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SIMULATIONS AT CZECH POULTRY MARKET

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Abstract

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This paper defines the possible scenarios of the development of the poultry market in the Czech Republic, in view of the trends in production, consumption and foreign trade. The individual scenarios are based upon the forecasts of selected factors that have a substantial impact on the poultry market and whose changes can be expected in the subsequent years with great likelihood. The article sets out and addresses various scenarios for the period of 2012–2014. The scenarios are based upon the partial equilibrium model of the poultry market, which has been derived on the basis of time series and panel data within the years 1995–2009. The conducted analysis clearly shows that changes in the prices of agricultural producers will have an effect on changes in the production of poultry meat, an increase in VAT through consumer prices will impact the rate of domestic consumption, as well as changes in disposable income. Similarly, a change in the exchange rate will have an effect on the amount of poultry imported into the Czech Republic.

simulations, poultry meat, chicken meat, production, consumption, foreign trade

The production of poultry meat is often mentioned as the type of sector that shows development trends within all of agriculture. As this is usually a vertically completely integrated chain, this sector plays a significant role within the entire sector of meat production. The market share of this sector has expanded very dramatically within the past decades, along with the occurrence of increases in the effectiveness of production, which was reflected in relatively low prices that compete with other meat substitutes. That is also the main factor that, together with the non-existence of cultural or religious obstacles to consumption and a high level of nutrition value, leads to increases in the attractiveness of this sector. As stated by Magdelaine *et al.* (2008), the main trends in the consumption of poultry meat have not changed even after the bird flu affair.

The poultry market is affected by many factors whose influence is mutually interconnected. Social-economic, psychological and seasonal factors significantly affect the price of poultry meat, together with the balance of supply and demand on such market (Aral *et al.*, 2010).

The poultry sector holds a significant role within agriculture not only in the Czech Republic, but also in many other countries around the world, and thus it becomes the object of research on an international level. Dagdemir *et al.* (2004) utilized supply and demand models and, on the basis of data from the years 1983–1998, ascertained that in Turkey, the production of poultry meat is influenced by the production price of beef and poultry meat, and that the population growth and consumer price of mutton affect the consumption of poultry meat. In this case, the elasticity of supply was ascertained to be higher than the elasticity of demand, which indicates that producers are more sensitive to a change in price than are the consumers of poultry meat. Nevertheless, the values of supply elasticity can also be expected to be relatively low, primarily in view of the short production cycle of poultry meat.

The empirical results of GARCH models (Generalized Autoregressive Conditional Heteroskedasticity) indicate that for the Greek broiler market, a non-linear asymmetrical GARCH model (NAGARCH) is the most appropriate, as it better describes the volatility in prices of industrial

producers of broilers within the Greek poultry industry (Rezitis, Stavropoulos, 2010). In addition, other findings proved that the price volatility is an important risk factor and the price of feed for poultry is the most significant cost factor for the sensitivity function of supply (supply response function).

Taiwan models, which evaluated data from the years 1995–2007, show time series for the prices of broilers, whose logarithms and growth rates are stationary, and that estimated Symmetric and Asymmetric Conditional Volatility Models describe data extremely well (Huang *et al*., 2009).

The model approach, based on Hamilton's construction, was utilized by Holt, McKenzie (2003) to predict the price expectations of poultry producers in the USA. The results showed that together with quasi-rational forecasts, an actual supply shock, futures prices and ex-post errors in price forecasts affected price expectations of poultry meat producers. According to previous findings of the first author (Holt, Aradhyula, 1998), the application of the GARCH-M model is more precise in monitoring the sensitivity of the production of broilers on price influences. The results proved that sensitivity of production to fluctuation of prices of industrial producers.

The results set out above are always based upon the analysis of a specific partial market of poultry meat, but, nevertheless, the factors that are examined in this case and the basic tendencies may also be considered to be valid within a broader context.

MATERIAL AND METHODS

The objective of this article is to simulate, on the basis of forecasted values of selected factors affecting the poultry market in the Czech Republic, the possible scenarios of its future development. The possible scenarios are simulated for the years 2012–2014. For the simulations, the basic factors that affect the supply and demand of poultry meat, and for which, on the basis of economic policy, certain significant changes may already be anticipated today, were forecasted.

The simulated scenarios are based on the partial equilibrium model, which was derived on the basis of time series and panel data in the years 1995–2009[1]. In view of the nature of the commodity being analyzed and in view of the nature of the changes on the world market, primarily the factors affecting poultry production, its consumption and foreign trade are examined in the following text. The simulation is thus based on the following equations of the derivative model:

i) poultry production:

$$P_t = 0,327057 \times AP_{(t-1)}^{0,510102} \times P_{(t-1)}^{0,919353},$$

where

P_t .....poultry production (thousands of tonnes of live mass)

$AP_{(t-1)}$ ..price of agricultural producers of poultry delayed by 1 period (CZK/kg)

$P_{(t-1)}$ .....poultry production delayed by 1 period (thousands of tonnes of live mass)

ii) poultry consumption:

$$C_t = 0,00000853 \times CP_t^{-0,42822897} \times BCP_t^{0,29127168} \times I_t^{0,48469949},$$

where

C_t.....poultry consumption (kg/person/year)

CP_t .....consumer price of poultry (CZK/kg)

BCP_t ...consumer price of beef (CZK/kg)

I_t .....income (thousands of CZK)

iii) poultry import:

$$\mathrm{Im}_t = 0,161731 \times DC_{(t-1)}^{2,37294} \times IP_t^{-1,9352},$$

where

Im_t ..... import of chicken meat (thousands of tonnes)

$DC_{(t-1)}$ ... domestic consumption of chicken meat delayed by 1 period (thousands of tonnes)

IP_t..... import price (CZK/kg).

RESULTS AND DISCUSSION

In view of the current economic situation on the global, European as well as Czech market, it is at least interesting to look at what can ensue in the coming years. Chicken and poultry meat more generally can be categorized among basic foodstuffs, which means that they are included among goods for which a part of the real income must be expended. The question is, in what way significant economic changes and reforms will affect the income of the population of the Czech Republic and in what way they will affect the price of foodstuffs and other products. Subsequently, the impact of changes in these factors on overall expenditures and consumption of individual goods will also be interesting. However, not only do the economic crisis and reforms affect consumers, but they also significantly affect agricultural producers, processing entities as well as foreign trade in individual commodities. The possible scenarios of trends on the poultry meat market in the Czech Republic are simulated in the following text.

1 The partial equilibrium model is described in more detail by Šobrová *et al.* (2011).

I. Poultry Production

Poultry meat production is simulated on the basis of the expectation of a change in the price of agricultural producers (AP). The simulation of poultry production is based upon the anticipated minimum and maximum value of AP and its volatility.

The anticipated changes in the prices of agricultural producers are based on the anticipated growth in prices of factors entering into production. The main factors whose growth may be anticipated in the subsequent years and which have a significant share in the costs associated with poultry production include the consumption of energies and the consumption of feed mixtures. In this regard, the first to be simulated is the change in AP, on the basis of minimum and maximum values in the years 2004–2009. In view of the extremes, the overall ambivalence of AP and the anticipated changes in the main factors determining the price of agricultural producers of chicken meat, it may be expected that in the subsequent years, the AP will range in the interval of 17.49–24.64 CZK/kg (see Tab. I).

I: *Simulation of Production – Change of AP*

	min	**max**
AP (CZK/kg)	19.21	22.82
AP-simulation (CZK/kg)	17.49	24.64
Production (thousands of tonnes of live mass)	220.36	262.52

Source: Own calculation

On the basis of the simulated price, the production level in the subsequent periods should be in the range of 220.4–262.5 thousand tonnes of live mass (see Tab. I). It may thus be stated that the anticipated change in the AP should not significantly affect the level of poultry production. Production in 2009 reached a level of approximately 244 thousands of tonnes of live mass, which also corresponds to the simulated range.

Besides the above anticipated range of AP, the price volatility was also examined with the consideration of a various rate of probability (see Tab. II). The volatility of the examined time series is examined on the basis of minimum and maximum prices within the period of 2004–2009 decreased by 9% and increased by 8%, at a significance level of $\alpha = 0.4$ and $\alpha = 0.05$.

Firstly, it is appropriate to emphasize that under ceteris paribus conditions, the sensitivity of production to the price in the previous year is 0.51%. This relationship, which is dynamic in time, thus fully reflects the uniqueness of agricultural primary production, when production lags behind price by a certain time period.

However, a simulation on the basis of basic minimum and maximum prices must be conducted in consideration of further contexts. The fact is that the minimum price was recorded in 2006, when the so-called bird flu broke out in full, and just as in the year 2001, for example, when the first case of BSE appeared in the Czech Republic, the chicken meat production sector showed a significant plunge in price for reasons of a considerably irrational approach of consumers to such fact. Therefore, the price for that year is thus shows certain signs of a remote value. After a 9% decrease, the value of the price is then CZK 17.49, which is, even for top producers in the field, a unit revenue that is difficult to accept. On the other hand, the basic value for the maximum price used in the simulations is the value for the year 2008 and is at a level of 22.82 CZK/kg. This price is once again significantly positively affected by the economic boom, which was just graduating in the Czech Republic in the said year. After an increase by the pre-set 8%, the value of the price going into the simulation is then at a level of 24.64 CZK/kg.

Tab. II shows that on the basis of the assumptions, the minimum price of agricultural producers will, with a probability of 60% range within the interval of 138.49–350.63 CZK/kg, while the maximum AP will be within the interval of 456.05–441.63 CZK/kg. At a significance level of $\alpha = 0.05$ the minimum AP was simulated within a range of 87.04–557.89 CZK/kg and the maximum AP was within a range of 92.76–742.94 CZK/kg. The breadth of the simulated intervals is significantly higher at a significance level of 0.05, i.e. at a 95% probability of the said forecast, than at a significance level of 0.4, i.e. at a 60% probability of the said forecast. The most positive value is the production of chicken meat at a level of 742.94 thousand tonnes of live mass, which could, under certain circumstances, be achievable only in the course of a long-term time range, while, on

II: *Simulation of Production – Volatility of AP*

	$\alpha = 0.4$		**$\alpha = 0.05$**	
	–9%	**8%**	**–9%**	**8%**
AP (CZK/kg)	22.82	19.21	22.82	19.21
parameter AP – upper	0.67	0.67	0.83	0.83
parameter AP – lower	0.35	0.35	0.19	0.19
Production (thousands of tonnes of live mass) – upper	350.63	441.63	557.89	742.94
Production (thousands of tonnes of live mass) – lower	138.49	156.05	87.04	92.76

Source: Own calculation

the other hand, a highly negative lowest simulated value at a level of 87.04 thousand tonnes of live mass could, in the event of extremely poor development, be achieved within a medium-term time range. However, the issue of the simulation of prices lies in the fact that if the price level increases or decreases, then this phenomenon will occur globally or at least within the entire internal European Union market. Therefore, the simulated values must be approached with a certain respect.

II. Poultry Consumption

Poultry consumption is simulated on the basis of the anticipated changes in the income of consumers and consumer prices (CP) of poultry. In view of the unavailability of underlying data for chicken meat itself, the consumption was modelled at the poultry level. Nevertheless, it may be anticipated that the trends as well as reactions of poultry meat correspond to the trends of chicken meat. The consumption of chicken meat in the Czech Republic constitutes approximately 96% of the consumption of poultry, and thus the difference between them is negligible.

Change in the Consumer Price:

As has already been stated, the first thing to be examined is the effect of anticipated changes in the consumer price of poultry meat on its consumption. In the subsequent years, growth in consumer price may be anticipated, primarily on grounds of expected changes in the VAT rate. Currently, VAT at a rate of 14% is anticipated for the year 2012, and two possible scenarios are being considered for the year 2013, specifically 17.5% and 19%. The impact of the change in the consumer price on the consumption of poultry meat as a result of a change in VAT under otherwise equal conditions (conditions of the year 2009) is set out in the following text.

Tab. III contains VAT values, values of the consumer price of poultry meat, and the consumption of poultry in three considered scenarios. The consumer price level was set on the basis of the forecasted value for the year 2011 and the inclusion of the change in the rate of VAT for the following period. Within the scope of the scenarios being considered, there is an evident growth in the consumer price with a growing rate of VAT. In the case of these considered changes, a decline in the consumption of poultry meat can be expected as compared to the year 2009 (the last period used for the estimation of the consumption function) by up to 20% under otherwise equal conditions (average consumption of poultry meat in the year 2009 in the Czech Republic reached a level of 22.26 kg/person/year). The above shows that an increase in the consumer price by 3–8% (the simulated values) will decrease the consumption of chicken meat by 1–3.5%.

Change of Income:

A further section focuses on the simulation of the consumption of poultry meat depending on the anticipated changes in income, ceteris paribus. Tab. IV contains the anticipated values of the main factors that can affect the income level within the subsequent periods. In this regard, we can anticipate a growing level of income and inflation within the subsequent years (the specific estimate is based upon materials from the Ministry of Finance of the Czech Republic). The income level for the years 2012, 2013 and 2014 was estimated on the basis of the anticipated trends in inflation as well as a growth in income. Further, three various scenarios evaluating the effect of a change in income on consumption of poultry meat were simulated.

The calculations conducted show that even despite the current economic situation and despite the expected inflation level, there should be a moderate growth in income by 1–4% as compared to the year 2009. Such growth will have a positive impact on the level of poultry consumption. The growth in income caused by the considered changes should increase the consumption of poultry by approximately 0.5–2% as compared to the year 2009. This once again corresponds to the nature of poultry as essential or relatively essential goods.

III: *Simulation of Consumption – Change of CP*

	2012	2013a	2013b
VAT (%)	14.00	17.50	19.00
CP (CZK/kg)	72.10	74.52	75.56
Consumption (kg/person/year)	21.99	21.66	21.52

Source: Own calculation

IV: *Simulation of Consumption – Change of Income*

	2012	2013	2014
Inflation (%)	3.20	1.60	2.10
Growth of income (%)	2.70	2.90	4.70
Income (thousands of CZK)	154.31	157.10	159.12
Consumption (kg/person/year)	22.38	22.58	22.72

Source: Ministry of Finance of the Czech Republic, own calculation

V: *Simulation of Consumption – Change of CP and Income*

	2012	2013a	2013b
VAT (%)	14.00	17.50	19.00
Income (thousands of CZK)	154.31	157.10	157.10
CP (CZK/kg)	72.10	74.52	75.56
Consumption (kg/person/year)	22.11	21.98	21.84

Source: Ministry of Finance of the Czech Republic, own calculation

Change of Consumer Price and Income:

In conclusion, the consumption of poultry was simulated on the basis of the joint influence of the anticipated changes of income and the consumer price of poultry. The anticipated changes of income as well as of the consumer price were considered at the same level as in the case of the previous scenarios. The level of consumption was once again simulated in three scenarios, specifically for the year 2012 as well as for two variants for the year 2013 (in view of the anticipated changes in the rate of VAT). The conducted calculations show that in the event of the anticipated changes of income and consumer price, under otherwise equal conditions, there will be a decline in the consumption of poultry as compared to the analyzed year of 2009 (see Tab. V). The calculation shows that with the simultaneous growth of the consumer price by 3–8% and income by 1–2% (for the years 2012 and 2013) as compared to the year 2009, there will be a decline in the consumption of poultry by 0.5–2%.

On the basis of the conducted analysis, it may be stated that the consumption of poultry meat reacts more sensitively to a change in the consumption price than to a change in income. With the anticipated change in the consumer price, there will be a more significant decline in the consumption of poultry meat than in the case of the anticipated change in income. If both changes are taken into consideration simultaneously, the effect of a change of income will partially suppress a significant decline in consumption caused by a change in consumer price. It may be stated that these conclusions correspond to the assumptions and expectations, primarily in view of the nature of the examined commodity. Thus, neither the anticipated changes in income nor consumer prices should have a significant effect in subsequent years on the consumption level of poultry meat in the Czech Republic.

III. Import of Chicken Meat

The import of chicken meat is simulated on the basis of the anticipated trends in the exchange rate in the years 2012, 2013 and 2014, the values of which will be reflected into the imported amount through the import price. In this case, there is a simulation of the import of chicken meat (goods codes 020711, 020712, 020713 and 020714) into the Czech Republic on the basis of a change in the CZK/EUR exchange rate, while everything else remains under ceteris paribus conditions as compared to the year 2009.

The anticipated exchange rate is based on data from the Ministry of Finance of the Czech Republic. The CZK/EUR exchange rate appears to be more significant than the CZK/USD exchange rate, as more than half of the import of chicken meat into the Czech Republic is coming from European Union countries, although the greatest importer is Brazil. More detailed information on the territorial structure of the import of chicken meat is provided by the Czech Statistics Office. The Czech National Bank also provides a very sound forecast in regard to development trends for exchange rates, but at the time of the processing of this analysis, its forecast for the year 2014 had not been published yet. Nevertheless, the forecast of the Ministry of Finance can also undoubtedly be considered to have a high probability.

At this extremely turbulent time, the factors that form the CZK/EUR exchange rate, i.e. primarily the future state (growth or decline) of the GNP, can also be seen as considerably stochastic. In view of the fact that a one-percent change in the exchange rate has a negative effect on the level of imports by just under 2%, such fact must be taken into due consideration when evaluating simulated values, as the elasticity is very high in this case.

Further, the volatility of the import of chicken meat has been evaluated for 60% reliability and 95% reliability. The intervals of the simulated amount of imports of chicken meat depending on the anticipated trends in the CZK/EUR exchange rate under otherwise equal conditions are set out in Tab. VI. The conducted simulations show that, with a reliability of 60%, import within the analyzed years will range in the interval of approximately 32–104 thousand of tonnes of live mass. With a reliability of 95%, the simulated values range between 18.5–177 thousand tonnes of live mass.

The variability of forecasted values, or the range of specific resulting intervals, can be understood as very broad. It is very likely that the growth tendency of import will continue to be maintained. With more or less constant domestic consumption (since the year 2003, it has been achieving values slightly over 200 thousand tonnes of live mass), such fact can only mean one thing – domestic producers will continue to be pushed out by foreign producers within the domestic market. It may also be expected that in the future, the relative significance of import from non-European countries could increase in view of

VI: *Simulation of Import*

	α = 0.4			α = 0.05		
	2012	**2013**	**2014**	**2012**	**2013**	**2014**
Exchange Rate CZK/EUR	23.50	22.80	22.20	23.50	22.80	22.20
Parameter IP – upper	–1.78	–1,78	–1.78	–1.63	–1.63	–1.63
Parameter IP – lower	–2.09	–2.09	–2.09	–2.24	–2.24	–2.24
Import (thousands of tonnes of live mass) – upper	93.89	99.10	103.93	161.46	169.64	177.20
Import (thousands of tonnes of live mass) – lower	31.75	33.82	35.75	18.46	19.76	20.97

Note: IP = import price
Source: Ministry of Finance of the Czech Republic, own calculation

the fact that non-European countries usually have significantly lesser requirements for cage raising of poultry, i.e. a lesser minimum space for individual broiler chickens in cages.

The calculated intervals clearly show that the lower the significance level, the narrower the interval must be. Therefore, at a relatively high significance level ($\alpha = 0.05$) there is a situation where the upper limit of the interval is 8.5–9× higher for the forecasted periods than the lower limit of this interval, while at a considerably lower significance level ($\alpha = 0.4$) the upper limits are approximately 3× higher.

In any case, the Czech Republic will continue to cover a significant part of the consumption of chicken meat through imports, and domestic producers will continue to face constantly higher and higher foreign competition caused not only by the expected strengthening of the Czech crown in the future.

CONCLUSIONS

This article has addressed simulations of the impact of anticipated changes in the main factors that affect the poultry market in the Czech Republic. The analysis has focused primarily on changes in the prices of agricultural producers as a result of increases in the prices of inputs into production, as well as on the impact of anticipated changes of consumer prices and income on consumption and, last but not least, on changes in the import of chicken meat.

Simulated scenarios for the period of the years 2012–2014 showed that anticipated changes in the prices of agricultural producers should not substantially affect the production of chicken meat. Further, it was ascertained that the consumption of poultry meat reacts more sensitively to changes in consumer prices than to changes in income. That was also reflected in the simulated scenarios that utilized the anticipated increase in VAT, inflation and changes in consumers' real income. The analysis once again showed that the anticipated changes in economic factors should not substantially affect the demand for poultry meat within the subsequent years. Last but not least, the results of the analysis showed that we cannot expect the demand for poultry meat to be covered only by way of domestic production. In regard to the position of the Czech Republic on an international level as well as in view of the competitiveness of Czech producers and the cost level of production in other countries, it may be presumed that a part of the demand will always be covered through import.

It is evident that the analysis of changes of agricultural-foodstuffs markets, which relates to the global economic crisis, government policy and the possible trends in Czech agriculture, is undoubtedly important. This is also evidenced by the interest of other authors in the given issues, on a partial level as well as on an aggregate level. For example, Syrovátka (2011) emphasizes the significance of the price of foodstuffs in relation to the overall demand for foodstuffs. On the basis of the derived differential model, he states that an increase in VAT by 1% over the initial (10%) rate can cause a decrease in the demand for foodstuffs in the average Czech household by 0.4652%. In the case of an increase in income tax by 1% over the initial value (15%), the demand for foodstuffs can fall by up to 0.6899%. Such analysis also showed that changes in the volume of consumer demand for foodstuffs will be conveyed at the same percentage rate into demand functions within the scope of agricultural-foodstuffs verticals.

In conclusion, we may state that all results correspond to the nature of the analyzed commodity, i.e. poultry meat, which may be rather considered to be relatively essential goods that are in demand by consumers, but also have their substitutes that are easily available to Czech consumers.

SUMMARY

The objective of this article was to simulate, on the basis of forecasted values of selected factors affecting the poultry market in the Czech Republic, the possible scenarios of its future development. The possible scenarios are simulated for the years 2012–2014. For the simulations, the basic factors that affect the supply and demand of poultry meat, and for which, on the basis of economic policy, certain significant changes may already be anticipated today, were forecasted.

The simulated scenarios considering poultry production, consumption and import are based on the partial equilibrium model describing the main relations at the Czech poultry market. Poultry meat production is simulated on the basis of the expectation of a change in the price of agricultural producers. Poultry consumption is simulated on the basis of the anticipated changes in the income of consumers and consumer prices of poultry; concretely changes influenced by anticipated changes of VAT, inflation and real income. The import of chicken meat is simulated on the basis of the anticipated trends in the exchange rate in the years 2012, 2013 and 2014, the values of which will be reflected into the imported amount through the import price.

Simulated scenarios for the period of the years 2012–2014 showed that anticipated changes in the prices of agricultural producers should not substantially affect the production of chicken meat. Further, it was ascertained that the consumption of poultry meat reacts more sensitively to changes in consumer prices than to changes in income. Last but not least, the results of the analysis showed that we cannot expect the demand for poultry meat to be covered only by way of domestic production.

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