Primary submission: 05.07.2014 | Final acceptance: 12.12.2014

Gross Value Added and Total Factor Productivity In Czech Sectors

Tomáš Volek[1], Martina Novotná[1]

ABSTRACT The main purpose of this paper is to consider the development of total factor productivity in the development of gross value added in individual sectors of the economy of the Czech Republic in the period from 1996 - 2011. The National Account was the source of the data. The paper addresses the importance of extensive and intensive sources of economic growth in individual sectors. It was found that the development of total factor productivity does not match the growth of gross value added. The growth of gross value added was significantly influenced by extensive and intensive sources of growth in all of the economy and its sectors. The hypothesis stating that if the total factor productivity rises faster than the gross value added, then the extensive factor is negative was accepted for all sectors of the economy. The influence of intensive factors was primarily found in the manufacturing and commercial service sectors. The results of this study indicate differences in the sources of growth in individual sectors.

KEY WORDS: gross value added; total factor productivity; sectors;

JEL Classification: D24, E01, E23

[1] University of South Bohemia, Faculty of Economics, Czech Republic

Introduction

In measuring the productivity and efficiency of an economy, papers also increasingly address the sector view. Within a sector, we can assume significant differences in the reactions to changing internal or external economic environments. These differences can also be found within the dynamics of individual indicators of performance and productivity, which can be attributed to the material orientation of these sectors. We ask what the relationship between the dynamics of gross value added (GVA) and the development of total factor productivity (TFP) is from the point of view of individual sectors and whether we can identify common features across individual sectors.

The production function is the basis for measuring productivity and performance sectors or regions. If Q represents output and K and L represent capital and labor 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 (Solow, 1957). This value is sometimes called the Solow residual (productivity). A critic of the Solow residual, Mankiw (1989), argues that the use of the primal Solow residual is not adequate to measure changes in the economy's technological abilities over short horizons. The growth rate of real output can be separated into contributions from the growth rate of capital and labor and a residual from the total factor productivity growth

Correspondence concerning this article should be addressed to: **Tomáš Volek**, University of South Bohemia, Faculty of Economics, Studentská 13, 370 05 České Budějovice, Czech Republic. E-mail: volek@ef.jcu.cz

(Barro & Sala-i-Martin, 2004). We can decompose the productivity growth into two mutually exclusive and exhaustive components: changes in technical efficiency over time and shifts in technology over time (Färe et al., 1994). The problem for economies or sectors occurs when productivity growth lags behind other countries (Baumol, 1986) or sectors. On the other hand, aggregate productivity has been converging over the period. Bernard & Jones (1996) and Färe, Grosskopf and Margaritis (2006) found that aggregate productivity was converging in countries but they found disparate behavior in sectors.

The performance of economies may be measured by the gross domestic product (Pavelka, 2007) or gross value added. Gross value added is often used to measure the output of sectors (Sixta, Vltavska, & Zbranek, 2011) or small regions (Johnston, 2011). Sources (factors) of growth in gross value added can be divided into extensive resources, when referring to extensive growth, or can be intensive, when referring to intensive growth. Extensive and intensive growth are the results of qualitative and quantitative changes in factors of productivity (Hájek & Mihola, 2009). Productivity is the ratio of outputs to inputs (Coelli et al., 2005). Productivity = output/input. Productivity is a key economic indicator, believed to be a critical driver or factor in accounting for economic growth and prosperity (Fried et al., 2008). There are many different productivity measures. The choice between them depends on the purpose of the productivity measurement and, in many instances, on the availability of data. The simplest and the most frequently encountered measure is labor and capital productivity. Labor productivity is related to the efficiency of production. Labor productivity is the ratio of gross domestic product and total employment (van Praag & Versloot, 2007) or gross value added and total employment (Basile & De Benedictis, 2008), represented by an indicator of total hours worked (Fadejeva & Melihovs, 2010). Capital productivity is formed by relating output to capital input (Van de Klundert & Potters, 1997). Technical progress is measured by the total factor productivity indicator (Crespo, 2008). The total factor productivity is an indicator commonly used for many different purposes in economic theory, history, and policy. We will look at some problems concerning its measurement and interpretation (Lipsey & Carlaw, 2004). The total factor productivity (TFP) approach to measuring changes in technology is used in economics. Gross output and value added are based on total factor productivity (TFP) measures (Balk, 2009). Jorgenson & Stiroh (2000) recommend gross output rather than value added for industry-level productivity. O'Mahony & Timmer (2009) recommend the measurement of total factor productivity based on value added. Factors beside the stock of technological knowledge determine relative total factor productivity levels at a point in time (Prescott& Lawrence, 1997). Productivity affects and is influenced by the business cycle. An important general characteristic of business cycles appears to be the tendency of outputs in different sectors to move together. This hypothesis was confirmed by Long & Plosser (1987). They said that that some sectors display less coherence with other sectors. On the other hand, Bhattacharjee, Castro and Jensen-Butler (2009) showed that the development of productivity in business cycles has shown substantial variation across sectors. Investment and investment-specific technology have a significant role in changes of productivity in business cycles (Ireland & Schuh, 2008). Bhattacharjee et al. (2009) showed that the development of productivity in business cycles has shown substantial variation in sectors.

Trends in growth of total output (gross domestic product or gross value added) and growth of total factor productivity may indicate types of economies (Bajona & Locay, 2009) or types of sectors. Hájek (2006) addresses the dynamics of total factor productivity in the Czech Republic. This analysis shows that industry, transport, communications, and other services were involved in the speeding up of the growth of macroeconomic total factor productivity. Dybczak & Flek (2007) found similar results regarding the role of sectors in the Czech economy. They found sectors to be the main drivers of economic growth in industry. Subsequent analyses dealt with the productivity and growth of individual sectors such as the food industry (Čechura & Hockmann, 2010) and the information and communications technology (ICT) sector (Fischer et al., 2013). Regarding Eastern European countries, Peneder & Stehrer (2007) found the source of growth of total factor productivity to be higher-tech sectors.

 DOI: 10.5709/ce.1897-9254.157

Material and Methodology

The main aim of this paper is to consider the development of total factor productivity in the development of gross value added in individual sectors of the economy of the Czech Republic. At the same time, the authors set themselves the task of trying to determine in what connections the extensive increase of GVA prevails and when an intensive factor (TFP). The National Account for the period 1996-2011, an interval of 16 years, was the source of the data. The figures for the monitored indicators in individual sectors were probed in real terms that use the constant prices of 2005. Sectors are classified according to the Statistical Classification of Economic Activities (NACE). To verify the validity of the stated hypotheses, either static induction or tests on hypotheses of relative frequency were used. The tests of hypotheses enable a decision to be made on the principle of the tested hypothesis and the alternative hypothesis, which rejects it. The decision results from the value of the tested statistics. The set of permissible values splits into two parts: rejection of sector statistics containing values of a test criterion benefitting and acceptance of sector statistics containing values of the test statistics accepting. The borders between them are called the critical values. For individual sectors the hypothesis was tested on the premise that the relative frequency of a particular variant of a feature in the basic file is equal to a specific frequency.

The null hypothesis

$H_0 : \pi = \pi_0$.

If random sampling has a sufficient extent (300 monitoring samples were included), the following statistics can be used as the test statistic

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

where if the hypothesis H_0 is valid, an approximately standard normal distribution and where p is the relative frequency (Hindls, Hronová, & Novák, 1999).

The chosen criterion of validity is 80%. This criterion is considered to be a conservative limit. It is impossible to expect any phenomena to be valid in 100% of cases.

TFP = Total Factor Productivity $\boldsymbol{A}_1/\boldsymbol{A}_0$ was obtained from the productive function proceeding from this growth accounting (Jílek et al., 2005).

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

where

$\boldsymbol{Y}_1/\boldsymbol{Y}_0$ is the index of a real product (GVA in prices of 2005),

$\boldsymbol{K}_1/\boldsymbol{K}_0$ is the index of the real gross stock of long-term property (the index of fixed capital formation in prices of 2005),

$\boldsymbol{L}_1/\boldsymbol{L}_0$ is the index of the number of hours worked,

α_{Lt} is the arithmetic mean from the proportions of compensation of employees in GVA in basic and current periods,

α_{Kt} is the arithmetical mean from the proportion of gross operating surpluses in GVA in the basic and current periods.

From above mentioned, the result is that $\alpha_{Lt} + \alpha_{Kt} = 1$.

In making calculations, the Törnquist formula of discrete approximation of the Divisius integral index was used, i.e.:

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

This implies that:

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

The equation in the first set of square brackets in formula 3 represents an intensive factor of real product growth (i), and the one in the second set of square brackets is an extensive factor of growth (e).

Relatively, it is possible to express both factors this way:

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

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

and the following relationship stands for both parameters:

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

This formula ensures that both factors fully cover the possibility of their compensatory relationship.

Results and Discussion

The first step of the analysis was to consider the mutual development of the indicators GVA (a chain index was constructed) and TFP (expressing dynamics of multifactor productivity). Graph 1 shows clearly the years in which the gains of GVA increase and, on the contrary, when they decrease and how total factor productivity develops. In the years of rapid growth, 2003-2006, TFP also reaches the highest level in the monitored period but it does not parallel the growth of GVA. In this period, we can assume extensive growth, i.e., an increase in the levels of factors of production, labor and capital. The biggest difference in the growth rates of the monitored indicators can be observed in 2007; when regarding the decrease of the TFP below value 1, we can assume that the growth of GVA was reached by extensive growth factors (see graph 2).

Based on the development of the above mentioned indicators for the whole economy (graph 1) and the analysis of the growth rate of GVA on the impact of extensive and intensive growth factors (graph 2), we can identify these facts:

- ***The extensive factor is negative***, in the case when TFP rises (TFP > 1) and TFP > I GVA (which holds for the years 1997, 1998, 1999, 2003, 2009; but in 2009, TFP > 1 and GVA falls rapidly, with even I GVA < 1; the extensive factor prevails and is at the same time logically negative)
- ***The intensive factor is negative,*** in the case when TFP falls (TFP < 1) (which holds for the year 2007) and TFP < 1 < I GVA,
- ***The extensive factor has a prevailing impact on the growth of GVA***, provided that TFP < I GVA > 1 and the inter-annual gains of TFP decrease (which holds for the years 2000, 2002, 2005, 2007),
- ***The intensive factor has a prevailing impact on the growth of GVA***, provided that TFP < I GVA > 1 and the inter-annual gains of TFP increase (which holds for the years 2001, 2006, 2010).

The problem is whether the discovered facts also represent the individual sectors of the national economy. The further aim of this study was to determine the extent to which these facts can be generalized. From the theoretical analysis of the problem, four hypotheses were formulated, and they were verified in the next step of analysis in sections of the NACE over a period of 16 years. For verification, we used tests of hypotheses on relative frequency at the significance level α = 0.05 (see methodology).

Hypothesis 1:
$e < 0$, i.e., the extensive factor is negative if 1 < TFP > I GVA,

Hypothesis 2:
$i < 0$, i.e., the intensive factor is negative if TFP < 1 < I GVA,

Hypothesis 3:
$e > |0.5|$, i.e., the extensive factor prevails if TFP < I GVA > 1 and the inter-annual gains of TFP decrease,

Hypothesis 4:
$i > |0.5|$, i.e., the intensive factor prevails if TFP < I GVA > 1 and the inter-annual gains of TFP increase.

The aim was to verify whether the above hypotheses are true for at least 80% or more samples monitored in individual sections of the NACE. Thus, the hypothesis $H_0 : \pi \geq 80\%$ was tested against the alternative $H_A : \pi < 80\%$.

In the following part, the results of testing the aforementioned hypotheses at the chosen levels of significance are stated.

Hypothesis 1

$e < 0$, i.e., the extensive factor is negative if 1 < TFP > I GVA

$$H_0 : \pi \geq 80\%$$

$$H_A : \pi < 80\%$$

It is clear from the given testing that the null hypothesis implying that 80% and more observations correspond cannot be rejected (Table 1). On more detailed analysis, it was found that the inequality is valid even

 DOI: 10.5709/ce.1897-9254.157

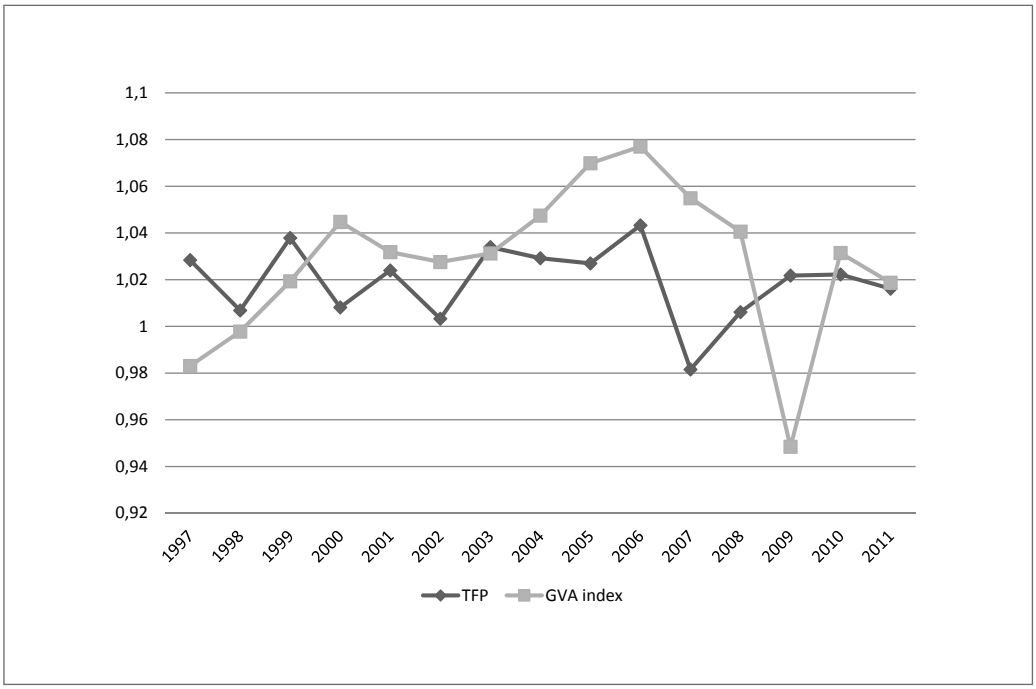

Figure 1. Development of indexes of GVA and TFP (1996-2011)

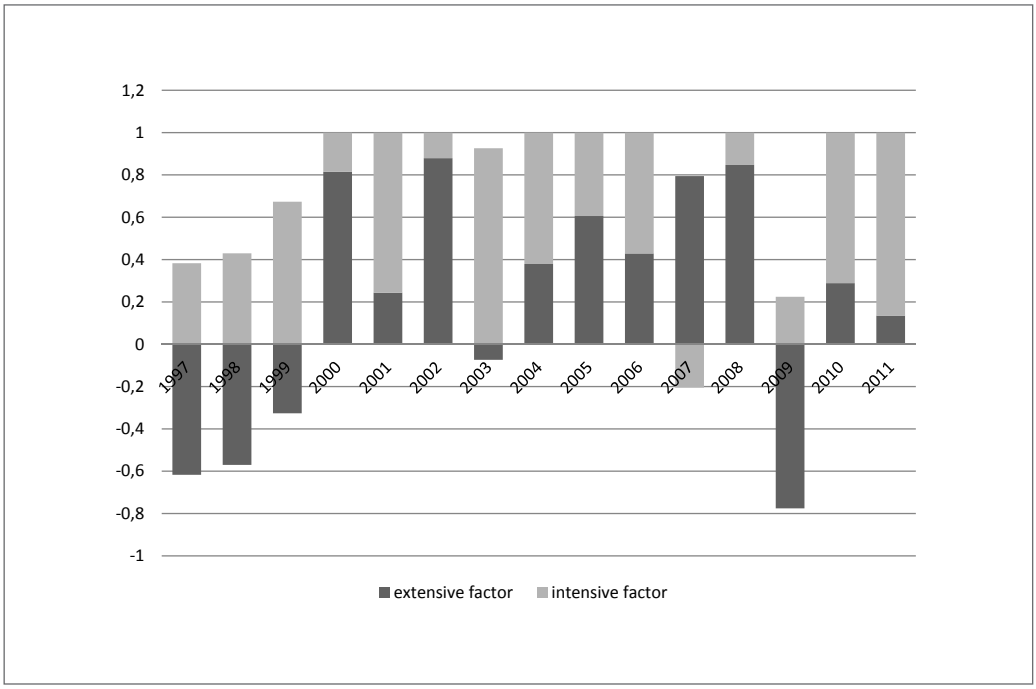

Figure 2. Development source of growth in Czech Republic in 1996-2011

Table 1. The results of hypothesis 1

NACE		u	p
A	Agriculture, forestry and fishing	1.323	0.907*
B	Mining and quarrying	1.414	0.921*
C	Manufacturing	1.323	0.907*
D	Electricity, gas, steam and air conditioning supply	1.323	0.907*
E	Water supply, sewerage, waste management and remediation activities	1.225	0.890*
F	Construction	1.323	0.907*
G	Wholesale and retail trade, repair of motor vehicles and motorcycles	1.118	0.868*
H	Transportation and storage	1.118	0.868*
I	Accommodation and food service activities	1.323	0.907*
J	Information and communication	1.118	0.868*
K	Financial and insurance activities	1.414	0.921*
L	Real estate activities	1.000	0.841*
M	Professional, scientific and technical activities	1.118	0.868*
N	Administrative and support service activities	1.225	0.890*
O	Public administration and defense, compulsory social security	1.323	0.907*
P	Education	1.225	0.890*
Q	Human health and social work activities	1.118	0.868*
R	Arts, entertainment and recreation	1.118	0.868*
S	Other service activities	1.323	0.907*

Note: * p>0.05

in 100% of observations regardless of the sector of the NACE or period. The conclusion is that TFP grows more quickly than gross value added in all sectors. The main reason for the GVA growth is the growth of the productivity of factors of production with the possibility of reducing the amount of production factors.

Hypothesis 2

$i < 0$, i.e., the intensive factor is negative if TFP < 1 < I GVA

$H_0 : \pi \geq 80\%$

$H_A : \pi < 80\%$

The results of this test (Table 2) show that the null hypothesis can be rejected, implying that 80% and more of the observations support the given inequality but in only some sections of the NACE (in Table 2 these sections are highlighted). These sections are as follows: C- Manufacturing; G- Wholesale and retail trade; I- Information and communication; K- Financial and insurance activities; L- Real estate activities; P- Education; O- Public administration and defense, compulsory social security; N- Administrative and support service activities; K- Financial and insurance activities; and M - Professional, scientific and technical activities. By contrast, we rejected the

 DOI: 10.5709/ce.1897-9254.157

Table 2. The results of hypothesis 2

NACE		u	p
A	Agriculture, forestry and fishing	-3.878	0.000
B	Mining and quarrying	-5.167	0.000
C	Manufacturing	0.866	0.807*
D	Electricity, gas, steam and air conditioning supply	-2.121	0.017
E	Water supply. sewerage, waste management and remediation activities	-4.743	0.000
F	Construction	-3.005	0.001
G	Wholesale and retail trade, repair of motor vehicles and motorcycles	0.000	0.500*
H	Transportation and storage	-2.858	0.002
I	Accommodation and food service activities	-4.333	0.000
J	Information and communication	-0.816	0.207*
K	Financial and insurance activities	-1.512	0.065*
L	Real estate activities	-1.237	0.108*
M	Professional, scientific and technical activities	-1.581	0.057*
N	Administrative and support service activities	-0.167	0.434*
O	Public administration and defense, compulsory social security	-0.567	0.285*
P	Education	-1.000	0.159*
Q	Human health and social work activities	-4.773	0.000
R	Arts, entertainment and recreation	-3.500	0.000
S	Other service activities	-3.005	0.001

Note: * p>0.05

null hypothesis for the other sectors and accepted the alternative when the given hypothesis is valid in less than 80% of cases. If the gross value added increases and TFP decreases, there is still a 5% probability that the intensity factors are positive in the sectors. It was found that the intensity factors are not negative in sector A (agriculture, forestry and fishing). The main reason could be the subsidy policy of the EU, which is concentrated on increasing the quality of production rather than on increasing the amount of production. The same finding regarding intensity factors was found in sectors that could be described as capital intensive - prevailing factor capital (B, D, E, H) and in sectors that are labor intensive (F, I, Q, R, S).

Hypothesis 3

$e > |0.5|$, i.e., the extensive factor prevails if TFP < I GVA > 1 and the inter-annual gains of TFP decrease

$H_0 : \pi \geq 80\%$

$H_A : \pi < 80\%$

The given testing of the hypothesis shows (Table 3) that the null Hypothesis can be rejected, implying that

Table 3. The results of hypothesis 3

NACE		u	p
A	Agriculture, forestry and fishing	-1.500	0.067*
B	Mining and quarrying	-4.773	0.000
C	Manufacturing	0.000	0.500*
D	Electricity, gas, steam and air conditioning supply	-3.402	0.000
E	Water supply, sewerage, waste management and remediation activities	-2.021	0.022
F	Construction	-2.667	0.004
G	Wholesale and retail trade, repair of motor vehicles and motorcycles	-0.567	0.285*
H	Transportation and storage	-3.402	0.000
I	Accommodation and food service activities	-3.878	0.000
J	Information and communication	-1.118	0.132*
K	Financial and insurance activities	-1.837	0.033
L	Real estate activities	-1.237	0.108*
M	Professional, scientific and technical activities	-1.512	0.065*
N	Administrative and support service activities	-2.864	0.002
O	Public administration and defense, compulsory social security	-2.121	0.017
P	Education	-3.005	0.001
Q	Human health and social work activities	-3.354	0.000
R	Arts, entertainment and recreation	-2.457	0.007
S	Other service activities	-3.402	0.000

Note: * p>0.05

in 80% or more cases, the given inequality is valid. These are highlighted in Table 3, namely the following sections: A-Agriculture, forestry and fishing; C-Manufacturing; J-Information and communication; G-Wholesale and retail trade, repair of motor vehicles and motorcycles; R-Real estate activities; and M-Professional, scientific and technical activities. In contrast, we refused the null hypothesis and accepted the alternative hypothesis, when the given hypothesis was valid in less than 80% of cases. If the GVA is growing faster than the TFP and TFP increments are reduced, then a substantial part of the extensity factor in these sectors is caused by an increase of the labor force.

Hypothesis 4

$i > |0.5|$, i.e., the intensive factor prevails if TFP < I GVA > 1 and the inter-annual gains of TFP increase.

$H_0 : \pi \geq 80\%$

$H_A : \pi < 80\%$

From the results of Table 4, it is obvious that we rejected the null hypothesis in all sectors and accepted the alternative, when the given hypothesis of the relation between the GVA and the intensive growth factor is valid in less than 80% of cases.

 DOI: 10.5709/ce.1897-9254.157

Table 4. The results of hypothesis 4

NACE		u	p
A	Agriculture, forestry and fishing	-6.633	0.000
B	Mining and quarrying	-4.347	0.000
C	Manufacturing	-3.953	0.000
D	Electricity, gas, steam and air conditioning supply	-4.773	0.000
E	Water supply, sewerage, waste management and remediation activities	-5.485	0.000
F	Construction	-4.899	0.000
G	Wholesale and retail trade, repair of motor vehicles and motorcycles	-3.889	0.000
H	Transportation and storage	-2.121	0.017
I	Accommodation and food service activities	-6.000	0.000
J	Information and communication	-4.743	0.000
K	Financial and insurance activities	-5.167	0.000
L	Real estate activities	-5.292	0.000
M	Professional, scientific and technical activities	-3.889	0.000
N	Administrative and support service activities	-4.000	0.000
O	Public administration and defense, compulsory social security	-5.292	0.000
P	Education	-4.347	0.000
Q	Human health and social work activities	-5.534	0.000
R	Arts, entertainment and recreation	-5.657	0.000
S	Other service activities	-4.773	0.000

Note: * p>0.05

Conclusion

The aim of this article was to consider the development of TFP in the development of GVA in individual sections of the economy of the Czech Republic, with regard to the effects of extensive and intensive growth. When viewing the whole CR, it was found that the development of TFP does not match the growth of GVA. Thus, intensive factors are not the only source of growth but the extensive factors of labor and capital are also important.

The authors of the article tried to reveal the links between sources of GVA growth in individual sections of the NACE on the basis of proving non-equations, proceeding from the material analysis of the problem and from the observed relations between the monitored indicators for the entire national economy of the CR. Four hypotheses were formulated and gradually tested in individual sectors of the national economy.

The first and the second hypotheses tested the conditions when extensive or intensive factors influence the growth of GVA negatively. The first hypothesis proceeds from a logical exploration: if the productivity of factors of production rises faster than the GVA, the extensive factor should be negative. The growth of factors of production balances the negative effect of extensive growth. This development can be found mainly in a period of

less favorable development of the economy (inter-annual decrease of factors of production – employees or gross fixed capital formation). It was proved that if the considered non-equation of the first hypothesis is valid in sectors of the NACE, the extensive factor is negative in all observations. On the basis of testing the second hypothesis, proving the non-equation in the sectors of the NACE regarding the negative intensive factor was possible in more than 80% of the observations in only some of the sections. These sections include processing and manufacturing (C), some commercial sections (G, I, K, L) and public services (O, N). Here, it is necessary to differentiate the commercial services and production sector from the public services sector. The given relationship appears in the fields of processing, manufacturing, and public services, especially in the periods of economic growth. This indicates that primary manufacturing attracts a considerable amount of business cycle effects (Andersson, 2001). In contrast, no relationship between the public services sector and the business cycle was identified.

The third and fourth hypotheses focused on monitoring such a relationship between indicators when the prevailing effect of extensive or intensive factors of growth of GVA can be either proven or disproven. Hypothesis three identifies sections where the effect of extensive factors prevails. In the national economy as a whole, extensive factors prevailed when the GVA increased faster than the TFP and the inter-annual gains of TFP decreased. The test of the hypothesis proved that the given relations are valid in 80% or more cases only in some sections. The assumption that the prevailing effect of the extensive factors will primarily be in sections with a high pressure on increasing the volume of production without greater links to the necessity of growth of TFP was proven. This assumption was identified in the manufacturing (C) and commercial services sectors (G, J, L) but also, surprisingly, in the agriculture, forestry and fishery sectors (A), which is to some extent limited by natural conditions and the subsidy system.

The last hypothesis was directed at the prevailing effect of an intensive factor of growth. In the national economy as a whole, the intensive factor (positive or negative) prevailed when the GVA inter-annually increased faster than the TFP and, at the same time, the inter-annual gains of the TFP increased. Unfortunately, in the monitored sections of the NACE, it was impossible to testify to the assumed link in more than 80% of the observations. It is possible to assume that the growth of GVA is also influenced by other factors.

References

Andersson, L. (2001). Openness and total factor productivity in Swedish manufacturing, 1980-1995. *Weltwirtschaftliches Archiv*, 137 (4), 690-713.

Bajona, C., Locay, L. (2009). Entrepreneurship and productivity: The slow growth of the planned economies. *Review of Economic Dynamics*, 12 (3), 505-522.

Balk B. M. (2009). On the Relation between Gross Output and Value Added Based Productivity Measures: The Importance of the Domar Factor. *Macroeconomic Dynamics*, 13, 241-267.

Barro, J. R., & Sala-i-Martin, X. (2004). *Economic growth* (2nd ed.). Cambridge, MA: The MIT Press.

Basile, R., & De Benedictis, L. (2008). Regional unemployment and productivity in Europe. *Papers in Regional Science*, 87 (2), 173-192.

Baumol, W. J. (1986). Productivity Growth, Convergence, and Welfare: What the Long-Run Data Show. *The American Economic Review,* 76 (5), 1072-1085.

Bernard, A. B., & Jones, C. I. (1996). Comparing Apples to Oranges: Productivity Convergence and Measurement Across Industries and Countries. *The American Economic Review*, 86 (5), 1216-1238.

Bhattacharjee, A., de Castro, E., & Jensen-Butler, C. (2009). Regional variation in productivity: a study of the Danish economy. *Journal of Productivity Analysis*, 31 (3), 195-212.

Coelli, T. D., Prasada Rao, D. S., O'Donnell, C. J., & Battese G. E. (2005). *An Introduction to Efficiency and Productivity Analysis* (2nd ed.). New York, NY: Springer.

Crespo, R. (2008). Total factor productivity: an unobserved components approach. *Applied Economics*, 40 (16), 2085-2097.

Čechura, L., & Hockmann, H. (2010). Sources of economical growth in the Czech food processing. *Prague Economic Papers*, 2, 169-182.

Dybczak, K., & Flek, V. (2007). Supply-side adjustments in the Czech Republic: A cross-sector perspective. *Eastern European Economics*, 45 (6), 29-45.

 DOI: 10.5709/ce.1897-9254.157

Fischer, J., Vltavska, K., Doucek, P., & Hanclova, J. (2013). The influence of information and communication technologies on labour productivity and total factor productivity in the Czech Republic. *Politicka Ekonomie*, 2013 (5), 653-674.

Fadejeva, L., & Melihovs, A. (2010).Measuring Total Factor Productivity and Variable Factor Utilization. Sector Approach, the Case of Latvia. *Eastern European Economics*, 48 (5), 63-101.

Färe, R., Grosskopf, S., Norris, M., & Zhang, Z. (1994). Productivity Growth, Technical Progress, and Efficiency Change in Industrialized Countries. *The American Economic Review*, 84 (1), 66-83.

Färe, R., Grosskopf, S., & Margaritis, D. (2006). Productivity Growth and Convergence in the European Union. *Journal of Productivity Analysis*, 25 (1-2), 111-141.

Fried, H. O., Knox Lovell, C. A., & Schmidt, S. S. (2008). Efficiency and productivity. In H. O. Fried, C. A. Knox Lovell & S. S. Schmidt (Eds.), *The measurement of productive efficiency and productivity growth* (pp. 3-91). New York, NY: Oxford University Press.

Hájek, M., & Mihola, J. (2009). Analysis of Total Factor Productivity Contribution to Economic Growth of the Czech Republic. *Politicka Ekonomie*, 2009 (6), 740-753.

Hájek, M. (2006). Sources of economic growth, total factor productivity and structure in the Czech Republic. *Politicka Ekonomie*, 2006 (2), 170-189.

Hindls, R., Hronová, S., & Novák, I. (1999). *Analýza dat v manažerském rozhodování* [Data analysis in managerial decision]. Prague: Grada Publishing.

Ireland, P. N., & Schuh, S. (2008). Productivity and US macroeconomic performance: Interpreting the past and predicting the future with a two-sector real business cycle model. *Review of Economic Dynamics*, 11 (3), 473-492.

Jílek, J. Fischer, J., Hindls, R., Hronová, S., Moravová, J., & Zelený, M. (2005). *Nástin sociálněhospodářské statistiky* [Outline of socio-economic statistics]. Prague: Oeconomica.

Johnston, A. (2011). The Economic Performance of UK Cities, 1995-2005: Driven by Knowledge-based Sectors or Consumption-based Sectors? *European Planning Studies*, 19 (12), 2095-2108.

Jorgenson, D. W., & Stiroh, K. J. (2000). U.S. Economic Growth at the Industry Level. *The American Economic Review*, 90 (2), 161-167.

Lipsey, R. G., & Garlaw, K. I. (2004). Total factor productivity and the measurement of technological change. *Canadian Journal of Economics*, 37 (4), 1118-1150.

Long, J. B., & Plosser, C. I. (1987). Sectoral vs. Aggregate Shocks In The Business Cycle. *American Economic Review*, 77 (2), 333-336. doi: 10.2307/1805474

Mankiw, N. G. (1989). Real Business Cycles: A New Keynesian Perspective. *Journal of Economic Perspectives*, 3 (3), 79-90.

O'Mahony, M., & Timmer, M. P. (2009). Output, Input and Productivity Measures at the Industry Level: The EU KLEMS Database. *The Economic Journal*, 119 (538), F374-F403.

Pavelka, T. (2007). Employment as one of the sources of economic growth: Development of employment in region. In P. Jedlicka (Ed.), *Hradecke Ekonomicke Dny 2007* [*Hradec Economic Days 2007*]. *Economic growth and development in the region* (pp. 137-141). Hradec Králové: Gaudeamus.

Peneder, M., & Stehrer, R. (2007). Neighbours in Transition. *National Institute Economic Review*, 200 (1), 96-104.

Sixta, J., Vltavska, K., & Zbranek, J. (2011).Total factor productivity measurement based on labour and capital services. *Politicka Ekonomie*, 2011 (5), 599-617.

van Praag, C. M., & Versloot, P. H. (2007). The Economic Benefits and Costs of Entrepreneurship: A Review of the Research. *Foundations and Trends in Entrepreneurship*, 4 (2), 65-154.

Prescott, E. C., & Lawrence, R. (1997). A Theory of Total Factor Productivity. *International Economic Review*, 39 (3), 525-551.

Solow, R. M. (1957). Technical Change and the Aggregate Production Function. *The Review of Economics and Statistics*, 39 (3), 312-320.

Van de Klundert, T., & Potters, J. (1997). McKinsey on capital productivity. *Economist*, 145 (1), 101-109.

 DOI: 10.5709/ce.1897-9254.157