Specifics in the chosen production chain?

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Abstract

It is possible to consider the production chain as a highly complicated system, within the framework of which different links and mutual relations function. Therefore it is necessary to analyze the complexity of the production chain functioning for the purpose of enhanced knowledge on the existence and the regularities functioning among different production elements. The contribution deals with an analysis of the price transmission in the production chain of cereals, within which only certain partial parts have been earmarked. Co-integration analysis, VECM and impulse-response analysis have been used for the price transmission analysis. Information mentioned in the paper resulted from the solution of a research intention VZ MSM 6046070906 „The Economics of resources of Czech agriculture and their efficient use in framework of multifunctional agri-food systems".

Key words

Price transmission, wheat, industrial producers' price, agricultural producers' price, fodder mixtures, poultry meat, pork.

Anotace

Výrobkovou vertikálu lze považovat za velmi složitý systém, v rámci něhož fungují rozličné vazby a vzájemné vztahy. Složitost fungování výrobkové vertikály je proto třeba analyzovat za účelem zvýšení poznání o existenci a zákonitostech, které fungují mezi různými výrobními články. Příspěvek se zabývá analýzou cenové transmise ve výrobkové vertikále obilovin, v rámci které jsou vyčleněny pouze některé dílčí části. Pro analýzu cenové transmise jsou využity kointegrační analýza, VECM a impulse-response analýza. Příspěvek vznikl v rámci řešení Výzkumného záměru MSM 6046070906 „Ekonomika zdrojů českého zemědělství a jejich efektivní využívání v rámci multifunkčních zemědělskopotravinářských systémů".

Klíčová slova

Cenová transmise, pšenice, cena průmyslových výrobců, cena zemědělských výrobců, krmné směsi, drůbeží maso, vepřové maso.

Introduction

The agricultural commodities market belongs to highly organized markets (Mankiw, 2000). Havránek (1992) draws the attention to the fact that the market structure of the sector is always more complicated, it is a combination of more types, with a transitory form among the particular types, and thus it can be described with model categories with difficulties. Therefore for a deeper analysis, it is always necessary to consider, whether the market of the given sector is more perfectly competitive, as the case may be less imperfectly competitive, where the market solution will approximate the perfect competitive solution. Upon considerable simplification it is then possible to determine the competition type according to the fact whether the entity is the so-called price taker (accepting the price) or price maker (creating the price).

Various price levels may be identified in the production chain of the commodity of wheat – agricultural producers' price, industrial producers' price, consumer prices, import price, export price, etc. Within the analysis of the price transmission, the mutual relations between the price of wheat agricultural producers, the price of poultry meat and pork agricultural producers and the price of industrial producers of fodder mixtures for broilers and pigs are explored.

The results of this research follow up with the achieved results concerning the price transmission analysis that has been carried out according to the hypothesis: price of the industrial producers of fodder mixtures (PIPFM) for particular animal categories (pigs, poultry – broilers) is significantly determined by the price of the wheat agricultural producers - PWAP (Gallová, 2009). It results from these results and from the analysis of the relations between PWAP and PIP of all fodder mixtures that the fodder mixtures for fattening of pigs accept the wheat price change and transfer it into the fodder mixture price. It means that the producers of the fodder mixtures for pigs react in case of increase of PAP of wheat by increase of the fodder mixture price for pigs and to the contrary, however with a different intensity. To the contrary, the statistically significant relation between PWAP and PIPFM for broilers and PIPFM for pigs has not been proven. It means the producers of these fodder mixtures do not consider the wheat price increase or decline as a significant factor leading to increase of decline in the fodder mixtures prices. These prices tend to converge to equilibrium state.

Representation of wheat in the fodder mixtures for the particular animal categories is considerably differentiated. The highest wheat utilization, as regards the natural extent, is obvious in poultry breeding, followed by pig breeding. This is given in particular by the number of animals, fodder mixture consumption in a feeding ration and at the same time by high wheat share in the fodder mixtures for poultry, namely both in fattening of broilers and in fattening of turkey and in breeding of laying hens.

Objective and methodology

Frey and Manera (2005) were dealing with the analysis of asymmetric price transmission and they mention that a number of econometric tools exist that may be used for exploration of mutual relations between the prices of inputs and outputs. Among these tools, they mention e.g. ADL models (Autoregressive Distributed Lag), PAM models (Partial Adjustment Model), ECM (Error/Equilibrium Correction Model), RSM (Regime Switching Model), etc.

The objective of the contribution is to analyze by means of the econometric modeling tools, VAR models (Vector autoregressive model), as the case may be VECM (Vector Error Correction Model) the price transmission in the production chain of cereals, and using the impulse-response analysis the exploration of the long-term dynamics of the chosen system. With regard to the complexity of the whole production chain of the cereals, the analysis has been carried out in the part of the production chain focusing on fattening of farm animals. For this reason, as the basic variables entering into two price transmission models being analyzed the following have been defined: prices of industrial producers of fodder mixtures in CZK/t (differentiated according to the farm animals categories to fodder mixtures for broilers in model 1 – PIPFMB - prices of industrial producers of fodder mixtures for broilers), for pigs in fattening above 65 kg in model 2 – PIPFMPF/price of industrial producers of fodder mixtures for pigs in fattening above 65 kg) and the price of agricultural producers of meat in CZK/t (differentiated according to the animal categories to the price of agricultural producers of a table chicken in model 1 – PAPCM /price of agricultural producers of chicken meat/ , slaughter pig in model 2 – PAPSP /price of agricultural producers of slaughter pig/). The source data with monthly periodicity have been drawn from the database of the Czech Statistical Office for the period of 1995 – 2007.

VECM may be written down as follows:

$$\Delta X_t = \eta + \Pi X_{t-1} + \sum_{s=1}^{p} C_s \Delta X_{t-s} + u_t \qquad (1)$$

where Cs = 0 for s > p, Xt is k x 1 vector of variables integrated of order 1, i.e. I(1), u1, …,ut are iid (0,Σ) and Π is matrix of long-run relation. If the variables are not co-integrated, then VECM reduces to VAR model that may be written e.g. as follows:

$$\Delta X_t = \eta + \sum_{s=1}^{p} C_s \Delta X_{t-s} + u_t \qquad (2)$$

The procedure is modified similarly also in case of inclusion of a long-term relation. If the matrix Π has a full rank, then there is no difference between the VAR model and the Vector Error Correction model (VECM), i.e. the time series are stationary. The model VAR(p) may be written down in the form (3) (see e.g. Bierens (2007), Banerjee et al.

(2003) and others), while it is assumed that CS = 0

for s > p:
$$X_t = \eta + \sum_{s=1}^{p} C_s X_{t-s} + U_t \qquad (3)$$

A necessary condition for a strict stationary of the VAR(p) model is that the error process Ut is strictly stationary and lag polynominal (4).

C(L) = Ik – C1L - … - CpLp (4)

This process is stationary, if the roots of the equation Ik – C1L - … - CpLp = 0 lie outside the unit circle. Then it is possible to write (on condition that E(Xt)=η=0, i.e. we consider for illustration a simpler model structure form):

$$X_t = [C(L)]^{-1} U_t = \sum_{s=0}^{\infty} \psi_s U_{t-s} \qquad (5)$$

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

In connection with the contribution's objectives the following hypotheses have been defined:

H1: The price of agricultural producers of different types of meat (pork, chicken) is determined by the fodder mixtures prices significantly.

H2: The analyzed prices in the chosen wheat production chain are co-integrated, i.e. they converge to equilibrium state in long period of time.

H3: Time lag exists within particular elements of the wheat production chain corresponding to the production cycle length of the particular use directions (fattening of pigs and poultry).

The first step in the price transmission analysis was testing of seasonability of the source data of the monthly time series using seasonal indexes. If the seasonability had been proven in the time series on the basis of the performed seasonal character test, then it was necessary to proceed to the data adjustment fort the seasonal character by means of adding a seasonal variable (SIN2Π), an dummy variable (DUM). The dummy variable (DUM) has been constructed as a null-one vector. In this vector, ones are attributed to the periods (months) in which significant fluctuations occurred in the time series of the analyzed data, i.e. they eliminate short-term extreme price values. The seasonal variable and the variable describing the production cycle length have been defined using the harmonic function in the following form: $f: \quad y = A\sin(\omega t + \varphi_0)$ (6) , where A, ω, φ0 are real constants, t is time. The constant A, i.e. the amplitude of the function, is estimated as a parameter of the variable $(\sin(\omega t + \varphi_0))^2$ of the defined econometric model. $(\omega t + \varphi_0)$ phase (φ0 initial phase), as the case may be the period of the function has been determined according to the expectation of the nature of the seasonal character in the agricultural sector. It means the seasonal variable is expressed according to relation (7).

$$\left(\sin\left(\frac{\pi}{12}t - \frac{\pi}{12}\right)\right)^2 \qquad (7).$$

After the adjustment of the data for the seasonability it is possible to proceed to unit root test – the stationarity test. The stationarity of the time series has been analyzed using ADF (Augmented Dickey-Fuller) test for maximum lag equal to12 (p = 12). The null hypothesis H0 assumes the data is not stationary and thus integrated of order 1, it means I(1). This hypothesis is not rejected if the calculated value of the testing criterion is higher than the tabular value of the testing criterion of ADF test (testing has been performed at the significance level 0.05). If it be to the contrary, then it is valid that the time series are stationary – integrated of order 0, i.e. I(0).

If the data is not stationary, it is possible to proceed to VECM construction, namely by means of testing of a long-term relation among the variables. If there is a long-term relation among the variables, then a co-integration vector (r) exists, characterizing this relation. If the existence of the long-term relation among the variables is confirmed (of the co-integration vector) by means of eigenvector, then the calculated value of the testing criterion must be higher than the critical value (again tested at the significance level 0.05). Thus the null hypothesis H0 is refused: r = 0 in favor of the alternative hypothesis: HA: r = 1 (where r = number of co-integration vectors). Co-integration can be understood as the statistical proof of the long-term relation existence among the variables (Thomas, 1993 in Zhou, Buongiorno, 2005), where the co-integrated variables are not stationary, but their linear combinations are stationary.

Using the Microfit 4.0 software an estimation of the model parameters has been carried out on the basis of the method of the least co-integrated squares with subsequent diagnostic tests (Pesaran a kol., 2003): functional form test, normality test, heteroscedasticity test, test of serial autocorrelation of residuals. The diagnostic tests come out from the assumptions the classical linear regression model shall fulfill: assumption of homoscedasticity (i.e. assumption of final and constant dispersion of random components), uncorrelated residuals, assumption of orthogonality (the random component and the regression coefficients are uncorrelated), zero mean value of the random component and the assumption of the normal distribution.

For each of these diagnostic tests, two testing statistics have been calculated – Lagrange multiplicator (LM statistics) coming out from $\chi 2$ distribution and F-statistics, as the case may be modified LM (LM F) coming out from F-distribution. Impulse-response analysis has been used for exploration of the long-term system dynamics. Using these methods offers detailed information on the price transmission nature and the influence of innovations (shocks) on the price development. Graphic display of the impulse-response analysis assumes then a shock (measured in the chart on the axis y) at the amount of the standard deviation, it means that the unit shock caused by the given variable corresponds to the size of the standard deviation of this variable.

Results and discussion

By means of two-equation model 1, as the case may be model 2, the relations have been analyzed between PIP of fodder mixtures for broilers, as the case may be for pigs, and PAP of poultry meat – chicken I, as the case may be slaughter pig. Construction of both models comes out from the following hypothesis: if PIP of the fodder mixture for the given farm animal category grows, then on condition of functioning price transmission increase of PAP of meat of the given animal category occurs, since the fodder mixtures represent significant cost item in the fattening and increase in the production costs should transpose in the price of the product being offered (the price of the fattened broiler, as the case may be the price of the slaughter pig).

However, increase in PIP of the fodder mixture may be also related to a number of shocks, which may occur both in plant production and in animal production (e.g. influence of weather, lack or excess of precipitation, poor harvest, consumers' interest in the given meat type, etc.). Let's suppose that the increase of PIP of the fodder mixture, e.g. for broilers occurs in consequence of increase in the price of the fodder mixture components. If we suppose the fodder mixtures producers adhere to the fodder mixture composition, i.e. they do not, within the endeavor to maintain the fodder mixture quality, (i.e. its nutrient parameters, digestibility and assumed body mass gain of the animals in fattening) replace the more expensive components with the cheaper ones. The problem of the fodder mixtures components substitution can be exactly worse digestibility of the fodder mixtures, which has its negative impacts on efficiency of animals and their body mass gain. Limited substitution of the fodder mixture components is also related as a rule with the fodder mixture production according to the client's conditions, i.e. with "made-to-measure" fodder mixture production for a specific company and with the specific efficiency rate.

It means that if supply shock occurs in the agricultural producers' market (e.g. due the influence of increase in the price of fodder – fodder mixture), then under otherwise same conditions, shifting of the supply curve occurs. The newly arisen break-even point of the supply and demand curves is, compared to the original equilibrium state, characterized with a higher price and lower quantity.

Increase in the fodder mixture price as of the production factor may lead with certain economic entities operating in the fattening area to short-term or long-term unprofitability in consequence of the fact that the price of the product being produced (chicken meat) does not achieve the minimum price limit (i.e. that PAPCM is below the level of the minimum average costs during long period of time, as the case may be below the level of the minimum of average variable costs in short period of time) and is subsequently transposed in the negative profitability of the fattening.

Negative income from operations or fall in the profitability of the fattening will result in lower interest of the meat producers in this part of the business plan, which will show up with certain lag in drop in poultry meat production. With regard to the market environment dynamic character, rational behavior of the economic entities and the market reaction (i.e. of offering entities and those making enquiries), it is obvious that the supply shock will not remain without a response. Thus, e.g. due to the drop in the domestics poultry meat production, growing foreign trade share in the form of import may occur on condition that the imported meat price is lower than the price in the domestic market. The similar situation may occur then also within model 2.

The source data of model 1 was, with regard to the methodic procedures, first tested for the presence of the seasonability using seasonal indexes. This test has proven that the time series contain a seasonal component. In respect of this fact, artificial variables DUM1 have been added into the model (null-one vector to PAPCM – values one in the period 7/1996 – 2/1999 and 2/2001 – 2/2002) and DUM2 (null-one vector to PIPFMB /price of industrial producers of fodder mixtures for broilers/ – values 1 in the period 2/2001 – 2/2002).

The similar situation has occurred also in case of model 2, where the monthly price series of the source data (PAPSP and PIPFMPF) have confirmed presence of the seasonability based on the results of the seasonal indexes. In respect of this fact, three variables have been added into the model 2 (DUM1, DUM2, SIN2П). The artificial variable DUM1 has been constructed to the variable PAPSP in the form of a null-one vector, where it acquired the value 1 as a rule in the last three months of the first three years, subsequently then in the summer period of 1998 and in autumn 2000, 2001 and 2004. The variable DUM2 is related to the variable PIPFMPF. Vector of the values DUM2 acquired the value 1 from September 1996 as long as till July of the following year, than at the turn of 2000 and 2002 and in the end of 2003. The endeavor of both DUM variables was to eliminate high price variances (high decline or increase in prices from the average level).

The unit root test – ADF test for testing of stationarity of both models has shown that the data appear at the chosen lag of (lag for 12 periods have been tested) as non-stationary, integrated if order I(1). The order of the model has been determined according to the AIC testing criterion, where on the basis of its results the lag of 9 periods has been chosen for model 1 (VECM(9) estimation has been performed) and 6 periods for model 2 (estimation VECM (6)).

It results from the co-integration test results of both models that at the significance level of 5%, the calculated value of the testing criterion is higher than the critical value, and thus the long-term relation exists among the variables. At the significance level of 5% we refuse the null hypothesis in favor of the alternative hypothesis (HA: number of co-integration vectors r = 1). It means that the variables are co-integrated with one co-integration vector and the long-term relation exists among them.

The parameters VECM(9) and VECM(6) (with an unlimited constant and trend in the co-integration vector) have been estimated with the method of the least (co-integrated) squares. The statistical characteristics of the price transmission models show that the parameters estimations seem to be unbiased and consistent. (Table 1, Table 2).

Different rate of dependence tightness in particular equations of model 1 results from the values of the determination coefficients (R2). It is possible to state that the changes of the dependent variable in the 1st equation (PAPCM) are explained of 56.23% by the changes of the independent variables. In the 2nd equation, the change of the dependent variable (PIPFMB) is explained by the chosen regression of 39.60%. Both two values of the determination coefficients may be considered, with regard to the character of the analyzed relations, as satisfactory and it is possible to proceed to further analysis VECM(9). The results of the diagnostic statistical tests mentioned in Table 1, Table 2 show further characteristics of model 1 and of the estimated parameters. In both equations of the model no serial autocorrelation of residuals has been proven since the results of the test refuse the hypothesis on autocorrelation of residuals. The test of the functional form of both equations being followed shows correctness of the analytical form of the

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      ECM for variable CZVMK estimated by OLS based on cointegrating VAR(9)
******************************************************************************
                        Dependent variable is dCZVMK
         135 observations used for estimation from 1995M10 to 2006M12
******************************************************************************
 Regressor              Coefficient       Standard Error         T-Ratio[Prob]
 Intercept                  2835.0            637.7482            4.4453[.000]
 dCZVMK1                    .30475             .085808            3.5515[.001]
 dCPVKSB1                  -.24283              .26529          -.91534[.362]
 dCZVMK2                    .25461             .087799            2.8999[.004]
 dCPVKSB2                  -.11823              .26472          -.44663[.656]
 dCZVMK3                  -.098007             .087012           -1.1264[.262]
 dCPVKSB3                  .058394              .26370            .22144[.825]
 dCZVMK4                    .11337             .087885            1.2900[.200]
 dCPVKSB4                   .22353              .26375            .84753[.398]
 dCZVMK5                    .14443             .088062            1.6401[.104]
 dCPVKSB5                   .16216              .26396            .61433[.540]
 dCZVMK6                   -.20141             .087063           -2.3133[.022]
 dCPVKSB6                   .11686              .26363            .44328[.658]
 dCZVMK7                    .37555             .088473            4.2448[.000]
 dCPVKSB7                  -.31125              .26301           -1.1834[.239]
 dCZVMK8                  -.030729             .092945          -.33062[.742]
 dCPVKSB8                   .45907              .25662            1.7889[.076]
 ecm1(-1)                  -.13515             .030793           -4.3889[.000]
 DUM1                     206.7250            110.2908            1.8744[.063]
 DUM2                     -23.0800            101.5773          -.22722[.821]
******************************************************************************
 R-Squared                     .56230   R-Bar-Squared                   .48998
 S.E. of Regression          301.4228   F-stat.    F( 19, 115)    7.7755[.000]
 Mean of Dependent Variable  -15.7407   S.D. of Dependent Variable    422.0685
 Residual Sum of Squares     1.04E+07   Equation Log-likelihood      -951.3830
 Akaike Info. Criterion     -971.3830   Schwarz Bayesian Criterion     -1000.4
 DW-statistic                  1.9192   System Log-likelihood          -1758.5
******************************************************************************
     *    Test Statistics  *        LM Version        *         F Version
******************************************************************************
* A:Serial Correlation*CHSQ(  12)=  17.3919[.135]*F(  12, 103)=   1.2693[.248]
* B:Functional Form   *CHSQ(   1)=   .53617[.464]*F(   1, 114)=   .45457[.502]
   * C:Normality         *CHSQ(   2)=   4.7111[.095]*       Not applicable
* D:Heteroscedasticity*CHSQ(   1)=  12.1226[.000]*F(   1, 133)=  13.1212[.000]
******************************************************************************
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Source: own calculations

Table 1: VECM(9) – 1st equation of model 1.

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     ECM for variable CPVKSB estimated by OLS based on cointegrating VAR(9)
******************************************************************************
                       Dependent variable is dCPVKSB,
         135 observations used for estimation from 1995M10 to 2006M12
******************************************************************************
 Regressor              Coefficient       Standard Error         T-Ratio[Prob]
 Intercept                847.5960            219.2020            3.8667[.000]
 dCZVMK1                   .029725             .029493            1.0079[.316]
 dCPVKSB1                   .12685             .091185            1.3911[.167]
 dCZVMK2                   .011651             .030178            .38607[.700]
 dCPVKSB2                  .035156             .090987            .38638[.700]
 dCZVMK3                   .038140             .029907            1.2753[.205]
 dCPVKSB3                 .0059054             .090636          .065155[.948]
 dCZVMK4                  .0015511             .030207          .051348[.959]
 dCPVKSB4                 -.030172             .090654          -.33283[.740]
 dCZVMK5                   .031649             .030268            1.0456[.298]
 dCPVKSB5                 -.034910             .090727          -.38478[.701]
 dCZVMK6                   .026369             .029925            .88120[.380]
 dCPVKSB6                  .080102             .090611            .88402[.379]
 dCZVMK7                   .029669             .030409            .97564[.331]
 dCPVKSB7                  .043371             .090398            .47977[.632]
 dCZVMK8                   .046400             .031946            1.4524[.149]
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dCPVKSB8                  -.18634          .088203          -2.1126[.037]
ecm1(-1)                 -.040524          .010584          -3.8288[.000]
DUM1                      92.8651          37.9083           2.4497[.016]
DUM2                      -3.5948          34.9134          -.10296[.918]
***************************************************************************
R-Squared                     .39596   R-Bar-Squared                  .29616
S.E. of Regression          103.6028   F-stat.    F( 19, 115)    3.9676[.000]
Mean of Dependent Variable    3.7990   S.D. of Dependent Variable   123.4911
Residual Sum of Squares      1234357   Equation Log-likelihood     -807.2098
Akaike Info. Criterion     -827.2098   Schwarz Bayesian Criterion  -856.2625
DW-statistic                  1.8944   System Log-likelihood         -1758.5
***************************************************************************
     *    Test Statistics  *        LM Version        *         F Version
***************************************************************************
* A:Serial Correlation*CHSQ(  12)=  17.5683[.129]*F(  12, 103)=   1.2841[.239]
* B:Functional Form   *CHSQ(   1)=  .031449[.859]*F(   1, 114)=  .026563[.871]
   * C:Normality         *CHSQ(   2)=  49.4746[.000]*       Not applicable
* D:Heteroscedasticity*CHSQ(   1)=   1.5252[.217]*F(   1, 133)=   1.5198[.220]
***************************************************************************
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Source: own calculations

Table 2: VECM(9) – 2nd equation of model 1.

model. Assumption of normality has been fulfilled only in the first equation where the hypothesis on the normal distribution of the residuals has not been rejected. It also results from the performed tests that there is significant heteroscedasticity in the 1st equation of the model; it means that the assumption of final and constant dispersion of random components (residuals) is not fulfilled. The second equation already rejected the null hypothesis in favor of the alternative hypothesis, it means that in the second equation the above-mentioned assumption of homoscedasticity of the random component is fulfilled.

Estimations of the parameters VECM(6) and results of the diagnostic tests are given in Table 3 and Table 4. The values of the determination coefficients (R2) show medium high rate of dependence tightness in particular equations of the model. Changes of the dependent variable in the 1st equation (PAPSP) are of 46.6% by the changes of the independent variables. In the 2nd equation, the change of the dependent variable (PIPFMPF) may be explained by the chosen regression of 57.7%. It results from the results of these tests in both equations that the hypothesis on serial autocorrelation of residuals and heteroscedasticity has been refused in the model. It means the results do not confirm the dependence of random components and confirm the assumption of final and constant dispersion of random components. Choice of the correct analytical form of the model results from the functional form test. Assumption of normality was fulfilled only in the second equation where the hypothesis on the normal distribution of the residuals has not been refused.

The results of the co-integration analysis of model 1 (VECM(9)) are based on testing of structural hypotheses where the co-integration vector has been normalized according to the variable PAPCM (thus A1 = 1). The normalized co-integration vector (PAPCM; PIPFMB; Trend) (1.0000; -0.55036; 34.6485) shows long-term equilibrium relation among the variables, of which it results that PIPFMB influences PAPCM positively and from the point of view of the sign it complies with the above-defined hypothesis (increase in the fodder mixture price will lead to increase in the cost for chicken fattening and thus to fall of the producers' interest in production of this meat type; this fact may result in drop in production, i.e. in lower meat supply being expressed in the growth of PAPCM; similarly, the growth in the chicken meat price will lead to increase in the producers' interest in production of the chicken meat, thus to increased supply, which will express itself as growth in the inquiry for the production factor – the fodder mixture price). It means the unit price in PIPFMB (PIPFMB growth by 1 CZK/t) will lead to PAPCM growth (by 0.55 CZK/t). To the contrary, the influence of the trend on PAPCM is negative; interannually the decline of PAPCM by 34.65 CZK/t occurs. The magnitude of this interannual change is in accordance with the direction of the linear trend function describing dependence of PAPCM on time (y = 25533 – 34.603x, where x is the time vector) since PAPCM

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      ECM for variable CPVKSV estimated by OLS based on cointegrating VAR(6)
 ******************************************************************************
                           Dependent variable is dCPVKSV
          138 observations used for estimation from 1995M7  to 2006M12
 ******************************************************************************
 Regressor                Coefficient        Standard Error         T-Ratio[Prob]
 Intercept                  300.3203            65.8039              4.5639[.000]
 dCPVKSV1                     .27592            .085677              3.2205[.002]
 dCZVMV1                   -.0010330           .0035200            -.29347[.770]
 dCPVKSV2                     .17195            .089222              1.9272[.056]
 dCZVMV2                   -.0057017           .0038102            -1.4964[.137]
 dCPVKSV3                     .14323            .092198              1.5536[.123]
 dCZVMV3                    .0025004           .0041101             .60834[.544]
 dCPVKSV4                     .14433            .092497              1.5604[.121]
 dCZVMV4                   -.0024508           .0036641            -.66886[.505]
 dCPVKSV5                    .073698            .090684             .81269[.418]
 dCZVMV5                   -.0021409           .0032910            -.65053[.517]
 ecm1(-1)                   -.079052            .020006            -3.9515[.000]
 DUM1                        -6.5171            22.5097            -.28952[.773]
 DUM2                        47.2775            24.2417             1.9503[.053]
 SIN2PI                     -51.3878            25.4043            -2.0228[.045]
 ******************************************************************************
 R-Squared                        .46636   R-Bar-Squared                   .40562
 S.E. of Regression              79.6077   F-stat.    F( 14, 123)    7.6779[.000]
 Mean of Dependent Variable       3.2728   S.D. of Dependent Variable    103.2575
 Residual Sum of Squares        779498.4   Equation Log-likelihood      -791.9150
 Akaike Info. Criterion        -806.9150   Schwarz Bayesian Criterion   -828.8694
 DW-statistic                     1.9960   System Log-likelihood          -2023.8
 ******************************************************************************
      *    Test Statistics  *        LM Version        *         F Version
 ******************************************************************************
 * A:Serial Correlation*CHSQ(  12)=  12.0271[.444]*F(  12, 111)=   .88313[.566]
 * B:Functional Form   *CHSQ(   1)=  .011974[.913]*F(   1, 122)=  .010587[.918]
    * C:Normality         *CHSQ(   2)= 285.9287[.000]*       Not applicable
 * D:Heteroscedasticity*CHSQ(   1)=   1.0190[.313]*F(   1, 136)=   1.0117[.316]
 ******************************************************************************
```

Source: own calculations

Table 3: VECM(6) – 1st equation of model 2.

```
      ECM for variable CZVMV estimated by OLS based on cointegrating VAR(6)
 ******************************************************************************
                           Dependent variable is dCZVMV
          138 observations used for estimation from 1995M7  to 2006M12
 ******************************************************************************
 Regressor                Coefficient        Standard Error         T-Ratio[Prob]
 Intercept                   -3477.2             1612.8             -2.1560[.033]
 dCPVKSV1                    -.68988             2.0999             -.32854[.743]
 dCZVMV1                      .50575            .086272              5.8623[.000]
 dCPVKSV2                     4.2619             2.1868              1.9490[.054]
 dCZVMV2                     -.53521            .093385             -5.7312[.000]
 dCPVKSV3                    -2.9148             2.2597             -1.2899[.200]
 dCZVMV3                      .20430             .10074              2.0280[.045]
 dCPVKSV4                    -2.4667             2.2670             -1.0881[.279]
 dCZVMV4                     -.28250            .089804             -3.1457[.002]
 dCPVKSV5                     5.7375             2.2226              2.5814[.011]
 dCZVMV5                      .14641            .080659              1.8152[.072]
 ecm1(-1)                     .68436             .49032              1.3957[.165]
 DUM1                         1747.4           551.6975              3.1674[.002]
 DUM2                        -1536.6           594.1473             -2.5863[.011]
 SIN2PI                       2742.8           622.6413              4.4051[.000]
 ******************************************************************************
 R-Squared                        .57726   R-Bar-Squared                   .52914
 S.E. of Regression               1951.1   F-stat.    F( 14, 123)   11.9969[.000]
 Mean of Dependent Variable      11.3478   S.D. of Dependent Variable      2843.4
 Residual Sum of Squares        4.68E+08   Equation Log-likelihood        -1233.4
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  Akaike Info. Criterion       -1248.4   Schwarz Bayesian Criterion     -1270.3
  DW-statistic                  1.9667   System Log-likelihood          -2023.8
 ******************************************************************************
      *    Test Statistics  *        LM Version        *         F Version
 ******************************************************************************
 * A:Serial Correlation*CHSQ(  12)=  17.7697[.123]*F(  12, 111)=   1.3671[.192]
 * B:Functional Form   *CHSQ(   1)=   .31893[.572]*F(   1, 122)=   .28260[.596]
    * C:Normality        *CHSQ(   2)=   1.9076[.385]*       Not applicable
 * D:Heteroscedasticity*CHSQ(   1)=   .10319[.748]*F(   1, 136)=   .10177[.750]
 ******************************************************************************
```

Source: own calculations

Table 4: VECM(6) – 2nd equation of model 2.

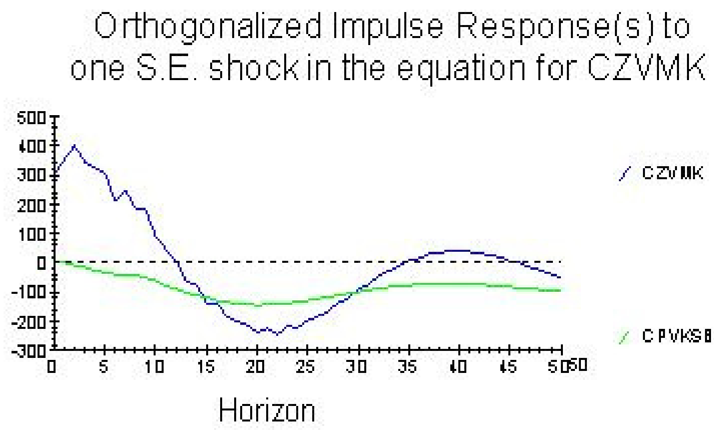
shows long-term downward tendency. The parameter α signifies that in case of a shock, the 1st equation returns faster to the equilibrium state, i.e. PAPCM. Existence of the long-term relation between PAPCM and PIPFMB is obvious from the resulting co-integration vector. The long-term influence among the prices is, with regard to the statistical significance of the co-integration vector bidirectional, which is in accordance with the defined hypothesis, on the basis of which, according to the assumption of the functioning price transmission, PAPCM influences PIPFMB and to the contrary. In case of the influence of PIPFMB on PAPCM it is possible to search for the links where the fodder mixtures create the main and in fact also “the only one” type of the fodder that may be used for fattening of chicken and they are thus the main component of the costs of fattening. The fodder mixtures are understood here as the only fodder in wider meaning, i.e. as structure of various types of fodder mixtures with regard to the fattening stages and age of the animals. It means it is not possible to combine the feeding ration of other types of fodder, such as e.g. in case of bovine animals; i.e. it is not possible to combine nutrition e.g. of bulk feed and concentrates (fodder mixtures). Nutrition of the poultry comes out from the fact that according to the category and age of the poultry, feeding only with the relevant fodder mixture intended for the given animal category is possible. With regard to rational behavior of the entities operating in the agricultural market and in the suppliers’ market (the suppliers’ market = the market where the fodder mixture producers operate) and with regard to the fodder not being substitutable, it is therefore obvious that this price, based on model 1 results, from the long-term point of view has been co-creating the development of the costs of fattening, by means of which it also influences determining of the minimum price level, i.e. the minimum price of 1 kg of the table chicken. However, the practical problem remains that the immediate PAPCM in the time of expedition of the particular cyclic fattening does not have to cover this minimum level in full and impacts the resulting fattening profitability (of the cyclic fattening taken out of store).

The long term relation between PAPCM and PIPFMB may be interpreted as follows. If in consequence of a shock e.g. decline of PAPCM occurs, this change is accompanied with reduced producers’ interest in poultry meat production. In respect of this fact, necessarily fall in the interest of the primary agricultural producers in the fodder mixtures for fattening of broilers occurs. Surplus of the fodder mixtures in consequence of lower sales induces pressure on price reduction of the fodder mixtures. The price reduction of the fodder mixtures on the part of the fodder mixture producer may occur in different ways. E.g. if the FM producer has no possibility to influence the input raw materials prices, then it has a possibility, in accordance with the quality parameters, requirements for the nutrition and limitations in accordance with the valid regulations, to modify the fodder mixture composition so that the more expensive raw materials might be replaced with cheaper ones. It means the producer will consider minimization of the production cost detrimental to other parameters – e.g. the qualitative ones, showing up in aggravated conversion of the fodder with regard to digestibility of components, etc. The price reduction of the fodder mixtures will subsequently lead to reduction of the production costs of poultry meat (under the assumption that the costs of the fodder influence significantly the structure of the total costs of fattening), due to which the change of the profit margin in poultry meat production may occur. The change of the profit margin influences then the agricultural producers’ decision-making. If at the same time with regard to the lower PAPCM growth in demand for the poultry meat occurs, then rational behavior of all entities will occur, which is analogy to the above-defined process. However, it is necessary to point out at the same time that besides the mutual influence of the prices also other factors impact, which determine the price development. As the other determinants e.g. foreign trade, in particular import from abroad, health conditions (e.g. bird flu), size and utilization degree of the production capacities in the Czech Republic, length of the production cycle and others may be considered. However, the influence of these components and its quantification is not a subject-matter of this analysis.

The results of the co-integration analysis of model 2 (VECM(6)) are based on testing of structural hypotheses. The co-integration vector has been normalized according to the variable PAPSP (thus A1 = 1). The normalized co-integration vector (PAPSP; PIPFMPF; Trend) shows the long-term equilibrium relation among the variables, which may be quantified as follows: (1.0000; -37.8241; -63.3377). The co-integration vector values confirm positive influence of PIPFMPF on PAPSP, and on the basis of the calculations, it is possible to state that the unit change in PIPFMPF (PIPFMPF growth by 1 CZK/t) will lead to PAPSP growth (by 37.82 CZK/t). From the point of view of the sign (positive influence of PIPFMPF on PAPSP), it complies with the defined hypothesis (increase in the pork price will lead to increased producers' interest in production of this meat type, thus to the growth in supply, which will show up in increased demand for the production factor – and thus also in the fodder mixture price). The influence of the trend on PAPSP is also positive; interannually it leads to the increase of PAPSP by 63.34 CZK/t.

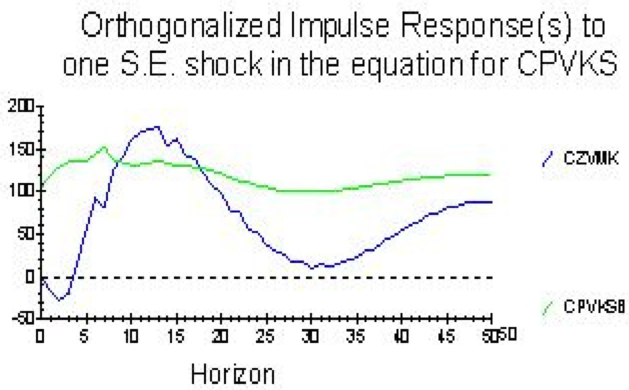
The long-term relation between PAPSP and PIPFMPF is obvious from the resulting co-integration vector. The co-integration vector (ecm1) is statistically significant only in the 1st equation of the model, thus in case of the dependence of PIPFMPF on the other endogenous and exogenous variables of model 2. It means that the statistically provable influence of PAPSP on PIPFMPF exists, however the influence of PIPFMPF on PAPCM is not significant according to the results. Magnitude of the parameter α signifies that in case of a shock, the 2nd equation returns faster to the equilibrium state, i.e. PAPSP. The existence of the long-term relation between PAPSP and PIPFMPF may mean that if, e.g. due to an influence of a shock, the decline of PAPSP occurs, then this change is accompanied with reduced producers' interest in pork production. In respect of this fact, necessarily fall in the interests of the primary agricultural producers in the fodder mixtures for fattening of pigs occurs. Surplus of the fodder mixtures in consequence of lower sales induces pressure on price reduction of the fodder mixtures. The price reduction of the fodder mixtures (under the similar conditions defined in model 1) will subsequently lead to reduction of the production costs of pork, due to which change of the profit margin in fattening may occur. The change of the profit margin influences then the agricultural producers' decision-making. If at the same time with regard to the lower PAPSP growth in demand for the pork occurs, then rational behavior of all entities will occur, which is analogy to the above-defined process. However, it is necessary to point out at the same time that besides the mutual influence of the prices also other factors impact, which determine the price development. In particular foreign trade (either with meat or piglets) can be considered as another determinant since PAPSP is related to the price in the EU. Other determinants, which may play their role here, are e.g. health conditions, size and utilization degree of the production capacities in the Czech Republic, length of the production cycle, concentration of the production, meat producers' negotiation position in the production chain and others. However, the influence of these components and its quantification is not a subject-matter of this analysis.

From long-term point of view and **the results of impulse-response analysis** of model 1 (chart 1 and 2) it is possible to state that the prices tend towards an equilibrium, while the length of return to the equilibrium is similar for particular innovations (90 months). Higher reaction intensity is obvious for PAPCM compared PIPFMB, namely in case of both innovations (both in PAPCM and in PIPFMB). The system dynamics and character of the price transmission may be influenced by many factors. One of the factors may be the length of the production cycle of the fodder mixture components, which corresponds to certain extent to the lag of the analyzed model (i.e. 9 months). As the beginning of the production cycle of the cereals, the months of September/October may be considered with the highest probability, i.e. the time sowing. With regard to the fact that in particular cereals represent a significant share in the fodder mixtures structure, influence of this production cycle, together with its characteristics, may be considered as significant. However, in practice it is also possible to consider the market cycle as the length of the production cycle of cereals, i.e. the cycle e.g. from harvest to harvest in the length of 12 months. With regard to the fact that the corn of wheat is not convenient to be fed directly after the harvest but to the contrary, it is convenient to let it "stand", exactly this market cycle may appear as insignificant and the difference between the production and the market cycles may be related to inventory creation. The production cycle length itself of the fattening of chicken broilers (2 months) does not obviously play the decisive role in the system dynamics. One of the reasons may be existence of long-term contractual relations and long-term contracts between hatchers of chicken broilers and fattening of broilers. These contracts reduce then the business plan short-term variability. At the same time, with regard to the fact that the fattening production cycle turns over 6 – 8times per year, the achieved results point out that contingent shocks affecting one of the production cycles do not influence decision-making of the economic entities (agricultural meat producers) to significant extent during very short time period. This would then mean that, within the adaptive behavior, the chicken meat producers would expect that this short-term fluctuation will "go off" till the market realization of the next cyclic fattening. However, if the above-mentioned shock in sale of broilers from the following cycle remained, then it would be possible to expect subsequent "adapting" reactions of the agricultural producers and the fodder mixture producers.



Source: own calculations

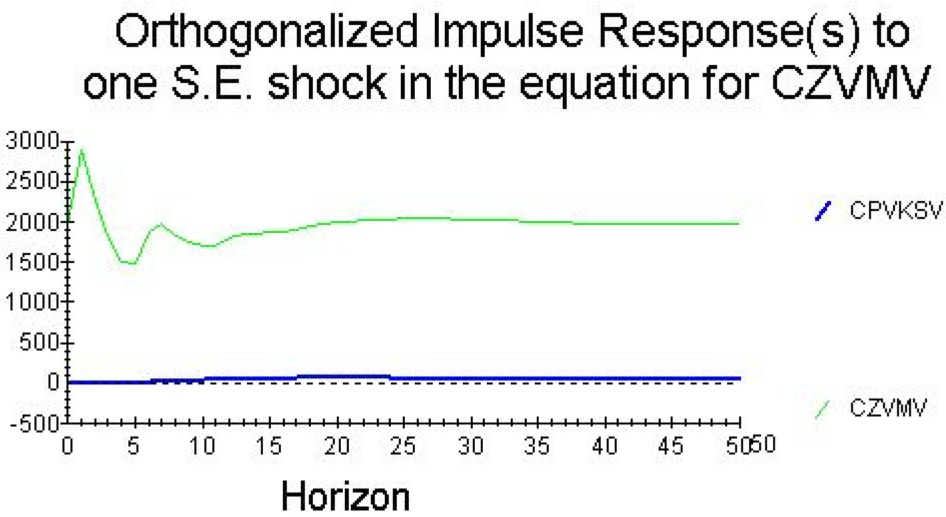
Chart :1 I-R analysis of reaction to innovations of PAPCM.



Source: own calculations

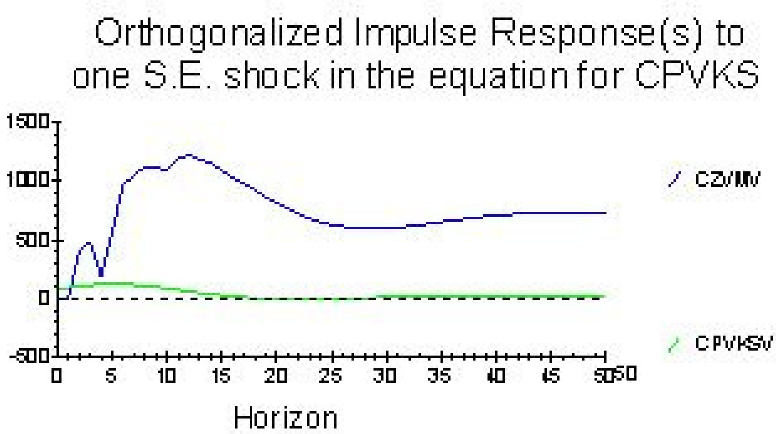
Chart 2: I-R analysis of reaction to innovations of PIPFMB.

It results from the long-term point of view and the results of the impulse-response analysis of model 2 (charts 3 and 4) that the prices tend towards an equilibrium, while the length of return to the equilibrium state is similar for particular innovations (33 months). Both the price of the industrial producers of fodder mixtures for pigs and the price of the agricultural producers of pork show from long-term point of view the highest variability compared to the poultry sector. It results from the analysis of the characteristics and results of VECM(6) and the price transmission that the lag of the model corresponds to the length of the whole production cycle (i.e. from birth to slaughter). Since the average length of fattening from birth to slaughter weight (108 - 112kg) is 175 days on average. The long-term relation between the analyzed prices results from the price transmission nature, however, its statistical significance has been proven only in single-direction. This points out at the fact that while PAPSP influences statistically significantly PIPFMPF, the fodder mixture price does not influence the price of the slaughter pigs statistically significantly any more. This fact may signify to certain extent that the element on the lower production chain degree (agricultural primary production – fattening) has smaller and slower "adapting" processes in case of innovation (market shock). This may be also a consequence of the fact that PAPSP corresponds to the price in the EU, i.e. the import price, since in the sector of pork breeding the import within the EU is relatively significant. In case PAPSP is low, growth in the export of piglets occurs. At the same time the results signify that in spite of the fact the farmers note the change in the fodder mixture price, they transfer this change in the production costs (of the fodder mixture price) into the final product price change much more slowly and, as a rule, with very low intensity. Thus it is possible to conclude about the control mechanism "from the top", i.e. to the vertical controlled from the top – by the higher element of the production chain. With regard to the relatively longer production cycle, e.g. compared to the poultry fattening, the suppliers' market (i.e. the fodder mixture producers for pigs) in the fattening category above 65 kg has enough time for adaptation processes, namely for several reasons. One of them may be the fact that on the basis of the number of animals and fattening in A2 category (30 – 65kg), it is possible to estimate the need of the fodder mixtures for the follow-up category A3. If we assume that the meat price influences the size of fattening (the farmers' interest in fattening and thus also the numbers of animals in fattening), then the demand for the production factor related to fattening – the fodder mixture – co-creates the price of fodder mixtures.



Source: own calculations

Chart 3: I-R analysis of reaction to innovations of PAPSP.



Source: own calculations

Chart 4: I-R analysis of reaction to innovations of PIPFMPF.

Conclusion

Analysis of the dynamics of the chosen production chain points out at the fact that there are long-term relations among the chosen prices in the production chain, however the character of these relations is different to certain extent depending on the animal production sector where the feeding wheat is consumed and in relation to the length of the production cycle of the fattening itself. It is not possible to claim that use of wheat in fattening of monogastric animals shows identical regularities. To the contrary, a number of differences have been identified that are related either only to pig breeding or only to poultry breeding. In all elements of the analyzed production chain, different intensity in the transmission of the price change into the price of the coherent products has been proven, and to the contrary, thus the different influence of the market force of the coherent elements in the production chain.

The results of the co-integration analysis, VECM, Impulse-Response analysis point out at certain regularities of the relations between the industrial producers' prices of the fodder mixtures and the prices of the agricultural meat producers and they signify possibilities of effective allocation of wheat in the production chain.

The link between the production cycle length and the order of the model leads in the analysis of the relations between PIPFMB and PAPCM (model 1) to rejection of hypothesis H3, which claims that the time lag exists within the particular elements of the wheat production chain corresponding to the production cycle length. According to AIC criterion, the length of the lag has been determined as 9 cycles in poultry breeding. However, if we take into account the production cycle length of fattening of broilers (2 months), then it is obvious that this production cycle does not play the decisive role in the system dynamics, and in the same way the production cycle in breeding of pigs being fattened may not be described as 2 month cycle. To the contrary, it is not possible to refuse hypothesis H3 in model 2, since the order of the model corresponds to the production cycle length, i.e. 6 months.

By means of the results of model 1, it is further possible to evaluate the mutual relations between the price of the fodder mixtures for broilers and the poultry meet price. The results of the co-integration analysis and VECM(9) signify functionality of the price transmission in both directions, i.e. PAP of poultry meat influences PIP of fodder mixtures for broilers and to the contrary, PIP of fodder mixtures for broilers influences PAP of poultry meat. Impulse-Response analysis points out at the fact that in case of a shock in some of the analyzed variables, going off of this reaction occurs in certain time horizon and the prices tend to converge to equilibrium. These facts lead to the situation where it is not possible to reject hypothesis H1 or hypothesis H2 in the poultry breeding sector. Functionality of this price transmission is obviously related also to the production concentration and the vertical integration extent among the poultry meat producers and the producers of the fodder mixtures. Peak and little differentiated technology among the companies may thus in case of the price transmission malfunction react, due to the short production cycle, much earlier by reducing of the production. With regard to the vertical interconnection among the producers of the fodder mixtures and the poultry fattening, then in case of increase in PIPFM, short-term meat production reduction occurs. With regard to the loss (as the case may be decline in the profit), which due to this situation arises to the producers of the fodder mixtures, the meat producers may induce pressure on faster reaction of PIPFMB towards the targeted price level.

The results of model 2 show whether and, as the case may be in which manner the pork producers react to the fodder mixture price change. It results from the price transmission nature and the relations between PAPSP and PIPFMPF that PIPFMPF does not influence statistically significantly the price the farmer will get when selling slaughter pigs and leads at the same time to rejection of hypothesis H1 in the pig breeding sector. Further to hypothesis H2, it can be stated it is not possible to refuse this hypothesis since the prices are co-integrated with one co-integration vector and in case of an innovation (shock) its going-off occurs and the reaction exhausts. In fattening of pigs it is not possible to speak about such unified technology (from the point of view of body the mass gain and efficiency) and concentrated production. Also the production cycle length in this sector does not enable such fast and short-term production reduction and the meat producers do not have strong negotiation position in the relation to the meat industry.

The impacts of the price transmission results of the above-mentioned models on the allocation effectiveness of wheat and, as the case may be profitability of fattening or economics of agricultural companies may be analyzed further in details, and these facts shall be therefore subject-matter of further research.

The production chain shows the features of a demand controlled system. The demand controlled system both from the meat processors and from the fodder mixture producers is obvious in the poultry breeding, to the contrary, in pig breeding the influence of the fodder mixture processors is evident, the influence of the meat processors is not significant in this production chain element. In addition to that, in the production chain of the poultry breeding, obviously the concentration of production and holding-type interconnection among the meat producers and the fodder mixture producers shows up significantly, which supports functionality of this transmission in poultry breeding. Knowledge about the regularities of the prices and their mutual links seems as fundamental with regard to the existence of the economic limitations that may influence allocation of wheat in the production chain.

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