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FORECASTING THE ECONOMIC GROWTH IN ROMANIA WITH THE COBB–DOUGLAS PRODUCTION FUNCTION

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Abstract: *The Cobb-Douglas production function is an important analysis tool which is used to characterize the supply side of the Romanian economy capacity, during 2000-2017, and to forecast the future tendency of economic growth for the next two years. The study comprises two approaches of the Romanian economy forecasting. One approach consists of building two scenarios, one optimistic and another pessimistic, based on the target output of IMF experts' opinions. We compared these scenarios of the results for three sub-periods and for the entire analysed period. Another approach was to compound the separate forecasts of factors. The results proved to be consistent between the two approaches, as well as regarding the historical data.*

Key words: *economic growth, Cobb-Douglas production function, growth decomposition, target output based forecasts; factor forecasts.*

1. Introduction

The economic performance and output growth measurement have represented the focus of 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).

The technical progress is considered to be an exogenous factor which comprises not only the technical innovative changes, but also the policy-induced changes, which can affect the capital stock growth, mainly the changes in the investment/GDP ratio.

"*The most empirical studies do not suggest macro-policies have much influence on labour force growth*" (Andersen and Gruen, 1995), although the role of entrepreneurship on the Total Factor Productivity in the long run has been proved (Erken et al. 2018).

The technical progress was similar during the development process for almost all the

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countries. The growth differences between countries emphasize the exogenous character of policies and economic decisions of policy-makers, which have influenced the economic growth, being also a measure of total factors' productivity (Dowrick 1995).

The growth differences between countries are especially influenced by the initial economic conditions, and more, by the initial level of productivity. These aspects of the initial conditions even of endogenous nature are considered by Dowrick (1995) as semi-exogenous. The subsequent growth is determined to a certain extent by the starting point. The estimation of TFP was a main theme for researchers Gehringer, Martínez-Zarzoso, and Nowak-Lehmann Danzinger (2014).

Measuring the stock of capital was an important subject, also the estimation based on the perpetual inventory method – in many scientific research studies (Berlemann and Wesselhöft 2014; Nehru and Dhareshwar 1993; Corrado et al. 2005; Scutaru et al. 2008).

2. Objectives

The purpose of this analysis was to make a forecasting for the Romanian economic growth in 2018 and 2019, based on the quarterly historical data during 2000-2017.

Our analysis regarded the modalities of obtaining the forecasts, and the checking of their consistency from a dynamic perspective.

Using the Cobb-Douglas production function for the decomposition method of the factors' contributions to output growth allows a prospective overview on the economic growth.

After applying the Cobb-Douglas function on the historical quarterly data of the Romanian economy for three sub-periods identified during the period 2000 – 2017, we used the Cobb-Douglas function to forecast the growth of the Romanian economy for 2018 and 2019.

The forecasting approaches are of two types: a target forecast based on IMF experts' opinion and an independently established one, based on separate forecasts of factors and their compounding in different scenarios.

The conclusions 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, an analysis tool of the economy capacity

An important analysis tool of the supply drivers of economic growth is the growth decomposition. The production function represents a tool which can summarize the production constraint of an economy, i.e. the volume of goods and services that it is able to produce. Trying to measure these two factors also offers us an image of the efficiency of their use for obtaining the output: goods and services. The aspect connected to the efficient use of the production factors is the Total Factor Productivity.

The Cobb-Douglas production function explains the drivers of growth on the supply side, because capital, *K*, and labour, *L*, are input factors in order to obtain the output, *Y*, in equation (1).

The Total Factor Productivity, A in equation (1), is influenced by the technological level of the economy and by economic policies. Besides technology, the economic structure, the management and the governmental policies are also determinants of the Total Factor Productivity.

$$Y = AK^{\alpha} L^{1-\alpha}, \ 0<\alpha<1 \tag{1}$$

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

The decomposition of factors contributions equation with the Cobb-Douglas production function is often used and its form is as in equation (2).

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

It is important to emphasize the constant returns to scale, meaning that increasing capital by 1%, and labour by 1%, the increase in the total output is equal to 1%. This property is useful to express the output per capita. Expressing on the per worker basis means multiplying the equation (1), both capital and labour, with a quantity *x=1/L*, which will determine the output per worker depending on capital per worker and the decomposition per worker basis in equation (3).

$$\frac{Y}{L} = A \cdot \left(\frac{K}{L}\right)^{\alpha} \tag{3}$$

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

3.2. Measuring the capital stock in an economy

The data about the capital stock could either be estimated based upon surveys or knowing the motion of the capital stock over time from one period to the next, the "perpetual inventory method" can apply, as in equation (4).

$$K_t = K_{t-1} + I_t - DEP_t \tag{4}$$

K_t – Capital stock from the current period, *t*;
K_{t-1} – Capital stock from the previous period, *t-1*;

I_t – Investment expenditures from the current period, *t*;
DEP_t – Depreciation of capital stock for the current period, *t*.

The capital value is a stock variable, available at a moment in time, and the investments represent a flow referring to the period *t*. Investments is used to buy capital equipment and to build fixed capital; that will conduct to an increase of the output.

The capital is changing in time and the new goods and services are used to obtain other goods and services. We estimate the value of capital stock in the current period, by considering it from the previous period, by adding the investments and subtracting the depreciation of the capital stock taking place. Because we can never be sure about the depreciation rate, based on some estimates, we can consider a fix rate of depreciation, δ in the new equation of capital stock inventory method, in equation (5):

$$K_t = K_{t-1}(1-\delta) + I_t \tag{5}$$

According to Nehru and Dhareshwar (1993), there are many approaches for establishing the initial capital stock[2], but none of them is satisfactory. Also, there is no theory to determine which approach conducts to the least error.

3.3. The labour factor

The working age population (*WAP*) represents the main basin for the employment of labour, the labour force (*LF*). From the working age population, some are going to school or are working home and do not act on the labour market. The ratio between the number of people of working age participating as labour force in the market and the total working age population is *the labour force participation rate (lfpr)*.

The labour force (*LF*) is: *LF = WAP * lfpr*.

From the labour force (*LF*), not all the people are working; there are people looking for a job or waiting for a better job and they are not counted as employed people, who are actively working. The factor of labour, *L*, in the production function of the economy, is the number of employed workers and it can be estimated by multiplying the labour force by the employment rate (*er*). *L = LF * er*

[2] Seeing the capital stock as an accumulation of past investments in equation (5'):

$$K_t = (1-\delta)^t K(0) + \sum_{i=0}^{t-1} I_{t-i}(1-\delta)^i, \tag{5'}$$

there appears the problem of estimating the initial capital stock *K(0)* used in the estimating of the capital stock K_t. Nehru and Dhareshwar (1993) suggest the Harberger technique according to the initial investment value can be estimated through a linear regression of log investment against time. The theoretical value of I(1) is used to calculate the initial capital stock using equation (5'').

$$K(0) = \hat{I}(1)/(g+\delta) \tag{5''}$$

where *g* is the average quarterly growth rate of output and δ - the depreciation rate of capital, assumed to equal 0.01. Using long series of data the errors effect is lost.

The employment rate (*er*) varies on the phases of business cycles of the national economy. During expansions, employment rate increases and the wages are increasing; during recessions, it drops, and so do the wages.

3.4. The total factor productivity

The Total Factor Productivity (TFP) is referred to as the efficiency of using the input factors in the production process to be transformed in outputs.

Often the total factor productivity is seen as a state of technology in an economy. The increase of the Total Factor Productivity supposes the existence of technological innovations. As a consequence, more goods and services can be produced at a lower cost, conducting to a lower price, meaning an efficiency of using the resources: labour and capital.

Other aspects apart from technology of the Total Factor Productivity refer to institutional management and policies.

> "*The ease of knowledge diffusion is, of course, not fully determined by technology and capital accumulation, but it is also affected, at any given capital stock, by institutions (as, for example, barriers to travel and trade).*" (Strulik 2012).

The transports technology innovations, the capital accumulation and factors as the development of railway network, customs liberalization, exchange rates and currency agreements (Keller and Shiue 2008) have contributed to the European economic integration.

The productivity was also positively influenced by the development of communications. The computers, the internet and the latest mobile phones are important developments even if some economists are pessimistic about the advancement of the technologically led growth.

The impact of certain innovations is different depending on the historical state of social and economic development stages. Between the key factors affecting the total productivity, the health state of population and the new medical conditions may be also considered.

Some reform measures could effectively increase the Total Factor Productivity. Recent surveys of IMF found the kinds of reforms being important in certain countries with advanced, emerging market or low-income economies:

- Privatizing the financial sector is effective for all type of economies;
- Reforms of a country's fiscal structure (the tax system) for all types of economies;
- Agricultural deregulation was effective in low-income countries, and
- Infrastructure development, in the low-income and emerging market countries

(Tanner, 2017).

The concept of Total Factor Productivity becomes more measurable, trying to find the impact of the governance and economic policies.

World Bank has developed an indicator, called "*the doing business index*", which measures a country's economic efficiency. This index comprises aspects related to economic enterprises such as: the easiness of starting a business, the easiness of getting electricity, registering the property, paying taxes, protecting measures of investors,

getting a credit, and trading conditions across borders. There is a direct correlation between the doing business index and the Total Factor Productivity, because the development of the private business sector positively influences the national economic development. A higher level of the Total Factor Productivity can be partially due to a healthier business environment, meaning a higher output per worker.

3.5. Investments, the motor of capital stock growth

Here, the role of investments is to be emphasized, as the motor of capital stock growth, and their effects on GDP growth. The capital stock at time *t* is equal to the capital stock at time *t-1*, plus the investments on productive capital, minus the depreciation, in equations (4) and (5). The depreciation is considered as a constant ratio of previous periods' capital stock, δ, in equation (6).

$$K_t = K_{t-1} + I_t - DEP_t = K_{t-1} + I_t - \delta K_{t-1} \quad (6)$$

Equation (7) of the capital stock growth rate is obtained by dividing K_t in equation (6) by the capital stock of the previous period, K_{t-1}.

$$\%\Delta K = \frac{K_t}{K_{t-1}} - 1 = \frac{K_{t-1} + I_t - DEP_t}{K_{t-1}} - 1 = \frac{K_{t-1} + I_t - \delta K_{t-1}}{K_{t-1}} - 1 = \frac{I_t - \delta K_{t-1}}{K_{t-1}} = \frac{I_t}{K_{t-1}} - \delta \quad (7)$$

The growth rate of the capital stock equals the flow of gross investment scaled by the previous period capital stock minus the depreciation ratio, δ in equation (7').

$$\%\Delta K = \frac{I_t}{K_{t-1}} - \delta \quad (7')$$

The ratio of gross investments and the capital stock of the previous period, $\frac{I_t}{K_{t-1}}$, shows that investments represent the main increasing factor for the capital stock, all the others remaining constant. If the ratio $\frac{I_t}{K_{t-1}}$ is greater than the depreciation ratio δ, than the country invests more than the depreciation of the capital stock. It is said that the net investments per capital stock ratio is positive; it means that the capital stock growth is positive. If the depreciation ratio is greater, then the capital stock is decreasing, because the growth of the capital stock is negative. In this way the ratio of investments to the capital stock is calculated, both gross and net.

The gross investments ratio to the previous period's capital stock, shortly named the gross investments ratio, minus the depreciation rate, gives the net investment ratio.

3.6. The effects of investments to GDP

Another indicator which characterizes investments is the ratio of investments to GDP. The flow of investments in the specified currency is equal to the ratio of investments to GDP times GDP itself.

$$I_t = \frac{Investments}{GDP} \cdot Y_t = \frac{Investments}{GDP} \cdot AK^{\alpha}L^{(1-\alpha)} \quad (8)$$

The flow of investments at time *t* can rise, either due the increase of investments to GDP ratio, or to the increase of GDP itself. When GDP is increasing, the investments can rise even if the Investments to GDP ratio is constant.

Starting from the production function, the factors of GDP growth to be considered are the Total Factor Productivity, the capital and the labour. The TFP should usually increase in the long run. The TFP ascending tendency shows an increase from time to time, and then TFP continues to stay constant, and then the increase repeats and again the constant stays the same. The nature of TFP can explain this behaviour, by the non-returnable and lasting beneficial effects to the GDP development, when technological changes or managerial reforms appear. More output conducts to capital accumulation.

The TFP growth has two kinds of effects on GDP simultaneously, in the short run and in the long run. The direct effect of TFP is when its rise conducts to the rise of output.

When the investment ratio to GDP is constant and GDP increases due to the TFP, than the amount added to the flow of investments calculated by equation (8) is called *the induced investments effect* and it represents the long run implication of TFP. In the long run perspective, the direct impact has indirect or induced effects on the capital accumulation, both at present and also in the future. The gradual effects of TFP in the process of capital accumulation are felt over time.

3.7. A prospective look over economic growth

The use of the historical data offers a view over the economic past and also over the present. Thinking of growth in the next years based on the analysis tool of the Cobb-Douglas production function, some assumptions need to be done.

There could be two ways of approach. In both approaches, the analysis based on the averages of variables in the sub-periods and in the whole period is recommended to be used (Tanner 2017). The most recent sub-period can be compared to the whole period.

One way is starting with the forecast of output, and using the growth decomposition to focus on what is going to happen with the capital and the employment in the next years, if their future values are consistent with the historical data. Therefore, the Total Factor Productivity can be calculated and a view over its behaviour is also important.

Another way is to separately consider the forecasts for the production factors: the capital, the labour, and the TFP - and to compound these variables to obtain the future values of the output. The assumption that the employment growth keeps the same level as in the most recent sub-period is reasonable to get the forecasts for the factor labour,

L. For the capital growth, the perpetual inventory method can be used, to get the future values of capital. The Total Factor Productivity growth can be calculated as residual, like for the historical data per worker basis, in equation (3). This way of forecasting seems to be good when an analyst's opinion about the target value of output is missing.

For the future sub-period, the TFP growth is the average output growth per worker minus α times the capital growth per worker. Comparing the TFP growth of the most recent period and looking at its evolution starting from the beginning of the whole period offers information about the effects of some new technologies or some reforms. The reality check can be applied for the Total Factor Productivity growth.

The questions about the GDP per worker growth goal, the prospective value for the capital per worker growth and that for the TFP growth can receive the answers if they were too optimistic, realistic or too pessimistic.

4. Results and Discussions

4.1. IMF expert-based forecast of Romania's GDP growth

IMF publishes the forecasts in the World Economic Outlook (WEO), twice per year, in spring and fall. In fall 2018, the forecast for the 2018 economic output growth for Romania, decreased from 5.1% in spring to 3.963%. The downward tendency for the Romanian economy was set on the basis of the global economic growth in 2018, set at 3.9% and declined at 3.7%. In the *October 2018* issue of the *World Economic Outlook,* in the report "Challenges to Steady Growth", chapter 1 "Global Prospects and Policies", projections are established for the global growth in 2018 and 2019 until 2023:

"Global growth for 2018–19 is projected to remain steady at its 2017 level, but its pace is less vigorous than projected in April and it has become less balanced. Downside risks to global growth have risen in the past six months and the potential for upside surprises has receded. Global growth is projected at 3.7 percent for 2018-19 - 0.2 percentage point lower for both years than forecast in April. The downward revision reflects surprises that suppressed activity in early 2018 in some major advanced economies, the negative effects of the trade measures implemented or approved between April and mid-September, as well as a weaker outlook for some key emerging market and developing economies arising from country-specific factors, tighter financial conditions, geopolitical tensions, and higher oil import bills."

The IMF projection of the GDP growth rate for 2018 of 3.963% rounded at 4.0% is in accordance with our calculated growth rate for the Romanian economy in the period Q1 2000 - Q4 2017, and presented in Table 1.

The IMF projection of the percentage of Gross Investments ratio in GDP for 2018 is 24.3%, being exactly the average of these weights of Gross Investments in GDP, calculated for the period Q1 2000 - Q4 2017, and presented in Table 1. We conclude that IMF considers the economic indicators calculated for the entire period analysed Q1 2000 - Q4 2017, when making projections for 2018. Table 1 contains the IMF projections of Romanian GDP growth rates, and those of Gross Investments ratios in GDP, for the period 2016 - 2022.

In 2018, the projection of the growth rate from spring WEO declined in WEO autumn edition. In the previous two years, the spring and the fall projections were quite close, but for 2018, the forecasting drops, in fall 2018 to 4%.

Table 1

Projections of Romanian GDP growth rates and Gross Investments ratios in GDP

Years	IMF projections for Romanian GDP growth (%)		Results based on own calculations	IMF projections for % of Investments in GDP
	Spring WEO	Fall WEO		
2016	4.82	4.823	4.8	23.785
2017	6.99	6.947	6.8	24.437
2018	5.10	3.963	*4.2**	24.3
2019	3.50	3.433		22.881
2020	3.10	3.251		22.809
2021	3.10	3.231		22.595
2022	3.10	3.176		22.482

*(Annual % change), * - average growth rate y-o-y of data based on Q1 and Q2 2018*

Table 2 contains the GDP growth rates calculated from the quarterly data of the Romanian economy, compared to the IMF annual projections for the period 2000-2009 and for each year starting with 2010 until 2019, and also for the year 2023[3].

Table 2

Romanian GDP growth rates, compared to the IMF annual projections

Years	**IMF Average Projections (%)**	**Romanian economy (%)**
2000 - 2009	4.8	4.8
2010	-2.8	-2.7
2011	2.0	2.0
2012	1.2	1.3
2013	3.5	3.3
2014	3.4	3.5
2015	3.9	3.9
2016	4.8	4.8
2017	6.9	6.8
2018	***4.0***	
2019	***3.4***	
2023	***3.1***	

(Annual % change)

[3] https://www.imf.org/en/Publications/WEO/Issues/2018/09/24/world-economic-outlook-october-2018#Full%20Report, Table A4. Emerging Market and Developing Economies: Real GDP at p. 156.

The IMF prognoses are quite very close to the Romanian economic reality, and are close to the GDP calculated growth rates. The effective values of the real GDP for quarters Q1 2018 and Q2 2018 are comprised within the interval we established, based on the spring and autumn IMF assumptions.

The pessimistic scenario is based on the last IMF projections of output growth of 3.963% for 2018 and 3.433% for 2019, in Table 2. The IMF estimation of the growth rate for 2018 equals the average growth rate we calculated for the entire period Q1 2000 – Q4 2017. The optimistic scenario considers the spring IMF projections of the growth rate of 5.10% for 2018 and 3.50% for 2019.

Considering the two scenarios based on the IMF projections from spring and autumn 2018, for the years 2018 and 2019, the forecasting are presented in Fig. 1.

The real GDP in the two first quarters of 2018 belong to the identified intervals, closer to the lower limits of intervals, proving an appropriate approach of the forecasting.

The European Commission has also significantly changed the autumn estimations of Romanian economic growth for 2018 in decline, from 4.5% to 3.6%, and, for 2019, a growth rate of 3.8% from 3.9% was estimated, which was the spring established value[4].

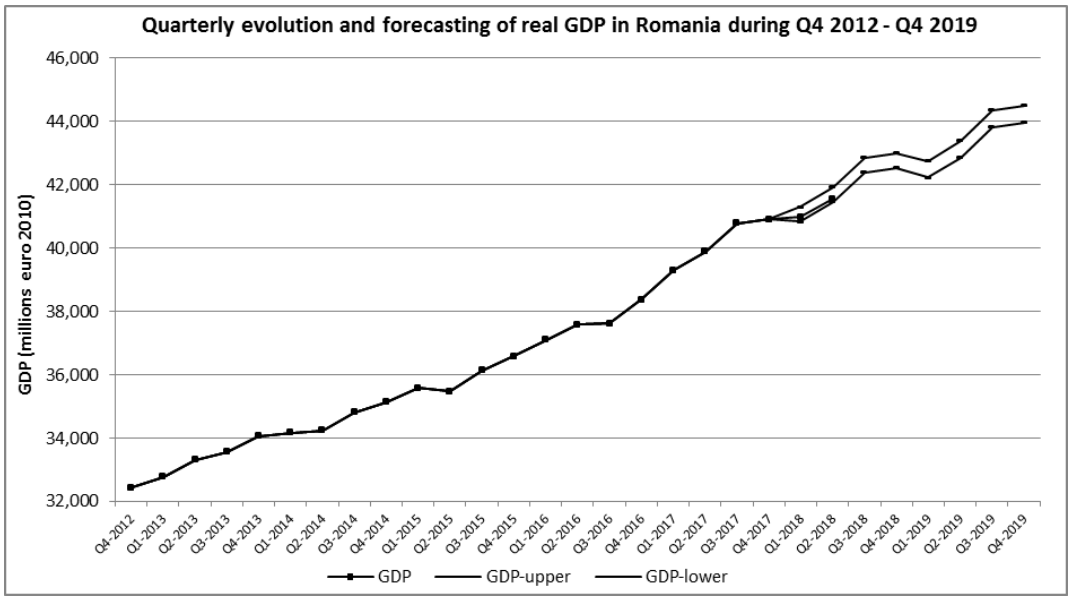

Fig. 1. *Scenarios of forecasting the quarterly GDP in Romania for 2018 and 2019*

We evaluate the appropriate standard of living for the two scenarios of economic growth in Romania, for 2018, in Table 3 to identify which of two projections should be better to consider.

For the four quarters of 2018, we consider as constant the Gross Investment per Capital Ratio, being the value of the most recent sub-period, i.e. 2%, in order to find the

[4]https://ec.europa.eu/eurostat/documents/2995521/9378018/2-14112018-BP-EN.pdf/b4fd131d-8938-4ef6-9cb5-9c2f73d2809d

GFCF (Gross Fix Capital Formation) and to continue estimating the capital stock using the perpetual inventory method.

The same action is taken for the dynamic rate of the employees' number, keeping the value of the most recent sub-period, meaning 1.6%.

We can forecast the real GDP values for 2018 and calculate the average weight of the real Investments as share in GDP, in both scenarios. The Gross Investments ratio in GDP was estimated at 23.8% for the pessimistic scenario, and at 23.6% for the optimistic scenario, in both cases being lesser than 24.3%, the IMF prognosis for 2018, in Table 1.

Keeping the growth rates for labour, belonging to the most recent period, involves 0 to the differences of labour growth projections with respect to the period Q4 2012 - Q4 2017, for both scenarios (lower and upper), in Table 3.

The prospective growth assessment with respect to the most recent period Q4 2012 - Q4 2017 and to the whole period Q1 2000 - Q4 2017, in Table 3, conducts to the conclusion that the IMF lower projection offers the lowest differences in both cases.

Looking at the consequences of accepting the pessimistic scenario, we can see the indicators for the standard of living more deteriorated with respect of the whole period Q1 2000 - Q4 2017, which is only natural in this situation of slowing the economic growth. In Table 3 we can see that the pessimistic scenario (lower IMF assumption) presents differences closer both to the recent sub-period Q4 2012 - Q4 2017, and to the whole period Q1 2000 - Q4 2017. The conclusion is that IMF new estimation for 2018 is much closer to the Romanian economic reality. Furthermore, we notice that the IMF new economic growth estimation for 2018 is consistent with the most recent period Q4 2012 - Q4 2017.

Prospective growth assessment for the two scenarios Table 3

Assessment for medium term	IMF Assumption for Q1 2018 - Q4 2018		Difference with respect to the most recent period Q4 2012 - Q4 2017		Difference with respect to the whole period Q1 2000 - Q4 2017	
(% per year)	lower	upper	lower	upper	lower	upper
Output growth	**3.9**	**5.1**	-0.4	0.8	0.0	1.2
Capital growth	**3.2**	**3.2**	-0.1	-0.1	-0.6	-0.6
Employment growth	**1.6**	**1.6**	0.0	0.0	1.1	1.1
Average GDP growth per worker	2.3	3.5	-0.4	0.8	-1.1	0.1
Capital growth per worker	1.6	1.6	-0.1	-0.1	-1.7	-1.7
TFP growth	1.8	3.0	-0.4	0.8	-0.6	0.6

For Q1 2018 and Q2 2018, we used the effective quarterly real GDP, the empirical values of quarterly real GFCF and the employees' number. Together with the last IMF projections of the GDP growth of 3.9% for Q3 2018 and Q4 2018, and of 3.4% for each quarter of 2019, we calculated the growth decomposition, to see how much the capital growth and the employment growth in 2018 should be, as well as the TFP.

The obtained values of averages for the four quarters in 2018 and of 2019 are presented in Table 4. The dynamic rates of the growth components, the decomposition of economic growth and the standard of living determined by the components, for the whole analysed period, for the recent sub-period Q4 2012 – Q4 2017 and for the next two years, are presented in Table 4.

Analysing and comparing the average values for each indicator, we may conclude that the economic growth declines during the following two years. The declining tendency of the output growth in 2019 compared with 2018, and with the recent sub-period Q4 2012 – Q4 2017 is caused by the reducing growth rate of employment and of its contribution, but also by the decline in TFP growth.

The employment growth for 2018 is 1.9% calculated as the average level of the first three quarters, and for Q4, considering the average level of the most recent sub-period, meaning 1.6%. For the quarters of 2019, the average level of the most recent sub-period was kept, i.e. 1.6%. The employment contribution seems to have a decline in its contribution from 1.3% in 2018 to 1.1% in 2019, in Table 4.

The key role of economic growth belongs to the capital stock and to investments. The capital's contribution is around 1% in both following two years, when the capital continues to increase by around 3% and the net investments/ capital ratios are kept constant at 0.8%, in Table 4. The gross investment as % share in GDP decreases from 25% in the most recent sub-period at around 23% in the next two years, as a consequence of the weak performances of the Romanian economic policies.

Forecasts based on IMF projections for 2018 and 2019 Table 4

Averages for period: (% per year)	**Whole period Q1 2000 - Q4 2017**	**Recent period Q4 2012 - Q4 2017**	**Q1 2018 - Q4 2018**	**Q1 2019 - Q4 2019**
GDP growth	3.9	4.3	4.1	3.4
TFP growth	2.4	2.2	1.8	1.3
Capital growth	3.8	3.3	3.1	3.2
Capital growth contribution	1.1	1.0	0.9	1.0
Employment growth	0.5	1.6	1.9	1.6
Employment contribution	0.4	1.1	1.3	1.1
Standard of living				
Average GDP growth *per worker*	3.4	2.7	2.2	1.8
Average capital growth *per worker*	3.3	1.7	1.2	1.6
TFP growth	2.4	2.2	1.8	1.3
Investment ratios				
Net -- in % of capital stock	0.9	0.8	0.8	0.8
Gross -- in % of output	24.3	25.0	23.3	23.5

The TFP is also a component which clearly decreases its growth, pointing at the lack of government performance.

The average GDP growth per worker is decreasing, conducting to a decline in the Romanian standard of living, as seen in Table 4.

4.2. Independent forecasting of Romanian GDP growth in 2018 and 2019

We can suppose that there is no expert opinion related to the economic growth, and based on the historical data we are able to offer some forecasts of output growth.

Trying to offer a good forecast of the GDP growth may start from separately considering the future values of the three factors: capital, labour, and total factor productivity; compounding these components, we can obtain the future values of output.

We have three options of producing independent forecasts based on the composition method of the components' forecasts. The results are presented in Table 6, in the last three double columns, each forecast option for 2018 and 2019. These approaches may be compared with the experts' estimations for the Romanian GDP growth for 2018 and 2019, considered to be target forecasts, in Table 6.

The first option is to start forecasting at the end of 2017, without any future known value for any indicator. The other two options are based on the already known values of indicators for Q1 2018 and Q2 2018.

Considering the first option, the future values of the capital stock can be estimated using the perpetual inventory method, in equation (5). The Gross Investment/ Capital ratio is mostly constant, of about 2.2%, as average for the entire period, in Table 5.

Investments ratios during the sub-periods and for the whole period Table 5

Sub-periods of the period 2000-2017	**Gross Investment / Capital Ratio (I_t/K_{t-1}) (%)**	**Quarterly depreciation ratio (d) (%)**	**Net Investment / Capital Ratio (I_t/K_{t-1})-d (%)**
Q1 2000 - Q4 2008	2.3	1.25	1.0
Q1 2009 - Q3 2012	2.3	1.25	1.0
Q4 2012 - Q4 2017	2.0	1.25	0.8
Q1 2000 - Q4 2017	2.2	1.25	0.9

Note: "t-1" is previous quarter

Table 5 contains the averages of the quarterly indicators Gross Investment/Capital Ratio and Net Investment/Capital Ratio during the emphasized sub-periods. For Romania, the constant quarterly depreciation (d) was assumed at 1.25%. The depreciation rate is supposed to be 5% per year, meaning 1.25% per quarter[5].

[5] "…., 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)." "Two methods were used for determining the initial capital stock: - the first one, similar to the approach of Bergoeing et al. (2002) for annual data, has assumed that the ratio of the capital stock values in the first two periods is equal to the geometric average of the ratios in the first twelve quarters". "The second one, similar to the approach of Harberger (1978), assumes a capital growth rate equals to the average growth rate of real GDP for the analyzed period" (Gălăţescu, Rădulescu, Copaciu, 2007, p.12)

The net investment ratio slowly decreased during all the three sub-periods, and even lower during the third sub-period, although on the entire period 2000 - 2017 there was a quarterly slight increase of about 0.9%.

The investment ratios show investments as a key driver of capital stock development. The two indicators, Gross Investment Rate (% of GDP) from Table 1, and the Net Investment/ Capital Ratio, from Table 5, show the importance of investments for the capital increase and also for obtaining the GDP. The investments represent the motor of economic development and the standard of living increasing.

We consider the value of 2.0% for the Gross Investment/ Capital Ratio, the average of the most recent period Q4 2012 – Q4 2017 being available for the next two years 2018 and 2019. For each quarter we calculate the new levels of Real Gross Fixed Capital Formation, I_t (euro 2010, millions). Based on equation (5), we estimate K_t, the value of the capital stock. The growth rate of the estimated capital stock (*K*) is established on % year-on-year; the average dynamic rate of the capital stock is 3.2% in both 2018 and 2019. The contribution of the capital stock to output growth is 1% on the average in both 2018 and 2019. For the component of labour, we make the assumption of constant movement and we keep the same growth rate of 1.6%, the average value of the most recent sub-period Q4 2012 – Q4 2017, as in Table 4, starting with Q1 2018 and for each quarter in 2019. The contribution of employment to the output growth is constant, being 1.1% on the average in both 2018 and 2019, in Table 6.

Comparing the results of forecasting approaches Table 6

Averages for period: (% per year)	Period Q4-2012 Q4-2017	Target forecast (%)		Compounded forecast 1 (%)		Compounded forecast 2(%)		Compounded forecast 3 (%)	
		2018	2019	2018	2019	2018	2019	2018	2019
Average GDP growth	**4.3**	**4.1**	**3.4**	4.3	4.2	4.3	4.2	**4.1**	**3.4**
TFP growth	**2.2**	1.9	1.4	2.2	2.1	2.2	2.1	**2.0**	2.1
Capital growth	**3.2**	3.1	3.0	3.2	3.2	3.1	3.2	**3.1**	3.2
Capital growth contribution	**1.0**	0.9	0.9	1.0	1.0	0.9	1.0	**0.9**	1.0
Employment growth	**1.6**	1.8	1.6	1.6	1.6	1.9	1.6	**1.6**	0.5
Employment contribution	**1.1**	1.2	1.1	1.1	1.1	1.3	1.1	**1.1**	0.4
Standard of living (% per year)**:**									
GDP growth *per worker*	**2.7**	2.3	1.8	2.6	2.6	2.4	2.6	**2.5**	2.9
Capital growth *per worker*	**1.6**	1.3	1.4	1.6	1.6	1.2	1.6	**1.5**	2.7
Investment Ratios									
Net -- in % of capital stock	**0.8**	0.8	0.7	0.8	0.8	0.8	0.8	**0.8**	0.8
Gross -- in % of output	**25.0**	23.7	22.9	23.7	23.7	23.3	23.4	**23.3**	23.5

The TFP growth of the most recent sub-period Q4 2012 – Q4 2017 was 2.2%; we used the moving averages method having the same length of the last sub-period, for obtaining the new TFP values. The average values of the TFP growth contributions are: 2.2% for 2018 and 2.1% for 2019, in Table 6.

The output growth may be calculated based on equation (2); the average GDP growth in 2018 is 4.3% and 4.2% in 2019. We noticed that for the first two quarters of 2018, our forecasts of GDP growth rates are equal with the Q1 and Q2 effective dynamic rates. We appreciate that this method is good and it can be used in the short term, for the next two or three quarters.

Based on the concept of per worker basis, the GDP growth per worker can be calculated as the sum of TFP and α times the capital growth per worker. Then the GDP growth rate is obtained by adding the employment growth rate to the GDP growth per worker. The average value of GDP growth per worker is 2.6% in both 2018 and 2019.

The second option is to repeat the action above described, but considering the effective values for Q1 and Q2 2018 of real GDP, of gross investments and of employees' number, this last indicator even for the first three quarters of 2018, we get the same results as in the previous independent approach; the average GDP growth of 4.3% in 2018 and of 4.2% in 2019.

The third option is based on the assumptions of the second approach, but for the component of labour, considering the employment growth rate of 0.5%, the average value of the entire period 2000 – 2017, starting with Q4 2018 and for each quarter in 2019. The explanation for considering the lower value of employees' number growth is based on the phenomenon of migration which has high dimensions, especially within the young Romanian people. The results of this approach are: the average GDP growth of 4.1% in 2018 and of 3.4% in 2019.

The decomposition of the output growth on the components' contributions represents a useful tool of forecasting in the short term. As we can see, the growth rate in 2018 was just 4.1% in reality. The forecast by compounding the components in the third option proved to be exactly 4.1%[6]; based on this conclusion, we appreciate that the GDP growth rate in 2019 will be 3.4%.

Based on the effective GDP growth rate in 2018, we can discuss the decomposition of growth on factors contributions in 2018 compared with the recent period 2012-2017.

We may conclude that the annual capital growth declines from 3.2% to 3.1%, and the capital contribution from 1% to 0.9% in 2018. The employment yearly growth during Q4 2012-Q4 2017 of 1.6% was the same in 2018, and also its contribution was kept at 1.1% in 2018. Referring to the standard of living, we see its deterioration of the GDP growth per worker from 2.7% per year during Q4 2012-Q4 2017 to 2.5% in 2018, and also the declining of capital growth per worker from 1.6% to 1.5%. The Net Investment/ Capital ratio kept constant at 0.8%, but the Gross Investment Rate % in output dropped from 25% to 23.3%.

Considering this option of forecast also for 2019, the GDP growth decline of 3.4% is found in the decrease of the labour growth a 0.5% and the labour contribution to output

[6] http://www.insse.ro/cms/sites/default/files/com_presa/com_pdf/pib_tr1e2019.pdf

growth from in average of 1.1% in 2018 to 0.4% in 2019. The capital growth in 2019 will be the same as in the previous two forecasting options described above and as during the period Q4 2012-Q4 2017.

The IMF target forecast for 2019 is the same with our pessimistic forecasting option of the compounding factor components, being the third one. The 2019 IMF framework of forecasting found the decomposition of factors more pessimistic, offering lower values for almost all indicators, as presented in Table 6.

5. Conclusions

The economists could expect a reasonable growth rate for the country, considering the consistency with the historical data.

The target forecast approach based on the IMF experts' opinion for the Romanian GDP growth for 2018 and 2019 can be compared with the independent method based on the compounding of components' separate forecasts. Our compounded forecasts are based mainly on the most recent sub-period, and, as a consequence, the calculated values of the average GDP growth (% per year) and of the indicators characterizing the standard of living are more optimistic than those based on experts' opinions.

This approach of compounding the separate forecasts of components proved to be good, especially for one year ahead, here 2018, when compared with the new updates of estimations for 2018, but it can also be considered for 2019[7]. However, the declines of the Gross Investment Rate in output could raise some concerns about the future economic development in Romania.

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[7] https://ec.europa.eu/eurostat/documents/2995521/9378018/2-14112018-BP-EN.pdf/b4fd131d-8938-4ef6-9cb5-9c2f73d2809d

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