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Erosion and Crisis of the European Growth Potential. What Can the EU and the National Governments Do?[1]

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.

Keywords: potential growth, growth accounting, European Union, crisis, total factor productivity

JEL classification: O11, O41, O52, E17

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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 moderating growth potential 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 latest 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.

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. (For details see e.g. Denis et al., 2002; Denis et al., 2006; Hobza–Mc Morrow–Mourre, 2009; Basu–Fernald, 2009; Steindel, 2009; D'Auria et al., 2010; Havik et al., 2014)

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.[1] However, there are significant problems,

[1] We get the filtered series (τ_t) from the original GDP series (y_t) with the help of the following algorithm:
$$\min_{\tau_t} \sum_{t=1}^{T} (y_t - \tau_t)^2 + \lambda \sum_{t=2}^{T-1} \left[(\tau_{t+1} - \tau_t) - (\tau_t - \tau_{t-1}) \right]^2$$

too. The method of HP filters does not have its roots in economic theories. Its features depend on the specific value of the smoothing parameters.[2]

On the other hand, as all centred 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.[3]

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 (innovation, geographical location, institutional system, macroeconomic policy etc.). (See e.g. the overall analysis of Jones–Romer, 2011)

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

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2 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.

3 NAWRU: Non-Accelerating Wage Rate of Unemployment.

literature. (e.g. EC, 2014, 2015; 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., 2006; D'Auria et al., 2010; Havik et al., 2014) The methodology of the production function approach is described in the Appendix.

Impact of the Crisis on the Potential Growth

The financial and economic crisis might have a significant impact on potential growth. In the short run the significant decrease in the level of potential output is the result of the decrease in the productive capital stock (increasing capital depreciation), and the negative impact on the labour supply and structural unemployment. The decisive question is: what is the impact of the crisis on the long-term potential output growth. If potential growth intensifies due to the increasing productive capital stock and more favourable employment environment after the crisis, then the loss caused by the decrease in the output level might be compensated for after a while. As the crisis may force out structural change, which in turn increases the efficiency of the economy, the economy might get on a higher, sustainable growth path.

In order to understand profoundly the impacts of the crisis on the potential output and its growth, the individual growth factors need to be analysed in detail. As mentioned above, under the framework of the production function approach the recession might have an impact on growth through three different channels: capital accumulation, labour input and total factor productivity. Labour supply can further be divided into the participation rate; the average hours worked and the working age population; and the structural unemployment rate. (The latter is NAWRU – *Non-Accelerating Wage Rate of Unemployment*.) Total factor productivity (TFP) shows the effectiveness of the use of production factors.[4]

For the time being, economic recession may have different impacts on these factors of potential growth. Depending on the mechanism of the growth process, the relation between downturn and potential growth may be both negative and positive.

Financial crises in general have deep impacts on the long-term output growth. (See Furceri–Mourougane, 2009; Haltmaier, 2012; Ball, 2014) According to Cerra and Saxena's analysis (2008) recession was not followed by a rapid recovery in these cases, moreover, neither was the loss of trend output fully recovered. The loss of the GDP level was generally not offset by higher growth after the crisis.

Recessions following a financial market crisis are deeper than "ordinary" recessions. Those are generally associated with a significant decrease in housing prices and construction output. (For more details see Reinhard–Rogoff, 2009; Claessens et al., 2008; Crafts, 2012) Consumption decreases significantly during recessions. It reflects also the loss of assets (e.g. decrease in housing prices).

Economic recessions (not only the financial crises) have had diverse effects on the long-term potential growth in the European countries in the last few decades. Potential

[4] As the latter is actually unobservable, it is often calculated as the residue.

growth – based on our calculations – has increased in about half of the countries during the decade following the crisis.

The dynamics of capital accumulation has decelerated in most European economies in the short- and medium term. (For details see e.g. Haugh et al., 2009; Hobza et al., 2009; Noord et al., 2009) In the long run the contribution of capital accumulation to the potential growth has basically not changed in most EU Member States. Dynamism of capital intensity slowed down in a smaller group of the examined countries (Finland, Sweden and Ireland). Although the recession affected their capital accumulation in the short run, the structural factors played a decisive role in the long run. The growth model of these economies changed significantly in the 1990s: due to the change in the economic structure, capital accumulation declined and the contribution of the TFP to the potential growth increased.

Haugh et al. (2009) argue that the output loss resulting from a bank crisis is 2–3 times higher than the loss originating from other kinds of downturns, and also the output needs more time to reach its potential level. The latest crisis is a very robust one as regards the level of both the output and the investment. It can only be compared to the great world economic crisis of 1930s.

In terms of the demand components, the main factor in the downturn was the collapse of the fixed capital formation. The development of household consumption, the fixed capital formation and the net exports contributed to the recession, as well. It is not clear, however, what mechanism can result in the increase in investment or private consumption. The deleveraging has continued in the household and the corporate sectors (financial and non-financial sectors) also during the deepening of the recession.

The likelihood of lasting effects on potential growth is much higher in case of the latest crisis than in any previous recession. The length of the crisis, its global nature and the change in the risk related behaviour might explain that. It has had an adverse effect on investments – on intangible investments in particular (namely R&D) – which has a severe impact on the TFP growth and the potential output. On the one hand the NAIRU might increase due to the hysteresis effect (as shown by Blanchard et al., 1989; 2000; Gali, 2015), resulting in a further drop in the potential output level and a slowing down in potential growth in the short and medium term. Many discouraged workers left the labour market and this way decreased the labour supply.

Structural adjustment and the reallocation of resources are of decisive importance. The latent erosion of potential growth (hidden by relatively favourable actual growth rates) in the years preceding the crisis and transitionally very low capital costs in the period of the great moderation resulted in the exceptionally high level of the investment rate in the EU member states. However, this accumulation was not based on a high level of a marginal product of capital resulting from improving total factor productivity. Investment boom was mainly restricted to non-traded goods and services (mainly real estate). Overheating of the economy was accompanied by an asset bubble and, with the outbreak of the crisis, recession and adjustment became unavoidable. External imbalances, significant current account deficits and increasing vulnerability characterized the member states with the most at stake. The unavoidable adjustment requires reallocation of resources from the non-tradable to the tradable sector. As the competition is more intense and the cost pressure is higher, productivity in the

export-oriented sectors is higher, so increasing their share will improve efficiency, too. A fast reallocation of resources may reduce the loss in the growth potential. Integration into global value chains may enhance the structural change. Reallocation disturbances, however, may worsen the utilization of resources and increase the rate of unemployment.[5]

The changing attitude to risk prevents R&D and innovation financing. It holds back reallocation of resources to potentially more dynamic activities, weakening the growth of total factor productivity in the longer term.

Although the double-dip recession has been a great challenge for the European economy, the output shows a slightly increasing trend since spring 2013 in most of the member states (the exceptions are the countries with the highest level of sovereign debt).[6] Nevertheless, the long lasting recession has had significant and permanent impact on the main factors of the production function. Negative structural developments can be expected on the potential growth path. Among the risks, we can mention the echo phenomenon. Recession generally results in investment scarcity and strong depreciation of capital stock. There is a positive echo in the phase of the boom. Renewal of capital is fast due to the investment boom, there are technological breakthroughs and the dynamism of the total factor productivity can possibly increase. This kind of process characterized Sweden and Finland after the recession of the 1990s.

The latest crisis results in a loss of potential output for the European Union. At the same time, parallel reductions in the medium and longer term dynamics of the potential output (supposing unchanged policies) seem to be unavoidable mainly due to the significantly weakening dynamics of total factor productivity.

Development of Potential Growth and Its Factors (Quantitative Analysis[7])

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

5 As possibilities and conditions of the different member states are very different as regards their structural change, their recovery should follow a different pattern, as well.

6 The strengthening interaction between the bank and sovereign debt crises resulted in more pronounced real economic effects. There was an unfavourable switchover in the examined period. (See Furceri–Zdienicka, 2012)
Since 2011, not only problems of the bank sector, but also the problems related to sovereign debt have been increasingly accentuated in the processes of the European crisis. This is an important feature of the deep financial crisis. (See Reinhart–Rogoff, 2011; Claessens et al., 2011; Mody–Sandri, 2012)

7 Analyses are based on the OGWG database as of 2017 winter.

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.[8] The group of the Mediterranean countries (M3) 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.[9] The labour contribution was positive between 1995–2008, however the growth rate of labour productivity has continuously decreased since 1993. As the capital contribution to the potential growth did not decrease significantly until 2009 (its rate 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.)

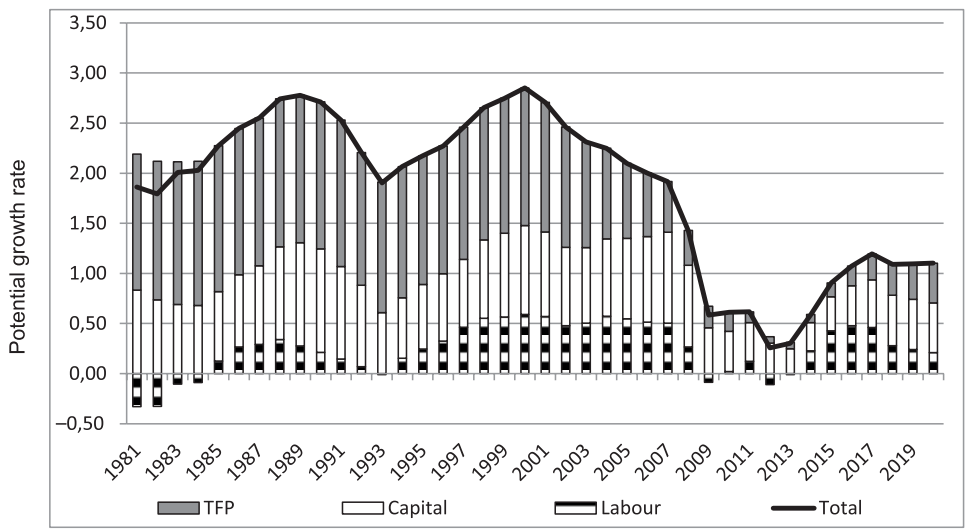

Figure 1.
Development of potential growth and its factors in the EU15
Source: Authors' own calculation

The growth model of the F6 countries shares the same characteristics. As regards the F6, the labour contribution to the potential growth was moderate but positive over almost all

[8] 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.

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

the examined period. The capital 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.

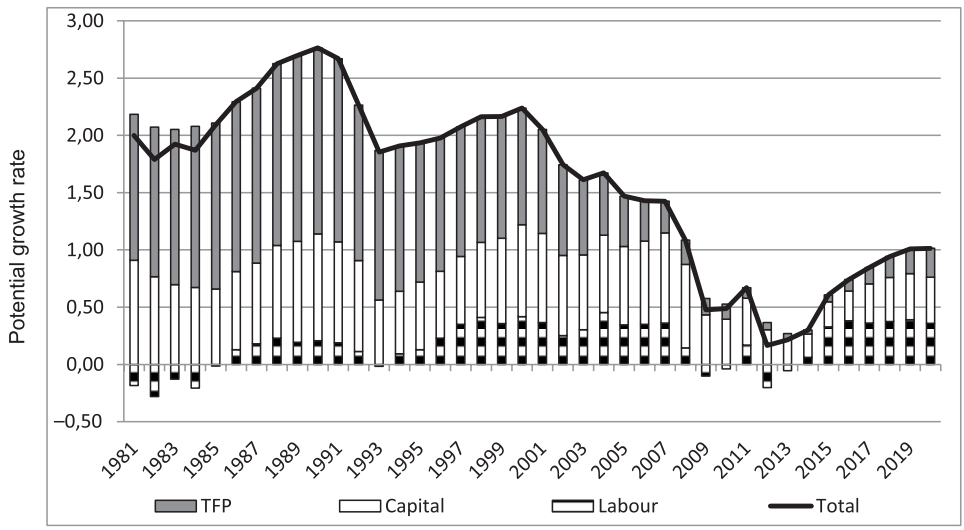

Figure 2.
Development of potential growth and its factors in the F6 countries
Source: Authors' own calculation

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 effect of the capital 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. The contribution of TFP 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). The contribution of labour became negative again at the time of the crisis. The contributions of capital and TFP moderated significantly, too. The dynamism of the labour productivity improved again at the time of the recovery:

simulations suggest that the contribution of both capital deepening and TFP will reach 0.6% by 2019–2020.

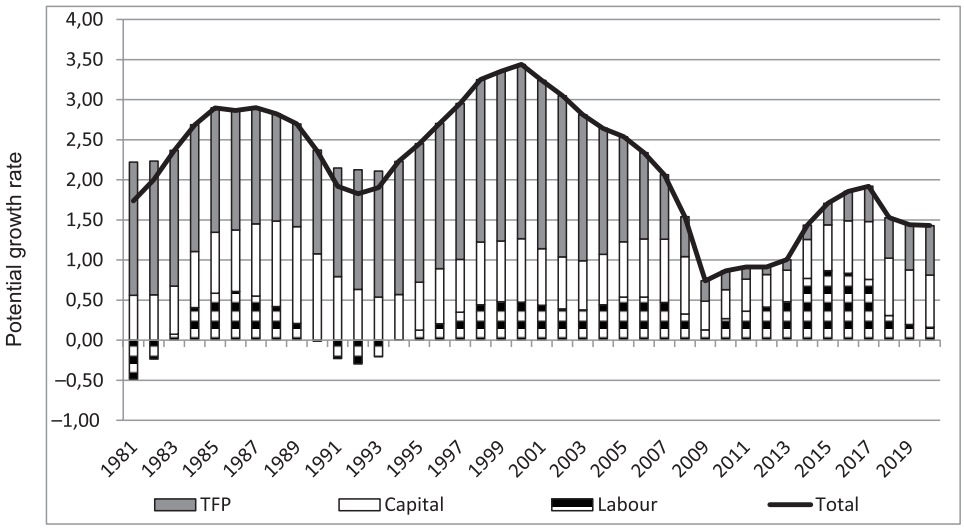

Figure 3.
Development of potential growth and its factors in the N6 countries
Source: Authors' own calculation

Following the accession, the rate of potential growth steadily increased for more than two decades in the countries of the M3 (see Figure 4). The contribution of labour 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. The contribution of capital 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. The contribution of labour 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. The contribution of TFP 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.

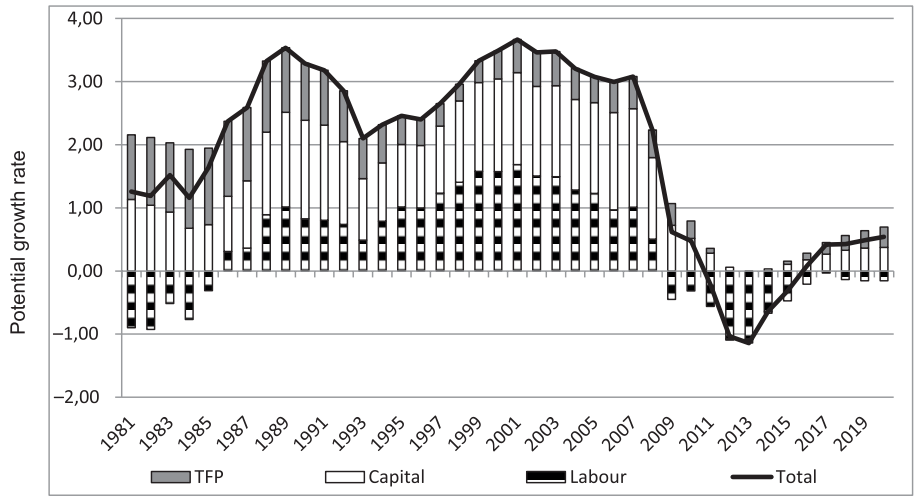

Figure 4.
Development of potential growth and its factors in the M3 countries
Source: Authors' own calculation

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 1990s regarding the contribution of TFP. The contribution of capital has increased from the middle of the 1990s. 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. (The effect of labour became negative and in parallel to the moderating TFP, the contribution of capital accumulation 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.

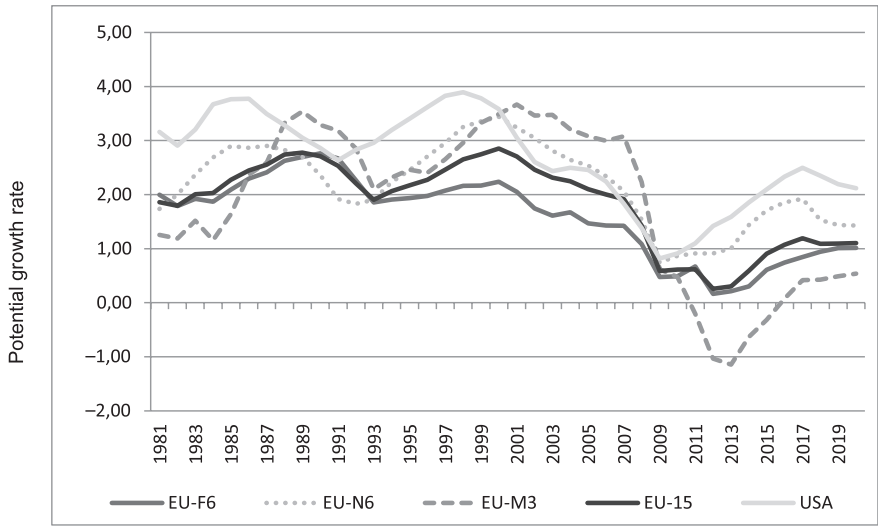

Figure 5.
Development of potential growth in the examined country groups
Source: Authors' own calculation

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)[10] 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 Eurozone (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 half of the pre-crisis level in the examined European countries.

[10] 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					F6					N6					M3				
	1988–1993	1994–2000	2001–2008	2009–2013	2014–2018	1988–1993	1994–2000	2001–2008	2009–2013	2014–2018	1988–1993	1994–2000	2001–2008	2009–2013	2014–2018	1988–1993	1994–2000	2001–2008	2009–2013	2014–2018
PF potential growth	2.48	2.46	2.25	0.47	1.01	2.48	2.07	1.63	0.40	0.78	2.26	2.91	2.67	0.89	1.62	3.05	2.80	3.28	0.46	0.14
Labour productivity	2.31	2.05	1.72	0.49	0.68	2.33	1.78	1.28	0.45	0.46	2.28	2.62	2.21	0.58	1.06	2.25	1.57	1.97	0.44	0.40
Total labour (hours) contribution	0.17	0.41	0.53	-0.01	0.33	0.15	0.28	0.35	-0.05	0.32	-0.02	0.30	0.46	0.33	0.56	0.79	1.23	1.31	-0.70	-0.26
Capital accumulation contribution	0.89	0.73	0.82	0.36	0.43	0.81	0.65	0.71	0.35	0.32	0.89	0.69	0.69	0.38	0.64	1.36	1.16	1.47	0.32	0.24
TFP contribution	1.42	1.32	0.91	0.13	0.25	1.52	1.14	0.57	0.10	0.14	1.39	1.92	1.53	0.17	0.42	0.89	0.41	0.50	0.12	0.16
NAIRU (% of labour force)	8.59	8.63	7.73	8.90	9.30	8.13	8.78	7.91	8.52	9.61	7.41	6.82	5.83	6.23	5.89	14.23	12.81	11.73	16.12	17.80
Investment ratio (% of potential output)	21.60	20.45	22.00	19.29	19.92	21.37	20.39	22.13	20.31	20.21	21.84	19.83	19.83	17.59	19.58	22.49	22.38	26.83	19.53	20.16

Source: Authors' own calculation

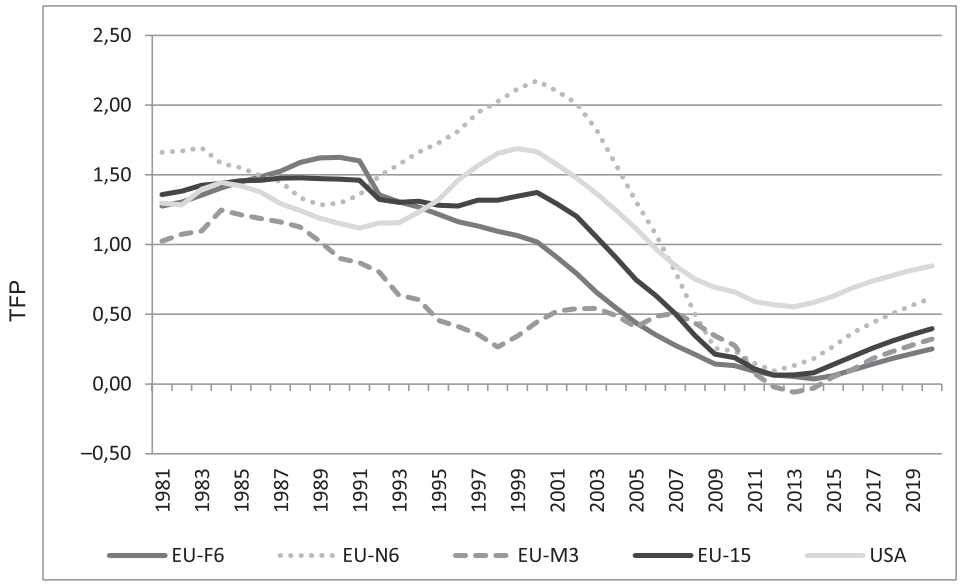

Figure 6.
Contribution of TFP to potential output growth
Source: Authors' own calculation

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. It is important to compare the European and the US growth model. 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 1990s onwards than in the EU15. This higher dynamic is expected to last also in the medium term.
4. Due to the globalization and competitiveness problems of the European Union's economy – the current average annual rate of potential growth in the European Union of 1.2% could significantly fall in the coming decades. The decisive structural element here is the decreasing dynamics of total factor productivity. At the same time, potential growth prospects of the EU12 are more unfavourable than that of the EU15, convergence may stop and even divergence may become apparent. (Elekes–Halmai, 2013)
5. The risk of shock repetition is high. The expected changes project a further erosion of the European growth potential. That is: due to the crisis and its potential longer term impacts, development of the potential growth on the longer term might even be more unfavourable than indicated in the previous points. The trajectory of a permanent shock poses the threat of the complete collapse of the European growth and catch-up model.

What Can the EU and the National Governments Do?

It is interesting to examine *what is in the background of the more dynamic US TFP growth.* Several studies have argued that the crisis hit more seriously the EU. Although most of the EU member states managed to recover, they paid a high price: growing unemployment rates which can also contribute to the slower productivity growth. Hysteresis effects may have emerged following the financial crisis. As outlined by economist Nouriel Roubini (2016), protracted recessions can slow productivity growth for two reasons: because people who remain unemployed for a long time lose their skills and because slowing investment prevents the latest technologies embedded in capital goods from being used. And this will have a roll over effect increasing the productivity gap between the US and the EU.

The Nobel laureate economist Robert Solow (1956) noted that rising incomes should not largely be attributed to capital accumulation, but to technological progress. Joseph Schumpeter (1934) argued that the central virtue of a market economy was its capacity to innovate. And these arguments seem to be confirmed by the latest Global Competitiveness Report (GCR, 2017). The authors argue that productivity remains a key driver of prosperity, although measuring productivity has become more complex during the rise of the Fourth Industrial Revolution. Prosperity can increase only if inputs of production are used in smarter and more efficient ways to fulfil constantly evolving human demands. And *this is a question of innovative capacity.* Even the meaning of innovation had to be updated. "The capacity of a country to be innovative has to be thought of as an ecosystem that not only produces scientific knowledge but also enables all industries – including in the service sector – and society at large to be more flexible, interconnected, and open to new ideas

and business models. This way of understanding innovation focuses on a country's ability to bring new products and services to market, and it attributes equal importance to non-technical and technical inventions."(Schumpeter, 1934)

So how the EU performs in this changing environment? Looking at the rankings of the GCR, we can find that the EU still performs above the global average in terms of competitiveness. This is driven by the performance of a group of regional champions: the Netherlands (4th), Germany (5th), Sweden (6th), the United Kingdom (7th), Finland (10th), and Denmark (12th). As for the EU as a whole, there is a wide dispersion in regional performance on several pillars. The largest gap is in the macroeconomic environment pillar, a reflection of the fact that the region has been recovering unevenly from the global financial crisis. *Europe's median performance is weakest across the innovation indicators*. And this is an important fact, especially relative to the US performance.

It is enough to look at the list of the world's top 10 technology companies (based on their market value): Apple, Alphabet (Google and its side-projects), Microsoft, Facebook, Samsung, Oracle, Tencent, Intel, Cisco Systems and IBM. It is also interesting to see in which areas we can find the most valuable start-ups (or unicorns): Uber (US, ride-hailing service and mobile application), Didi Kuaidi (the biggest ride-hailing company in China), Xiaomi (China, smartphones, mobile apps, and related electronics), Airbnb (US, social website – accommodation), Palantir (US, software and services company, specializing in data analysis). The top 3 sectors covered are: E-commerce, Internet Software & Services and FinTech. More than half (54%) of the world's unicorns are based in the United States. Other countries with the most unicorns include China (23%), India (4%), the UK (4%), Germany (2%) and South Korea (2%). No other country has three or more private companies with a valuation of at least $1 billion. There are no European companies on the top 10 lists at all. We can also see that market size does really matter. It could not be an accidental event that the most valuable tech companies can be found in the largest and most populated countries. Economies of scale is an important factor both as regards innovations and production. In order to push the costs down we need markets. That is why the single market and market liberalization is so important.

It is true, that the large domestic market in the United States represents a major source of competitiveness advantage over other advanced economies. But the United States ranks 3rd for the third consecutive year, which cannot exclusively be explained by the market size. From the point of view of cost competitiveness, it is also an important development that although both the US and the EU used to be a net importer of oil, due to the technological developments (fracking) the US nowadays can rely on its shale stocks pushing down the prices and therefore costs of production. The EU has extensive shale stocks as well, but here (as in so many cases – e.g. agricultural and food production, animal welfare, environmental protection etc.) European producers have to meet stricter standards. Most of the EU member states prohibit fracking due to environmental concerns.[11] The higher standards mean usually extra costs for the European producers

[11] It is worth noting here that environmental factors or more specifically the climate agreement may rearrange the markets in the future. Stock valuations of a lot of oil companies are based on assets (oil stocks) that cannot be mined due to the carbon limits. This is the so called carbon bubble. Burst of this bubble may even result in a financial crisis.

which costs are not always honoured by the market. Based on their performance however, "it is tempting to assume that the competitiveness *factors that matter the most for* firms and *countries looking to benefit from the Fourth Industrial Revolution are linked primarily to measures of technological sophistication and innovation".* (WEF, 2017: 53)

Porter and Heppelmann (2014) argue that information technology is revolutionizing products. The changing nature of products is disrupting the value chains and the *smart, connected products have brought about a new era of competition.* "It is the expanded capabilities of smart, connected products and the data they generate that are ushering in a new era of competition. […] These new types of products alter industry structure and the nature of competition, exposing companies to new competitive opportunities and threats. They are reshaping industry boundaries and creating entirely new industries." (Porter–Heppelmann, 2014) And the leading position of the USA on this area is unquestionable.

So what the EU and the governments that do not want to lag behind can do in order to improve the performance? The answer interestingly comes from Mohammed bin Rashid Al Maktoum (2015), the Vice President and Prime Minister of the United Arab Emirates and Ruler of Dubai. He argues that countries whose governments grow old face the same fate as outdated companies. Their choice is simple: innovate or become irrelevant. *"The lifecycle of companies should teach governments that the secret of eternal youth is constant innovation."* (Maktoum, 2015) The first key to business-like innovation in government is a focus on skills. Top-tier companies continuously invest in their employees to provide them with the right skills for the marketplace. Governments must do the same, by constantly upgrading skills and nurturing innovation among their own employees, across key sectors of the economy, and at the foundations of the education system. The second key to transforming governments into engines of innovation is to shift the balance of investment toward intangibles, as in the private sector: in the knowledge and skills of their employees and the intellectual property embedded in their products. "Governments, too, should think strategically about shifting their spending away from tangible infrastructure like roads and buildings, and toward intangibles like education and research and development in order to build and sustain a knowledge economy." (Maktoum, 2015)

In sum: "to be truly innovative, a country should not only file patents and support research and development in science and technology, but *should also provide a networked, connected environment that promotes creativity and entrepreneurship, fosters collaboration, and rewards individuals who are open-minded and embrace new ways to perform tasks."* (WEF, 2017)

Governments have a lot to do in order to enhance the innovative capacity of their countries. The possibilities of the Fourth Industrial Revolution to produce productivity gains depend on a number of factors. "Ultimately the goal is for individuals, firms, and sectors to be able to access emerging technologies, incorporate them into their innovation and operational processes, and participate meaningfully in both new and transforming value networks." (WEF, 2017: 53) The Global Information Technology Report (WEF, 2016) reveals that *countries looking to capitalize on economic gains of ICTs should promote not just access, but also adoption and use of digital networks.*

While the Fourth Industrial Revolution will feature technologies such as the blockchain that can support both private and public governance, these technologies alone will not replace the importance of an enabling environment. Technology has yet to show its full impact on productivity. *We need time to re-invent our organizations, laws, and rules to fully leverage new technologies*. In some cases, a governance vacuum prevents some of the more advanced technologies, such as self-driving cars and drones, from being translated into reality. In other cases, we recognize the potential of new technologies but do not yet know how best to deploy them. (WEF, 2017: 53) Reil Kurzweil (2005) wrote in his book that the power of human-created technology is expanding at an exponential pace and development becomes more visible around 2020.[12]

Sometimes it takes years that an innovation becomes productive and begins to generate income. It cannot be done without support. But it is the government's liability where the resources are channelled. Private incentives are not always well aligned with social returns. "Firms can gain from innovations that increase their market power, enable them to circumvent regulations, or channel rents that would otherwise accrue to others. Successful industrial policies identify sources of positive externalities – sectors where learning might generate benefits elsewhere in the economy." (Stiglitz, 2014) Governments must follow industrial policies – in which governments intervene in the allocation of resources among sectors or favour some technologies over others – this can help infant economies learn. And it is not easy to find the prospective successful areas. The theory of strategic trade policy may help but in general we can say that governments should be able to identify the areas with the highest possible spill-over benefits to other economic activities. Such policies, when adopted, have been frequent targets of criticism. "Studies show that average returns to the economy from government research projects are actually higher than those from private-sector projects. Especially because the government invests more heavily in important basic research." (Stiglitz, 2014) Benefits of the development of the Internet, the discovery of DNA, robotics, IT and nanotechnologies are unquestionable. And Stiglitz argues that evidence that knowledge generated by clean tech can be similar. Jung (2014) writes that "policymakers need to understand how to establish, manage, and thus measure the conditions that encourage innovators to flock to a region and forge a prosperous future there. Innovation metrics must capture the value of new ideas years before those ideas become profitable in traditionally measured ways." He also identifies some important features that characterize a thriving innovation ecosystem in its birth stages: they include top-level talent, serial entrepreneurs with good track records, start-ups backed by reputable capital, and breakthrough products protected by intellectual-property rights. He (and his colleagues) found that five of today's most successful start-ups in the information-technology sector had two attributes in common by the end of their third year in business: they had filed more than one patent and been funded by more than one top venture-capital firm. And this highlights another

[12] "The Singularity will represent the culmination of the merger of our biological thinking and existence with our technology, resulting in a world that is still human but that transcends our biological roots. There will be no distinction, post-Singularity, between human and machine or between physical and virtual reality. If you wonder what will remain unequivocally human in such a world, it's simply this quality: ours is the species that inherently seeks to extend its physical and mental reach beyond current limitations." (Kurzweil, 2005: 25)

important difference between the US and EU innovation environment: financing. Risk-taking level of the US society is much higher. It is a part of the "business as usual" to fail. However, European societies do not really tolerate business fails. That is why it is so difficult to get resources to finance new ideas. And this is not only true for official and bank sector funding. Venture capital is more limited, as well.

Even the measurement can be a source of concern. "Productivity measurements capture only monetary transactions, so non-monetary transactions (e.g. those initiated in the sharing economy) may not be captured. We may not be able to measure spreading free digital services correctly – how do we account for the output of companies such as Google or Wikipedia or for the matchmaking efficiency achieved by Etsy or Airbnb? And how do we measure cross-border trade in data?" (WEF, 2017: 54) In the same way, qualitative improvements to products and services (mainly due to the positive impacts of the Internet of Things) are equally inherently difficult to capture in national accounts. "There is a growing awareness among policymakers and planners that virtual assets like creative talent and entrepreneurial skill make up an increasing portion of a country's wealth." (Jung, 2014) The US Bureau of Economic Analysis acknowledged this when it changed the definition of GDP in 2013 to represent better the contributions of intellectual property and research and development to productivity and economic vitality. As former US Federal Reserve Chairman Ben Bernanke noted in a 2011 speech, "We will be more likely to promote innovative activity if we are able to measure it more effectively and document its role in economic growth." (Jung, 2014)

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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 case of labour and capital, as well. (For details see Havik et al., 2014)

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

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

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

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

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.[13]

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.

The contribution of capital 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 Havik et al., 2014) Investment shows significant fluctuation over the years. The contributions of capital, 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

[13] 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.

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:

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

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:

$$LPt=(POPWt*PARTSt*(1-NAWRUt)*HOURSTt$$

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:

$$4.\ YPOT=LP\ 0.65\ K\ 0.35\ SRK$$

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.[14] Projections for 2017–2020 in the OGWG database can be considered technical extrapolations instead of forecasts.

[14] 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.