Partial equilibrium model – Pork

Model dílčí rovnováhy ve vertikále vepřového masa

Michal MALÝ*

*Czech University of Life Sciences, Faculty of Economics and Management, Department of Economics, Kamýcká 1076, 16521, Prague, Czech Republic, e-mail: maly@pef.czu.cz

Abstract

The paper is focused on design, specification and quantification a model of partial equilibrium in the pork meat vertical in the Czech Republic. Characterized within the analyzed relations in the commodity vertical will be demand-offer relationships on partial levels of the commodity chain on the basis of which the functional relations of the simultaneous model of the above-mentioned market will subsequently be specified. The quantified model enables the definition and description of the main determinants of the pork offer and demand. The data used was acquired from the Situation and forecast reports (MA CR), from the Annual reports on the state of agriculture (IAEI) and from the public statistics (CSO), for the period from 1995-2011. With regard to respecting the simultaneous relations, the model estimate was carried out by means of the two-level method of least squares with subsequent statistic-econometrical verification. The acquired model shows sufficient robustness for market analyses and possible simulation calculations.

Keywords: partial equilibrium model, meat, pork, farmer, producer, consumer, vertical.

Abstrakt

Příspěvek je zaměřen na navržení, specifikaci a kvantifikaci modelu dílčí rovnováhy ve vertikále vepřového masa v České republice a na základě dosažených výstupů analyzuje a hodnotí vztahy ve vertikále vepřového masa. V rámci analyzovaných vazeb v komoditní vertikále byly charakterizovány poptávkově nabídkové vztahy na dílčích úrovních komoditního řetězce, na základě kterých byly následně specifikovány funkční vazby simultánního modelu výše uvedeného trhu. Kvantifikovaný model vymezit a popsat hlavní determinanty nabídky a poptávky po vepřovém mase. Použitá data byla získána ze Situačních a výhledových zpráv (MZE ČR) a z Výročních zpráv o stavu zemědělství (UZEI), a to za období let 1995-2011. Odhad modelu byl s ohledem na respektování simultánních vazeb proveden dvoustupňovou metodou nejmenších čtverců s následnou statisticko-ekonometrickou verifikací. Získaný model vykazuje dostatečnou robustnost pro analýzu trhu a případné simulační propočty.

Klíčová slova: model dílčí rovnováhy, maso, vepřové maso, zemědělec, zpracovatel, spotřebitel, vertikála.

Detailní abstrakt

Obsahem příspěvku je navržení, specifikace, kvantifikace a verifikace modelu dílčí rovnováhy ve vertikále vepřového masa v České republice. Pro koncepci modelu je využíván obecný přístup general to specific, tj. v úvodní fázi je sestaven obecný model rovnováhy na dílčím trhu odpovídající ekonomické teorii. Následně je model na základě dosažených výstupů při uvalení restrikcí plynoucích z verifikačního procesu specifikován do funkčního tvaru pro zvolenou komoditní vertikálu.
Po dosažení finálního tvaru je model dále verifikován z pohledu statistického i ekonometrického, přičemž výsledné odhady jsou z funkčního hlediska interpretovány. Z takto dosažených výstupů jsou dále analyzovány a hodnoceny vztahy ve vertikále vepřového masa, zejména pak charakter poptávkově nabídkových vztahů na dílčích úrovních komoditního řetězce.
Použitá data byla získána ze Situačních a výhledových zpráv (MZE ČR) a z Výročních zpráv o stavu zemědělství (UZEI), a to za období let 1995-2011. Odhad modelu byl s ohledem na respektování simultánních vazeb proveden dvoustupňovou metodou nejmenších čtverců s následnou statisticko-ekonometrickou verifikací. Kvantifikovaný model umožňuje vymezit a popsat hlavní determinanty nabídky a poptávky po vepřovém mase, přičemž byla potvrzena extrémně klesající tendence farmářské nabídky, byly indetifikovány dílčí příčiny velmi negativního vývoje trhu, na úrovni zpracovatelů byla potvrzena jejich stále ještě velmi silná pozice, což se dále projevuje i na úrovni spotřebitelů kdy byl prokázán významný vliv zpracovatelské ceny, z čehož lze usuzovat na nabídkově řízenou vertikálu.
Získaný model pak vykazuje dostatečnou robustnost pro navazující analýzu trhu a případné simulační propočty, které budou předmětem dalšího výzkumu.

Introduction

In terms of the overall volume, pork meat is the most consumed type of meat in the world and to date in the Czech Republic as well, whereby the main causes of this situation are undoubtedly its popularity among end consumers and economic effectiveness of production primarily among advanced world producers.
Pork meat is also one of the most important raw materials for the production of meat products and intermediate products. Besides appropriate qualitative parameters, the desirable sensory properties also have a share in that, such as the typical coloration of pork meat, which favorably affects the visual color appearance of undivided pork meat products, and therefore, pork meat and products from it, even during certain stagnation, are maintaining their first place in the world ranking of production and consumption.
On the basis of general business criteria including the maximization of profit, the market success of food products, including pork meat, is influenced primarily by the following factors: hygienic wholesomeness, the quality of food products, and the price of food products. In this sense, pork meat is competitive at least in terms of hygienic wholesomeness and qualitative requirements. When comparing price competition,

there are clashes primarily with poultry meat, which shows relatively lower unit prices per kg of pure muscle meat, but is not, in view of its different qualitative and sensory characteristics, always usable for the same purposes as pork meat, which enables pork meat, even despite all of the competitive pressures, primarily from foreign producers, to defend its position on the market.

The development of the hog farming sector, which was, until recently, considered to be one of the most stable and prospectively the most effective segments of agricultural production, was since approximately the beginning of the 2000's relatively significantly influenced by the development in the beef and poultry meat segment. Producers of slaughterhouse hogs in the Czech Republic began to face an increase in the numbers and thus also the production of competitive types of meat, but at the same time also a decline in the demand and a significant decline in the prices of pork. The causes of such an unfavorable situation must be sought within the situation on the beef meat market in 2001, when, through the effects of the BSE disease and the occurrence of foot-and-mouth disease, the demand for, consumption of as well as price of this commodity significantly declined throughout Europe. Paradoxically, the decline in demand for beef as a result of the occurrence of the said diseases affected the Czech consumer only very minimally. According to the market research conducted by the Ahold and Tesco chains, a significant decline was not seen as a result of the said facts and beef has thus not lost the confidence of the Czech consumer (despite all of its difficulties, beef still has a traditional representation in the Czech menu), but nevertheless, the demand declined, primarily for reasons of price. As a result of that, the demand for pork meat increased short-term, and subsequently also significantly the CZV. Hog farmers reacted to this, for them favorable, economic situation with an increased number of pregnant sows, and thereby also piglets born. In the first half of 2002, the surplus of slaughterhouse hogs was not yet significantly visible; the supply of slaughterhouse hogs was slightly lower than within the same period of 2001 (by 1 %). However, the significant excess of pressure of the supply in connection with the previous development already began to show at the end of the year 2002, primarily in December, when final reserves also increased significantly. A share in the excess of supply over demand was also had by the greater import of live hogs and pork meat. In 2003, this excess of pressure continued and the crisis deepened further. (MA CZ, SFR Pork, 2005) Within the subsequent period, the already very tense market situation was compounded by the significant price pressure of cheap imports from abroad, which very quickly pushed the buyout price of domestic production of pork meat to the threshold, and subsequently even below the threshold, of zero profitability. The result is, even despite the real inflation of other food products, the non-increase of the consumer price, which is advantageous from the viewpoint of the end consumer, but short-sighted, as domestic producers are decimated by the price pressure of retailers at the highest level of the vertical (thanks to cheap imports), whereby self-sufficiency falls below a reasonable threshold. According to the information of the Agricultural Chamber of the Czech Republic, the share of domestic production in overall consumption fell below 50 %, i.e. more than half of the overall usage of pork meat in the Czech Republic must currently be covered by import! Unfortunately, currently, the analyzed partial market is still not being successfully stabilized, which, in assessing the significant sector indicators, shows significant fluctuations and differences from similar markets of animal production products.

For further development, the continuing liberalization of prices and a slight decline in the consumption of pork meat per capita are anticipated. Unless the stabilization of domestic production occurs as a result of market support or, on the other hand, regulation by state authorities, then we can expect a further increase in import, a decline in domestic slaughter and more difficulty with sales opportunities for pork meat as a result of an insufficiently speedy reaction of producers and processors to changed hygienic and veterinary regulations; for example, see Malý, Kroupová et al. (2011).

Material and Methods

The conducted analysis of the commodity vertical for pork meat was based on principles of the partial equilibrium commodity model (for example, see Labys, Pollak, 1984 or Regorsek et al., 2011), respecting three levels of the product vertical on the given market. At each level, supply-demand relations are created, which then further mutually interconnect even between individual entities at various degrees of the vertical, whereby simultaneous links arise that affect the overall concept of the model. According to Hallam (1990), four basic types of commodity models can be classified depending on the utilized analytical form of functional links and the manner of (non-)inclusion of the factor of time. Within the said classification, the applied partial equilibrium model can be considered to be linear, simultaneous and dynamic, as it includes two-way links between demand-supply variables with the simultaneous utilization of the basic linear function form and the inclusion of a time vector, including the time differentiation of significant determinants of the given level of the vertical. The primary level of the vertical consists of agricultural producers, who are portrayed in the model as entities offering a supply of live animals for the purpose of slaughterhouse processing. The behavior of the said farmers is determined by the presumption of the adaptive price expectation of the said entities (Nerlov, 2001) and, in terms of the functional links, the supply of slaughterhouse animals is influenced by the overall numbers of slaughterhouse animals, the ratio of the farm price of pork meat and the price of the industrial feed producer (the price of the industrial producer of feeds was set as an average of the price of feed mixtures for the pre-battening category and the battening category, i.e. over 65 kg), and further, the variable of the time vector was also included in the said relationship, for the option of portraying the long-term development of the supply of pork meat depending on technological changes in production, see correlation **(1)**. The numbers of hogs are further dependent on their value from the previous period for the expression of the necessary inertia of production, the prices of the agricultural producer per kg of live weight once again from the preceding period, because, e.g. according to Hellberg-Bahr (2012), the supply is a function of the price of the previous period for reasons of delay, and further, numbers are also dependent on the ratio of import prices and export prices (TARIC classification) for the option of portraying the explicit effect of foreign trade, see correlation **(2)**. For the expression of the price of the agricultural producer, numbers of hogs from the current period as well as from the preceding period, the processor price of jointed pork meat and the ratio of the farm price and the price of the feed producer were included among the explanatory variables, see correlation **(3)**. The said correlations characterize the farm level, which comprises the supply portion for the demand of the subsequent processor level.

Farm level:

$$Q_{SA,BM,t} = f\left(NC_{PM,t}, \frac{PAP_{PM,t}}{PP_{f,t}}, T\right) \quad (1)$$

$Q_{SA,PM,t}$ supply quantity of pork meat – production (t of live weight)
$NC_{PM,t}$ numbers of hogs (battening category) derived from **(2)** (thousands of animals)

$$NC_{PM,t} = f\left(NC_{PM,t-1}, PAP_{PM,t-1}, \frac{IP_{PM,t}}{EP_{PM,t}}\right) \quad (2)$$

$PAP_{PM,t}$ price of the agricultural producer of pork meat derived from **(3)** (CZK*t^{-1} of live weight)

$$PAP_{PM,t} = f\left(NC_{PM,t}, NC_{PM,t-1}, PP_{PM,t}, \frac{PAP_{PM,t}}{PP_{f,t}}\right) \quad (3)$$

$IP_{PM,t}$ import price of pork meat ($*t^{-1})
$EP_{PM,t}$ export price of pork meat ($*t^{-1})
$PP_{PM,t}$ processor price /average/ of pork meat derived from **(8)** (CZK*t^{-1})
$PP_{f,t}$ price of the industrial producer – feed mixture /average/ (CZK*t^{-1})
T time vector (proxy variable of technological changes)

The modeled pork meat market is, within the environment of the national economy of the Czech Republic, significantly determined by foreign trade, and thus, even in the model, it is conceived as open. The said aspect is more than evident especially in the current period of massive volumes of imports into the Czech Republic. The foreign sector can have a significant effect both on the supply side – primarily at the processor level, as well as on demand side – primarily at the consumer level, but also once again at the processor level. According to a number of studies of agricultural foreign trade (for example, a comprehensive FAO study (Sarris A., Hallam D., 2006)), correlations **(4)** and **(5)** were utilized for the expression of the import and export of pork meat, whereby the import of pork meat is determined by the quantity of demand for pork meat, the import price of the imported quantity for selected customs groups and the domestic slaughter of pork meat. In view of the relatively low production and the long-term excess of supply over demand, the export of pork meat is then influenced only by the ration of the export price and the processor price in consideration of the quantity of domestic slaughter.

Meat import:

$$Q_{IM,PM,t} = f(IPK_{PM,t}, DS_{PM,t}, Q_{DC,PM,t}) \quad (4)$$

$Q_{IM,PM,t}$ imported quantity of pork meat (thousands of t of slaughterhouse weight)
$Q_{DC,PM,t}$ quantity of demand for pork meat derived from **(9)** (thousands of t of slaughterhouse weight)
$IPK_{PM,t}$ import price of pork meat (CZK*t^{-1})
$DS_{PM,t}$ domestic slaughter of pork derived from **(6)** (thousands of t of slaughterhouse weight)

Meat export:

$$Q_{EX,PM,t} = f\left(\frac{IP_{PM,t}}{EP_{PM,t}}, DS_{PM,t}\right) \quad (5)$$

$Q_{EX,PM,t}$ exported quantity of pork meat (thousands of t of slaughterhouse weight)
$IP_{PM,t}$ import price of pork meat ($*t^{-1})
$EP_{PM,t}$ export price of pork meat ($*t^{-1})
$DS_{PM,t}$ domestic slaughter of pork derived from **(6)** (thousands of t of slaughterhouse weight)

The subsequent level of the vertical, representing slaughterhouses, or meat processing plants, which include the slaughterhouse processing of purchased quantities of animals, whereby the product is first the slaughterhouse-processed trunk, statistically monitored under the indicator of domestic slaughter, which can itself be the object of both foreign trade, as well as domestic demand of subsequent elements of the vertical. The relationship between domestic slaughter and the processed quantity of slaughterhouse animals (see correlation **(6)**) is then purely technological and is dependent only on the slaughterhouse utilization percentage, the determination of which is the reason for the inclusion of correlation **(6)** into the structure of the model, and which is primarily determined by, for example, the breed, gender, or age of the slaughterhouse animal. The primary processing of the slaughterhouse trunk is usually accompanied by the subsequent processing and production of jointed meat, which is already a standard product of the supply at the processor level, both for external meat-butchery plants, as well as for the end consumer. According to Hallam (1994), the amount of the supply of jointed meat is influenced by a whole range of exogenous as well as endogenous effects, whereby, for the conceived model (see correlation **(7)**), in view of the specific properties of the food product market in the Czech Republic, the endogenous effects of the amount of imported pork meat derived from correlation **(4)**, the exported amount of pork meat from correlation **(5)**, and the demand amount of pork meat from correlation **(9)** were utilized. The supply of processors thereby takes into consideration not only the volume of foreign trade, but also the primary determinant in the form of domestic consumption. The supply on the part of the processor is implemented on the market for the price of the industrial processor, which is, according to correlation **(8)**, determined by the agricultural price and by the consumer price as the follow-up prices in the price transmission process, and by the import price, because the import amount significantly modifies the amount of the overall supply. The said price iterations are based on a number of studies conducted on the meat market in the Czech Republic, e.g. Čechura, Šobrová (2008), or Lechanová (2006).

Processor:

$$\mathrm{DS_{PM,t}} = \mathrm{f}\left(\mathrm{Q_{SA,PM,t}}\right) \tag{6}$$

$DS_{,PM,t}$ domestic slaughter of pork (thousands of t of slaughterhouse weight)
$Q_{SA,PM,t}$ supply quantity of pork meat derived from **(1)** (thousands of t of live weight)

$$\mathrm{Q_{SP,PM,t}} = \mathrm{f}\left(\mathrm{Q_{IM,PM,t}}, \mathrm{Q_{EX,PM,t}}, \mathrm{Q_{DC,PM,t}}\right) \tag{7}$$

$Q_{SP,PM,t}$ supply quantity of jointed pork meat
$Q_{IM,PM,t}$ imported quantity of pork meat derived from **(4)** (thousands of t of slaughterhouse weight)

$Q_{EX,PM,t}$ exported quantity of pork meat derived from **(5)** (thousands of t of slaughterhouse weight)
$Q_{DC,PM,t}$ demand quantity of pork meat derived from **(9)** (thousands of t of slaughterhouse weight)

$$\mathrm{PP_{PM,t}} = \mathrm{f}\left(\mathrm{PAP_{PM,t}}, \mathrm{CP_{PM,t}}, \mathrm{IP_{PM,t-1}}\right) \quad (8)$$

$PP_{PM,t}$ processor price /average/ of pork meat (CZK*t^{-1})
$PAP_{PM,t}$ price of agricultural producer of pork meat derived from **(3)** (CZK*t^{-1}of live weight)
$CP_{PM,t}$ consumer price of pork meat derived from **(10)** (CZK*t^{-1})
$IP_{PM,t}$ import price of pork meat ($*t^{-1})

According to classic microeconomic theory (for example, see Varian (2002)), the final processor supply is followed up by partial consumer demand, which is, however, because of the broad assortment of meat products, statistically abstracted into a comprehensive indicator of pork meat consumption. According to similarly conceived partial equilibrium models (for example, see Moro et al. (2002)) and on the basis of microeconomic theory, consumer demand is, according to correlation **(9)**, dependent on the consumer price of beef meat, on the delayed consumer price of pork meat, and on the size of final reserves, the amount of which is determined by domestic production and foreign trade, and which enable the balancing of any price fluctuations. The consumer price of pork meat is then, according to correlation **(10)**, on the basis of price transmission, dependent on the processor price of pork meat, on the consumer price of chicken meat (substitution effects between pork and chicken meat are anticipated, as the absolute amounts of prices are closest to one another out of the other types of meat), and on the ratio of the import price and the export price, expressing the motivation of the foreign sector to enter onto the domestic market and thereby to also influence the consumer price (for example, see Schaffer (2008)).

Consumer:

$$\mathrm{Q_{DCD,PM,t}} = \mathrm{f}\left(\mathrm{CP_{BM,t}}, \mathrm{CP_{PM,t-1}}, \mathrm{FR_{PM,t}}\right) \quad (9)$$

$Q_{DCD,PM,t}$ demand quantity of pork meat (thousands of t)
$CP_{BM,t}$ consumer price of beef meat (CZK*t^{-1})
$CP_{PM,t}$ consumer price of pork meat derived from **(10)** (CZK*t^{-1})
$FR_{PM,t}$ final reserve of pork meat (thousands of t)

$$\mathrm{CP_{PM,t}} = \mathrm{f}\left(\mathrm{PP_{PM,t}}, \mathrm{CP_{PLM,t}}, \frac{\mathrm{IP_{PM,t}}}{\mathrm{EP_{PM,t}}}\right) \quad (10)$$

$CP_{PM,t}$ consumer price of pork meat /average/ (CZK*t^{-1})
$PP_{PM,t}$ processor price of pork meat /average/ derived from **(8)** (CZK*t^{-1})
$CP_{PLM,t}$ consumer price of chicken meat (breasts) (CZK*t^{-1})
$IP_{PM,t}$ import price of pork meat ($*t^{-1})
$EP_{PM,t}$ export price of pork meat ($*t^{-1})

For the expression of the equilibrium status, the model was supplemented with a balance identity **(11)** covering the model.

Balance:

$$Q_{IM,PM,t} + Q_{SP,PM,t} = Q_{DC,PM,t} + Q_{EX,PM,t} \quad (11)$$

As has already been stated above, in the interest of simplifying the basic output, the applied analytical form of the conceived model was a linear function, and, for the estimate, the two-step method of least squares (TSLS) was utilized, which belongs among the methods with limited information, but, nevertheless, it was applied within the environment of the Gretl 1.8.7. program by way of a one-time estimate of simultaneous equations. The congruence of estimated equations with data is standardly quantified by way of a tested adjusted coefficient of determination and the statistical verification of estimated parameters was conducted on the basis of the *t* test. The econometric assumptions were verified by way of routine methods for simultaneous models (Kenedy, 2008). Multi-co-linearity was tested by way of the Farrar-Glauber test (see Green, 2008), autocorrelation of the residuals was tested by way of the Ljung-Box test (see Gujarati, 2003), heteroskedasticity was tested by way of the combined ARCH test with autocorrelation (see Cipra, 2008). The ARCH test utilizes the principles of the Lagrange Multiplier test (Green, 2008) and verifying the absence of group heteroskedasticity. The normality of distribution of the residual component was tested by way of the multidimensional Doornik-Hansen test (see Doornik, Hansen, 1994).

Data Characteristics

The quantification of the specified commodity model of partial equilibrium on the pork meat market was based on data that were obtained from Situational and Outlook Reports (Ministry of Agriculture of the Czech Republic), from Annual Reports on the State of Agriculture (UZEI) and from the public statistics of the Czech Statistical Office, for the period of the years 1995-2011. In view of the nature of some of the variables that are monitored only in time-aggregated annual values, the data base was necessarily limited by this restriction and for the actual estimate, time series data with a total number of 459 observations were utilized.
For the verification of one of the basic econometric assumptions of the absence of perfect multi-co-linearity, the Farrar-Glauber test was conducted on underlying data of the finally specified model, whereby the paired correlation matrix was quantified. On the basis of the values of correlation coefficients (*RCC*), undesirable intensity was identified, whereby the found characteristics were subsequently taken into consideration in the specification of the final partial equilibrium model on the monitored market.

Results and Discussion

Within the specification, a general eleven-equation simultaneous model was first drawn up, which was subsequently modified on the basis of tested characteristics and the verification of econometric assumptions, and, by way of imposed restrictions, a specific model was generated as a final result, the subsequent estimate of which was conducted in accordance with the principle of limited information and will subsequently be interpreted.

The introductory explained variable within the commodity vertical is the amount of supply of pork meat at the agricultural producer level, whereby the estimate of parameters of the explanatory variables is set out – see Equation 1 in Figure 1.

Figure 1. Results of Equation 1 estimation

```
Equation 1 /Source: own calculations/
Dependent variable: QSA
Instruments: const DV_5 T NCp_1 PAP_1 DV_3 IPK IP_1 CP_b CP_p_1
  FR CP_pl

            coefficient   std. error    t-ratio   p-value
  ---------------------------------------------------------
  const     524067        103024        5.087     3.64e-07 ***
  NCp       74.7005       22.6759       3.294     0.0010   ***
  DV_5      -12990.2      4327.39       -3.002    0.0027   ***
  T         -14083.2      3557.86       -3.958    7.55e-05 ***

R-squared           0.990439   Adjusted R-squared   0.988048
```

It is evident from the outputs that while overall numbers of hogs have, in accordance with expectations, a positive effect on the development of the farm supply, the dummy variable *DV_5* has a negative effect, as does also the factor of time, the negative parameter of which fully corresponds to the significant and long-term decline in the values of the explained variable. In terms of intensity, a unit positive change in the overall numbers of hogs in the battening category would increase the overall supply by more than 74 tons of live weight, ceteris paribus. However, the said relatively high intensity is only seeming, as the unit change would potentially represent an increase in hogs of a thousand head. After adequate modification in the order of units, which also takes into consideration the average slaughterhouse weight of pigs in the Czech Republic, it can be stated that the direction as well as the intensity of the effect are very likely fully reasonable. A further explanatory variable is created artificially by the ratio of the farm price of a ton of pork meat and the industrial price for a ton of prepared feed mixture. According to the achieved parameter, the given variable has a negative effect with the intensity of the change of the endogenous variable by almost 13 thousand units, ceteris paribus. The achieved result unfortunately documents the long-term negative development within the analyzed vertical. The fact is, the conceived dummy variable should, under otherwise identical circumstances, theoretically have a positive effect. However, within the specified model, the asymmetrical development of the farm price and of feed prices, as the main components of inputs into production, is fully evident. As a result of the faster growing prices of inputs than of outputs, the resulting dummy decreases within the analyzed period and thus it is necessary to interpret the achieved parameter upon a negative change, whereby it then corresponds to the economic assumptions. However, at the same time, it is appropriate to call attention to the fact that, within the analyzed period, a decrease in the farm buyout price actually occurs, and the resulting negative direction is thereby also determined. The intensity of the effect then evidenced the very high sensitivity of the volume of farm supply in regard to prices of outputs as well as inputs, which once again confirms the negative development within the given vertical, as reactions to changes in prices will be greater and greater the more the utilized prices approach zero profitability of production. Similar results were also achieved, for example, by Da Silva et al. (2008).

The last included variable was the time vector, the negative value of which indicates a long-term and significant decline in the domestic supply of slaughterhouse hogs. From a statistical viewpoint, it may be stated that all of the parameters of the explanatory variables are statistically significant at a selected level of significance (α=0.01), the closeness of dependence measured by way of an adjusted coefficient of determination is relatively very high (R^2=0.98), whereby the conclusiveness of the indicator was verified for all of the equations of the model by way of a standardized F-test.

For the verification of econometric assumptions and the achievement of the required properties of the estimate, comprehensive tests of heteroskedasticity, autocorrelation of residuals and the normality of the distribution of the random component were conducted for all of the equations. The quantified statistics are comprehensively set out in the conclusion of the estimate, where the achieved values are also interpreted. However, we can now already state in advance that the conducted tests confirmed the observance of basic econometric assumptions of the linear model.

The subsequent explained variable is the numbers of hogs in the battening category, which are, according to the analyzed relations, dependent on numbers in the previous period, on the farm price also in the previous period, and on the dummy variable representing the ratio of the export and import price. Outputs of the conducted estimate are illustrated in the subsequent field, see Equation 2 in Figure 2.

Figure 2. Results of Equation 2 estimation

```
Equation 2 /Source: own calsulation/
Dependent variable: NCp
Instruments: const DV_5 T NCp_1 PAP_1 DV_3 IPK IP_1 CP_b CP_p_1
  FR CP_pl

            coefficient    std. error    t-ratio    p-value
  ---------------------------------------------------------
  const      -174.174       467.959      -0.3722    0.7097
  NCp_1       0.816603      0.0820059     9.958     2.33e-023 ***
  PAP_1       0.0335352     0.0122679     2.734     0.0063    ***
  DV_3       -561.798       235.672      -2.384     0.0171    **

R-squared            0.968284   Adjusted R-squared   0.960355
```

The achieved output values correspond to the situation on the pork meat market and provide arguments for an extensive sector analysis of the causes of the given development. A significant fact in this regard is the long-term decline in the numbers of hogs, which is seen as a sub-proportional effect of the numbers of hogs from the previous period, i.e. a unit change in the previous period is accompanied by a change of state in the current period of only 0.8 unit, ceteris paribus. The estimate also shows the positive effect of the value of the buyout price from the previous period, which does correspond to the economic assumptions, but, nevertheless, the very weak intensity (a unit increase would imply an increase in numbers of 0.03 unit, ceteris paribus) indicates that any increase in prices would have to be relatively intense so that it would at least stop the constant decline in domestic production. In statistical terms, it may be stated that all of the parameters of the explanatory variables with the exception of the constant are highly statistically conclusive at a level of significance (α=0.05) and the closeness of dependence measured by way of an adjusted coefficient of determination is once again relatively very high (R^2=0.96).

The last explained variable at the producer level was the producer buyout price, i.e. the farm price, where the regressive effect of numbers as well as of the domestic processor price was anticipated, and in view of the course of the market characteristics, a dummy variable for the portrayal of the basic tendencies in production was also included in the equation. The conducted estimates of parameters are evidenced in Figure 3.

Figure 3. Results of Equation 3 estimation

```
Equation 3 /Source: own calsulation/
Dependent variable: PAP
Instruments: const DV_5 T NCp_1 PAP_1 DV_3 IPK IP_1 CP_b CP_p_1
  FR CP_pl

             coefficient     std. error    t-ratio    p-value
  ---------------------------------------------------------------
  const      -20369.3        4051.66       -5.027     4.97e-07  ***
  NCp        -3.40276        1.69854       -2.003     0.0451    **
  NCp_1      3.20243         1.65614       1.934      0.0532    *
  PP_p       0.612923        0.0662847     9.247      2.31e-020 ***
  DV_5       947.255         396.734       2.388      0.0170    **

R-squared           0.956854   Adjusted R-squared   0.941164
```

The quantification of the parameters indicates, firstly, a very interesting difference in the effect of the numbers of hogs in the course of time. While numbers from the current period have a negative effect, i.e. their unit increase would likely, as a result of the increased current supply, decrease the current buyout price (by 3.4 units, ceteris paribus), but the numbers of hogs in the preceding period have, on the contrary, a positive effect with a slightly lower intensity (3.2 units). In view of the length of the production cycle in the battening of hogs (approximately 3 – 4 months in the Czech Republic), it is evident from the outputs that upon a change in the states and thus subsequently also the primary supply, balancing processes occur relatively quickly. If an increase of states had occurred in the preceding year, then, thanks to the speed of the turnabout, all of the subsequent adequate reactions are seen on the demand side and as well as the supply side in the course of one period of the model, and as a result the above is also accompanied by a growth in buyout prices.
A further explanatory variable is the processor price, which, according to the assumptions, has a motivating effect, i.e. a positive effect, but, nevertheless, in terms of intensity, strong pressure on the producer is evident, as a unit increase in the price of the industrial processor would be accompanied by an increase in the farm price of only 0.61 units, ceteris paribus! The said aspect evidences a demand-driven vertical, whereby the negotiating strength of current producers on the first level of the commodity vertical is significantly weakened.
For the option of also extending the analysis to input processes, a dummy variable in the form of the ratio of the agricultural buyout price and the industrial feed producer price was once again further utilized in the assessed relationship. The achieved positive value of the parameter evidences that if the current slump in production output prices as compared to production input prices were to be stopped, i.e. the value of the dummy would increase, and if the dummy is defined as the ratio of the said prices, then under the assumption of the result achieved by the model. However,

at the same time, it is evident that upon a unit increase of the ratio of the said prices, a significant increase in agricultural producer prices must occur. In statistical terms, it may be stated that all of the parameters of the explanatory variables are statistically significant at a necessary level of significance (α=0.06) and the closeness of dependency measured by way of an adjusted coefficient of determination is once again relatively very high (R^2=0.94).
In the subsequent phase, an estimate of the parameters of the equations characterizing foreign trade in pork meat was conducted. Estimates of the parameters of the import equation are set out in Equation 4 in Figure 4, and Equation 5 in Figure 5 then sets out an estimate of the parameters of export.

Figure 4. Results of Equation 4 estimation

```
Equation 4 /Source: own calsulation/
Dependent variable: IM
Instruments: const DV_5 T NCp_1 PAP_1 DV_3 IPK IP_1 CP_b CP_p_1
  FR CP_pl

             coefficient     std. error     t-ratio    p-value
  ---------------------------------------------------------------
  const      444500          79413.5        5.597      2.18e-08  ***
  IPK        -1.62835        0.427801       -3.806     0.0001    ***
  DS         -1.33772        0.0474911      -28.17     1.45e-174 ***
  QDC        0.410985        0.149957       2.741      0.0061    ***

R-squared           0.991843   Adjusted R-squared   0.989803
```

The conducted estimate achieved the anticipated values of parameters, which, within the quantified model, have an effect that is in accordance with the materially logical verification. A unit increase in the import price would, in view of the current very low prices on the domestic market, decrease the competitiveness of imported products, and the volume of import into the Czech Republic within selected customs groups would thereby very likely also significantly decline (by 1.6 units, ceteris paribus). A unit increase in the consumer demand would bring about an increase in import of 0.41 unit, ceteris paribus, which corresponds to the fact that the growing import of products from abroad has an ever growing share in the satisfaction of the domestic demand. If domestic processors were to succeed in increasing domestic slaughter by a unit, then the result of the model indicates a decrease in import by approximately 1.4 unit, ceteris paribus. The achieved direction as well as intensity is fully adequate in terms of the expectations of the market as well as in regard to economic theory. Very similar implications were achieved, for example, by San Juan-Mejía (2007)
In statistical terms, it can be stated that all of the parameters of the explanatory variables are statistically significant at the selected level of significance (α=0.01), the closeness of dependency measured by way of an adjusted coefficient of determination is still very high (R^2=0.98).

Figure 5. Results of Equation 5 estimation

```
Equation 5 /Source: own calsulation/
Dependent variable: EX
Instruments: const DV_5 T NCp_1 PAP_1 DV_3 IPK IP_1 CP_b CP_p_1
  FR CP_pl

             coefficient     std. error     t-ratio    p-value
  ---------------------------------------------------------------
  const      103261          16258.4        6.351      2.14e-010 ***
  DV_3       -17158.0        8898.44        -1.928     0.0538    *
  DS         -0.194398       0.0271559      -7.159     8.15e-013 ***

R-squared           0.845236   Adjusted R-squared   0.821427
```

Within the export equation, a dummy variable was once again utilized, which is comprised of the ratio of the import price and of the export price of pork meat. It is evident from the resulting value that an increase in the said ratio by a unit will bring about a decrease in export by approximately 17 thousand tons/year, ceteris paribus, i.e. the higher the value of the import price as compared to the export price, there should be a decline in the export of pork meat, which can be considered a plausible outcome of the economic principles of foreign trade based on a decrease in the interest in export in the case of a decline of export prices. Similarly, for example, see also Kuhn (2004). The value of export in the conceived model is also significantly affected by the development of domestic slaughter. Here, an interesting output was achieved in the form of a negative parameter, i.e. an increase in domestic slaughter will not bring about an increase in export, as was originally expected. The reason seems to be the consideration that with the current state of the vertical, an increase in slaughter would rather tend to be allocated to the domestic market, which could lead to a decrease in the dependence on high volumes of import.
A statistical assessment evidences that both commented explanatory variables are statistically significant at the selected level of significance (α=0.06). The closeness of dependence measured by way of an adjusted coefficient of determination is still at a very high value (R^2=0.79).
Within the system, the processor level is first modeled by way of a simple dependence of domestic slaughter and domestic supply of slaughterhouse animals, the outputs of which are illustrated in Figure 6.

Figure 6. Results of Equation 6 estimation

```
Equation 6 /Source: own calsulation/
Dependent variable: DS
Instruments: const DV_5 T NCp_1 PAP_1 DV_3 IPK IP_1 CP_b CP_p_1
  FR CP_pl

             coefficient     std. error     t-ratio   p-value
  --------------------------------------------------------------
  const      45234.5         8373.07        5.402     6.58e-08 ***
  QSA        0.591605        0.0154434      38.31     0.0000   ***

R-squared           0.990561   Adjusted R-squared   0.989887
```

The purpose of the quantified correlation was the verification of the theories of the indicated value of the technological coefficient of slaughterhouse utilization percentage, which was achieved only in part, as the resulting value of utilization percentage of approximately 59% is below the threshold of the commonly achieved

level of up to 80%. The statistical verification is evident in the case of this equation, conclusiveness exceeds a 99.9% likelihood, similarly to the closeness of dependence, which is legitimately close to a deterministic correlation.
The subsequent Equation 7 in Figure 7 contains estimated parameters of the equation explaining the supply of jointed meat at the processor level.

Figure 7. Results of Equation 7 estimation

```
Equation 7 /Source: own calsulation/
Dependent variable: QSP
Instruments: const DV_5 T NCp_1 PAP_1 DV_3 IPK IP_1 CP_b CP_p_1
  FR CP_pl

            coefficient     std. error     t-ratio    p-value
  ---------------------------------------------------------------
  const       63638.4         45403.1        1.402      0.1610
  IM          -1.12608        0.105958      -10.63      2.22e-026 ***
  EX           1.27460        0.627358        2.032     0.0422    **
  QDC          0.883760       0.0908705       9.725     2.35e-022 ***

R-squared           0.991144   Adjusted R-squared   0.988929
```

The achieved values of the parameters are, in terms of economic verification, adequate, as the quantity of imported pork meat decreases the domestic processor supply (a unit increase of import predicates a decrease in supply of 1.13 units, ceteris paribus) and, conversely, a unit increase in export would bring about an increase in the processor supply of jointed meat by 1.27 units, ceteris paribus. The negative effect of growing import on domestic supply is in accordance with the expectations and, unfortunately, also with the actual situation, when domestic production is gradually pushed out by imports from abroad (but also within the EU). A similarly positive parameter of export is expected, because for an increase in possible export, it is also necessary to increase domestic production. An economically relevant variable in the form of consumer demand also influences the amount of the supply in an adequate positive direction, but, nevertheless, it is appropriate to notice that in terms of intensity, the effect of the consumer is sub-proportional, i.e. a unit increase in consumption brings about an increase in domestic supply of 0.88 unit, ceteris paribus, which once again enables the conclusion of the significance of foreign trade in satisfying the demand for pork meat in the Czech Republic. At the same time, the possible consequence can be predicated that domestic production is likely already not even able to satisfy domestic demand, and, also, that the decline in domestic production is not necessarily caused by a decline in the amount of consumption. However, a similar result was also achieved, for example, by Istudor et al. (2007) in simulations of the effects on the slaughter of hogs. The above must be subjected to a deeper examination of the commodity structure, which will be the subject of further work. From a statistical viewpoint, the closeness of dependence is once again at a high level (R^2=0.99) in the said function and all effects are statistically significant (α=0.05).
At the processor level, an equation portraying the effect of determinants of the industrial producer price, i.e. the processor price, was also conceived, see Equation 8 in Figure 8.

Figure 8. Results of Equation 8 estimation

```
Equation 8 /Source: own calsulation/
Dependent variable: PP_p
Instruments: const DV_5 T NCp_1 PAP_1 DV_3 IPK IP_1 CP_b CP_p_1
  FR CP_pl

            coefficient     std. error    t-ratio   p-value
  ---------------------------------------------------------
  const     15813.6         5046.84       3.133     0.0017   ***
  PAP       0.746982        0.168759      4.426     9.58e-06 ***
  CP_p      0.393768        0.0888417     4.432     9.33e-06 ***
  IP_1      -0.960968       0.483257      -1.989    0.0468   **

R-squared           0.978427   Adjusted R-squared   0.973034
```

The interpretation of the quantified parameters corresponds to the economic assumptions. The price of the agricultural producer relatively strongly affects the explained variable, as a unit increase in the farm price increases the processor price by 0.74 unit, ceteris paribus. In view of the processes of price transmission, the said fact is to be expected, but nevertheless indicates that the increase in the processor price would be lower than the original impulse. Further, a unit increase in the consumer price would once again bring about an increase in the processor price, but only by 0.39 unit (ceteris paribus), which can lead to the conclusion of the possible composition of the resulting consumer price including the proportion of individual components, and in translation also in regard to the negotiating strength within supplier-customer relations. The last included variable was the delayed import price, the negative parameter of which evidences the long-term relationships of domestic production and the volume of foreign trade. Statistical verification evidences that all of the parameters of the explanatory variables are statistically significant at a selected level of significance (α=0.05) and the closeness of dependence measured by way of an adjusted coefficient of determination is once again at a relatively very high level (R^2=0.97).

In the second to last stochastic equation of the specified commodity model, the consumer demand for pork meat is explained, which is dependent on the consumer price per kg of beef meat, on the delayed consumer price and on the amount of final reserves of pork meat, see Equation 9 in Figure 9.

Figure 9. Results of Equation 9 estimation

```
Equation 9 /Source: own calsulation/
Dependent variable: QDC
Instruments: const DV_5 T NCp_1 PAP_1 DV_3 IPK IP_1 CP_b CP_p_1
  FR CP_pl

            coefficient     std. error    t-ratio   p-value
  ---------------------------------------------------------
  const     614671          142651        4.309     1.64e-05 ***
  CP_b      -1.65542        0.755666      -2.191    0.0285   **
  CP_p_1    1.38454         0.806629      1.716     0.0861   *
  FR        -5.87565        1.63851       -3.586    0.0003   ***

R-squared           0.781128   Adjusted R-squared   0.726410
```

The provided outputs of the estimate are slightly contradictory, as a unit increase in the consumer price in the preceding period brings about a significant positive change in the consumption for the current period of 1.38 units, ceteris paribus, and further, a unit increase in final reserves of pork meat corresponds to a sharp decline in

consumption of approximately 5.9 units. Both results are likely only a consequence of long-term trends among the monitored variables, and not an explanation of the relevant relationships, which is also evidenced by the lowest achieved coefficient of determination within the model (R^2=0.73). The said relationships should likely be subjected to deeper analysis in subsequent work. Last but not least, the analyzed relationship enables the conclusion of a complementary relationship between beef and pork meat, which is evidenced by the negative effect of the consumer price of beef meat on the consumption of pork meat. Similar effects in the sense of high sensitivity of consumption were achieved, for example, by Zhao et al. (2000), whereby the outputs of the published research show that if a similarly high price sensitivity is achieved in the case of basic needs goods, then it is usually already near the level of saturation and consumers are no longer willing to accept either an increase in price, or an increase in supply.
In statistical terms, it may be stated that all of the parameters of the explanatory variables are statistically significant at the necessary level of significance (α=0.1).
The last stochastic equation of the model is focused on modeling the consumer price, in order to enable the analysis of the mutual effects on individual levels of the vertical. The consumer price is explained by way of the processor price, the consumer price of chicken meat, and a dummy variable, which consists of the proportion of the import and export price of pork meat, see Equation 10 in Figure 10.

Figure 10. Results of Equation 10 estimation

```
Equation 10 /Source: own calsulation/
Dependent variable: CP_p
Instruments: const DV_5 T NCp_1 PAP_1 DV_3 IPK IP_1 CP_b CP_p_1
  FR CP_pl

            coefficient     std. error    t-ratio    p-value
  ---------------------------------------------------------
  const      17327.6         7644.83       2.267      0.0234    **
  PP_p       0.878046        0.0753634     11.65      2.27e-031 ***
  CP_pl      0.297567        0.0684439     4.348      1.38e-05  ***
  DV_3       -4141.28        2185.94       -1.895     0.0582    *

R-squared           0.969977   Adjusted R-squared   0.962471
```

In terms of the achieved outputs, it may be stated that a unit increase in the processor price would, ceteris paribus, increase the consumer price by 0.88 of a unit, whereby the ascertained direction and intensity correspond to the assumptions. The consumer price of chicken meat has a positive effect (a unit increase in the price of chicken meat would bring about an increase in the price of pork meat at the consumer level of 0.3 unit, ceteris paribus), and thus we can tend to conclude that there is a complementary relationship of both types of meat. The last analyzed variable was a dummy consisting of the ratio of the import and export price of beef meat, a unit increase of which would, under the condition of ceteris paribus, imply a significant decline in the consumer price of pork meat. An increase in the ratio, which means either an increase in the import price or a decrease in the export price, would likely create space for an increase in domestic production and thereby subsequently also the forced decline in the consumer price.
All of the quantified parameters are statistically significant at a level of significance (α=0.06). The closeness of dependence measured by the adjusted coefficient of determination once again reaches a high value (R^2=0.96).

For a comprehensive recapitulation of the quantified relationships, it is appropriate to record the resulting form of the estimated simultaneous commodity model of pork meat in the Czech Republic by way of an equational notation (as the model was intended for the portrayal of equilibrium, a necessary part of it is a balance identity):

$$\underset{(103024)}{Q_{SA,PM,t}} = \underset{(22.7)}{524067} + \underset{(4327.4)}{74.7NC_{PM,t}} - \underset{(3557.9)}{12990.2DV1} - 14083.2T$$

$$\underset{(467.9)}{NC_{PM,t}} = \underset{(0,082)}{-174.17} + \underset{(0,012)}{0.8NC_{PM,t-1}} + \underset{(235.7)}{0.03PAP_{PM,t-1}} - 561.8DV3$$

$$\underset{(4051.7)}{PAP_{PM,t}} = \underset{(1.7)}{-20369.3} - \underset{(1.7)}{3.4NC_{PM,t}} + \underset{(0.07)}{3.2NC_{PM,t-1}} + \underset{(396.7)}{0.6PP_{PM,t}} + 947.3DV5$$

$$\underset{(79413)}{Q_{IM,PM,t}} = \underset{(0.43)}{444500} - \underset{(0.047)}{1.6IPK_{PM,t}} - \underset{(0.15)}{1.3DS_{PM,t}} + 0.4Q_{DC,PM,t}$$

$$\underset{(16258.4)}{Q_{EX,PM,t}} = \underset{(8898.4)}{103261} - \underset{(0.027)}{17158DV3} - 0.19DS_{PM,t}$$

$$\underset{(8373.07)}{DS_{PM,t}} = \underset{(0,015)}{45234.5} + 0.59Q_{SA,PM,t}$$

$$\underset{(45403)}{Q_{SP,PM,t}} = \underset{(0.1)}{63638.4} - \underset{(0.63)}{1.126Q_{IM,PM,t}} + \underset{(0.09)}{1.27Q_{EX,PM,t}} + 0.88Q_{DC,PM,t}$$

$$\underset{(5046)}{PP_{PM,t}} = \underset{(0.17)}{15813.6} + \underset{(0.09)}{0.75PAP_{PM,t}} + \underset{(0.48)}{0.39CP_{PM,t}} - 0.96IP_{PM,t-1}$$

$$\underset{(142651)}{Q_{DC,PM,t}} = \underset{(0.76)}{614671} - \underset{(0.8)}{1.655CP_{BM,t}} + \underset{(1.6)}{1.38CP_{PM,t-1}} - 5.88FR_{PM,t}$$

$$\underset{(7644.8)}{CP_{PM,t}} = \underset{(0.075)}{17327.6} + \underset{(0.068)}{0.878PP_{PM,t}} + \underset{(2186.9)}{0.298CP_{PLM,t}} - 4141.3DV3$$

$$Q_{IM,PM,t} + Q_{SP,PM,t} = Q_{DC,PM,t} + Q_{EX,PM,t}$$

In the introduction to the conducted analysis of estimated correlations, a reference to the comprehensive testing of econometric assumptions of the created model was mentioned, the results of which are set out in the following tables 1, 2 and 3. For the verification of the normal distribution of random components, the multi-criteria Doornik – Hansen test was chosen (see Table 1), the achieved p-value of which documents the confirmation of the zero hypothesis of the normal distribution of residuals in the conceived equations.

Table 1 - Test for multivariate normality of residuals

Doornik- Hansen	Chi-square(20) = 24.5522	With p-value = 0.219101

Source: Own calculations

The verification of the absence of autocorrelation of residuals was conducted by way of the Ljung-Box test, a simplified summary of which for all stochastic equations of the specified model is set out – see Table 2.

Table 2 - Ljung-Box test (critical value = 0.05)

Equation 1: Ljung-Box Q': Chi-square(1) = 0.00047108 [0.9827]
Equation 2: Ljung-Box Q': Chi-square(1) = 0.192782 [0.6606]
Equation 3: Ljung-Box Q': Chi-square(1) = 0.349199 [0.5546]

Equation 4: Ljung-Box Q': Chi-square(1) = 0.190318 [0.6627]
Equation 5: Ljung-Box Q': Chi-square(1) = 0.202273 [0.6529]
Equation 6: Ljung-Box Q': Chi-square(1) = 0.00200353 [0.9643]
Equation 7: Ljung-Box Q': Chi-square(1) = 0.293171 [0.5882]
Equation 8: Ljung-Box Q': Chi-square(1) = 0.369387 [0.5433]
Equation 9: Ljung-Box Q': Chi-square(1) = 0.50523 [0.4772]
Equation 10: Ljung-Box Q': Chi-square(1) = 1.50362 [0.2201]

Source: Own calculations

On the basis of a comparison of the achieved p-values with the critical value of the LB test, it may be stated that the model is free of autocorrelation of residuals.
In conclusion, heteroskedasticity was also tested, by way of the combined ARCH test. Since autocorrelation of residuals was already ruled out by way of the previous LB test, the applied combined test can also be utilized for verification, by which the hypothesis of homoskedasticity is subsequently conclusively confirmed, see Table 3.

Table 3 - ARCH test (critical value = 0.05)

Equation 1: Test statistic: LM = 0.0538502 with p-value = P(Chi-Square(1) > 0.0538502) = 0.816494
Equation 2: Test statistic: LM = 0.866503 with p-value = P(Chi-Square(1) > 0.866503) = 0.351925
Equation 3: Test statistic: LM = 2.01552 with p-value = P(Chi-Square(1) > 2.01552) = 0.155698
Equation 4: Test statistic: LM = 0.248029 with p-value = P(Chi-Square(1) > 0.248029) = 0.618467
Equation 5: Test statistic: LM = 0.429815 with p-value = P(Chi-Square(1) > 0.429815) = 0.51208
Equation 6: Test statistic: LM = 3.19776 with p-value = P(Chi-Square(1) > 3.19776) = 0.0737391
Equation 7: Test statistic: LM = 0.0871343 with p-value = P(Chi-Square(1) > 0.0871343) = 0.767852
Equation 8: Test statistic: LM = 0.0369301

with p-value = P(Chi-Square(1) > 0.0369301) = 0.847607
Equation 9: Test statistic: LM = 0.355434 with p-value = P(Chi-Square(1) > 0.355434) = 0.551053
Equation 10: Test statistic: LM = 0.0408815 with p-value = P(Chi-Square(1) > 0.0408815) = 0.839767

Source: Own calculations

The outputs show that the zero hypothesis of homoskedasticity cannot be dismissed for any of the tested equations, whereby the observance of the basic econometric assumptions of the conceived model is confirmed.

Conclusion

The analyzed pork meat market underwent significant changes within the analyzed period, which were determined by both the economic development of a small open economy, as well as by several significant shocks, which significantly affected both the structure of the market, as well as the mutual interactions within the vertical, and also the reactions of the involved entities to external impulses. In the comprehensive assessment of the overall development of the basic levels of the monitored vertical, it is necessary to state that the overall supply at the agricultural producer level decreased by more than 46%; numbers of hogs in the battening category actually declined by more than 54%. Interesting in terms of the agricultural producer as well as the end consumer of pork meat products is the positive development in the overall supply, which increased in the course of the monitored period by more than 4.6 %. Negative development is then documented by way of significantly differentiated changes in the individual levels of the vertical. The price of the agricultural producer for the analyzed period decreased by approximately 21%, which, when compared to the growth in the prices of all inputs into production, is a more than alarming value. When compared to the growth in the processor price (9.4 %) and the weighted consumer price (9.37 %), the development of the growth of prices is very disproportional and huge pressure is evident primarily on the production level of the vertical, thanks to which the development of the consumer price is likely still perceived by end customers as reasonable. However, the secondary effects of the said pressure create a liquidation environment for domestic production, whereby, with a relatively stable demand, a huge space is created for the import of pork meat, for which the end consumer will once again unwittingly likely pay as a final result, firstly through a possible decrease in quality, and secondly through a very likely subsequent uncontrollable growth of consumer prices in the long-term.
In terms of further basic characteristics, it can be stated that, within the monitored period, along with the above-mentioned increase in the supply of jointed meat, there was also a simultaneous decline in domestic slaughter by 43%, a sharp increase in import of 3000% with the simultaneous increase in the import price by 163%. Several partial conclusions can be conceived from the above. The decline in production does not correspond to the decline in numbers, which is apparently caused precisely by increased import, which balances out the forced stoppages of Czech farmers, whose buyout prices are pushed down to such a low level that, for a number of entities,

production is no longer profitable and significant decreases in numbers occur. For the Czech consumer, it is also not good news that the balancing out of the decline of the production base occurs by way of import along with an extreme increase of the import price, which must subsequently necessarily determine the subsequent segments of the vertical. Last but not least, the increasing end prices do not thus have to be the result of price increases at the production level, but of the behavior of foreign trade entities, who import products for high prices and, on the other hand, likely export products with a low added value and with a lower increase in the export price.

In the analysis of the outputs of the conceived commodity model, some facts set out in the previous sections of the conclusions are confirmed and some partial results then provide support for the further interpretations of the links within the analyzed vertical.

The model confirmed an extremely declining tendency of the farm supply, which is, however, still relatively sensitive primarily to increases in numbers, i.e. with a stop to the current decline and possible increase in numbers, domestic production could flexibly increase. Declining numbers of hogs in the battening category are unfortunately not being stopped even by the development of the farm buyout price, which is also declining and despite the fact that, according to the results of the model, its increase could have a positive effect, then in terms of intensity the effect is more than negligible and thereby proves the difficult situation of Czech farmers. In assessing the opposite direction of the effect, the agricultural producer price is surprisingly very sensitive to changes in numbers and primarily their initial positive impulse could very quickly increase buyout prices, which would start up subsequent processes within the vertical. Purchasers (processors) have a very strong position in the vertical, which is further also evidenced by the positive effect of the processor price on the buyout price.

Significant increases in the volumes of import as well as export are modified by the development in the proportion between the domestic and foreign price, as well as by the development in domestic consumption, which is confirmed by the outputs of the estimated model. Both categories showed significant increases, whereby, however, the absolute assessment of the growth in export is based upon very low values in the initial period, i.e. despite the fact that, relatively, the increase in export is higher than the increase in import, the situation in terms of the values of volumes is the exact opposite. According to the model, imports into the Czech Republic would also continue to be increased, with a growth in the domestic demand, that very likely being to the detriment of domestic production. Within the equation of export, standard economic principles were proven, which increase export along with an increase in the export price. The overall domestic supply of the processor sector is, according to the outputs of the model, strongly and negatively influenced primarily by the conducted import. The processor price is sub-proportionally stimulating for the farm price and, at the same time, it is also sub-proportionally pulled by the consumer price, which means a demand-driven process of the vertical. The domestic consumption function does not completely have the anticipated development, as increases in the consumer price would bring about increases in the demand, and increases in reserves would increase the demand. In terms of the consumer price, statistically significant effects of the processor price, of the price of chicken meat and of foreign trade prices can be seen, whereby the price of the industrial producer increases the consumer price, similarly as the price of chicken meat.

Overall, it may be stated that the estimated model does a very good job of reflecting the principles of the analyzed vertical as analyzed above, declares the selected determinants of the development of the supply of as well as the demand for pork meat as well as the basic relationships between the individual levels of the pork meat vertical, and thus it can be considered to be an appropriate tool for the ensuing analysis of the pork meat market and the subsequent simulation calculations.

Acknowledgements

Knowledge introduced in this paper resulted from the conclusions of the research study GACR P402-11-P595 - Partial Equilibrium Model of the Meat Market.

References

Cipra, T. (2008) Financial econometrics. Ekopress, Prague (in Czech)

Čechura L., Šobrová L. (2008) The price transmission in pork meat agri-food chain. Agricultural Economics, 54(2):77-84.

Da Silva e Souza G, Alves E, Gazzola R, Marra R. (2008) The meat market in brazil: A partial equilibrium model. Revista De Economia e Sociologia Rural, 46(4):1189-208.

Doornik, J.A., Hansen, H. (1994) An Omnibus Test for Univariate and Multivariate Normality, Working Paper, Nuffield College, Oxford

Green, W.H., (2008) Econometric Analysis. 6th edition. Pearson Prentice Hall, New Jersey

Gujarati, D.N., (2003) Basic Econometrics. 4th Edition. McGraw Hill, New York

Hallam, D., (1990) Econometric modelling of agricultural commodity markets. New Fetter Lane, London

Hellberg-Bahr A, Spiller A. (2012) How to treat farmers fairly? Results of a farmer surfy, International Food and Agribusiness Management Review, 15(3):87-98.

Istudor, N., Manole, V., Ion, R.A., Pirjol, T. (2004) Mathematical Model for Optimizing the Profit of the Pork Meat Chain, Journal of Applied Quantitative Methods, Vol. 2, 1693-5098

Kenedy, P. (2008) A Guide to Econometrics. 6th edition. Blackwell Publishing, Oxford

Kuhn, A. (2004) Regional Agricultural Sector Model for Ukraine, Working Paper No. 27, The Institute for Economic Research and Policy Consulting, Kiev

Labys, W.C., Pollak, P.K., (1984) Commodity Models for Forecasting and Policy Analysis. Nichols Publishing Company, New York

Lechanová, I., (2006) The Transmission Process of Supply and Demand Shocks in Czech Meat Commodity Chain. Agricultural Economics, vol. 52(9), 0139-570X.

Malý M, Kroupová Z, Žídková D, Peterová J, Šobrová L, Čechura L, Pánková L, Mach J, Křístková Z, Maier T, Hučko J. (2011) Potential for pork production in the czech republic. Agricultural Economics, 57(11):545-54.

Malý, M., (2009) Price Models in Poultry Meat Vertical. Scientia Agriculturae Bohemica, 2-09, 1211-3174.

Ministry of Agricuture Czech Republic, (1995 – 2009) General information about Agriculture in the Czech Republic, Prague, Institut of Agricultural Economics and Information (in Czech)

Ministry of Agricuture Czech Republic, (1995 – 2010) Situation and Forcast Report – Beef, Prague, Ministry of Agriculture Czech Republic (in Czech)

Ministry of Agricuture Czech Republic, (1995 – 2010) Situation and Forcast Report – Pork, Prague, Ministry of Agriculture Czech Republic (in Czech)

Moro, D., Sckokai, P., Soregakoli, C., (2002) A partial equilibrium model of the BEF and dairy sector in Italy under imperfekt competition. In the Xth EAAE Congress Exploring Diversity in the European Agri -Food Syste', [online] Zaragoza (Published 2002) Available at: http://ageconsearch.umn.edu/bitstream/24787/1/cp02mo45.pdf [Accessed 11.11.2012]

Nerlov M., (2001) Expectations, Information and Dynamics, Handbook of Agricultural Economics, Elsevier Science, Amsterdam

Regorsek D, Erjavec E, Kozar M, Kavcic S., (2011) Economic effects of integration and reform processes - partial equilibrium approach. Bulgarian Journal of Agricultural Science 17(6):721-9.

San Juan-Mejía Z.M., Martínez-Damián M.A., García-Mata R., (2007) Effect of pork meat imports on the mexican beef meat market. Agrociencia, 41(8):929-38.

Sarris, A., Hallam, D., (2006) Agricultural Commodity Markets and Trade, Food and Agriculture Organization of the United Nations, Edward Elgar Publishing, Gheltenham

Schaffer, P., (2008) Commodity Modelling and Pricing, John Wiley & Sons, New jersey, Hoboken

Varian, H.R., (1992) Microeconomic Analysis. Third Edition. W.W. Norton & Company Ltd., London

Zhao, X., Mullen, J.D., Griffith, G.R., Griffiths, W.E., Piggot, R.R., (2000) An Equilibrium Displacement Model of the Australian Beef Industry, Economic Research Report No.4, NSW Agriculture, Orange