The role of credit rationing in Czech agriculture – the case of large agricultural enterprises

Role úvěrového omezení v českém zemědělství – případ velkých zemědělských podniků

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Abstract: The article is concerned with the analysis of the role of credit rationing in Czech agriculture on the case of large agricultural enterprises. The part of results, first presents the author's derivation of the theoretical model (model CR-AS), which represents a good tool (approach) for the analysis of credit rationing on sector level. Second, the focus on large agricultural enterprises and relevant characteristic of agriculture ask for a small adjustment of the derived model CR-AS in the part of model application. Third, the adjusted model is expressed numerically by the employment of econometric methodology. The estimation of the model is made per partes. The co-integration is used for fitting the Cobb-Douglas production function, which embodies the long run production characteristics of large agricultural enterprises. The CR^D curve is derived based on the stability assumption of the production function that is essential considering the recursive nature of the model. Finally, the specified model is employed in the ex-post analysis of the impact of credit rationing on production level of large agricultural enterprises. The outputs of the analysis suggest that, in average, the group of large agricultural enterprises might not be directly influenced by possible presence of credit rationing on the agricultural loan market. Nevertheless, that might not be the case of small and middle enterprises. The analysis continues with the investigation of possible meeting of credit rationing within both the group of large agricultural enterprises and the group of small and middle enterprises and stresses his implications. Furthermore, the role of the PGRLF (Support and Guarantee Farm and Forestry Fund) is analysed and discussed on the subject of reduction of credit rationing phenomena on the agricultural loan market.

Key words: loan, credit rationing, large agricultural enterprise, production function, PGRLF (Support and Guarantee Farm and Forestry Fund)

Abstrakt: Článek se zabývá rolí úvěrového omezení v českém zemědělství na případu velkých zemědělských podniků. V části výsledků je nejprve odvozen obecný teoretický model (model CR-AS), který představuje vhodný nástroj pro analýzu vlivu úvěrového omezení na odvětvové úrovni. Zaměření se na skupinu velkých zemědělských podniků a zohlednění relevantních charakteristických rysů zemědělského odvětví vyžaduje v části aplikace modelu CR-AS jeho menší přizpůsobení. Následně je provedeno vyčíslení modelu CR-AS za použití běžných ekonometrických technik. Odhad modelu je realizován per partes. Nejprve je pomocí kointegrační analýzy vyčíslena Cobb-Douglasova produkční funkce, která odráží dlouhodobé produkční charakteristiky velkých zemědělských podniků. Za předpokladu stability této produkční funkce, jež je důležitá vzhledem k rekurzivní povaze modelu v části křivky CR^D, je přistoupeno k odvození křivky CR^D. Po derivaci křivek modelu CR-AS je provedena ex-post analýza vlivu úvěrového omezení na produkční činnost velkých zemědělských podniků. Z této analýzy plyne, že skupina velkých zemědělských podniků se v průměru nezdá být přímo determinována případným výskytem úvěrového omezení na zemědělském úvěrovém trhu tak, jak je tomu možné u skupiny malých a středních podniků. V této části příspěvku jsou dále analyzovány možnosti výskytu úvěrového omezení jak u skupiny velkých, tak i malých a středních podniků a zdůrazněny jeho implikace. Dále je analyzována a diskutována role PGRLF ve vztahu k eliminaci úvěrového omezení na zemědělském úvěrovém trhu.

Klíčová slova: bankovní úvěr, úvěrové omezení, velký zemědělský podnik, produkční funkce, PGRLF

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Credit rationing phenomenon is a result of the presence of asymmetric information on the credit market. The asymmetric information is one of the reasons of market failure by the allocation of production factors. Generally said, the presence of asymmetric information may be defined as the situation when one side of the market knows more than the other one. The more informed one has information superiority, i.e. it has the market advantage. The importance of asymmetric information gave rise to a new theory of firm that explains some points of empirical observed firm behaviours that are difficult to explain in terms of the traditional theory of the firm (see e.g. Greenwald, Stiglitz 1990). The ability to explain economic phenomena attracted many economists. The paper "Credit Rationing in Markets with Imperfect Information" written by Stiglitz and Weis (1971) laid the basis to consequent models, which have been interested in the analysis of credit rationing.

Credit rationing may or may not be important on the branch level. It depends on several factors that will be discussed later by the derivation of the author's theoretical model, which will be employed in the analysis of the role of credit rationing in Czech agriculture or in the group of large agricultural enterprises respectively. The inferences of the analysis will serve for discussion of the role of the PGRLF in Czech agriculture and other forms of subsidies to agriculture.

AIMS AND METHODOLOGY

The aim of the article is to analyze the role of credit rationing in Czech agriculture on the case of large agricultural enterprises by the use of derived theoretical model, and to stress the significant elements of the concept.

The hypothesis says that credits or loans respectively create a significantly important part of business cash flow that is very hard to be substitutable. Thus, the meeting of credit rationing causes a reduction of agricultural output.

The cointegration analysis is used to fit the production function in the paper that is a part of the derived theoretical model. Precisely said, the linkage of cointegration analysis with VAR (vector autoregression) modelling is used, i.e. the VECM (Vector Error Correction Model) is employed in the analysis of production relations. The estimation of (Cobb-Douglass) production function with output of added value (VA) and inputs of capital and Land/Workers stands for the period of 1997–2002 with quarterly periodicity. The data set is available in the database of the Czech Statistical Office, especially in the publication – "Chosen financial indicators of agricultural enterprises" and in the database of Producer Prices. The time series are seasonally adjusted in the statistical software Statgraphics, expressed in real values and logarithmic transformed. The RATS software version 6 is employed in unit roots tests and the package CATS in RATS is used to estimate the VECM.

There are several reasons for using co-integration analysis in the paper. Generally said, the cointegration analysis offers to avoid the problems arising from the analysis of nonstationary data on one hand and not losing the long run part (information) of the data set on the other hand. Furthermore, the linkage of cointegration analysis with the VAR modelling resulting in estimation of the (V)ECM offers to analyse both short run dynamics and long run relationship of the variables.

The general form of the VECM is as follows:

$$\text{(i)}\quad \Delta X_t = \eta + \Pi X_{t-1} + \sum_{s=1}^{p} C_s \Delta X_{t-s} + \psi D_t + u_t$$

where: $C_S = 0$ for $s > p$, X_t is $g \times 1$ vector of stochastic variables and $u_1, \ldots, u_t$ are *niid* $(0, \Sigma)$ and D_t is a vector of nonstochastic variables.

The purpose of such analysis is to distinguish between stationarity by linear combinations and by differencing. The hypothesis of cointegration is formulated as a reduced rank of the Π-matrix, which contains two coefficients α and β. The coefficients α and β are $p \times r$ matrices of full rank. The hypothesis implies that the process ΔX_t is stationary, X_t is non-stationary, but $\beta' X_t$ is stationary. Thus, it can be said that the relations βX_t are stationary relations among nonstationary variables (Hansen, Juselius 2002).

The Cobb-Douglas production function has the form of:

$$\text{(ii)}\quad VA_t = a \times \text{Capital}_t^b \times (\text{Land/Workers})_t^c \times k \ln u_t$$

and in linear form (after logarithmic transformation)

$$\text{(iii)}\quad \ln VA_t = \ln a + b\ln\text{Capital}_t + c\ln(\text{Land/Workers})_t + k\ln u_t$$

where: $t = 1, 2, \ldots, n$; VA = value added (in thousand CZK); Capital (in million CZK); Land/Workers (hectares/workers) and u = residual.

That is in terms of the VECM:

$$\text{(iv)}\quad \Delta X_t = \Pi X_{t-1} + \sum_{s=1}^{5} C_s \Delta X_{t-s} + u_t$$

where: X_t contains variables *VA*, Capital (*C*) and Land/Workers and ΔX_t its first differences, i.e. *dVA* a *d*Capital and *d*Land per Workers.

The assumptions of the derived model CR-AS and other important methodological aspects of the theoretical model or of the estimation (quantification) will be pointed out in a part of the results to make the paper more readable.

RUSULTS AND DISCUSSION

Theoretical model – model CR-AS

The idea of the model CR-AS (Credit Rationing – Aggregate Supply) is based on the assumption that credit financing is an important and only to a certain extent substitutable part of business cash flow. Thus, the presence of credit rationing on credit markets may have a significant effect on the production level or the economic activity of the affected enterprises respectively. The credit substitution is assumed to be possible in the way credits for shareholders' capital (the other financial recourses are assumed to be constant and thus not important in the model). Then, the lower is the possible substitution of financial resources (credit substitution), the larger is the effect of credit rationing on production level of affected enterprises. Moreover, taking into consideration the extreme case, i.e. the zero credit substitution, the credit rationing occurrence causes the reduction of the (intended) production level of the affected enterprises. In other words, the affected enterprises have lack of financial recourses for purchasing or hiring inputs on such a level that ensures the intended production level derived from the anticipated future business development (especially price development). According to Blinder (1985) the situation, when companies cannot produce as many as they are able to sale, is called "the failure of effective supply". The failure of effective supply may be very dangerous since the recession, initiated by the decrease in supply rather than in demand, may cause the increase of prices, when economic activity is contracted.

In order to make the model closer to reality, the existence of credit substitution is assumed. However, this substitution is finite and differs from sector to sector of the economy as well as from company to company. Consequently, credit rationing may be in one sector more important than in the other ones.

Moreover, depending on the structure and on the institutional character of economy, the significant occurrence of credit rationing phenomena may have an influence on the real output of economy. However, in fact we may regard its impact very questionable and empirically very hard to measure on the aggregate level. That is, we may suppose that the restriction of one business activity may result in the support of another business activity having the same (in average) or even in some cases a higher profitability level. Thus, the capital allocation may not be deteriorated on the aggregate level or at least significantly deteriorated for the purpose of empirical investigation. It does not mean that the economy is or is not Pareto efficient. It only means that we may only discuss the effect of credit rationing occurrence on the aggregate level than to incorporate it in macroeconomic models.

The situation is, however, different from the viewpoint of sector analysis. That is, credit rationing may have a very significant effect on the sector of interest depending on several factors. Among others, we may appoint the most important ones – the size (structure) of companies in the sector and the profitability and risk level of the sector. These factors will be discussed later.

The model CR-AS in its basic representation will be of macroeconomic nature. The sector modification of the model will be done later in the part of model application. The modification has to follow the sector characteristics and thus it is more appropriate to choose the general than specific approach for model construction. The model is derived under the following assumptions:

- Credits are very important part of firms' cash flow. If the firms are credit rationed, i.e. they have shortage of financial resources ceteris paribus, they have to reduce their (intended) production level.
- The credit substitution is finite, i.e. the substitution of credit for shareholders' capital and vice versa is possible only to some extent.
- The credit multiplier works in economy (see Blinder 1985). That is, assuming the case of growing demand, firms ask for more credits because they are attracted to produce more due to the higher (increasing) value of marginal production. Higher economic activity induces the inflow of deposits to the banking system. Consequently, this inflow stimulates further credit expansion that maintains the growth of both the side of demand and the side of supply.
- The model incorporates risk premium free interest rate on the supply side. Thus, the adverse selection and moral hazard problem is involved in this way.
- The interest rate affects the decisions of the demand side about the height of credit employed in the process of input optimizing. Combining with the second assumption, the firms operate within the specific area of isoquant.

– The credit multiplier works alongside the traditional expenditure multiplier in the economy. The difference, compared to the traditional model, is the final effect of the monetary policy actions. That is, the economy is more sensitive to monetary policy, in other words, the credit channel makes the monetary policy more expansionary (see Bernanke, Blinder 1988).
– The adaptive expectations and rational decision process are assumed.
– Money plays no role in the model. The firms hold money only to secure the (intended) production level. That is, money adjusts passively to the income. Monetary policy has an effect on the economy through the interest rate channel (next to the credit channel) and also through non-anticipated changes of the price level. The model takes in monetary activities by incorporating adverse selection and moral hazard problem.
– The price level is formed on the market as a result of the interaction between demand and supply. There is no significant deformation.

The Curve – Cr^S

The Curve Cr^S represents the credit supply and can be derived as follows. The equation (1) is the equation of deposits (D_{Et}), which create the main part of the liabilities in the balance sheet of banks. The deposits in nominal expression are the function of nominal product. The marginal propensity to saving (s) has an important role in the relationship. The larger is the marginal propensity to saving, the more financial resources the banks have and therefore the higher investment expenditures may be expected (it is following the identity $I = S$; the banking system is an agent between saving and deficit unit in the economy).

$$D_{Et} = s \times Y_t \times P_t \quad (1)$$

We consider that the deposits can be employed in 3 ways or divided in 3 components respectively. Reserves are the first component, which is, in fact, the obligatory part of deposits. Subtracting reserves as the obligatory part of deposits, the left amount can be invested. It is assumed that there are only two kinds of investments in the model. The first one represents credits and the second one, bonds. The sum of these 3 components has to be equal to the total amount of deposits in banking sector (see identity 2).

$$D_{Et} = R_t + Cr_t + B_t \quad (2)$$

The total reserves are expressed in the equation (3), in which the reserves are the sum of the obligatory ratio of reserves and of the exceeded reserves. The exceeded reserves are the decreasing function of the potentional product (see relation 4). The potentional product is assumed to be constant (in the short and middle period). The function (4) expresses the important implication. If the actual product is bellow the potential product, the exceeded reserves exist and can be invested.

$$R_t = r \times D_{Et} + E_t \quad (3)$$

$$E_t = \beta_1 \times (\ddot{Y} - Y_t) \times P_t \quad (4)$$

After defining the non-investment part of deposits, it is possible to proceed to the investment one. Though there are assumed just two investment parts of deposits, there may be defined only one of them as the second one is the adjunct. However, there has to be taken into account the competition between these parts, i.e. there exists substitute relation as this substitution may be considered to be non-perfect.

The equation of the credits (5) may be expressed like the function of deposits (with respecting the obligatory ratio of reserves) and the gap between the actual and potentional product ($Y_t - \ddot{Y}$). The parameter (h) is very important in the equation. It informs about the increase of credits by the growth of the deposits. The relationship between the actual and potential product can be viewed as the correction of the credit amount with respect to the business cycle.

$$Cr_t = h \times (1 - r) \times D_{Et} + \beta_2 \times (Y_t - \ddot{Y}) \times P_t \quad (5)$$

Having defined the deposit in the equation (1), it is possible to incorporate equation (1) into (5). The result of this substitution is the equation (6), in which the product is the driven variable of credits.

$$Cr_t = h \times (1 - r) \times s \times Y_t \times P_t + \beta_2 \times (Y_t - \ddot{Y}) \times P_t \quad (6)$$

Moreover, the equation (6) can be formulated more adequately and more pragmatically. The nominal credit amount may be converted to real expression by dividing the equation by the price deflator (P_t). It is also important to consider the competitive relation between the two investment parts of deposits. This competition may be expressed by the relevant risk premium free interest rates. "ib_{CR}" represents the average risk free credit interest rate and "ib_{CR}" is the average risk free bond interest rate. The relation ($ib_{CR} - ib_B$) has the influence on the allocation of bank portfolio. It is important to mention again that the substitution of credits and bonds is finite and dependent on the economic situation. Thus, the equation (6) can be rewritten into the equation (7). The equation (7) represents the credit supply curve.

$$Cr^S_t/P_t = h \times (1 - r) \times s \times Y_t + \beta_2 \times (Y_t - \ddot{Y}) + \beta_3 \times \times (ib_{cr} - ib_B) + u_t \quad (7)$$

The curve Cr^S can be summarised as follows. The curve represents the credit supply and it is in real term the function of the actual product (in time *t*), the gap between the actual and potential product and also the difference in risk free interest rate on credits and risk free interest rate on bonds. The structural parameters may be assumed to be time invariant as long as there is no significant change in the credit policy of banks. Conversely, if there is a significant change in credit policy, the parameters might be modified. Only one exception exists. The parameter β_3 might fluctuate during the business cycle. This part of the equation expresses not only the competitive relation but also the effects of monetary policy. The risk premium is very important to be involved due to incorporating of the adverse selection and moral hazard problems. Finally, the equation is possible to divide into two parts – the endogenous one, where the driven variable is product, and the exogenous one, where the driven force is central bank (however, in fact the effects might be mixed).

The Curve – Cr^D

The Curve Cr^D represents the firm credit demand. The level of credit demand reflects the intended production level, i.e. Cr^D embodies credit demand of supply side of the economy. However, by the derivation of Cr^D curve, it is essential to consider the interaction between supply and demand on the product market. This interaction determines the (intended) production level and thus has to be incorporated in the curve (i.e. the link between financial (capital) market and product market is important to involve). Moreover, we consider all variables in real terms.

The derivation of Cr^D starts with the characterisation of the aggregate demand. The demand quantity (i.e. firms' sales) may be expressed as the function of autonomous consumption (*A*), product (*Y*) and wealth (*W*) in equation (8). The bigger the named variables are and the bigger the marginal propensity to consumption and the effect of the wealth (*sW*) are, the higher the firms' sales are. The effect of the wealth may be regarded to be very small (especially in case of the agricultural sector that will be analysed), therefore, it will not be considered further.

$$Xt = A + cYt + sW \quad (8)$$

The Cobb-Douglass (aggregate) production function (9) represents the aggregate supply. The equation (9) describes the transformation of inputs, i.e. capital (C_t), labour (L_t) and material (M_t) having constant technological conditions, into the output (final product). The variable capital contains shareholders' capital and loans. Business credits change according to temporary changes in material in time $t + 1$. The long run changes in material result in changes of working capital. Firms demand so many inputs in time *t* that it is necessary to produce the intended level of output in time $t + 1$. The technological conditions involved in the function are assumed to be constant in short and middle run. The input substitution is supposed to be finite. That is, the quantity of the individual input depends on its price but only to some extent. The firms follow the rule of optimal input combination (i.e. the values of marginal products are equal). The firms want to be price efficient. The technical efficiency does not change in short and middle run, thus the economic efficiency is determined by the price efficiency.

$$Y_{t+1} = \gamma\, C_t^{\alpha} L_t^{\beta} M_t^{\delta} \quad (9)$$

The equation (10) represents expectations and the decision process about the intended production Y_{t+1}. The equation expresses the dependence of the intended production level (in time $t + 1$) on the actual production level (in time *t*) and on the expected price level (EP_{t+1}). The equation follows the assumption that the decisions are rational and expectations are adaptive. Therefore, the firms make the best decisions about the future development on the basis of the disposable information.

$$Y_{t+1} = \nu Yt + \varepsilon EP_{t+1} \quad (10)$$

The price forecast is very important in the model because it affects the intended production. The forecast is based on the rule of supply and demand (term (11)). The rule says that the future price depends on the difference in supply quantity and demand quantity. We can also consider the validity of Philips curve (P_{t+1} = я $P_t + \phi\,(Y - \ddot{Y})$) or the combination of the *SD* rule and Philips curve, i.e. $P_{t+1} = \lambda \times (Y_t - X_t) + oP_t + \phi\,(Y_t - \ddot{Y})$ (see Blinder 1985). However, by the analysis of the agricultural sector, the soundness of (11) is more sufficient to consider.

$$P_{t+1} = \lambda \times (Y_t - X_t) \quad (11)$$

Returning again to the aggregate production function and using a little math, it is possible to derive from the production function the capital like dependent variable (see (12)). The function (12) is in fact the isoquant curve for the dependent variable capital. It means that one can work out the necessary capital for the intended production level. In order to optimize the factor combination, factor prices have to be considered (i.e. firms target the price efficiency). However, according to the second assumption, the factor substitution is limited. Firms operate in the finite area of isoquant curve. Considering different level of production, firms operate on an expansion curve. The expansion curve changes the slope with the change of factor price ratio.

$$C_t = \sqrt[\alpha]{\frac{Yt+1}{\gamma \times L_t^{\beta} \times M_t^{\delta}}} \qquad (12)$$

Moreover, the ratio of credits in the capital has to be defined in order to make possible the derivation of Cr^D. Assuming the capital has only two parts – shareholders' capital and credits, the capital can be rewritten like identity (13a). Furthermore, it is supposed that firms follow some targeted risk level and thus keep constant ratio (κ) of core capital in the total capital. This assumption is expressed in (13b). Finally, (13c) is the result of the substitution of (13b) into (13a) and shows the relationship between capital and credits.

$$C_t = CC_t + Cr_t \qquad (13a)$$

$$CC_t = \kappa C_t \qquad (13b)$$

$$C_t = 1/(1 - \kappa) \times Cr_t \qquad (13c)$$

The substitution of (13c) into (12) results in the equation (14a) that illustrates the relation among credits as the dependent variable and the intended production and inputs as the independent variables.

$$Cr^D{}_t = (1-\kappa)\ \sqrt[\alpha]{\frac{Yt+1}{\gamma \times L_t^{\beta} \times M_t^{\delta}}} \qquad (14a)$$

Based on the previous definitions of the intended production and price expectation, the relation (14a) calls for a small adjustment. Recall that the intended product is expressed by the equation (10) and expected price or the anticipation of price level respectively by (11). The substitution of (11) into (10) and this (10) into (14a) results in (14b), which is the final form of the curve $Cr^D{}_t$.

$$Cr^D{}_t = (1-\kappa)\ \sqrt[\alpha]{\frac{\upsilon Yt + \varepsilon\lambda((1-c)Yt - A)}{\gamma \times L_t^{\beta} \times M_t^{\delta}}} + u_t \qquad (14b)$$

The curve Cr^D can be summarised as follows. The curve represents the credit demand (expressed in real term). The equation (14b) states that the credit demand depends on the actual production level, the relationship between demand and supply on the product market (it affects the price level), the inputs and the ratio of shareholders' capital in total capital (the ratio is assumed to be constant in middle run).

Finally, there has to be defined the occurrence of credit rationing phenomena. It may be found in many empirical studies that banks restrict the total credit amount or sector credit amount to a given maximum level, which can be denote $Cr^M{}_t$. The actual credit demand is then equal to the minimal value of the variable $Cr^D{}_t$ and $Cr^M{}_t$ (see relation 15). If the credit demand is higher than maximum credit level, the credit rationing is met in the market.

$$Cr^A{}_t = min\ (Cr^D{}_t;\ Cr^L{}_t) \qquad (15)$$

CR-AS model – Application

The above derived theoretical model CR-AS will be, after a small adjustment, employed in the analysis of the role of credit rationing in the Czech agriculture or in the group of large agricultural enterprises respectively. As far as the adjustment of theoretical model is concerned, it takes into account the aspects of agricultural market and agricultural production. The aim of the analysis at the large agricultural enterprises respects the size heterogeneity of agricultural sector.

The analysis can start with the quantification of the Cr^D curve. The Cr^D curve represents the supply side of economy. Thus, the quantification of Cr^D curve starts with the estimation of production relations, i.e. with the estimation of production function. In spite of the fact that the attention is paid to supply side of the economy, the demand side must not be ignored. The demand and supply interact each other all the time and are determined by this interaction. Thus, the nature of this interaction has to be born in mind due to its economic consequences. The attention to this fact will be paid in the process of parameter quantification of the Cr^D later.

The production function is a basis of the Cr^D curve because it represents the creation of agricultural output. The (Cobb-Douglas) production function of large agricultural enterprises was estimated in the form of (16). The data set was taken from the database of the Czech Statistical Office, especially in the publication "Chosen financial indicators of agricultural enterprises". The database contains the chosen financial indicators of the group of large agricultural enterprises in the period 1997–2002 with quarterly periodicity. The group of enterprises had been changing within a selected period. To avoid the distortion, the estimation is based on the average enterprise, i.e. each indicator in time t is divided by the number of enterprises in the group in the time t. The transformation respects the nature of data set and can be regarded as a good way to obtain representative time series of the selected variables of the group (especially assuming the normal distribution of the group that is relevant with respect to the central limit theorem or the law of large numbers). The inputs into the transformation process are Capital (million CZK) and Land/Workers (hectares/workers). The variable material is not included in the production function to avoid the possible duplicity with the variable capital despite of using a different period, i.e. material in time t+1 and capital in time t. The different period respects the quarterly periodicity of data set and the nature of production. The structural separibility was tested. The test suggests that the exclusion of material is possible, i.e. the exclusion does not effect the estimation of parameters. The output of production function is value added (thousand CZK). The statistical characteristics of the fitted model are introduced below in the equation (16). The R-Squared statistic indicates that the model as fitted explains 62.22%, 58.44% (adjusted R-Squared) respectively, of the variability in value added. The model appears to fit the data well especially respecting the other in this production function not included variables that have an effect on output. The Durbin Watson test statistic does not imply that autocorrelation exists. Tests of significance for the included variables report that H_0 may be rejected for all structural parameters (including intercept) at 5% level of significance. That is, all variables are significant regressors. It may be seen from standard errors (SE) situated below the relevant structural parameters.

The structural parameters of the fitted production function of large agricultural enterprises represent the elasticity (see the logarithmic transformation), i.e. the efficiency of given production factor. The sum of these structural parameters informs about the stage of homogeneity of production function. The elasticity of value added with respect to capital is estimated as 0.47536. The sign is positive and consistent with the economic theory. The magnitude suggests that for each 1% change in the level of capital, we expect the volume of value added in average to change by about 0.475%. The magnitude also follows the economic theory. The elasticity of value added with respect to Land/Workers is fitted as 0.68122. The sign and magnitude satisfy the economic criteria. The magnitude informs that for each 1% change in the level of Land/Workers, there is expected the rise in value added by about 0.68%. The result suggests that the Land/Workers is more productive than Capital. The Land/Workers determines the value added by about 1/5 more than Capital. The sum of structural parameters is higher than unit (exactly 1.15658). That is the stage of homogeneity of estimated production function expresses increasing returns to scale within the interval of employed data set, however, it may not be out of this interval.

$$VA_{t+1}{}' = 127.08549 \times \text{Capital}_t^{0.47536} \times \text{Land/Workers}_t^{0.68122}$$

(SE) (0.7587) (0.1921) (0.2879)

R^2/R^2(Adj.) = 62.22/58.44 D-W test = 2.1572 (16)

$$\text{Capital}_t = \sqrt[0.47536]{\frac{VA_{t+1}}{127.08549 \times \text{Land/Workers}_t^{0.68122}}} \quad (17)$$

From the above estimated production function, the dependence of capital (C_t) on the other variables may be expressed by the use of the basic mathematical apparatus. The relevancy of this transformation, i.e. with respect to the possible biased of the estimated relation, was investigated by the estimation and analysis of the VECM (Vector Error Correction Model) (see Čechura 2005). The analysis of the VECM shows that all variables in equation (16) are endogenous. Moreover, the long run relationship among the variables exists, i.e. the variables seem to be co-integrated. From the equation (17), it is easy to quantify the volume of Capital that is needed for securing intended production level. Assuming that the substitution of production factors is finite, it is possible to think over that the enterprises, by the effort to be price efficient, intend to move on the expansion curve in the space of isoquant curves. The curve of expansion will change the slope by the price movement of production factors. However, the change of the slope is finite.

In the analysis of Cr^D curve, the attention will be paid to the determination of credit demand. That is, there will be analysed "a sort of" expansion curve. Recalling again the assumption of finite substitution, it means that the isoquants have frontiers.

Furthermore, to quantify the Cr^D curve, there has to be expressed the ratio of credits (loans) (Cr_t) in total capital (C_t). It is possible to assume (with little simplification see the derivation of theoretical model) that the total capital can be divided into two parts – shareholders' capital and credits (see the identity (18)). Furthermore, it is supposed that firms follow some targeted risk level and thus keep a constant ratio of core capital on the total capital. Thus it is assumed that the enterprises want to keep an optimal capital structure with respect to capital costs and targeted risk level. The capital structure will change only by occurring of significant innovations in the environment. The ratio of shareholders' capital in the total capital in the equation (19) is the result of the analysis of the balance sheet of large agricultural enterprises (Čechura 2005) and according to the results of this analysis the ratio may be assumed to be optimal. Finally, equation (20) is the result of the substitution of (19) into (18) and shows the relationship between the capital and credits.

$$C_t = CC_t + Cr_t \quad (18)$$

$$CC_t = 0.55C_t \quad (19)$$

$$C_t = 1/(1 - 0.55) \times Cr_t \quad (20)$$

$$Cr_t^D = $$

$$= (1-0.55)^{0.47536}\sqrt{\frac{VA_{t+1}}{127.08549 \times \text{Land/Workers}_t^{0.68122}}} \quad (21)$$

The substitution of (20) into (17) results in the equation (21), which illustrates the relation among credits as the dependent variable and the intended production and inputs as the independent variables.

The equation (21) describes the relation among the credits in time t and the intended production in time $t + 1$ and the variable Land/Workers in time t. The variable Land/Workers may be considered as entering the relation with constant increase with respect to the long run increase of the production (or vice versa). The higher attention should be paid to the intended production. It is important to know the formation of these variables because it highly determines the analyzed Cr^D curve. Generally speaking, the intended production is determined based on enterprises' expectations. These expectations are highly connected with price development or price anticipation respectively as a key factor of the utility function. Thus, the equation of the intended production may be expressed as the dependence of the production in time $t + 1$ on the production in time t and the expected price ($t + 1$) (see the equation 22). The price prognosis is based on the relation between supply and demand. That is, the demand side enters the Cr^D curve on this place by determining the firm utility function and the future output. The price prognosis may be expressed in the equation (23), i.e. the price in time $t + 1$ is a function of the price in time t, $t - 1$, $t - 2$ and $t - 3$. The equation is based on the assumption that the interaction between supply and demand constitutes the price in the market and this interaction may be substituted for the price development in the past. Recall, we assume adaptive expectations. Thus, the price prognosis set up in equation (23) may be considered as the efficient price anticipation with respect to adaptive expectations, time series memory and quarterly periodicity of data set.

The intended agricultural production, which enters the equation (21), is generated in the recursive model written in (22) and (23). The 3-stage least square methods (3SLS) was used to estimate the structural parameters of this model. The results of the estimation, i.e. structural parameters and basic statistic characteristics (standard errors (*SE*), coefficient of determination, Durbin-Watson test), are presented in points (24) and (25). The results suggest that the fitted model passes the statistical assumptions well, except of the non-significant structural parameters on price in the first equation. The model also does not contradict with the economic theory. To sum up, the fitted model passes the conditions to enter the Cr^D curve. The analysis of the model will not be done separately on this place. It will be a part of the analysis of Cr^D curve.

The prognosis of the intended agricultural production (i.e. agricultural production in time $t + 1$):

$$VA_{t+1} = \beta VA_t + \delta P_{t+1} + \varepsilon_{1t} \quad (22)$$

$$P_{t+1} = \alpha + \gamma_0 P_t + \gamma_1 P_{t-1} + \gamma_2 P_{t-2} + \gamma P_{t-3} + \varepsilon_{2t} \quad (23)$$

(Estimation by three-stage least squares (3SLS)
(the time series are logarithmic transformed)

$$VA_{+1}' = 0.925VA + 0.146P_{t+1} \quad (24)$$

(SE) (0.177) (0.342)
$R^2 = 0.32$ D-W = 2.556

$$P_{t+1}' = 2.145 + 1.171P_t - 0.567P_{t-1} + 0.497P_{t-2} - 0.557P_{t-3} \quad (25)$$

(SE) (0.558) (0.173) (0.253) (0.224) (0.160)
$R^2 = 0.861$ D-W = 2.102

The model of the intended production (see 24 and 25) may be exploited in the final derivation of Cr^D curve. The fitted recursive model may be reduced, i.e. the equation (25) is substituted into (24). The reduction form of the equation of the intended production expressed in an exponential form (see the logarithmic transformation) is then substituted into

$$Cr_t^{D'} = (1-0.55)^{0.47536}\sqrt{\frac{1.3678 \times VA_t^{0.925} \times P_t^{0.17097} \times P_{t-1}^{-0.0828} \times P_{t-2}^{0.0726} \times P_{t-3}^{-0.0813}}{127.08549 \times \text{Land/Workers}_t^{0.68122}}} \quad (26)$$

the equation (21). This final substitution results in the equation (26), which is the final form of Cr^D curve of big agricultural enterprises. The Cr^D curve may be described as follows. The demanded credits are a function of agricultural output (in this case added value), agricultural price in time *t*, *t* – 1, *t* – 2 and *t* – 3 and the variable Land/Workers. Furthermore, the demand is determined by the change in capital structure, which is assumed to be constant (see the discussion above). In the other case, the changes in the ratio between the core capital and credits cause the fluctuations of the Cr^D curve.

The theoretical form of Cr^S curve derived in previous chapter holds for macroeconomic analysis of supply side of the economy or big and important sector in the economy respectively. However, taking into account the ratio of deposits and credits in the Czech Republic, the application of the derived Cr^S curve in sector analysis raises big problems. To avoid these problems in the analysis of the group of large agricultural enterprises, the Cr^S curve will be defined in a more realistic way. Taking into consideration just banks and their attitude to loan supply, we may conclude without any significant simplification of the analysed problematic that banks set up a maximal limit of loan amount to the sector, which they are not willing to overshoot with respect to risk rules and the optimalization of loan portfolio as well. The maximal limit may be set up in different ways. For example, the maximal limit can be set up according to the generally defined ratio in bank portfolio or according to the rules of optimal capital structure or according to the collateral possibilities or combination of the above ones (of course with respect to the rate of return of a given sector or group of enterprises respectively.). The maximal limit of loans is here set up according to collateral possibilities. It can be regarded as a good anticipation of the maximal limit of loan supply of the analysed group.

The collateral possibilities of the group of large agricultural enterprises may be estimated, based on the analysis of balance sheet, in the height of 30% of the total capital. It means that assuming the granted credits are in the height of 70% to the collateral with respect to risk level, the maximal limit may be set up in the height of 21% of the total capital. The defined maximal limit will embody the Cr^S curve of big agricultural enterprises.

The quantified Cr^D and Cr^S curves are plotted in Figures 1a, b to make the graphic analysis possible. The Figure 1a shows the analysed relationship respecting the time sequence. That is, the figure illustrates the changes in credit demand with respect to changes in added value and in the variable Land/Workers. The Figure 1b shows the curves after rearranging the added value based on the height. Such a rearranging offers to analyse the model CR-AS in a more transparent way. To make the analysis richer, it is also useful to employ the Figure 2 in the analysis of model CR-AS. The curves are drawn in Figure 2 holding the variable Land/Workers constant. In such a way, the volatility of curves in Figures 1a, b is removed. The Figure 2 is a bit more theoretical compared to Figures 1a, b, which are based on fitted model CR-AS, however, it offers us to analyse the relationship more precisely and also to analyse the hypothetical situation by dividing the figure into 2 parts. So, for better understanding, it is helpful to exploit both Figures 1a, b and Figure 2.

The analysis of the model CR-AS is efficient to start with the explanation of the difference in Cr^{D1} and Cr^{D2} curves. The Cr^{D1} curve corresponds with the quantified Cr^D curve (see (26)). It would represent

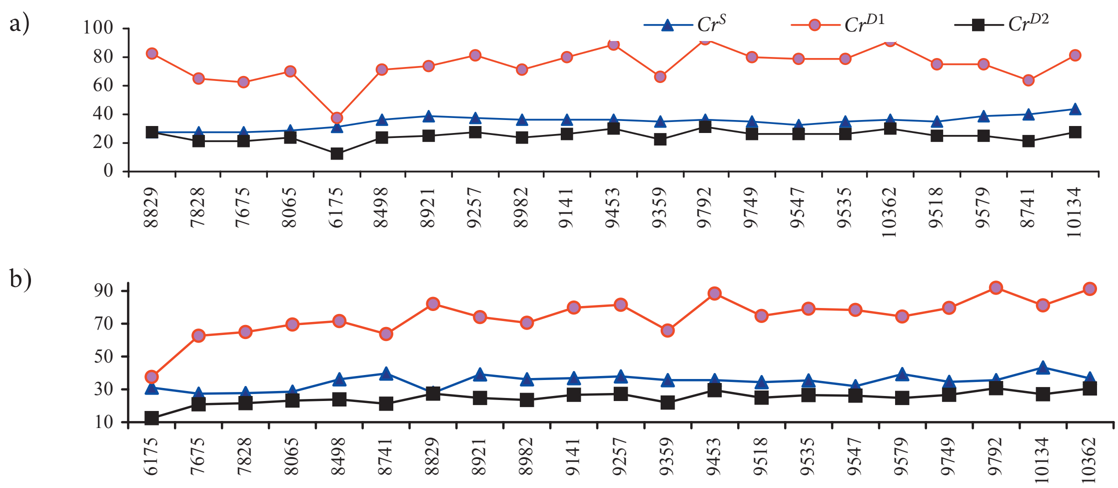

Figure 1. Model CR-AS – group of large agricultural enterprises

loan demand if all credits were equal to loans. In fact, the credits are, however, created by more financial resources (e.g. supplier credit, etc.). According to the analysis of balance sheet, the loans are 15% of the total capital. Thus, Cr^{D2} curve is quantified for this ratio and represents banking credit channel. The Cr^{D1} curve may represent a sort of broad credit channel.

The inclusion of broad credit channel in the analysis has the following reasons. First, the empirical studies point out that, in some cases, the traditional credit channel may not work significantly in the economy, as the theory suggests. Moreover, some empirical macroeconomists attribute it no role in the economy. However, as far as the broad credit channel is concerned, the macroeconomists regard it to play a very significant role in the economy, especially in the time of recession. Second, recalling that we assume that the enterprises target to keep the optimal capital structure on one hand, i.e. the rate of credits in total capital is constant in middle and long run, it may be supposed that the structure of credits is changeable on the other hand. Thus, the other aspects of model CR-AS raise, that is, the slope and time behaviour of Cr^{D1} a Cr^{D2} curves have to be considered. The slope of Cr^{D} curve is determined by the rate of credits in total capital, by the structural parameter of the variable Land/Workers and by the structural parameter of capital in production function. The structural parameters of variables Land/Workers and Capital may be pretty well regarded to be time invariant. The rate of credits in the total capital will change after structural shocks or it may be volatile in short time. Consequently, the Cr^{D} curve changes the slope in time, i.e. it is not stable. The Figure 2 shows the expected volatility of Cr^{D} curve by arrows. Taking into account the higher changeability of the rate of loans in credit, the Cr^{D2} curve is less stable compared to Cr^{D1}. Time behaviour of the Cr^{D} curve is determined by the intended agricultural production (see the prognosis of the intended agricultural production) and by the value of the variable Land/Workers. The Cr^{S} curve is entirely determined by the way of setting the credit limit. In the case of this analysis, the slope of the Cr^{S} curve is determined by the height of the collateral that can be regarded as time variant. Thus, the slope of the Cr^{S} curve is also changeable (see the arrows in Figure 2).

Now it is time to employ the CR-AS model in the analysis of the group of large agricultural enterprises. The Cr^{D1} and Cr^{D2} curves has a positive slope (see Figure 1b). It means that the credit or loan demand respectively increases with growing agricultural output. The Cr^{S} curve has a positive slope due to increasing the total capital determined by the growing agricultural output. In other words, the loan limit or the loan supply respectively goes up with increasing collaterals in the analysed time period. The volatility of Cr^{D} curves is a result of the variability in the variable Land/Workers. The volatility of Cr^{S} curve is determined by the fluctuations in the height of the total capital that reflects the firm economic results in time *t*. Respecting the above mentioned facts, it is possible either virtually or imaginarily to flatten the Cr^{S} curve, i.e. the Cr^{S} curve may be drawn like a line. Moreover, the short time finite substitution of production factors may also be removed (or glossed over). That is, instead of paying interest to the volatility of the Cr^{D1} and Cr^{D2} curves, it is worth to analyse the location of curves in Figure 1b. The Cr^{D2} curve in Figure 1b is located bellow Cr^{S} curves. That is, if we were interested in looking for credit rationing occurrence in the analysed model (see Figure 1b) under the given assumptions, we would conclude that the group of large agricultural enterprises, i.e. the enterprises with more than 100 employees, do not meet the credit rationing phenomenon in the loan market. The reason is that the loan demand represented by Cr^{D2} curve in Figure 1b lies below the loan supply. The question is: what does the Cr^{D1} curve, representing the broad credit channel, inform

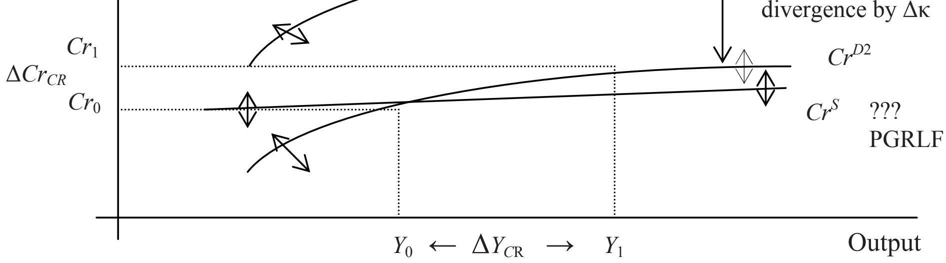

Figure 2. Model CR-AS – theoretical and empirical consequences

us about (see the definition of the curve above) with respect to the position of the curve, i.e. above the loan supply or loan limit respectively. We may consider the situation of the credit structure alteration. This situation can occur for example due to some business shock resulting in rationing of the amount of trade credits (or other possibilities). And consequently, firms will ask for a higher loan incorporation in the total credits. It means that the Cr^{D2} curve will come near the Cr^{D1} curve. With regard to the near position of the Cr^{D2} and Cr^{S} curves (see Figure 1b), it can easy happen that the Cr^{D2} curve will be above the Cr^{S} curve. This situation is plotted in Figure 2. In this case, the enterprises meet the credit rationing phenomena because banks are not willing to overshoot their maximal loan limit. In the case of finite loan substitution or in extreme case zero loan substitution respectively, the agricultural output would be restricted. It can be graphically presented as follows. The intended production based on prognosis is assumed to be in the height of Y_1. This level of agricultural production asks for the loan demand Cr_1. However, with respect to the presence of credit rationing, the loan demand would be satisfied up to the height of the loan limit, i.e. Cr_0. Consequently, assuming the finite loan substitution or in extreme case zero substitution respectively, the agricultural production would be restricted on the level Y_0. The loss of production would be ΔY_{CR}, which is mathematically expressed in the equation (28).

After the analysis of the quantified model CR-AS the following part of the paper analyses and discusses some aspects of the model more in details. The discussion also includes the group of small and middle enterprises to make the analysis more valuable.

Let us assume that we have the following initial conditions. The variable Land/Workers is constant. The Cr^{D2} curve is below the Cr^{S} curve, i.e. the enterprises do not meet the credit rationing. And the enterprises demand such amount of total credits that corresponds with the location of Cr^{D1} above Cr^{S}. The Figure 2 shows this situation in its left part, i.e. to the point of intersection of the curves Cr^{D2} and Cr^{S}. Under these conditions, the enterprises produce as much output as they intend to produce. However, it is worth analysing the variants, which consider factors that induce to shift the curves. The first variant has already been roughly analysed. Recalling it, the increase of loans in the credit structure causes the convergence of the Cr^{D2} to Cr^{D1} curve. This situation can arise from several reasons, e.g. changes in suppliers, reaching the trade credit limits, contraction in delivery time etc. Such situations increase the firm's credit demand and may lead to the surplus of credit demand over the credit supply and thus to the rationing of the intended production. These situations can happen with higher probability in the group of small and middle enterprises. The group of small and middle enterprises can be regarded as having the Cr^{S} curve closer to Cr^{D2} curve compared to the group of large enterprises. Especially taking into consideration just investments, financial resources significantly limit the group of small and middle enterprises. Thus they are in many cases not able to carry out large investments. Furthermore, the surplus of credit demand over the credit supply can result in the group of small and middle enterprises in a bankruptcy. The above-analysed aspects are more powerful in the time of recession. The time of recession is characterised by the contraction of all credits or of all parts of capital. The general price decrease causes the decline of collaterals. That is, it results in the drop-off of the Cr^{S}. This situation can lead, if the situation has not happened yet, to the surplus of the Cr^{D2} over Cr^{S}. The affected firm or firms respectively produce still less than they intend to produce and it can consequently lead to further decrease of the output.

The role of the PGRLF (Support and Guarantee Farm and Forestry Fund) in Czech agriculture seems to be very important in the light of our analysis. The fund enters our model as an agent that reduces the presence of the credit rationing phenomenon in the market. It means that its activities shift up the Cr^{S} curve of agricultural enterprises (and especially the Cr^{S} of small and middle enterprise). The efficiency of its activities asks, however, for a detailed analysis which will not be made in this paper.

CONCLUSION

The analysis of credit financing and its determination of economic activity have both macroeconomic

The losts of production in the case of credit rationing occurrence ceteris paribus:

$$Cr_1 = (1-0.55)\sqrt[0.47536]{\frac{1.3678 \times AV_t^{0.925} \times P_t^{0.17097} \times P_{t-1}^{-0.0828} \times P_{t-2}^{0.0726} \times P_{t-3}^{-0.0813}}{127.08549 \times \text{Land/Workers}_t^{0.68122}}} \tag{27}$$

$$\Delta VA_{t+1} = 127.08549 \times [1/(1-\kappa) \times (Cr_1 - Cr_0)]^{0.47536} \times \text{Land/Workers}^{0.68122} \tag{28}$$

and microeconomic consequences. The nature of the analysis depends on several factors. However, we should always bear in mind that it is important to build the steady bridge between microeconomic and macroeconomic analysis to keep the inferences of the analysis valid (Okun 1981). The microeconomic structure of the economy determines the role of agents in the credit channel and their importance. Therefore, the definition of theoretical model on macroeconomic level has to take into account the microeconomic structure of the economy.

The results of the analysis of the group of large agricultural enterprises can be summarised as follows. First, the analysis suggests that the group, generally speaking, does not meet the credit rationing phenomenon. That is, the production is not negatively determined by the shortage of credits or loans respectively. The large agricultural enterprises seem to have even some reserves to eliminate the influence of negative shocks.

Second, if the firms' Cr^{D2} curve operates close to the Cr^{S} curve, there can be several reasons for it (e.g. the size of the firm, the ownership, etc.), it indicates the presence of a higher risk, which results from the higher probability of the meeting of credit rationing. The situation can result in bankruptcy in the extreme case.

Finally, the analysis suggests that the hypothesis of the paper cannot be rejected on this stage.

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