



# Littera Scripta

2/2014



Recenzovaný časopis VŠTE



# LITTERA SCRIPTA

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České Budějovice, prosinec 2014

Za redakční radu  
prof. Ing. Jan Váchal, CSc.

## INTRODUCTORY WORD

Dear readers,

I am pleased that you have this time find your way again to the journal *Littera Scripta*, which we have regularly published for you for seven years. I can announce to you with pleasure, that our journal has again been included in the List of reviewed nonimpacted journals published in the Czech Republic, where it was excluded last year. I, therefore, believe, that we have to present you the issue containing significantly lower number of articles, nevertheless all of the published papers passed the review process successfully and I am looking forward to greater interest from many authors in the forthcoming year.

You were previously informed, that the section of technology and natural sciences was canceled and since July the journal focuses only on topics from the economic area. In this context I afford to remind you, that the articles continue to be published free of charge, after an impartial and high quality review process and we are very glad if you decide to publish any scientific work in the field of business economics, management and marketing or in public sector economy, governance, management and administration.

Let me thank you, that although times are very unfavorable for reviewed journals, you read the pages of our journal regularly and we will be pleased if you decide to contribute with your papers for the next issues.

In conclusion let me wish you successful ending to this year and a Merry Christmas and I believe, that we will still meet at regular times to read the new developments in the area of social sciences.

České Budějovice, December 2014

on behalf of the editorial board  
Prof. Ing. Jan Váchal, CSc.

# PRŮBĚH RECENZNÍHO ŘÍZENÍ / REVIEW PROCEEDINGS

Do čísla 2/2014 byly zařazeny 3 recenzované příspěvky od 7 autorů z 6 pracovišť. /

In issue 2/2014 3 reviewed articles written by 7 authors from 6 institutions were included.

## Články / Articles

Počet doručených článků / Number of articles received: 3

Počet článků vyřazených v 1. kole recenzního řízení / Number of articles rejected in 1<sup>st</sup> round of review proceedings: 0

Počet článků vyřazených ve 2. kole recenzního řízení / Number of articles rejected in 2<sup>nd</sup> round of review proceedings: 0

Počet článků přijatých k tisku po dokončení recenzního řízení / Number of articles agreed to be published: 3

## Recenzní rozhodnutí / Review conclusions

Počet zpracovaných recenzí / Number of reviews delivered: 7

- z toho recenzováno recenzentem s titulem doc. nebo prof. / from which was reviewed by reviewer with Doc. or Prof. degree: 5 (71.4 %)

	Recenzenti s doc. či prof. Reviewers with Doc. or Prof. degree	Ostatní Other	Celkem In total
Přijato beze změn Published without changes	1	1	2
Přijato, doporučeno zohlednit navrhované úpravy Published, suggested considering some remarks	2	0	2
Přijato po celkové revizi příspěvku Published after over-all revision	2	0	2
Odmítnuto Denied	0	1	1

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# Impact of the Financial Crisis on the European Labour Market

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## Abstract

This article analyzes the main indicators of the labour market in the Czech Republic, Russia and European Union. The authors seek relation of labour market development and global financial crisis followed by recession in European countries. The main problems of high unemployment rate, structural differences and very strong youth unemployment and its possible consequences are discussed too. Attention is also paid to the development of nominal and real wages.

**Keywords:** labour market, unemployment, employment rate, unemployment rate, youth unemployment rate, average nominal and real wage

## Introduction

The labour market development in each country is influenced by a large number of factors. Among the most important we can mention the demographic fluctuations, structural changes in the economy and development of the small and medium-sized enterprises sector, the level of labour productivity, regional dimension of employment, social factors and also employment of foreigners.

In a globalized world, where competition has intensified, labour markets strongly reflected the impact of foreign influences. For this reason, the global financial crises followed by recession in developed countries had a significant impact on the European economy and its labour market. The length and depth of the labour market crisis has worsened labour market imbalance and contribute to extended spells of unemployment in many countries. The aim of this paper is to analyze the main indicators of the labour market development in the Czech Republic, European Union and Russia.

## Methodology and objective

The paper answers the questions: “What impact the financial crisis had on the development of unemployment in in the Czech Republic, European Union and

Russia and how unemployment has increased during an economic downturn?” The data based on which the paper was carried out was obtained from the Czech Statistical Office database, the Eurostat database and the Russian State Committee on statistics RF database and other public sources.

Unemployment has been a serious problem of market economies for decades. Unemployment is defined as a situation where someone of working age is not able to get a job but would like to be in full time employment. Unemployment is expressed by the unemployment rate which is defined as a percentage of the country’s work force which is unemployed (Kennedy, 2008). The basic formula for measuring unemployment is following:

$$u = \frac{U}{L + U}$$

Where:  $u$  is the unemployment rate;  
 $U$  is a number of unemployed people;  
 $L$  is a number of employed people.

The statistical definition of employment and unemployment is based on the Recommendation of the 13<sup>th</sup> International Conference of Labour Statisticians, convened in 1982 by the International Labour Organisation (ILO). The ILO methodology defines the unemployed as all persons above a specified age who during the reference period were without a job, did not work an hour for pay, and were in an active manner seeking job they would be able to join within two weeks at the latest. This methodology is uniform for all EU Member States and produces internationally comparable data.

The general unemployment rate according to the ILO definition includes in EU countries the age group 15–64 years. In Russia the general unemployment rate is also calculated by IOL methodology and the registered unemployment rate – in accordance with the Law on employment in the Russian Federation which says that at the employment service are not be recognized as unemployed persons who have not attained the age of 16, taking full-time tuition in educational institutions, pensioners by age, seniority or entitled to special benefits. Since retirement age in Russia is 55 years for women and 60 years for men, so this group of persons effects on the rate substantially.

The labour force is the total number of people employed and unemployed. The youth unemployment rate is the unemployment rate of people aged 15–24.

The employee income is defined as the total remuneration, in cash or in kind, payable by an employer to an employee in return for work done by the latter during the income reference period.

## Results and discussion

### The labour market in the Czech Republic

The situation on the labour market in the Czech Republic is characterized in 2012 and early 2013, by a few contradictory phenomena. Although the economy

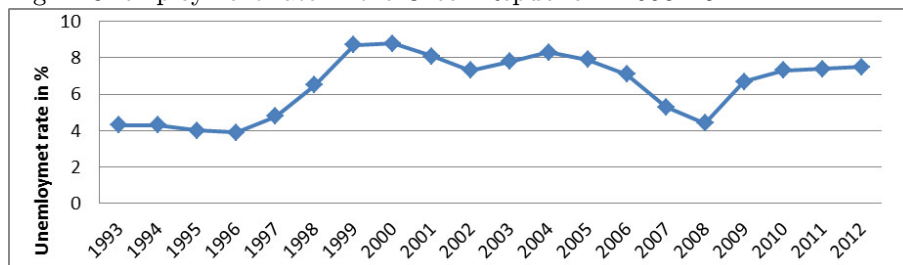
is the evolution of the GDP in a recession, the employment rate for several quarters in a row is steadily increasing. At the same time is a strong increase in the number of registered jobless people and increasing unemployment. These phenomena are explained by a micro-labour market related to the use of other types of jobs than those that are given by a relationship of employment or business. In addition to employment there was also atypical development in the area of wages.

In 2012 in the CR 5,091,500 persons there were employed, i.e. about 0.39% more than in 2011, when employment also grew by 0.26%, while in the previous two years we have seen annual declines – in 2009 1.78% and in 2010 by 1.02%. A loss of employed persons was recorded in agriculture, industry, construction and utilities sectors. The increase was detected in the real estate sector (5.8%), financial services (+4%) and the total for the professional, scientific, technical and administrative activities (+2.1%). Most of the new jobs were created in the trade sector, which provides jobs for more than a quarter of employees in the Czech economy, as well as industry, however, jobs in 2012 decreased. In construction the number of employed decreases for three years in a row. Growth in total employment affected the group of persons without the status of employees, consisting of people doing business individually and helping family members, but also people working on contracts for work and business owners of companies. It can be assumed that this group is increasing overall employment in the Czech Republic during the ongoing recession. The number of workers in an employment relationship, however, in contrast to total employment is declining, and it has been four years in a row. The employment rate in the age group 20–64 reached in the first quarter of 2013 71.6% of which 80.1 for men and 63.0 for women (CSU, 2013).

The Czech Republic is characterized by relatively low level of unemployment. In 2013 the labour market from the view of unemployment already only stagnated between 6.9% – 7% unemployed persons. The rate of unemployed persons, according to new methodology, is calculated as a proportion of all unemployed people in the age 15–64.

Long-term development of the unemployment rate is reflected in the following chart 1. After the formation of the CR there was general unemployment rate around 4%. Since 1997, the unemployment rate began to rise sharply, while in 2000 it reached almost to 9 percent. Since that time gained values about 7–8 percent. There is also apparent progressive decline in unemployment after joining the European Union up to a value of 4%. In the consequence of the financial crisis and the long-term recession of the Czech economy there is again an increase in the unemployment rate. Unemployment rate again exceeds 7%.

Fig. 1 Unemployment rate in the Czech Republic in 1993–2012



Source: CSU, 2013a

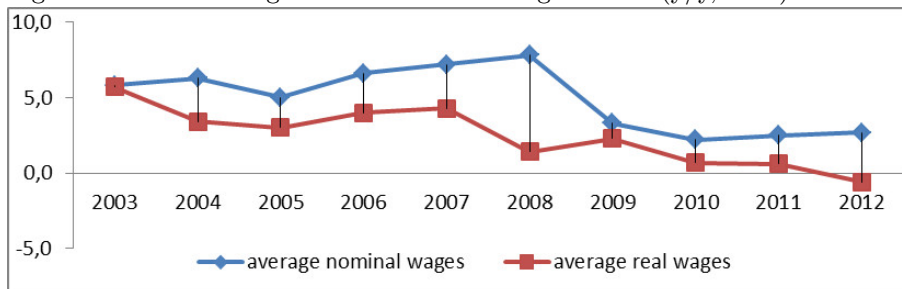
In the Czech republic there are distinct regional differences in the situation on the labour market. The highest unemployment rate is in a long-term in structurally afflicted regions, i.e. in the Ustecky, Karlovarsky and Moravskoslezsky regions. Apart from Prague low unemployment rate are to be found in Plzensky, Jihocesky and Stredocesky regions.

Risk groups on the job market comprise especially women with small children, people with low qualification, handicapped people, people over 50 years of age, new graduates and young people without work experience. The main risk factor on the labour market is a low level of education. Groups where different handicaps cumulate, e.g. young unqualified people, face the greatest threat. The specific rate of unemployment of young people to 24 years of age has reached 19.5% at present. The key problems in the labour market are the growth in long-term unemployment, unemployment among young people and the shortage of vacancies (CSU, 2013).

The analysis of wages is very interesting. The average monthly nominal wage in 2012 amounted to CZK 25,101, median salary is 22,247 CZK. Median wages as the mean value is not as sensitive to extreme values on average. While in the CR roughly two-thirds of employees earn less than the value of the average wage, the median exactly bisects the set of employees in half. By comparing the average and median also provides the opportunity to monitor the variability of wages. A tenth of workers with low earnings have lower wages than 11,929 CZK (1<sup>st</sup> decile), while the tenth best remunerated had higher wages than 40,715 CZK (9<sup>th</sup> decile) and decile ratio was 3.4. Significantly higher average wage growth compared with an increase of the median wage indicates the extreme earnings growth. The most significant effect on the wage level of employees was level of education achieved. Undergraduates received by median values of double wages (CZK 32,786) than workers with primary and early school leavers (15,695 CZK). The tenth best remunerated undergraduates receive a wage higher than CZK 72,808, on the other hand, had a tenth of workers with primary education less than 9,962 CZK (Holý, 2013).

When monitoring the development of average wages is evident that the growth of nominal and real wages gone through two distinct phases as shown in Figure 2.

Fig. 2 Trends in average nominal and real wages in CR (y/y, in %)



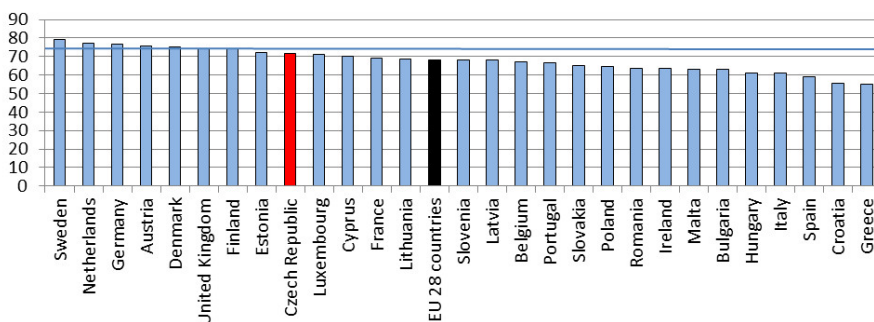
Source: CSU, 2013b

After joining the EU annual growth in nominal and real wages increased every year since 2005, but after 2008 there was a significant reduction in real and nominal wages due to labor cost savings. In the years 2010–2012 there is indeed an apparent stagnation and slight increase in real wages but due to the very restrictive economic policies of the Czech government there was a decrease in real wages, which in 2012 reached a value of even -0.6% (IPSV, 2013).

### EU labour market and position of the Czech labour market within the EU

EU countries adopted a fundamental strategic document Europe 2020, part of which are also targets for providing jobs and deals with the situation on the labour market. The main goal is to increase the employment rate of people aged 20–64 years to 75% in this decade (Eurostat, 2011). The labour market of the EU, however, shows significant differences. The following chart shows how this goal is implemented in member EU countries at present.

Fig. 3 Employment rate of age group 20–64 in the EU countries (in %)



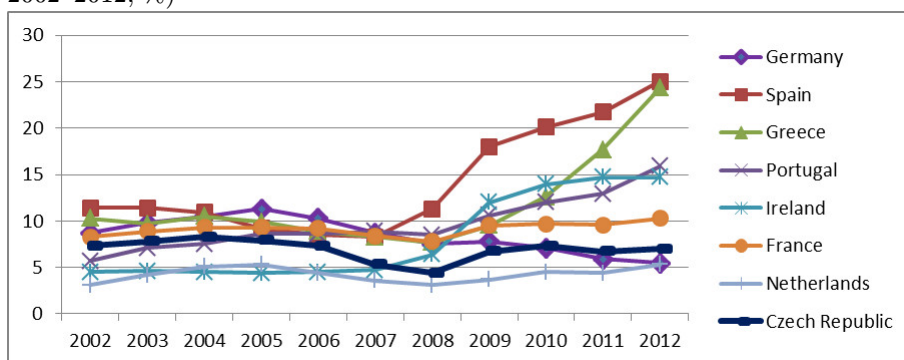
Source: Eurostat, 2013b

The graph shows that the employment rate is high in the Nordic countries and the countries of Western Europe. The required limit surpassed in Sweden, followed by the Netherlands, Germany, Austria and Denmark. On the other hand, southern European countries are generally characterized by low employment. Czech Republic is located on the 9<sup>th</sup> position above average of

28 member countries. The situation on the Czech labour market is strongly dependent on economic development in Germany.

When analyzing unemployment in EU countries there are again large differences. Among the 28 EU countries with the lowest unemployment rate ranks Austria, Germany, the Netherlands and Luxembourg. The unemployment rate is still maintained at high levels especially in the southern states of Europe and the Baltic region. In Spain reached 25.2% and in Greece 25%. The general unemployment rate in the Czech Republic is below the long term average of the EU. In Figure 4 there are trends in unemployment rate in selected EU countries in 2002–2012.

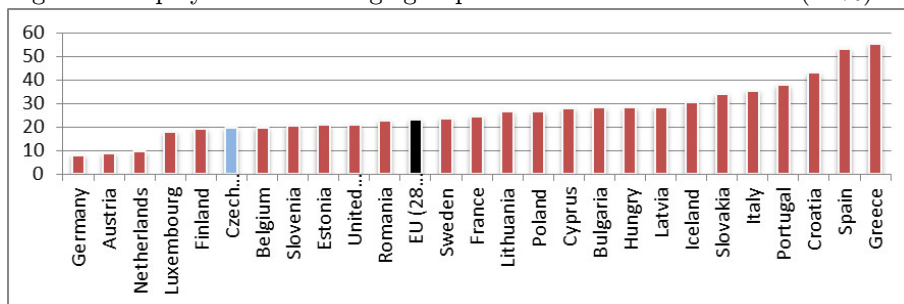
Fig.4 Trends in unemployment rate in chosen EU countries (annual average, 2002–2012, %)



Source: Eurostat, 2013

Youth unemployment has become a serious problem in many European countries. Young people have been hit particularly hard by the crisis. At present, nearly 6 million people in the EU under the age of 25 are unemployed and a total of 7.5 million are not in employment, education or training. Youth unemployment rates in Europe stood at 23.5% in the first quarter of 2013, more than twice the – already very high – rate for the population at large. In some countries (Spain, Greece) more than half of the young people who want to work are unemployed (Eurostat, 2013a).

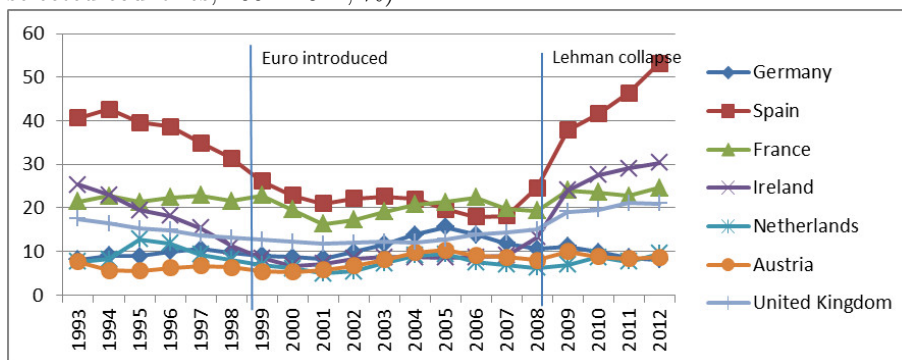
Fig. 5 Unemployment rate of age group less 25 in the EU countries (in %)



Source: Eurostat, 2013a

The chart in Fig. 6 shows that unemployment among the youth is increasing faster after the global financial crises.

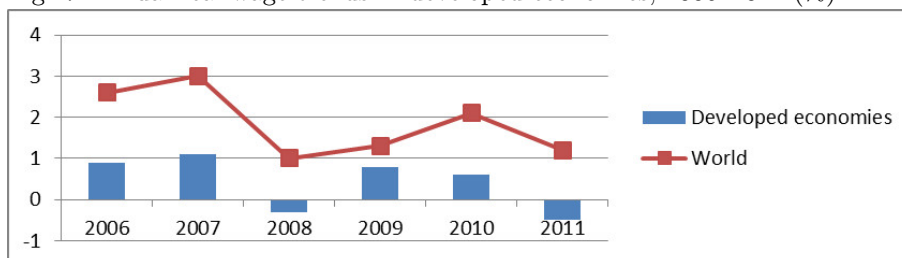
Fig. 6 Trends in European youth unemployment rate (under 25 years old, selected countries, 1992–2012, %)



Source: Eurostat, 2013

Youth unemployment has a profound impact on individuals as well as on society and the economy. Unless current trends are reversed quickly, today's levels of youth unemployment risk damaging the longer-term employment prospects for young people, with serious implications for future growth and social cohesion. This is a reflection of broader, deep-rooted problems in the functioning of labour markets.

Fig. 7 Annual real wage trends in developed economies, 2006–2011 (%)



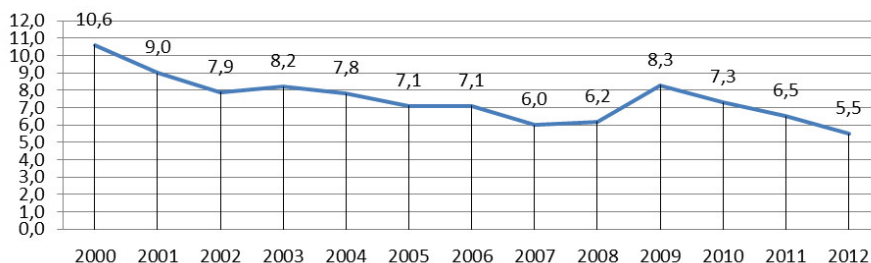
Source: ILO, 2013

### The labour market in Russia

The situation on labour market in Russia in 2012 and in the first half of 2013 can be characterized as stable. All the main indicators have reached the level of 2008. Long-term evolution of unemployment rate is reflected in the following chart 9. The progressive decline in unemployment had continued to the crisis of 2008. In 2009 unemployment rate reached its maximum point of 8.3% for last ten years. Negative trends were broken thanks to the anti-crisis program of the Government enacted in 2009 (Russia, 2009). It provided for strengthening

of social protection of the population and the creation of jobs; boosting domestic demand for the products of Russian enterprises; stimulating small business development and support of innovative activity in the economy; reducing the tax burden on business and people; reduction of administrative pressure on business; increase of stability of the national financial system. These measures produced an effect and the unemployment curve come down.

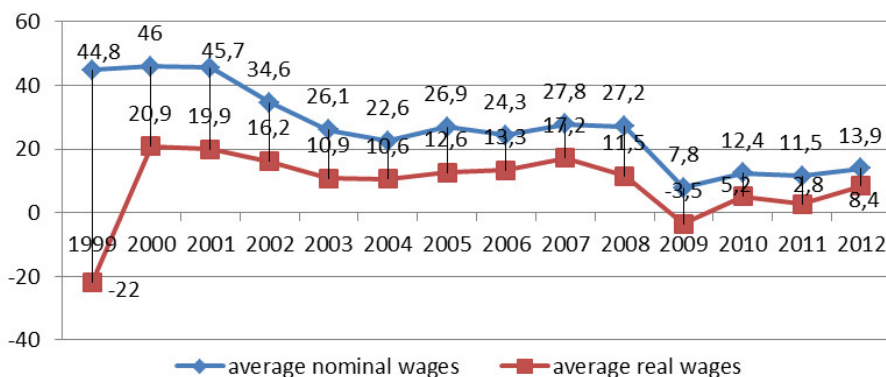
Fig. 8 Unemployment rate in the Russian Federation in 2000–2012 (y/y, %)



Source: Rosstat, 2013

When monitoring the development of average wages it is evident that the growth of nominal and real wages has gone through four distinct phases as shown in Figure 9.

Fig. 9 Trends in average nominal and real wages in RF (y/y, %)

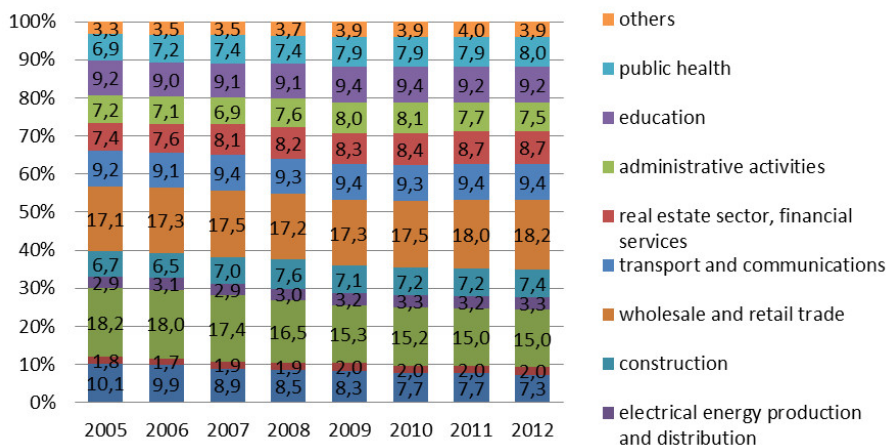


Source: Rosstat, 2013

Since 1990, the rate of decrease in real wages constituted about 30–50% per year. In 1999 its value was 34.8% of the level of 1991. And only in 2007 it reached the pre-reform level, and in 2008 exceeded it at 16.6%. However, since 2008, the situation is the opposite – the wage growth rate began to decline and in 2009 accounted for -3.5%. Thanks to the Government’s anti-crisis policy trends were reversed and in 2012 its growth rate was 8.4 (Russia, 2012).

Structural change of the Russian economy was deepened by the economic crisis that accelerated rate of the real sector reduction – from 37.5% in 2008 to 35.9% in 2009 (by 1.6 pct). In 2012 the reduction practically stopped – percentage of the real sector fell by 0.1 pct to the share of 35%. You can find details in the chart 10.

Fig. 10 Employment structure by types of economic activities in RF in 2000–2012 (y/y, %)



Source: Rosstat, 2013

## Conclusions

Impact of the financial crisis on the European labour market is significant in the EU countries including the Czech Republic, in both the short and long term. The length and depth of the labour market crisis has worsened labour market mismatch. The analysed data showed the short-term impact in terms of reduced employment and increase in unemployment, but also strong pressure to reduce costs in the form of reducing the level of labour costs. Long-term effects are manifested in changes in the structure of unemployment. The most serious consequence is high youth unemployment and unemployment of the generation 50+. The crisis and subsequent recession have also intensified labour market differences between stronger and weaker EU economies. The huge divergences between countries are a powerful reminder of the still enormous economic imbalances inside the EU countries. Negative trends can be broken thanks to the anti-crisis programs of national governments and EU labour market policy.

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## Dopady finanční krize na evropský trh práce

Článek analyzuje hlavní indikátory trhu práce v České republice, Rusku a zemích EU. Autoři hledají souvislosti mezi vývojem na trhu práce a globální finanční a ekonomickou krizí, kterou následovala recese ve většině evropských zemí. Zabývají se problémy vysoké míry nezaměstnanosti, strukturálními rozdíly v nezaměstnanosti i vysokou nezaměstnaností mladých lidí a jejich možnými důsledky. Pozornost je věnována také vývoji nominálních a reálných mezd.

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# The Level and Determinants of Organizational and Marketing Innovativeness in Industrial Enterprises Functioning in the Polish Market on the Basis of Data for the Years 2010–2012

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## Abstract

The main aim of the article is to present a recognition of the factors influencing the innovative activity (organizational and marketing) of industrial enterprises in Poland. It was decided to specify 5 potential variables explaining innovative activity of enterprises. Multiple regression was used to test the significance of factors. The results show that the share of micro companies in the given division of manufacturing turned out to be a significant factor in determining the level of activity in the scope of marketing-related innovativeness. Companies owned by foreign subjects display higher activity in the sphere of innovative activity. The share of bank credits in short-term liabilities turns out to be a serious barrier to implementation of organizational innovations.

**Keywords:** organizational innovativeness, marketing innovativeness, enterprises, Poland

## Introduction

It is both endogenous (internal) and exogenous (external) factors that are distinguished as regards their influence on innovativeness in an organization. Among the first group there are the following: organizational structure, strategy of organization, accessibility of resources and new technologies, R&D intensity, organizational culture, communication, motivation of employees and their engagement (Alves et al., 2007), the size of the enterprise, readiness and motivation on the part of the management to take risk (Francik and Poczowski, 1991).

The external factors are, in turn, connected with the intensity of the relation between organizations and their environment. S. Rychtowski (2004)

includes the following in the set of external conditionings of innovativeness: services-oriented processes which cover the system of scientific research, information system (scientific-technical, economic and organizational), sociopolitical climate, legal norms and administrative regulations (the innovation policy of the state), all-market conditions (market mechanisms, economic calculation, prices), system of education and trainings, connections within the market and outside the market with partners who are sources of information and technology, technical infrastructure. On the other hand, A. Francik and A. Poczowski include competition in the market, market increase trend, rate of technological progress, economic situation, influence of the state on the economy, branch synergy linked to the choice of introducing innovation in the group of exogenous factors (Francik and Poczowski, 1991).

Organizations are affected by the environment in which they function (de Propris, 2002). Organizational innovations relate to the sphere of 'organization and management', as well as that of relations with the environment (Brzeziński, 2001). Interactions between organizations and the environment, as well as flows of knowledge, which are connected with them, are thus regarded as beneficial to accelerating innovativeness (Cohen and Levinthal, 1990; Lundvall, 1995). D. Mowery and N. Rosenberg perceive innovations as a process of acquiring knowledge which, in its greater part, remains outside formal actions oriented towards research-and-development, and in which the key role is played by organizational aspects. In the authors' opinion, organizational innovations are also an indicator of the significance which decision-makers assign to modern management as a factor determining effectiveness of activity and economic effectiveness of a company. A lack of perfecting of management systems (lack of organizational effectiveness), however, can result not only from underestimating the role of management as a determiner of effectiveness, but also – for instance – from limitations of the financial character, or that connected with accessible intellectual potential. Numerous studies deal with the influence of direct foreign investments on the innovativeness of economic subjects. Concrete benefits obtained from the flow of knowledge and skills from branches of supranational corporations into local companies can appear in the form of the following: projects, specifications, production know-how, quality control, techniques of mobilizing towards higher productivity, personnel trainings, etc. (Kuzel, 2005: 353–370). At the same time, foreign investments exert a vital influence not only on direct raising the technological level of companies in the host country, but on regional innovativeness as well, including effectiveness of innovations (Fu, 2007).

It follows from Cho and Pucik's studies that there a relation exists between innovativeness, quality and results obtained by a company (a rise in the value of effects, profitability and market value). Simultaneously, Cho and Pucik claim that the influence of the quality on the growth follows, in part, under the influence of innovativeness, similarly as the influence of innovativeness on profitability, in part, remains under the influence of the quality (Cho and

Pucik, 2005). A proper management of innovations<sup>1</sup> leads to improvement in results (financial but not only these) of the organization (Hull, 2004; Hull and Tidd, 2003; Jiménez-Jiménez and Sanz-Valle, 2011; Scott, Haozhe and Patricia, 2009; Ulusoy, Kilic and Alpkın, 2011; Jiménez-Jiménez and Sanz-Valle, 2011; Lin Wang and IYu, 2010; Tidd and Bessant, 2009). Tidd et al. (2005) maintain that managing innovations can have a positive effect on the growth of an organization through improvement in effectiveness, quality, positioning and share in the market. In this very same way, extra-technological innovations – e.g., of the organizational kind – can have a good effect on productivity (Hall, 1994). S. Yamin, A. Gunasekaran and F. Mavondo (1999) arrive at similar conclusions in their work, in which – while examining Australian enterprises – they notice a positive correlation between innovativeness and return on assets (ROA), as well as return on investment (ROI), or the share in the market. In turn, the hypothesis concerning a positive influence of innovations on financial results of companies is not confirmed in J. Darroch's studies (Darroch, 2005). Tidd and Bessant draw attention to considerable difficulty in building the model of dependence between innovativeness and results obtained by companies (Tidd and Bessant, 2009).

In the domestic conditions of Poland, studies dealing with the dependence between innovativeness and selected factors were carried out by, among others, A. Świadek (2012), M. Pichlak (2012), T. Kraśnicka (2013), Z. Mikolas, G. Głód, T. Ingram, W. Głód, M. Wronka (Kraśnicka, 2013). For instance, A. Świadek examined 415 businesses dealing with the manufacture of food products. It follows from the study that the innovation-related activity is the domain of large enterprises, with a mixed ownership structure (possessing both foreign and domestic capital within their structures of financing).

The research carried out by M. Pichlak demonstrated a positive relation between the level of innovativeness and effectiveness of companies (it was financial indexes and subjective assessment of effectiveness of an organization declared by the respondents which were made use of in the overall evaluation) (Pichlak, 2012).

In 2011, a research team under the leadership of T. Kraśnicka conducted a research survey (Stage I) concerning the level and conditionings behind innovativeness of enterprises and also their influence on a company's results. The research included a sample consisting of 250 companies based in Silesian Voivodship (Poland). It was found out that the identified dimensions of innovativeness do not correlate in any considerable or firm way with economic results, financial liquidity, and only very weakly – with estimated dynamics of incomes. At the second stage of the research, carried out in 101 businesses based in Silesian Voivodship in 2012, weak relations were revealed between product-related

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<sup>1</sup>M. Karlik defines managing innovations as a set of actions which include: changing the company's strategy, taking decisions with regard to innovative activities, organizing, controlling innovation-related activity of a company and supporting pro-innovative attitudes directed towards company's resources and applied with the intention of attaining company's targets in the sphere of innovation in an effective and efficient way.

and marketing-oriented innovations and results obtained by the manufacturers (Krašnicka 2013).

In view of the significance of innovativeness for raising competitiveness of enterprises, studies which deal with establishing determiners of innovativeness have been conducted for years now. The paper is an attempt at empirical verifying of hypotheses concerning determinants of innovative activity (organizational and marketing) of industrial enterprises, as well as working out a model to explain the influence of a group of selected factors (determining the force and direction of the factors influence) on this activity. Data relating to twenty-four divisions of manufacturing were analyzed. Multiple regression was used in order to examine the influence of selected independent variables on the dependent variable.

## **Material and Methods**

The authors of the present article have focused on organizational and marketing innovativeness as areas of actions supporting product- and process-related innovativeness. On the basis of a survey of studies, it can be thought that both of the basic areas of innovativeness remain in a relation with economic effectiveness. Facilitation of product- and process-oriented innovations remains then in a direct relation with economic effectiveness. As it has been indicated above, innovations in the sphere of organization and marketing are also interesting for the reason that they testify to appreciation or a lack of appreciation, on the part of decision-makers responsible for organizational matters, of the role of modern management from the point of view of the effectiveness of a company's activity. The aim of the article is, accordingly, to attempt to empirically verify the theses connected with determiners of pro-innovative activity of industrial enterprises within the sphere of organization and marketing, as well as to build a model explaining the influence of a group of selected factors (determination of the force and direction of the impact of the factors) on this activity.

The following research hypotheses have been accepted for the needs of this research:

- The form of ownership influences the organizational innovativeness/marketing innovativeness (the higher the share of foreign ownership, the higher the share of innovative enterprises).
- The size of economic subjects influences the organizational innovativeness/marketing innovativeness (the higher the share of micro subjects, the lower the share of innovative enterprises).
- The profitability of subjects influences the organizational innovativeness/marketing innovativeness (the higher the profitability, the higher the share of innovative enterprises).

- The liquidity of economic subjects influences the organizational innovativeness/marketing innovativeness (the higher the liquidity ratio, the higher the share of innovative enterprises).
- The share of bank credits in short-term liabilities of subjects influences the organizational innovativeness/marketing innovativeness (the higher the share of credits, the lower the share of innovative enterprises).

On the basis of data supplied by the Central Statistical Office (Dzida et al., 2013; GUS, 2011; GUS, 2012; GUS, 2013) and those found in the database provided by *rynkometr.pl* (Rynkometr, 2014), a special database was made with reference to divisions of manufacturing (data for the years 2010-2012). The Central Statistical Office and the Rynkometr each publish aggregate statistics (the NACE 2-digit level). The data concerning twenty-four divisions of the manufacturing<sup>2</sup> according to PKD (Polish Classification of Activities) were then subject to analysis (the NACE 2-digit level of industry disaggregation). From a purely practical perspective, the NACE 2-digit level of industry disaggregation is particularly useful when referring to data that are not easily available in a comparable format at firm level. From an analytical point of view, the NACE 2-digit level of industry disaggregation facilitate investigations into the impact of specific characteristics on innovations. It should be mentioned that most sectors at the two-digit aggregation level contain a variety of industries, which can differ in technological opportunities.

Due to the complexity of the analyzed dependences it is multiple regression (Szewczyk and Ciesielska 2011) which was used to examine the simultaneous influence of selected explanatory variables on the dependent variable:

$$Y = \alpha_0 + \alpha_1 X_1 + \alpha_2 X_2 + \dots + \alpha_k X_k + \varepsilon,$$

where:

$Y$  – dependent variable,

$X_1, X_2, \dots, X_k$  – independent variables,

$\alpha_0, \alpha_1, \alpha_2, \dots, \alpha_k$  – parameters,

$\varepsilon$  – residual error.

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<sup>2</sup>Division 10 – Manufacture of food products, 11 – Manufacture of beverages, 12 – Manufacture of tobacco products, 13 – Manufacture of textiles, 14 – Manufacture of wearing apparel, 15 – Manufacture of leather and related products, 16 – Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials, 17 – Manufacture of paper and paper products, 18 – Printing and reproduction of recorded media, 19 – Manufacture of coke and refined petroleum products, 20 – Manufacture of chemicals and chemical products, 21 – Manufacture of basic pharmaceutical products and pharmaceutical preparations, 22 – Manufacture of rubber and plastic products, 23 – Manufacture of other non-metallic mineral products, 24 – Manufacture of basic metals, 25 – Manufacture of fabricated metal products, except machinery and equipment, 26 – Manufacture of computer, electronic and optical products, 27 – Manufacture of electrical equipment, 28 – Manufacture of machinery and equipment n.e.c., 29 – Manufacture of motor vehicles, trailers and semi-trailers, 30 – Manufacture of other transport equipment, 31 – Manufacture of furniture, 32 – Other manufacturing, 33 – Repair and installation of machinery and equipment.

The authors also decided to include in the examination the following variables, which can influence the level of innovative activity in the sphere of organization and marketing:

- $X_1$  – share of foreign enterprises in economic subjects in total (Rynkometr, 2014),
- $X_2$  – share of micro enterprises in subjects in total (Rynkometr, 2014),
- $X_3$  – sales profitability ratio (the mean value for the years 2010-2012) (GUS, 2011; GUS, 2012; GUS, 2013),
- $X_4$  – liquidity ratio of the first degree (the mean value for the years 2010-2012) (GUS, 2011; GUS, 2012; GUS, 2013),
- $X_5$  – share of bank credits in short-term liabilities (the mean value for the years (2010-2012) (GUS, 2011; GUS, 2012; GUS, 2013).

In turn, the following were accepted as dependent variables:

- $Y_1$  – share of enterprises declaring introduction of organizational innovations in the years 2010-2012 (Dzida et al., 2013),
- $Y_2$  – share of enterprises declaring introduction of marketing innovations in the years 2010-2012 (Dzida et al., 2013).

The selection of the variables has been based on substantial premises described in the previous section of this article, and also on statistical ones (an analysis of the correlation between variables, coefficient of determination  $R^2$ , as well as corrected coefficient of determination  $\bar{R}^2$ ) (Nowak, 1994; Szewczyk and Ciesielska, 2011; Czyżyński, 1995). The process of selection consisted in determining coefficients of variation, coefficients of correlation between the variables<sup>3</sup>, and also on building the initial model which contains all assumed variables. In the next phases of the process, there followed elimination of the explanatory variables which did not influence the dependent variable in any significant way. The statistical significance of individual parameters was examined by means of Student's t-test (t-stat), while the total significance with the use of Fisher-Snedecor test (F-stat). The accepted level of significance was  $\alpha = 0.05$ .

## Results and Discussion

Variable  $X_1$  (the share of foreign enterprises in economic subjects in total) was included in the model due to the need for verifying the initially observed, clearly higher, level of organizational and marketing innovativeness among private industrial companies which remain in the hands of foreign owners. It reflects

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<sup>3</sup>Coefficient of variation is the measure of variability of the data. Independent variables should be characterized by suitably high variability (with  $v^*=0.1$  being the critical value of the coefficient).

the conviction that a peculiar ‘business culture’ was and is ‘imported’ into our country by enterprises having foreign head-offices (Janasz, 2011). Variable  $X_2$  (the share of micro enterprises in subjects in total) was included in the initial model due to the fact that, in the authors’ opinion, a scarce financial and intellectual potential, which companies of micro-size class usually have at their disposal, effectively inhibits introduction of significant organizational innovations and does not allow extensive marketing. Variables  $X_3$  and  $X_4$ , being selected measures of economic effectiveness, are examined due to the fact that it is most probably not only innovative activity that leads, by the assumption, to strengthening the economic situation of an enterprise, but in itself it is a factor which facilitates or even stimulates perfection, including innovativeness. More profitable enterprises are thus frequently better organized, and this – in return – raises the effectiveness of their activity. Variable  $X_5$  represents, in the authors’ opinion, a potential destimulant. If, then, the share of bank credits in short-term liabilities is high, a company – with high probability – is experiencing financial problems, and the credits are not of the pro-investment or developmental character, but play the rescuing role. This is clearly visible in years of crisis, e.g., in 2008 in Poland (Iwin-Garzyńska, 2010). A high averaged value of this measure should then negatively affect the organizational innovative activity and marketing innovative activity.  $Y_1$  and  $Y_2$  are independent variables representing the share of companies which are active in the sphere of organizational and marketing innovations: ( $Y_1$  – share of enterprises indicating introduction of organizational innovations in the years 2010–2012,  $Y_2$  – share of enterprises indicating introduction of marketing innovations in the years of 2010–2012).

An analysis of the values of coefficients of correlation (Table 1) leads to the conclusion acknowledging a strong positive correlation between the share of companies indicating introduction of organizational innovations in the years 2010–2012 ( $Y_1$ ) and the share of foreign enterprises ( $X_1$ ). In turn, a strong negative correlation occurs between the share of enterprises indicating introduction of organizational innovations ( $Y_1$ ) and the share of micro companies ( $X_2$ ), as well as the share of bank credits in short-term liabilities ( $X_3$ ),  $Y_1$  and  $X_5$  and between  $Y_2$  and  $X_2$ . A strong negative correlation occurs also between the share of enterprises indicating introduction of marketing innovations ( $Y_2$ ) and the share of micro companies ( $X_2$ ). The assessment of diagnostic usability of models was made on the basis of coefficient of determination  $R^2$  (determining the degree of adjusting the model to empirical data) and corrected coefficient of determination  $\bar{R}^2$  (the choice of a model during excluding successive explanatory variables at the successive stages of multiple regression).

Table 1. Pearson's linear correlation coefficients.

	$Y_1$	$Y_2$
$Y_1$	1.00	0.57
$Y_2$	0.57	1.00
$X_1$	<b>0.88</b>	0.26
$X_2$	<b>-0.72</b>	<b>-0.43</b>
$X_3$	-0.19	0.16
$X_4$	-0.40	-0.17
$X_5$	<b>-0.70</b>	-0.30

Source: Authors' own calculations done in Microsoft Excel

The obtained results (Table1) point to the fact that industrial businesses owned by foreign subjects display considerably higher activity in the sphere of innovative activity of the organizational character. The obtained result provides another argument supporting the thesis that these companies indeed contribute to spreading of new solutions in managing industrial enterprises and are a carrier of the peculiar 'business culture'. It seems that traditional companies originating from developed economies pay greater attention to the level of modernity of their management systems and local (native) managers, while associated with them, learn to apply and appreciate the significance of modern managing for obtained results. These enterprises, to the evidently greatest extent, organizationally support the processes of implementation of basic types of innovation: the process- and product-related ones. It can be thought that this type of innovativeness is at a higher degree – as regards foreign enterprises – an ordered process.

A large share of bank credits in short-term liabilities turns out to make a substantial obstacle in implementing organizational innovations. The high values of this coefficient can signal financial problems. In such a situation management boards concentrate – obviously – on them as the key questions from the point of view of survival, whereas auxiliary and supporting questions are marginalized. Despite the fact that the return-on-sales coefficient has not proved a statistically significant determiner of innovative activity in the organizational sphere, then – if one were to accept a slightly more liberal level of significance 0.1, it would have to be included in the determiners of this class of innovativeness. Generally, it appears that a high profitability stimulates organizational innovativeness (other indicators of profitability were not examined due to the lack of data), while financial difficulties greatly hamper this type of activity.

The relatively high level of  $R^2$  testifies to a good adjustment of the model to the empirical data. The sign of  $\alpha_i$  parameter, for each explanatory variable, was in accordance with that of the coefficient of correlation, which means an accordance of the direction of the influence of explanatory variable  $X_i$  on dependent variable  $Y$  (coincidence). The values of F-statistics, as well as those of t-statistics point to the significance of the parameters of the model ( $p < 0.05$ ).

Table 2. Regression output ( $Y_1$  – the share of enterprises indicating introduction of organizational innovations in the years 2010–2012)

	Coefficient	Standard error	t-stat	p-value
Intercept	15.349*	4.304	3.566	0.002
$X_1$	1.438*	0.235	6.123	0.000
$X_5$	-0.344*	0.165	-2.085	0.049
F-stat	47.461			
Significance F	0.000			
$R^2$	0.819			
$\overline{R}^2$	0.802			

\* significant at the significance level of 0.05

Source: Authors' own calculations done in Microsoft Excel

The model of multiple regression for the share of enterprises confirming the introduction of innovations in the area of organization presents itself in the following way:

$$\hat{Y}_1 = 15.349 + 1.438X_1 - 0.344X_5$$

Two explanatory variables ( $X_1$  – the share of micro companies in subjects in total,  $X_5$  – the share of bank credits in short-term liabilities) account for the 82% of the variability of the share of enterprises which indicated introduction of innovations in the sphere of their organization. If the share of foreign enterprises in economic subjects in total rises by 1%, and the share of bank credits in short-term liabilities remains unchanged, the share of enterprises confirming introduction of organizational innovations increases by 1.438%. If the share of bank credits in short-term liabilities rises by 1%, and the share of foreign companies in economic subjects in total remains unchanged, then the share of enterprises indicating introduction of organizational innovations decreases by 0.344%.

Table 3. Regression output (dependent variable:  $Y_2$  – the share of enterprises which indicated introduction of innovations in the sphere of marketing in the years 2010–2012)

	Coefficient	Standard error	t-stat	p-value
Intercept	40.531	12.436	3.259	0.004
$X_2$	-0.323	0.146	-2.211	0.038
F-stat	4.887			
Significance F	0.038			
$R^2$	0.182			
$\overline{R}^2$	0.144			

\*significant at the significance level of 0.05 Source: Authors' own calculations done in Microsoft Excel

The share of micro companies in the total number of subjects in the given section of processing industry turned out to be a significant factor in deter-

mining the level of activity in the scope of marketing-related innovativeness. The larger share of these subjects is connected with a considerable limitation of their activity in the sphere of marketing innovativeness. It can be thought that both the lower intellectual potential, which the companies have at their disposal, and their much lower financial resources provide a good explanation of the reason for this state of things. Companies of the micro-size class also more frequently have a local range of their activity, therefore an extensive marketing activity and innovativeness can be treated by them as unnecessary.

The model displays the property of coincidence: the values of Fischer-Snedecor F-statistics and those of t-statistics show the significance of the parameters of the model ( $p < 0.05$ ). The relatively low level of  $R^2$  testifies to a poor adjustment of the model to the empirical data.

The model of regression for enterprises indicating introduction of marketing-related innovations in the years 2010–2012 looks as follows:

$$\hat{Y}_1 = 40.531 - 0.323X_2$$

If the share of micro companies in economic subjects in total rises by 1%, the share of enterprises confirming introduction of marketing innovations decreases on the average by 0.323%. Explanatory variable  $X_2$  (the share of micro companies) accounts for merely 18% of the variability of the share of enterprises indicating introduction of innovations in the area of marketing.

## Conclusions

On the basis of the conducted research the following conclusions can be formulated:

1. Companies which are owned by foreign entities display a visibly higher level of organizational and marketing innovativeness among private industrial enterprises.
2. The share of bank credits in short-term liabilities turns out to be a serious barrier to implementation of organizational innovations; it can be a sign of financial problems faced by a company. It can de facto be thought that financial problems impede to a considerable extent the activity within the scope organizational innovativeness.
3. A substantial share of micro enterprises in the total number of subjects in the given sector of processing industry turns out to be a vital factor in decreasing the level of activity in the scope of marketing-oriented innovativeness.

Some potential limitations in the study should be mentioned. It should be noted that industries are heterogenous in terms of capital intensity and technology used. A deeper analysis of the differences in the industry structure should be based on more disaggregated data than 2 digit NACE-codes. Therefore a future studies on the current topic are therefore recommended.

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# Modeling of the Impacts of Revenue from Emission Allowances Trading on Selected Macroeconomic Indicators in the Czech Republic

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## Abstract

The aim of this paper is to create and in terms of the Czech Republic also to apply a simultaneous model for determination of macroeconomic impacts of the trading of emission allowances. Another aim is to determine its adequateness of application both from econometric and economic point of view, or alternatively to define its limits and restrictions. At first, prerequisites and characteristics of the model are defined. The application of the model in terms of the Czech Republic is performed next followed by economic and econometric verification. The conclusion of the paper contains evaluation of the impacts of the changes in revenue from allowances on select basic macroeconomic indicators, as for instance inflation, unemployment, government purchases or net export. In case revenue from trading of emission allowances in the Czech Republic rise by 1 billion CZK, unemployment falls by 0.15% and the government expenses will increase by approximately 1.032 billion CZK and net export will increase as well, but only by 194 million CZK. Regarding inflation, the result of simultaneous model or the paired regression is the fact that revenue from allowances and inflation are independent on each other.

**Keywords:** emission allowances, regression analysis, EU ETS revenue, simultaneous model

## Introduction

Green gas production in the Czech Republic is relatively high due to high share of industry and high energetic demands. There are about 400 machines involved in the system in the Czech Republic, including over 250 machines in the energy sector. The emission allowances trading system (EU ETS) covers about 60% of all green gas emissions in the Czech Republic (EU average is 40%). Industry makes one third of the Czech Republic's GDP. On the contrary, agriculture together with fishery holds about 2% of GDP. However, EU ETS

has been dealing with a crisis given due to excess of supply of allowances over its demand and thus also by its very low price (price of allowance was only 5.9 Euro in the November of 2014). The original predictions of the system impact on the Czech Republic were optimistic due to increase in revenues achieved by selling allowances to the national budget. These prognoses, however, were not confirmed.

The aim of the paper is to evaluate the impacts of the EU ETS on selected macroeconomic indicators by creating a simultaneous model. From this point of view, this paper is unique though there are expert studies containing revenues estimations for the third trading period, but there are only a few studies dealing with consequent impacts. The advantage of this model is the fact that by performing the two-stage regression of the corresponding structural parameters and assessing their statistical significance, it is possible to determine, based on the sensitivity analysis of percentage change of the impact on inflation, unemployment and international relations and on percentage change (growth, decrease) of emission allowances revenue. A partial aim is to verify or falsify the hypothesis whether this model is adequate for examining the macroeconomic impacts of the EU ETS. In case this hypothesis would be confirmed, the model for determination of macroeconomic impacts of EU ETS could be used for any member state of the EU.

## Literature review

Macroeconomic analyses of EU ETS system were naturally being prepared before starting of the system itself. However, EU ETS analyses applied for the first and the second trading period may not be applied for the period after 2012 due to fundamental changes (system revision for 2013). Furthermore, given the unpredictability of the allowance price and unclarity of implementation of rules for the third trading period, performing rather of ex-post analyses may be expected.

Therefore, the first analysis may be assumed to be the Model Based Analysis of the 2008 EU Policy Package on Climate Change and Renewable based on the model GEMINI-E3 and Primes (Capros, 2008). Factually, it is the analysis of impacts accompanying the climatologically-energetic package. The results of analyses imply that these impacts will be higher especially in post-communist countries of Central and Eastern Europe, thus including the Czech Republic. It is caused by two main factors:

- In the nineties, post-communist states went through economic transformation from centrally controlled to market economy. This transformation was connected to production decrease and thus also to decrease of green gas emissions. When economy recovery was taking place, green gas emissions were never increased to the level it occupied before 1990 and therefore, the majority of post-communist countries have been long since fulfilling the aims of the Kyoto protocol. However, the aims in Climatologically-energetic package are derived from 2005 and therefore,

these states will factually decrease emissions compared to 1990 by far more than old member states of the EU.

- The second factor is the fuel base, in which there is a higher level of coal and generally higher carbon intensity of economies of post-communist countries (mainly Poland, Bulgaria, Estonia and the Czech Republic).

If there were no redistribution mechanisms in the Climatologically-energetic package, the study estimates the costs for fulfilling the aims of the Czech Republic to be annually on the level of 1.12% GDP. By utilizing all flexible and redistribution mechanisms, the Czech Republic could profit – expenses would be on the level of – 0.51% of GDP. In terms of the EU, expenses in 2020 would be on the level of 0.4–0.6% of GDP.

Alternatively to the analysis of the Commission, Christoph Böhringer, Andreas Löschel, Ulf Moslener and Thomas F. Rutherford (2009) arranged the analysis of impact, which deals more with the aims of climatology policy (at the same time, these authors used three models of the general stability in their study – DART, PACE, GEMINI-E3). This analysis shows two major findings: Reaching the reduction aim of 20% would lead to a loss of wealth by 0.5–2% in the case of utilizing all flexible mechanisms. The results of the above introduced study were consequently confirmed by Claudia Hermeling, Andrea Löschel and Tim Mennel (2012). These authors, however, applied a new approach in the analysis of climatology policy impacts and their analysis is based on the PACE model with the use of Gauss quadrature.

Climatological-energetic package for the budgets of the EU member states are analyzed by Pippo Ranci in terms of the THINK project (Ranci, 2011). The study identifies main factors impacting states' budgets. These are for instance introducing auctions that naturally have impact on income increase and on the contrary income decrease will cause possible decrease of GDP and lower tax collection from fossil fuels consumption. Impacts on individual states fundamentally differ, the highest negative impacts are expected in Bulgaria and Estonia (0.38–0.71% of GDP). On the contrary, in case of Hungary, Lithuania, Latvia and Romania the authors expect positive impact (+0.5% of GDP). In case of the Czech Republic, the authors expect increase of national budget's incomes in the level of 0.3% of GDP. In the whole EU they subsequently expect increase by 0.09%.

In recent years, there has been a growing trend with the existence of empirical studies which are concerned with the research of the prediction of emission allowances prices and revenue impacts of the EU ETS (European Trading System). The below mentioned studies use a broad methodological framework. For instance, Ščasný and Piša (2009) used an econometric model E3M2, while Kiuiila and Markandya (2005) used a CGE model and Labandeira and Rodríguez (2013) used the integrated macro and micro model. ILO (2009) uses a slightly different method of modeling with the use of VAR model of time series.

Klepper and Peterson (2005) worked with the CGE model (specifically DART) to assess the macroeconomic impacts of the EU ETS in 2012. The scenario included the National Allocation Plan (NAP) for each member state

of the EU-15 for the first trading period of 2005–2007. The model showed that the implementation of the EU ETS system leads to a loss of welfare by 0.9% in the EU-15 compared to the baseline BAU (loss of welfare due to ETS without the possibility of using CDM and JI would increase to 1.7%). In their article, Niels Anger and Ulrich Oberndorfer (2008) evaluate the impact of the EU ETS on employment. They concluded that the allocation of emission allowances had in the first phase no significant impact on employment in regulated German companies. For the results of their study they used an econometric model based on CGE. There are other simulations of ETS effect on the whole economics. For instance COWI (2004) uses a model GTAP-ECAT (European Carbon Allowance Trading) to evaluate the impacts of EU ETS on the competitiveness of European countries. The basic scenario was BAU (business as usual) where the policy of emission reducing is not established. Beside this scenario, another two are also analyzed: the scenario with the short-term trend of polluter adaptation to the change of technology (modernization) or the opposite – the scenario with the long-term trend of company’s adaptation to the change of technology. Introducing of CDM and JI credits to the EU25 is determined exogenously (representing 100 million tons of carbon). The output of the model is the information that GDP will decrease in the EU by 0.36% with the long-term adaptation and by 0.48% for the short-term adapting.

## Material and Methods

The model formation and determination of parameters are preceded by collecting foundation data, i.e. statistic data (time series). In this case, the time series from 2013 to 2020 is purposefully chosen as these years cover the third stage of the EU ETS when the trading with emission allowances in terms of auctions started. The data prediction was obtained from internal documents of the Ministry of finance, except for the R indicators (revenues from emission allowances), which were predicted on the basis of the Box Jenkins method, specifically ARIMA (1,1,1). This prediction was performed in the BAU scenario, i.e. without any external interventions. Only since 2015 to 2020, the prediction covers backloading (gradual removal of 900 million allowances from auctions and its return at the end of the period).

Fig. 1: Foundation data

<b>Rok</b>	<b>Y<sub>t</sub></b>	<b>C<sub>t</sub></b>	<b>G<sub>t</sub></b>	<b>NX<sub>t</sub></b>	<b>R</b>	<b>r<sub>t</sub></b>	<b>Δπ<sub>t</sub></b>	<b>Ig</b>	<b>U<sub>t</sub></b>
	Bilion CZK	Bilion CZK	Bilion CZK	Bilion CZK	Bilion CZK	%, r/r	%, r/r	Bilion CZK	%
2013	3858	1922.0	807.0	210	0.53	0.04	2.30	920.00	7.60
2014	3939	1965.0	803.0	214	1.57	0.03	1.90	957.00	7.70
2015	4079	2042.0	807.0	232	3.91	0.03	2.10	998.00	7.30
2016	4228	2116.0	815.0	260	11.17	0.02	2.00	1037.00	6.70
2017	4274	2145.0	815.0	278	12.48	0.02	2.10	1036.40	6.20
2018	4310	2195.0	817.8	240	14.12	0.01	2.00	1057.51	5.90
2019	4404	2245.0	820.6	260	14.36	0.01	2.20	1078.63	5.50
2020	4503	2296.0	823.4	284	15.64	0.01	2.10	1099.74	5.20

The author is aware of three major restrictions of the model. A first, it is problematic to have such a short time series (although purposefully chosen). This weak point may be, however, eliminated if included in the model of the fourth trading period (currently, however, due to absence of any legislature and information, it is impossible to predict data in this time horizon). The second restriction is right in the foundation data as it is only a prediction and therefore, the model may be partially misrepresented. But this limitation may also be minimized in the course of time by improving the accuracy of estimations as we will obtain more detailed information about EU ETS reformation or about development of the economy. It is also necessary to mention the issue of multicollinearity. Processes in the economy connect and mutually impact strongly other processes and it is very difficult to determine a specific cause of the given change. The model may be created if we accept these limitations.

This custom creation of the simultaneous model is based on the definition and selection of endogenous and predetermined variables including modeling their mutual logical and macroeconomic linkages. The parameters of the econometric model, together with the parameters of the distribution of its random components determine the economic structure and are called structural parameters. The simultaneous nature of the model lies in the fact that the non delayed endogenous variables play a simultaneous part in the model, i.e. simultaneously in the function of the response, as well as explanatory variables, and at the same time are determined by the solution of all equations in the model simultaneously.

The first equation of the model (2) defines the dependency of the gross domestic product ( $Y_t$ ) on the change in the price level in a given time ( $\Delta\pi_t$ ), the change of the government expenses ( $G_t$ ), the change in gross business investment ( $Ig_t$ ) and the unemployment rate ( $U_t$ ). The consumption of "C" was removed from this equation because of multicollinearity, i.e. strong dependency between predetermined variables. The dependency of GDP on the government expenses and investments is evident even from the expenditure method of GDP calculation. Investments are one of the most important factors affecting GDP. In statistics, they are the summation of supplies changes, amount of valuable purchases and so called creation of the gross fixed capital that is a representation of how local and foreign companies expand their capacities and by that also their growth potential of the whole economy. The unemployment rate is included in the equation due to the "Theory of potential product" in which in 2000 M. Hájek and V. Bezděk (2000) used this variable for the analysis of potential product estimation (they applied the two-factor Cobb-Douglas production function). The dependence of the rate of unemployment and the change in the price level is verified by the Phillips curve which was the source for Gordon's (1989) conception of the simple equation:  $\pi_t = \alpha^* \pi_{t-1} + \beta^* (U_t - U^*)$ ,  $\pi_t$  labels the inflation rate,  $U_t$  the rate of unemployment in time  $t$  and  $U^*$  the natural rate of unemployment. Ten years later, J. S. Sekhon (1999) designed the modification of the model for inflation in the form of  $\pi_t - \pi_t^* = \beta(U_t - U^*) + X_t + v_t$ , where  $X_t$  contains other regressors determined

for the control of supply shocks (e. g. exchange rate, import prices, price of oil etc.) and  $v$  is the error constituent.

The second equation of the created simultaneous model (3) defines the dependence of investments on revenues from auctions with allowances (the price of allowances \* their number) and also on the discount rate and consumption. In the model, investments ( $I_{g_t}$ ) represent the simultaneously endogenous variable, which in the fifth model equation specifies the definitional relation for the net export, revenue from allowances trading is the predetermined variable. Predetermined variables are all exogenous (independent) variables in the model and endogenous (dependent) variables lagged in time are the households' consumption ( $C_t$ ). The investment demand is given especially by the interest rate. The function of investments itself is:  $I = I_a - b_i$ , where  $b$  is the sensitivity of autonomous expenses (investments) on the interest rate. The relation of consumption and investments is already recorded in the expense model of J. M. Keynes, where in the most simple two-sector model the expenses consist of the household consumption and companies investments. In the equation, the relation between companies investments and revenue from allowances is stated intentionally as the change in revenue of allowances is given for instance by the change of allowance price which affects the demand of companies for investments for so called green technologies.

The third equation of the created simultaneous model (4) specifies the dependence of the government expenditures ( $G_t$ ) on the size of the gross domestic product ( $Y_t$ ), on the change of the interest rate ( $r_t$ ) and consumption from the previous period ( $C_{t-1}$ ). The relation of government expenses and the interest level may be in the form of expenses for debt repayments, which can change due to the interest rate which, among other things, affects the amount of government expenses.

The fourth equation of the simultaneous model (5) defines the dependence of consumption on the gross domestic product, the net export in given time ( $NX_t$ ) and on the year-on-year change of the interest (discount) rate ( $r_t$ ). Net export is the difference between export and import. Changing these values affects consumption. The relationship between consumption and the interest rate is verified by many macroeconomic theories, because if the interest rate increases, consumption decreases in favor of savings (or household investments).

The fifth equation (6) defines the gross domestic product – specifically it is a balance equation of the GDP usage expressed for the net export.

The structural form of the simultaneous equations model expresses the interdependence of all endogenous and all predetermined variables.

Matrix equation of the simultaneous equation model is in this form:

$$B^*Y_t + \Gamma^*X_t = U_t, \tag{1}$$

- where  $B$  = matrix of simultaneously endogenous variables parameters
- $\Gamma$  = the matrix of simultaneously endogenous and predetermined variables parameters
- $U_t$  = vector of random components

$$Y_t = k + \beta^* G_t + \gamma^* \Delta \pi_t + \beta^* I g_t + \gamma^* U_t + u_{1t} \quad (2)$$

$$I g_t = a + \gamma^* R_t + \beta^* C_t + \gamma^* r_t + u_{2t} \quad (3)$$

$$G_t = e + \beta^* Y_t + \gamma^* r_t + \gamma^* C_{t-1} + u_{3t} \quad (4)$$

$$C_t = s + \beta^* N X_t + \beta^* Y_t + \gamma^* r_t + u_{4t} \quad (5)$$

$$N X_t = Y_t - I g_t - G_t - C_t \quad (6)$$

The two-stage method of the smallest squares is one of the most widespread and most common methods for point estimations of the structural parameters of simultaneous equations models. The application of the method is performed for each equation separately. At first, in the first stage we replace the matrix of observed values of the endogenous variables by the matrix of theoretical values (balanced). Next, we apply the common method of the smallest squares to estimate the structural parameters of a given equation.

The mentioned issues can be generally expressed according to the following equation (Čechura, 2008)

$$y_{1t} = B_{12}^* y_{2t} + B_{1g\Delta}^* y_{g\Delta t} + \Gamma_{11}^* x_{1t} + \Gamma_{12}^* x_{2t} + \dots + \Gamma_{1k}^* x_{k\Delta t} + u_{1t} \quad (7)$$

$Y_2$  = matrix of observed values of the endogenous variables included in the equation of the simultaneous model

$X^*$  = matrix of predetermined variables included in the equation of a given simultaneous model ( $X_{1t} + \dots X_{k\Delta t}$ )

$X^{**}$  = matrix of the values of predetermined variables not included in the estimated equation, but occurring in other equations of a given simultaneous model

$K$  = complex matrix consisting of four submatrices

Matrix of the values of predetermined variables in the equations of the model consists of two submatrices:  $X = [X^*; X^{**}]$

$$\text{Level: } \hat{Y}_2 = X^* (X^{T*} X)^{-1} X^{T*} Y_2 \quad (8)$$

$$\text{Level: } \begin{bmatrix} B_2 \\ \Gamma_{1*} \end{bmatrix} = \begin{bmatrix} \hat{Y}_2^T \hat{Y}_2 & Y_2^T X^* \\ X^{T*} Y_2 & X^{T*} X^* \end{bmatrix} * \begin{bmatrix} \hat{Y}_2^T \\ X^{T*} \end{bmatrix} * y_1 \quad (9)$$

$y_1$  = vector of real values of the response of endogenous variables

$$K = \begin{bmatrix} \hat{Y}_2^T \hat{Y}_2 & Y_2^T X^* \\ X^{T*} Y_2 & X^{T*} X^* \end{bmatrix} \quad (10)$$

## Results

The partial output of the model is in the form of the following parameters in individual equations: (11)

$$Y_t = -1053 + 4.06G_t - 23.22\Delta\pi_t + 2.32Ig_t - 57.58U_t + u_{1t}$$

$$Ig_t = 629.72 + 2.36R_t + 0.192C_t - 1707.4r_t + u_{2t}$$

$$G_t = 624.7 + 0.026Y_t + 269.1r_t + 0.036C_{t-1} + u_{3t}$$

$$C_t = -819.30 - 0.93NX_t + 0.75Y_t + 1090.6r_t + u_{4t}$$

In case the government purchases increase by 1 billion CZK, the gross domestic product will increase by 4.06 billion CZK. With the increase in investment expenses by 1 billion CZK, the GDP will increase as well, approximately by 2.3 billion CZK. However, if the unemployment rate increases by 1%, GDP will fall by 58 billion CZK. The multiplier connected to revenue from allowances is 2.36 in the second equation, i.e. if these revenues increase by 1 billion CZK, the investment expenses of the companies will increase by 2.36 billion CZK, which eventually increase GDP by nearly 5.5 billion crowns. If the nominal product increases by one unit (1 billion CZK), it will lead to the growth of the government expenses by 26 million CZK. Conversely, when the annual growth rate of interest (discount) rate increases by 1% it gets to the decrease in consumption (in favor of savings) by almost 1 billion CZK. If net export falls by 1 billion CZK, it will lead to the growth of consumption by 0.93 million CZK. One of the advantages of the model is its potential usage for other prognoses because if any of the parameters constituting GDP changes (consumption, investments, government expenses, net export), then with the help of obtained parameters we can determine the impact on the gross domestic product.

## Verification of the simultaneous model

The economic verification assesses especially the direction and intensity of the impact of explanatory variables on the explained variable. At the same time it is verified, whether there is a direct or indirect dependence.

The structure of the model is based on the universally valid calculation of GDP by the expense method ( $GDP = C + Ig + G + NX$ ).

This calculation consists of the definition of the equation from which individual indicators are gradually explained. In the first equation there is the direct relationship between the gross domestic product and government expenses or investments. This follows from the valid expenditure method of GDP calculation. At the same time, the equation shows that GDP has an indirect relationship with unemployment. In the second equation, investments (of the companies) have a direct relationship with revenues from emission allowances. Revenue from allowances grow with the rise of their price which in the long

term forces the companies to increase their investments in green technologies and thereby reduce the cost connected with the purchases of allowances. At the same time, there is a direct correlation between consumption and investments. This is also valid since when the growth of households consumption increases, the company obtains an income, which is then invested (for instance to new production or to the bank products etc.). According to the third equation, the government purchases will rise if the product grows as well. And in the fourth equation, the consumption positively depends on GDP growth. Both statements are correct. If net export is declining, household's consumption increases. This statement is correct provided the decrease in net export happens due to the increase of import.

Econometric verification is primarily concerned with the issues of autocorrelation and multicollinearity. For this paper, we have chosen the detection of multicollinearity. This requires forming the correlation matrix. The correlation coefficient gains values in absolute value between 0 and 1. The more the value approaches 1, the greater dependency exists between the variables. The main diagonal of the correlation matrix consists of ones. Other components of the matrix represent pair coefficient of the correlation between corresponding pairs of explanatory variables, which should not exceed the value of the absolute expression of 0.9 (Koop, 2008). If they do not exceed this value, there is a very strong dependence between the variables and the corresponding variables should not occur on the right side of one model equation simultaneously.

Fig. 2: Correlation matrix

	$Y_t$	$I_{g_t}$	$G_t$	$C_t$	$NX$	$\Delta\pi_t$	$U_t$	$R_t$	$r_t$	$C_{t-1}$
$Y_t$	1.000	0.994	0.954	0.997	0.891	-0.049	-0.973	0.972	-0.968	0.974
$I_{g_t}$	0.994	1.000	0.922	0.990	0.865	-0.125	-0.948	0.963	-0.972	0.948
$G_t$	0.954	0.927	1.000	0.959	0.838	0.149	-0.979	0.958	-0.920	0.974
$C_t$	0.997	0.990	0.959	1.000	0.855	-0.982	-0.982	0.967	-0.977	0.983
$NX$	0.891	0.865	0.838	0.855	1.000	-0.003	-0.834	0.872	-0.782	0.845
$\Delta\pi_t$	-0.049	-0.125	0.149	-0.031	-0.003	1.000	-0.094	-0.070	0.196	0.075
$U_t$	-0.973	-0.948	-0.979	-0.982	-0.834	-0.094	1.000	-0.960	0.952	-0.999
$R_t$	0.972	0.963	0.958	0.967	0.872	-0.070	-0.960	1.000	-0.955	0.959
$r_t$	-0.968	-0.740	-0.920	-0.977	-0.782	0.196	0.952	-0.955	1.000	-0.954
$C_{t-1}$	0.974	0.948	0.974	0.983	0.845	0.075	-0.999	0.959	-0.954	1.000

## Discussion

Revenues from allowances of emission limits of  $CO_2$  and the alternative expense of the capital (interests) are on the edge of significance (possible small distortion due to rounding) and have multiplicative effect on the development of companies' gross investments. From numerical solutions of the first two equations of the simultaneous model follows that revenues from the sale of emission allowances statistically on the edge of significance contribute to the growth of the gross domestic product.

The third equation of our simultaneous model indicates the statistically significant dependence (on the percentage level of significance  $\alpha = 0.2$ ) on the mean value of government expenses. When setting the statistical significance of structural parameters, other macroeconomic variables are not statistically significant. Government expenses and revenues from auctioning of emission

allowances are, in terms of the simultaneous model, bound by functionally structural parameters  $e$ ,  $f$ ,  $p$  and  $b$ . With the exception of parameter  $e$  are all the others statistically insignificant, therefore, after calculating the pair regression, the following finding arises: There is a strong dependence between  $G$  and  $R_t$ : 92%. The parameter  $b_4$  is 1.03236. Therefore it can be stated that if revenue from allowances coming to the state budget increase by 1 billion CZK, it will have positive impact on government expenses in the form of the growth by approximately 1.032 billion CZK.

The dependence between unemployment and revenue from EUA is very high as the coefficient of determination is 92%. In case the government revenue increases by 1 billion CZK, unemployment falls by 0.15%. From statistical and econometric verification, after testing for the significance of structural parameters “ $p$ ”, “ $c$ ” and “ $b$ ” follows that both parameters are statistically insignificant (parameter  $b$  is on the edge of significance), therefore as in the case of the previous example, the sensitivity analysis is performed with the help of simple linear regression between the change in the price level (dependent variable) and revenue from EUA (independent variable). The regression coefficient is equal to  $a_3 = 2.10$  (which is amount of the annual change in the price level in %, in case revenue from emission allowances were zero) and  $b_3 = -0.0014$ . Examined indicators (the price level and revenue from EUA) are interdependent; the coefficient of determination is only 6.97%, which makes it impossible to determine the partial change for the sensitivity analysis.

When determining the indirect impacts of  $R_t$  on  $NX$ , it is necessary to take into consideration the parameters  $m$ ,  $x$  and  $b$ . All of these are statistically insignificant according to the t-test, therefore, the regression was performed once again where the parameter  $b_5$  was of 0.19451 and the determination coefficient was 76% which is a relatively strong dependence. It can therefore be stated that when revenue from allowances increase by 1 billion CZK, net export will increase by 194 million CZK.

In this work we modeled the impacts of revenue from emission allowances on selected macroeconomic indicators with the help of the simultaneous model. However, this model has a number of limitations and due to this fact, the results could be distorted. When testing the significance of the corresponding structural parameters, the other variables are not very significant for the model. This is mainly due to the fact that in our calculations we worked with the smaller number of observations ( $n = 8$ ). In the first equation, 6 structural parameters were estimated and the number of freedom levels was reduced to 2 by which the estimation of residual distribution of the basic file significantly increased. The high residual variance of the basic file caused the decrease of the value in the denominator of the t-test. This distortion or inaccuracy could be removed by a greater number of observations, i.e. longer time series of a minimum of 20 years of development of the corresponding macroeconomic variables contained in the first equation. However, as already stated, the length of the time series was chosen deliberately because the trading period began during the third phase which dates from 2013 to 2020. In addition, the results point out to the potential presence of so-called spurious correlation or spurious

regression which occurs when the change in the values of one variable is related to the change of values in other variable. The observed correlation between the variables can mean that there is another, to our observing still hidden variable, which acts as a cause of both occurrences.

Another problem of this model, as already implied above, is the occurrence of strong multicollinearity in several cases. The peak value is between  $Ig$  and  $C_t$ ,  $Y_t$  and  $C_t$ ,  $Ig$  and  $Y_t$ ,  $U_t$  and  $C_{t-1}$ . At these pairs it was therefore thoroughly observed whether they are not on the same side of the equation. Due to the fact that multicollinearity reduces the accuracy of estimations and may cause errors, the consumption was removed especially from the first equation because it is the most problematic part in terms of multicollinearity. Correlation coefficients are generally very high, which may be caused due to the tendency of the time series to evolve in the same direction, due to the lagged variable or due to the higher number of explanatory variables than is the scope of the selection. Besides omitting the colinear variables, we can also eliminate multicollinearity due to the larger scope of selection or restriction of parameters.

I would therefore conclude that this model is not optimal for detecting the macroeconomic impacts of trading emission allowances and I would therefore reject the stated hypothesis at the beginning of the work. Nevertheless, the aim of the paper was fulfilled. The model may be used to prove economic relations; it shows high dependencies between basic economic magnitudes. It may also be used in practice when applying fiscal policy as, through the model, it is possible to predict the trend of consequence of the change in the individual magnitudes as for instance increasing government expenses or interest rate.

It would be adequate to use SW Gretl or R for the further research. Determination of revenues impacts on the state budget (or on the economy of a EU member state) and test the stationarity of the time series with the help of Augmented Dickey-Fuller test. The time series would consequently be differentiated and possible presence of autocorrelation would be investigated with the help of Autocorrelation and Partial-autocorrelation function.

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