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POTENTIAL GDP AND ITS FACTORS ASSESSMENT

The object of the study is the reserves of economic growth in the country on the example of Ukraine. One of the problems of such studies is the calculation of potential GDP, which is not observed, but is calculated on the basis of various methods. Also problematic is the choice of method/methods of calculating potential GDP and potential values of its factors. Any estimate of the potential value of a variable is based on one or more statistical relationships and therefore contains an element of uncertainty. In order to reduce uncertainty, 2 methods were used to determine the potential values of the components of GDP – the growth rate of employment, fixed capital and TFP (total factor productivity).

The study used the methods of one-dimensional statistical filters Hodrick-Prescott and Baxter-King to estimate the potential values of GDP and the model of the production function to calculate potential GDP based on the potential values of its factors. The main reasons for the slowdown in Ukraine's GDP have been identified, the main of which is low capital productivity due to budget constraints. The second place in this ranking was taken by labor productivity, the last third – by TFP. Weak productivity and investment growth reinforced each other. Capital has the highest growth potential in Ukraine. Therefore, measures to stimulate capital investment, including in research and innovation and human capital, are important. Other factors that affect GDP through labor productivity and TFP are population aging, emigration, and tight lending conditions. To neutralize these factors, it is necessary to create new jobs, facilitate the conditions for obtaining loans by enterprises, stimulate advanced training and lifelong learning. The proposed approach to the separate calculation of potential values of GDP factors and their analysis find reserves for GDP growth. This provides the advantages of this method over other approaches.

Keywords: *potential GDP, production function, labor productivity, capital productivity, total factor productivity.*

1. Introduction

The COVID-19 pandemic has caused significant damage to the economy, which requires decisive action by the government. Developing optimal short- and long-term policies requires an understanding of the sources of economic recovery and growth. One method of determining the presence or absence of these sources is to calculate potential GDP. Analysis of potential GDP factors reveals the factors, hindering GDP growth and sources of economic growth.

Potential GDP is not observed, but is calculated using different methods. The GDP gap is the difference between potential and actual GDP. Approaches to determining potential GDP and GDP gap and analysis of the results are described in many works of the International Monetary Fund. For example, [1] summarizes the methodology and results of the IMF's study of potential GDP in developed and developing countries. In [2], Swedish researchers consider a number of different methods that can be used to estimate the potential output and production gap. These indicators were used to identify opportunities for sustainable non-inflationary growth and to assess the position of macroeconomic policy.

National banks of foreign countries use potential GDP:
– to conduct counter-cyclical fiscal policy [3, 4];
– to analyze the cyclical components of the balance sheet, revenues and expenditures of the budget [5];
– to analyze inflationary processes and to implement macroeconomic forecasts [6–8].

Recently, the attention of international organizations has focused on finding sources to slow down the release of goods and services in different countries and in the world as a whole, which are observed after the crisis of 2009 and today [9–11]. Of particular concern is the slowdown in productivity growth and total factor productivity, as they are the main source of long-term per capita income growth and poverty reduction and GDP growth. To this end, in 2020–2021, a number of studies on the decomposition of potential outputs and GDP were performed, where the potential values of each factor were assessed separately. The analysis of the dynamics of potential values of the main factors of GDP – labor [12], capital [13] and other factors [14] – and their gaps allows to determine the reasons for the slowdown of each factor and economic growth.

Thus, the *object of the study* is selected sources of economic growth in the country on the example of Ukraine. *The purpose of the study* is to assess the contribution of independent factors to GDP and determine the reasons for the slowdown in these factors.

2. Methods of research

In Ukraine, The Government's Priority Action Plan [15] provides for measures to attract additional financial resources for the implementation of medical guarantee programs, support for Ukrainian exporters, budget support for the Energy Efficiency Fund, etc. These measures require financial resources and, accordingly, the identification of sources of GDP growth and increase budget revenues. Therefore, the presented work, which identifies risks to Ukraine's economic growth and, thus, identifies possible sources of this growth, is promising for Ukraine.

Calculations of the potential GDP of Ukraine also took place. In particular, in [16] the potential GDP was determined with the help of the Hodrick-Prescott filter and the presence of statistically significant influence of tax and monetary policy on the long-term trend of the country's development was confirmed. In the forecast model of the National Bank of Ukraine [17], potential GDP is calculated using the multidimensional Kalman filter, the results are used to identify inflationary pressures and possible imbalances in the economy of Ukraine [18]. In [19], based on the two-factor production function, an estimate of the GDP gap for the Ukrainian economy from 2000 to 2017 was made. Also, the current and forecast dynamics of factors (production, human, scientific and technological, financial, foreign economic) that significantly affect the value of Ukraine's GDP were determined.

This paper uses a three-factor model of the production function to determine potential GDP, for which all three factors are separately pre-smoothed using two statistical methods. Then the contributions of these factors to the growth rates of actual and potential GDP are calculated. These contributions are compared and the reasons, influencing the difference in contributions (demographic, technological, investment, acquisition of intellectual property rights), are analyzed.

Potential GDP is the maximum or equilibrium amount that an economy can withstand without creating inflationary pressures [1]. Another definition of potential GDP is the level of GDP that could be achieved given the available reserves of capital and labor if an economy was neither in growth nor in recession [20].

The key role, played by the concept of potential release in the work, stimulated the research to develop and update methods for its evaluation.

Methods for calculating potential GDP values are divided into 3 groups – using statistical filters, using econometric models and based on theoretical ideas about the relationship between unemployment and inflation. The same approaches are used to calculate the potential values of GDP factors and other variables.

Most of the methods, used by the International Monetary Fund (IMF) and the European Commission, focus on the production function approach. This approach is considered a classic and it helps to identify factors that contribute to changes in the growth rate of potential output over the past three decades [1, 21].

The most common statistical methods are the Hodrick-Prescott method (e. g. [3, 22], Kalman, Beveridge-Nelson, Baxter-King. As well as models (SVAR, ARMA, etc.), dynamic general equilibrium models (DSGE models) [1, 2, 19].

The methods of Hodrick-Prescott and Baxter King were used by adapting the approaches of the European Commission [22, 23] to the calculation of potential values of labor productivity, capital and TFP (total factor productivity) [18].

To estimate both real and potential GDP, this paper uses one of the most common methods – the production function with three variables:

$$Y_t = F_t(K_t,\ L_t,\ A_t), \tag{1}$$

or

$$\dot{Y} = (1-\alpha-\beta)\dot{A} + \alpha\dot{L} + \beta\dot{K}, \tag{2}$$

where Y – GDP, measured in value terms at constant prices;

K – fixed capital, used in the production process and measured in value terms at constant prices;

L – resource of living labor, which is measured by the number of employees, the number of man-hours worked or the amount of labor costs in value terms at constant prices;

A – structural parameters of the production function or parameters of scientific and technological progress (total factor productivity or TFP) [13];

$\dot{A}$ – growth rate of TFP in year t;

$\dot{Y}$ – GDP growth rate in year t;

$\dot{L}$ – growth rate of labor in year t;

$\dot{K}$ – growth rate of capital in year t;

a – coefficient calculated as a share of «Wages of employees» in GDP;

β – coefficient calculated as a share of gross fixed capital formation (GFCF) in GDP.

For real GDP, independent variables are the real values of independent variables, and for potential – potential. Potential GDP is a function of potential capital stock K_t, potential employment L_t and potential total factor productivity A_t. This is the level of GDP, at which there should be no inflationary pressure of demand.

To find new opportunities and sources of economic growth, this paper analyzes the impact on economic growth of its components – labor, capital and technological progress, which can be done by comparing the contribution of these components to real and potential GDP, which is another novelty for Ukraine.

As in similar studies, this paper uses a constant return to scale, the coefficients for formula (2) are calculated for the actual values of wages of employees, GFCF, GDP and are used to calculate potential GDP.

3. Research results and discussion

The following statistics were used for the calculations:
– rates of change in GDP in annual terms (% to the previous year);
– rates of change of the employed population in annual terms;
– rates of change of fixed capital in annual terms.

The rate of change of the actual TFP was calculated on the basis of formula (2) for the actual values of all its variables.

According to the results of the application of statistical filters, the potential values of labor productivity, capital and TFP, which are long-term trends of these variables, were obtained.

Labor productivity is the main long-term driver of economic growth, and the basis of its growth is technological innovation. Its contribution to the rate of change in GDP, both actual and potential, was the largest before the crisis of 2009. The growth of the contribution in the post-crisis period of 2012–2018 did not reach the values of the pre-crisis period.

The contribution of potential labor productivity to the rate of change in potential GDP, calculated by the Baxter King method, is much higher than the real contribution – from 3–4 to 28 and more times (except in 2009). The potential productivity, calculated by the Hodrick-Prescott method, almost repeats the dynamics of the real contribution and differs from it only by 0.01–0.07 percentage points (pp), except for 2009–2010 – 3.6 pp. (Fig. 1).

In Fig. 1 the data are given for actual productivity (italics) and potential based on the Baxter-King method.

Fig. 1. Dynamics of the contribution of real and potential labor productivity in Ukraine with the use of different smoothing procedures in the rate of change of the corresponding GDP, pp, 2004–2018 (calculated by the author based on data [24, 25])

«Technological» shocks or changes are identified as explaining most fluctuations in productivity over long-term periods (more than 10 years). Potential productivity does not take into account fluctuations at shorter frequencies and is resistant to noise factors, i. e., to many other factors, such as demand shocks. Potential productivity demonstrates long-term innovation in labor productivity, suggesting that these extremely sustainable changes are likely to consist of supply-side structural factors.

The reasons for the significant difference between real productivity and its potential level are:

– high emigration, which reduces the supply of domestic labor, which is the basis for the growth of potential production;

– demographic changes (aging population, low birth rate, gender inequality in the sense of prejudice against women with small children), which have a significant negative impact on the potential output;

– low levels of capital investment;

– new technologies that can both replace and complement the work. World Bank data [9] suggest that the substitution effect dominates in the short run. The typical 1.0 percent improvement in productivity due to technology reduces employment in the first year by 0.2 percent in developed economies and by 0.1 percent in developing countries. In the short run, technological change is displacing employment, but the productivity gap in Ukraine is much larger than that, caused by the impact of technology.

Long-term trends in labor productivity in Ukraine indicate that there are significant resources to increase it, and thus GDP growth. But there is a need for state regulation of the labor market to reduce the outflow of labor abroad and improve the skills of workers in accordance with modern needs. As well as the introduction of real flexible employment, improving the level and quality of education of young people, which should replace the older generation in the workplace, and rejuvenate the employed population. The trend towards greater automation and digitalization is growing in developing countries, increasing the importance of measures to improve the skills of the workforce while strengthening the social safety net for workers who change jobs.

Real capital productivity in Ukraine grew insignificantly compared to labor productivity until 2008, then its rate decreased, as well as the volume of fixed capital (2008–2009 and in 2011–2017 and 2020), Table 1.

The contribution of potential productivity of capital to the rate of change in potential GDP, calculated by the Baxter King method, is much higher than the real contribution – from 5 to 150 times (except in 2009). The contribution of potential productivity, calculated by the Hodrick-Prescott method, almost repeats the contribution of the real contribution and differs from it only by (−0.1)−(−1.7) pp. (i. e., its contribution is less than the contribution of real productivity of capital).

Table 1

The value of gross fixed capital formation and growth of net foreign investment in Ukraine in relation to GDP in 2011–2020, %

Indicator	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Gross fixed capital formation, % of GDP	17.65	18.99	16.86	14.14	13.55	15.46	15.78	17.65	17.62	13.04
Growth of net foreign investment, % of GDP	1.73	2.00	1.09	−11.50	−6.85	−0.96	0.34	0.99	3.81	−0.02

Note: calculated based on data [24, 26]

The highest contributions to the rate of change in GDP were made by capital before the crisis of 2009, in 2009 the contribution was negative by all methods. The growth of the contribution in the post-crisis period of 2012–2018 did not reach the values of the pre-crisis period (Fig. 2).
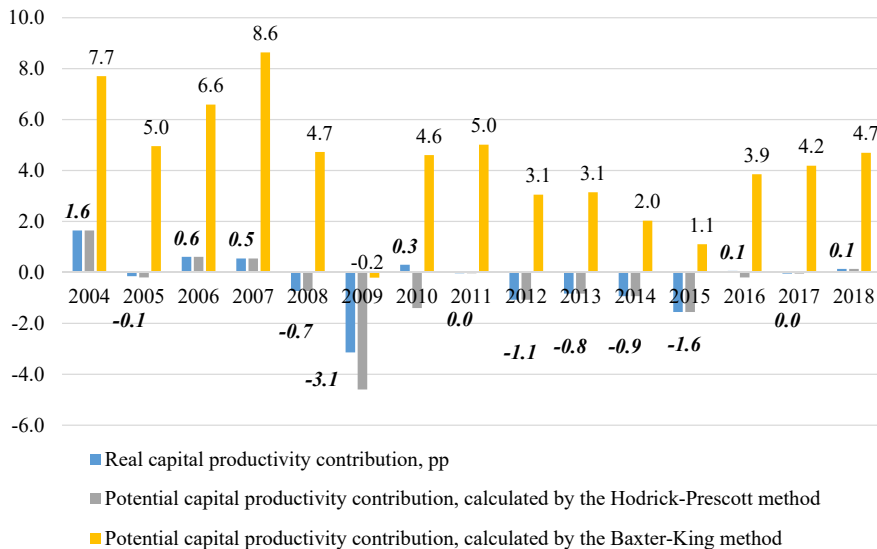
Fig. 2. Dynamics of the contribution of real and potential capital productivity in Ukraine with the use of different smoothing procedures in the rate of change of the corresponding GDP, pp, 2004–2018 (calculated by the author based on data [24, 25])

In Fig. 2 the data are given for actual capital productivity (italics) and potential based on the Baxter-King method.

The low values of real productivity of capital are explained by a significant degree of depreciation of fixed assets in Ukraine (60.6 % in 2018) and insignificant amounts of capital and foreign direct investment, which are unable to update fixed assets to the required level. In 2020, the decline in capital investment was the largest in 10 years. Their volume in 2020 was only 10 % of GDP. Decreased production investment reduces the level of capital in the production function and, consequently, GDP.

In Ukraine, public capital investment was low due to budget constraints. In general, public investment is positively correlated with private investment, with a very low share of public investment in GDP, causing low private investment.

The new global financial crisis has exacerbated the decline in capital productivity growth, which may have a lasting impact on potential output growth, as capital productivity has a significant impact on long-term economic growth and labor productivity growth.

Capital investment was also weak in most developed economies. The persistent weakness of investment, despite historically low interest rates, has raised concerns about the risk of «stagnation».

In general, over the last 20 years (except for the crisis of 2009, 2014–2015, 2020), the TFP in Ukraine has grown at a high average annual rate of 10.3 %. In all the crisis years, the TFP fell at an average annual rate of 22.4 %, because in such years, companies are trying to survive, rather than invest in innovation. The growth of the TFP in the post-crisis period of 2016–2018 resumed, but at a slower pace compared to the period before 2009.

The contribution of potential TFP to the rate of change in potential GDP, calculated by the Baxter-King method, is higher than the real contribution – from 2.4 (2007) to 19.5 times (2016). In the crisis years (2009 and 2014–2015), the contribution of potential TFP is 65–73 % of the real one. The contribution of potential TFP, calculated by the Hodrick-Prescott method, almost repeats the contribution of real TFP in 2004–2008, 2011–2013, 2016–2018. But in crisis and post-crisis years it is less than the contribution of real TFP in 3.4– 25.8 times (Fig. 3).

In Fig. 3 the data are given for actual TFP (italics) and potential based on the Baxter-King method.
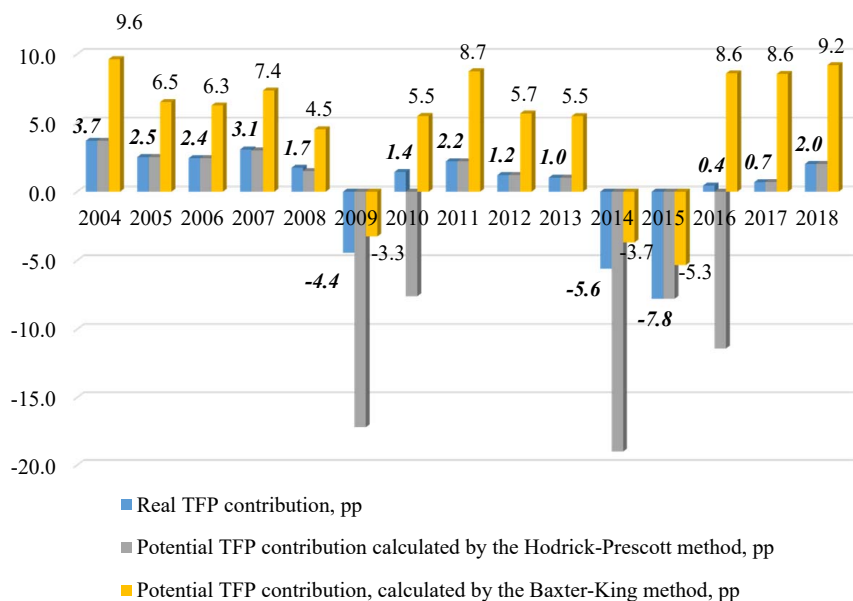
Fig. 3. Dynamics of the contribution of real and potential TFP in Ukraine using different smoothing procedures in the rate of change of the corresponding GDP, pp, 2004–2018 (calculated by the author based on data [24, 25])

Potential TFP represents the contribution of technology to GDP, because it is the technological impact that manifests itself in the long run. The real TFP is influenced by short-term or non-technological factors, in particular:
– reducing the cost of science and innovation, especially business;

– a significant share of technology transfer in the form of «know-how, agreements on purchase (transfer) of technology», which inhibits the widespread introduction of new technologies, reduces funding for research and innovation;

– demographic factors, first of all population aging. Employee skills tend to increase until a certain age and then begin to decline with a concomitant effect on innovation and productivity;

– strict conditions and limited access to credit for enterprises, including innovative ones;

– insignificant amounts of capital investments.

The excess of real TFP over potential in crisis years means that in such years the management does not introduce new technologies, but thinks about the survival of an enterprise. TFP has been growing for the most part over the years due to non-technological factors, including administrative ones. Given the importance of introducing new technologies for economic growth, the Ukrainian trend is threatening long-term growth.

The obtained results contain only estimated values of the gaps between the actual and potential values of labor productivity, capital and TFP. But on the basis of their analysis it is possible to determine the factors, influencing GDP and reserves for its growth. Therefore, the results of the work can be used as markers for the development of measures and plans for the recovery of Ukraine's economy, including after the COVID crisis.

In further research it is necessary to carry out a full analysis of determinants, influencing GDP factors using econometric models, taking into account macroeconomic, fiscal, tax indicators. Thus, to define a full set of the specified factors of influence. As well as provide proposals for policy measures to neutralize the negative factors that contribute to slow growth or decline in GDP.

4. Conclusions

The study has obtained the potential values of GDP and its three independent variables – employment, capital investment and total factor productivity. Based on the analysis of these potential values, the main factors that slow down Ukraine's GDP have been identified and measures to eliminate or reduce these factors have been proposed.

It is shown, that potential output/GDP is a concept, used in economic analysis to measure the highest level of production (gross domestic product) that an economy can achieve without creating inflationary pressures. Determining the potential level of each indicator (GDP and its components) is the purification of its actual value from cyclical components and identification of the trend component, or the highest possible level. The comparison of the contributions of actual and potential values of independent variables to GDP allowed us to determine the main factors behind the slowdown or decline in its growth rate. In Ukraine, capital is the main factor in reducing real GDP growth in the last 10 years and has the highest growth potential – at least 5 times. According to IMF research, declining investment is a key factor that leads to a constant loss of production and total factor productivity [13]. The contribution of the potential labor productivity to the rate of change in potential GDP is at least 3–4 times higher than the real contribution. The contribution of the potential TFP exceeds the contribu-

tion of the actual one by at least 2.4 times, except for the crisis years (2009, 2014–2015), when its contribution was 0.6–0.7 contribution of the actual TFP.

It is noted, that «technological» shocks or changes are identified as explaining most fluctuations in productivity over long-term periods (more than 10 years). Among the technological impulses, the main ones are digital technologies, which will only intensify, as artificial intelligence, advanced robotics and cyberphysical systems will take the digital revolution to a new level. However, productivity growth has slowed as digital technologies spread, both in advanced economies and in Ukraine. This was facilitated by declining populations, especially those of working age, and low capital investment. Weak productivity and investment growth reinforced each other. Growth rates in both actual and potential TFPs in Ukraine have also slowed since the 2009 crisis. Potential TFP is a contribution of technology to GDP and should grow faster as digital technologies develop. But in Ukraine, short-term or non-technological factors have a greater impact on real TFP, primarily population aging and low levels of capital investment and investment in innovation. Thus, the main problems in Ukraine are demographic (population decline and aging) and insignificant amounts of capital investment. Measures to stimulate capital investment, including in research and innovation and human capital, are important for Ukraine. The results obtained may be useful to specialists of the Ministry of Education and Science and the Ministry of Economy of Ukraine in developing policy measures to increase economic growth and neutralize threats to this growth.

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