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ANALYSING THE CONTRIBUTIONS OF ECONOMIC GROWTH FACTORS IN ROMANIA

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Abstract: *This paper provides an empirical analysis of the macroeconomic growth in Romania during 2000-2017. The Cobb-Douglas production function was used to characterize the supply side of the economy capacity. Using quarterly data and based on the growth decomposition, we found out the contributions of capital, labour, and of the Total Factor Productivity to the output growth, on three sub-periods during 2000–2017. These findings also highlighted the standard of living, when considering the capital and the output per worker basis. Using the Cobb-Douglas production function for the growth decomposition brings a better understanding of the driving forces behind the GDP growth. The growth rates of output and of the production factors could vary considerably over time.*

Key words: *economic growth, Cobb-Douglas production function, growth decomposition, production factor, standard of living.*

1. Introduction

The people's life quality and a higher level of the living standard should be the main purposes of policymakers. The citizens' standard of living is determined by the economic capacity to produce goods and services. An aggregate supply constraint is just the capacity of a country to produce goods and services.

The supply constraint is changing and it influences the growth of the country's output. The production factors which consist of the inputs into the national economic system are capital and labour.

For more than six decades, the Solow-Swan model has been used to explain the output growth depending on its factors: the technical progress, capital and labour inputs. This model is a Cobb-Douglas production function of the output, determined with constant returns to scale.

Tanner (2014) showed that the standard of living is a multi-dimensional concept, difficult to be measured. The output of a country is an imperfect indicator of the well-being; it is more important how much people and what they are consuming rather than what they produce.

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On a per-worker basis, a part of the economic growth is due to the savings and investments - the key drivers of capital accumulation and the rest of the growth is explained as the result of changes in the Total Factor Productivity (Tanner 2014). At the steady state – a long-run equilibrium of constantly acting variables - it becomes clear that only a continuous increasing in Total Factor Productivity (TFP) can conduct to a continual economic growth (Tanner, 2014).

The economic performance and the output growth measurement constituted the purpose for many researchers and economists of national and international institutions, well-known for their contributions in theorizing concepts in the economic practice (Gălăţescu, et al. 2007; Strulik 2012, 2014; Stiglitz et al. 2009; Shahin 2012; Dowrick 1995; Andersen and Gruen 1995; Tanner 2014, 2017).

2. Objectives

The paper is based on the production function as an important analysis tool of the economy capacity. The theoretical framework contains a presentation of Cobb-Douglas production function and the economic growth decomposition on factors. With the growth decomposition, we identified the contributions of capital, labour and of TFP to the output growth. Here the role of investments is emphasized, as the motor of capital stock growth, and also the per worker approach, in analysing the standard of living.

The main objective of the analysis is to assess the drivers of the economic growth in Romania and of the standard of living, per worker basis, using the growth decomposition. The Cobb-Douglas function was applied on the historical quarterly data of Romanian economy for three sub-periods identified during the period 2000 – 2017; the results were commented and compared within the analysis.

The conclusions of this study present the comparisons of the economic growth forecasts, including the further directions of research and the limitations of the study.

3. Methodology of Research

3.1. The Cobb-Douglas Production Function

The most widely used production function is the Cobb-Douglas function, in equation (1).

$$Y = AK^{\alpha}L^{1-\alpha}\ ,\ 0 < \alpha < 1 \qquad (1)$$

The total output, *Y*, is on the left hand side. On the right side, the two factors of production, capital (*K*) elevated to a factor α times labour (*L*) elevated to other factor (*1 - α*), are multiplied by *A*, the Total Factor Productivity (TFP).

The labour factor (*L*) is considered to be the number of employees in an economy.

The exponential coefficients may be considered as growth elasticities.

If considering $\alpha = 0.3$ (often used for the United States), the capital stock (*K*) rises by 1% and all the others are kept constant, the output would grow by 0.3%. The coefficient α is varying somewhat between countries. The value of 0.3 is often used by the

economists for their own country. The elasticity of output with respect to labour is (*1 - α*), meaning if employment increases by 1%, the output would increase by 0.7%. The restriction of $0 < \alpha < 1$ assumed by the Cobb-Douglas production function satisfies the condition that the marginal products of both capital and labour be positive and diminishing. The increase in total output with 1% is due: 0.3% to capital increasing by 1%, and 0.7% to the labour increasing by 1%.

This kind of interpretations makes the Cobb-Douglas production function a very good tool, being widely used.

3.2. Growth decomposition with the Cobb-Douglas production function

The form of growth rate in the Cobb-Douglas production function allows the growth decomposition, explaining certain economic growth over time. When converting a term with an exponent to a growth rate, this rate of the variable is multiplied by the exponent.

The growth rate of the output is situated on the left hand side in the equation (2). On the right hand side, the terms are, in order: the growth rate of TFP, the growth rate of capital stock multiplied by α and the growth rate of labour times *(1 - α)*, its exponent being the labour elasticity.

$$\%\Delta Y = \%\Delta A + \alpha\%\Delta K + (1-\alpha)\%\Delta L \quad (2)$$

The growth rate of capital stock times α is *the contribution of capital to the growth rate of output*, meaning that when the capital stock rises by 1%, the output will rise by 0.3% (α = 0.3). One would say that the capital's contribution to growth is 0.3%. If labour grows by 1%, then the contribution of labour *to the growth rate of the output* is 0.7%.

The growth rate of the Total Factor Productivity - $\%\Delta A$, is calculated as a residual, in equation (3) being the output growth rate minus the α% the capital growth rate and minus (*1 – α*)% the employment growth rate.

$$\%\Delta A = \%\Delta Y - \alpha\%\Delta K - (1-\alpha)\%\Delta L \quad (3)$$

The residual term of the Total Factor Productivity changes by moving up and down, a good reason for which it should be explained.

3.3. Per worker basis approach, in analysing the living standard

The interest in analysing the economic growth has the final purpose to characterize the living standard of the country.

The consideration of the aspects about the living standard conducts to the approach of calculating the production per person or per worker basis. Starting from the Cobb-Douglas production function and dividing by the labour factor, *L*, in equation (4), the output per worker equals the Total Factor Productivity, *A*, times capital per worker.

$$Y = AK^{\alpha}L^{1-\alpha}; \quad \frac{Y}{L} = A\left(\frac{K}{L}\right)^{\alpha} \tag{4}$$

The assumption of the constant returns to the scale of the production function works here, in equation (4); by dividing both the left and the right side term by any number, in this case by labour, *L*, the output per worker results as a function of capital per worker.

Taking equation (2) of the growth rate of output as sum of the factors' contributions and subtracting the labour contribution from the output growth, on the left side, equation (5) is obtained, which is also obtained as equation (4) written on the growth rate basis.

$$\underbrace{\%\Delta Y - \%\Delta L}_{\text{Growth per worker}} = \underbrace{\%\Delta A(res)}_{\text{TFP growth}} + \alpha\underbrace{[\%\Delta K - \%\Delta L]}_{\text{Growth of capital per worker}} \tag{5}$$

The growth of output per worker is on the left hand side of equation (5), and on the right side is the growth of TFP plus α times the growth of capital per worker. The calculation of TFP as residual in equation (6) is the same as initially calculated, exactly as in equation (3).

$$\underbrace{\%\Delta A(res)}_{\text{TFP growth}} = \underbrace{\%\Delta Y - \%\Delta L}_{\text{Growth per worker}} - \alpha\underbrace{[\%\Delta K - \%\Delta L]}_{\text{Growth of capital per worker}} = \%\Delta Y - \alpha\%\Delta K - (1-\alpha)\%\Delta L \tag{6}$$

The investments do not always give a higher standard of living of the people in a country especially when they are not effective. Another reason is that the effects of investments are felt over time; they do not immediately increase the standard of living.

As seen in equation (5), the growth of TFP is the component which can have a greater impact, and more, the part of TFP which represents the policies of the government, meaning the reforms taken by the political leading party. Moreover, the identification of those reforms which bring a bigger rise of TFP is important for the economic diagnostic of a country.

4. Results and Discussions

4.1. Assessing the drivers of economic growth in Romania using the growth decomposition

The quarterly growth rates of GDP in Romania during Q1 2000 - Q2 2018 can be seen in Fig. 1. In Romania, the economic crisis began in the fourth quarter of the year 2008, and the output decreasing continued during eight quarters, until the beginning of 2011.

In Romania, the economic growth tendency changed, a fact caused by the economic crisis started in 2008, not to be soon recovered.

In the paper *Potential GDP Estimation for Romania,* the authors (Gălăţescu et al. 2007) used the Cobb-Douglas production function and assumed the capital and labour weights to be 0.33 and 0.67. Dobrescu (2006) used a value of α = 0.35 for the weight of capital and (*1* - α) = 0.65, the weight of labour in the production function. In this paper, we used the weights of 0.3 for capital, and 0.7 for labour.

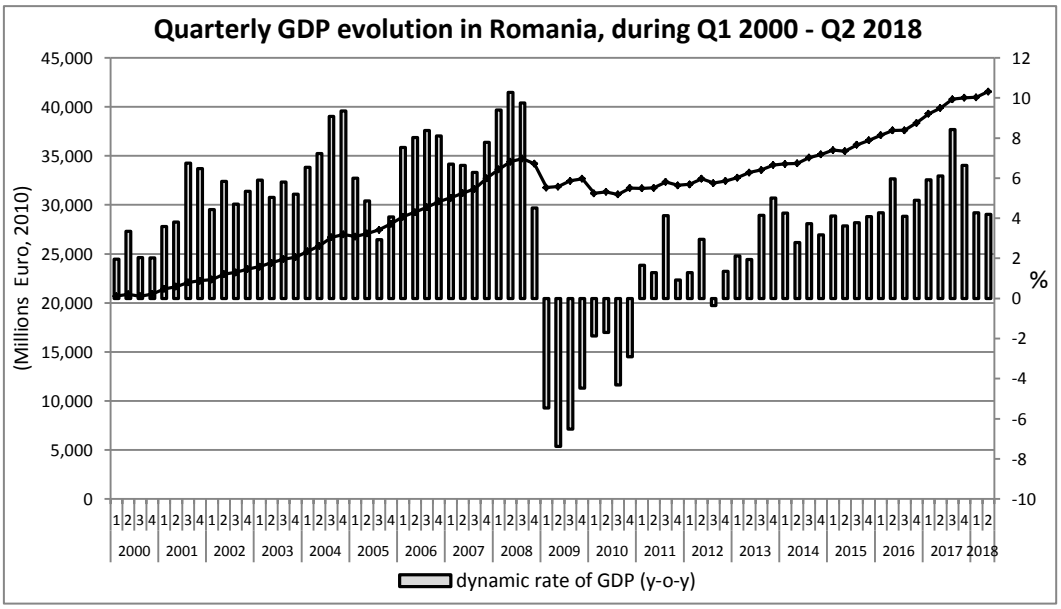

Fig. 1. *Evolution of quarterly GDP and dynamic rates (y-o-y)*

Based on Fig. 1, we established the following three sub-periods to analyse the quarterly growth behaviour of real GDP and of the factors labour and capital: Q1 2000 – Q4 2008, Q1 2009 – Q3 2012 and Q4 2012 – Q4 2017.

Emphasizing the growth decomposition for the Romanian economy using the Cobb-Douglas production function supposes to follow the phases of calculating the capital stock (*K*), the employment (*L*), the growth rates for *Y*, *K*, and *L*, then the contributions to growth of *K*, *L*, and of *A* as a residual, also the averages for sub-periods and interpreting the results.

Calculating the growth rates of output supposes to consider a year over year basis, y-o-y. For example, the growth rate of the real GDP (*Y*) in Q1 2001 was of 3.6%; this assumes the consideration of the GDP in Q1 2001 over GDP in Q1 2000 minus one, and expressed in % y-o-y basis. The averages of y-o-y GDP growth rates for sub-periods of the analysed period 2000-2017 are presented in Table 1.

The indicator Gross Fixed Capital Formation (GFCF) comprises the investments for the total economy, government, business and the households sectors. The share of this indicator as a percentage of GDP is the gross investment. The quarterly GDP values of Romania, and the quarterly Gross Fixed Capital Formation, which are the gross investments (*I*), are denominated in real currency million euro 2010 and are available on

Eurostat. The time series used in this analysis start from Q1 1999 until Q4 2017. We use the assumption that the ratio capital per output[2] (*K/Y*) is 300%.

The capital stock is 300% of GDP. Another assumption is the existence of a quarterly amount of the gross investment. The starting point is to estimate the capital stock of the first quarter 1999, K_t, which equals 3 times the annualized value of GDP, i.e. multiplying $GDP_{Q1\ 1999}$ by 4, because the year has four quarters. Then the capital estimated for the second quarter of 1999, as in equation (7), is the capital of Q1 1999 times (1 - δ), where δ is the depreciation rate, which is considered 5% per year, meaning 1.25% per quarter[3].

$$K_t = K_{t-1}(1-\delta) + I_t \tag{7}$$

The analysed period is Q1 2000 until Q4 2017. The use of the previous year, 1999, before the considered period, tries to damp errors of capital stock estimation with perpetual inventory method, letting the effects of investments to act. The share of gross investments in GDP during the analysed period had a quarterly average of 24.3%, in Table 1. The growth rates of the capital stock, on a year over year basis (y-o-y) and the average growth rates of the estimated capital stock for the three sub-periods of the analysed period 2000 – 2017 are presented in Table 1.

For Romania, the data refer to the labour force as total employment, in thousands persons with ages between 15 and 64 years and all ISCED 2011 levels of education (seasonally and calendar adjusted data, domestic concept, source Eurostat). The number of employees should be calculated applying the employment rate for each quarter to the labour force. The employment rate can be calculated for each quarter by dividing the number of employees to the labour force. In Q1 2000, the employment rate was around 54% and in Q4 2017 it was more than 75%.

The averages of the employment growth rate (%) during the three sub-periods and for the whole period are presented in Table 1. The employment rates (*er*) increased over the three sub-periods, as seen in Table 1.

Average indicators of the sub-periods and of the whole period Table 1

Sub-periods of the period 2000-2017	Growth Rates of Components (% y-o-y)			Gross Investment Rate (% of GDP)	Employment Rate (*er)*(%)
	Real GDP (*Y*)	Estimated Capital Stock (*K*)	Employment (*L*)		
Q1 2000 - Q4 2008	6.0	3.7	1.1	22.9	64.0
Q1 2009 - Q3 2012	-1.5	4.7	-2.2	26.6	67.4
Q4 2012 - Q4 2017	4.3	3.3	1.6	25.0	71.8
Q1 2000 - Q4 2017	3.9	3.8	0.5	24.3	67.0

[2] "The capital coefficient is simply the amount of capital divided by the gross domestic product. The capital coefficient informs how much capital is needed to generate one unit of output." (Berlemann and Wesselhöft, 2014, p. 20)

[3] "…., the chosen annual depreciation rate was similar to the one generally used in the literature, namely 5 percent (implying a quarterly rate of 1.25 percent)." (Gălăţescu, Rădulescu, Copaciu, 2007, p.12)

As it can be seen in Table 1, in the first sub-period from 2000 until 2008, before the economic crisis started, the real GDP (*Y*) recorded quite a high level of dynamic rate of about 6%, which decreased during the second sub-period Q1 2009 – Q3 2012, even becoming negative, followed by restarting during Q4 2012 – Q4 2017.

The estimated capital had a higher growth rate in the second sub-period, during the economic crisis, when employment had even a negative dynamic rate. Looking at the entire analysed period, the growth rates of GDP, estimated capital stock and employment were positive, but those of employment were the lowest values. The overall tendency of the dynamic growth rates of the three indicators *Y*, *K*, and *L* during the entire period was an increasing one. The capital stock had the growth rate close to that of GDP, for the entire period Q1 2000 – Q4 2017. The growth rates of the capital stock were positive, emphasizing the key role of investments for economic growth.

The contribution to the output growth of the capital stock is calculated using $\alpha=0.3$ times the capital stock growth. The contribution of employment is obtained multiplying the factor $(1-\alpha)=0.7$ by the employment growth rate. Then the contribution of the Total Factor Productivity (TFP) is a residual obtained from the total growth of *Y* minus the contribution of capital minus the contribution of labour, as in equation (3).

The average contributions of the factors' growth rates to the output growth rate for the analysed sub-periods of the whole period 2000 - 2017 are presented in Table 2.

Growth decomposition during the sub-periods and the whole period Table 2

Sub-periods of the period 2000-2017	Real GDP (*Y*) (% y-o-y)	Contributions to Growth (%)		
		Estimated TFP (*A*)	Estimated Capital Stock (*K*)	Employment (*L*)
Q1 2000 - Q4 2008	6.0	4.1	1.1	0.7
Q1 2009 - Q3 2012	-1.5	-1.4	1.4	-1.6
Q4 2012 - Q4 2017	4.3	2.2	1.0	1.1
Q1 2000 - Q4 2017	3.9	2.4	1.1	0.4

The *Employment contribution to GDP growth* during the period Q1 2000 – Q4 2017 was 0.4% on the average.

For the Romanian economy, during the period 2000 - 2017, the key driver of output growth was the growth of the stock of productive capital, having an almost constant average contribution of 1.1% to the output growth. TFP had the highest contribution of about 2.4% on the average.

The contributions of production factors to the yearly dynamic rates of GDP change are presented in Fig. 2. We notice all the positive contributions of the capital stock during the entire analysed period; during the crisis, it was the only positive contribution. Another conclusion is about the negative contribution of the labour factor from time to time, especially during the crisis, both in Table 2 and in Fig. 2.

During the economic crisis, which started in Romania at the end of 2008, the negative contribution of TFP is the only sub-period characterized by this type of behaviour. The negative TFP shows the inefficient effects of management measures taken by the

government, combined with the interrelationship effects between world economies, proving the dependence of the Romanian economy, and the unsustainable character of its economic development.

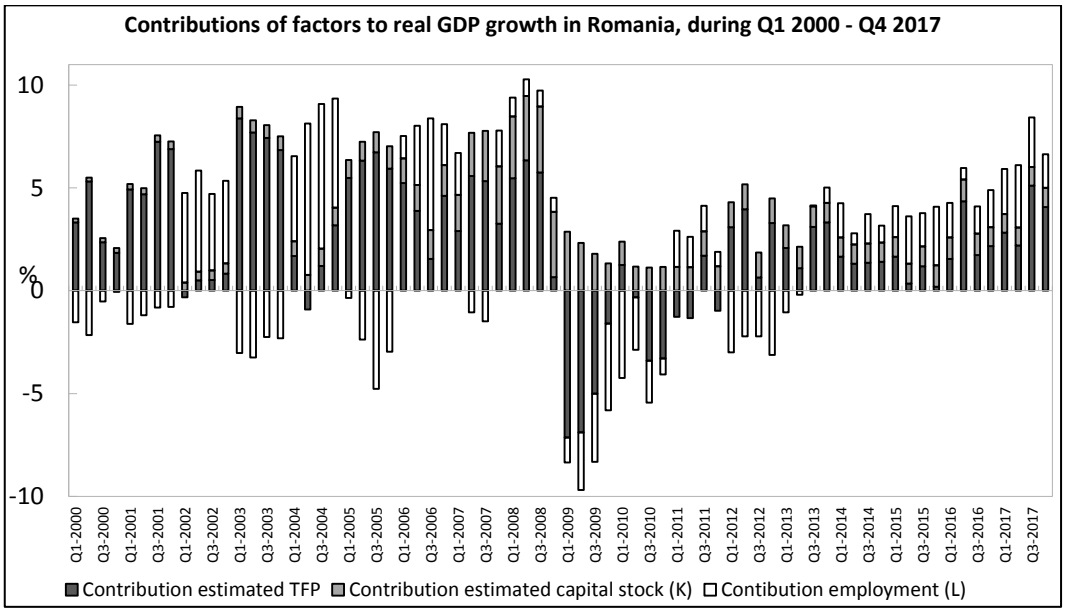

Fig. 2. Contributions of factors to GDP growth in Romania, during Q1 2000 - Q4 2017

The factors' contributions to the real GDP growth on each analysed sub-period and for the entire period is presented in Table 3.

Fig. 3 presents the contributions of factors for each sub-period. The height of the column of contributions represents the average growth rate of GDP in % per year. The evolution of the factors' contributions can be compared during the sub-periods and for the entire period.

The average growth of GDP was of 6% during the first sub-period; when the economic crisis began in Romania, it dropped down to -1.5% during 2009 until the third quarter of 2012, and from that moment, the average yearly dynamic rate was 4.3%. For the entire period, the average growth rate of GDP was 3.9%.

Factors' contributions to economic growth on sub-periods and entire period Table 3

Averages for period: (% / year)	Q1 2000 - Q4 2008	Q1 2009 - Q3 2012	Q4 2012 - Q4 2017	Q1 2000 - Q4 2017
Average GDP Growth	6.0	-1.5	4.3	3.9
TFP growth	4.1	-1.4	2.2	2.4
Capital Growth	3.7	4.7	3.3	3.8
Capital Growth Contribution	1.1	1.4	1.0	1.1
Employment Growth	1.1	-2.2	1.6	0.5
Employment Contribution	0.7	-1.6	1.1	0.4

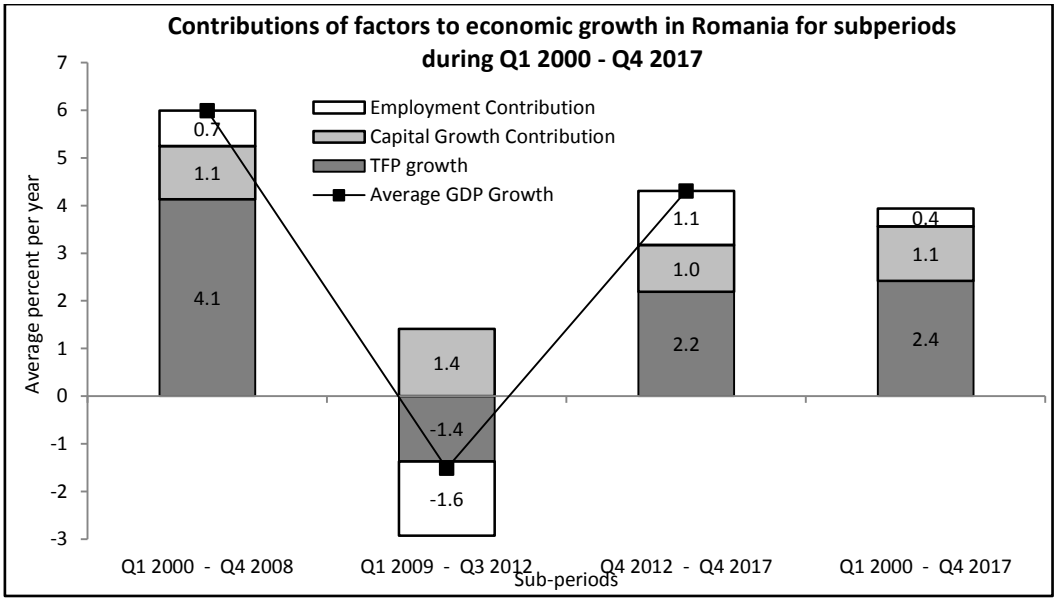

Fig. 3. *Factors' contributions to economic growth in Romania for the sub-periods and the entire period Q1 2000 - Q4 2017*

We see that the contribution of the capital growth to GDP growth was positive and almost constant, close to 1%, in all the three sub-periods, and also the entire analysed period. The employment's growth contribution seems to be more sensitive, having much lower values compared with the capital and TFP contributions. The highest contribution to output growth is that of TFP, being lesser in absolute value during the period of decline Q1 2009 – Q3 2012, when it was negative. The TFP also comprises the innovations and technical progress, but also the governmental policies and the effects of the globalization phenomenon. The high values of TFP contributions show that the economic growth does not have a sustainable character, being too exposed to the external risks of international organisations and companies.

4.2. The living standard in Romania - the growth decomposition per worker basis

The analysis of the GDP growth based on its main factors follows the interest for characterizing the standard of living of Romanian people, during the period 2000-2017.

The indicators calculated per worker basis offer information about the standard of living. All the indicators from Table 4 are in % per year. These indicators are calculated based on equation (5).

The *average GDP growth per worker* is calculated by subtracting the employment growth from the average GDP growth, presented in Table 3. For the sub-period Q1 2000 - Q4 2008: 6% - 1.1% = 4.9%. Similarly, the calculations are for the next sub-periods and for the entire period: 3.9% - 0.5% =3.4%. The average *capital growth per worker* is calculated by subtracting the *employment growth* from the *average capital growth* from Table 3; for the entire period Q1 2000 - Q4 2017: 3.8% - 0.5% =3.3%.

The living standard in Romania on sub-periods and entire period Table 4

Standard of living: (% per year)	Q1 2000 - Q4 2008	Q1 2009 - Q3 2012	Q4 2012 - Q4 2017	Q1 2000 - Q4 2017
Average GDP growth *per worker*	4.9	0.7	2.7	3.4
Capital growth *per worker*	2.7	6.9	1.7	3.3
TFP growth *per worker*	4.1	-1.4	2.2	2.4

TFP is calculated as residual, based on equation (6). TFP growth is the difference between *the average GDP growth per worker* and α (the capital share) times *the average capital growth per worker*, both presented in Table 4. For the entire period Q1 2000 - Q4 2017: 3.4% - 0.3*3.3% = 2.4%. The TFP values are identical with the values from Table 3, which are obtained as averages on sub-periods and for the entire period, from the calculated values TFP, as residuals based on equation (3) for each quarter on y-o-y basis. In Table 4, there is an alternative calculation of TFP, from the GDP growth per worker basis subtracting α times the capital growth per worker.

5. Conclusions

The country's increasing or decreasing supply side of economic growth can be explained with the production function tool. The economic growth depends on its factors: capital and the labour.

The way the production factors are transformed in output efficiently is characterized by the total factor productivity. The capital stock is built through investment expenditures. The labour component consists of the working age population that has a job, meaning the employees' number. The migration phenomenon causes the labour force to shrink when the workers emigrate; they are leaving the country for a job abroad. The labour force is growing in case of immigration, when people enter the economy from abroad.

More developments of the obtained results can be further made. The elasticities α and 1 - α should correspond to the factors' expenditure shares. Choosing the value of the capital's and labour's share of 0.3, respectively 0.7, may represent another research direction. Professors Cobb and Douglas established these values in their research available for the United States of America. The shares of production factors may be different for other countries. The new informational technologies and the technical progress significantly influenced the production relationships and the importance of factors costs.

We used a basic definition of the labour factor as the number of employees. A further research direction could consider the adjustment of the quality of the labour force. Some indicators of the labour quality could be the literacy rate and the school enrolment rate at primary, secondary and tertiary level. Also the digitalization degree of some activities, and the features of New Economy found in an economy globalization world could be future directions in analysing the quality of labour within a national

economy. There are also difficulties in recording and estimating the employed persons, especially for those persons who work in the informal sector.

The estimation methods for the capital could be subject to future research. The perpetual inventory method depends on the initial value of the capital stock, of the investment and of the depreciation rate.

The TFP represents a measure of the factors' efficiency and productivity. But TFP is calculated as residuals, and it includes all the differences described above as future directions for research.

Although there are some problems related to the Cobb-Douglas function, this tool is still useful for the analysing the factors' contributions to economic growth, as presented in this paper.

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