THE CO-INTEGRATION ANALYSIS OF THE RELATION BETWEEN AGRICULTURAL PRODUCT MARKET AND LOAN MARKET*

L. Čechura

Czech University of Life Sciences, Faculty of Economics and Management, Department of Agricultural Economics, Prague, Czech Republic

The paper deals with the co-integration analysis of the relationship between the agricultural product market and the loan market. The relationship between the agricultural product market and loan market is examined on the basis of a defined theoretical framework. VAR analysis and co-integration are used to fit the theoretical model, i.e. VECM (Vector Error Correction Model) is fitted. The results of the paper suggest that the long equilibrium relationship between agricultural output and agricultural loans exists. Moreover, the credit rationing may have a short-run effect on the sector level but the long equilibrium relationship may be deteriorated by the long-run effect of the period of "structural shedding". Furthermore, the different results could be obtained by dividing the agricultural entrepreneurs according to their size due to the significant differences in their performance. The relation between agricultural product market and loan market is supported by the existence of additional credit channel representing by nominal agricultural interest rate.

agricultural output; agricultural loans; co-integration analysis; VECM; equilibrium relationship

INTRODUCTION

Traditional macroeconomic analysis assumes that credit markets work efficiently. Under this assumption they can be left out of consideration in the analysis. However, in reality the market efficiency is deteriorated by the presence of information asymmetry. The information asymmetry among debtors and creditors has a negative effect on the market mechanism, i.e. the market is not cleared by interest rate. The creditors are not able to observe sufficiently bad debtors due to the presence of imperfect information. As a result a certain part of potential debtors is rationed. The stronger is the information asymmetry the higher is the credit rationing. The effect of information asymmetry is supported by increasing the risk level that can be induced by a price movement (or higher price volatility) or changes in economy.

The topic of the paper is very upcoming. Many well-known economists, e.g. Bernanke, Blinder, Stiglitz, Bondt, Gertler and Mishkin, find credits and asymmetric information in the centre of economic interest. And, they extend or alter the traditional theory with respect to their role. Among others, it can be mentioned that the importance of asymmetric information gave rise to a new theory of the firm that explains some points of empirical observed firm behaviours that are difficult to explain in terms of the traditional theory of the firm (Greenwald, Stiglitz, 1990). The empirical studies are a very important tool for comparing the theory with economic data. In the Czech Republic the problem of loans and/or asymmetric information was investigated by e.g. Buchtíková, Izák, Janda, Hampl, Matoušek etc. The problem of agricultural loans was analysed by Bečvárová, Buchtíková, Čechura and Janda. For example, Buchtíková was concerned with the analysis of all sectors in Czech economy. She found that loans played a crucial role in the foreign financing of plants in the first half of the nineties. Janda aimed at the problem of credit rationing associated with the existence of PGRLF. The analyses offer very interesting and profitable results. However, many problems remain for further investigation in the agricultural sector.

The quantity of usable loans may or may not be important at the sector level. It depends on several factors that are discussed in the theoretical framework of the paper and later on also on the results of the co-integration analysis. The inferences of the analysis serve for the discussion about the role of loans in Czech agriculture and other factors determining both the agricultural product market and agricultural loan market.

MATERIAL AND METHODS

The aim of the paper is to analyse the relation between the agricultural product market and loan market by employment of co-integration analysis.

The hypothesis states that loans are an important and only to a certain extent substitutable part of the business cash flow. Then, the presence of credit rationing on the market has a negative impact on agricultural production, i.e. the quantity of usable loans is a significant determinant of agricultural output.

Theoretical framework

The theoretical framework comes out from the above stated hypothesis. That is, we assume that the quantity of

* The research was financed by the grant project 402/06/P364 by Czech Science Foundation (GACR).

usable loans is a significant determinant of agricultural output due to the importance of loan financing in business cash flow that cannot be easily replaced. Strictly speaking, the credit substitution is assumed to be possible only to a certain extent. Then, the lower is the possible substitution of financial resources (loan substitution) the larger is the effect of credit rationing on the production level of affected enterprises. Moreover, taking into consideration the extreme case, i.e. the zero loan substitution, the credit rationing occurrence causes the reduction of (intended) production level of affected enterprises. In other words, the affected enterprises suffer from the lack of financial recourses for purchasing or hiring inputs at such a level that ensures the intended production level derived from anticipated future business development (especially price development). According to Blinder (1985) the situation, in which companies cannot produce as much as they are able to sell, 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.

The theoretical model is based on the conventional macroeconomic IS-LM model adjusting for sector level and agricultural features and is derived under following assumptions:

(i) Loans are a 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.

(ii) The credit substitution is finite, i.e. the substitution of credit for shareholders' capital and vice versa is possible only to some extent.

(iii) The quantity of demanded loans depends on the level of production. That is, assuming the case of growing demand, firms ask for more credits because they are attracted to produce more due to higher (increasing) value of marginal production and vice versa.

(iv) The presence of asymmetric information on the loan market is assumed, i.e. the firms face the credit rationing due to the presence of adverse selection and a moral hazard problem.

(v) The effect of asymmetric information depends on the risk level. That is, the higher the risk level, the higher credit rationing.

(vi) 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 specific area of isoquants.

(vii) The adaptive expectations and rational decision process are assumed.

(viii) 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.

Generally speaking, the effect of credit rationing depends 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 on in the analysis.

As stated above, the theoretical model comes out from the conventional IS-LM model, which usually consists of three equations and stands on neokeynesian's assumptions. However, the model is adjusted for sector level and respects its basic features. The theoretical model consists of four equations. The first equation states for the agricultural product. The relation is based on the dynamic aggregate demand function supplemented by loans. The loans represent the influence of money (loan) market on the product market. As stated above it is assumed that money plays no role in the model, i.e. firms hold money only to secure the (intended) production level. Thus, the product market is influenced by money market via cash flow of firms. The relation between the product and price depends on the nature of the agri-food chain, i.e. if there is upstream or downstream market power. Agricultural product is supposed to be positively determined by the amount of agricultural loans, i.e. the increase in agricultural loans in time t affects the increase of intended product. The lagged product in the first equation states for the adjustment process in the decisions based on past information about the character of agricultural market.

The second equation represents the inverse relation between product and price. That is, in this case the price is the function of the lagged price and product in time t and t-p, where p is the length of lag. The equation stresses the fact that the relation between price and product is simultaneous. This point is very important for this part of econometric modelling.

The third equation describes the relation between loans, the value of marginal product and interest rate. It is assumed that the increase in the risk adjusted value of marginal product has a positive effect on loans. The value of marginal product is used because it is a criterion for the profit maximisation. That is, it determines the level of production. The relation between loans and agricultural interest rate represents the classical loan demand function.

The fourth equation states for the constitution of agricultural interest rate by banks. The agricultural interest rate is a function of loans and the sum of past differences of the risk adjusted values of marginal product.

$$(1)\quad y_t = \alpha_1 y_{t-1} + \alpha_2 p_{t-1} + \alpha_3 L_{t-1} + u_{1t}$$

$$(2)\quad p_t = p_{t-1} + \sum_{n=0}^{p} \beta_1 y_{t-n} + u_{2t}$$

$$(3)\quad L_t = \gamma_1 L_{t-1} + \gamma_2 (y'_{t-1} \cdot p_{t-1}) + \gamma_3 i_t + u_{3t}$$

$$(4)\quad i_t = d + \delta_0 L_t + \sum_{n=1}^{N} \delta_n \Delta (y'_{t-n} \cdot p_{t-n}) + u_{4t}$$

Furthermore, the theoretical model is adapted for the use of co-integration analysis in the form of VECM (Vector Error Correction Model). In such a form all variables are endogenous and mutually dependent. That is, VECM is more general compared to the above derived theoretical

model and does not demand for the strict theoretical definition (see the methodological aspects of VAR and co-integration analysis).

There are four endogenous variables in VECM – agricultural output, index of agricultural prices, quantity of loans and interest rate on agricultural loans. The agricultural output (logAY) in prices of 1995 is logarithmically transformed and the seasonality is removed by moving averages. Index of agricultural prices (where 1995 = 100) enters the model in the form of logarithmic differences in time t and t-4 (dlogAP), i.e. the index of agricultural prices is seasonally differenced. The quantity of agricultural loans (logL) is deflated by index of agricultural prices, logarithmically transformed and seasonally adjusted. Agricultural interest rate (lgoia) is in nominal expression and also logarithmically transformed.

The data set has a quarterly periodicity and starts in 1995:01 and ends in 2003:04. The data set is gathered from the Czech Statistical Office and ARAD database of the Czech Central Bank. The RATS software version 6 and the CATS package in RATS are used to fit the model and to test them.

Econometric methodology

The linkage of co-integration analysis with VAR modelling is used to fit the theoretical model.

The VAR modelling follows the idea that all variables in the model are stochastic and simultaneously dependent. That is, the model structure contains just endogenous variables, whose lags are equal. The VAR(p) model is possible to write in the form of (i) (Bierens, 2001; Banerjee et al., 2003, and others) whilst it assumes that $C_S = 0$ for s > p:

$$\text{(i)}\quad X_t = \eta + \sum_{s=1}^{p} C_s X_{t-s} + U_t,$$ [1]

where X_t is g x 1 vector of stochastic stationary variables, p denotes the length of lags and $u_1, \ldots, u_t$ are nid (0, Σ).

The important and satisfactory condition of strict stationarity of VAR(p) model is strict stationarity of residuals u_t. The model is possible to rewrite into a form of (ii) like polynomial matrix by using system lag operator.

$$\text{(ii)}\quad C(L) = I_k - C_1 L - \ldots - C_p L^p.$$

The process is stationary if the roots of equation ($I_k - C_1 L - \ldots - C_p L^p = 0$) lay outside the unit circle. Then it is possible to write[2]:

$$\text{(iii)}\quad X_t = [C(L)]^{-1} U_t = \sum_{s=0}^{\infty} \psi_s U_{t-s},$$

where $\sum_{s=0}^{\infty} \psi_{ij,s}^2 < \infty$ holds for $i = 1, 2, \ldots, k$ and $j = 1, 2, \ldots, k$.

[1] In the case of $E(X_t) = \eta = 0$ simplifies the VAR (p) model into a form of $X_t = \sum_{s=1}^{p} C_s X_{t-s} + U_t$

[2] If we assume that $E(X_t) = \eta = 0$, i.e. the easier form of model structure.

The economic series are usually integrated of order d. To get stationary series one must difference the time series d times. The differencing used in VAR modelling to get stationary time series, however, omits any information about long-run adjustments that the data may contain. The VAR model informs about a short-run relationship among variables. The information about long-run is not provided. This feature of VAR modelling can be regarded as a specification mistake when the long run relationship among the variables exists. In other words, if the long-run relationship exists the model should contain it. Thus, the concept of co-integration should be employed.

The co-integration analysis is a powerful one because it allows describing the existence of an equilibrium, or stationary (long-run), relationship among two or more time-series, each of which is individually non-stationary. The modelling non-stationary time series may result in spurious regression. Thus, it can be said that the regressions involving levels of time series of non-stationary variables make sense if and only if these variables are co-integrated (Banerjee et al., 2003).

The linkage of co-integration analysis with VAR modelling results in VECM (Vector Error Correction Model). In this case the relationship (i) contains error correction mechanism, i.e. the general form of VECM can be expressed in (iv). Vector Error-correction mechanisms combine the advantages of modelling both the levels and differences. Thus, in VECM the dynamics of both short-run (changes) and long-run (levels) adjustment processes are modelled simultaneously.

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

where $C_S = 0$ for $s > p$, X_t is g x 1 vector of stochastic non-stationary (integrated of order 1) variables and $u_1, \ldots, u_t$ are nid (0, Σ) and D_t is a vector of non-stochastic variables. The hypothesis of co-integration is formulated as a reduced rank of the Π-matrix, which contains two coefficients α and β. The coefficients α and β are g x 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 non-stationary variables (Hansen, Juselius, 2002). The essential problem is the determination of r, that is identifying the number of co-integrating vectors, and in the estimation of the co-integrating matrix β. The procedure employed in this paper to determine r and estimate the co-integrating matrix β is that of Johansen (Hansen, Juselius, 2002; Charemza et al., 2003).

RESULTS AND DISCUSSION

The analysis starts with unit roots to test the order of integration in the analysis of employed variables. Based on the results of ADF (Augmented Dickey Fuller) all endogenous variables, i.e. the logarithm of agricultural output (logAY), seasonally differenced index of agricultural prices logarithmically transformed (dlogAP), quantity of

loans (logL) also in logarithms and the logarithm of interest rate on agricultural loans (logia) seem to be integrated of order 1 (i.e. I(1)).

According to the information criterions and specification tests the model was estimated in the following form. As a deterministic component one dummy variable is used. The dummy variable can eliminate the impact of changes on the money market after 1997. This period can be called "the structural shedding" of debts. The dummy variable contains number 1 for the period 1998:04 – 2002:02 and for the remainder it contains number 0. The next deterministic component is an unrestricted constant. That is, it is supposed that the variable follows a linear trend in the VAR space. The length of the lag was chosen based on AIC (Akaike's Information Criterion) and SIC (Schwarz Information Criterion) respecting both economic assumptions and the length of time series.

Table 1 contains the results of co-integration analysis of the model of Czech agriculture, which, as stated above, consists of 4 endogenous variables, 1 dummy variable, an unrestricted constant in the VAR space and which has 4 lags in the VAR space. The L-max test and Trace test show that the model contains two co-integrating vectors at the level of significance 10%. That is, the results do not offer unique information about the long-run relationship among variables and to get one co-integrating vector it

Table 1. Results of co-integration analysis of model of Czech agriculture

Endogenous series:	logAY	dlogAP	logL	logia		Effective sample:	1996:01 to 2003:03
Exogenous series:	DUM2					Lag(s) in VAR-model:	4
Deterministic series:	unrestricted constant					No. of observations:	31
I(1) ANALYSIS							
Eigenvalue	L-max	Trace	H0: r	p-r	L-max90	Trace 90	
0.78990	48.37	84.53	0	4	17.14	43.84	
0.54090	24.13	36.16	1	3	13.39	26.70	
0.28910	10.58	12.03	2	2	10.60	13.31	
0.04580	1.45	1.45	3	1	2.71	2.71	
BETA (transposed)				ALPHA			
LogAY	dlogAP	logL	logia				
–51.962	–29.416	0.671	–29.728	0.005	–0.014	0.003	0.000
5.183	15.452	7.720	–19.479	0.020	0.003	–0.017	0.002
–42.128	–19.555	–16.748	0.664	0.001	–0.006	0.016	0.002
93.827	–2.787	–11.905	74.512	–0.027	–0.006	–0.008	0.004
PI							
LogAY	dlogAP	logL	logia				
–0.485	–0.435	–0.160	0.116				
–0.195	–0.232	0.293	–0.549				
–0.569	–0.446	–0.336	0.246				
2.118	0.836	0.014	1.248				

Table 2. Re-normalisation of vectors of eigenvalue – a model of Czech agriculture

The matrices based on 1 co-integration vector							
BETA (transposed)							
LogAY	DlogAP	logL	logia				
1.000	0.566	–0.013	0.572				
0.335	1.000	0.500	–1.261				
ALPHA			T-values for ALPHA				
DlogAY	–0.276	–0.212	–2.054	–5.318			
DdlogAP	–1.046	0.041	–3.369	0.446			
DlogL	–0.064	–0.093	–0.216	–1.065			
Dlogia	1.394	–0.096	5.030	–1.160			
PI				T-values for PI			
DlogAY	DdlogAP	DlogL	Dlogia				
–0.347	–0.369	–0.103	0.11	–2.571	–4.291	–5.12	1.197
–1.032	–0.551	0.034	–0.65	3.308	–2.775	0.736	–3.063
–0.095	–0.129	–0.046	0.081	–0.320	–0.686	–1.042	0.403
1.362	0.694	–0.066	0.918	4.890	3.914	–1.591	4.843

demands running of tests of structural hypothesis. However, these tests go behind the scope of this paper, which is aimed at the identification of the basic features of the relationship between the agricultural product market and the loan market and not at the precise determination of the long-run relationship between them. The sufficient information is that the long-run relationship exists and that it is of such an approximate form. Furthermore, the long-run relationship can be derived from the two obtained co-integrating vectors by an economic evaluation, which is carried out.

Re-normalisation of vectors of eigenvalue of the model for $r = 2$ in Table 2 represents a re-calculation of matrices in Table 1 (corresponding rows) with respect to driven variables, which are the logarithm of agricultural output and the seasonally differenced logarithm of index of agricultural prices. Thus, Table 2 offers co-integrating vectors just with the respect to these two variables, including the tests of significance for correction coefficient α and tests of significance for matrix Π. The first co-integrating vector is normalised for agricultural output. It supplies us with the following information. The agricultural output is in this simultaneous relationship negatively determined by agricultural prices and agricultural interest rate and positively by the amount of agricultural loans. The negative relationship with agricultural prices corresponds with the demand driven chain. That is, the increase in agricultural prices results in the long run in the decrease of demanded (consumed) agricultural output (product) or in the substitution effect foreign for domestic production respectively. It means that in the long period the relationship, in which the increase of price has a negative impact on agricultural product due to the competitive relationship with the foreign supply, is relevant. Furthermore, the effect of the variability of agricultural prices and, thus, the risk factor should be considered. The relative increase in risk level with respect to the firm assets leads to the rise of the risk premium connected with whatever increase in the production that reduces the risk adjusted marginal product. The relationship between an agricultural product and agricultural prices is also influenced (deteriorated) by subsidies and grants. It is also important to mention the significant role of multinational chains in the agri-food chain. The multinational chains push towards the low price level and give the agri-food chain the demand driven nature, i.e. upstream power. The multinational chains also contribute to the higher price variability or higher uncertainty about the price development (with the above mentioned consequences), respectively. To sum up, the long-run relationship may be determined by all the discussed factors.

The structural parameter between the price and product in the co-integrating vector corresponds with the assumption about the agricultural price elasticity and, thus, it does not contradict the economic theory. The parameter can be regarded as a good estimation of the relationship between an agricultural product and an agricultural price on the sector level over a long period. From the point of view of the short-run, the presence of cobweb mechanism that can be analysed by impulse-response analysis should be taken into account.

The next variable in the co-integrating vector is the amount of agricultural loans. The relationship between an agricultural output and agricultural loans is very important with respect to the aim of the paper. But, considering the simultaneous relationships among in the analyses employed variables (see the theoretical framework) all of them have an important role in the analyses and supply us with important information about the agricultural product and the loan market and their consequences.

The first co-integrating vector suggests that the relationship between the agricultural output and the amount of agricultural loans is positive, i.e. an increase in the amount of agricultural loans results in the increase of agricultural output. However, the deeper investigation of this equilibrium relationship shows that not all characteristics correspond with established assumptions. That is, the assumption of a simultaneous relationship may be a bit distorted. Thus, the assumption that follows the concept of exogenous and endogenous money can be warped. It can be discussed as follows. Firstly, the co-integrating vector is not significant in the equation for agricultural loans. It indicates that loans may have an exogenous feature in this relationship. Secondly, the intensity, i.e. the size of the

Table 3. Residual analysis of the model of Czech agriculture

Correlation matrix				Multivariate statistics		
DlogAY	DdlogAP	DlogL	Dlogia	Log(det(sigma)) =	–30.98217	
1.000000				Information criteria: SC =	–23.44956	
–0.404150	1.000000			HQ =	–25.56972	
0.570399	–0.805276	1.000000		Trace correlation =	0.73653	
–0.125207	0.448497	–0.223220	1.000000	LM(1)	12.632	p-val = 0.70
Standard deviations of residuals				LM(4)	16.869	p-val = 0.39
0.014394	0.033262	0.031578	0.029703	Test for normality	8.974	p-val = 0.34

Univariate statistics						
MEAN	STD.DEV	SKEWNESS	KURTOSIS	ARCH(2)	Normality	*R*-squared
0.000000	0.014394	–1.207042	5.991979	0.794	9.416	0.640
0.000000	0.033262	0.673029	3.202288	2.758	2.872	0.717
0.000000	0.031578	–0.540904	2.978046	3.590	1.913	0.621
0.000000	0.029703	–0.050909	1.735378	4.907	3.450	0.684

parameter, in the co-integrating vector is very low. The intensity does not fully correspond to the intensity which can be supposed when it is straightforwardly derived based on the typical representation of loans in the balance sheet of agricultural plants within the analysed period.

The above-mentioned facts suggest that the amount of agricultural loans may not play a significant role in the determination of agricultural output over a long period. However, the acceptance of such a conclusion would omit both the important features of agricultural sector in the analysed period and, also, other aspects of the model.

The first important feature of the analysed period (more closely Čechura, 2004) is the structural shock in 1997, which resulted in a significant drop of the amount of agricultural loans. The situation can be described as follows. Before 1997, especially in transformation period it can be characterised as a period with very "soft" budget environment and very relaxed conditions on the loan market. Loans were one of the most important foreign financial resources and taking into account the nature of privatisation it removed the problem of shortage of financial resources of the Czech entrepreneurs. The same situation prevailed in the agricultural sector and to a certain extent it was supported by the PGRLF. The change occurred after the monetary turbulences in 1997. The Banks tightened up their loan policy. That is the credit creation was targeted especially at the "good" borrowers. Low profitable and insolvent plants faced a credit rationing phenomenon. This resulted in a significant drop of the loans advanced in many sectors, including agriculture. This period can be called (at least in this paper) as "structural shedding" of insolvency due to its target. The aim consisted, on the one hand, of the revitalization of the bank sector and, on the other hand, of the secondary restructuralisation of industry, i.e. removing non-profitable plants. Altogether, it can be said that the shock had a significant importance and, thus, it had to influence the relationship between a product and loans. The model tries to catch this shock by incorporating the dummy variable (see the theoretical framework for its characterisation). The dummy variable should capture the effect of "structural shedding" and thus remove, or at least decrease, the probable bias of the relationship between the agricultural output and the loans.

The dummy variable is a significant regressor in the equation for agriculture output at the 5% level of significance and it is positive. In the equation for agriculture loans it is staying at the edge of significance and it has negative parameter. The parameters (especially their signs) correspond with the hypothesis that the period of "structural shedding" has a significant importance in the development of agricultural loans or in the relationship between the agricultural output and the agricultural loans respectively. That is, in spite of the decrease in loans, i.e. many plants (especially the small and middle ones) face the credit rationing phenomenon, which should result in the reduction of production according to the established assumptions, the total agricultural output is not significantly affected. This result implies that the agricultural sector may be flexible enough to compensate for the limitation and/or the replacement of one group of agricultural entrepreneurs. Because the temporary decrease in agricultural production has an effect on the increase of agricultural prices, which is an impulse for the increase in the production by the capital powerful plants. Thus, the credit rationing may have a short-run effect on the sector level but the long equilibrium relationship may be, in this case, somewhat deteriorated by the long-run effect of the period of "structural shedding". Furthermore, the results suggest that different results could be obtained by splitting the agricultural entrepreneurs according to their size due to the significant differences in performance of agricultural plants.

To sum up, the long equilibrium relationship between an agricultural output and agricultural loans exists. The sign corresponds with economic theory, however, the intensity seems to be low. The size of the parameter in co-integrating vector can be affected by both the period of "structural shedding" and the significant heterogeneity of entrepreneurs in agricultural sector (it can be also considered as the difference between the usage of total amount of agricultural loans vs. the amount of new agricultural loans). It can be assumed, that if all plants in the agricultural sector had faced the credit rationing phenomenon, the structural parameter would have been higher. Furthermore, the conclusion about the scope of determination of agricultural output by loan market must be complemented by the results of the forth element in the co-integrating vector, i.e. the agricultural interest rate. Since the nominal agricultural interest rate is a representative of additional credit channel, it has an effect on the balance sheet of agricultural plants. The agricultural interest rate has a negative impact on agricultural output. That is, the increase in nominal agricultural interest rate results in the decrease of agricultural output. This issue supports the inference that the loan market can play a more important role at the sector level than it is suggested by the size of the structural parameters of the loans in the co-integrating vector. Moreover, it informs that not only the accessibility but also the price of the money is an important determinant of agricultural output.

The second co-integrating vector is significant only in the first equation, i.e. in the equation for agricultural output. The co-integrating vector contains inverse relationships between the agricultural output and agricultural prices that correspond with the theoretical assumptions. This result supports what was stated above. The relationship between agricultural prices and agricultural loans is also negative. This corresponds with the first co-integrating vector, in which the increase in loans resulted in an increase of agricultural product. The same can be said about the agricultural interest rate, which of course determines agricultural prices in a positive manner.

Thus, the second co-integrating vector does not contradict the first one. The derivation of a unique co-integrating vector requires the test of structural hypotheses. However, according to the analysis of the first co-integrating vector and its tests of significance it can be expected that the unique co-integrating vector is very close to the first one.

The residual analysis (Table 3) informs about the basic statistical features of the fitted model. The LM(1) and

LM(4) tests do not suggest that the autocorrelation exists at the 5% level of significance. The hypotheses about the normal distribution of residuals cannot also be rejected at the 5% level of significance. The coefficients of determination are within 0.621 and 0.717 that can be regarded as very good results from the economic point of view. Also, the other statistical tests and characteristics imply that the model as a whole has sufficient statistical characteristics.

CONCLUSIONS

The co-integration analysis of the relationship between the agricultural product market and the loan market shows several important and for further research, stimulating results. The most important one can be highlighted. There exists a long-run equilibrium relationship between agricultural output and agricultural loans. Thus, the increase of agricultural loans determines the increase of agricultural output and vice versa. Moreover, the increase of asymmetric information on the agricultural loan market resulting in an increase of credit rationing has a negative impact on the agricultural output. However, the reduction is not as large in the long period as it could be assumed. The reason can be found in the considerable heterogeneity of agricultural plants, in the period of "structural shedding" or in the use of the amount of agricultural loans instead of the amount of new agricultural loans. The importance of the relation between the agricultural product market and the loan market was supported by the relation between the agricultural output and the nominal agricultural interest rate as a representative of an additional credit channel (balance sheet channel). Furthermore, it can be said that the results correspond to other studies, which are aimed at the problem of agricultural loans in Czech agriculture. To sum up, the paper hypothesis can be rejected.

REFERENCES

BANERJEE, A. et al.: Co-integration, error correction and the econometric analysis of non-stationary data. Oxford, University Press 2003.

BERNANKE, B. S. – BLINDER, A. S.: Credit, Money, and Aggregate Demand, March 1988, www.nber.org/paper/w2534 – 18/10/2003.

BIERENS, H. J.: Vector time series and innovation response analysis. Pennsylvania State University, 2001, http://econ.la.psu.edu/~hbierens/easyreg.htm – 27/8/2003.

BLINDER, A. S.: Credit rationing and Effective Supply Failures, May 1985, Cambridge, www.nber.org/paper/w1619 – 24/10/2003.

BUCHTÍKOVÁ, A.: Bankovní úvěry a jejich vliv na vývoj sektorů a odvětví národního hospodářství ČR v roce 1995 (Bank loans and their effect on the development of fields and branches of the national economy of the Czech Republic in 1995). VP No. 79, Měnová sekce ČNB, Praha, 1997.

CHAREMZA, W.W. et al.: New directions in econometric practice: general to specific modelling, co-integration and vector autoregression. Northampton, Edward Elgar 2003.

ČECHURA, L.: Vybrané aspekty úvěrové politiky obchodních bank a jejího vlivu na ekonomickou rovnováhu v zemědělství. Nepublikovaná doktorská práce (Some aspects of loan policy of commercial banks and their influence on the econonic equilibrium in agriculture. Unpublished thesis). 2005.

GREENWALD, B. C. – STIGLITZ J. E.: Asymmetric information and the new theory of the firm: financial constraints and risk behaviour, National Bureau of Economic Research, w.p. 3359. Cambridge, 1990.

HANSEN, H. – JUSELIUS, K.: CATS in RATS: Cointegration Analysis of Time Series. ESTIMA, Evanston, USA, 2002.

JANDA, K.: Credit rationing under Asymmetric information and the fund of guarantees for agriculture and forestry, working paper, August 1994, www.cerge.cz, 1.3.2003.

Received for publication on March 22, 2006
Accepted for publication on February 7, 2007

ČECHURA, L. (Česká zemědělská univerzita, Fakulta provozně ekonomická, Praha, Česká republika):

Kointegrační analýza vztahu mezi trhem zemědělského produktu a úvěrovým trhem.

Scientia Agric. Bohem., *38*, 2007: 93–99.

Příspěvek se zabývá kointegrační analýzou vztahu mezi trhem zemědělského produktu a úvěrovým trhem. Tento vztah je analyzován na základě definovaného teoretického modelu a s využitím kombinace ekonometrických přístupů kointegrační analýzy a VAR modelování, která ústí v odhad VECM (Vector Error Correction Model). Výsledky odhadu VECM ukazují, že dlouhodobý vztah mezi zemědělským výstupem a množstvím zemědělských úvěrů existuje. Přítomnost úvěrového omezení má spíše krátkodobý negativní vliv na zemědělský sektor. Dlouhodobý vztah může být zkreslen obdobím tzv. „strukturálního setřásání" zadluženosti. Dále bylo v rámci analýzy zjištěno, že různé výsledky odhadu mohou být dosaženy pro velikostně různé skupiny zemědělských podniků, a to vzhledem k významné heterogenitě zemědělských podniků. Vztah mezi trhem zemědělského produktu a úvěrovým trhem byl dále podpořen existencí dodatečného úvěrového kanálu, který funguje přes nominální zemědělskou úrokovou sazbu.

zemědělský výstup; zemědělský úvěr; zemědělské ceny; zemědělská úroková sazba; VECM; rovnovážný vztah; úvěrové omezení

Contact Address:

Ing. Lukáš Čechura, Ph.D., Česká zemědělská univerzita v Praze, Fakulta provozně ekonomická, Kamýcká 129, 165 21 Praha 6-Suchdol, Česká republika, tel.: +420 224 382 250, e-mail: cechura@pef.czu.cz