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Covid-19 Pandemic Lockdown vs. Business Cycle Clock Registration of New Passenger Cars in European Countries

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Abstract:

Purpose: *The aim of this article is to evaluate the impact of the lockdown caused by the Covid-19 pandemic on the economic situation measured by the number of new passenger cars registered in selected European countries.*
Design/Methodology/Approach: *The assessment of economic changes was conducted using a business cycle clock (BCC) using the number of newly registered passenger cars. Use working day and seasonally adjusted - Car registration, a new passenger car monthly series, was estimated with a Hodrick-Prescott filter.*
Findings: *The lockdown caused by the Covid-19 pandemic had a negative impact on the economy measured by newly registered cars.*
Practical Implications: *The varying effects of the lockdown can be evaluated with a business cycle clock.*
Originality/Value: *The study was based on monthly data up to October 2020 and showed the high usefulness of BCC results.*

Keywords: *Lockdown, pandemic, Covid-19, economic crisis, business cycle, business cycle clock, Hodrick-Prescott filter, registration new passenger car.*

JEL codes: *C22, E32, O57*

Paper type: *Research study.*

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1. Introduction

The aim of the article is to assess the impact of lockdown (non-pharmaceutical countermeasures) in the first period of the Covid-19 pandemic on the economic situation measured by the number of registered new passenger cars in selected European countries. This evaluation is done by using Business Cycle Clock (BCC).

The World Health Organization (WHO) on March 11, 2020 announces that the Covid-19 epidemic is a global pandemic. In many European countries, between March 5 and March 24, 2020, a number of non-pharmaceutical countermeasures were introduced (Flaxman *et al.*, 2020; 2020a; Desvars-Larrive *et al.*,. 2020; Haug *et al.*, 2020; Stanczyk, 2020), which limit the social and economic freedom. These restrictions included ordered school closure, case-based measures, forbidding public events, the encouragement of social distancing, and others. Forecasting of the dynamics of confirmed Covid-19 cases for selected European countries shows a substantial increase in the pandemic in March and April and a slow decline in May and June (Kufel, 2020).

2. Crisis on the New Passenger Cars' Market in European Countries

There was a considerable drop in new cars' sales during the lockdown, although car dealerships were open in most countries. This was due to the following factors:

- In many European countries, during the lockdown, numerous restrictions on citizens' movement were introduced, which limited to the most urgent issues: shopping for necessities or health issues. The purchase of a new car did not belong to any of these categories. It should also be noted that even the current servicing of the vehicle was difficult. For example, in Poland, there were problems with the seasonal replacement of tires. There were few customers in open car dealerships.

- Another reason for low sales was people's fear of the crisis in the labor market. The perspective of labor market instability makes consumers more careful about spending their funds and better planning expenses. This was due to the possibility of losing the source of income. The decision to buy a new car is often dictated by an impulse, a desire to raise their social status. It was difficult to expect emotional buying decisions in uncertain times of crisis.

- Another reason is the suspension of car production. The car manufacturers tried to produce cars as regularly as possible. Possible factory stoppage could cause a significant decrease in the availability of the offered models on the market. Among many manufacturers, a common practice was even planning the suspension of production and introducing at that time, e.g., modernizing the production line or changing the so-called "model of the year." Such changes were often made during the holiday period when most of the crew was on vacation.

The suspension of production started in the lockdown when employees had to stay at home, e.g., as care for small children. In addition, the volume of production was influenced by the planning of production in the system, the so-called just in time (JIT), i.e., providing manufacturers with all the necessary elements for assembly at the required time and in the required number. The main benefit of JIT is the reduction of realization time to a minimum, which brings significant savings associated with the decrease in stocks. Currently, automotive companies do not produce the necessary parts for the assembly of their cars themselves. They are supported by specialized sub-suppliers, who are obliged to deliver the required parts directly to the production line. The JIT method has its advantages because the concerns do not have to store components. The disadvantage is that every delay in the supply chain causes a delay in the whole production process.

This happened during the lockdown period. The discontinuation of deliveries by sub-suppliers resulted in the lack of availability of parts on the production lines. This resulted in the suspension of production of the whole concern. Therefore, the lack of production caused a shortage of new cars to dealers, decreased the number of sold cars, and, consequently, registered new vehicles. Dealers sold out entire warehouses. The stock was small because the lockdown took place practically at the beginning of the year (the end of the first quarter), where, e.g., the sales of the year 2019 were still taking place, which additionally caused clearing of the warehouses of dealers and importers.

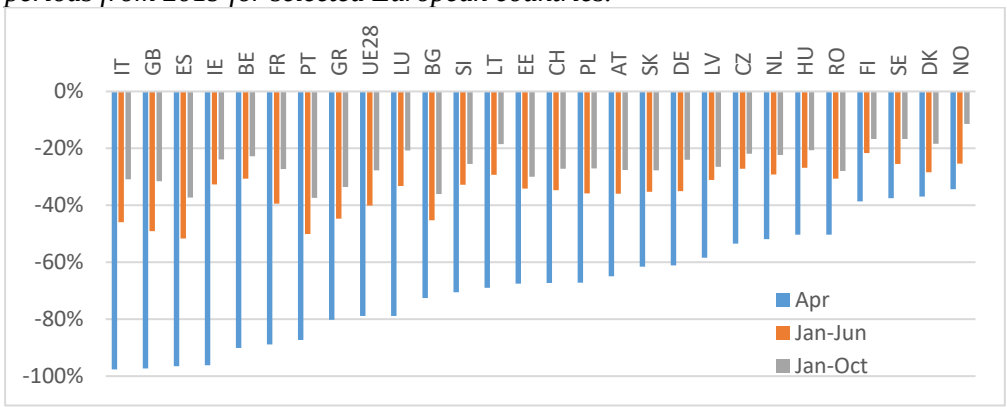
- Another reason for the decreased sales of new cars on the European market in 2020 was introducing a very restrictive Euro 6d and Euro 6d-temp emission standard measured according to WLTP (Worldwide Harmonised Light Vehicle Test Procedure). The introduction of a new way of testing fuel consumption and CO_2 emissions caused manufacturers to obtain new approvals for their engines. A significant amount of the engines had to be withdrawn from the market as sub-standard. The most restrictive stage of introducing the standards was at the end of 2019. Changes in approval caused that at the end of the third quarter of 2019, there was a significant increase in the registration of new cars on the European market, but this was an apparent increase because most of them were registrations on dealers or importers. Later, such vehicles were sold as second-hand cars, which were not covered by the WLTP standard. Thus, the increase in sales at the end of the third quarter of 2019 resulted in the "cleaning" of warehouses, which, with limited production due to long approval procedures for new models, resulted in a lack of sufficient stock for sale. In 2020, dealers were entering virtually no stock, waiting for cars coming straight from the new production.

The above reasons caused a crisis in the automotive market in all European countries. Figure 1 shows the decrease in new passenger car registrations in April 2020 compared to April 2019, in the period January-June 2020 to January-June 2019, and January-October 2020 to January-October 2019.

The first decrease in passenger car sales started in March 2020, but the biggest one was in April 2020, reaching from 97.6% for Italy to 34% for Norway. In many European countries, the crisis in the automotive market has taken a different course. From January to October 2020, the most significant drop was recorded in Portugal with 37.4% and the smallest in Norway with 11.4%. The impact of the lockdown on the market of new passenger car registration can be assessed precisely employing a business cycle clock. For the construction of the business cycle clock, monthly data from 2004:01 to 2020:10 were used for selected 25 EU countries, Switzerland, Norway, and the EU28 in total.

To build the business cycle clock, two components must be distinguished: the long-term trend and the business cycle component. Before these components are distinguished, the seasonality and variations in the number of working days in particular months should be eliminated. TRAMO/SEATS procedure is most often used to eliminate seasonality. Using process filtration methods, a long-term trend is extracted as a low-frequency fraction of the process. The most commonly used filter is Hodrick-Prescott (Hodrick and Prescot, 1997) or its modification (Kaiser and Maravall, 1999). A Butterworth filter is also proposed, which in particular cases is identical to the Hodrick-Prescott filter (Pollock, 2000). The Baxter-King filter (Baxter and King, 1999) and Christian-Fitzgerald filter (Christiano and Fitzgerald, 2003) are also used in literature. A broad description of these filters' usefulness for extracting trends of different bands of frequencies can be found in Osińska *et al.* (2014) and (2016). The following article uses the Hodrick-Prescott filter.

Figure 1. *Dynamics of the decrease in the registration of new passenger cars in the periods: April 2020, January-June 2020, January-October 2020 to the respective periods from 2019 for selected European countries.*



Source: *Own calculation based on db.nomics.world data.*

The Hodrick-Prescott filter is used for the decomposition of a time series into two components: g_t trend and c_t cyclic component:

$$y_t = g_t + c_t ,$$

for t = 1, 2, ..., T. The g_t trend component is estimated by minimizing the function:

$$min[\sum_{t=1}^{T}(y_t - g_t)^2 + \lambda \sum_{t=3}^{T}(\Delta^2 g_t)^2] ,$$

where λ is the non-negative smoothing parameter. The relationship between the λ parameter and the moment of a cut-off of the gain function ω_0, and the length of the alignment period *m* is shown in the following formula:

$$\lambda = 1/\left(12\left(1 - cos(\omega_0)\right)^2\right), \omega_0 = 2\pi/m ,$$

Examples or relation beetween λ, ω_0 and *m* for monthly data are in Table 1.

Table 1. *Hodrick-Prescott filter λ parameter for monthly time series depending on the cycle length - m*

Cycle lenght		Omega - ω_0	Lambda
years	*m*-months	(in degrees)	λ
5	60	6.00	2 777
6	72	5.00	5 755
7.55	**90.57**	**3.98**	**14 400**
8	96	3.75	18 178
10	120	3.00	44 369
12	**144**	**2.50**	**92 000**
14	168	2.14	170 411
16	192	1.88	290 698

Source: *Own calculation.*

The value of the λ parameter proposed by the authors of the H-P filter for a monthly time series is λ =14400, which means cutting off 90.57 months, or 7.55 years. To determine the long-term trend for the monthly data concerning the absolute value of registration new passenger car for the period from 2004:01 to 2020:10, i.e., T=202 observations, the parameter λ=92000 was used, i.e., the long-term trend for the cycle of 144 months (12 years).

After applying the H-P filter, the received business cycle component has an average equal to zero and the form of an irregular sinusoid, with variable amplitude and different lengths of growth and decline phases. The choice of the cut-off moment ω_0=2.5, i.e., the 12 years, has been widely described in the paper (Kufel, 2003). A description of the cyclic clock can be found in several articles (Van Ruth, Schouten, and Wekier, 2005; Abberger and Nierhaus, 2010; Ulrichs and Błażej, 2014; Kufel *et. al.*, 2015). There are 4 phases of the business cycle that illustrate the position in a given quarter of the coordinate system, as follows:

- the first quarter of the clock - expansion phase - above the trend and upward trend;
- the second quarter of the clock - the slowdown phase - above the trend and the

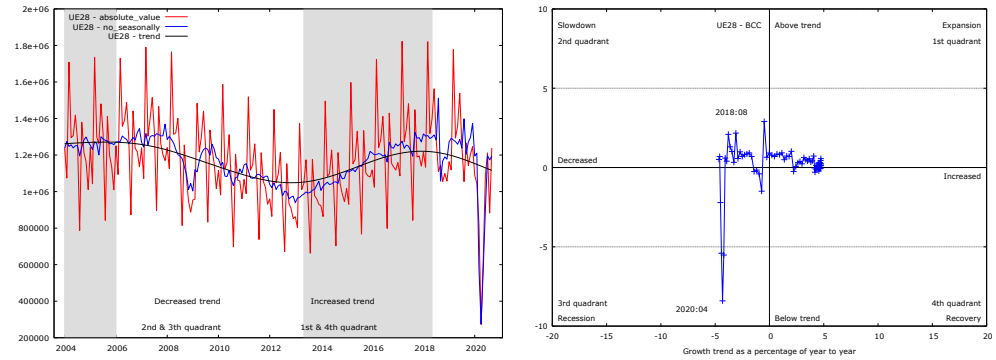
downward trend;
- the third quarter of the clock - recession phase - below the trend and the downward trend;
- the fourth quarter of the clock - recovery phase - below the trend and rising trend.

The economic clock's coordinates are determined as standardized deviations from the long-term trend (y) and the year-on-year percentage increase/decrease for the long-term trend (x). All calculations, including the automatic download of data from the db.nomics.world repository was performed using the gretl software (Cottrell and Lucchetti, 2020).

3. Empirical Results

The sale of passenger cars was limited by the lockdown caused by the Covid-19 epidemic. In March and April 2020, the pandemic was characterized by great uncertainty regarding its further evolution phases. The beginnings of the removal of lockdown restrictions in European countries were in May and June 2020. The monthly dynamics of sales (registration) of new passenger cars for 28 European Union countries from 2004:01 to 2020:10 are shown in Figure 2.

Figure 2. *Monthly registration new passenger car (abslute value), monthly working day and seasonally adjusted registration new passenger car and long-term trend for 2004:01 to 2020:10 for UE28 (left graph). Busines Cycle Clock for registration new passenger car for 2015:01 to 2020:10 for UE28 (right graph).*



Source: *Own calculation based on db.nomics.world data – provider: European Central Bank.*

Estimating the business cycle clock required eliminating the seasonal effect and the adjustment of monthly data to an equal number of working days in each month. The statistical data comes from Europen Central Bank and can be accessed through the db.nomics.world repository. All data covered the same period from 2004:01 to 2020:10 (n=202 months) for selected 25 European Union countries, Switzerland and Norway, and total data for EU28 and Euro Area. The economic cycle clock for EU28 is presented in the right graph of Figure 2 for the period from 2015:01 to 2020:10 (n=70 months).

The left graph (Figure 2) shows the ranges of the long-term trend growth (gray background), which correspond to the 1st quadrant (Expansion) and 4th quadrant (Recovery) in the business cycle clock. Periods with no background highlighted correspond to the 2nd quadrant (Slowdown) and 3rd quadrant (Recession).

Figure 3 (in Appendix) shows processes for the 25 EU countries, Norway, and Switzerland. These charts show that the largest recession was in April 2020. However, for Austria, it was in March 2020, and for Netherlands, Sweden, Finland, and Romania in May 2020. For Poland, Lithuania, Hungary, and Greece, the decline in sales did not change the long-term upward trend, but only the recovery phase (4th quadrant). Only the sale of passenger cars in 4 countries: Norway, Greece, Estonia, and Romania, did not exceed the long-term sales trend.

The business cycle clock also provides an opportunity to evaluate the intensity of the recession by evaluating the strength of the decline observed on the Y-axis. The largest fall in car sales concerning the long-term trend was recorded for the EU28 and the UK, Luxembourg, France, Belgium, Italy, and Switzerland.

4. Conclusions

After the first lockdown period, the passenger car sales market in Europe is slowly beginning to recover. This is due to several elements. One of them is the return of car manufacturers to regular operation. During the lockdown period, many manufacturers have overcome the difficulties of introducing new WLTP homologation procedures. The supply chain has been launched after the lockdown period so that concerns can deliver newly produced cars to dealers.

After the initial pessimism phase, people start to be more optimistic about the future and plan to spend more on purchases, such as a new car. The fact that interest rates have fallen in most EU countries is not insignificant. This gives access to cheaper loans to buy a new car. It is especially important for institutional clients (companies) because they are responsible for a significant number of new car registrations in some EU countries (e.g., Poland).

Most European countries' population has slowly adapted to the new reality, and people have learned to function and make decisions. There are small sales increases in various countries, but it may take several more years to recover previous years' sales trends.
The presented business cycle clock tool gives an opportunity to comprehensively analyze crises, their depth, impact on long-term trends, and the speed of recovering from them.

References:

Abberger, K., Nierhaus, W. 2010. The Ifo Business Cycle Clock: Circular Correlation with the Real GDP. CESifo Working Paper No. 3179, 2010.

Baxter, M., King, R.G. 1999. Measuring business cycles: Approximate bandpass filters. The Review of Economics and Statistics, 81(4), 575-593.

Christiano, L., Fitzgerald, T.J. 2003. The bandpass filter. International Economic Review, 44(2), 435-465.

Cottrell, A., Lucchetti, R. 2020. Gretl user's guide, gnu regression, econometric time-series library, gretl.sourceforge.net. Retrieved from http:/ricardo.ecn.wfu. edu/pub/gretl/manual/PDF/gretl-guide-a4.pdf.

Desvars-Larrive, A., Dervic, E., Haug, N. et al. 2020. A structured open dataset of government interventions in response to COVID-19. Sci Data, 7, 285. https://doi.org/10.1038/s41597-020-00609-9.

Eickmeier, S., Breitung, J. 2006. How Synchronized are New EU Member States with the Euro Area? Evidence from a Structural Factor Model. Journal of Comparative Economics, Vol. 34, No. 3, 538-563.

Flaxman, S., Mishra, S., Gandy, A., et al. 2020. Estimating the number of infections and the im-pact of non-pharmaceutical interventions on COVID-19 in European countries: Technical description update. arXiv preprint arXiv:2004.11342.

Flaxman, S., Mishra, S., Gandy, A., et al. 2020a. Report 13: estimating the number of infections and the im-pact of non-pharmaceutical interventions on COVID-19 in 11 European coun-tries. Imperial College London. doi: 10.25561/77731.

Estrella, A. 2007. Extracting Business Cycle Fluctuations: What Do Time Series Filters Really Do? Staff Report No. 289, Federal Reserve Bank of New York.

Gächter, M., Riedl, A., Ritzberger-Grünwald, D. 2012. Business cycle synchronization in the euro area and the impact of the financial crisis. Monetary Policy and The Economy, Q2/12, 33-60.

Haug, N., Geyrhofer, L., Londei, A., et al. 2020. Ranking the effectiveness of worldwide COVID-19 government interventions. Nat Hum Behav. https://doi.org/10.1038/s41562-020-01009-0.

Hodrick, R.J., Prescott, E.C. 1997. Postwar U.S. business cycles: an empirical investigation. Journal of Money Credit and Banking, vol. 29, no. 1, 1-16.

Kaiser, R., Maravall, A. 1999. Estimation of the business cycle: A modified Hodrick-Prescott filter. Spanish Economic Review, 1, 175-206.

Kufel, T. 2003. Długofalowość w ekonomii a pojęcie trendu. Przegląd Statystyczny, 50(1), 33-44.

Kufel, T. 2020. ARIMA-based forecasting of the dynamics of confirmed Covid-19 cases for selected European countries. Equilibrium. Quarterly Journal of Economics and Economic Policy, 15(2), 181-204.

Kufel, T., Osińska, M., Błażejowski, M., Kufel, P. 2015. Zegar cyklu koniunkturalnego p ańst w UE i USA wl atach 1 995-2013 w świetle badań synchronizacji. Prace Naukowe Uniwersytetu Ekonomicznego we Wrocławiu, (385 Taksonomia 25 Klasyfikacja i analiza danych-teoria i zastosowania), 138-146.

Osińska, M., Błażejowski, M., Kufel, P., Kufel, T. 2014. Comparative Analysis of Selected Filters in Application to Business Cycle Synchronization. Prace Naukowe Uniwersytetu Ekonomicznego we Wrocławiu. Taksonomia, 23, 41-50.

Osińska, M., Kufel, T., Błażejowski, M., Kufel, P. 2016. Business Cycle Synchronization in the EU Economies After the Recession of 2007-2009. Argumenta Oeconomica, 2(37), 5-30.

Pollock, D.S.G. 2000. Trend estimation and de-trending via rational square-wave filters. Journal of Econometrics, 99, 317-334.

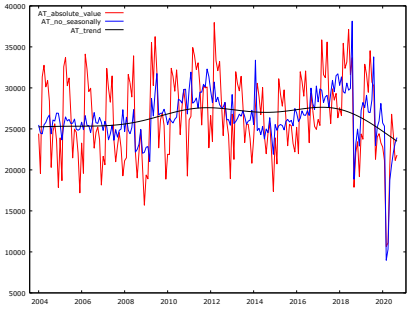
Stanczyk, K., 2020. "Anti-Crisis Shield" as an Example of State Interventionism During the Crisis Caused by the Covid-19 Virus Pandemic in Poland. European Research Studies Journal, Volume XXIII, Special Issue 3, 116-136, DOI: 10.35808/ersj/1857.

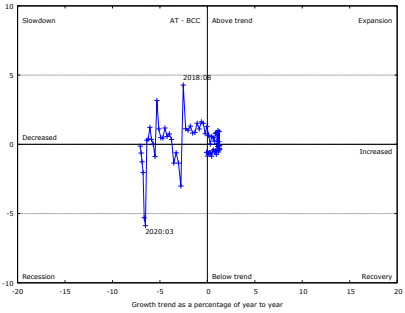
Ulrichs, M., Błażej, M. 2014. Zastosowanie metod statystycznych i ekonometrycznych do badań koniunktury gospodarczej, Wiadomości Statystyczne. GUS, 9, 57-75.

Van Ruth, F., Schouten, B., Wekker, R. 2005. The Statistics Netherlands' Business Cycle Tracer. Methodological Aspects; Concept, Cycle Computation and Indicator Selection. Statistics Netherlands, Report 2005-MIC-44.

Appendix:

Figure 3. *Monthly registration new passenger car (abslute value), monthly working day and seasonally adjusted registration new passenger car and long-term trend for 2004:01 to 2020:10 (left graph) and Busines Cycle Clock for registration new passenger car for 2015:01 to 2020:10 for UE28 (right graph) for select European country.*





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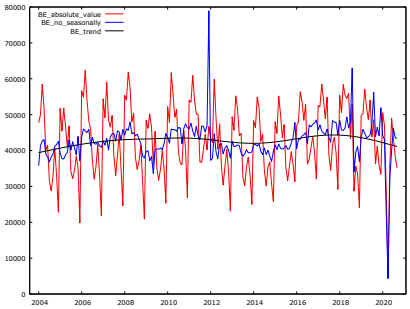

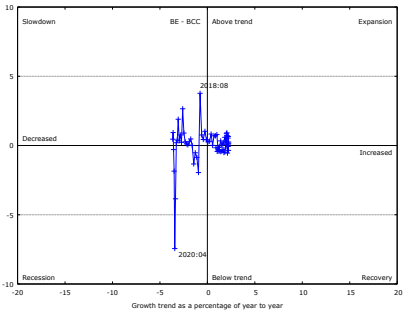

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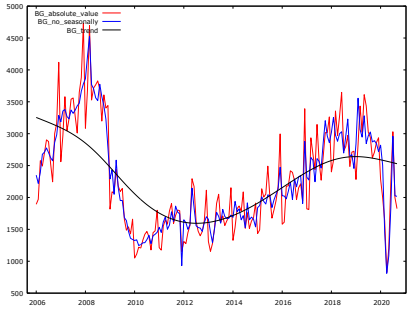
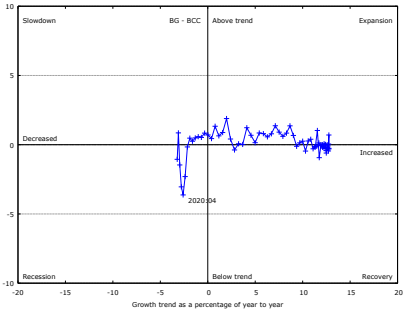
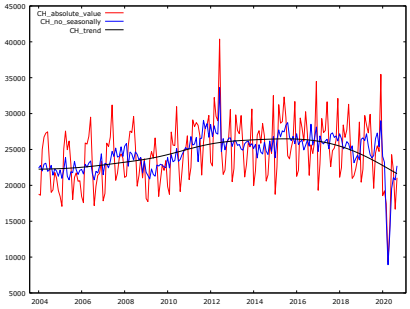


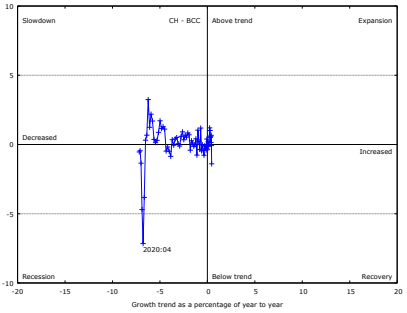


3. BG – Bulgaria

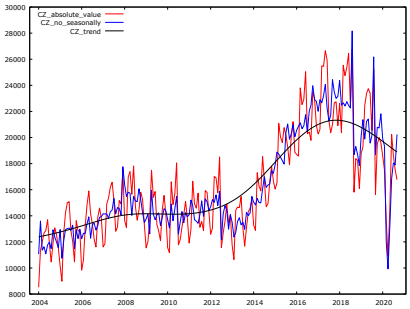
Source: *Own calculation based on db.nomics.world data.*

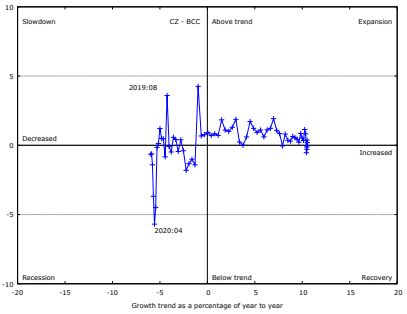
Figure 3. *Continued*





4. CH – Switerlands





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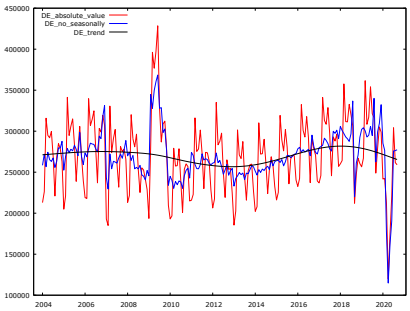

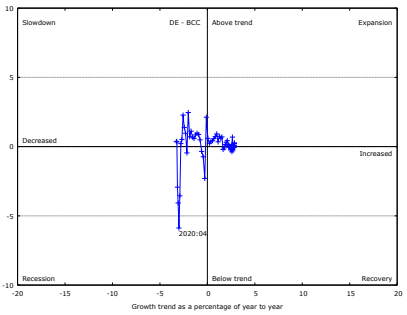

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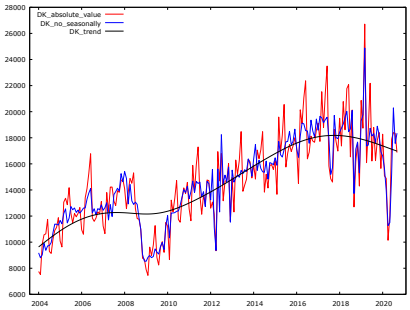

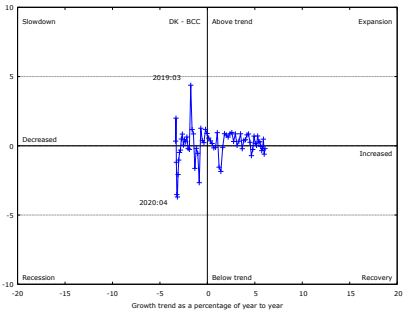

7. DK – Denmark

Source: *Own calculation based on db.nomics.world data.*

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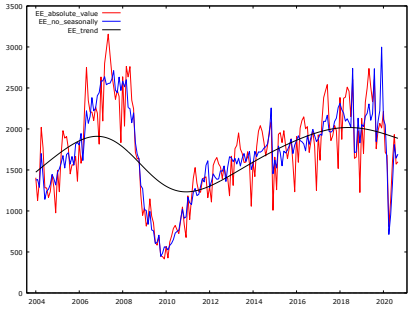
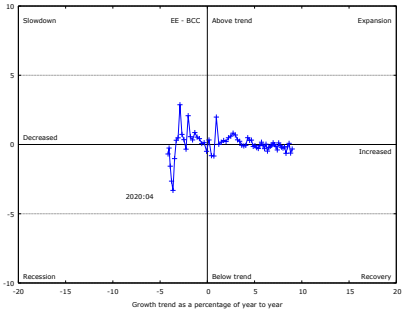
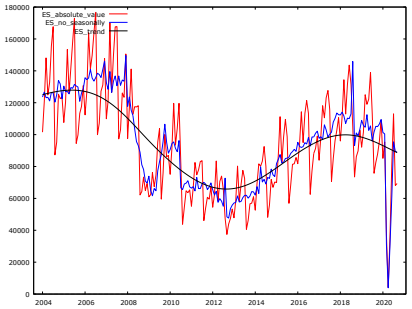
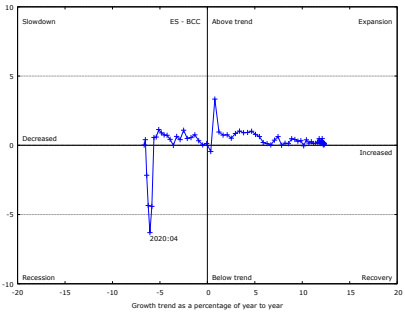


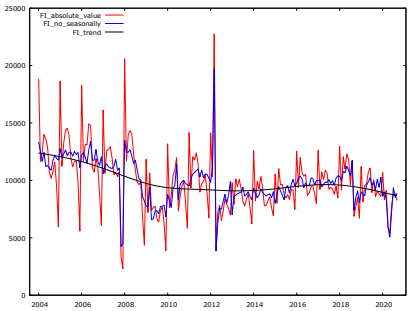


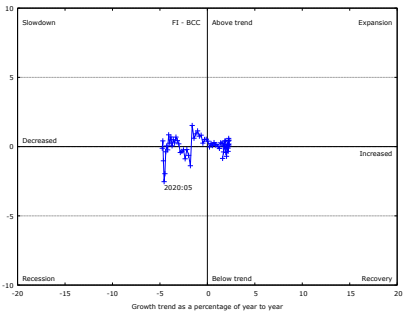
8. EE – Estonia



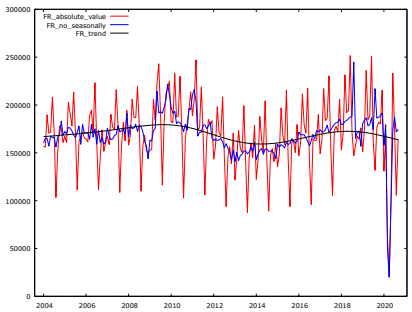


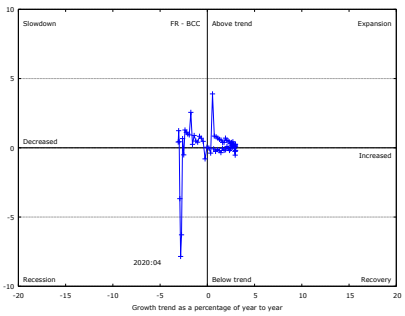
9. ES - Spain





10. FI – Finland

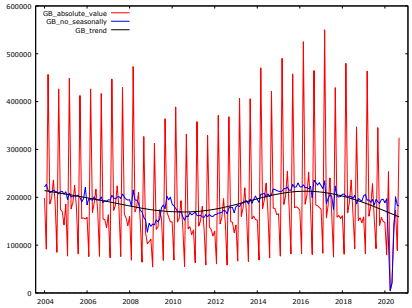


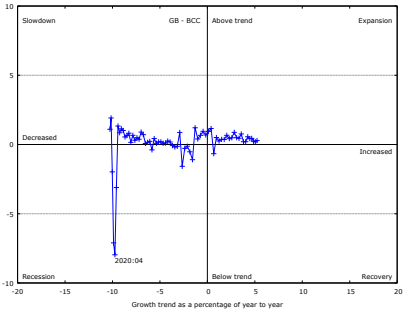


11. FR – France

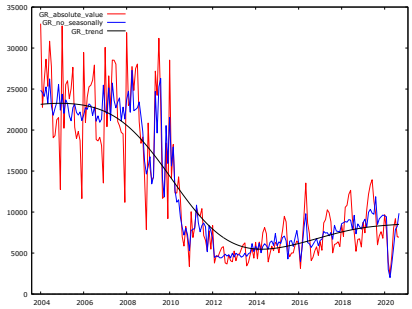
Source: *Own calculation based on db.nomics.world data.*

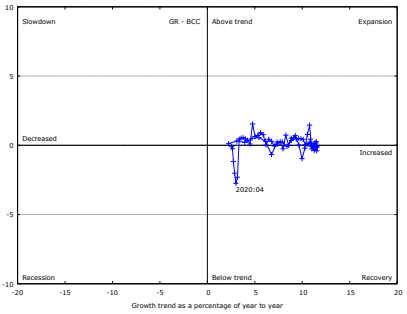
Figure 3. *Continued*



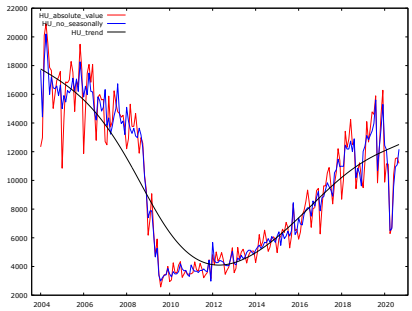


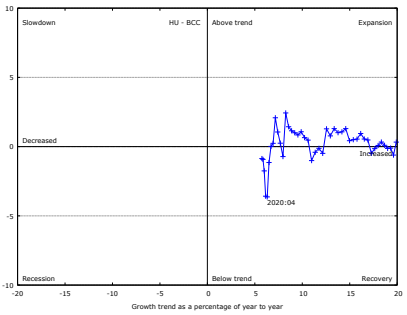
12. GB – United Kingdom



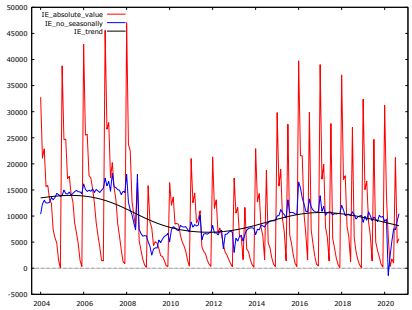


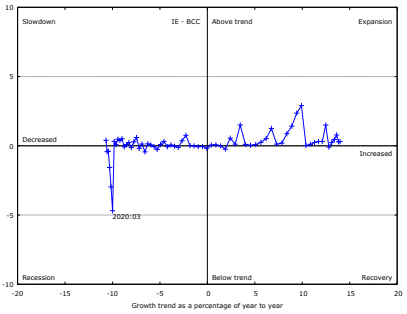
13. GR – Greece





14. HU - Hungary

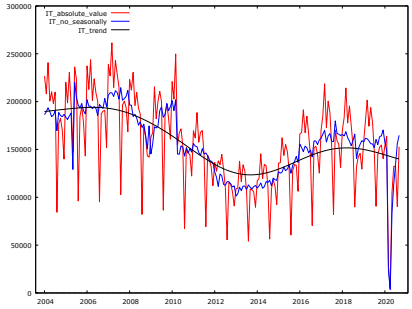


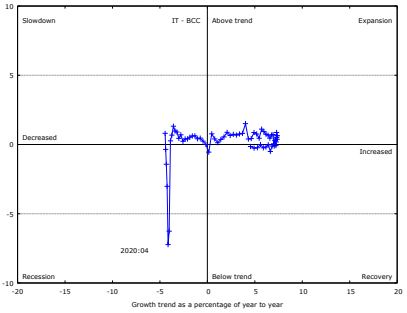


15. IE - Irland

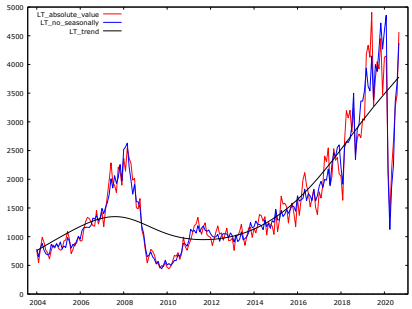
Source: *Own calculation based on db.nomics.world data.*

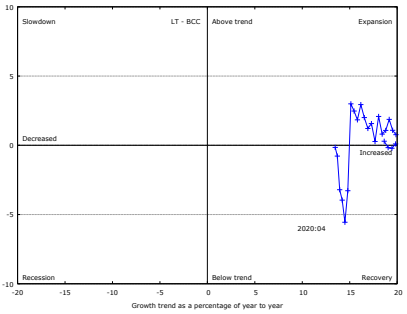
Figure 3. *Continued*



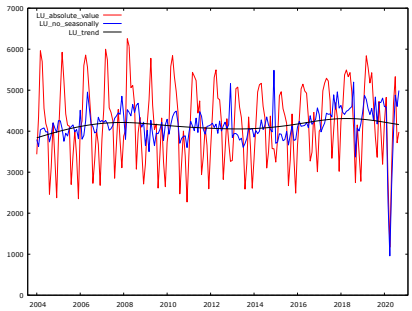


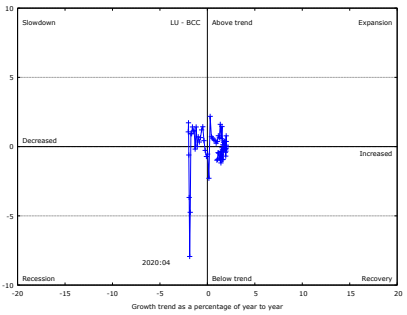
16. IT - Italy



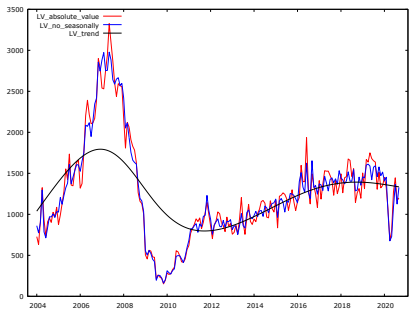


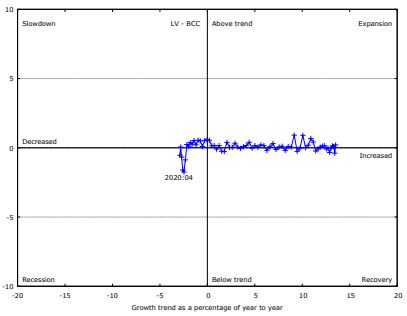
17. LT - Lithuania





18. LU - Luxembourg

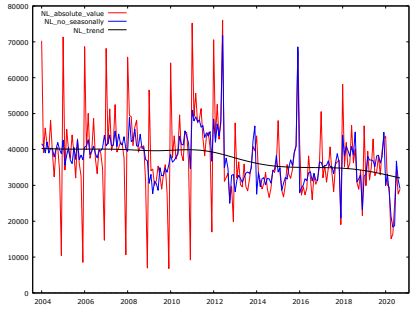


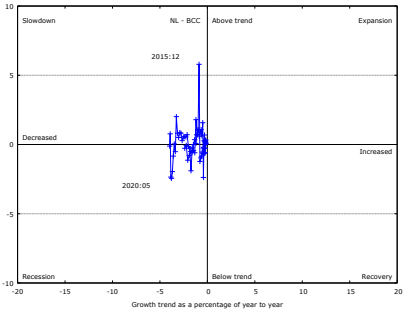


19. LV - Latvia

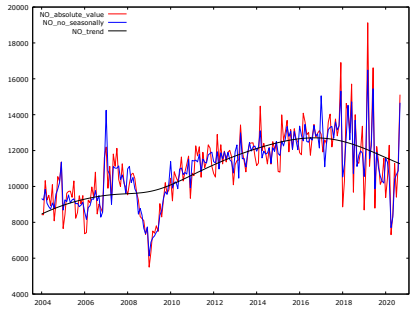
Source: *Own calculation based on db.nomics.world data.*

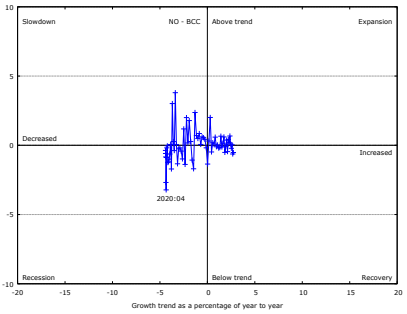
Figure 3. *Continued*



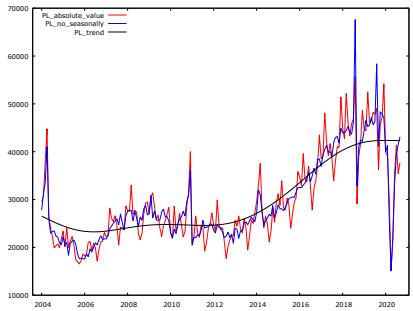


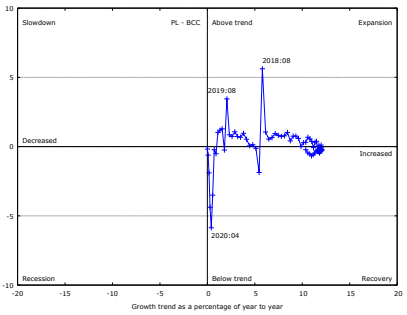
20. NL – Netherlands



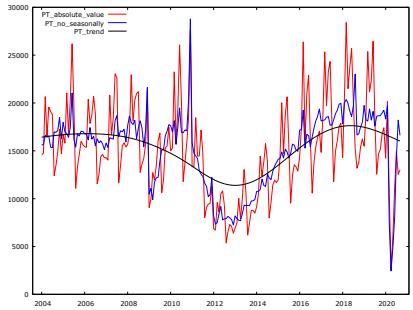


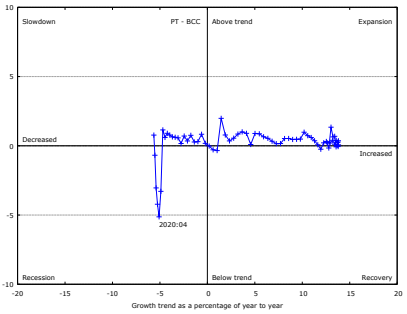
21. NO – Norway





22. PL – Poland

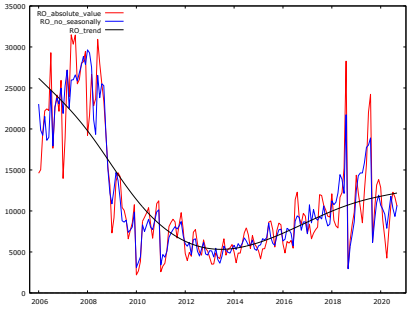


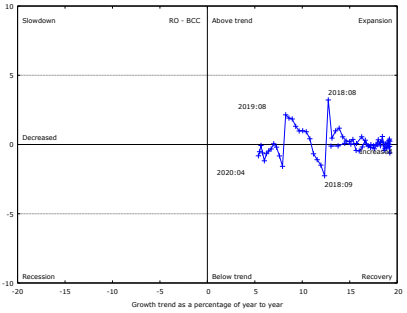


23. PT – Portugal

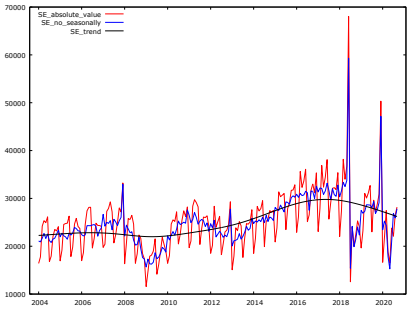
Source: *Own calculation based on db.nomics.world data.*

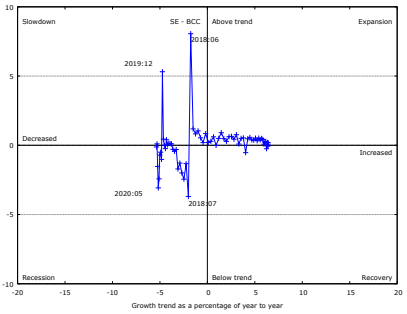
Figure 3. *Continued.*



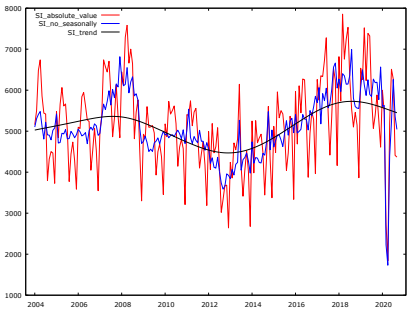


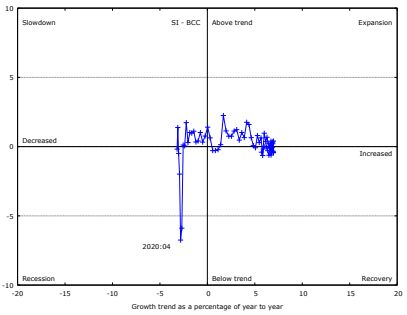
24. RO – Romania



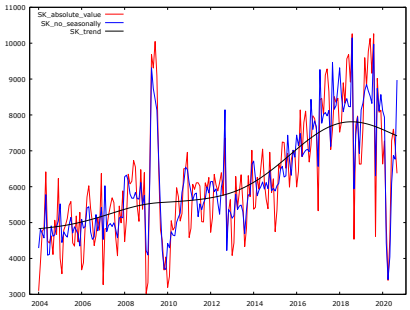


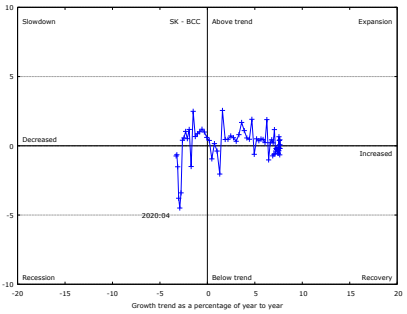
25. SE – Sweden





26. SI – Slovenia





27. SK - Slovakia

Source: *Own calculation based on db.nomics.world data.*