REALATINOSHIP BETWEEN THE DEVELOPEMENT OF THE GROSS VALUE ADDED AND THE TOTAL FACTOR PRODUCTIVITY IN THE CZECH INDUSTRY

Tomáš Volek – Martina Novotná

Abstract

The aim of this paper is to examine relations between the development of the total factor productivity (TFP) and the development of Gross value added in the context of growth GVA (extensive or intensive growth sources). The analysis focuses on the Czech Republic industry. Data sources were taken from the Czech Republic national accounts in the period of 1996-2011. It was found that the share of industry in the GVA added is continuously growing. The most important part of the industry is the manufacturing industry (90% of the GVA industry). The development of the total factor productivity mirrors the development of the GVA. The dynamics of the both variables GVA and TFP is influenced by the business cycle. The performed analysis confirmed two hypotheses primarily in the manufacturing industry. The first hypothesis assumes that the intensive factor prevails if the value of the TFP is greater than the GVA index and, at the same time, the TFP is greater than 1. The second hypothesis assumes that the extensive factor prevails if the value of the GVA index is greater than the TFP and, at the same time TFP, is less than 1.

Key words: Gross value added, Total factor productivity, Industry,

JEL Code: D24, E01, E23

Introduction

The basic indicator which is used for evaluation of effectiveness the production factors exploitation in industry is indicator of total factor productivity (TFP). This indicator has the significant role as a resource for rising of competitiveness of the Czech industry. On the other hand the basic indicator of industry performance is gross value added (GVA). The value of GVA is not constant but variable. The question is, what is the link between the dynamics of both indicators (GVA and TFP) over time and how they react in individual sections of industry.

The basis for measuring productivity and performance industry is production function. If Q represents output and K and L represent capital and labour inputs in "physical" units,

then the aggregate production function can be written as: Q = F (K,L;t). The variable t for time appears in F to allow for technical change. It will be seen that I amusing the phrase "technical change" as a short-hand expression for any kind of shift in the production function (Solow 1957). Other authors as Baumol, Atkinson, Romer, Blanchar, Coelli, Kejak, Freid or Färe continued and continue with Solow fundamental work.

Output is possible to measure by the gross domestic product or gross value added. Gross value added is often used to measure the output of the sector (Sixta et al. 2011). Sources of growth in gross value added can be divided into extensive resources then we talk about the extensive growth or can be intense, then talk about intensive growth. If we talk about the extensive and intensive growth is the result of qualitative and quantitative changes in factors productivity (Hájek, Mihola 2009) – labour productivity, capital productivity and total factor productivity.

Total factor productivity is indicator commonly used for many different purposes in theory, history, and policy, we look at some problems concerning its measurement and interpretation (Lipsey, Carlaw 2004). In economics is the total factor productivity (TFP) approach to measuring changes in technology. We have gross-output and value added based total factor productivity (TFP) measures (Balk 2009). Jorgenson (2000) recommends for industry-level productivity gross output rather than value-added. O'Mahony, Timmer (2009) recommend measurement total factor productivity based on value-added. Factors besides the stock of technological knowledge determine relative total factor productivity levels at a point in time (Prescott, Lawrence 1998). Productivity is influenced by business cycle and productivity affects the business cycle. Main concept of business cycle is theory of real business cycles. Theory of real business cycle is focused on explain economic fluctuations. The main authors of the theory of real business cycles (real business cycles - RBC) are Kydland, Prescott (1982), whose model is considered as a standard RBC model. Bhattacharjee et al. (2009) showed that development of productivity in business cycle has showed substantial variation in sectors.

Trends in growth total output (gross domestic product or gross value added) and growth total factor productivity could indicate type of economies (Bajona, Locay 2009). The same relationship could indicate type of sector.

1. Material and methodology

The main aim of the paper is to examine relations between the development of the total factor productivity (TFP) and the development of Gross value added in the context of growth GVA (extensive or intensive growth sources). The analysis focuses on the Czech Republic industry. Within the NACE classification (Classification of Economic Activities), activities under the sections B (mining and quarrying), C (manufacturing) and D (electricity, gas, steam and air conditioning supply) are considered to be industrial activities - industry. Data sources were taken from the Czech Republic national accounts in the period of 1996-2011. Values of monitored indicators were determinated as real namely in current prices of year 2005. Total Factor Productivity (TFP = Total Factor Productivity) was determined by the production function based on growth accounting (Jilek, 2005).

Considering two factors of production: labour (L), capital (C) we can count the aggregate productivity of factors of production (TFP A_1/A_0 through indices of products (Y), capital (C), and labour (L), or

$$\frac{A_1}{A_0} = \frac{Y_1}{Y_0} \cdot \left(\frac{K_1}{K_0}\right)^{-\alpha_{Kt}} \cdot \left(\frac{L_1}{L_0}\right)^{-\alpha_{Lt}} \qquad (1)$$

where Y_1/Y_0 is the index of real product (of GVA in prices PPS),

K_1/K_0 is the index of real gross stock of long-term property (index of creation of gross fixed capital formation)

L_1/L_0 is the index of ether the number of hours worked off or average number of employees

α_{Lt} is the arithmetical mean from the compensation of employees ´ratio in GVA in the basic and current period,

α_{Kt} is the arithmetical mean from the gross operating surplus in GVA in the basic and current period, thus it applies that $\alpha_{Lt} + \alpha_{Kt} = 1$.

The calculation formula was used Törnquist discrete approximations Divisiov integral index, namely:

$$\ln A_t - \ln A_{t-1} = (\ln Y_t - \ln Y_{t-1}) - \alpha_{Kt}(\ln K_t - \ln K_{t-1}) - \alpha_{Lt}(\ln L_t - \ln L_{t-1}) . \qquad (2)$$

This implies:

$$(\ln Y_t - \ln Y_{t-1}) = [(\ln A_t - \ln A_{t-1})] + [\alpha_{Kt}(\ln K_t - \ln K_{t-1}) + \alpha_{Lt}(\ln L_t - \ln L_{t-1})] \qquad (3)$$

The first bracket formula 3 is the intensity factor of growth of real output (i), the second bracket is extensive growth factor (e).

Relatively both factors can be expressed as follows:

$$i = \frac{\ln A_t - \ln A_{t-1}}{\left|(\ln A_t - \ln A_{t-1})\right| + \left|[\alpha_{Kt}(\ln K_t - \ln K_{t-1}) + \alpha_{Lt}(\ln L_t - \ln L_{t-1})]\right|}, \quad (4)$$

$$e = \frac{\alpha_{Kt}(\ln K_t - \ln K_{t-1}) + \alpha_{Lt}(\ln L_t - \ln L_{t-1})}{\left|(\ln A_t - \ln A_{t-1})\right| + \left|[\alpha_{Kt}(\ln K_t - \ln K_{t-1}) + \alpha_{Lt}(\ln L_t - \ln L_{t-1})]\right|}, \quad (5)$$

between the two parameters is valid the following relationship:

$|i| + |e| = 1.$

The relationship ensures, that both the considered factors cover exactly 100% with the possibility of their full compensation.

The analysis of data has brought the following hypotheses:

If increasing total factor productivity ($\frac{A_1}{A_0}$ = TFP > 1) and at the same time growing faster than the gross value added, (TFP> I GVA), then we can assume that the intensity factor of GVA growth prevail.

If decreasing total factor productivity ($\frac{A_1}{A_0}$ = TFP < 1) and at the same time growing slowly than the gross value added, (TFP < I GVA) , then we can assume that the extensive factor of GVA growth prevail.

To verify the validity of hypotheses has been used statistical induction, specifically test hypotheses about the relative frequency.

Test the hypothesis allows to decide between testing hypothesis H_0 and alternative hypothesis H_A, based on decision rule. The decision is based on the value of test criterion. The set of allowable values is divided into two parts: the critical field containing values test criterion argument in favour H_A of adopting a field containing values test criterion argument in favour H_0. The border between them is the critical value. For each sector were tested the

hypothesis that the relative frequency of some character variations in the basic set is equal to a specific number. The null hypothesis is:

$H_0 : \pi = \pi_0$.

If a random sample of sufficient scale, is possible to use as a test criterion statistics:

$$U = \frac{(p - \pi_0).\sqrt{n}}{\sqrt{\pi_0.(1-\pi_0)}}, \qquad (6)$$

which has, if the hypothesis H_0 is valid, approximately asymptotically standard normal distribution (Hindls, Novák, Hronová, 1999).

2. Results

The first step of the analysis was to determine the development of the share of industry sections B-D (NACE) in total gross value added of the economy and also to determine which sections of the industry section have the highest share in industry output.

2.1. Industry and GVA

Table 1 illustrates the shares in the years 1996 - 2011. This period was divided into 5 intervals. The basis for determining of intervals was the dynamics of the gross value added in industry (Graph1). The trend of development GVA for the whole economy and industry is very similar (Graph 1). There is visible influence of the business cycle.

Tab. 1: Structure of gross value added (GVA) in the Czech Republic (in %)

	1996-2000	2001-2003	2004-2006	2007-2009	2010-2011
share of industry on GVA	25,11	26,83	30,13	32,89	33,96
share of manufacturing on GVA industry	75,84	80,83	84,49	87,23	89,83

Source : Own calculations based on the data of National account

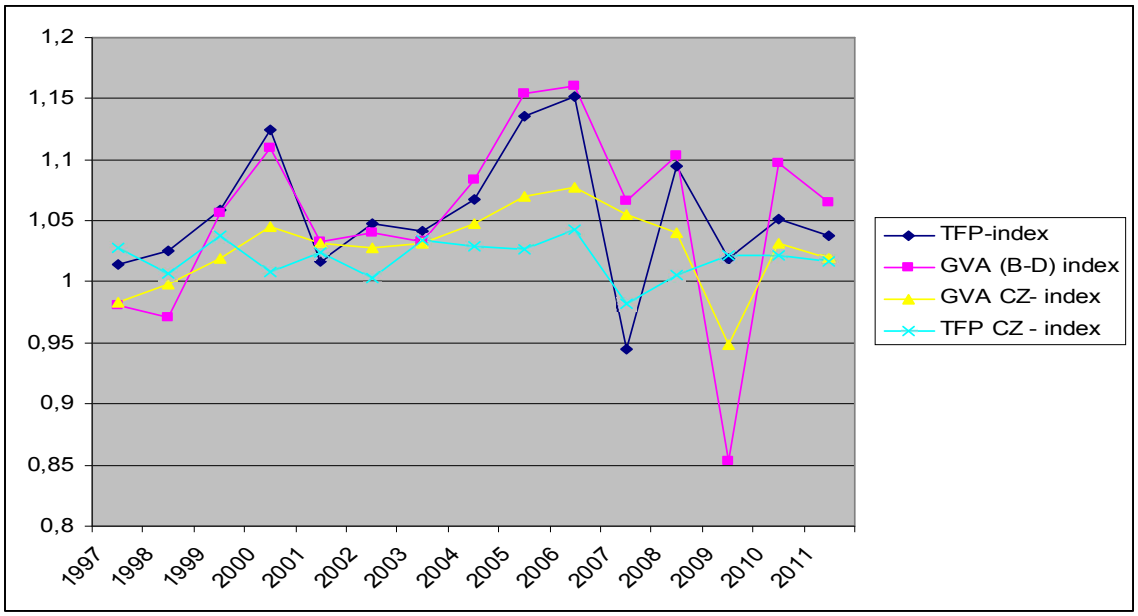
Table 1 shows that the importance of industry (section B-D of NACE) on total GVA economy, regardless of the real business cycle. The value of share has increased in 16 years from initial value 25,11 % to value 34%. The most important sections from industrial sections of NACE is manufacturing (Section C). The importance of the manufacturing on total industry has increased and share of manufacturing in GVA industry is about 90% .

The next step of the analysis was to compare the development of gross value added in the industry with the development of total factor productivity. Graph 1 shows the dynamics of the indicators. Using Graph 2 it is possible to analyse to what extent it contributes to the

growth or decline in GVA in industry change in efficiency of factors of production, which is divided on the impact of extensive factor (change of a factor of production, labour and capital) and the effect of intensive factor (change in efficiency of factors of production, which is in some extent determined by technical progress).

In particular intensity factor, contributes to the competitiveness of industry and ultimately whole economy of the Czech Republic. Index of total factor productivity over the entire 16 years relatively significantly copying the index of GVA for this sector compared for example with the development whole economy. The differences in the dynamics of indicators are in industry significantly larger. Major differences in the dynamics of indicators were especially in a periods when there was more radical change in 2007 and 2009.

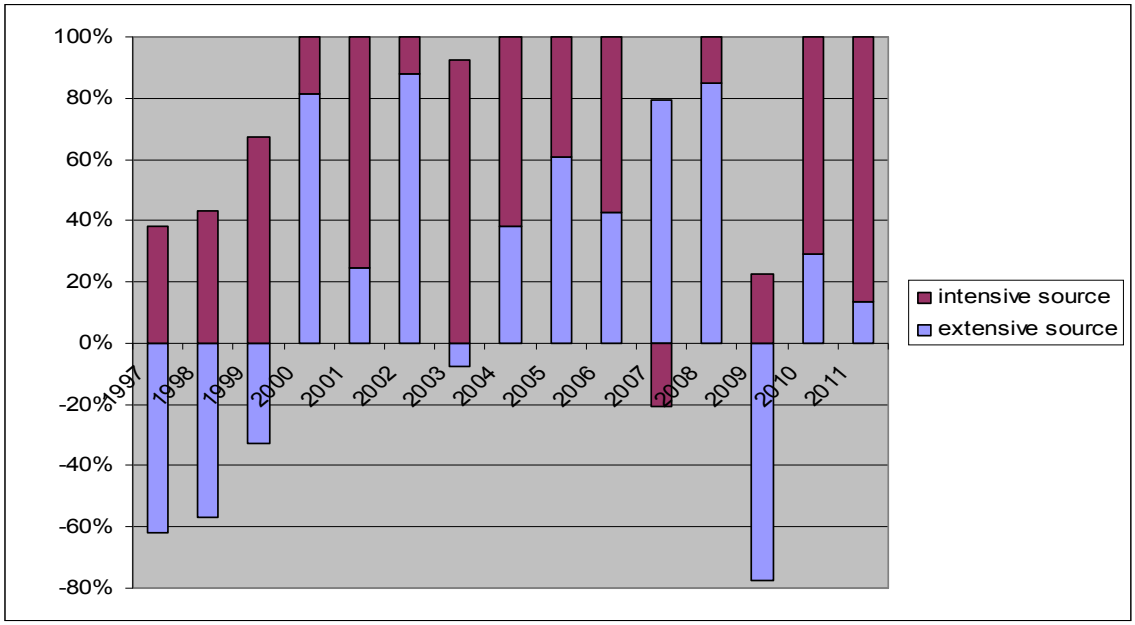
Graph 1: Development of GVA and TFP in industry (NACE Section B - D) in the years 1996-2011



Source : Own calculations based on the data of National account

The development of sources of growth of gross value added of industry (Graph 2) allows us to find out in which period dominated influence of extensive factor or intensive and in which period was one factor partially or completely replaced by another factor.

Graph 2 : Development of share intensive and extensive factors in the development of Czech industry GVA (%)



Source : Own calculations based on the data of National account

2.2.Relationship between GVA and TFP

Based on the development of indicators (gross value added, total factor productivity and the analysis of changes in GVA impact of extensive and intensive growth factors) for industry (graph 1 and 2) we could observed the following findings:

• extensive factor is negative - if the TFP increases (TFP > 1), and TFP> index GVA (valid for the years 1997, 1998, 1999, 2003, 2009)

• intensive factor is negative - if the TFP decreases (TFP <1), valid for 2007, when TFP <1 < index GVA.

From a theoretical and practical analysis of the problems were formulated two hypotheses that will be verified in the next step in the analysis of the sections industry for a period of 16 years. Were used for verification testing hypotheses about the relative frequency on the significance level $\alpha = 0.05$.

Hypothesis 1:

If TFP> 1 and TFP> index GVA, then the intensity factor> | 0.5 |, or the prevails

Hypothesis 2:

If TFP <1 and index GVA> TFP then extensive factor> | 0.5 |, or the prevails

The aim was to verify, if the hypothesis is valid at least for 80% observations in sections of industry.

So it was tested the hypothesis $H_0 : \pi \geq 80\%$ against the alternative $H_A : \pi < 80\%$.

The following table 2. shows us that the first hypothesis is valid at least 80% of the observations in manufacturing. We could not refuse the null hypothesis. On the contrary, we could not to confirm the hypothesis for industry section B (mining, quarrying) and D (electricity, gas, steam and air conditioning supply). We have to refuse the null hypothesis in favour of the alternative hypothesis.

Tab. 2: The results of hypotheses 1

NACE	nA/n	u	P
B Mining and quarrying	0,400	-3,873	0,000
C Manufacturing	0,667	-1,291	0,098
D Electricity, gas, steam and air conditioning supply	0,533	-2,582	0,005

Source : Own calculations based on the data of National account

The following table 3. shows us that the second hypothesis is valid at least 80% of the observations in sections C industry (manufacturing) and D (electricity, gas, steam and air conditioning supply). On the contrary, we could not to confirm the hypothesis for section industry B (mining and quarrying). We have to refuse the null hypothesis in favour of the alternative hypothesis.

Tab. 3: The results of hypotheses 2

NACE	nA/n	u	p
B Mining and quarrying	0,267	-5,164	0,000
C Manufacturing	0,867	0,645	0,741
D Electricity, gas, steam and air conditioning supply	0,667	-1,291	0,098

Source : Own calculations based on the data of National account

Conclusion

The article dealt with relationship between development gross value added and total factor productivity in Czech industry. It was found, that the share of industry in the total gross value added of economy continuously growing. The most important part of the industry is the manufacturing industry (90% of GVA industry). Development of the index total factor productivity index copies the development of gross value added. It was found clearly greater fluctuations in monitored indicators industry TFP and GVA. It is obvious that at the dynamics of both variables GVA and TFP are influence by business cycle. From the

theoretical and practical analysis of indicators were formulated two hypotheses. The first hypothesis assume, that the intensive factor prevails if the value of TFP is greater than GVA index and at the same time TFP is greater than 1. It was found that that hypothesis is valid for section C industry (manufacturing). The second hypothesis assume, that the extensive factor prevails if the value of GVA index is greater than TFP and at the same time TFP is lower than 1. It was found that that hypothesis is valid for section C industry (manufacturing) and D (electricity, gas, steam and air conditioning supply).

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Contact

Tomáš Volek

Faculty of Economics, University of South Bohemia

Studentská 13, 370 05 České Budějovice, Czech Republic

volek@ef.jcu.cz

Martina Novotná

Faculty of Economics, University of South Bohemia

Studentská 13, 370 05 České Budějovice, Czech Republic

novnotna@ef.jcu.cz