

Article

# The computation of the output gap in Polish economy in the light of the secular stagnation scenario (sustainability antithesis)

Elżbieta Szaruga <sup>1,\*</sup>

<sup>1</sup> Institute of Spatial Management and Socio-Economic Geography, University of Szczecin; Mickiewicza 64 Street, Szczecin 71-101, Poland; elzbieta.szaruga@usz.edu.pl

\* Correspondence: elzbieta.szaruga@usz.edu.pl

**Abstract:** The research problem was formulated as a question: are demand-supply shocks affecting the opening up of a negative or positive output gap? The hypothesis was formulated: demand-supply shocks have a significant impact on the opening up and deepening of the negative output gap, thereby causing real GDP to shrink or potential GDP to grow. The spatial range applies to Poland and the time period - 2008:Q1-2019:Q4. The methodology consists of three stages: the first is the decomposition of the time series using the TRAMO/SEATS on the components: seasonality, trend-cycle, irregular; the second - the decomposition of the trend-cycle component using the Hodrick-Prescott filter into two separate components; the third is the calculation of the output gap; forecast with VECM and IRF approximation. The output gap is in the range of - 11% to +10%. After cleaning it, the shock elements are between -2.2% and 2%. Demand-supply shocks open up and widen the negative output gap. Based on forecasts, the output gap will be positive by the end of 2022, close to 0% (optimal scenario), rising to 5% (optimistic scenario) and negative, deepening to - 4% (pessimistic scenario). Two of these scenarios point to a growing risk of secular stagnation.

**Keywords:** coronavirus pandemic (2019+); cycle; Hodrick-Prescott filter; output gap; Polish economy; secular stagnation; sustainability; trend

---

## 1. Introduction

The global economic crisis 2008+ and the crisis associated with the coronavirus pandemic (2019+) highlighted the imperfections of economic policy and economic theories adopted so far. It is noted that in 2020 the crisis 2008+ has not yet ended (despite relatively positive cyclical/conjectural moments as a result of strengthening of internal demand). It can be assumed that it took the next phase of the life cycle, transforming into another crisis, which has its source in supply and demand shocks. Each impulse, this time a coronavirus pandemic 2019+, which affects the imbalance of demand and supply functions, strengthens the effects of the crisis that has already begun. It is believed that the next phase of the crisis's life may be secular stagnation (antithesis of sustainability). In this context the sustainability is a short-term and long-term concept of the development without any deep crises in economy, but economy could drift and be influenced by demand-supply shocks. Sustainability harmonize the orders of modern economies. It should be emphasized that the threat of secular stagnation is increased the more the longer the dominant role of the growth paradigm, the so-called growthmania, is emphasized.

Growthmania is in fact the pursuit of continuous growth, insufficient understanding of the limits of growth and ultimately fetishism of GDP. This fetishism is manifested not only in the construction of indicators containing GDP in their structure (despite its many imperfections), but also analysing the economic situation solely based on GDP cycles, or estimating the output (product) gap in isolation from social and environmental spheres. This problem seems to be "swollen" due to the lack of an alternative indicator that could relate to a long time perspective. New suggestions for indicators are justified and desirable. However, either their frequency of publication is rare (once a year; annual

data), or the width of the time range is insufficient (too few observations for some analyses), or both. Therefore, one approaches alternative indicators for GDP with a distance (maybe distrust), focusing on the traditional approach.

The paper also focuses on the analysis of GDP and the output gap. Some dilemmas related to the methodical approach to estimating the output gap, containing the irregular (random) component were pointed out. Although the author of this paper notices the problem of growthmania, and also defines GDP in a way, basing analysis on this indicator. However, the essence of this approach is to refer to the problem of estimating the output gap, which is one of the benchmarks in the decision-making process of politicians and economists. Because the significance of the output gap is of particular importance not only for the monetary transmission mechanism, but translates into multidimensional effects in the entire economy. Thus, the output gap functions in the constructivist order, in which reality is modelled and in the ecological order, where decisions are made. In addition, it should be noted that this gap is continually affected by short-term and long-term disturbances on both the demand and supply side, therefore its estimation is subject to uncertainty. In other words, the order in which the output gap is forming drifts towards entropy.

The research problem is raised in the form of a question: are demand-supply shocks affecting the opening up of a negative or positive output gap? In the context of this research problem, a research hypothesis has been put forward: Demand-supply shocks have a significant impact on the opening up and deepening of the negative output gap, thereby causing real GDP to shrink or potential GDP to grow. This hypothesis was subordinated to the research objective of computing the output gap and assessing the impulse response from demand-supply shocks to the output gap.

The paper consists of five parts. The first is introduction. The second part discusses the growth paradigm in the context of secular stagnation and reviews the literature regarding the problem of estimating the output gap. The third part introduces the research methodology and describes the data on the basis of which the research related to the estimation of the output gap was carried out. The fourth part is devoted to the presentation of empirical results of estimation output gap along with a detailed description of the stages of research. This section also sets out the response of the output gap to shock and the forecast of the output gap by 2022. The paper ends with summary conclusions.

## 2. Literature background

There is a debate in economics about the directions of socio-economic policy and its future. Until now, economic reality was created by neoliberalism. In could be (or actually should) look for the sources of the global crisis 2008+ and the crisis caused by demand and supply shocks, originally caused by the impulse of a coronavirus pandemic.

The idea of promoting uninterrupted and harmonized development is the sustainable development. Sustainable development is based on harmonization of economic, environmental and social objectives in short-term and long-term decisions. Sustainability is inscribed in the need for development programming [1 by 2]. However, economic development based on the idea of sustainable development is not solely focused on economic growth, as in neoliberalism or growthmania. The approach, which is the antithesis of sustainable development [3] (p. 162), is the secular stagnation that is more broadly discussed later in the article.

Elżbieta Mączyńska emphasizes that "neoliberalism is a system that shoots itself in the foot (...)", noting that it focuses exclusively on growth (it is a kind of deification of GDP) without deliberating on social and ecological issues [4] (p. B7).

In this context, the interpretation of pro-growth thinking becomes particularly important. Herman E. Daly aptly called pro-growth thinking devoid of reflection on the limits of growth-oriented and mass consumerism - growthmania (about growthmania vide [5] (pp. 149-167)). It is worth mentioning that growthmania is litotes for the concept of de-growth (Serge Latouche raises the issue around the term 'de-growth'. In his opinion, this concept is not synonymous with negative growth, because as Latouche notes, then it would be an oxymoron. However, "de-growth" highlights the fact that modern economies are dominated by the image of growth; by: Latouche [6]). It seems

that this term is now *en vogue* in the context of the spectrum of secular stagnation (about secular stagnation vide [7] (pp. 62-69), that is a consequence of the global crisis started in 2007 [8] (p. 11).

Pro-growth thinking is basically conditioned by understanding the idea of economic growth. Józefa Famielec presented the interpretation of the essence of economic growth in the context of economic theory and forward thinking. The professor emphasized that economic growth is of fundamental importance for economics, as it sets the direction of the creators of socio-economic reality, which is why he is considered one of the elementary paradigms. Associating it mainly through the prism of consumer and investment activities, limits its comprehension to the category of GDP or national income - without a clear alternative taking into account other factors (even civilization) [9] (pp. 16-17).

The forecasts of Thomas Piketty [10] (p. 122) correspond well with this understanding of economic growth. Piketty exposes the inability to continue growing like a "hockey stick" ("J" shaped growth - dynamic and infinite growth). Because, as he himself estimates, if growth continues, it is likely that it will not exceed the rate of 1.5% per year. However, the growth rate that has been observed up to now - at 4-5% - is, according to Piketty, a historical exception, a temporary situation (in the post-war period in Europe; currently in China, which is catching up with other economies). It is confirmed by the fact that so far no country has permanently maintained a growth rate of more than 1.5% per year after reaching a point on the technological limit of production capabilities (the original translation uses the wording "world technological frontier") on a global scale [10] (p. 122).

Matthias Schmelzer holds a similar view. According to him, the growth paradigm could be justified until the mid-twentieth century, but nowadays, in a situation of depletion of natural resources and dynamic changes, it is not desirable, and may even be catastrophic [11] (p. 270).

As Hubert Buch-Hansen emphasizes, many economists believe that the rapid growth of economic systems is a leading cause of the environmental crisis and that continuing growth does not allow to overcome the crisis. However, he asks the question whether the transition towards non-growth economies requires a move away from capitalism [12] (p. 168). It seems that the answer can be found in ordoliberalism.

By extending the above considerations, Józefa Famielec explains that the interferences between the economy are autogenic and based on the laws of nature. She also notes that it could not resort to escapism over the course of these dependencies, but you must model economic processes in harmony with the natural and social environment, which is to serve order - Ordo [13] (p. 114).

The conclusions are confirmation of Naomi Klein, who claims that order is already destabilized, and therefore believes that any steps should be taken to transform "controlled post-growth" (post-growth is used interchangeably with the word de-growth) from the Great Depression to the "Great Transformation" [14] (p. 100). In other words, it can be argued that N. Klein also notes that the world is falling into entropy and that global economic processes need to be ordered in harmony with other orders, especially environmental ones. She simply proposes to limit consumption through demand-regulating tools. This approach should not be confused with the attitudes presented by Will Potter [15] rather than through solutions that promote ecological consumption [14] (pp. 100-101). Opposition to hyper-consumerism seems understandable, but on the other hand, which is associated with a deflation gap, reducing demand can lead to a dangerous deflationary spiral, another crisis and secular stagnation.

In the light of these considerations, the interpretation of secular stagnation is interesting. Panagiotis E. Petrakis, Pantelis C. Kostis and Kyriaki I. Kafka [16] identify the secular stagnation with a new era, new times in economics initiated by the global crisis 2007+. These new times bring inevitable socio-economic changes, thus affecting all participants in the world economy and increasing uncertainty [16] (p. 1910). These unavoidable changes include: a new multipolar and globalized world, excellent competition and market liberalization, hyper-competition, transformation of the economy from industry to services, strengthening of the position of individuals in the conditions of changing globalization, aging of the society, migration problem, climate change, destructive technologies [17].

It is impossible to disagree with this approach, moreover, secular stagnation is a possible scenario in the light of the crisis caused by the coronavirus pandemic. It is believed that a new stage

in economic life is beginning, a transformation of the economy towards the Internet of Things and the twilight of capitalism [18], although this vision of the world was already proposed after the global economic crisis 2007+. In response to alarming signals from the world of the economy, attention was drawn to the need to measure economic breakdowns. It has been noted that the effects of a deep crisis will always affect the development of the economy in such a way that it will never be possible to close the gap between the current and past state [19] (p. 58). Robert Shiller, writing about the great illusion - yesterday and today, emphasized that along with the evolution of modern weapons of mass destruction, it is necessary to build tools to reduce aggression. According to him, one should move away from the "great illusion" and its consequences by improving financial capitalism, humanization and democratization [20] (p. 330). Perhaps it is worth considering these words in the context of the new reality after the 2019+ coronavirus pandemic. Bernard Landais [21] at the end of his book entitled "Economic fluctuations. A New Synthesis" wrote about additional threats, global opening of economies, and an improperly regulated recession. He noted that free trade protection was a panacea for not getting into the aftermath of the 2007+ crisis as deeply as it did during the 1930s crisis. He asks the question "And how will it be tomorrow?" [21] (p. 157). His question is valid in the current crisis. In addition, you can ask another question, whether after the experience of coronavirus, the protection of free trade is a panacea for preventing crises.

In the light of this problem, it is worth considering the issue of secular stagnation, which, incidentally, is conditioned, among others, by the spread of the output gap [22] (p. 51). Research on estimating the output gap has been carried out, among others: Álvarez & Gómez-Loscos [23], Ahmad & Sharma [24], Łyziak [25], Buncic & Müller [26], Zhang & Murasawa [27], Pichette, Robitaille, Salameh, & St-Amant [28], Marcellino & Musso [29], Kamada [30], González-Astudillo [31]. Particularly interesting are studies in which the demand gap has been computed using Hodrick-Prescott filtration, among others: Grant & Chan [32], Mise, Kim, & Newbold [33], Razzak [34], Jašová, Moessner, & Takáts [35], Ince & Papell [36], Maravall & del Río [37], Mitra, Maheswari, & Mitra [38], Amador-Torres, et al. [39], de Carvalho & Rua [40].

### 3. Data, Methods & Steps

The research was conducted on the basis of quarterly macroeconomic data, which concerns on Poland and relates to the time range - from first quarter of 2008 to fourth quarter of 2019 (2008:Q1-2019:Q4). The adopted time range fulfils the condition of the minimum number of the observations in accordance with MQ [41] (p. 14) for the Tramo/Seats method and provides a sufficient number of degrees of freedom for Vector Error Correction Models with accepted delays (which is described in more detail later in the paper). In addition, the adopted time range corresponds to the period assigned to the 2008+ global crisis and the period in which the coronavirus pandemic began (SARS-CoV-2). The following symbol were adopted as representative variable [42]: GDP – gross domestic product at current prices; raw data expressed in mln €.

The study was divided into two parts. In the first part, the data was seasonally adjusted using the Tramo/Seats method to reduce the impact of seasonal fluctuations on the tested object - this is particularly important from the point of view of short-term trends, decomposing them into a seasonal, trend-cycle and irregular components. Then the trend-cycle component was decomposed by Hodrick-Prescott filtration for trend and cycle (separately).

The study was divided into two parts. In the first part, the data was seasonally adjusted using the Tramo/Seats method in order to reduce the impact of seasonal fluctuations on the tested object. This is particularly important from the point of view of short-term trends, decomposing them into a seasonal, trend-cycle and irregular components. Then the trend-cycle component was decomposed by the Hodrick-Prescott filtration method [43] for the trend and cycle according to the formula:

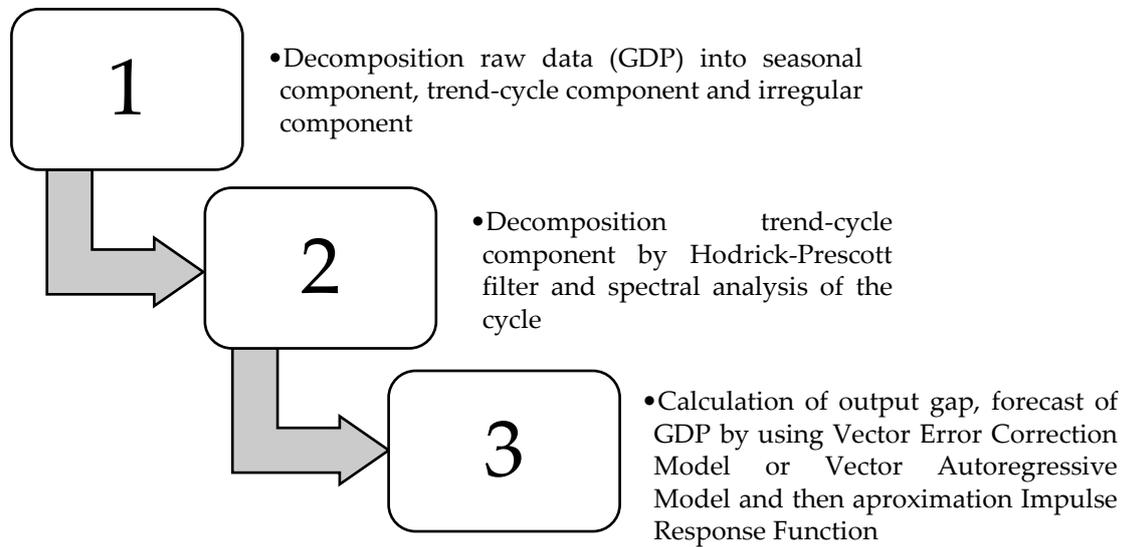
$$\min_{\tau_t} \{ \sum_{t=1}^T (y_t - \tau_t)^2 + \lambda \sum_{t=2}^{T-1} [(\tau_{t+1} - \tau_t) - (\tau_t - \tau_{t-1})]^2 \} \quad (1)$$

where:

T number of observation

$\tau_t$  smoothy series,  
 $y_t$  input series.

The second part estimates the output gap. The estimation of the output gap was based on the decomposition of GDP with the Hodrick-Prescott filter. It is calculated as relative difference between real and potential GDP [44]. Calculations were carried out in the Gretl program. The framework of methodology is shown below.



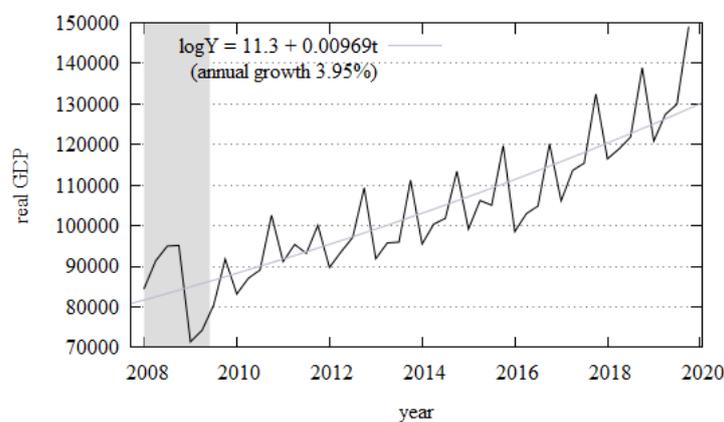
**Figure 1.** An original proposal for a framework

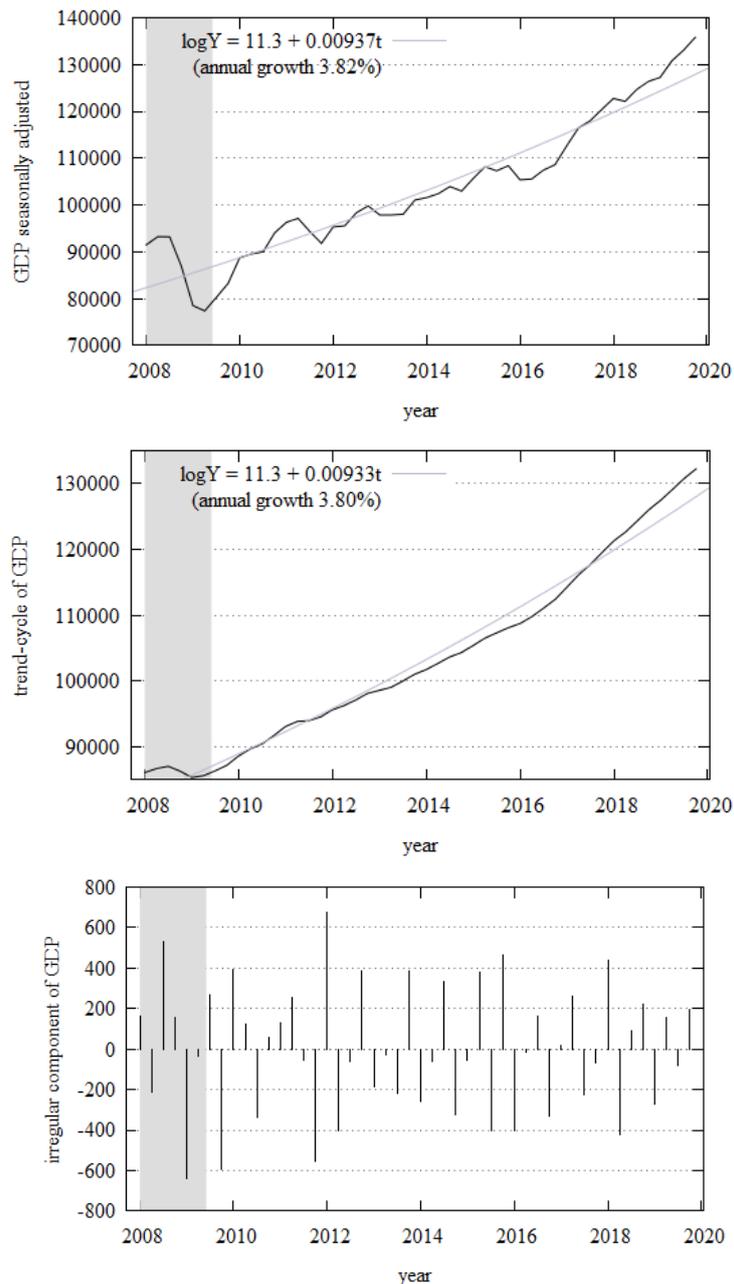
**Source:** own elaboration.

The empirical results are shown in the next part of paper.

### 3. Empirical results

In this analysis of the data after taking the logarithm into account, they have been subjected to a decomposition by Tramo/Seats for eliminating seasonal variations [detail in Appendix 1]. However, empirical results are presented for GDP and calculated output gap. Figure 2 shows the decomposition of logarithmic GDP into a seasonal, a trend-cycle and an irregular components. It should be noted that GDP minus the seasonal component is called seasonally adjusted GDP. The seasonally adjusted GDP minus the irregular component should be equal to the trend-cycle component.





**Figure 2.** GDP decomposition using the TRAMO/SEATS method

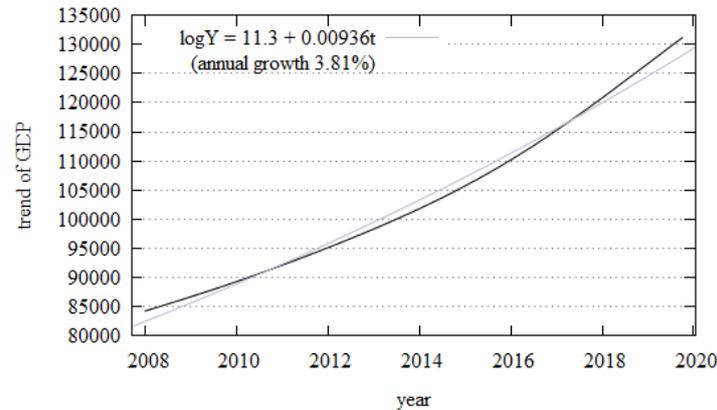
NBER recession is marked in grey colour (zone). The grey line is the best fit line.

**Source:** own calculations carried out in the Gretl program based on data from the EuroStat database [42].

Based on the graphs in Figure 2, it can be seen that the grey zone is marked NBER recession. NBER recession falls on the period 2008: Q1-2009: Q1, when GDP fell for several consecutive months. In the analysed period, GDP indicates an upward trend and uneven seasonality. Before seasonal adjustment, annual GDP growth was estimated at 3.95% over the whole period considered, after adjustment at 3.82%. After excluding the irregular component (shock factor) - this increase was estimated at 3.80%, with reference to the aggregate trend and cyclical component. The irregular component had the strongest negative impact in the following periods: 2009:Q1; 2009:Q4; 2011:Q4; 2018:Q2; and positive in: 2008:Q3 and 2012:Q1.

Based on the trend-cycle component, it can be confirmed that the upward trend is maintained throughout the period considered. However, in order to examine the cycle around the long-term

trend, it was necessary to decompose the trend-cycle component into two separate components using a Hodrick-Prescott filter (figure 3).



**Figure 3.** Decomposition of the trend component of GDP by Hodrick-Prescott filter ( $\lambda=1600$ )

The grey line is the best fit line.

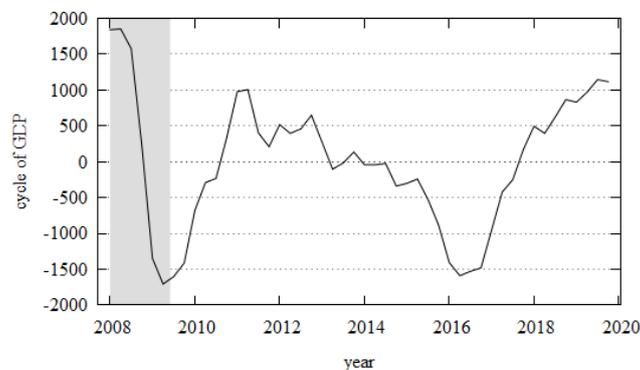
**Source:** own calculations carried out in the Gretl program based on the results obtained from the Tramo/Seats analysis.

Based on figure 3, it can be seen that the trend component is an increasing function that can be represented as an exponential function (taking into account the previously used logarithmic transformation) as:

$$\log Y = 11.3 + 0.00936t. \quad (2)$$

According to this record, the quarterly increase for the GDP trend was 0.9525%, while the annual increase was 3.81%. The growth dynamics was lower in 2008:Q1-2015:Q4 than in 2016:Q1-2019:Q4.

The next figure (figure 4) presents the decomposed cyclical component of GDP.



**Figure 4.** Cycle component of real GDP

NBER recession is marked in grey colour (zone).

**Source:** own calculations carried out in the Gretl program based on the results obtained from the Tramo/Seats analysis.

Analysing the cyclical component (figure 4), four periods above the long-term trend are distinguished: 2008:Q1-2008:Q4; 2010:Q4-2013:Q1; 2013:Q4; 2017:Q4-2019:Q4. 50% of the observations are below the long-term trend: 2009:Q1-2010:Q3; 2013:Q2-2013:Q3; 2014:Q1-2017:Q3 (there is also another term, i.e. a secular trend, including in: Osiatyński [45] (pp. 298-299), Block & Majewski [46] (pp. 67-69). You can see the formation of a flag, consisting of a wedge between the resistance line and the support line (2011:Q2-2014:Q3). The formation of the flag is also interesting (2018:Q1-2019:Q4). The cycle is counted between two depressions, i.e. between the periods 2009:Q2 and 2016:Q2 (7 years).

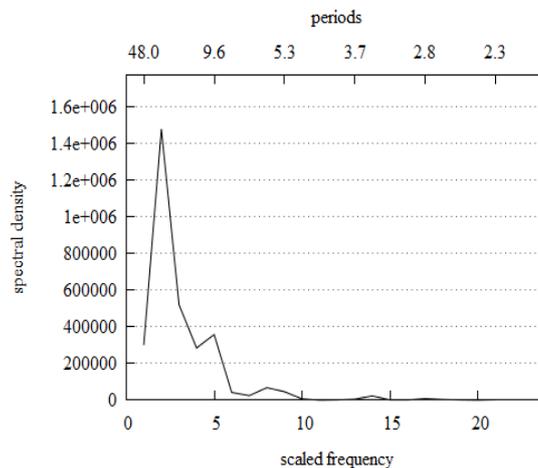
The above conclusions are supported by spectral analysis on the length of the business cycle. Table 1 and figure 5 present a periodogram that analysis is based on a stationary cyclic component.

**Table 1.** Periodogram for cycle component of GDP

	scaled		spectral	scaled		spectral	
omega	frequency	periods	density	omega	frequency	periods	density
0.13	1.00	48.00	303880.00	1.70	13.00	3.69	5181.40
0.26	2.00	24.00	1479500.00	1.83	14.00	3.43	23117.00
0.39	3.00	16.00	521040.00	1.96	15.00	3.20	1449.00
0.52	4.00	12.00	284630.00	2.09	16.00	3.00	1129.00
0.65	5.00	9.60	357590.00	2.23	17.00	2.82	8371.20
0.79	6.00	8.00	41835.00	2.36	18.00	2.67	3713.40
0.92	7.00	6.86	24670.00	2.49	19.00	2.53	1474.30
1.05	8.00	6.00	68119.00	2.62	20.00	2.40	488.43
1.18	9.00	5.33	45813.00	2.75	21.00	2.29	518.93
1.31	10.00	4.80	6635.10	2.88	22.00	2.18	514.01
1.44	11.00	4.36	265.37	3.01	23.00	2.09	575.11
1.57	12.00	4.00	1431.90	3.14	24.00	2.00	556.50

Cyclic component was previously subjected to stationary testing with an ADF test: optimal delay for the ADF test = 4 (according to AIC); model:  $(1-L)y = (a-1)y(-1) + \dots + e$ ; 1st-order autocorrelation coeff. for  $e$ : 0.169; lagged differences:  $F(4, 38) = 10.723$  [0.0000]; estimated value of  $(a - 1)$ : -0.106036; test statistic:  $\tau_{nc}(1) = -1.75418$ ; asymptotic p-value 0.07543. Therefore, the null hypothesis about the occurrence of the unit root  $a = 1$ . process I (1) should be rejected in favour of the hypothesis about stationary series.

**Source:** own calculations carried out in the Gretl program based on the results obtained for the cyclical component with Hodrick-Prescott filter decomposition.

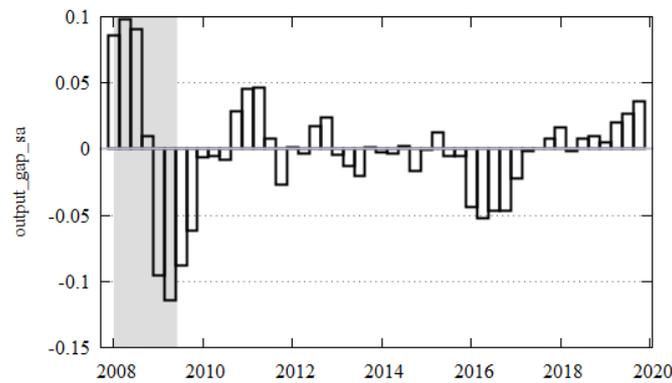


**Figure 5.** Periodogram of the cycle component of real GDP

**Source:** own calculations carried out in the Gretl program based on the results obtained for the cyclical component with Hodrick-Prescott filter decomposition.

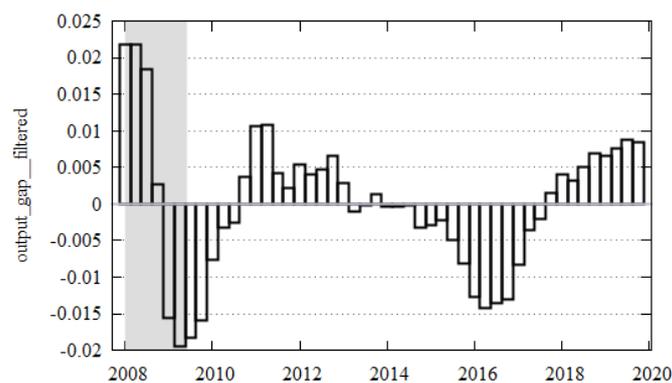
Based on figure 5, it can be seen that the cyclical nature of real GDP is shaped by four types of business cycles. The first lasting 24 quarters (6 years), the second lasting 9.60 quarters, the third lasting 6 quarters and the fourth - 3.69 quarters. The 6-year and 9.60-quarter cycle is dominant. However, it is worth emphasizing that "leakage" occurs between cycles. It is possible to eliminate the leakage effect by changing the observation. Due to the specifics of the research, it was assumed that the output gap can be shaped by overlapping cycles of different lengths.

As mentioned before, decomposition with the Hodrick-Prescott filter is of fundamental importance in estimating the output gap (figure 6 and figure 7).



**Figure 6.** Output gap (% of potential GDP seasonally adjusted)

**Source:** own calculations carried out in the Gretl program based on the results obtained for the trend component with Hodrick-Prescott filter decomposition and seasonally adjusted GDP from decomposition by the Tramo/Seats method.



**Figure 7.** Output gap (% of potential GDP filtered)

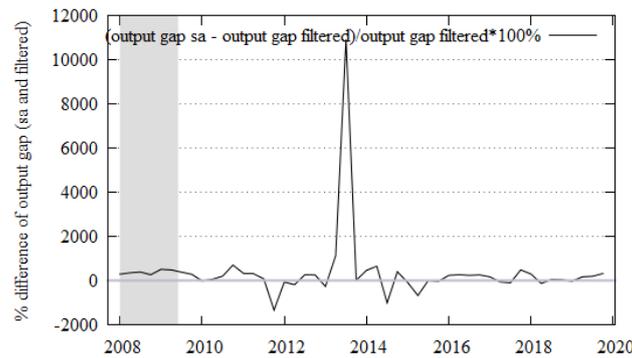
Output gap was previously subjected to stationary testing with an ADF test: optimal delay for the ADF test = 4 (according to AIC); model:  $(1-L)y = (a-1)y(-1) + \dots + e$ ; 1st-order autocorrelation coeff. for e: 0.159; lagged differences:  $F(4, 38) = 11.420 [0.0000]$ ; estimated value of  $(a - 1)$ : -0.129988; test statistic:  $\tau_{nc}(1) = -2.07994$ ; asymptotic p-value 0.03605. Therefore, the null hypothesis about the occurrence of the unit root  $a = 1$ , process I (1) should be rejected in favour of the hypothesis about stationary series.

**Source:** own calculations carried out in the Gretl program based on the results obtained for the trend component with Hodrick-Prescott filter decomposition and corrected GDP (eliminated seasonality and irregular component) from decomposition by the Tramo/Seats method.

As can be seen from figure 6, the output gap related to potential seasonally adjusted GDP would even reach around 10% in 2008:Q2 and 2008:Q3 and around -10% in 2009:Q1 and around -11% in 2009:Q2. These values would be overestimated by an irregular component (among others: shocks, innovations, crisis and other phenomena referred to as the "Black Swan" derived from the title of the book [47]).

Based on the output gap cleared of an irregular component (figure 7), that contains sources of uncertainty, shocks, innovations and other impulses for the economy, one could see a reduction in its level. The cleaned output gap reaches a maximum of approx. 2.2% or a minimum of approx. -2%. This level of the demand gap, calculated by the Tramo/Seats method in order to decompose into

individual components (taking into account seasonal adjustment) and then subjected to filtration and purification from an irregular component.



**Figure 8.** Relative difference of output gap (in %)

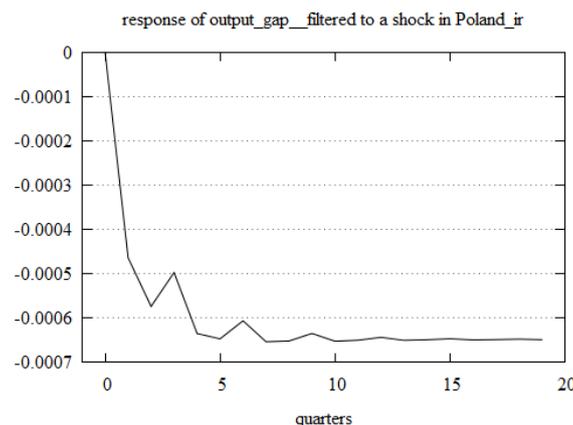
Relative difference of output gap =  $(\text{output gap sa} - \text{output gap filtered}) / \text{output gap filtered} * 100\%$ .

Relative difference of output gap was previously subjected to stationary testing with an ADF test: optimal delay for the ADF test = 4 (according to AIC); model:  $(1-L)y = (a-1)y(-1) + \dots + e$ ; 1st-order autocorrelation coeff. for e: 0.007; lagged differences:  $F(2, 42) = 0.169$  [0.8451]; estimated value of  $(a - 1)$ : -0.807329; test statistic:  $\tau_{nc}(1) = -3.27519$ ; asymptotic p-value 0.001033. Therefore, the null hypothesis about the occurrence of the unit root  $a = 1$ . process  $I(1)$  should be rejected in favour of the hypothesis about stationary series.

**Source:** own calculations.

When comparing figures 6 and 7, the irregular component overestimates the output gap from approx. 5% to 10921% (module with +/- value). The highest revaluation modules would be recorded for the following periods (figure 8): 2013:Q2 (10921.00%); 2011:Q4 (-1334.50%); 2013:Q2 (1130.85%); 2014:Q3 (-1010.52%).

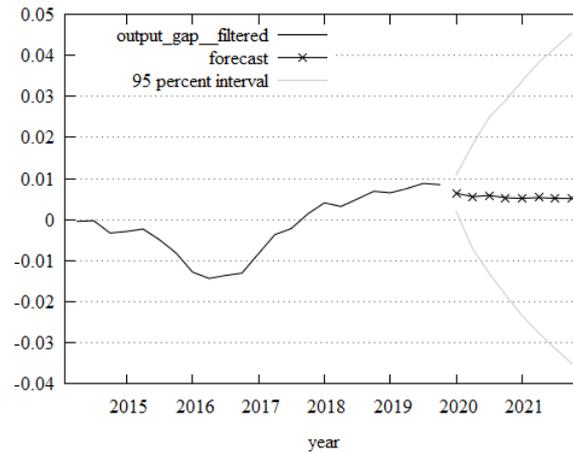
Figure 9 shows the impact of the demand-supply shock in GDP, which affects the deepening of the output gap. In time from the shock, this meltdown exacerbates the negative output gap. Since the 13th quarter, the impulse has remained constant negative levels without dredging over time.



**Figure 9.** Response of output gap to shock of GDP (in %)

**Source:** own computations on the basis of Impulse Response Function from Vector Error Correction Model.

Figure 9 shows a forecast for the output gap from 2020:Q1-2021:Q4.



**Figure 10.** Forecast of output gap of GDP (in %)

**Source:** own computations on the basis of Vector Error Correction Model.

The output gap is likely to remain slightly positive, but it will push for a closure and move towards a negative output gap under the shock of the pandemic of coronavirus (2019+). After about 13 quarters, that is, at the turn of 2022/2023 it will turn into a negative gap. However, if the shock caused by the pandemic of coronavirus deepens, the output gap could even reach -4% of GDP, or if domestic demand were strengthened through an active socio-economic policy it could reach around +5% of GDP.

#### 4. Discussion

On the basis of the above research results, it can be made clear that GDP is being influenced by a growing trend, leaking cycles and seasonality. At the same time, shocks of varying severity and direction of action are hidden in it. Reducing non-anticipated changes of a random (shock) nature reduces the demand gap (outside the narrow time range) and captures non-random inflection points. This is in line with the fact that supply-demand shocks increase the span between real and potential GDP, opening up or deepening the demand gap, particularly in the minus. It should therefore be noted that a shock component has a significant impact on the opening of the output gap. It also has a long delay, which is important for building short-term and long-term forecasts.

In subsequent studies, the analysis of the output gap should be extended by the conjectural clock and Vector Error Correction Models (VECM). The next step in this study would be a comparative analysis of the output gap using both (1) the decomposition technique (preceded by the TRAMO/SEATS analysis) and (2) the structural VEC models that are not presented in this article. However, they have been used to estimate impulse response function and forecast. An indispensable element would also be the reference to the Phillips curve and the extension of models with additional quasi-exogenous and endogenous variables.

#### 5. Conclusions

The assessment of the output gap in the light of secular stagnation (sustainability antithesis) is important as it shows the span between potential and real GDP. In the event of a negative output gap, demand barriers and slow growth (including development) can be found. However, the output gap primarily expresses the inability to adapt development potential to its economic resources and thus the scale of non-harmonisation of sustainable development.

The loss of the possibility of this adaptation is mainly influenced by shocks of different origins. These can be demand-supply shocks, structural, political, social or environmental shocks (such as the corona pandemic). It is therefore extremely important to build scenarios for the development of the

output gap under shocks and without their participation. This allows to assess the scale of the "clean" output gap (without shocks) and the output gap created by shocks of different origins.

An occurrence of at least one shock associated with the source of Alvin Hansen's secular stagnation causes a slowdown in demand and the balancing process. In the age of the corona virus pandemic, one of the sources of secular stagnation, such as the limitation of territorial expansion, is noted, which indirectly reduces globalisation. This adversely affects the conditions of development, the increase in its dynamics and the flow of knowledge, resources and investment.

**Author Contributions:** E.S. created the conceptualization; prepared resources; described methodology; conducted formal analysis; carried out investigation; supervised the work; watched over the administration; wrote the paper.

**Funding:** The project is financed within the framework of the program of the Minister of Science and Higher Education under the name "Regional Excellence Initiative" in the years 2019 - 2022; project number 001/RID/2018/19; the amount of financing PLN 10,684,000.00.

**Conflicts of Interest:** The authors declare no conflict of interest.

## Appendix A. SIGNAL EXTRACTION IN 'ARIMA' TIME SERIES

### REDUCED OUTPUT

-----

SERIES TITLE: Poland

PREADJUSTED WITH TRAMO : YES

NO OF OBSERVATIONS = 48

X 10.0D 3

YEAR	1ST	2ND	3RD	4TH
2008	84.523	91.375	94.987	95.140
2009	71.380	74.219	80.420	91.758
2010	83.189	87.044	89.075	102.579
2011	91.161	95.381	93.184	100.090
2012	89.702	93.531	97.113	109.333
2013	91.869	95.753	95.952	111.232
2014	95.485	100.379	101.805	113.426
2015	99.152	106.213	105.063	119.696
2016	98.547	102.949	104.853	120.145
2017	106.113	113.623	115.416	132.455
2018	116.466	118.913	121.861	138.923
2019	120.874	127.438	129.920	148.878

TRANSFORMATION: Z -> Z

NONSEASONAL DIFFERENCING D= 0

SEASONAL DIFFERENCING BD= 1

TYPE OF ESTIMATION: MAXIMUM LIKELIHOOD

### MODEL FITTED

NONSEASONAL P= 0 D= 0 Q= 3

SEASONAL BP= 0 BD= 1 BQ= 1

PERIODICITY MQ= 4

PARAMETERS FIXED 0

### PARAMETER ESTIMATES

MEAN = 3661.03

SE = 0.00000

### ARIMA PARAMETERS

THETA = 1.0789 0.8582 0.4182

SE = 0.1766 0.2215 0.1839

BTHETA = -0.4081

SE = 0.1920

### RESIDUALS

YEAR	ST	2ND	3RD	4TH
2007		481.958	365.157	1523.686
2008	3208.605	907.464	436.583	-5387.711
2009	-9555.069	-3687.398	-1835.695	957.582
2010	4269.705	-3020.703	-2449.115	7269.401
2011	724.240	-650.415	-3183.126	-901.465
2012	979.581	-2282.548	2176.266	2909.636
2013	-6769.259	1098.483	-1342.648	3088.055
2014	-3793.235	1827.522	245.802	-1815.770
2015	519.119	2996.320	-3218.476	2652.933
2016	-5809.622	-730.296	670.942	-76.219
2017	1898.863	2273.037	1222.327	3602.536
2018	1657.182	-1910.436	4067.976	2492.656
2019	-1556.272	4122.924	2256.769	3393.650

### RESIDUALS STATISTICS

-----

MEAN= 0.1240E+03 (SE =437.6360)

SKEWNESS= -0.6916E+00 (SE = 0.3430)

KURTOSIS= 0.3749E+01 (SE = 0.6860)

STANDARD DEVIATION= 0.3577E+04

### AUTOCORRELATIONS OF RESIDUAL

-----

	0.0587	0.0342	0.0308	-0.0987	-0.0316	0.0280
SE	0.1400	0.1405	0.1407	0.1408	0.1422	0.1423
	-0.1067	0.0856	-0.1706	0.1734	0.1266	0.0433
SE	0.1424	0.1440	0.1450	0.1488	0.1527	0.1548

	-0.0953	-0.0344	-0.0807	0.0343	0.0795	0.0825
SE	0.1550	0.1562	0.1563	0.1571	0.1573	0.1581
	-0.1090	0.0298	-0.0339	-0.0960	0.0237	0.0169
SE	0.1589	0.1604	0.1605	0.1606	0.1617	0.1618
	-0.1480	0.0438	0.0206	0.1163	0.1004	-0.0747
SE	0.1618	0.1645	0.1647	0.1648	0.1664	0.1675
	0.0422	-0.0673	-0.2017	0.0010	-0.0329	-0.0535
SE	0.1682	0.1684	0.1689	0.1736	0.1736	0.1737

THE LJUNG-BOX Q VALUE IS 7.67

IF RESIDUALS ARE RANDOM IT SHOULD BE DISTRIBUTED AS CHI-SQUARED (12)

TRANSFORMATION: Z -> Z

NONSEASONAL DIFFERENCING D= 0

SEASONAL DIFFERENCING BD= 1

TYPE OF ESTIMATION : MAXIMUM LIKELIHOOD

#### MODEL FITTED

NONSEASONAL P= 0 D= 0 Q= 3

SEASONAL BP= 0 BD= 1 BQ= 1

PERIODICITY MQ= 4

PARAMETERS FIXED 0

PARAMETER ESTIMATES

MEAN = 3661.03

SE = 0.00000

#### ARIMA PARAMETERS

THETA = 1.0789 0.8582 0.4182

SE = 0.1766 0.2215 0.1839

BTHETA = -0.4081

SE = 0.1920

#### RESIDUALS

YEAR	1ST	2ND	3RD	4TH
2007		481.958	365.157	1523.686
2008	3208.605	907.464	436.583	-5387.711
2009	-9555.069	-3687.398	-1835.695	957.582
2010	4269.705	-3020.703	-2449.115	7269.401
2011	724.240	-650.415	-3183.126	-901.465
2012	979.581	-2282.548	2176.266	2909.636
2013	-6769.259	1098.483	-1342.648	3088.055

2014	-3793.235	1827.522	245.802	-1815.770
2015	519.119	2996.320	-3218.476	2652.933
2016	-5809.622	-730.296	670.942	-76.219
2017	1898.863	2273.037	1222.327	3602.536
2018	1657.182	-1910.436	4067.976	2492.656
2019	-1556.272	4122.924	2256.769	3393.650

### RESIDUALS STATISTICS

-----  
 MEAN= 0.1240E+03 (SE = 437.6360)  
 SKEWNESS= -0.6916E+00 (SE = 0.3430)  
 KURTOSIS= 0.3749E+01 (SE = 0.6860)  
 STANDARD DEVIATION= 0.3577E+04

### AUTOCORRELATIONS OF RESIDUAL

-----

	0.0587	0.0342	0.0308	-0.0987	-0.0316	0.0280
SE	0.1400	0.1405	0.1407	0.1408	0.1422	0.1423
	-0.1067	0.0856	-0.1706	0.1734	0.1266	0.0433
SE	0.1424	0.1440	0.1450	0.1488	0.1527	0.1548
	-0.0953	-0.0344	-0.0807	0.0343	0.0795	0.0825
SE	0.1550	0.1562	0.1563	0.1571	0.1573	0.1581
	-0.1090	0.0298	-0.0339	-0.0960	0.0237	0.0169
SE	0.1589	0.1604	0.1605	0.1606	0.1617	0.1618
	-0.1480	0.0438	0.0206	0.1163	0.1004	-0.0747
SE	0.1618	0.1645	0.1647	0.1648	0.1664	0.1675
	0.0422	-0.0673	-0.2017	0.0010	-0.0329	-0.0535
SE	0.1682	0.1684	0.1689	0.1736	0.1736	0.1737

THE LJUNG-BOX Q VALUE IS 7.67

IF RESIDUALS ARE RANDOM IT SHOULD BE DISTRIBUTED AS CHI-SQUARED (12)

### AUTOCORRELATIONS OF SQUARED RESIDUAL

-----  
 THE LJUNG-BOX Q VALUE IS 9.64  
 IF RESIDUALS ARE RANDOM IT SHOULD BE DISTRIBUTED AS CHI-SQUARED (12)

**DERIVATION OF THE COMPONENT MODELS : „THE SPECIFICATION OF SOME OF THE MODELS MAY BE UNRELIABLE”**

**MODELS FOR THE COMPONENTS**

-----				
TREND-CYCLE NUMERATOR	1.0000	1.0000		
TREND-CYCLE DENOMINATOR	1.0000	-1.0000		
INNOV. VAR. (*)	0.06164			
SEAS. NUMERATOR	1.0000	1.4989	1.5577	0.6866
SEAS. DENOMINATOR	1.0000	1.0000	1.0000	1.0000
INNOV. VAR. (*)	0.08241			
TRANSITORY NUMERATOR	1.0000	1.4881	1.2474	0.7593
TRANSITORY DENOMINATOR	1.0000			
INNOV. VAR. (*)	0.22476			
IRREGULAR VAR.	0.05826			
SEASONALLY ADJUSTED NUMERATOR				
1.0000	0.1925	-0.2198	-0.4972	-0.7867
SEASONALLY ADJUSTED	DENOMINATOR			
1.0000	-1.0000			
INNOV. VAR. (*)	0.36599			
(*) IN UNITS OF VAR(A)				

**DETERMINISTIC COMPONENT FROM TRAMO**-----  
NONE

DERIVATION OF THE FILTERS : OK

**COMPONENTS (STATIONARY TRANSFORMATION): SECOND MOMENTS**

		TREND-CYCLE			ADJUSTED		
LAG	COMPONENT	ESTIMATOR	ESTIMATE	COMPONENT	ESTIMATOR	ESTIMATE	
LAG1	AUTCOR	0.500	0.758	0.762	0.333	0.392	0.390
LAG4	AUTCOR	0.000	0.344	0.249	-0.403	-0.553	0.319
VAR. (*)		0.123	0.031	0.027	0.714	0.684	0.510

		IRREGULAR			SEASONAL		
LAG	COMPONENT	ESTIMATOR	ESTIMATE	COMPONENT	ESTIMATOR	ESTIMATE	
LAG1	AUTCOR	0.000	-0.584	-0.530	0.798	0.371	0.379
LAG4	AUTCOR	0.000	-0.160	-0.319	0.000	0.112	-0.018
VAR. (*)		0.058	0.011	0.008	0.506	0.031	0.024

(\*) IN UNITS OF VAR(A)

**ESTIMATION ERROR VARIANCE**

(In units of Var(a))

	TREND-CYCLE	ADJUSTED
FINAL ESTIMATION ERROR	0.760	0.088
REVISION IN CON-CURRENT ERROR	0.277	0.076
TOTAL ESTIMATION ERROR (CONCURRENT ESTIMATOR)	1.037	0.164

**PERCENTAGE REDUCTION IN THE STANDARD ERROR OF THE REVISION AFTER ADDITIONAL YEARS (COMPARISON WITH CONCURRENT ESTIMATORS)**

AFTER 1 YEAR	57.45	51.82
AFTER 2 YEAR	81.87	77.57
AFTER 3 YEAR	92.51	90.55
AFTER 4 YEAR	97.01	96.38
AFTER 5 YEAR	98.82	98.66

AVERAGE PERCENTAGE REDUCTION IN RMSE FROM CONCURRENT ADJUSTMENT 14.31

**STANDARD ERROR OF THE CONCURRENT RATES OF ESTIMATORS**

(In points of annualized percent growth. Linear approximations)

	TREND-CYCLE	SA SERIES	ORIGINAL SERIES
PERIOD TO PERIOD GROWTH OF THE SERIES (T11) (CENTERED) ESTIMATOR	0.379E+04	0.159E+04	
OF THE ANNUAL GROWTH (T 1 4)	0.431E+04	0.590E+04	0.609E+04

**SEASONAL COMPONENT**

**X 10.0D 2**

YEAR	1ST	2ND	3RD	4TH
2008	-69.692	-18.638	17.910	82.186
2009	-71.009	-31.435	1.675	85.382
2010	-55.386	-24.835	-9.093	85.223
2011	-51.324	-17.589	-11.454	83.037
2012	-55.919	-20.295	-12.436	95.452
2013	-59.953	-21.140	-20.765	101.784
2014	-60.778	-20.306	-21.192	104.546
2015	-65.116	-19.466	-22.377	113.065
2016	-68.289	-25.942	-25.763	115.212
2017	-65.179	-27.941	-25.504	120.775
2018	-63.070	-32.224	-28.102	125.336
2019	-63.896	-33.232	-31.213	130.733

**STANDARD ERROR OF SEASONAL**

YEAR	1ST	2ND	3RD	4TH
------	-----	-----	-----	-----

2008	1446.733	1236.431	1225.981	1208.803
2009	1160.935	1105.650	1099.993	1092.754
2010	1082.261	1067.800	1067.025	1064.871
2011	1063.545	1060.619	1060.583	1060.197
2012	1060.065	1059.613	1059.612	1059.565
2013	1059.548	1059.488	1059.488	1059.479
2014	1059.483	1059.488	1059.488	1059.548
2015	1059.565	1059.612	1059.613	1060.065
2016	1060.197	1060.583	1060.619	1063.545
2017	1064.871	1067.025	1067.800	1082.261
2018	1092.754	1099.993	1105.650	1160.935
2019	1208.803	1225.981	1236.431	1446.733

**TRANSITORY COMPONENT**

<b>YEAR</b>	<b>1ST</b>	<b>2ND</b>	<b>3RD</b>	<b>4TH</b>
2008	5217.233	6723.223	5603.968	441.187
2009	-6242.254	-8235.036	-6391.066	-3411.979
2010	-289.267	-295.748	-136.891	2263.902
2011	3064.093	3020.574	379.967	-2223.446
2012	-1020.200	-333.397	1270.432	1260.587
2013	-537.918	-1158.195	-1746.726	-359.113
2014	61.991	-219.043	-74.298	-1049.263
2015	315.732	1262.614	379.405	-175.182
2016	-2972.818	-4218.249	-3817.041	-3467.858
2017	-1658.460	-0.322	475.056	900.055
2018	1030.989	-89.815	244.494	113.707
2019	42.864	1487.886	2348.417	3376.133

**STANDARD ERROR OF TRANSITORY COMP.**

<b>YEAR</b>	<b>1ST</b>	<b>2ND</b>	<b>3RD</b>	<b>4TH</b>
2008	3056.537	3052.552	2945.955	2783.087
2009	2679.912	2671.175	2652.968	2628.538
2010	2612.142	2608.454	2606.593	2602.855
2011	2599.578	2598.820	2598.679	2597.958
2012	2597.325	2597.222	2597.208	2597.055
2013	2596.952	2596.940	2596.937	2596.893
2014	2596.907	2596.937	2596.940	2596.952
2015	2597.055	2597.208	2597.222	2597.325
2016	2597.958	2598.679	2598.820	2599.578
2017	2602.855	2606.593	2608.454	2612.142
2018	2628.538	2652.968	2671.175	2679.912
2019	2783.087	2945.955	3052.552	3056.537

**TREND-CYCLE**

**X 10.0D 3**

<b>YEAR</b>	<b>1ST</b>	<b>2ND</b>	<b>3RD</b>	<b>4TH</b>
2008	86.110	86.728	87.060	86.322
2009	85.364	85.634	86.378	87.224
2010	88.627	89.701	90.458	91.733
2011	93.101	93.863	94.001	94.564
2012	95.639	96.294	97.146	98.143
2013	98.589	99.050	99.996	101.030
2014	101.758	102.688	103.666	104.342
2015	105.403	106.520	107.327	108.101
2016	108.751	109.775	111.086	112.423
2017	114.271	116.158	117.716	119.548
2018	121.302	122.650	124.338	126.053
2019	127.495	129.114	130.775	132.231

**STANDARD ERROR OF TREND-CYCLE**

<b>YEAR</b>	<b>1ST</b>	<b>2ND</b>	<b>3RD</b>	<b>4TH</b>
2008	3642.500	3462.133	3344.097	3264.688
2009	3220.065	3181.809	3154.837	3144.401
2010	3137.571	3129.202	3124.768	3123.502
2011	3122.147	3120.553	3119.951	3119.755
2012	3119.471	3119.218	3119.135	3119.096
2013	3119.044	3119.008	3118.994	3118.978
2014	3118.986	3118.994	3119.008	3119.044
2015	3119.096	3119.135	3119.218	3119.471
2016	3119.755	3119.951	3120.553	3122.147
2017	3123.502	3124.768	3129.202	3137.571
2018	3144.401	3154.837	3181.809	3220.065
2019	3264.688	3344.097	3462.133	3642.500

**SEASONALLY ADJUSTED SERIES****X 10.0D 3**

<b>YEAR</b>	<b>1ST</b>	<b>2ND</b>	<b>3RD</b>	<b>4TH</b>
2008	91.492	93.239	93.196	86.921
2009	78.480	77.363	80.252	83.220
2010	88.728	89.528	89.985	94.057
2011	96.293	97.140	94.329	91.786
2012	95.294	95.560	98.357	99.788
2013	97.865	97.867	98.029	101.054
2014	101.563	102.410	103.924	102.971
2015	105.664	108.160	107.301	108.390
2016	105.375	105.543	107.429	108.624
2017	112.631	116.417	117.966	120.378
2018	122.773	122.135	124.671	126.389

2019	127.264	130.761	133.041	135.805
------	---------	---------	---------	---------

**STANDARD ERROR OF SEASONALLY ADJUSTED SERIES**

YEAR	1ST	2ND	3RD	4TH
2008	1446.733	1236.431	1225.981	1208.803
2009	1160.935	1105.650	1099.993	1092.754
2010	1082.261	1067.800	1067.025	1064.871
2011	1063.545	1060.619	1060.583	1060.197
2012	1060.065	1059.613	1059.612	1059.565
2013	1059.548	1059.488	1059.488	1059.479
2014	1059.483	1059.488	1059.488	1059.548
2015	1059.565	1059.612	1059.613	1060.065
2016	1060.197	1060.583	1060.619	1063.545
2017	1064.871	1067.025	1067.800	1082.261
2018	1092.754	1099.993	1105.650	1160.935
2019	1208.803	1225.981	1236.431	1446.733

**IRREGULAR COMPONENT**

YEAR	1ST	2ND	3RD	4TH
2008	164.527	-212.974	532.715	158.184
2009	-641.282	-36.114	265.643	-591.464
2010	390.209	122.652	-336.139	59.925
2011	128.289	256.550	-51.869	-554.036
2012	675.694	-400.775	-60.005	383.783
2013	-186.473	-25.415	-220.538	383.175
2014	-257.243	-59.805	332.770	-320.986
2015	-54.683	376.934	-405.200	463.231
2016	-402.276	-13.973	160.226	-331.075
2017	17.949	259.000	-224.270	-70.672
2018	439.748	-424.895	88.501	222.238
2019	-274.458	158.814	-81.833	197.698

**References**

1. Litman, T. Well Measured: Developing Indicators for Sustainable and Livable Transport Planning. Victoria Transport Policy Institute, Victoria, Canada, 2018. Available online: <http://www.vtppi.org/wellmeas.pdf> (accessed 18th May 2018).
2. Szaruga, E., Skapska, E., Załoga, E. i Matwiejczuk, W. Trust and Distress Prediction in Modal Shift Potential of Long-Distance Road Freight in Containers: Modeling Approach in Transport Services for Sustainability. *Sustainability* **2018**, *10* (7), 2370. doi:10.3390/su10072370.
3. Mączyńska, E. Regional Asymmetries – Basis, Consequences and Counter-measures. *MAZOWSZE Studia Regionalne* **2015**, *17*, pp. 159-165.

4. Neoliberalizm jest groźny dla rozwoju kraju (interview with prof. Elżbieta Mączyńska) [into English: Neoliberalism is dangerous for the development of the country]. *Rzeczpospolita* (published: 15th June 2016).
5. Daly, H. E. Steady-state economics versus growthmania: A critique of the orthodox conceptions of growth, wants, scarcity, and efficiency. *Policy Sciences* **1974**, 5(2), pp. 149-167. doi:10.1007/BF00148038.
6. Latouche, S. *Farewell to Growth*. Polity Press: Cambridge, Malden, 2009.
7. Mączyńska, E. Potencjał rozwojowy Polski w kontekście hipotezy o nowej sekularnej stagnacji [into English: Poland's development potential in the context of the hypothesis of a new secular stagnation]. *Biuletyn PTE* **2015**, 2(69), pp. 62-69.
8. Łaski, K. *Wykłady z makroekonomii. Gospodarka kapitalistyczna bez bezrobocia* [into English: *Lectures on macroeconomics. Capitalist economy without unemployment*]. Osiatyński, J., Ed.; Polish Economy Society: Warsaw, Poland, 2015.
9. Famielec, J. Ekologizacja jako paradygmat rozwoju społeczno-gospodarczego [into English: Ecologization as a paradigm of socio-economic development]. In *Ekologizacja gospodarki* [into English: *Greening the economy*], Kożuch, M., Ed. Fundacja Uniwersytetu Ekonomicznego w Krakowie: Kraków, Poland, 2015.
10. Piketty, T. *Chronicles. On Our Troubled Times*. VIKING an imprint of PENGUIN BOOKS, n.p., 2016.
11. Schmelzer, M. The growth paradigm: History, hegemony, and the contested making of economic growthmanship. *Ecological Economics* **2015**, 118; pp. 262-271. doi:10.1016/j.ecolecon.2015.07.029.
12. Buch-Hansen, H. Capitalist diversity and de-growth trajectories to steady-state economies. *Ecological Economics* **2014**, 106, pp. 167-173. doi:10.1016/j.ecolecon.2014.07.030.
13. Famielec, J. Stanowiony porządek ekologiczny versus spontaniczny ład gospodarczy [into English: Ecological order versus spontaneous economic order]. In *Spontaniczne i stanowione elementy ładu gospodarczego w procesie transformacji - dryf ładu czy jego doskonalenie?* [into English: *Spontaneous and constituted elements of economic order in the transformation process - order drift or improvement?*], Pysz, P., Grabska, A., Moszyński, M., Eds.; Polish Economy Society: Warsaw, Poland, 2014.
14. Klein, N. *To zmienia wszystko. Kapitalizm kontra klimat* [into English: *It changes everything. Capitalism versus climate*]. Jankowska, H. & Makaruk, K., Trans.; Warszawskie Wydawnictwo Literackie MUZA SA: Warsaw, Poland, 2016.
15. Potter, W. *Green is the New Red: An Insider's Account of a Social Movement Under Siege*. City Lights Books: San Francisco, USA, 2011.
16. Petrakis, P. E., Kostis, P. C., Kafka, K. I. Secular stagnation, faltering innovation, and high uncertainty: New-era entrepreneurship appraisal using knowledge-based thinking. *Journal of Business Research* **2016**, 69(5), pp. 1909-1913. doi:10.1016/j.jbusres.2015.10.078.
17. Petrakis, P. E., Konstantakopoulou, D. *Uncertainty in Entrepreneurial Decision Making. The Competitive Advantages of Strategic Creativity*. Palgrave Macmillan: New York, USA, 2015. doi:10.1057/9781137460790.
18. Rifkin, J., *The zero marginal cost society*, 2nd ed.; Griffin: New York, USA, 2015.
19. Stiglitz, J.E., Fitoussi, J.-P., Durand, M. *Poza PKB: Mierzymy to co ma znaczenie dla rozwoju społeczno-gospodarczego* (in original: *Beyond GDP: Measuring What Counts for Economic and Social Performance*), 1st ed., Polish Economic Society: Warsaw, Poland, 2019.
20. Schiller, R.J. *Finanse a dobrobyt społeczny* (in original: *Finance and the Good Society*), 1st ed., Polish Economic Society: Warsaw, Poland, 2016.
21. Landais, B. *Fluktuacje gospodarcze. Nowa synteza* (in original: *Les fluctuations économiques. Une synthèse nouvelle*, into English: *Economic fluctuations. New synthesis*), 1st ed.; Publishing House of Jagiellonian University, Publishers: Publishing House of the Poznan University of Economics and Business: Kraków, Poland, 2019.
22. Kotowicz-Jawor, J., Pietrewicz, L., Zajfert, M., Mączyńska, E., Baczek, T., Puchała-Krzywina, E., Grzelońska, U. *Innovativeness of Polish Economy in the Transitional Stage of Development*, Publisher: Publishing House of University of Łódź: Łódź, Poland, 2019.
23. Álvarez, L. J., Gómez-Loscos, A. A menu on output gap estimation methods. *Journal of Policy Modeling* **2018**, 40, pp. 827-850. doi:10.1016/j.jpolmod.2017.03.008.
24. Ahmad, W., Sharma, S. K. Testing output gap and economic uncertainty as an explicator of stock market returns. *Research in International Business and Finance* **2018**, 45, pp. 293-306. doi:10.1016/j.ribaf.2017.07.162.

25. Łyziak, T. Do global output gaps help forecast domestic inflation? Evidence from Phillips curves for Poland. *International Journal of Forecasting* **2019**, *35*, pp. 1032-1041. doi:10.1016/j.ijforecast.2019.03.006.
26. Buncic, D., Müller, O. Measuring the output gap in Switzerland with linear opinion pools. *Economic Modelling* **2017**, *64*, pp. 153-171. doi:10.1016/j.econmod.2017.03.007.
27. Zhang, C., Murasawa, Y. Output gap measurement and the New Keynesian Phillips curve for China. *Economic Modelling* **2011**, *28*, pp. 2462-2468. doi:10.1016/j.econmod.2011.07.003.
28. Pichette, L., Robitaille, M.-N., Salameh, M., St-Amant, P. (2019). Dismiss the output gaps? To use with caution given their limitations. *Economic Modelling* **2019**, *76*, pp. 199-215. doi:10.1016/j.econmod.2018.08.001.
29. Marcellino, M., Musso, A. The reliability of real-time estimates of the euro area output gap. *Economic Modelling* **2011**, *28*, pp. 1842-1856. doi:10.1016/j.econmod.2011.03.014.
30. Kamada, K. Real-time estimation of the output gap in Japan and its usefulness for inflation forecasting and policymaking. *North American Journal of Economics and Finance* **2005**, *16*, pp. 309-332. doi:10.1016/j.najef.2005.05.004.
31. González-Astudillo, M. An output gap measure for the euro area: Exploiting country-level and cross-sectional data heterogeneity. *European Economic Review* **2019**, *120*, 103301. doi:10.1016/j.eurocorev.2019.103301.
32. Grant, A. L., Chan, J. C. Reconciling output gaps: Unobserved components model and Hodrick–Prescott filter. *Journal of Economic Dynamics & Control* **2017**, *75*, pp. 114-121. doi:10.1016/j.jedc.2016.12.004.
33. Mise, E., Kim, T.-H., Newbold, P. On suboptimality of the Hodrick–Prescott filter at time series endpoints. *Journal of Macroeconomics* **2005**, *27*, pp. 53-67. doi:10.1016/j.jmacro.2003.09.003.
34. Razzak, W. The Hodrick-Prescott technique: A smoother versus a filter. An application to New Zealand GDP. *Economics Letters* **1997**, *57*, pp. 163-168.
35. Jašová, M., Moessner, R., Takáts, E. Domestic and global output gaps as inflation drivers: What does the Phillips curve tell? *Economic Modelling* **2020**, *87*, pp. 238-253. doi:10.1016/j.econmod.2019.07.025.
36. Ince, O., Papell, D. H. The (un)reliability of real-time output gap estimates with revised data. *Economic Modelling* **2013**, *33*, pp. 713-721. doi:10.1016/j.econmod.2013.05.023.
37. Maravall, A., del Río, A. Temporal aggregation, systematic sampling, and the Hodrick–Prescott filter. *Computational Statistics & Data Analysis* **2007**, *52*, pp. 975-998. doi:10.1016/j.csda.2007.08.001.
38. Mitra, S., Maheswari, V., Mitra, A. A wavelet filtering based estimation of output gap. *Applied Mathematics and Computation* **2011**, *218*, pp. 3710-3722. doi:10.1016/j.amc.2011.09.013.
39. Amador-Torres, J. S., Gomez-Gonzalez, J. E., Ojeda-Joya, J. N., Jaulin-Mendez, O. F., Tenjo-Galarza, F. Mind the gap: Computing finance-neutral output gaps in Latin-American economies. *Economic Systems* **2016**, *40*, pp. 444-452. doi:10.1016/j.ecosys.2015.09.007.
40. de Carvalho, M., & Rua, A. Real-time nowcasting the US output gap: Singular spectrum analysis at work. *International Journal of Forecasting* **2017**, *33*, pp. 185-198. doi:10.1016/j.ijforecast.2015.09.004.
41. Gómez, V., Maravall, A. *Programs TRAMO (Time Series Regression with ARIMA Noise Missing Observations, and Outliers) and SEATS (Signal Extraction in ARIMA Times Series). Instructions for the User*, November 1997. Available online: [http://www.bde.es/f/webbde/SES/servicio/Programas\\_estadisticos\\_y\\_econometricos/Programas/ficheros/manualdos.pdf](http://www.bde.es/f/webbde/SES/servicio/Programas_estadisticos_y_econometricos/Programas/ficheros/manualdos.pdf) (accessed on 10<sup>th</sup> July 2016).
42. EuroStat database. Available online: <https://ec.europa.eu/eurostat/data/database/> (accessed on 05<sup>th</sup> April 2020).
43. Hodrick, R.P. Postwar U.S. business cycles: an empirical investigation. *J. Money Credit Bank* **1997**, *29*(1), pp. 1-16.
44. Yamada, H., Jin, L. Japan's output gap estimation and  $\ell_1$  trend filtering. *Empirical Economics* **2013**, *45*(1), pp. 81-88. doi:10.1007/s00181-012-0625-x.
45. Osiatyński, J., Ed. *Collected Works of Michał Kalecki: Capitalism. Business Cycles and Full Employment*, Clarendon Press: Oxford, UK, 1990.
46. Block, T.H., Majewski, R.C. Methods and methodology in historical macroeconomics. In *Transformational Growth and the Business Cycle*, Nell E.J., Ed., Routledge: London, UK, 2005.
47. Taleb, N.N. *Czarny Łabędź: o skutkach nieprzewidywalnych zdarzeń* [in original: *The black swan: the impact of the highly improbable*], Kurhaus Publishing: Warsaw, Poland, 2015.