest rate in equilibrium.

Each lender can provide at most one loan. Hence each lender can be viewed as making a choice of which type of farmer he would prefer to lend to; the lender can only choose between two types of farmer. Because the lenders are homogeneous we can suppose that, if there exists a unique equilibrium contract (R_L, π_L), in an equilibrium, all lenders lending to type L farmers will offer the same interest rate R_L and the same probability of granting a loan π_L. The same reasoning applies for the lenders borrowing to type H farmers.

The game of this model has two stages:

Stage 1: Lenders choose a loan contract to offer, taking the offers of other lenders as given.

Stage 2: Farmers observe the offers from stage 1 and then choose to apply for the loan contracts they view as most attractive. We assume that each farmer can apply for only one loan.

As a solution to this game, a standard Nash equilibrium definition applies: a Nash equilibrium is a set of contract offers (R_i^*,π_i^*), for i=L, H, such that given these offers, no lender has an incentive to offer a different loan contract. Thus the equilibrium definition of Rothschild and Stiglitz (1976) is imposed.

Generally there are three kinds of outcome of this game:

1. No equilibrium.
2. Pooling equilibrium, in which both types of farmers choose the same contract. This means that farmers are pooled together and information about the type of each farmer is not revealed.
3. Separating equilibrium, in which each type of farmer chooses his type-specific contract. Farmers are in this way separated into two groups and information about the type of each farmer is revealed.

In the following analysis we shall concentrate on the separating type of an equilibrium with conditions for its existence given in part 4 of this paper.

4. The Equilibrium in the Absence of a Government Intervention

In the absence of government intervention, the expected utility of a type i farmer receiving a type j loan contract will be:

$$U_{ij}=\pi_j P_i(y-R_j) + (1-\pi_j)\beta_i. \qquad i,j = L, H. \tag{2}$$

The first term in (2) $\pi_j P_i(y-R_j)$ represents the expected utility from operating a project funded by a lender. The second term $(1-\pi_j)\beta_i$ is an expected utility from a utilization of outside opportunities occurring when the farmer does not obtain a loan.

In a separating equilibrium, each farmer of type i will receive either no contract or the type i contract, i.e. the contract of his type. In equilibrium, U_{ii} will be maximized subject to the self-selection constraints:

$$U_{ii}\geq U_{ij}, \qquad i,j= L, H, \quad i \neq j, \tag{3a}$$

and a zero-profit condition for lenders serving either type of farmer:

$$P_i R_i - 1 = 0. \quad i=L, H. \tag{4}$$

Self-selection constraints mean that the type i farmer does not obtain a higher utility by obtaining a type j farmer contract. So as long as the self-selection constraints are satisfied, each farmer in separating equilibrium reveals his type by choosing the contract designed for his type.

A zero-profit condition is brought about by a competition between lenders. Its meaning is evident: The expected revenue obtained in the second period, which implies the lender's expected second-period consumption $c_2=P_iR_i$, is equal to the lender's opportunity cost of his loan. This opportunity cost is given by a lender's first-period consumption $c_1=1$, which would be possible if the lender did not loan his one unit of a fund's endowment.

The main graphical tool of the analysis of this model is the indifference curves map, as depicted in Figure 1. Each indifference curve is, as usual, a locus of pairs (R_i,π_i), for i=L, H, such that the farmer of type i is indifferent (obtains the same utility) between accepting any of the contracts (R_i,π_i) on a given indifference curve.

The indifference curves located more towards the northwest corner of the Figure 1 are associated with a higher utility because, with a constant R, they bring a higher probability of granting a loan; the other way around, with a constant probability of granting a loan, they allow a farmer to pay a lower interest rate. So, the contracts on an indifference curve U_i^1 are preferred to the contracts on U_i^2 and these are in turn preferred to those on U_i^3.

In order to be able to draw a reasonably simple map of indifference curves, we maintain two assumptions in the subsequent analysis.

First, we assume that projects are productive enough so that an increase in the probability of obtaining a private sector loan increases farmers' utility at all relevant interest rates. This is ensured by assuming that a successful project return y is sufficiently large to have a positive marginal utility with respect to π_i. The relevant inequalities for a value of y are derived by differentiating U_{ii} with respect to π_i, using a condition (4) to substitute $1/P_i$ for R_i in a first partial derivative and finally expressing y:

$$y>1/P_i + \beta_i/P_i. \tag{A1}$$

The condition (A1) also means that all projects have their expected gross returns P_iy higher than their social opportunity cost $(1+\beta_i)$. Therefore any amount of credit rationing, which decreases the number of realized projects, represents a social efficiency loss.

Second, we impose a "single crossing condition," i.e. that the marginal rate of substitution $(MRS_i=-(\partial U_{ii}/\partial R_i)/(\partial U_{ii}/\partial \pi_i)>0)$ of a type L farmer exceeds that of a type H farmer at any point $S=(R^s ,\pi^s)$ in the R-π plane as depicted in Figure

2. The purpose of this condition is to make sure that the indifference curves of both types of farmer are upward sloping, that the indifference curves of high default risk farmers are flatter than the ones of low risk farmers, and that any two indifference curves U_L, U_H intersect at most once.

Proposition 1: The "single crossing condition" is satisfied if, and only if:

$$\beta_L/P_L > \beta_H/P_H. \tag{A2}$$

Proof: proposition 1 is proved by computing MRS_i at any point $S=(R^s, \pi^s)$ in the R-π plane. At each point S there are two indifference curves crossing each other such that $R_L=R_H=R^s$ and $\pi_L=\pi_H=\pi^s$.

$$MRS_i(S)=\pi^s P_i/[P_i(y-R^s)-\beta_i]. \tag{A2a}$$

To obtain the condition (A2) is just a question of substituting from (A2a) into (A2b)

$$MRS_H(S) < MRS_L(S) \tag{A2b}$$

and performing a simple algebraic manipulation, during which we also make use of a condition (A1).QED

Because, according to our definition of high- and low-risk farmers in part 3.1.2. as farmers with success probabilities $P_H < P_L$, condition (A2) holds when the opportunity cost β for a type H farmer is sufficiently less than that for a type L farmer. This is intuitively plausible, as it holds when borrowers who have a relatively high probability of not defaulting also have better outside opportunities for their efforts in the event that their loan applications are denied and, consequently, have a higher opportunity cost β. This assumption ensures that type H farmers have relatively less aversion to paying higher interest rates in return for a higher probability of a loan approval. Using (A2) we can simplify a pair of type specific restrictions (A1) into a sufficient condition for positive marginal utility to both types of farmers:

$$y > 1/P_H + \beta_L/P_L. \tag{A3}$$

Under (A2) and (A3), a separating equilibrium (when it exists) is depicted in Figure 3. As shown there, the only equilibrium interest rates consistent with (4) are $R_H^*=1/P_H$ and $R_L^*=1/P_L$. Also, since (3a) does not bind in the determination of the equilibrium solution (R_H^*,π_H^*) for a high-risk farmer, a maximization of

U_{HH}, contained in an Appendix 5, yields $\pi_H^*=1$. The self-selection constraint (3a) is not binding for the maximization problem of a high-risk farmer because a low-risk farmer never wants to pretend that he is a high-risk farmer and a high-risk farmer has no incentive to keep his utility lower in order to prevent a low-risk farmer applying for contracts designated for a high-risk farmer.

The solution $\pi_H^*=1$ means that <u>all high-risk farmers willing to pay the market risk-adjusted rate of interest R_H^* will receive loans</u>.

The only binding constraint in (3a) is the constraint for a maximization problem of a low-risk farmer

$$U_{HH}=U_{HL}, \tag{3b}$$

which says that, in order to separate low-risk farmers from high-risk farmers, the contract designated for a low-risk farmer has to be such that the high-risk farmer cannot improve his utility by a deviation from a contract designated for him to the contract designated for a low-risk farmer.

In order to solve the equilibrium value of π_L we substitute the appropriate expected utilities from (2) into (3b) using the equilibrium value of $\pi_H^*=1$:

$$1P_H(y-R_H^*)+(1-1)\beta_H = \pi_L^* P_H(y-R_L^*) + (1-\pi_L^*)\beta_H. \tag{5a}$$

We substitute in an equation (5a) for R_i^* from (4) and we obtain

$$P_H(y-1/P_H) = \pi_L^* P_H(y-1/P_L) + (1-\pi_L^*)\beta_H. \tag{5b}$$

Finally we express from (5b) the equilibrium value of a probability of granting a loan contract to a low-risk farmer

$$\pi_L^* = \frac{y-(\frac{1}{P_H}+\frac{\beta_H}{P_H})}{y-(\frac{1}{P_L}+\frac{\beta_H}{P_H})} < 1. \tag{5c}$$

Because $P_H<P_L$ it follows that $\pi_L^* < 1$. This means that <u>a positive fraction $(1-\pi_L^*)$ of low-risk farmers willing to pay the market risk-adjusted interest rate R_L^* will not receive loans, while a fraction π_L^* of otherwise identical farmers will receive loans</u>.

Thus, lenders sort farmers into risk classes *ex post*, by making it tougher to obtain low-interest loans, by granting only a fraction of loan applications that desire the low interest rate. If this credit rationing were not in place, high-risk farmers would apply for the lower interest loan designated for low-risk farmers and there would be no separating equilibrium.

This is a type of credit rationing that stands in marked contrast to what would occur in a perfectly competitive loan market where lenders know farmer types *ex ante*. This full information case is described in an Appendix 6. In a full information market, while (4) would still govern interest rates, the maximization of expected utility in the absence of a self-selection constraint (3a) would yield $\pi_L^*=\pi_H^*=1$. This means that there would be no credit rationing and standard results of a free market mechanism equating a supply and a demand for credit would apply. Thus, while the high-risk farmers receive the same treatment in both cases, the existence of a private information creates a "credit gap" that makes the low-risk type farmers worse off. This is the price that must be paid to ensure sorting, i.e. that high-risk farmers will not misrepresent themselves to obtain the low-risk farmers' contracts. According to Cooper (1984) these results are generic and persist with more than two types when indexing type by the size of (opportunity cost/ probability of granting a loan) ratio β_i/P_i.

When interpreting the results of this model, we have to keep in mind a crucial condition of informational asymmetry, that lenders cannot observe a borrower's default risk class *ex ante*. This condition is in agreement with the empirical observation of the Czech loan officers who admit that very often they are faced with a number of applications for loans on agricultural projects and they are just not able to find out which of these projects has the best chance to succeed.

Given the limited time, human capital, and money resources of the Czech loan officers, they are in the best case just able to state a risk class of farmers in a given region as a group, but are not able to distinguish between risk classes inside a farmers' population. In this situation the limited resources devoted to agricultural credit are very often allocated on a subjective basis, depending on a loan officer's discretion with a high level of irregularity in the decision to grant a loan to one farmer and to reject another farmer.

If the lenders could costlessly and objectively partition farmers into risk classes *ex ante*, the adverse selection type of rationing would not occur, i.e. every farmer willing to pay the appropriate risk-adjusted interest rate would receive credit. Thus, the results of this model are meant to apply in circumstances where objective credit analyses of individual loan applications are either too costly or uninformative to be as useful as the sorting mechanism modelled here. This situation corresponds very well to a situation of economies in transition with only slowly emerging and unexperienced institutional commercial banking structures. In the Czech transitional economy, this assumption is particularly well-suited to an agricultural sector with an unclear future of production patterns and with changing comparative advantages and economic priorities. The problem of informational asymmetry is particularly accentuated in the case of starting small farmers with a lack of entrepreneurial and credit history.

Figure 3 characterizes a sorting equilibrium when it exists. The question of the existence of an equilibrium in these types of model has already been addressed in Rothschild and Stiglitz (1976). Exactly as in their paper, a contract (R_θ, π_θ) pooling both types of farmer might exist which would earn non-negative profits and attract both types. If so, (R_i^*, π_i^*) cannot be an equilibrium. Moreover, (R_θ, π_θ) cannot be an equilibrium either, for the same reasons given in Rothschild and Stiglitz. In this case, no equilibrium exists.

Recalling that θ is the population fraction of high-risk farmers, the pooling contract (R_θ, π_θ) earns non-negative profit to a lender, if the size of interest rate R_θ and an expected probability of success in (4) are such that

$$[\theta P_H + (1-\theta)P_L]R_\theta \geq 1, \tag{6a}$$

where the term $[\theta P_H + (1-\theta)P_L]$ is an expected probability of a success of a farmer of an unknown type.

If the proportion of low-risk farmers is high enough, the problem of a cross-subsidization of high risk-farmers by low-risk farmers diminishes. With low number of high-risk farmers, it is no longer efficient for low-risk farmers to accept credit rationing in order to separate from high risk-farmers and there may exist a pooling contract, as depicted by the point Y in the Figure 4.

However, if θ is sufficiently large, the dotted constraint set defined by (6a) shrinks to the right of the point C (say, to the point X) to preclude the possibility of a pooling contract that type L agents would prefer over (R_L^*, π_L^*). A low-risk farmer prefers the separating contract E_L^*, which generates a utility level U_L^*, to any contract to the right of an indifference curve U_L^*. The utility of such a contract as X, which is given by an indifference curve U_L^P, is always lower than U_L^*. This ensures the existence of equilibrium as depicted in Figure 3. In fact, it is easy to see from Figure 4 that the larger β_L/P_L - β_H/P_H is (i.e., the greater the difference in the relative slopes of the indifference curves), the smaller θ needs to be in order to rule out such a pooling contract. The same can also be seen from the inequality (6a), which is satisfied for a lower θ with a growth in P_H and/or with a decrease in P_L.

More precisely, existence is guaranteed if θ is sufficiently large to ensure that the point $X=\{R_\theta=1/[\theta P_H+(1-\theta)P_L],\ \pi=1\}$ lies to the right of the indifference curve U_L^*, so no low-risk farmer would prefer any contract in the dotted (to the right of X) region to (R_L^*, π_L^*), i.e. no low-risk farmer wants to pool with a high risk-farmer. Using (2),

$$U_{LL}(R_\theta, \pi_L=1) = P_L(y-R_\theta). \tag{6b}$$

The critical value of the population fraction of high-risk farmers θ^C, such that $\forall\ \theta>\theta^C$ do not admit the existence of a preferred pooling contract, is obtained in the following way: The value of R_θ obtained from the (6a) considered as an equation is substituted into (6b) considered for equilibrium utility U_{LL}^*:

$$U_{LL}^*=P_L\{y-1/[\theta P_H+(1-\theta)P_L]\}. \tag{6c}$$

From (6c) the critical value of θ^C is obtained by an algebraic manipulation as

$$\theta^C = [(y-U_{LL}^*/P_L)^{-1} - P_L]/(P_H-P_L).$$

The positive fraction $0<\theta^C<1$ exists if the following condition is satisfied:

$$1<y-U_{LL}^*<P_L/P^H.$$

The assumption that a proportion of high-risk farmers in a farmers' population is high enough to prevent the existence of a pooling contract is quite a reasonable one in the conditions of Czech agriculture. Both farmers and banks would probably agree that the number of high-risk farmers is significantly higher than the number of low-risk farmers in the Czech Republic.

5. Government Interventions

5.1. Non-Targeted Loan Guarantees

5.1.1. Basic Model

We suppose that the government offers to guarantee a fraction α of the amount of each private loan made to farmers. (In the actual implementation of the Czech Fund of Guarantees program, the maximum fraction α generally depends on the average length of time of the maturation of a debt. For the short term credit up to 2 years α=0.5, for the medium term credit up to 5 years α=0.7, and for the long term credit over 5 years α=0.85. In some cases it is possible for the Fund of Guarantees to provide a full guarantee with α=1 to a lender, but the Fund of Guarantees requires, in these cases, the farmer's collateral in return).

The utility function of a farmer is still (2), because the farmer does not care if his loan is guaranteed or not. He is only interested in the probability of obtaining a loan and in the required interest rate on it.

The zero profit condition for lenders in this case is no longer given by (4), but by

$$P_iR_i + \alpha(1-P_i)R_i - 1 = 0, \qquad i = L, H. \tag{7a}$$

The first term in (7a), (P_iR_i), is an expected revenue to a lender from a successful project. The second term, $\alpha(1-P_i)R_i$, is an expected return to a lender from a guaranteed portion of an unsuccessful project. The opportunity cost of lending one unit of funds is 1, which is a third term in (7a).

The resulting separating equilibrium (R_i^G, π_i^G) is shown in Figure 5.

The existence of a separating equilibrium can be guaranteed by an argument similar to the one used in the previous section. We assume that θ is sufficiently large to ensure that the point X={$R_\theta=1/[\theta(P_H + \alpha(1-P_H)) + (1-\theta)(P_L + \alpha(1-P_L))]$, π=1} lies to the right of the indifference curve U_L^G in the Figure 6. The first coordinate of a point X is obtained from (7a) by substituting R_θ for R_i and by substituting the expected value of $P=[\theta P_H + (1-\theta)P_L]$ for P_i.

5.1.2. Welfare consequences

The comparison of the equilibrium interest rates R_i^G and R_i^* (i=L, H) on the horizontal axis in Figure 5 shows that <u>the loan guarantee program has the effect of reducing equilibrium interest rates for both types of farmers</u>. (Competition forces lenders to pass the profits stemming from loan guarantees through to the farmers.) The decrease of an interest rate with the increase of a guarantee level α can be shown also algebraically by expressing R_i from (7a) and differentiating with respect to α. This results in

$$\frac{\partial R_i}{\partial \alpha}=\frac{P_i-1}{[P_i+\alpha(1-P_i)]^2}<0. \tag{7b}$$

The probability of granting a loan to a high-risk farmer is the same as in a model without government intervention presented in section 4, $\pi_H^G=\pi_H^*=1$. The single crossing condition is still (A2), so the only binding self-selection constraint in (3a) is

$$U_{HH}=U_{HL}. \tag{8a}$$

After an substitution of appropriate utilities U_{HH}, U_{LL} from (2) into (8a) we obtain

$$\pi_H^G P_H(y-R_H^G)+(1-\pi_H^G)\beta_H=\pi_L^G P_H(y-R_L^G)+(1-\pi_L^G)\beta_H. \tag{8b}$$

Because $\pi_H^G=1$, (8b) simplifies into an equation

$$P_H(y-R_H^G)=\pi_L^G P_H(y-R_L^G)+(1-\pi_L^G)\beta_H, \tag{8c}$$

which can be easily solved for π_L^G:

$$\pi_L^G=\frac{P_H(y-R_H^G)-\beta_H}{P_H(y-R_L^G)-\beta_H}. \tag{8d}$$

After a substitution for R_i^G from (7a) into (8d) we obtain a final expression for the value of a probability of granting a loan to a low-risk farmer:

$$\pi_L^G=\frac{y-[\frac{1}{P_H+\alpha(1-P_H)}+\frac{\beta_H}{P_H}]}{y-[\frac{1}{P_L+\alpha(1-P_L)}+\frac{\beta_H}{P_H}]}. \tag{8e}$$

Equation (8e) reduces to (5c) when α=0.

Proposition 2: The probability of granting a loan to a low-risk farmer increases with an increase in the percentage of a loan guarantee:

$$\partial\pi_L^G/\partial\alpha>0. \tag{8f}$$

Proof: See Appendix 1.

So <u>in addition to a lower interest rate, low-risk farmers will have a higher probability of getting a loan</u> as compared to a situation without government intervention. Expected utility of both types of farmers is thus increased by a loan guarantee program available to all lenders.

The social consequences of this program are as follows: by increasing π_L, the expected number of funded projects will increase, thus increasing an expected agricultural output and consumption. A reasonable measure of efficiency must consider the consumer welfare derived from increased consumption in addition to changes in farmers' welfare. A simple way to measure increased efficiency is by evaluating changes in the expected output of funded projects minus the cost of inputs employed in production. These costs of inputs per additional investment project operated are one unit of capital investment plus the opportunity cost of effort β. Total welfare defined in this way can be written as V^* (V^G) for a case without guarantees (with guarantees):

$$V^*=(1-\theta)\pi_L^*[P_Ly-(1+\beta_L)]+\theta\pi_H^*[P_Hy-(1+\beta_H)]$$

$$(V^G=(1-\theta)\pi_L^G[P_Ly-(1+\beta_L)]+\theta\pi_H^G[P_Hy-(1+\beta_H)]),$$

where $\pi_H^*=\pi_H^G=1$.

Thus the expected change in efficiency arising from the loan guarantee program as compared to a situation without government intervention is a change in total welfare:

$$V^G-V^*=(1-\theta)(\pi_L^G - \pi_L^*)[P_Ly - (1+\beta_L)]. \tag{9}$$

The expression (9) says that the change in the efficiency is given as an expected net benefit from one low-risk project, given that a project is financed and undertaken, $[P_Ly - (1+\beta_L)]$, multiplied by an increase in a probability of obtaining a finance for a low-risk project under a loan guarantee regime ($\pi_L^G - \pi_L^*$), multiplied by a fraction of low-risk farmers in a population ($1-\theta$).

From (8f) it follows that a term $(\pi_L^G - \pi_L^*)$ is positive. The assumption (A1) guarantees that the term $[P_L y - (1+\beta_L)]$ is positive. It means that the whole expression (9) is positive and that the loan guarantee program increases social efficiency.

The efficiency measure used in this model can be rationalized by assuming that consumers' expected utilities are linear in consumption (i.e. project output y). We have also implicitly assumed that the government's losses on its loan programs are financed by a nondistortionary lump sum taxation, which means that the government's losses are just a transfer payment, which is neutral from the efficiency evaluation point of view. In the absence of ideal lump sum taxes our efficiency measure has to be adjusted for the inefficiency of a real world government taxes used to finance government losses on a loan guarantees program.

5.2. Direct Targeted Loans

5.2.1. Basic Model

Now suppose the government offers to finance at an interest rate R_g a fraction α of loans denied by private lenders. It means that π_j a fraction of type j farmers' projects is financed by loans from commercial lenders, $\alpha(1-\pi_j)$ percent is financed by a government finance and $(1-\alpha)(1-\pi_j)$ percent of type j farmers' projects is not financed at all, and consequently not undertaken. This policy is similar to actual "targeted" direct loan programs, which attempt to verify that loans are granted only to those farmers who cannot obtain financing from commercial lenders.

The zero profit condition is again given by (4), so equilibrium interest rates are the same as in the model without government intervention $R_i^D=R_i^*=1/P_i$ (i= L, H).

The expected utility of a type i farmer given type j contract will not be (2) like in the model without a government intervention, but it will be rather:

$$U_{ij}=\pi_j P_i(y-R_j)+(1-\pi_j)P_i\alpha(y-R_g)+(1-\pi_j)(1-\alpha)\beta_i. \quad i,j=L,H. \qquad (10)$$

The first term in (10) is the same as a first term in (2) and represents the expected utility of a farmer derived from operating a project funded through a commercial lender. The second term is the expected utility from a government-funded project. The third term is the expected utility of outside opportunities occurring when the project is not undertaken.

Direct computation of marginal rates of substitution along the lines of the proof of (A2), presented in Appendix 2, verifies that the single crossing condition is still (A2).

We assume that the marginal expected utility associated with an increase in the probability of obtaining a direct government loan ($\partial U_{ii}/\partial\alpha$) is positive

$$\frac{\partial U_{ii}}{\partial\alpha}=(1-\pi_i)P_i(y-R_g)-\beta_i(1-\pi_i)\ >\ 0, \tag{10a}$$

so that direct loans will be taken when offered. A sufficient condition for this is obtained by expressing y from (10a):

$$y>R_g + \beta_i/P_i. \tag{10b}$$

Because of a single crossing condition (A2), the sufficient condition (10b) simplifies to

$$y>R_g + \beta_L/P_L. \tag{A4}$$

We again assume that the marginal expected utility associated with an increase in the probability of obtaining a private loan is positive. In the presence of government loans it requires a stronger condition than (A3):

$$y > (1/P_H + \beta_L/P_L) + \alpha(y - R_g - \beta_L/P_L). \tag{A5}$$

where the second term in brackets is positive by (A4).

The separating equilibrium (when it exists) is shown in Figure 7. The nonexistence due to a pooling can again be ruled out by assuming that θ is sufficiently large to ensure that the point $X=\{R_\theta=1/[\theta P_H+(1-\theta)P_L], \pi=1\}$ lies to the right of the indifference curve U_L^D in Figure 8.

5.2.2. Welfare consequences

The high-risk farmers are again not rationed and $\pi_H^D=1$. In order to obtain the equilibrium value of π_L^D we substitute appropriate utilities from (10) into a single binding self-selection constraint $U_{HH} = U_{HL}$ using condition $\pi_H^D=1$:

$$P_H(y-R_H)=\pi_L P_H(y-R_L)+(1-\pi_L)P_H\alpha(y-R_g)+(1-\pi_L)(1-\alpha)\beta_H. \tag{10c}$$

After using a zero profit condition (4) to substitute for R_i in (10c) and after some algebraic manipulations we obtain

$$\pi_L^D = \frac{y - [\frac{1}{P_H} + \frac{\beta_H}{P_H} + \alpha(y - R_g - \frac{\beta_H}{P_H}]}{y - [\frac{1}{P_L} + \frac{\beta_H}{P_H} + \alpha(y - R_g - \frac{\beta_H}{P_H}]}, \tag{11}$$

which reduces to (5c) when α=0.

Proposition 3: The government lending crowds out commercial lending and for $R_g < R_L^D$ this crowding out is on a greater than one-to-one basis.
Proof: See Appendix 3.

From Proposition 3 it follows that $\pi_L^D < \pi_L^* < 1$.

Because direct government loans are desired by those low-risk farmers who were refused private loans, the increase in a fraction α of loans financed through a government loan decreases the marginal expected utility associated with a higher private loan probability:

$$\partial^2 U_{ii}/\partial\pi_i\partial\alpha = -P_i(y-R_g)+\beta_i < 0,$$

which is true by (A4).

This decrease of a marginal utility is a decrease in the strength of the disciplining device (self-selection constraint), which is used to keep a high-risk farmer from applying for a low-risk farmer's contract. Therefore in order to decrease the expected utility for the high-risk farmer, stemming from his applying for the low-risk farmer's contract, the value of π_L^D, given by (11), must fall below the value π_L^* given by (5). Unlike the loan guarantee program, direct targeted loans increase the problem of an adverse selection by making it relatively more desirable for high-risk farmers to misrepresent their type.

Also, the social welfare effects of direct loans are more complex than those of loan guarantees. For while the additional funding of projects by the government will increase net output, the reduction in π_L implies a reduction of the number of projects financed through private commercial lenders. The change in an efficiency as compared to a situation without an intervention is thus given by replacing π_L^G in (9) by a term $\pi_L^D+(1-\pi_L^D)\alpha$:

$$(1-\theta)[\pi_L^D+(1-\pi_L^D)\alpha-\pi_L^*][P_Ly - (1+\beta_L)]. \tag{12}$$

Proposition 4: The change in efficiency (12) has the same sign as the government's expected profit on government loans (P_LR_g - 1), which in turn has the opposite side of the expected change in farmers' utility caused by an introduction of direct targeted government loans (U_{LL}^D - U_{LL}^*):

$$\text{sign}((12)) = \text{sign}(P_LR_g - 1) = -\,\text{sign}(U_{LL}^D - U_{LL}^*). \tag{13}$$

Proof: See Appendix 4.

It follows from Proposition 4 that efficiency is increased only when the government obtains profits and the utility of low-risk farmers decreases in comparison with a situation without intervention. In that case, low-risk farmers as a group will expect *ex ante* to be worse off, both because of the reduced probability of receiving private lenders loans (π_L) and because of an interest rate R_g>R_L.

In a case when government programs are aimed at aiding the group of low-risk farmers (who are rejected by private lenders) to increase their utility, according to equation (13), the government inevitably incurs losses. This also means, according to (13), a decrease in a social economic efficiency.

6. Conclusions and Discussion

The presented model describes a competitive market for an agricultural credit with many farmers and many lenders. All agents in the model are assumed to be risk neutral, thus eliminating any insurance role for governmental credit, and there is no aggregate risk.

The subject of this paper is the effect of a government intervention in agricultural credit markets characterized by informational asymmetry and adverse selection.

The principal result is that the welfare effects of credit support are not qualitatively indifferent to the determination of eligibility for government support or to the method of support chosen by a government.

Programs like Czech programs administered by a Fund of Guarantees, which are open to the whole population of farmers, are socially more efficient than programs which would be targeted only towards a group of low-risk farmers who were rejected by commercial lenders. The global loan guarantee programs also reduce the extent of credit rationing when compared to a situation without government intervention or to a situation with a targeted intervention.

These results could look counterintuitive at first. One could expect that a targeted program should achieve better results and be more cost effective (not counting cost, which has to be incurred to distinguish between a targeted group and the rest of a population of farmers) than non-specialized global programs open to all farmers. Also one could intuitively argue that the support should be targeted to the most efficient group of low-risk farmers, whose credit applications were rejected by lenders.

The main reason for the seemingly counterintuitive result of a presented model consists of the existence of informational asymmetry and a consequent need for a lender to create a mechanism which would identify the risk class of a farmer.

The mechanism used by a lender to achieve a self-selection of farmers into two risk groups is a reduction of a probability of granting a low-risk loan. This means the introduction of credit rationing for low-risk farmers.

If the government offers subsidized credit (either direct credit or guaranteed loans) only to a proportion of the low-risk farmers who were rejected by private lenders, this government intervention makes a low-risk contract more attractive to high-risk farmers. Therefore, in order to restore incentive compatibility (to enable a separation between low- and high-risk farmers) some other aspect of the low-risk contract must become less desirable. That means that the overall probability of obtaining a loan has to fall. In this way increased subsidies to the rationed farmers raise the extent of rationing. The loans from commercial lenders are crowded out on a greater than one-to-one basis. This is an equilibrium response and it is due to the existence of the incentive-compatibility constraint.

Targeted support faces an inevitable trade off either to increase the utility of some farmers and to decrease the chance of other farmers to obtain a loan and, in addition, to decrease the overall social efficiency or to increase the social efficiency by decreasing the expected utility of low-risk farmers.

It follows that, at least from the point of view of this game-theoretical model, the current Czech practice of a global support of agriculture can be fully justified.

The fact that the Fund of Guarantees programs do not restrict eligibility only to the farmers who are unable to obtain commercial credit allows them to avoid the danger of a type of moral hazard problem described in a context of U.S. agriculture by LaDue (1990), who points out that some marginal farmers do not work hard enough in order not to disqualify themselves for eligibility for government support. The optimization problem of those farmers is distorted by the presence of government support, which is granted only to farmers who do not qualify for commercial loans.

The additional result which follows from the model is in support of an approach used by the Fund of Guarantees, in which there is no single bank chosen to distribute the support to farmers but any bank can apply for loan guarantees on its loans to farmers. The resulting competition forces lenders to pass a benefit of global government guarantees to both low- and high- risk farmers. While in a stabilized market economy one could argue that there is no merit in decreasing interest rates for high risk farmers and distorting the market allocation mechanism, there exists a widespread opinion in Czech agriculture that the current rate of interest on commercial bank loans is too high for all types of farmers.

The Smith and Stutzer model upon which the game-theoretic argument of this paper is based is quite a simple application of an adverse selection model of Rothschild and Stiglitz (1976). Many extensions of that basic model and its credit rationing specification in Stiglitz and Weiss (1981) have shown that the nature of an equilibrium can be affected by incentive effects (Stiglitz and Weiss 1986), project characteristics, the set of available financial instruments (Webb 1992, 1993, Diamond 1991), alternative projects (Chan and Thakor 1987), information sharing (Yotsuzuka 1987), the shape of the production function (Milde and Riley 1988), and other characteristics. Especially interesting is an approach of a branch of credit rationing literature investigating a role of a collateral (Wette 1983, Besanko and Thakor 1987, Bester 1990).

One of the general results of collateral-based literature is that a use of a collateral can alleviate the need for credit rationing and consequently modify some of the results of this paper. But in the recent conditions of Czech agriculture, the model without explicit involvement of a collateral appears to correspond better to economic reality.

Although technically Czech farmers ought to be able to pledge some parts of their property as a collateral, practical difficulties virtually preclude this solution to the problem of credit rationing. The main part of farmer's property - land -

is not valued as in stabilized market economies and there is not a sufficiently liquid and efficient market for agriculturally used farm land in the Czech Republic. In addition the ownership rights to many parts of an agricultural property are not clear and do not create an environment in which lenders would willingly accept an agricultural collateral and the inefficiency caused by a difference in the collateral valuation by farmer and by lender would be minimised.

The specific transitional character of Czech agriculture allows us to use meaningfully even a relatively simple model of credit rationing in conditions of informational asymmetry. With the possible increase of the complexity of government interventions in agriculture and with an increase in institutional sophistication in the Czech finance sector there will probably appear more space and need for more involved models.

References

Black, F. and Scholes, M. (1973), The Pricing of Options and Corporate Liabilities, *Journal of Political Economy*, 81 (May-June), pp. 637-54.

Besanko, David, and Thakor, Anjan V. (1987), Collateral and Rationing: Sorting Equilibria in Monopolistic and Competitive Credit Markets, *International Economic Review*, 28(3) (October), pp.671-89.

Bester, Helmut (1990), The Role of Collateral in a Model of Debt Renegotiation, Network in Financial Markets Working Paper No.1, Centre for Economic Policy Research, London.

Chan, Yuk-Shee, and Thakor, Anjan V. (1987), Collateral and Competitive Equilibria with Moral Hazard and Private Information, *Journal of Finance*, 42(2) (June), pp.345-63.

Cooper, R. (1984), On Allocative Distortions in Problems of Self-Selection, *Rand Journal of Economics*, 15(4), pp.568-77.

Diamond, D. W. (1991), Monitoring and Reputation: The Choice Between Bank Loans and Directly Placed Debt, *Journal of Political Economy*, 99, pp.689-721.

Gale, William G.(1990a), Collateral, Rationing, and Government Intervention in Credit Markets, in R. Glenn Hubbard ed., Asymmetric Information, Corporate Finance, and Investment, Chicago, University of Chicago Press, pp. 43- 61.

Gale, William G.(1990b), Federal Lending and the Market for Credit, *Journal of Public Economics*, 42 (July) , pp. 177-93.

Gale, William G.(1991), Economic Effects of Federal Credit Programs, *American Economic Review* 81(1) (March) , pp. 133-52.

Innes, Robert (1990) Imperfect Information and the Theory of Government Intervention in Farm Credit Markets, American Journal of Agricultural Economics, 72(3) (August), pp.761-68.

Innes, Robert (1991) Investment and Government Intervention in Credit Markets When There is Asymmetric Information, Journal of Public Economics, 46(3) (December), pp.347-81.

Janda, Karel (1994), Oceňování úvěrových garancí na základě modelu oceňování opcí, Unpublished mimeograph, VUZE, Praha

LaDue, Eddy L. (1990), Moral Hazard in Federal Farm Lending, American Journal of Agricultural Economics, 72(3) (August), pp.774-79.

Luttrell, Clifton B. (1989), The High Cost of Farm Welfare, Washington, D.C, Cato Institute.

Merton, Robert C.(1990) Continuous-time Finance, Basil Blackwell, Oxford, pp.388-412, 625-648.

Milde, Hellmuth, and Rile, John G. (1988), Signaling in Credit Markets, Quarterly Journal of Economics, 103(1) (February), pp.101-30.

Pokyny pro poskytovani garance a dotace prostrednictvim Podpurneho a garancniho rolnickeho a lesnickeho fondu (The program guidelines for Fund of Guarantees) (1994), Ministerstvo zemedelstvi Ceske republiky, Agrospoj, Praha.

Smith, Bruce, and Stutzer, Michal (1988), Credit Rationing and Government Loan Programs: A Welfare Analysis, Working paper 395, Federal Reserve Bank of Minneapolis.

Smith, Bruce, and Stutzer, Michal (1988), Credit Rationing and Government Loan Programs: A Welfare Analysis, AREUEA Journal, 17(2), pp.177-93.

Stiglitz, Joseph E., and Weiss, Andrew (1981), Credit Rationing in Markets with Imperfect Information, American Economic Review, 71 (June), pp.393-411.

Stiglitz, Joseph E., and Weiss, Andrew (1986), Credit Rationing and Collateral. In Recent Development in Corporate Finance, ed. Jeremy Edwards, Julian Franks, Colin Mayer, and Stephen Schaefer, p.101-35. New York: Cambridge University Press.

Sturgess, Ian (1993), Specialized Credit Programmes during the Transitional Period towards a Market Economy; in Agricultural Policy in the Republic of Bulgaria, Sofia Economics University Press.

Sturgess, Ian (1994), Credit and Marketing in Bulgarian Agriculture during the Transition Period, Paper presented on Agricultural Economics Society Annual Conference, April 1994.

Rothschild, Michael, and Stiglitz, Joseph E. (1976), Equilibrium in Competitive Insurance markets: An essay on the Economics of Imperfect Information, Quarterly Journal of Economics, 90 (4), (November), pp.629-49.

Webb, David (1992), Project Selection with Screened and Contingent Debt, LSE Discussion Paper No.133, (February).

Webb, David (1993), The Trade-Off between Cash Flow and Net Present Value, The Scandinavian Journal of Economics, 95 (1), (March), pp.65-75.

Wette, Hildegard (1983), Collateral in Credit Rationing in Markets with Imperfect Information: Note, American Economic Review, 73 (June),pp.442-45.

Yotsuzuka, Toshiki (1987), Ricardian Equivalence in the Presence of Capital Market Imperfections, Journal of Monetary Economics, 20 (September), pp.411-36.

APPENDICES

Appendix 1 - Proof of Proposition 2.

By differentiation of (8e) we obtain

$$\frac{\partial \pi_L^G}{\partial \alpha} = \frac{\dfrac{1-P_H}{P_H+\alpha(1-P_H)}[y-[\dfrac{1}{P_L+\alpha(1-P_L)}+\dfrac{\beta_H}{P_H}]]}{[y-[\dfrac{1}{P_L+\alpha(1-P_L)}+\dfrac{\beta_H}{P_H}]]^2} -$$

$$\frac{[y-[\dfrac{1}{P_H+\alpha(1-P_H)}+\dfrac{\beta_H}{P_H}]]\dfrac{1-P_L}{P_L+\alpha(1-P_L)}}{[y-[\dfrac{1}{P_L+\alpha(1-P_L)}+\dfrac{\beta_H}{P_H}]]^2}. \qquad \text{(AP1.1)}$$

The numerator of (AP1.1) can be simplified by algebraic manipulations as

$$\frac{(P_L-P_H)(y-1-\dfrac{\beta_H}{P_H})}{[P_H+\alpha(1-P_H)][P_L+\alpha(1-P_L)]}. \qquad \text{(AP1.2)}$$

Both terms in the denominator are positive because they are linear combinations of 1 and α and subsequently positive and smaller than 1. The first term in the numerator of (AP1.2) is positive because of our basic assumption $P_L>P_H$. The second term in the numerator of (AP1.2) is positive because of a positive marginal utility condition (A1) modified to allow for a zero profit condition (7a). The modified condition (A1) is derived similarly to a derivation of (A1) by differentiating U_{ii} with respect to π_i, using condition (7a) to substitute $1/P_i$ for R_i in a first partial derivative and finally expressing y:

$$y > 1/[P_i+\alpha(1-P_i)] + \beta_i/P_i > 1+ \beta_i/P_i \,.$$

This completes the proof of the proposition that $\partial\pi_L^G/\partial\alpha>0$.

Appendix 2 - Verification of the single crossing condition for a direct targeted loan case

Similar to the proof of (A2) we compute a MRS at any point $S=(R^s, \pi^s)$:

$$MRS_i(S)=\pi^s P_i/[P_i(y-R^s)-P_i\alpha(y-R_g)-(1-\alpha)\beta_i]. \tag{AP2.1}$$

To obtain the condition (A2) is just a question of substituting from (AP2.1) into (A2b)

$$MRS_H(S) < MRS_L(S) \tag{A2b}$$

and performing a simple algebraic manipulation, during which we have to make sure that a denominator of the right hand side of (AP2.1) is positive. The positivity of that denominator is shown by rearranging its terms to obtain

$$y > (R^s+\beta_i/P_i)+\alpha(y-R_g-\beta_i/P_i),$$

which is positive by (A5).

Appendix 3 - Proof of Proposition 3.

Denote the denominator and the numerator of the right hand side of (11) as D and N, respectively.

$$\frac{\partial \pi_L^D}{\partial \alpha}=\frac{-(y-R_g-\frac{\beta_H}{P_H})D+N(y-R_g-\frac{\beta_H}{P_H})}{D^2},$$

which can be simplified as

$$\frac{\partial \pi_L^D}{\partial \alpha} = \frac{(y - R_g - \frac{\beta_H}{P_H})(\frac{1}{P_L} - \frac{1}{P_H})}{D^2}. \tag{AP3.1}$$

The first term in the numerator (y-R_g-β_H/P_H) is positive because of (A4). The second term in the numerator is negative because of our assumption $P_H<P_L$. This means that the partial derivative is negative.

So far, we have proved that government lending crowds out commercial lending.

Now we shall prove that this crowding out is on a greater than one-to-one basis for $R_g<R_L^D$.

Define the probability of a low-risk farmer obtaining any loan as

$$\pi_L^A=\pi_L^D+(1-\pi_L^D)\alpha. \tag{AP3.2}$$

Rearrange (AP3.2):

$$\pi_L^A=\pi_L^D+\alpha-\pi_L^D\alpha,$$

and take a first partial derivative:

$$\frac{\partial \pi_L^A}{\partial \alpha} = \frac{\partial \pi_L^D}{\partial \alpha} + 1 - \frac{\partial \pi_L^D}{\partial \alpha}\alpha - \pi_L^D,$$

which can be simplified as:

$$\frac{\partial \pi_L^A}{\partial \alpha} = \frac{(\frac{1}{P_L} - R_g)(\frac{1}{P_L} - \frac{1}{P_H})}{D^2}. \tag{AP3.3}$$

The second term in a numerator is negative because of our assumption $P_H<P_L$. The first term in a numerator is positive for $R_g<1/P_L=R_L^D$.

Appendix 4 - Proof of Proposition 4

As a first step we prove that sign((12)) = sign ($P_L R_g$-1).

The self-selection constraint $U_{HH}=U_{HL}$ given by (3a) is true for both a model without interventions and a model with government direct loans. In addition, we know that the equilibrium utility of a high-risk farmer is the same in both models. This means that

$$U_{HL}^{*}=U_{HH}^{*}=U_{HH}^{D}=U_{HL}^{D},$$

which can be further simplified into an equation

$$U_{HL}^{*}=U_{HL}^{D}. \qquad \text{(AP4.1)}$$

After a substitution of the relevant utility functions from (2) and (10) we obtain

$$\pi_L^{*}P_H(y-R_L^{*}) + (1-\pi_L^{*})\beta_H=\pi_L^{D}P_H(y-R_L^{D}) + (1-\pi_L^{D})P_H\alpha(y-R_g)+(1-\pi_L^{D})(1-\alpha)\beta_H. \qquad \text{(AP4.2)}$$

After further simplification using the fact that $R_L^{D}=R_L^{*}$, and after some algebraic manipulations we obtain

$$(\pi_L^D-\pi_L^*)=-\alpha(1-\pi_L^D)\frac{P_H(y-R_g)-\beta_H}{P_H(y-R_L^*)-\beta_H}. \qquad \text{(AP4.3)}$$

We add $\alpha(1-\pi_L^{D})$ to both sides of (AP4.3) to obtain an expression identical to the first term in (12):

$$(\pi_L^D+\alpha(1-\pi_L^D)-\pi_L^*)=\alpha(1-\pi_L^D)[1-\frac{P_H(y-R_g)-\beta_H}{P_H(y-R_L^*)-\beta_H}]. \qquad \text{(AP4.4)}$$

Both sides of (AP4.4) are positive (negative) if

$$P_H(y-R_g)-\beta_H < (>)\ P_H(y-R_L^{*})-\beta_H,$$

which simplifies into a condition

$$R_g > (<)\ R_L^{*}. \qquad \text{(AP4.5)}$$

It follows from the zero profit condition for commercial lenders (4) that $R_g > (<) R_L^*$ if the government makes profit on its loans to low-risk farmers, which means that $P_L R_g - 1 > 0$ ($P_L R_g - 1 < 0$).

This proves the first part of the Proposition 4.

As a second step we prove that $\mathrm{sign}(P_L R_g - 1) = -\mathrm{sign}(U_{LL}^D - U_{LL}^*)$.

We directly substitute for appropriate expressions for equilibrium utilities from (2) and (10) into $(U_{LL}^D - U_{LL}^*)$:

$$U_{LL}^D - U_{LL}^* = \pi_L^D P_L(y - R_L^D) + (1-\pi_L^D) P_L \alpha (y - R_g) + (1-\pi_L^D)(1-\alpha)\beta_L - \pi_L^* P_L(y - R_L^*) - (1-\pi_L^*)\beta_L. \quad \text{(AP4.6)}$$

The right hand side of equation (AP4.6) can be simplified using the fact that $R_L^D = R_L^*$:

$$U_{LL}^D - U_{LL}^* = (y - R_L^D) P_L (\pi_L^D - \pi_L^*) - \beta_L (1 - \pi_L^* - 1 + \pi_L^D) + \alpha(1-\pi_L^D)[P_L(y - R_g) - \beta_L],$$

which can be further simplified by collecting terms with $(\pi_L^D - \pi_L^*)$:

$$U_{LL}^D - U_{LL}^* = (\pi_L^D - \pi_L^*)[(y - R_L^D) P_L - \beta_L] + \alpha(1-\pi_L^D)[P_L(y - R_g) - \beta_L]. \quad \text{(AP4.7)}$$

From (AP4.7) it follows that $U_{LL}^D - U_{LL}^*$ is positive if

$$(\pi_L^D - \pi_L^*) > -\alpha(1-\pi_L^D) \frac{P_L(y - R_g) - \beta_L}{P_L(y - R_L^*) - \beta_L}. \quad \text{(AP4.8)}$$

After substitution for $(\pi_L^D - \pi_L^*)$ from (AP4.3) and cancelling terms with $-\alpha(1-\pi_L^D)$ we rewrite (AP4.8) in the following way:

$$\frac{P_H(y - R_g) - \beta_H}{P_H(y - R_L^*) - \beta_H} < \frac{P_L(y - R_g) - \beta_L}{P_L(y - R_L^*) - \beta_L}. \quad \text{(AP4.9)}$$

We divide both the numerator and denominator of the left hand side (right hand side) of (AP4.9) by P_H (P_L):

$$\frac{y-R_g-\frac{\beta_H}{P_H}}{y-R_L^*-\frac{\beta_H}{P_H}}<\frac{y-R_g-\frac{\beta_L}{P_L}}{y-R_L^*-\frac{\beta_L}{P_L}}. \qquad \text{(AP4.10)}$$

It follows from (A2) that an inequality (AP4.10) is satisfied if $R_g<R_L^*$, from which it follows that $P_LR_g-1 < 0$.

This completes the proof of the proposition that sign(P_LR_g-1) = -sign(U_{LL}^D-U_{LL}^*).

Appendix 5 - The Maximization problem of a high-risk farmer in the absence of government intervention

The high-risk farmer maximizes his utility with respect to his choice of a contract offering him a probability π_H of granting a loan:

max $U_{HH}=\pi_H P_H(y-R_H)+(1-\pi_H)\beta_H$ (from (2))
s.t. $R_H=1/P_H$ (from (4))
$0\leq\pi_H\leq 1$.

From the maximization problem it follows:

$$\partial U_{HH}/\partial\pi_H = P_H(y-R_H)-\beta_H. \quad \text{(AP5.1)}$$

The expression (AP5.1), which can be rewritten using a zero-profit condition (4):

$$\partial U_{HH}/\partial\pi_H = P_H(y-1/P_H)-\beta_H,$$

is under a positive marginal expected utility condition (A1)
always positive. This means that the value of a probability π_H maximizing utility function (2) is given by a binding constraint $\pi_H\leq 1$ as $\pi_H^*=1$.

Appendix 6 - Full Information Equilibrium

In a full information equilibrium the type of each individual farmer is common knowledge. This means that there are two separate markets in the model: one for each type of farmer.

In each of these two markets optimal contracts maximize expected farmer's utility U_{ii}, given by (2), subject to a zero-profit condition (4), and to a boundary condition for probability $0 \leq \pi_i \leq 1$.

We substitute P_iR_i from (4) into (2) and we obtain a Lagrangean:

$$L=\pi_i P_i y-\pi_i+(1-\pi_i)\beta_i,$$

which is maximized with respect to π_i.

Taking derivatives yields:

$$\partial L/\partial \pi_i = P_i y - 1 - \beta_i,$$

which is always positive because of (A1).

From this it follows, that an optimal value of π_i is given by an upper boundary condition for probability as $\pi_i = 1$, i=L,H.

Czech Summary

Přidělování úvěrů v podmínkách asymetrických informací a PGRLF

Po celém světě existuje mnoho různých programů vládní podpory zemědělství. Valná část těchto programů v U.S. a v zemích západní Evropy zaměřených na všeobecnou podporu zemědělství a drobného podnikání obsahuje výslovnou podmínku, že program je určen pouze pro farmáře, kteří nemohou získat úvěr od komerčních bank.

České programy poskytované prostřednictvím Podpůrného a garančního rolnického a lesnického fondu (PGRLF) jsou v ostrém kontrastu s touto praxí cílené podpory úvěrů. V Pokynech pro poskytování garance a dotace prostřednictvím PGRLF (1994) je samozřejmě uvedena řada omezení a podmínek pro poskytnutí podpory. Nikde však není výslovně zdůrazněno zaměření na cílenou speciální skupinu farmářů, kteří byli odmítnuti komerční bankou.

Nediskriminační charakter PGRLF je obzvláště zdůrazněn v paragrafu A.3.2 výše zmíněných pokynů (1994, str.9): "Jediným důvodem pro neuspokojení žadatele o podporu prostřednictvím Fondu, při splnění všech podmínek, je případný nedostatek finančních prostředků"."

Cílem prezentované práce je poskytnout teoretické zdůvodnění a ospravedlnění takovéto nediskriminační politiky.

Model použitý pro vysvětlení welfare efektů necíleného přístupu poskytování garancí PGRLF je založen na modelu Smith and Stutzer (1988, 1989), který patří do rozsáhlé skupiny modelů přidělování úvěrů iniciované významným článkem Stizlitz and Weiss (1981).

Základním problémem na trhu zemědělského úvěru je rozdílné mínění banky a zemědělce o perspektivách zamýšlených zemědělských projektů. Mnoho zemědělců považuje na základě svých privátních informací o stavu odpovídajících komoditních trhů a o úrovní svých vlastních podnikatelských schopností své projekty za potenciálně ziskové a ekonomicky životaschopné. Banky jsou často opačného mínění a odmítnou financovat zemědělské projekty, které by mohly být společensky efektivní.

Stiglitz and Weiss (1981) poskytli rigorózní modelové vysvětlení empiricky existujícího společensky neefektivního omezování úvěrů a nefungujícího volného tržního mechanismu v oblasti poskytování úvěrů. Toto vysvětlení je založeno na existenci informační asymetrie mezi věřitelem a dlužníkem a na z toho plynoucí adversní selekci. Při modelování a řešení tohoto problému je užíván teoretický aparát teorie her.

Základním nástrojem teorie her používaným v modelech založených na Stiglitz-Weiss přístupu je mechanismus vlastního výběru, který překonává informační asymetrii tím, že rozděluje zemědělce do zvlášních skupin podle rizikovosti jejich projektu. Základem mechanismu vlastního výběru je existence určitého třídícího kritéria s variabilními parametry. Každý farmář si volí určitou hodnotu tohoto třídícího parametru a tím odhalí věřiteli, do jaké rizikové skupiny patří.

Základním problém při tvorbě a uplatňování takovéhoto třídícího mechanismu je překonání přirozené tendence farmáře patřícího do jedné rizikové skupiny předstírat, že patří do skupiny jiné, pokud tato jiná skupina má šanci na získání příznivějších úvěrových podmínek. Tomuto předstírání lze zamezit tím, že úvěrové kontrakty pro tuto druhou skupinu jsou upraveny tak, že jsou méně příznivé. Každý farmář tak zjistí, že je v jeho zájmu setrvat na kontraktu určeném pro jeho rizikovou skupinu. Základním konceptem teorie her používaným v tom případě je Nash rovnováha.

Použitý model je standardní model o dvou obdobích popsaný v části 3 tohoto článku. Hráči v modelu jsou farmáři, věřitelé a vláda. Základní hra tohoto modelu má následující dvě fáze:

Fáze 1: Věřitelé nabídnou farmářům kontrakty skládající se z uspořádané dvojice (R_i, π_i), kde R_i je hrubá úroková míra pro farmáře typu i a π_i je pravděpodobnost poskytnutí úvěru farmáři typu i. Typy farmářů jsou i=L (farmář s nízkým rizikem bankrotu) a i=H (farmář s vysokým rizikem bankrotu).

Fáze 2: Farmáři pozorují nabídky z fáze 1 a potom si vyberou takový kontrakt, který považují pro sebe za nejlepší.

V části 4 je popsána rovnováha dosažená v modelu bez přítomnosti státní intervence. Pro toto řešení je charakteristické, že všichni vysoce rizikoví farmáři ochotní platit tržní úrokovou míru určenou pro vysoce rizikové farmáře obdrží úvěr, zatímco část nízko rizikových farmářů je při rovnovážné míře úvěru platné pro nízko rizikové farmáře bankou odmítnuta a úvěr neobdrží.

V části 5 jsou popsány výsledky modelu za přítomnosti dvou typů státních zásahů: necílených úvěrových garancí přístupných všem farmářům (část 5.1) a cílených přímých úvěrů poskytovaných pouze nízko rizikovým farmářům odmítnutým komerčními bankami (část 5.2). Současně jsou také zhodnoceny sociálně ekonomické efekty obou programů.

Základním závěrem modelu je, že programy, které jsou otevřené všem farmářům, tak jako programy PGRLF, jsou sociálně-ekonomicky efektivnější, než programy zaměřené pouze na skupinu nízko rizikových farmářů odmítnutých komerčními bankami.