# EFFECT OF SOARING WORLD CEREAL PRICES ON THE CZECH ECONOMY (WITH USE OF GENERAL EQUILIBRIUM APPROACH)*

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In connection to an outstanding growth of cereal prices in the world commodity markets observed in recent periods, the impact of such exogenous shocks on the economy gains increasing importance. This is especially the case of the Czech Republic, which as a relatively small country performs a role of a price taker. In view of this, the aim of this paper is to estimate possible impacts of cereal world price development on the Czech economy and to interpret the resulting changes with the use of the general equilibrium approach. Based on a long term development of wheat prices, three scenarios were analyzed considering prices under and above the threshold level of 200 USD/t. The findings show that with increasing world prices of wheat, producers of wheat are facing advantages compared to other producers and they considerably increase the volume of exports. However, the impact of external price effects on the other sectors of the economy is negative. The simulation results show that an increase of world cereal prices causes a decrease of the GDP and a growth of unemployment. Furthermore, the paper reveals that the influence of world commodity prices on the domestic economy gains importance if these prices persistently reach levels above the historic long term threshold.

CGE model; wheat; world prices; simulation; Czech Republic

## INTRODUCTION

The recent increase of cereal commodity prices in world markets has become one of the most important issues in current economic discussions. This unexpected development of commodity markets particularly affects developing countries because of the high share of food expenditures in their consumer baskets. Furthermore, agricultural producers in developing countries often do not benefit from high prices at all and if they could, such positive effects would be outweighed by the burden of consumers who represent a much more numerous group of the society (given that the highest share of the population in developing countries lives in urban areas) in contrast to the small and unorganized group of farmers.

However, expensive agricultural commodities also affect the economies of developed countries as most of the cereal commodities are used as intermediate products in other sectors. In addition to this, more expensive food represents an impulse for increasing inflation. On the other hand, a rise of commodity prices also has positive effects as the competitiveness of domestic producers grows with higher world price. In view of this, the development of world commodity markets and its impact on domestic economy should be assessed in a complex way including all agents of the economy.

As a member of the European Union, the Czech Republic is closely connected to the world markets and thus to any fluctuations that occur there. As a relatively small country, the Czech Republic cannot respond to given price fluctuations since it performs the role of a price taker. Therefore, the exogenous shocks in world markets have direct effects on the entire economy in many dimensions.

In connection to the uncertain future development of commodity markets, the aim of this paper is to estimate the possible impacts of world price fluctuations on the Czech economy and to interpret resulting changes of the current market equilibrium. In particular, the paper uses the methodology of general equilibrium as a tool to simulate the impacts of developments in the world markets for wheat, on various areas of the Czech economy, given that wheat can be considered as the most representative cereal traded in the Czech Republic.

## MATERIAL AND METHODS

In order to address the impacts to all markets of the economy, a multi-sectoral approach should be used. General equilibrium models take into account mutual transactions between all agents of the economy and thus they are suitable to solve problems having a multi-sectoral scope. From an intuitive point of view, general equilibrium represents one of the oldest topics in economic theory. The concept of the invisible hand, formalized by Adam Smith, already contained the ideas of market equilibrium, which were further extensively developed by Léon Walras, who is acknowledged as a founder of the general equilibrium theory.

Computable General Equilibrium (CGE) models represent a relatively new category of modelling methods

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which translate the concept of Walrasian general equilibrium into the realistic representation of specific economies. In practice, the multiple equilibria are formulated by means of a set of nonlinear simultaneous equations which are derived from the microeconomic theory of producer and consumer optimization with the aim of recording all possible transactions among the agents of the economy. Contrary to econometric models (e.g. Vector Autoregressive (VAR) models) which work with large time series, the CGE models work with a static dataset combined with a strong underlying theoretical framework (S c r i e c i e u , B l a k e , 2003). CGE models gained popularity during the 1990's due to increased interests in economic integration and competitiveness issues (K r a t e n a , 2005)[1].

In order to describe the present economy in the structure of the CGE model, the data should be arranged into the form of a Social Accounting Matrix (SAM). SAM represents a consistent accountancy framework which is used in the set of simultaneous equations to quantify the intensity of shocks introduced in the system (T a y l o r , v o n A r n i m , 2007). The Social Accounting Matrix contains information about the economy recorded in the System of National Accounts. Nowadays, after a pause in the field of economic modelling caused by a lack of relevant data, the Czech national accounts are fully compatible with the other countries of the European Union (J a n o v s k i j , R o j í č e k , 2004)[2].

The Social Accounting Matrix used in the paper is based on data provided by the Czech Statistical Office (CSO) in their published version of the SAM for the year 2005. Since the proposed CGE model is not focused on modelling financial markets, some of the accounts presented in the CSO SAM were aggregated. On the other hand, because of the intended focus of the model on agricultural markets, production and commodity sectors of the matrix were further disaggregated to enable a detailed focus on the agrarian sector. An aggregated form of the matrix which was used in the analysis is presented in Table 1.

Table 1. Aggregated SAM for CR (2005) in mln. CZK

| SAM CR 2005 | Com | Activities | Prod. factors | Institutions | Taxes | Capital account | Rest of the world | Total |
|---|---|---|---|---|---|---|---|---|
| Commodities | | 4,847,529 | | 2,120,934 | | 771,076 | 2,156,031 | 9,895,570 |
| Activities | 7,527,194 | | | | | | | 7,527,194 |
| Prod. factors | | 2,153,894 | | | | | 21,994 | 2,175,888 |
| Institutions | | | 2,130,356 | 1,710,966 | 280,289 | | 130,790 | 4,252,401 |
| Taxes | 308,057 | –27,768 | | | | | | 280,289 |
| Capital account | | 553,539 | | 147,885 | | 262,500 | 91,171 | 1,055,095 |
| ROW | 2,060,319 | | 45,532 | 272,616 | | 21,519 | | 2,399,986 |
| Total | 9,895,570 | 7,527,194 | 2,175,888 | 4,252,401 | 280,289 | 1,055,095 | 2,399, 986 | |

Source: Czech Statistical Office, author's elaboration

In the disaggregated matrix, commodities and activities accounts contain nine sub-accounts concerning only the sector of agriculture (as presented in Fig. 1) and two aggregated sectors representing the rest of the economy. The disaggregation of the respective agricultural accounts was possible with the approximations made from the GTAP database[3], which contains information on all agricultural sectors with respect to their production characteristics. The aggregated sector of manufacturing comprises the sectors C–I in the standard NACE classification and the aggregated sector of services include NACE sectors J-P (Czech Statistical Office, 2008). The final arrangement of the data represents a square matrix of range 38 x 38[4].

The data structure adopted in the SAM on the one hand provides a comprehensive overview of the economy and on the other hand contains all the elements of importance for formulating a CGE model. A schematic overview of the CGE model used in this paper is presented in Fig. 1.

## Description of the proposed CGE model

Based on the SAM in the previous section, various actors, institutions and flows are identified. The CGE methodology provides a valuable framework for modelling the interaction between these agents and their interdependence on endogenous changes and exogenous shocks. In order to define the relationships that exist between the various elements of the model, choices need to be made on how to represent the behaviour of agents. Besides, the equilibria in all markets need to be defined by means of market clearing equations, and assumptions on the market structure lead to zero profit conditions. These elements of the CGE model will be elicited in the following section.

[1] In the Czech Republic, there are two projects of CGE model construction – carried out by Czech National Bank and a joint project of Ministry of Finance with Ministry of Industry and Trade (J a n o v s k i j , R o j í č e k , 2004).

[2] Input-output tables (supply and use tables) of the Czech Republic covering the years 1995–2004 are available at the EUROSTAT (http://epp.eurostat.ec.europa.eu).

[3] GTAP (*Global Trade Analysis Project*) is a database containing data in form of the Social Accounting Matrices for 83 countries of the world (D i m a r a n a n , 2006).

[4] The full version of the SAM is available from the author upon request.

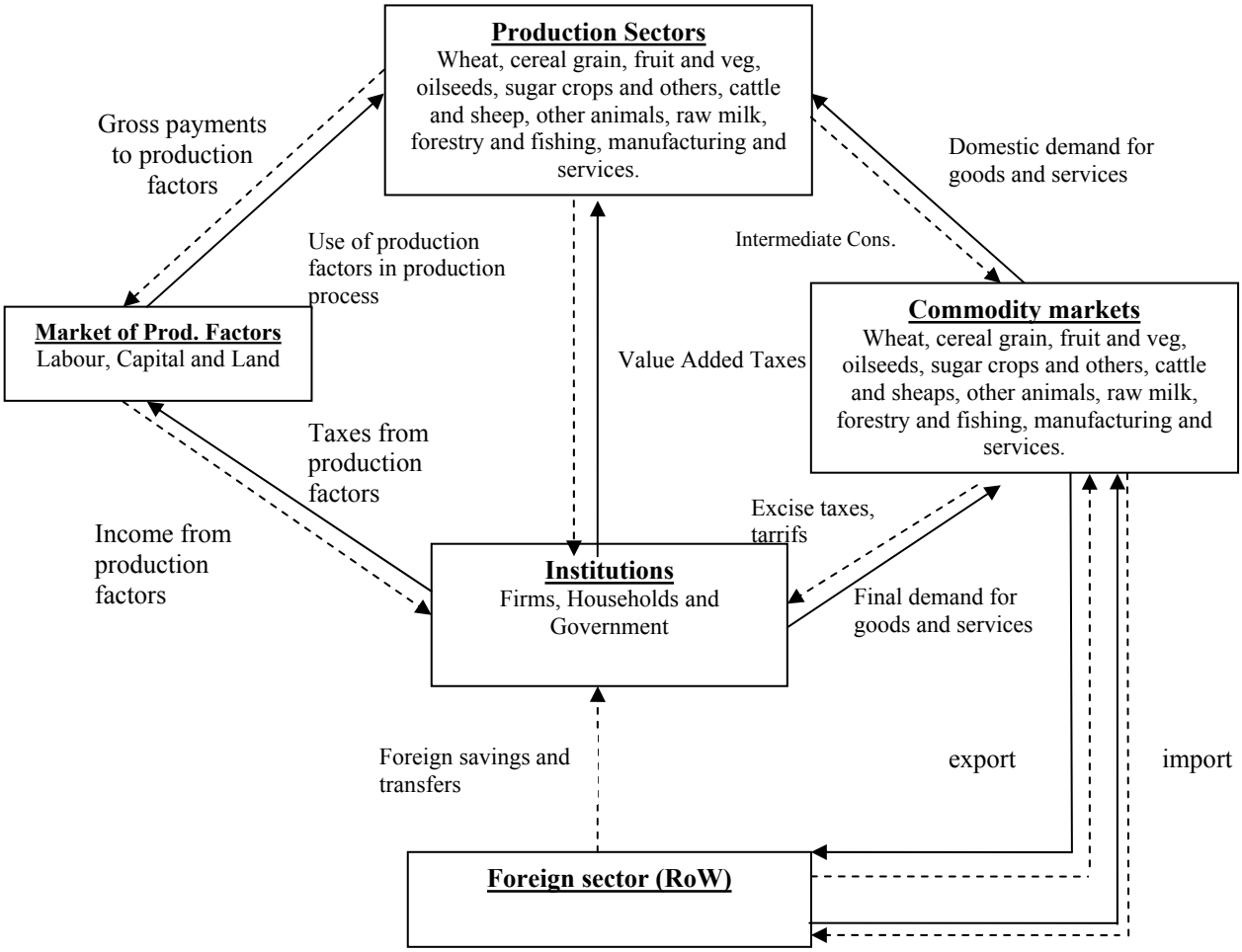



Fig. 1. Structure of flows in the economy
Source: Shoven and Whalley, 1984 (cit. in Scriecieu, Blake, 2003)

## 1. PRODUCTION STRUCTURE AND TECHNOLOGY

The CGE model does not consider individual firms but rather groups of similar firms aggregated into sectors. The various sectors are characterized by their production structure describing the relation between inputs into the production process and the output resulting from the economic activity. In this context it is assumed, that total domestic supply is a fixed factor Leontief combination of intermediate consumption and value added under perfect competition and constant returns to scale. The producers minimize the costs of employing production factors of capital, land and labour subject to their production technologies expressed by Constant Elasticity of Substitution function (CES). The CES function was first introduced by Arrow and Sollow in 1961. The functional form of the CES function that combines use of labour and capital-land labour in the first nest of the production structure is given in Formula 1.

$$XD_i = aF_i \left[ \gamma F_i . KD_i^{-\rho F} + (1 - \gamma F_i) . L_i^{-\rho F} \right]^{-1/\rho F}, \quad (1)$$

where $XD_i$ is the amount of the domestic production of the $i$-th production sector, $KD_i$ represents the demand for a capital-land bundle of the $i$-th sector; $L_i$ is the demand for labour in the $i$-th sector. The parameters of the CES function are represented by $aF_i$, which is the efficiency parameter and $\gamma F$ that is a distribution parameter. The parameter $-\rho F$ is derived from the elasticity of substitution according the Formula 2.

$$\sigma F_i = 1 / (1 + \rho F_i)^5, \quad (2)$$

where $\sigma F_i$ is the elasticity of substitution in the CES function.

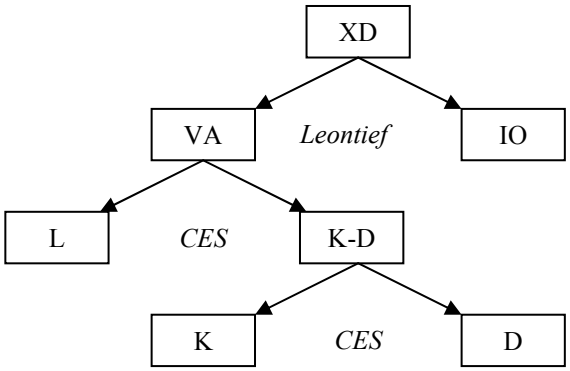
In the second nest of the production structure, the capital-land bundle is modelled with the following functional form (Formula 3):

$$KD_i = aG_i \left[ \gamma G_i . K_i^{-\rho G} + (1 - \gamma G_i) . L_i^{-\rho G} \right]^{-1/\rho G}, \quad (3)$$

where $KD_i$ is the amount of the capital-land bundle used in the production of the $i$-th sector, $K_i$ represents the demand for capital of the $i$-th sector and $D_i$ is the demand for land in the $i$-th sector. Analogically to the Formula 1, $aG_i$, $\gamma G_i$ and $-\rho G$ are the parameters of the CES function.

A schematic representation of the nested production structure used in the model is provided in Fig. 2.

[5] If the parameter $\rho Fi = 0$, the elasticity of substitution of the $i$-th sector $\sigma Fi = 1$ and the CES function is reduced to a Cobb-Douglas production function. If the $\rho Fi = -1$, the elasticity approaches $\infty$ and the CES function becomes a Leontief production function.




Note:
**XD**=total domestic production,
**K, L, D** = factors of production (D= land),
**VA**= value added,
**IO**= input output
*Terms in italic represent the functional relation which is assumed in the nested structure.*

Fig. 2. Nested production structure used in the CGE model
Source: author's elaboration

## 2. COMPOSITE COMMODITY

Total supply in the market is represented by a *composite commodity* consisting of the bundle of domestically produced goods supplied to domestic markets and imports, as presented in Fig. 3. The composite commodity is a result of two simultaneous forces in the model, first the intention of producer to find the most profitable combination between supply to foreign and domestic markets, expressed by a Constant Elasticity of Transformation (CET) function, and the intension of consumer to find optimal combination of imported and domestically produced commodity in the total consumption, expressed in the CES Armington function.

The functional form of the CET function is given in Formula 4.

$$XD_j = aT_j [\gamma T_j . E_j^{-\rho T} + (1-\gamma T_j) . XDD_j^{-\rho T}]^{-1/\rho T}, \quad (4)$$

where $XD_j$ is the amount of domestic production of the $j$-th commodity, $E_j$ is the amount of exports of $j$-th commodity to the Rest of the World and $XDD_j$ is the amount of domestic production of $j$-th commodity supplied to domestic market. Analogically to the CES function, $aT_j$, $\gamma T_j$ and $-\rho T$ are the parameters of the CET function.

CES function with Armington assumption is used to determine the extent of substitutability of the components of the composite commodity where it is assumed, that there is no perfect substitution between domestically produced and imported commodity. Functional form of the Armington CES function is provided in Formula 5.

$$X_j = aA_j [\gamma A_j . M_j^{-\rho A} + (1 - \gamma A_j) . XDD_j^{-\rho A}]^{-1/\rho A}, \quad (5)$$

where $X_j$ is the amount of total supply of the $j$-th commodity in the domestic market, $M_j$ is the amount of imports of $j$-th commodity from the Rest of the World; $XDD_j$ is the amount of domestic production of $j$-th commodity supplied to domestic market.

## 3. HOUSEHOLDS

The behaviour of households in the Czech economy is simulated by introducing one representative household in the model that optimises its utility subject to a budget constraint. Whereas microeconomic theory provides numerous suggestions, a standard choice in the field of CGE models is the Stone-Geary Linear Expenditure System (LES). The functional form of LES function is given in Formula 6.

$$U = \Pi [(Ci - \mu H_i)^{\alpha HLESi}], \quad (6)$$

where $U$ is the consumer's utility, $C_j$ is the amount of consumption of the $j$-th commodity, $\mu H_i$ represents the subsistence level of consumption of each $j$-th commodity[6] and $\alpha HLES_i$ is a preferential parameter of the respective $j$-th commodity in the consumer basket.

The households' consumption budget is determined by the net value of its income after taxation and transfers, reduced by its savings. The scheme of household income generation is presented in Fig. 4.

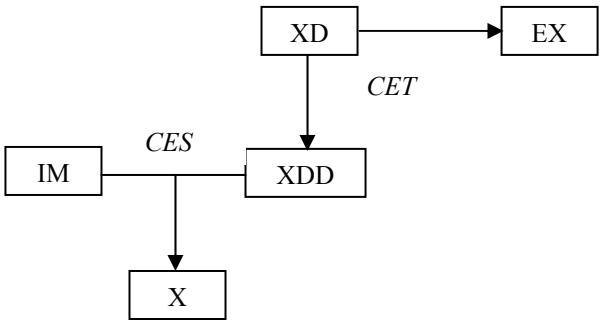
Constructed equations follow the structure of general equilibrium models:

**1. Demand equations**

Demand equations are derived from the optimization procedure following the behavioural assumptions made on the behaviour of the agents.

- Producers minimize costs of production factors subject to their technology expressed in the form of a CES function.
- Producers decide about the allocation of their product between domestic and foreign markets in order to maximize revenues expressed in form of a CET function.
- Composite commodity is derived as minimization of expenditures in the purchase of imported and domestically produced goods subject to a CES function with Armington substitution elasticities.
- Consumers maximize their LES utility function subject to budget constraint.

[6] If $\mu H = 0$, LES utility function is reduced to the Cobb-Douglas utility function.




**XD**= total domestic production,
**EX**= exports to the Rest of the World
**IM**= imports to the Rest of the World
**XDD**= domestic production sold in domestic market
**X** = composite commodity (total domestic supply)

Fig. 3. A schematic representation of domestic production and supply
Source: author's elaboration

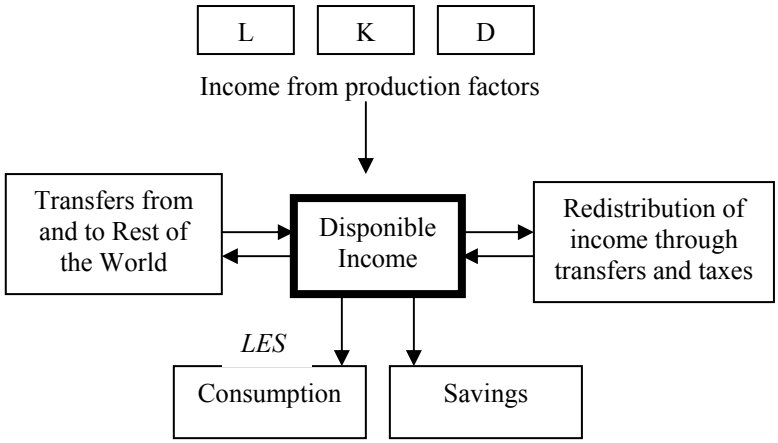



Fig. 4. Household income and spending
Source: author's elaboration

- Investments are allocated as a share of savings expressed in the form of the Cobb-Douglas investment function.

**2. Zero profit equations**

In the presence of perfect competition, the price is determined in zero profit conditions which equalize the output value to the costs of production.

**3. Market clearing equations**

In order to define the equilibria in the economy, market clearing equations are included, referring to equilibrium in the market of production factors and equilibrium in the commodity markets. According to these equilibrium conditions, supply meets demand for each of the markets in the model.

**4. Income balance equations**

Balance between revenues and expenditures is expressed in the income balance equations comprising all institutions of the economy.

In addition to the behavioural characteristics, the proposed model is based on the following assumptions:

- Fixed supply of production factors capital, labour and land.
- Capital is fully employed in all sectors, whereas land is employed only in sub-sectors of agriculture.
- Certain amounts of labour are not employed, modelled by a Phillips curve determining the level of unemployment.
- There are fixed governmental savings maintaining governmental budget unchanged.
- Following the assumption of a small country, both world export and import prices are fixed.
- Model closure consists in endogenous exchange rate adjusting to the level of fixed foreign savings.

## Calibration of parameters

With the functional forms used in the model, it is usually required to assign *a priori* the elasticity values associated with the respective function. The elasticities perform double roles; first of all they enable to derive other parameters contained in the specified function. For instance, by specification of the elasticity of substitution between labour and the capital-land bundle in the CES function, distribution parameter *gammaF* can be calibrated. Secondly, the value of elasticity predetermines the magnitude of reaction in the model, and thus it has a significant impact on the final results of any simulation. In CGE models, the elasticities can be either estimated with the use of econometric techniques, or their values can be adopted from previously carried out econometric studies. As the time series for econometric estimation are usually not available in their sufficient lengths, it is a common practice to use elasticity estimates from generally acknowledged sources. Selected elasticity parameters used in the model are displayed in Table 2. The values of these elasticities were adopted from GTAP data base which contains the world

Table 2. Elasticities used in the model

| Sector/Commodity | Wheat | Cereal grain | Fruit and vegetable | Oilseeds | Sugar crops | Cattle and sheep | Other animals | Raw milk | Forestry and fishing | Manuf. | Services |
|---|---|---|---|---|---|---|---|---|---|---|---|
| CET Transformation | –2.0 | –2.0 | –2.0 | –2.0 | –2.0 | –2.0 | –2.0 | –2.0 | –2.0 | –2.0 | –2.0 |
| CES Armington | 4.45 | 1.3 | 1.85 | 2.45 | 2.7 | 2.0 | 1.3 | 3.65 | 1.88 | 3.0 | 1.9 |
| Y elasticity | 0.62 | 0.62 | 0.62 | 0.62 | 0.62 | 0.62 | 0.82 | 0.82 | 0.3 | 0.94 | 1.3 |

wide elasticity estimations provided by the Purdue University (D i m a r a n a n , 2006).

As seen from the table, the elasticity parameters of the *CET transformation* function were set to a value of –2 in all considered sectors. This indicates that the flexibility of substitution between the supply to domestic and foreign markets is assumed equal in all sectors.

The elasticities used in the *CES Armington* function indicate the consumers' flexibility of substitution from domestically produced goods to imports as a result of changes in price relations. As Table 2 indicates, the CES Armington elasticities were set differently according the particular commodity group. For instance, the elasticity of wheat (commodity 1) is 4.45 and reaches the highest value. Therefore it is expected that there will be a strong response to world price shocks in favour of domestic production of wheat. Final demand for wheat and other commodities will depend strongly on the behaviour of consumers, expressed by the income elasticity parameters (*Y elasticity*). The income elasticity parameters are based on GTAP estimations which are provided for the Czech Republic referring to the year 2000. As reported in Table 2, the income elasticity with respect to agricultural commodities is the lowest with the exception of animal products. The elasticity of reaction grows with the level of processing and value added. The highest income elasticity is assumed in the demand for services. In view of these facts, the resulting price changes in the wheat market will not lead to a strong reaction from the consumers.

The constructed CGE model was used to estimate the impact of considered scenarios. As the scenarios elaborate on the empirical development of the commodity market, the definition of scenarios is included in the results chapter rather than in the methodological section.

## RESULTS

### Definition of scenarios

The excessive growth of commodity prices in world markets is a phenomenon of the recent years. When observing the long term development of the commodity markets in Fig. 5, it is apparent that the prices of the agricultural commodities together with other markets generally had a decreasing tendency. A break of this long term trend occurred after 2002, when prices of metals and fertilizers were soaring quickly, followed by the markets of agricultural and food commodities, which were hit by price inflation in 2005. This trend change suggests that the world economy has come to a new period, characterized by significant price inflation of agricultural commodities. There are several reasons explaining such price development. One of those might be a sudden sharp increase of fertilizer prices which have a strong impact on farmers' production costs.

Another factor contributing to the significant price increases is a continuous gap between world supply and

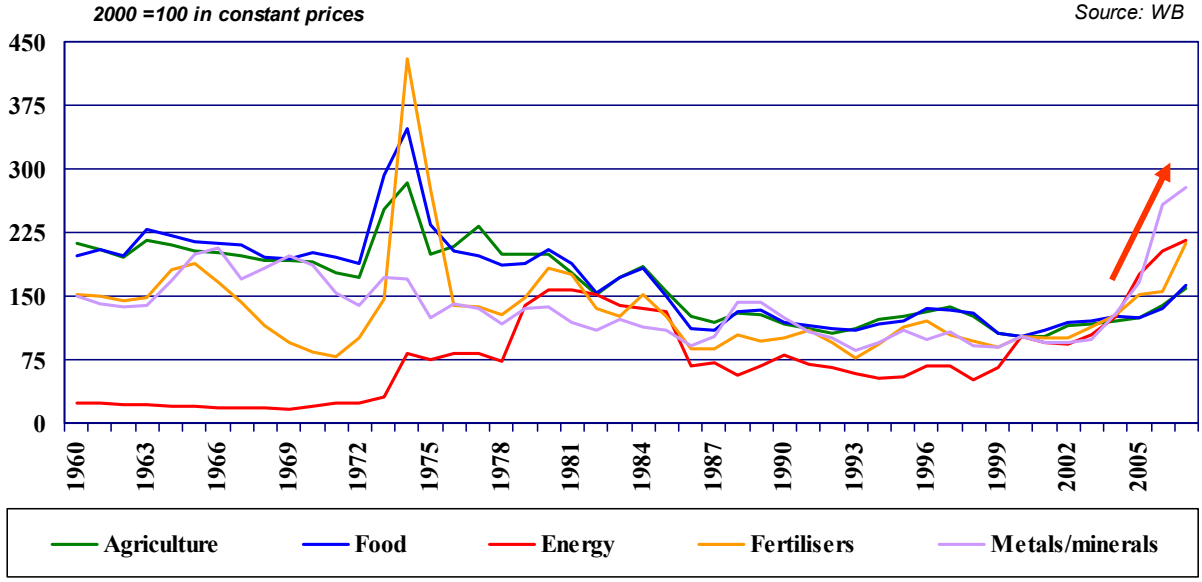



Fig. 5. Indexes of Real Commodity Prices
Source: EU Commission, DG Agri

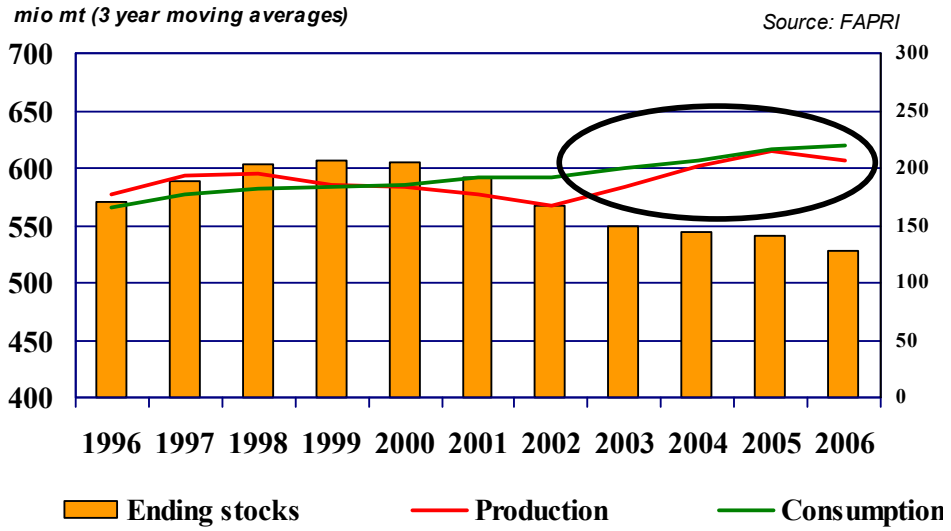



Fig. 6. World market of wheat
Source: EU Commission, DG Agri

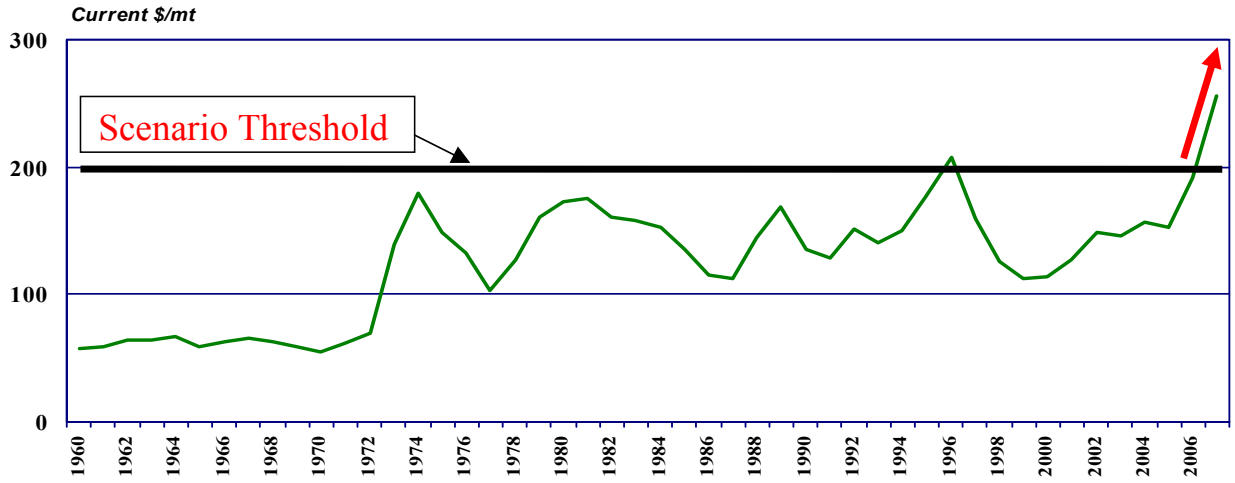



Fig. 7. Long term wheat price development
Source: EU Commission, DG Agri

world demand. As displayed in Fig. 6, during the last decade of the previous century, world production was fully able to satisfy world demand. However, with the beginning of the new millennium the proportions changed, drawing a completely different picture of the world market. As Fig. 6 shows, the continuous increasing trend of world demand together with fluctuating world supply caused global ending stocks to vanish in recent times.

As a result of the present deficiency of wheat supplies, the world prices adjust to market disequilibrium by continuous growth. This is clearly demonstrated in Fig. 7, where long term observations of wheat prices are presented. The development shows that during 40 years, world prices of wheat were fluctuating in the range of 100–200 USD/t, where the threshold price of 200 USD/t was never exceeded. However, the last period of development exhibits an outstanding and rapid growth. After 2006, the threshold level of 200 USD/t was highly exceeded.

In view of these facts, two future scenarios will be considered in the empirical part of this paper:

**Pessimistic scenario**: (World Export Price of wheat will be permanently > 200 USD/t fob)

The pessimistic scenario is based on the assumption that world supply will remain inelastic and insufficient. This argument could be supported by continuous protectionist agricultural policies of developed countries, where domestic farmers receive subsidies for set-asides and by increasing adverse impacts of climate change on world production zones. In addition to that, with inadequate investments into new technologies, the failure of using productivity potentials lying in the hands of developing countries would be continued, boosting the food prices continuously up. Ongoing governmental support of biofuels and continuous growth of demand from booming developing countries are other possible inflation drivers. When observing official projections of the FAPRI, OECD and USDA, their predicted Hard Red Winter Wheat Price (HRW) visibly exceeds the threshold level of 200 USD/t, thus supporting the pessimistic alternative (Fig. 8). It can be also added, that according to the OECD Agricultural

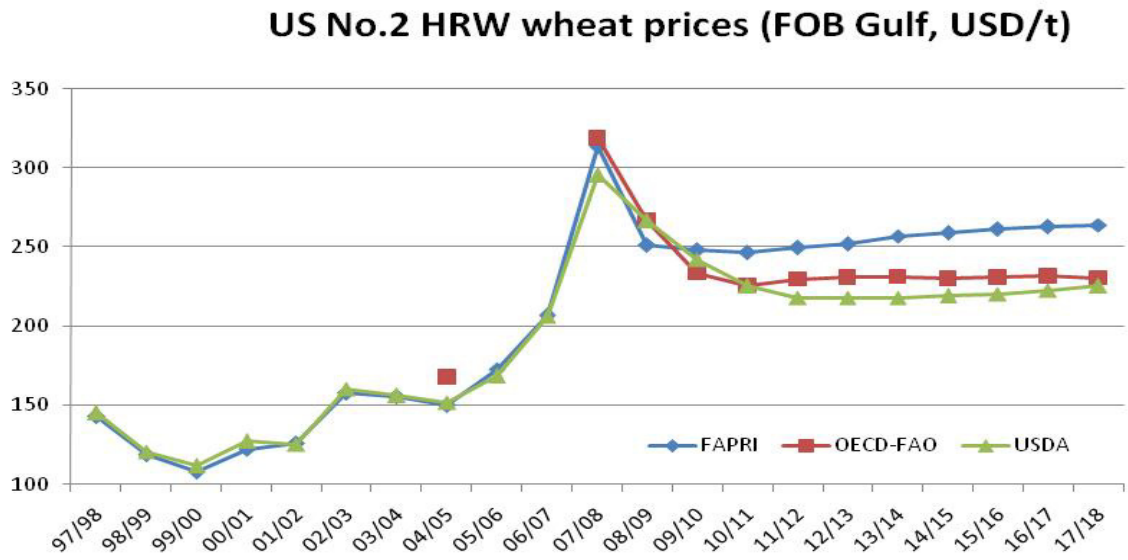



Fig. 8. Projections of wheat price development
Source: EU Commission, DG Agri

Table 3. Proposed scenarios

| | World Export Price in USD/t | Price shock within scenario | Simulation carried out |
|---|---|---|---|
| Baseline | 150 | 0% | PWE* = 1 |
| Scenario 1 | 100 | –33% | PWE´ = PWE*0.67 |
| Scenario 2 | 200 | +33% | PWE´ = PWE*1.33 |
| Scenario 3 | 250 | +67% | PWE´ = PWE*1.67 |

*PWE is a World Export Price at the benchmark equilibrium, PWE´ is a simulated new price level

Outlook for 2008–2017, it is expected that the prices of wheat and other cereal commodities could rise in the given period from 40% to 60% (OECD, 2008).

**Optimistic scenario**: (World Export Price of wheat will come back to its long term levels < 200 USD/t fob)

As an opposite view, the optimistic scenario is supported by prospects of liberalization of agricultural policies, not only with respect to foreign trade, but also in the internal context of the European Union, where a revision of the CAP, in the so called Health Check initiative, could lead to the abolition of set-aside and production quotas on particular products. Furthermore, possible positive climate change effects in the world wheat production zones, such as Canada, could increase world production capacities. A potential reduction in world demand as a result of the current financial crises would contribute to a decrease in the prices of commodities, including wheat.

To translate the hypotheses into exact figures, the following scenarios are proposed (Table 3). Since the benchmark equilibrium represents the Czech economy in 2005, the proposed baseline world price is 150 USD/t. In order to properly measure the sensitivity of the Czech economy on the change of world prices, various simulations related to the proposed scenarios are considered. The simulation concerning Scenario 1 is the most optimistic, with prices down to100 USD/t, which represents a decrease by 33% against the baseline. Scenario 2 represents a situation on the threshold with prices set to 200 USD/t that is 33% above the baseline price. Finally, Scenario 3 represents the pessimistic alternative when the price would reach 250 USD/t which is an increase of 67% against the baseline. The final column of Table 3 shows how the simulation is carried out in the GAMS code. Since all prices in the benchmark equilibrium bear value of 1 (being thus price indexes with respect to the numeraire), the changes in world prices are modelled as respective increase or decrease against the initial unity price.

Due to the fact that the constructed model has a static character, the changes are reported only with respect to the benchmark equilibrium.

## Simulation results

Every simulation that is carried out represents an external shock into the system. The benchmark equilibrium, which truly reflects the original structure of the economy, is changed and the economy adapts to find a new market equilibrium. In order to compute the impacts of these exogenous shocks in all dimensions of the model, advanced software tools are required which are able to deal with sizeable sets of simultaneous equations.[7]

[7] The results reported in this paper were obtained using the GAMS modelling package.

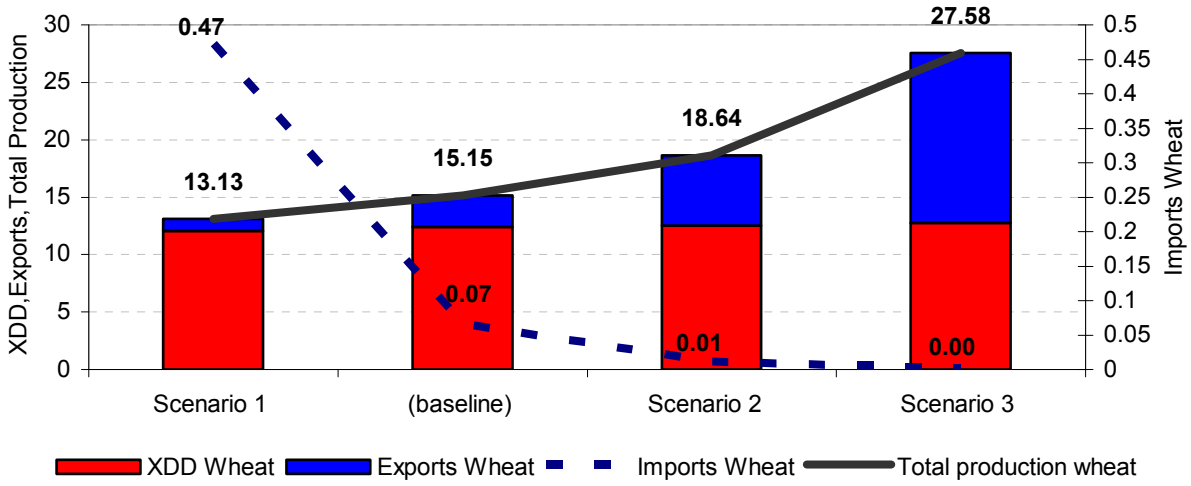



Fig. 9. Impact of price shocks on market of wheat (CZK bln.)

Table 4. Impact on the market of wheat

| Wheat price | Scenario 1 | (baseline) | Scenario 2 | Scenario 3 |
|---|---|---|---|---|
| | 100 | 150 | 200 | 250 |
| Exports | –60.4% | 0.0% | 120.8% | 434.7% |
| Domestic prod | –12.4% | 0.0% | 28.5% | 119.2% |
| Capital | –13.7% | 0.0% | 33.1% | 154.8% |
| Labour | –12.6% | 0.0% | 29.3% | 125.3% |
| Land | –11.5% | 0.0% | 25.8% | 101.9% |

In order to trace all consequent changes, it is useful to start from the main impact that the shock brings, which is the impact on the balance of payments. Following the assumption that the Czech Republic is a price taker; as the foreign price of wheat increases, the exports become more profitable for the producers and they try to shift their supplies from domestic markets to foreign markets. The increase in world prices also affects imports as they become more expensive. As a reaction, consumers might change their preferences towards domestically produced goods.

In the light of these assumptions, the empirical results of the simulation are displayed in Fig. 9, which shows the final impact on the market of wheat induced by different world price levels. The first impacts that the shocks cause are seen in the level of exports. With increasing world prices, the domestic producers react significantly by shifting their supply from domestic markets to exports. The results of the simulation concerning scenario 3 show that exports would rise by 400%. In the threshold level of the scenario 2, exports increase by 120%. It is also observed that when world prices drop by 33%, the exports of wheat decrease by 60%. These findings are in line with the initial values of CES Armington elasticities (provided in Table 2), which in case of wheat predetermine markedly elastic reaction.

Changes in exports are followed by series of reactions concerning stimulated domestic production. Results concerning Scenario 3 show that domestic production of wheat increases by 120%. As seen in the chart, the value of exports is considerably bigger than the resulting decrease of wheat imports, which are displayed in the secondary axis. As it can be also observed, the level of XDD – the domestic production supplied to domestic market remains stable with only slight increase.

Simulation results expressed in percentage changes are provided in the Table. 4. As the figure shows, the demand for all production factors – capital, labour and land grows. This is due to the fact the producers are motivated to achieve higher output and thus they increase the demand for production factors that they employ in their technological process. As the nested structure suggests, at first, combination of labour and capital-land bundle is determined and in the following step, the bundle splits between use of capital and land.

The strength of CGE modelling lies in the possibility of estimating the impacts of the shocks on other elements of the economy. One relation between the wheat sector and other sectors concerns the employment of production factors. Because the total supply of production factors is assumed to be constant in the short run, increased demand for capital, land and labour in the wheat sector implies a reduction in availability of these factors for other sectors. With fixed supply and increased demand, the relative prices of production factors – return to capital and rent increase in order to achieve the equilibrium. Since the wage rate is set as a *numeraire*, which implies that it is a basic price compared to which all other prices are expressed in relative terms, its level does not change. As the

Table 5. Impact of simulations on GDP components (in bln. CZK)

| | Scenario 1 | (baseline) | Scenario 2 | Scenario 3 |
|---|---|---|---|---|
| | 100 | 150 | 200 | 250 |
| Private consumption | 1155.4 | 1154.7 | 1153.1 | 1146.3 |
| Investments | 745.4 | 746.1 | 747.6 | 750.9 |
| Governmental consumption | 659.3 | 658.2 | 655.6 | 645.4 |
| Net exports | 96.8 | 95.7 | 91.5 | 76.2 |

Table 6. Impact of simulations on macroeconomic indicators

| | Scenario 1 | (baseline) | Scenario 2 | Scenario 3 |
|---|---|---|---|---|
| | 100 | 150 | 200 | 250 |
| Unemployed labour | –0.74% | 0.00% | 1.70% | 8.76% |
| GDP | –0.02% | 0.00% | –0.03% | –0.24% |
| Consumer utility | 0.07% | 0.00% | –0.15% | –0.80% |
| Total savings | –0.14% | 0.00% | 0.34% | 1.59% |

simulation prices increase, the return to capital and rent react in the same way. However, the reaction of land price is much stronger, in the worst case scenario relative price of land increases by 34% compared to wage rate while price of capital grows by 0.32%. This is due to limited supply of land and its role in the production process of cereal sectors.

The simulation results showed that the market of wheat is strongly stimulated as the world price grows. However opposite situation is observed in other markets of the economy. As all sectors employ the same production factors that have fixed supply, the capacities of other sectors production decrease. The strongest deficit is recorded in the case of land, where the use of land in other agricultural sectors decreases by 4%. As a reaction to that, the total production of other agricultural sectors drops by 4% too, followed by a decrease of manufacturing by 2%. The final impact of price simulations on production structure favours agriculture. Stimulated production of wheat causes gradual increase of the agricultural share in total economy. The most remarkable impact is recorded in the case of Scenario 3 where the participation of agriculture in the total economy increases from 2% to 3%.

The impact of world prices of wheat on total economy is observed in Table 5, where the development of all GDP components is demonstrated. The figure shows that as a result of the increasing world prices of wheat, both private and governmental consumption tend to decrease due to rise of equilibrium price in all other commodities. Therefore, the institutional income is shifted from consumption to saving which stimulate investments. The deterioration of foreign trade balance with an increase of wheat price is another finding resulting from the simulations. This is caused by dramatic decrease of exports in all other sectors of economy.

Development of GDP and unemployment is displayed in Table. 6. As seen in the figure, with growing external price of wheat, the structural changes concerning domestic production lead to decrease of GDP. In connection to decline in total production, the sectors demand less labour and therefore the amount of unemployed labour grows. Under the most pessimistic scenario, the unemployed labour force grows by 9%, which having a fixed labour supply in the economy represents an increase of the unemployment rate by one percentage point. As a reaction to higher unemployment and an increased price level, households' real income and consumer utility declines.

## DISCUSSION

As a starting point of the analyses presented in this paper, several assumptions were made regarding the behaviour of agents in the model as well as the structures of the markets in which they act. Whereas particularly the assumption of perfect competition is obviously not very realistic in all sectors, in the agricultural markets under attention in this study, is seems a fairly realistic representation of reality.

Furthermore, it could be discussed, whether all agents that are assumed to follow optimization behaviour in reality behave accordingly. It could be believed that most of the individuals in the role of producers seek to minimize their costs and most of the consumers act to maximize their consumption utility. In this respect, the elasticity parameters that describe agents' behaviour determine the magnitude of the reaction. As most of the parameters where based on GTAP estimations, their value is applicable to the case of the Czech Republic. It is a subject for further investigation whether the elasticity parameters used in the model mimic the contemporary reality closely enough.

Given that the baseline scenario refers to the year 2005, the simulations should be compared to the structure of the economy in this moment in time. However, it seems plausible to claim that the situation of the economy in 2005 is not structurally different from the state of the world nowadays, as the transformation period had finished by that time, and the restructuring process was at its end. It is assumed that the adjustment resulting from the economic

integration did not have significant influence anymore, as the Czech Republic was already a member of the European Union in the baseline year.

An extension of the research to include the production of biofuels would certainly be relevant, given that biofuels might play a role in the commodity price increases. However, due to scope of the paper, the impact of biofuels is solely considered in frame of the pessimistic scenario as one of the factors that contributes to the soaring food prices.

As a potential topic for further extension of the analyses, the behaviour of agricultural producers and the role that the Common Agricultural Policy plays in shaping this deserve particular attention. In future work, the conditions determined within the CAP should be included in the assumptions of the model.

## CONCLUSIONS

The simulations carried out in this paper provide a general picture of the possible impact of different world price levels on the Czech economy. Three scenarios were analyzed which were based on a long term development of wheat prices, where it can be observed that in recent periods prices of wheat exceed their long term threshold level of 200 USD/t. The results are compared for all proposed scenarios in order to observe the influence of price shocks in a continuous form. The general equilibrium approach enables to show that a shock carried out in one partial market has its repercussions transformed to all markets of the economy.

From the simulation results it follows that positive effects of an increase in world prices, which stimulate one partial sector of the economy – in this case wheat production – are outweighed by negative consequences in other sectors of agricultural production which compete for the same resources. The findings show that with increasing world prices of wheat, producers of wheat are facing advantages compared to other producers and they considerably increase the volume of exports.

If the world prices continue to fluctuate around the threshold level, the resulting changes are moderate. However, if the most radical scenario is adopted, the structural changes in the economy strengthen the role of agriculture. As the sectors of agriculture employ structurally less labour force in their production process, the decline of production in manufacturing and services leads to an increase in unemployment. In this respect, the changes are moderate under the scenario with prices at their threshold level, while under the most radical scenario the unemployment grows considerably. The domestic economy faces inflationary pressures, stimulated by the simulated incline in world prices, and the equilibrium prices of production factors of capital and land increase as well as the price level of all domestic commodities, except for wheat. The final value of the Gross Domestic Product has the tendency to deteriorate as world prices go up. Until the threshold level defined in Scenario 2, the GDP decline is negligible. With world wheat price exceeding 200 USD/t the value of GDP starts to decline faster.

Finally, the paper demonstrates that with the use of the general equilibrium approach it is possible to simulate, measure and interpret the results of complex changes in the economy, both at a sectoral level and from a macroeconomic, national perspective. Furthermore, the paper reveals that the influence of world commodity prices on the domestic economy gains importance if these prices persistently reach levels above the historical long term threshold. Therefore, if the mentioned projections of international institutions come true, it is advisable to anticipate structural adjustments in the economy of the Czech Republic.

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KŘÍSTKOVÁ, Z. (Česká zemědělská univerzita, Provozně ekonomická fakulta, katedra ekonomiky, Praha, Česká republika):

**Vliv změn světových cen pšenice na českou ekonomiku (s využitím přístupu obecné rovnováhy).**

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V souvislosti s výrazným růstem cen pšenice na světových trzích v posledním období narůstá význam hodnocení vlivu těchto exogenních šoků na ekonomiku. Tato problematika je obzvláště relevantní v případě České republiky, která jako relativně malá země nemůže ovlivnit světové ceny, ale musí se jim přizpůsobovat. V tomto kontextu je cílem příspěvku kvantifikovat a interpretovat výsledné změny dopadu možného vývoje cen pšenice na světových trzích na českou ekonomiku s využitím přístupu obecné rovnováhy. Na základě dlouholetého vývoje světových cen pšenice byly analyzovány tři scénáře vývoje, které byly navrženy podle dlouhodobého cenového stropu dosahujícího úrovně 200 USD/t.

Z výsledků vyplývá, že s rostoucími světovými cenami pšenice jsou producenti pšenice zvýhodňováni oproti ostatním producentům a výrazně zvyšují objem vývozů. Naopak, dopad externích cenových šoků na ostatní sektory ekonomiky je negativní. Výsledný efekt růstu cen komodit pak přináší pokles HDP a růst nezaměstnanosti. Příspěvek ukazuje, že vliv světových cen komodit bude nabývat na významu a způsobovat rozsáhlejší strukturální změny v ekonomice, jestliže světové ceny budou pokračovat v rostoucí tendenci překračující historický cenový strop.

CGE model; pšenice; světové ceny; simulace; Česká republika

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