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How to overcome the crisis of the European growth potential? The role of the government*

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Abstract

We suppose that the dramatic decline in the European output is more than a cyclical diversion from the potential output. We performed a medium term quantitative analysis combining data based on the production function and growth accounting approach. Our results show that the erosion of the European growth potential has been a longer latent process. It began well before the outbreak of the latest economic crisis. Simulations suggest that the recovery in the rate of potential growth can only be partial in the medium term and further erosion of the European growth potential can be expected in the longer term. Our analysis suggests that more attention should be focused on TFP growth. Therefore, the last part of our study tries to identify the factors that insure a more dynamic TFP growth and examine what the governments can do in order to increase productivity and overcome the crisis of the growth potential.[1]

JEL classification: O11, O41, O52, E17

Keywords: Potential growth, Growth accounting, European Union, Crisis, Total factor productivity

1. Introduction

In Europe, the pain caused by the current crisis has been particularly acute. We suppose that the dramatic loss of the European output is more than a cyclical diversion from the potential output. There were clear signs of the European growth potential moderating for a long time. The previously latent elements began 'to come to the surface' from the mid-1990s. At the same time, the financial and economic crisis that began in 2008 has had significant impacts on the European growth potential too. The impacts of the crisis and the slow recovery on the potential output are also reviewed in our paper. These tendencies are examined in detail through the quantitative analysis. In order to test our hypothesis we perform a medium term quantitative analysis combining data based on the production function and growth accounting approach.

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2. Methodology of the potential growth analysis

Potential growth is a cumulative measure showing the sustainable and non-inflationary growth generating capacity of the economy. Growth rate of the potential output reflects the steady-state economic dynamics (growth potential). Unlike the actual growth rate it does not contain cyclical factors[2].

The difference of the actual and the potential growth is the so called output gap, a fundamental measure of business cycles. Instruments of the economic policy strongly depend on the development of the output gap. However, it is very difficult to estimate the value of the output gap. Potential growth cannot be directly observed, while data on actual output could be updated from time to time.

The literature about growth is mainly dominated by articles discussing actual growth trends. These trends reflect the business (and other kind of) cycles and they provide important information. However, actual growth cannot permanently differ from potential growth.

The European growth model and the performance of its sub-models can be analysed also on the basis of potential growth. Potential growth can be analysed on the one hand based on the past development path. There is an advantage in the ex post analysis, namely that the degree of the actual output is known. At the same time, potential growth can be measured through future projections too. Methodological difficulties may occur in both cases.

Calculation (or estimation) of potential growth creates an opportunity to separate structural development from cyclical development. There are different approaches. Potential output can be estimated by trend outputs resulting from moving averages of GDP time series and different filtering approaches. The most commonly used application is the Hodrick-Prescott (HP) filter. It is a simple and transparent method. Data with the highest frequency are utilized through the application of the filter[3]. However, there are significant problems too. The method of HP filters does not have its

[2] For details see e.g.: Denis et al. (2002), Denis et al. (2006), Hobza- McMorrow- Mourre (Eds.) (2009), Basu - Fernald (2009), Steindel (2009), D'Auria et al. (2010), Havik et al. (2014).

[3] We get the filtered series (τ_i) from the original GDP series (y_t) with the help of the following algorithm:

$$\min_{\tau_t} \sum_{t=1}^{T} (y_t - \tau_t)^2 + \lambda \sum_{t=2}^{T-1} \left[(\tau_{t+1} - \tau_t) - (\tau_t - \tau_{t-1}) \right]^2$$

roots in economic theories. Its features depend on the specific value of the smoothing parameters[4].

On the other hand, as all centered filters, they are loaded with endpoint distortions, i.e. real time trend output estimates should be based on extrapolations of GDP, possibly with subsequent revisions. Finally, similarly to other methods applied for filtering GDP series, it cannot utilize information adequately to separate cyclical and structural changes.

An alternative to simple data filtering is based on the supply side model of the economy. Potential output is calculated in this case on the basis of a production function, which is the result of the combination of contributions of production factors and technological level. Compared with simple growth accounting, the production function based approach of potential output is consistent with the balanced utilization of the available resources (i.e.: oversupply or excess demand can be excluded).

However, although there are clear benefits relative to the HP filter, this approach has its limits too. Its credibility depends on both the accessibility and the quality of data on the contribution of production factors. This is a great challenge, especially as regards the new member states of the EU.

We follow the growth accounting and production function approach in order to calculate potential growth. This approach focuses mainly on the supply-side of the economy, on the quantity and quality of labour, accumulation of capital and on the total factor productivity as a driver of the output. The objective of this paper is to identify the impacts of these drivers and to decompose the growth rate of the output based on their impacts. In the production function approach potential growth can be calculated on the basis of the development of labour and capital inputs and of the total factor productivity. In order to apply the method, equilibrium rates of unemployment are required too. These are provided by the NAIRU or NAWRU approaches[5].

Under the framework of the production function approach, the determining factors of the neoclassical growth model are taken into account. Recent growth (and development) theories emphasize also the importance of further, mainly quality factors

[4] The smoothing parameter generally equals 100 in case of yearly GDP data. This is the standard value applied by the European Commission in trend output estimates.

[5] NAWRU: Non-Accelerating Wage Rate of Unemployment.

(innovation, geographical location, institutional system, macroeconomic policy etc.).[6] The latter factors are important also in the ex post analyses. The uncertainty involved in the ex ante analyses is, however, extremely high. In the production function approach these factors have an impact through the development of the total factor productivity. (The important qualitative factors of the economic system are taken into account in an implicit way.) At the same time, it is difficult to quantify some of the factors mentioned. That is why the ex ante analyses need to be carried out very cautiously. After all these considerations, the production function approach can be applied in researches on growth and development.

The production function and growth accounting approach has recently received increasing attention in the literature. As regards to their long term application, studies, e.g. on ageing in the European Union, are considered significant contributions to the literature (e.g.: EC, 2011, 2012; Carone et al., 2006). As an example of the short term approach and the mid-term extension of the growth accounting analysis we can mention the database of the EU EPC Output Gaps Working Group (OGWG). (For their methodology see Denis et al., 2002; Denis et al., 2006 and D'Auria et al., 2010.) The methodology of the production function approach is described in the Appendix.

3. Impact of the crisis on the potential growth

After the outbreak of the financial and economic crisis the world economy was week for years and the growth rate was well below the pre-crisis level[7]. Although the significant decrease in the prices of oil and other raw materials and the monetary expansion resulted in lower interest rates, they couldn't meet the positive growth expectations. Japan has been facing the problems of negative inflation for a long time, this time even the euro zone was forced to take steps in order to ease the pressure of negative inflation. The introduction of the quantitative easing was one of the most important steps. It had certain positive impacts as regards the deflation risk management, however, couldn't succeed in increasing inflation to the targeted level. Euro zone interest rate spreads decreased, share prices increased and the euro faced a

[6] See e.g. the overall analysis of Jones and Romer (2011).

[7] For details see e.g.: Furceri and Mourougane, 2009; Haugh et al., 2009; Hobza et al., 2009; Van den Noord et al., 2009; Reinhard and Rogoff, 2009; Crafts, 2012; Haltmaier, 2012; Ball, 2014.

huge level depreciation. High level of state and private sector debt played also an important role in holding back growth[8].

OECD outlooks (OECD, 2015, 2016) forecasted even in 2016 that growth rates can't reach their pre-crisis level either on the longer term. However, a growth in the level of GDP can be seen for most of the EU countries from 2016-2017 onwards. Growth can mainly be attributed to the improving investment environment (more favourable financing costs, increasing profits and better business outlook)[9].

The recovering growth rate had a high price: a relatively high rate of unemployment, especially as regards youth and minority groups[10]. There are also several other risks that may threaten the positive growth expectations: a sudden rise in financial market volatility, increasing costs of borrowing money, higher level of international trade protectionism and geopolitical risks.

Constant monetary adjustment and negative inflation expectations have resulted in decreasing long term bond yields in several countries. Most of the euro zone short and long term sovereign bonds e.g. have had negative yields. Long lasting low interest rates may challenge several money market players. Continuous higher risk-taking behaviour and search for greater yields may distort the evaluation of certain assets. The low interest rate environment is a challenge for the long term investors, e.g. for weaker European life insurance companies. Insurance companies must hold a significant part of their capital in liquid investment assets so as to be able to perform in case of a sudden payment need. Due to the low interest rates however, certain companies may not be able to meet the compulsory capital requirements. As (with their investments) there's a strong link between insurance sector and the other players of the financial system, a problem arising at the level of the insurance sector may spill-over to other players and other sectors.

Technological development, more regulated markets and a change in the structure of market players have resulted in a new microstructure of bond (or more precisely debt type) markets. As regards the near future, stricter monetary policy can be expected. Higher interest rates may result in more volatile asset prices and exchange rates. More

[8] For more details see e.g.: World Bank, 2015.

[9] For more details see e.g.: World Bank, 2018.

[10] For more details see e.g.: OECD, 2018.

limited bond market liquidity may have spill-over effects on other assets and markets as well.

4. Development of potential growth and its factors (Quantitative analysis[11])

As credible, longer term time series are not available as for the EU27, we examined the development of potential growth in the EU15 (member states of the EU before 2004) and in the United States in our growth accounting analysis. Countries of the EU15 were grouped into three groups. The six founding countries (DE, FR, IT, B, NL, L) of the European Economic Community (EEC) belong to the group of Founding 6 (F6). Economies of these countries have developed under the European integration framework for more than 50 years. These countries represent the continental European model (see Halmai – Vásáry, 2012). The "New" member states (N6) are the (relatively) more developed countries that joined the European Communities or the European Union in 1973 or in 1995: UK and IE representing the Anglo-Saxon model and DK, FI and SE following the Scandinavian model and finally AT.[12] The group of the Mediterranean countries (M3) countries comprises Greece (EL), which joined the Community in 1981 and the countries that have been member states since 1986 (ES and PT). Members of this latter group follow the so called Mediterranean (economic development) model.

Based on the above analysis we can summarize the main characteristics of the growth models of the examined country groups.

The potential growth rate of the EU15 has kept on decreasing since 1989 (see Figure 1). This decrease can be explained by the development of the labour productivity.[13] Labour's contribution was positive between 1995-2008, however the growth rate of labour productivity has continuously decreased since 1993. As capital's contribution to the potential growth did not decrease significantly until 2009 (its rate

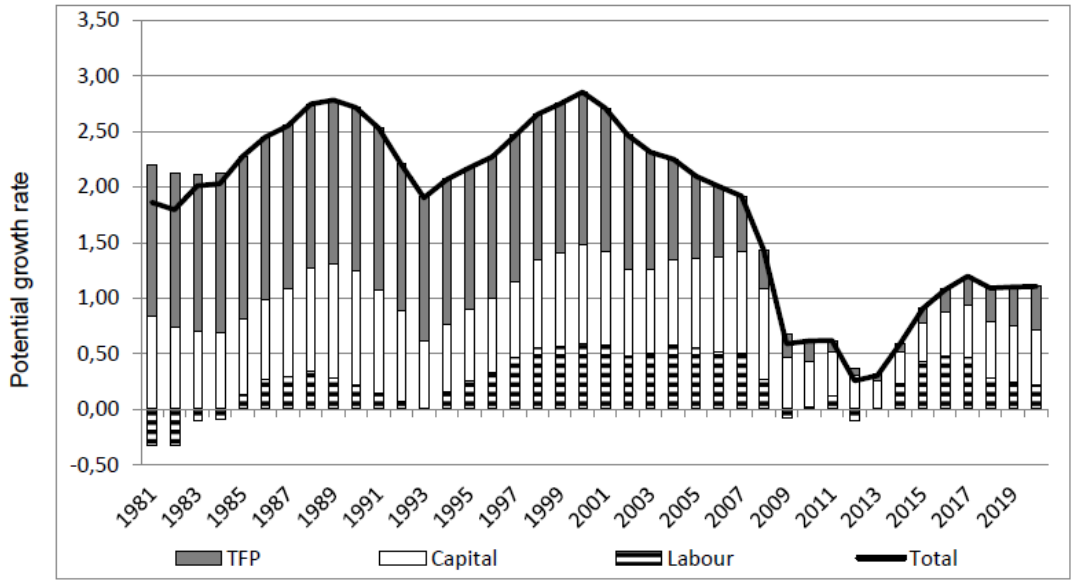
[11] Analyses are based on the OGWG database as of 2017 Winter.

[12] In the meantime the EU was enlarged by 10 new member states in 2004, by 2 in 2007 and by another one in 2013. These countries are considered to be the new member states nowadays. However, new member states refer to the above mentioned countries in this chapter.

[13] In this analysis framework labour productivity's impact on the potential growth is the sum of the capital's and TFP's contribution.

was between 0.7-0.9% per year), the unfavourable development of the total factor productivity became a structural factor as regards the decreasing trend of labour productivity. (The growth rate of total factor productivity dropped by a third between 1981 and 2017.)

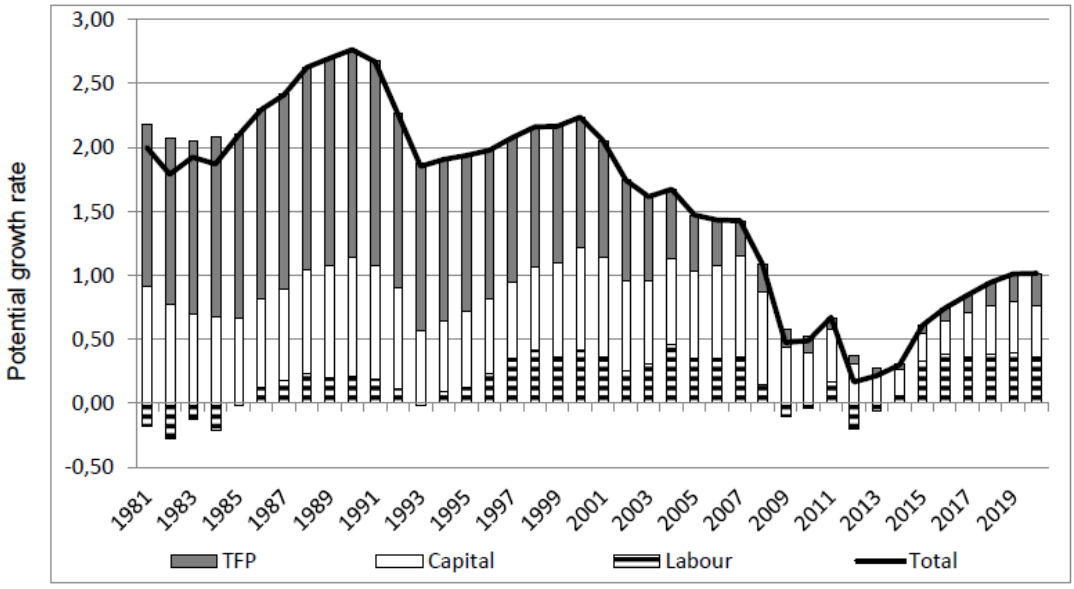
Figure 1. Development of potential growth and its factors in the EU15



Source: Authors' own calculation

The growth model of the F6 countries shares the same characteristics. As regards the F6, labour's contribution to the potential growth was moderate but positive over almost all the examined period. Capital's contribution was between 0.6-0.9% per year until 2009. The most important explaining factor of this dynamism (or more precisely of this decrease) was the permanent and strong decline of the TFP (see Figure 2). Therefore, we can conclude that the rate of potential growth dropped to 1.4% per year (from the rate of 2.8% in 1990) even before the crisis, and it will be around 1% in the examined period in the F6 countries.

Figure 2. Development of potential growth and its factors in the F6 countries

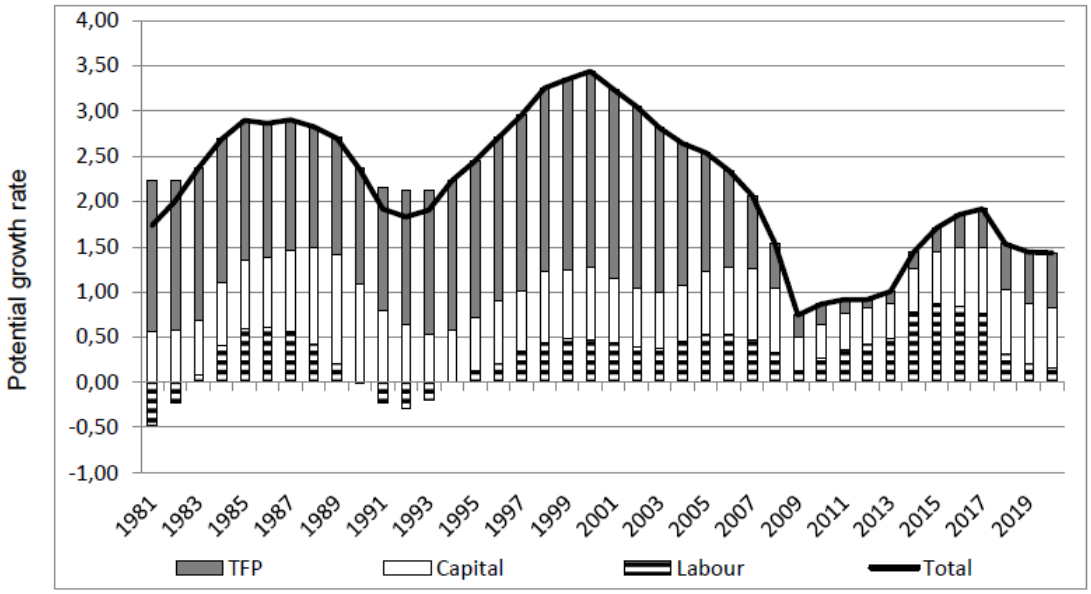


Source: Authors' own calculation

The main trends in the N6 differ from the previously reviewed situation of the F6 in several aspects. Countries of the N6 experienced the highest rate of potential growth in 1999-2000 (3.4% per year!). The decrease in this rate began only after that period (see Figure 3), arriving at 2.1% in 2007 and 0.8% at the bottom of the crisis (in 2009). However, from 2010 we can see the signs of recovery and the rate of potential growth could reach 1.8% by 2017-2018. (Exceeding the average rate of the EU15 by almost 50%.) Labour contributed to the rate of potential growth with 0.3-0.6% per year between 1984-1989 and 1996-2007. At the same time, the increasing labour productivity (2-3 % per year) was the decisive factor in the development of the potential growth, just as in the case of the F6. As the capital's effect was 0.7-1.0% in the periods of 1985-1991 and 1997-2008, development of the TFP was the dominant factor in their case too. TFP's contribution exceeded significantly even that of the United States until 2006. However, the growth rate of the TFP has showed an accelerating decreasing trend since 2000. This was partly compensated for by the effect of the transitionally increasing capital accumulation and by the increasing contribution of labour (as a result of the labour market reforms). Labour's contribution became negative again at the time of the crisis. Capital's and TFP's contributions moderated significantly too. The dynamism of

the labour productivity improved again at the time of the recovery: simulations suggest that both capital deepening's and TFP's contribution will reach 0.6% by 2019-2020.

Figure 3. Development of potential growth and its factors in the N6 countries

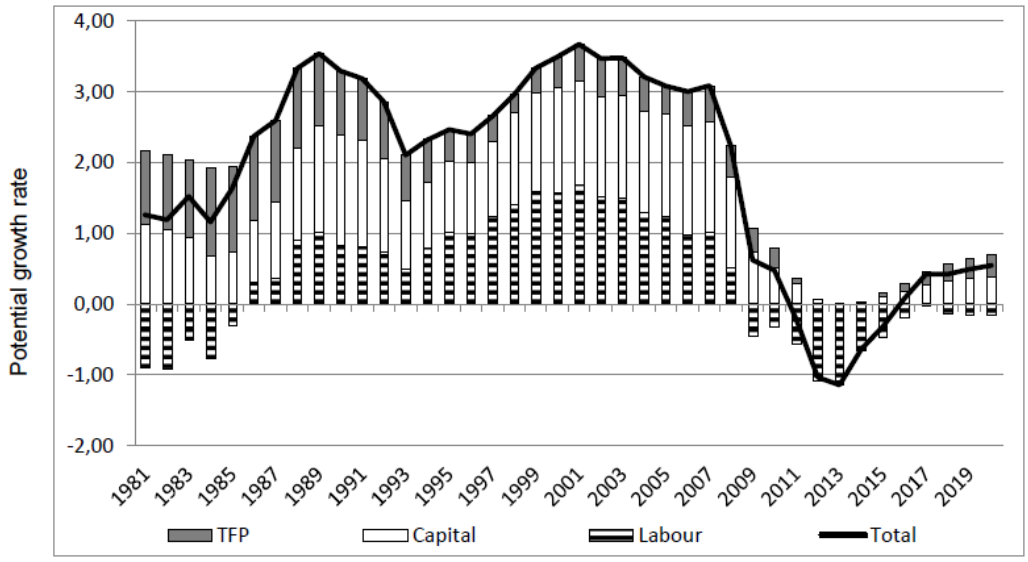


Source: Authors' own calculation

Following the accession, the rate of potential growth steadily increased for more than two decades in the countries of the M3 (see Figure 4). Labour's contribution became positive and significant (with structural unemployment decreasing simultaneously): its rate was 0.9-1.7% in the periods of 1988-1990 and 1997-2007. Capital's contribution was 1.1-1.6% between 1987-1992 and 1997-2008. Although TFP was above 1% until 1989, it began to decline after that period. The current crisis has resulted in a structural cut-off point in the development of potential growth of the M3. Our calculations show, that after a significant decrease, the rate of potential growth is expected to become and remain negative between 2011 and 2015 and staying below the average of the EU15 until the end of the examined period. Labour's contribution has been negative since 2009. The crisis, and particularly the sovereign debt crisis, that hit the examined countries especially hard, has resulted in significantly increasing capital costs and narrower capital accumulation possibilities. Therefore, capital – in fact – will not contribute to the growth of the potential output after 2011. TFP's contribution in the period 1995-2007 was around 0.4-0.5% per year, significantly less, than in the

previous period. This contribution was very low after the outbreak of the crisis, and it was negative in certain years. Therefore, we can argue, it will be this group of the M3 that will experience the most unfavourable labour productivity trend.

Figure 4. Development of potential growth and its factors in the M3 countries



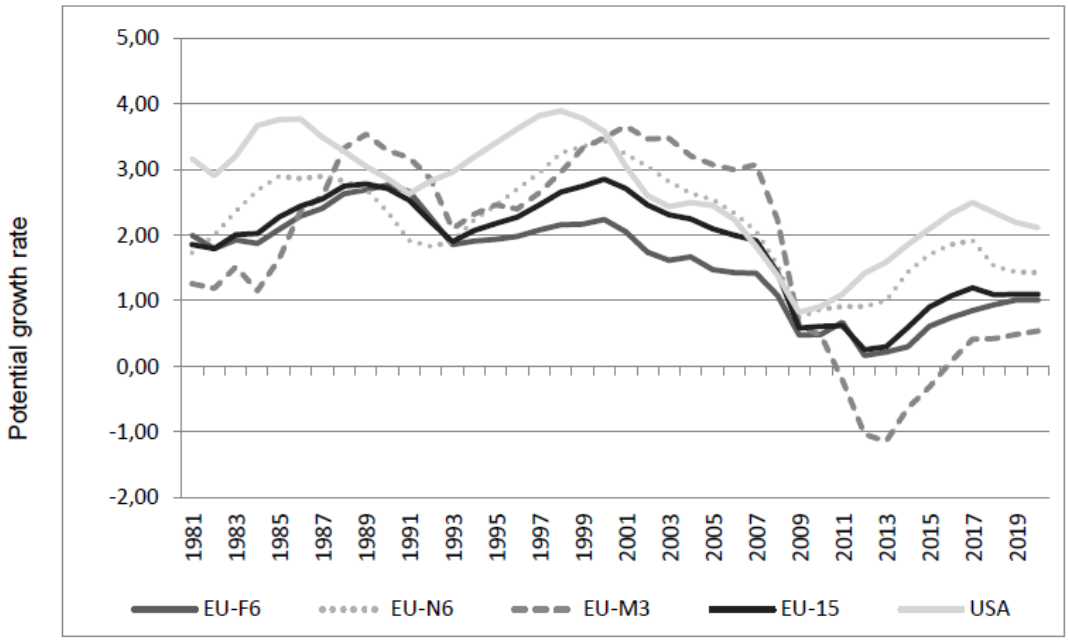
Source: Authors' own calculation

Structural unemployment (NAWRU) in the EU15 slightly increased until the mid-1990s and then decreased until the current crisis. Structural unemployment has been the highest in the M3 countries throughout the examined period. (Its ratio exceeded 10%.) NAWRU has decreased significantly since the mid '90s in the M3. It began to rise along with the emergence of the current crisis, reached a record level in 2010 and continues to rise. Projections suggest that structural unemployment will continue to rise between 2013-2020 due to the recovery and mainly to the sovereign debt crisis, however the average of the M3 may increase above 17% (!) from 2012.

The potential growth rate of the United States exceeded the EU15's average in almost all single years throughout the examined period (see Figure 5). The potential growth showed a relatively strong dynamism until the beginning of 2000: its rate fell below 3% only in certain years. As regards growth, permanent and significant positive contributions of labour were amongst the most important factors. At the same time, there was a significant (about 50%) increase between 1980 and the end of the 1990's regarding the TFP's contribution. Capital's contribution has increased from the middle

of the 1990's. The rate of potential growth has moderated since 2000, and it stood at 50% of the former level before the crisis. Any positive effect of labour has more or less faded away and the dynamism of the TFP has also started to decline. The potential growth rate declined dramatically between 2008 and 2011. (Labour's effect became negative and in parallel to the moderating TFP, capital accumulation's contribution significantly decreased.) Recovery characterizes the 2012-2018 period. Labour becomes positive again and contribution of all of the three factors (labour, TFP and capital) increases. Potential growth reached its pre-crisis level by 2014 in the United States.

Figure 5. Development of potential growth in the examined country groups



Source: Authors' own calculation

We can argue that the growth model of the USA involved a higher level of growth dynamics in the examined three and a half decades. Average growth potential of the EU15 lags behind that of the USA. We could not identify a catch up potential for the EU15 in the examined period. The same comment applies for the F6 countries. As regards their potential growth rate, the M3 countries managed to cut back somewhat on the large differences in certain periods (from 1988 to 1992 and between 2000 and 2009), but their fall-back relative to the better performing country groups seems to be unstoppable since the outbreak of the crisis. Development of potential growth in the

N6 countries however, is similar to that of the USA. (The growth of potential output between 2001 and 2008 was even faster in the N6 countries than in the USA.) Labour productivity, and particularly the dynamics of the total factor productivity, is the decisive factors in accounting for the growth performance of the N6. The growth rate of these factors exceeded the US levels up to 2006.

However, the USA had more robust structural characteristics (more favourable total factor productivity above all)[14] even before the outbreak of the crisis. Forecasted demographic and TFP trends and investment and productivity dynamics are more favourable than the forecasted trends for the EU15 and for the member states of the euro zone. (See Figure 6.) Therefore, it is not surprising that the dynamics of the pre-crisis growth potential can recover more or less in the United States, while it can reach only the half of the pre-crisis level in the examined European countries.

[14] The TFP gap, that has developed between the USA and the EU15 since the mid 1990s can mainly be attributed to the differences in the intensity of the competitive environment, differences in innovation mechanisms and industrial structure, and to the different ratio of ICT and ICT dependent sectors. Revealing impact mechanisms of these factors requires further research.

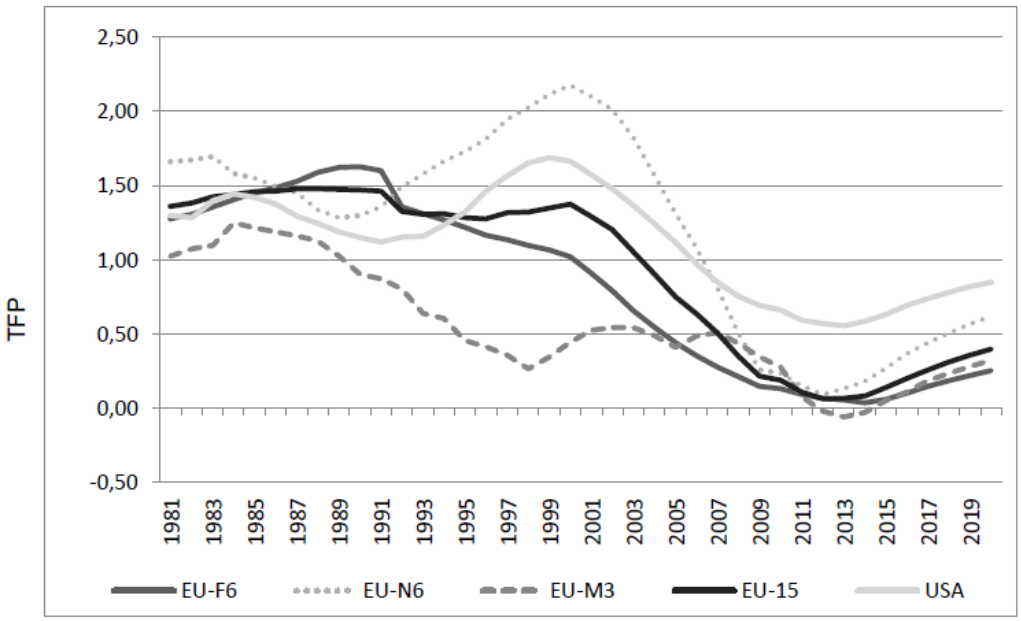
Table 1. Development of potential growth and its factors in the examined country groups

(% of potential GDP, annual average in the examined period)

	EU15					A6					U6					M3				
	1988-1993	1994-2000	2001-2008	2009-2013	2014-2017	1988-1993	1994-2000	2001-2008	2009-2013	2014-2017	1988-1993	1994-2000	2001-2008	2009-2013	2014-2017	1988-1993	1994-2000	2001-2008	2009-2013	2014-2017
PF Potential Growth	3	2,23	1,97	0,56	0,86	2,6	1,8	1,5	0,7	0,9	2,1	3,0	2,6	0,8	1,4	3,1	2,8	3,2	-0,6	-0,4
Total Labour (Hours) Contribution	0	0,49	0,62	0,00	0,09	0,5	0,4	0,5	0,2	0,2	0,1	0,5	0,6	0,2	0,3	0,9	1,2	1,4	-1,4	-0,9
Capital Accumula-tion Contribution	1	0,77	0,79	0,36	0,37	0,9	0,7	0,6	0,3	0,4	0,7	0,7	0,9	0,4	0,6	1,4	1,2	1,4	0,3	0,0
TFP Contribution	1	1,25	0,83	0,33	0,47	1,5	1,1	0,7	0,3	0,4	1,5	2,0	1,3	0,4	0,6	1,2	0,5	0,6	0,4	0,4
Labour productivity	2	2,02	1,62	0,69	0,84	2,4	1,8	1,3	0,6	0,8	2,2	2,7	2,2	0,8	1,2	2,6	1,7	2,0	0,7	0,4
NAWRU (% of Labour Force)	8	8,57	7,75	8,97	10,18	8,0	8,7	8,3	8,0	8,1	7,5	6,7	5,5	6,9	7,9	14,0	12,7	10,5	18,1	25,1
Investment Ratio (% of Potential Output)	19	18,98	20,16	17,69	17,90	19,6	19,0	19,5	17,9	18,1	17,5	17,3	18,5	16,3	17,5	23,4	23,2	27,5	19,6	17,6

Source: authors' own calculations

Figure 6. Contribution of TFP to potential output growth



Source: Authors' own calculation

5. Conclusions

The main conclusions are summarized as follows:

1. The rate of potential growth in the EU15 has continuously and gradually decreased since 1990. At the same time, the latest financial and economic crisis has resulted in a significant decline in the dynamism of the potential output and the simulations suggest that it can reach only half of the pre-crisis level in the medium term. It is the development of labour productivity that can explain the decreasing dynamism of potential output. Declining TFP growth rate is a decisive and structural factor of this development.
2. Significant differences are revealed among the different country groups of the EU15. Potential growth rate of the founding (F6) countries has declined continuously (mainly due to the development of the TFP). The dynamism of potential output increased until 2000 in the new member states (N6 countries), and then it began to gradually decline. The chance of a possible recovery is the greatest in this country group in the medium term. TFP is the dominant factor in their performance. The

Mediterranean (M3) countries followed a catch-up path until the outbreak of the latest crisis. High structural unemployment was successfully reduced and it became the decisive factor of potential growth. From 2009 onwards very serious growth crises have developed in these countries resulting in an extraordinary high level of the NAWRU and a low level of investment and TFP.

3. In the long run the potential growth rate shows a declining trend both in the USA and the EU15 countries. The TFP growth rate is much higher in the USA from the middle of the 1990's onwards than in the EU15 this higher – although declining – dynamics is expected to last also in the medium term. Further research is required to reveal the background of the different dynamics.
4. All of the results suggest the same conclusion: source of the problems is the decreasing dynamics of total factor productivity. If we want to stop (or perhaps reverse) the declining trend of potential growth in the European Union, we have to focus on the factors influencing the development of the TFP.
5. There's an increasing fear of a future (world) economic shock. Without improvement and correcting the current problems a further erosion of the European growth potential can be expected. This threatens not only the development of the potential growth but may result in further difficulties, e.g. market actors may lose their trust in the institutional system, there may be an increasing trend of long term unemployment etc.

What the national governments can do?

Globalisation and European Union itself has resulted in a reduced, limited national sovereignty. However, national governments still have several possibilities to reduce the negative effects of a possible future shock.

Fiscal policy e.g. can help to stabilize the economy at least in two ways. Automatic stabilisers (income proportional tax systems, expenditures and social benefits) can automatically increase the aggregate demand in case of a setback, while decrease it if

there's a boom in the economy. Another way to manage the possible negative effects of a shock is to apply shock-specific instruments however, this may require an effective fiscal stabilisation system.

Fiscal policy may have a decisive role in building up trust and influencing aggregate demand. The place for maneuver is relatively limited, nonetheless fiscal policy can effectively support the economic growth, decrease the potential risks and insure a sustainable debt service. Infrastructural investments e.g. will increase the aggregate demand on the short term and the potential output on the medium term. Relatively low prices of raw materials (e.g. oil) may create an opportunity to change the energy-related tax and support systems. These resources may compensate for the reduction in wage-related taxes and expenses which may be necessary in order to enhance employment. Re-allocation of these resources to education, health or infrastructural development may also be an efficient way to improve productivity and resource allocation. (For details see e.g.: IMF, 2015). Policy makers should be very responsive for these kinds of changes, as low oil prices provide unique opportunity for unavoidable structural reforms that seem to be almost impossible in times of higher oil prices.

As regards the long term unemployment, not only the above mentioned reduction of labour costs but also the carefully chosen level of minimal wages and restructuring of the unemployment benefit system (increasing the motivation in having a job) may help to increase the labour demand of the economy. (For details see e.g.: Banerji et al., 2014.)

This is a serious concern for the public policy based on the traditional employment model. Main objectives of these models is to help transition from traditional forms of employment to less traditional ones. New models suggest that social security systems, simplified registration and tax possibilities should cover all forms employment. (For details see e.g.: ILO, 2015).

In order to avoid brain drain and outflow of the domestic labour it is essential to create quality jobs and to enhance the diversification of the production capacity. (Risk of a potential future shock is higher if growth performance of a country depends only on a few export-oriented sectors.) The role of the economic policy is significant: anti-cyclical economic policy ensures the adequate level of aggregate demand, certain kinds of capital movement "limits" may be required to avoid problems caused by hot capital, stabile and competitive exchange rate etc. (For details see e.g.: ILO, 2014.)

Strategic approach of the long term development requires a switch in the economic policy: structural reforms that improve productivity may be more efficient than the monetary and fiscal adjustment. Ageing societies also point in the direction of productivity enhancing structural reforms, as the increasing labour market participation and employment rate can only partly combat the decreasing level of labour supply. (Japan e.g. bases its labour market strategy on robotics and digitalisation. Inward labour migration can also be an alternative. And – although only on the longer term – financially motivating parents to have more children may also be part of the solution.) Structural reforms may be of special importance for those emerging, medium-income countries that can no longer base their development on factors that characterised them during the process of low to medium income countries (cheap labour, rapidly increasing foreign direct investment in their export sectors etc.). Under these circumstances growth will increasingly be dependent on a multi-factor productivity driven by accumulated skills, knowledge, innovation and knowledge-based capital.

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Appendix

The production function approach focuses on the supply potential of the economy. In the framework of the production function approach potential GDP is the result of the combination of factor inputs and technological level (total factor productivity, TFP). While measuring potential output the cyclical factor is removed in the case of labour and capital as well. (For details see D'Auria, 2010.)

The Cobb-Douglas production function simplifies the analysis. Potential GDP can be calculated as follows:

$$Y = (U_L LE_L)^{\alpha} (U_K KE_K)^{1-\alpha} = L^{\alpha} K^{1-\alpha} * TFP \quad (1)$$

Where U_L, U_K is degree of excess capacity; E_L, E_K is efficiency level of the production factors

$$TFP = (E_L^{\alpha} E_K^{1-\alpha})(U_L^{\alpha} U_K^{1-\alpha}) \quad (2)$$

TFP summarizes the degree of utilization of production factors and their technological level. Factor inputs are measured in physical units. (Through hours worked for labour input and a comprehensive measure including spending on infrastructure and equipment for capital.)

The most important assumptions entering the specification of the production function are: constant returns to scale and factor price elasticity, which equals 1. The main advantage of these assumptions is simplicity. These assumptions are largely consistent with empirical evidence at the macro level. The assumption of unit elasticity is consistent with the relative constancy of nominal factor shares. The labour and capital elasticity are represented by α and (1- α). Under the assumption of constant returns to scale and perfect competition, these elasticities can be estimated from the wage share.[15]

[15] Based on the mean wage share for the EU15 over the period 1960-2003 α=0.63 and (1- α)=0.37. The OGWG calculated with 0.65 and 0.35 as factor elasticity.

While moving from actual to potential output the potential factor use (labour and capital input) and the trend level (normal level) of efficiency of factor inputs need to be defined.

Capital's contribution to the potential output is given by the full utilization of available capital in the economy. As capital stock is the indicator of full capacity, it is unnecessary to smooth time series when applying the production function approach. Series without smoothing tend to be more stable both for the EU and the USA. (For details see D'Auria et al., 2010.) Investment shows significant fluctuation over the years. Capital's contributions however, are relatively stable. (Net investment is only a small portion of capital stock in all of the years.)

It is more difficult to calculate the contribution of labour. Estimation of labour input has several steps. The starting point is the maximum possible level, the development of the working age population. The level of trend labour can be determined from participation rates by applying HP filters. The next step is the calculation of the trend unemployment in consistency with the NAWRU. Finally, we can calculate the potential labour supply (number of trend work hours) multiplying trend employment with average work hours. This approach generates relatively stable potential employment series. At the same time, yearly development of the series may strongly relate to long term demographic and labour market developments, to the actual population of working age, to trend participation rate and to the development of the structural unemployment.

As regards the production function approach potential output refers to the level of output which can be produced with a "normal" level of efficiency of factor input. This trend level efficiency level is measured by using a bivariate Kalman filter model which is based on the link between the TFP cycle and the degree of capacity utilization in the economy. (For details see Planas – Roeger – Rossi, 2010.) Normalizing the full utilization of factor inputs, the potential output can be described as follows:

$$Y^P = (L^P E_L^T)^{\alpha} (K E_K^T)^{1-\alpha} \tag{3}$$

In the model described briefly the exogenous variables are as follows: population of working age (POPW), smoothed participation rate (PARTS), investment ratio

(expressed as percentage of potential GDP, IYPOT) structural unemployment (Non-Accelerating Wage Rate of Unemployment - NAWRU), Kalman filtered Solow Residual and trend average hours worked (HOURST). The endogenous variables are the potential employment (LP), investment (I), capital stock (K) and the potential output. (YPOT).

Potential employment for a given time period is determined as follows:

$LP_t=(POPW_t*PARTS_t*(1-NAWRU_t)*HOURST_t$

Development of investment and capital stock are determined by the following equation:

$I_t=IYPOT_t*YPOT_t$ and $K_t=I_t+(1-dep_t)K_{t-1}$,

where dep_t is depreciation rate of year *t*.

Based on all these the equation of the potential output can be described as follows:

YPOT=LP 0.65 K 0.35 SRK (4)

We can determine the output gap with the following equation:

$$YGAP = (Y/YPOT - 1)$$

The output estimates derived from production functions show the present output capacity of the economy. Those enable a mid-term extension: they indicate the likely development, if past trends were to persist.[16] Projections for 2014-2018 in the OGWG database can be considered technical extrapolations instead of forecasts.

[16] In the mid-term extension the trend TFP, the NAWRU (Non-Accelerating Wage Rate of Unemployment), the population of working age, participation rate changes, average hours worked, and the investment to potential GDP ratio are determined.