Convergence of Inflation and Unemployment Rates: a Signal of Economic Slowdown?

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Abstract

In economic theory the Phillips curve presents the relationship between the unemployment rate and inflation rate. The inflation and unemployment rate bring important information about the stages of the economic cycle. This article attempts to find an answer to the question of whether the development of the difference between the unemployment and inflation rate, the so-called signal gap, may be an indicator of changes in the economic cycle. Quarterly data on the Czech Republic, France, Great Britain and the Republic of Korea were used to verify this hypothesis.

Keywords

Dynamic linear model, unemployment rate, inflation rate, signal gap, GDP

JEL code

C22, E37

INTRODUCTION

The unemployment and inflation rate are among the most important indicators whose values sensitively reflect the changing economic conditions and stages of the economic cycle. The periodicity of determining them (monthly and quarterly, respectively) and the internationally comparable methodology of their estimate place these indicators in the role of certain signalling information on the development of the national economy in the short-term periodicity. The period of a crisis (or recession) is always associated with a high unemployment rate which, with the transition to the stage of recovery, naturally (albeit slowly) falls. The unemployment rate, as a reflection of the growth of consumer prices, tends to be low during a period or crisis, recession respectively, and a return to economic growth is usually accompanied by a price growth expressed by an increasing inflation rate. This empirical evidence results in a hypothesis that during the peak of economic growth the values of these two indicators come closer together,

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i.e. the gap between them narrows. The peak of economic growth is followed by a weakening in economic activity, fall in demand, increase of unemployment and slower price growth. All this leads to the stage of recession which, in terms of the relationship between the unemployment and inflation rate, is displayed as an increase in the difference of their values. If this gap were to be an indicator of stages of the economic cycle, its values could play the role of a certain leading indicator enabling the signalling of changes in the development of the national economy; so we will call it the signal gap.

Some theoretical starting points also point to the fact that the relationship between the unemployment trend and price trend may indicate a change in a stage of the economic cycle. Generally speaking, long-term low unemployment gradually gives rise to a lack of labour force thereby suppressing wage growth. Wage growth is subsequently displayed in an increase of demand, which leads to a price growth that is reflected in the growth of the inflation rate. In view of the slow fall in unemployment, the growth of the inflation rate need not be significant nevertheless sooner or later this situation will force the central bank to a one-off or repeated increase of interest rates. This, in turn, leads to a slow fall in the unemployment rate and to a narrowing in the signal gap.

An increase in interest rates will contribute to a slowdown in economic growth, a fall of share prices and lower availability of foreign sources of financing. The slowdown of economic growth (measured by the GDP growth rate) is accompanied by the level of wages and salaries, whose growth has outpaced labour productivity growth and then led to a further slowdown in economic growth.

The economy is getting into a "vicious circle" resulting in a change of the stage of the economic cycle. Thus the task is to find a period when the falling value of the signal gap begins to indicate a change in the cycle stage, and find a model for such behaviour, including an estimate of what time in advance the determined fall of the signal gap indicates the change of the cycle stage.

The aim of this article is to verify the hypothesis that the value of the signal gap directed at the minimum is an indicator of the peak of economic growth (expressed by the GDP growth rate), which signals the transition to the recession stage. In other words, when the inflation and unemployment rate converge to the same number, a longer economic downturn can apparently often follow. Using methods for a time series analysis, we will then attempt to estimate the size of the time in advance of the minimum of this gap before an approaching recession. To verify this hypothesis, we will use quarterly data for the Czech Republic, France, Great Britain and the Republic of Korea.

1 THEORETICAL STARTING POINTS

The relationship between the unemployment and inflation rate is not a new phenomenon in short-term economic diagnostics. The so-called Phillips curve, as one of the postulates of economic theory, is based on the relationship between these two indicators. Originally A. W. Philips (Philips, 1958) defined the relationship between the trend of wage rates and the unemployment rate; only later did he modify it into the relationship between the inflation and unemployment rate. We know this generalisation as the so-called price-price Phillips curve which represented a significant impetus for later ideas of central banks about the possibilities of the "regulation" of the inflation rate based on the unemployment rate.

The idea of the possibilities of the direction of economic policy, based on Phillips' formulated relationship of two indicators, seemed attractive to the authors of economic policy and representatives of central banks. If it would be possible to influence unemployment by supporting demand, it would be possible to also regulate prices. The period of post-war recovery in Europe played into these ideas when relative price stability did not raise concerns about sharp price growth and high employment was maintained by high economic growth. The change in economic conditions in the 1970s (the oil crisis after the Yom Kippur War in October 1973, changes in the structure of the labour market, growth of labour productivity, expansion of information technologies) led to disillusion with the malfunction of the relationship between the inflation rate and unemployment rate in practical economic policy,

particularly in the long-term horizon. One of the most significant economic relationships (although only empirically observed, nevertheless often passed into law), suddenly ceased to apply. The reasons why this was the case was summed up in their paper especially by M. Friedman (Friedman, 1968) and E. Phelps (Phelps, 1967), who showed that unemployment is the outcome of an entire series of economic processes and that they cannot be "regulated" by influencing demand. A significant role in the loss of the importance of the Phillips curve is also played by the policy of central banks based on inflationary expectations. This totally naturally disrupts the relationship between the unemployment and inflation rate, since the expected inflation rate affects economic entities by determining, to a considerable extent, the actual inflation rate. Nevertheless, M. Friedman and E. Phelps admitted that in the short-term horizon the relationship based on the price-price Phillips curve applies, but is accompanied by the growth of inflationary expectations. The validity of the relationship determined by the Phillips curve, or the possibility to regulate the inflation rate based on the influence of demand was later disputed even in the short-term horizon (Atkeson and Ohanian, 2001) or (Lansing, 2002).

Deriving the relationship between the trend of the inflation and unemployment rate was based on (empirically observed) statistical dependence between these variables in that Phillips considered the unemployment rate as the explanatory variable (nevertheless, I. Fisher considered the inflation rate as the explanatory variable, see Fisher, 1973). The discussion concerning the relationship often led to the fact that dependence was interpreted as bilateral and almost no attention was devoted to the economic arguments that opted for the unemployment rate as the explanatory variable.

The long-term observed dependence in one country was therefore incorrectly economically generalised for a different time and different area, and without the mathematical accuracy of the derived relationship being proved, this relationship was used as an instrument of economic policy. It was only a matter of time before such an instrument failed. Statistically proven dependence still does not mean that this is causal dependence. It must also not be forgotten that two variables can only be seemingly statistically dependent, since both are influenced by a third variable (sometimes clearly and sometimes very well concealed) or simply show the identical time trend without any factual context of the limits of the considered variables being justified by this identical time trend.

Another statistical argument to dispute the idea that it is possible to transfer relationships between the unemployment and inflation rate, valid from the mid 19th century to the mid 20th century and even passed into law is the very content of these indicators. The definition and methods of determining these indicators have changed significantly since the time Phillips' paper was published. And this means their values, interpretation and ability to reflect reality as was the case 100 years ago have also changed.

Despite the doubts about the universal validity of the above described economic relationships, it is clear that the unemployment trend and price trend very sensitively react to changes in the economic cycle. So it is necessary to look at the new possibilities that the relationship of the values of these two indictors can bring us.

If it can be assumed that the peak stage of the economic cycle is accompanied by the increased demand for labour force reflected in the low unemployment rate and that the surplus of free funds and high demand causes a price rise (inflation rate), then the signal of an approaching point of "overheating" is the convergence of the values of these two indicators. In other words, the difference of the values of the unemployment and inflation rate which we call the signal gap decreases in the direction of the peak of the stage of economic growth, and is therefore not just the indicator of this state, but also the indicator of the transition to the stage of recession.

If we accept this assumption, then what should apply is that there is a connection between economic development (measured GDP growth rate) and the signal gap, or what should apply is that the signal gap fulfils the role of a leading indicator of change in the stages of the economic cycle. It is clear that a certain time lag must be considered which must be found using methods of time series analysis.

2 DATA AND ANALYSIS METHODOLOGY

To verify the validity of the hypothesis of the role of the signal gap, the selected indicators need to be defined first in terms of their content and periodicity, so that they best correspond to the theoretical assumptions and their values best reflect the development of economic boom during the analysed period. It must also be decided how long such a period should be so that the formal assumptions are met of the use of time series analysis methods, but also factual requirements, i.e. requirements to be able to affect stages of the economic cycle.[4] Last but not least, by using appropriate time series analysis methods to create a model description of the relationship of the GDP growth rate and signal gap, and find the signal gap lead, or lead of its changes before a change in economic development. The definition of indicators and subsequent analysis will rely on data of the Czech Republic, France, Great Britain and the Republic of Korea which are available on the websites of the relevant statistical offices.[5] The choice of these countries is determined to a certain extent by the unavailability of short-term data of the relevant periodicity and length of the time series on the websites of the absolute majority of statistical offices. There is no central source of data from which to obtain data in the required form for the same time period for a random country. So it was necessary to look through the websites of national statistical offices and find the relevant data.

The initial indicators for calculating signal gaps are the inflation and unemployment rate, which are methodically internationally comparable indicators. The values of these indicators are normally published in monthly, quarterly and annual periodicity. However, information applying to the development of the national economy (GDP growth rate) is only available in quarterly and annual periodicity. If we are to follow an economic boom in a short-term horizon, it is clear that we can only work with quarterly data.

The inflation rate is a relative increment corresponding to the consumer price index. The quarterly inflation rate is expressed by a percentage change of the price level in the given quarter in comparison with the immediately previous quarter; values are seasonally adjusted. This is formally the share of the base year of the consumer price index in the given quarter and the base year of the consumer price index in the previous quarter whereby the base is the same in both cases (in all stated countries the base is the average of 2015).

The fact that the inflation rate is estimated from the development of consumer prices is beneficial in terms of its international comparability. On the other hand, (given the definition of the household final consumption expenditure indicator), the inflation rate does not include the growth of real estate and construction work prices. This seems insufficient from the point of view of capturing the overall rise in prices. The solution in a given situation could be to use the GDP deflator, which should take into account the overall price movement. Here, however, we would encounter the problem of the interdependence of the GDP growth rate and the GDP deflator, and the definition of a signal gap would then be meaningless.

The unemployment rate is defined as the share of the number of unemployed in the number of economically active aged 15–64 years. In all the analysed countries the quarterly general unemployment rate was used, which is based on the definition of unemployed persons according to the conditions of the International Labour Organisation – ILO; the values are seasonally adjusted.

The signal gap is then defined as the difference between the (quarterly) unemployment rate (in %) and the (quarterly) inflation rate (in %). Its value is therefore expressed in percentage points. Values of this difference approaching zero signal the peak of the economic cycle phase, and are therefore an indicator of an early transition to a deceleration phase.

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[4] Given the requirement for a reasonable length of the time series from a formal and factual point of view, authors are naturally limited by the availability of data on the websites of statistical offices.

[5] See <*www.czso.cz*>; <*www.insee.fr*>; <*www.ons.gov.uk*>; <*http://kostat.go.kr*>.

To describe an economic boom the quarterly GDP growth rate indicator was used as it is the relative increment corresponding to the index comparing the value of GDP in the given quarter and in the previous quarter; the values are seasonally adjusted. The corresponding GDP values are expressed in the chained prices of the previous year (annual chain linked quarterly data).

When choosing the length of quarterly time series, we again referred to the availability of data on the websites of selected national statistical offices. The limiting factor was always the limited length of the time series of the unemployment and inflation rate. Nevertheless, even in these time limits, we had at least 80 observations from the selected countries. We consider the given length of the time series to be satisfactory not just for using tools of stochastic modelling, but also to describe the stages of the economic cycle.

These stages with varying intensity, in individual countries, also reflect the stages of the development of the world economy (slump primarily of Asian economies in the second half of the 1990s, the post-transformation crisis of the countries of Central and Eastern Europe, the rapid growth of the prices of American technology stock at the start of the millennium as the first signal of the global economic recession then approaching in 2008, the fiscal irresponsibility of developed European countries in years 2001–13 etc.

If we base our hypothesis on the assumption that the signal gap fulfils the role of lead indicator in relation to the GDP growth rate, it is necessary to show the dependence firstly of these time series. Therefore, the first step was the graph showing the progress of these series in which the series trend and their correlation can be seen well. These graphs indicated how strong the dependence will be between the series of the GDP growth rate (in graphs marked GDP) and the signal gap (in graphs marked GAP) for each of the analysed countries.

To prove dependence, including the time delay between both series, we used the cross-correlation function (CCF). This function is normally used as the linear dependence rate of two time series. Its advantage is the fact that apart from the dependence level, it also determines the direction of any linear dependence, i.e. also any time lag. The outcome is a table with values and a correlogram which shows the calculated correlation coefficients not just in the same time point t for both series, but also correlation coefficients in time t for one series and in time $t \pm 1$, $t \pm 2$ for the second series, etc. The correlogram also shows a 95% confidence interval for the values of the correlation coefficient, which considerably simplifies the identification of the statistically important values of this coefficient, including any time lag between the series. The CCF is defined[6] as:

$$\rho_{XY}(k) = \frac{\gamma_{XY}(k)}{\sigma_X \sigma_Y}, \tag{1}$$

where X_t and Y_t are the analysed time series. The CCF is then defined at k as the covariance of X_t and $Y_t + k$ for $k = 0, \pm 1, \pm 2, \ldots$, divided by a product of the standard deviations of both series, where σ_X and σ_Y are the standard deviation values for the series X_t and Y_t (respectively). It is clear that for the CCF the relationship is:

$$\rho_{XY}(k) = \rho_{XY}(-k). \tag{2}$$

Models appropriate for this situation are derived from the class of dynamic linear regression models. These models are based on ARIMA processes. It is assumed that the output series Y_t depends on its past time values $t - 1$, $t - 2$, … , then on the values of the input series X_t in time points t, $t - 1$, $t - 2$…

[6] The general definition of the CCF and its properties can be found for example in the paper of Wei (2006) or in Box, Jenkins, Reinsel (1994).

and on the values of the so-called noise time series Nt, which is self-regulated by the ARIMA process. The entire theory of linear dynamic models is described in detail[7] and very good results are achieved with it. In general, values of output series can be recorded using the following model,

$$Y_t = c + \nu_0 X_t + \nu_1 X_{t-1} + \nu_2 X_{t-2} + ... + \nu_K X_{t-K} + \frac{1}{(1 - \phi_1(B))(1 - \Phi_1(B^T))}\,\varepsilon_t\,, \tag{3}$$

where Y_t is the output series, X_t is the input series, c is constant, ν_i are unknown parameters for $i = 0, \ldots, K$, $\phi_1(B)$ is the autoregressive operator of order 1, $\Phi_1(B)$ is the seasonal autoregressive operator of order 1, ε_t is the random variable (white noise), B is the shift operator ($BY_t = Y_{t-1}$), L is the length of season (cf., e.g. Box, Jenkins, Reinsel, 1994).

A whole series of criteria exist for this type of model according to which the model can be verified. Most of them are based on the autocorrelation and partial autocorrelation function. Here we also used other tools such as the unit root test, homoscedasticity test, Dickey-Fuller tests and others.[8]

3 RESULTS OF THE ANALYSIS

We analysed the data from the four selected countries. These are the Czech Republic, France, Great Britain and the Republic of Korea. Generally speaking, these are countries marked for their developed economy and monitor and report indicators over the long-term which we use in our analyses.

Let us look at how the economy developed in the analysed countries in the last ca 30 years, how the time series of quarterly GDP growth rates and signal gaps (GAP), models and total results appeared for the individual countries. We will present the detailed results and analysis procedure, including the CCF, only for the data for the Czech Republic, to show how we proceeded. For the other countries we will proceed analogically and will present only a graph showing the progress of the series and resulting model.

3.1 Czech Republic

We had quarterly data available for the Czech Republic for the period of 1996–2019, so we worked with 95 observations.[9]

The period after 1990 was marked in the Czech Republic by a decline in economic activity in connection with the transition from a centrally planned to a market economy. The short period (up to 1993) was followed by economic growth which peaked in 1995 and 1996 (the value of the signal map close to zero is a good indicator here of the "overheating" of the economy and approaching economic crisis – see Figure 1) and subsequent recession in years 1997 and 1998.[10] The reasons for this economic crisis were internal and involved unresolved privatisation problems (including privatisation of the banks), the slow restructuring of industry, currency and credit crisis of the banking sector and a tough restrictive anti-inflationary policy. The year 2000 saw a turning point in economic development leading to growth and the start of a recovery resulting in the most successful years of economic development in the Czech Republic (which is illustrated by the signal gap's high values – see Figure 1).

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[7] For more see Wei (2006) or Box, Jenkins, Reinsel (1994).

[8] The entire analysis was carried out in Stagraphics Centurion, version 16. The model estimate may be carried out differently so the results in various softwares may differ. Obviously, this does not in any way matter provided that the theory is respected according to which the given procedures were programmed.

[9] Information for the 1st quarter of 1996 is not available.

[10] The low signal gap values (0.0 pp in the 3rd quarter of 1997, 0.9 pp resp. in the 2nd quarter of 1998) is the outcome here of state intervention in the economy in order to avert the growing state budget deficit and stop the downturn in the economy. This led to a sharp price growth in the presented quarters. Thus, in this case the low and isolated signal gap values cannot be considered a tendency that could be an indicator of an approaching recession, but a one-off reaction to state intervention.

However the stage of recovery, which is considered the period of 2001–04, and the following economic boom stage of 2005–07 had different features. The period of 2001–04 was marked by stable economic growth, supported by high rates of growth of industrial and building production, growth of consumption of households and general government, as well as the gradual improvement of foreign trade links, including terms of trade with significant strengthening of the Czech koruna and relatively high, but a stable unemployment rate, lower inflation rate and fall of the prices of industrial manufacturers. In the period of 2005–06 the basic growth factors change: there is a rise in the importance of foreign exchange, Czech currency strengthens significantly, the general government debt level stabilises, the general government deficit decreases and unemployment falls slightly. However, the positive results of the national economy of the Czech Republic ended with the onset firstly of the global financial crisis in years 2008–09 and the subsequent recession in 2010–12 (the signal gap values in 2007 gradually fell significantly to 0.9 p. p. in the first quarter of 2008, and indicated the start of a recession). The high values of the general government deficit with a downturn in economic activity led to a growth of the general government debt to values around 45% of GDP (i.e. relatively high above the long-term approximately 30%) and growth of unemployment.

The year 2014 saw a recovery supported by growth of industrial and building production, retail, growth of business and state investment (without a significant increase of its debt) and displayed by a fall in unemployment, real wage growth, surplus of the current account on the balance of payments. All this came at a low inflation rate, low unemployment rate and decreasing general government debt. From the third quarter of 2017 the Czech Republic shows a slowdown of growth (the average inter-quarter rate in this period is 0.6%) and the signal gap shows a decreasing tendency again during five quarters. The Czech economy comes up against barriers of further growth (the unemployment rate is below 3% and the inflation rate below 1%), and a slowdown in economic growth can be expected which actually came in 2019. However the year 2020 brought unpredictable problems with the COVID-19 pandemic, which will indisputably lead (not only in the Czech Republic, but also in the other analysed countries) to a significant fall of GDP and general government debt growth.

To illustrate the relationship of the trend of GDP and signal gaps, we will show the progress of both time series (see Figure 1). At first glance it is clear from the graph that there is dependence between the series. It appears that the GAP series shows very similar progress to that of the GDP series, nevertheless with a certain time delay. This fact should be confirmed by the CCF values (see Figure 1). The progress of the CCF should indicate a lot in terms of the shape of the model, it is clear that there exists a significant correlation between the studied GDP and GAP series in the time point t (GDP) and $t - 4$ (GAP). Thus, there is a time lag by four time units (a delay by four quarters, that is by an entire calendar year). We will use this fact when creating the model. This significant linear dependence with a time delay by four time units is not only apparent in the graph, but is also confirmed by the correlation coefficient zero value test. The correlation coefficient for the combination of time points t and $t - 4$ resulted as being significantly different from zero (as the only one that is not found in the 95% confidence interval).

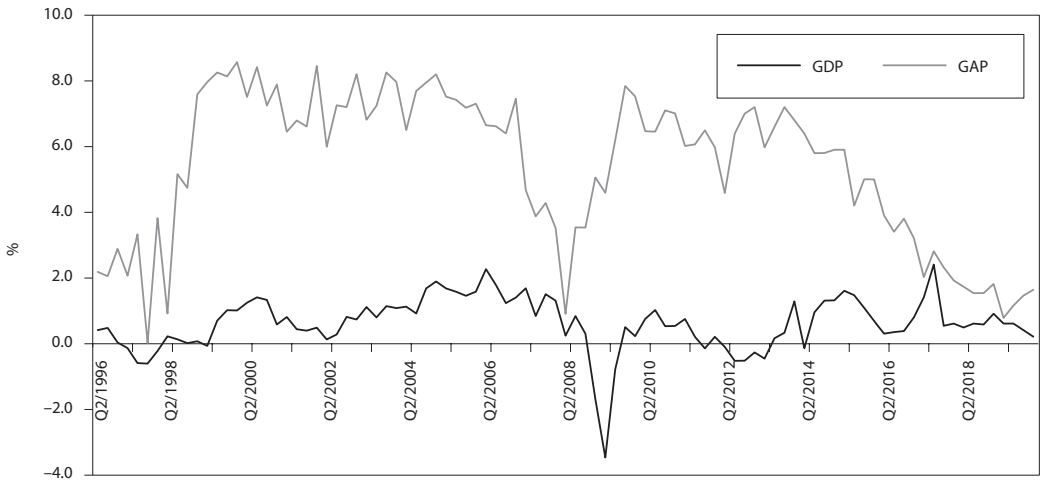
After we had analysed the ARIMA model for the GDP series, we proceeded to construct a transfer function model of the given Formula (3). Finally we reached the ARIMA model (0, 1, 1) with one regressor in the form of

$$Y_t = 0.173X_{t-4} + (1-0.283B)\varepsilon_t\,, \tag{4}$$

where Y_t is the series of the GDP quarterly growth rate after the current differentiating, X_t the series of the signal gap quarterly values, and ε_t is the standard white noise. It must be pointed out that the model went through a whole series of tests (tests of residue, the unit root, homoscedasticity, and Dickey-

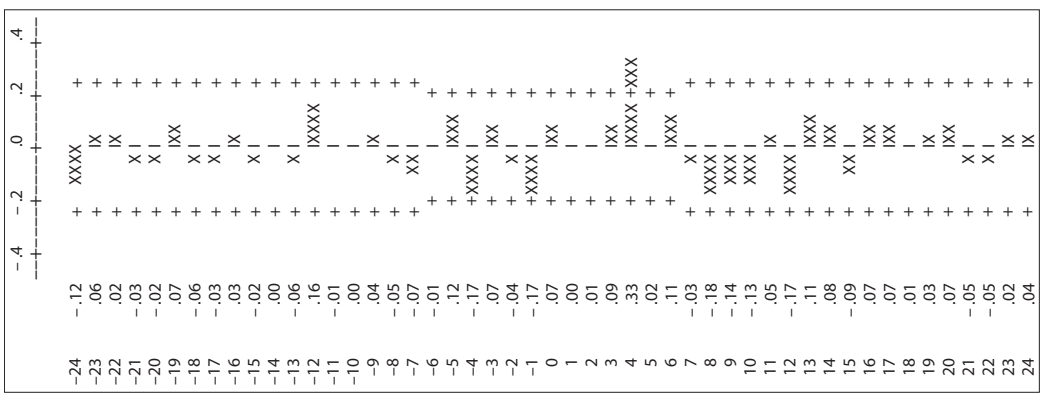
Fuller tests) and was shown to be fully adequate. The output from Stagraphics Centurion is presented in the following table. As model quality criteria, the usual rates were used which we also present and which support the model's adequacy.

Figure 1 Trend of the GDP growth rate and signal gaps – Czech Republic 1996–2019



Source: <*www.czso.cz*>

Figure 2 Graph showing the progress of CCF (Czech Republic) – 95 percent confidence interval



Source: Own calculations, <*www.czso.cz*>

This analysis demonstrates in the examples of the Czech Republic that the hypothesis concerning the prediction potential of the signal gap is valid. The model also shows with what delay after the signal gap values close to zero, a recession is approaching. In addition, the data of the Czech Republic show that the zero (or approaching zero) time isolated signal gap values may be the outcome of one-off state (e.g. fiscal, tax) measures influencing the price jump in the given quarter. Such one-off values cannot (given that they do not represent the tendency being asserted in several quarters) be considered an indicator of an approaching recession.

Table 1 Stagraphics Centurion output – Czech Republic

ARIMA Model Summary

Parameter	*Estimate*	*Stnd. Error*	*t*	*P-value*
MA(1)	0.283404	0.103777	2.7309	0.007571
LAG(Gap;4)	0.173216	0.0534385	3.2414	0.001657

Backforecasting: yes
Estimated white noise variance = 0.353578 with 92 degrees of freedom
Estimated white noise standard deviation = 0.594624
Number of iterations: 5

Forecast Summary

Parameter	*Estimation*
Statistic	*Period*
RMSE	0.594426
MAE	0.419092
ME	–0.00307198

Source: Own calculations, <*www.czso.cz*>

3.2 France

For France we had complete quarterly data available for the period of 1990–2019, which consist of 120 observations.

France is the sixth biggest world economy[11] and the second biggest in the Eurozone[12] (measured by nominal GDP). Its economic development after 1990 is characterised by low, but relatively stable GDP growth rates (the average annual GDP growth rate is 1.6%), low inflation rate (the average annual information rate 1.5%), high unemployment rate (with the lowest value of 7.4% in 2008 and the highest of 10.7% in 1997) and rising general government debt (from the value of 35.6% of GDP in 1990 to 98.1% of GDP in 2019).[13]

In terms of quarterly GDP growth rates, the critical periods were between 1992 and 1993, the second quarter of 2003 and the period from the second quarter of 2008 to the second quarter of 2009 when there was an inter-quarter fall in GDP. This was preceded by decreasing signal gap values during 1991, during 2002 respectively, during 2007 respectively (see Figure 3).

The reason for the economic decline in the early 1990s was the postponement of major reform steps which, in an aging population, disrupted the economic and financial balance. Subsequently, the reform of pension and health insurance was adopted and measures were taken to boost the economy and reduce unemployment.

The loss of competitiveness on foreign markets had a negative impact on France's economic growth in the first years of the 21st century. Therefore, the French government adopted a stabilisation programme for years 2004–06, which led to the greater success of French exporters, primarily to Asian markets and a return to the stage of economic growth. The economic and fiscal crisis of 2008–09 had a heavy impact on the French economy, GDP fell continuously for five quarters, the general government deficit rose to 7.2% of GDP, the general government debt rose year-on-year by 14 p. p. in relation to GDP, falling demand suppressed price growth, which resulted in deflation (between 2008 and 2009).[14]

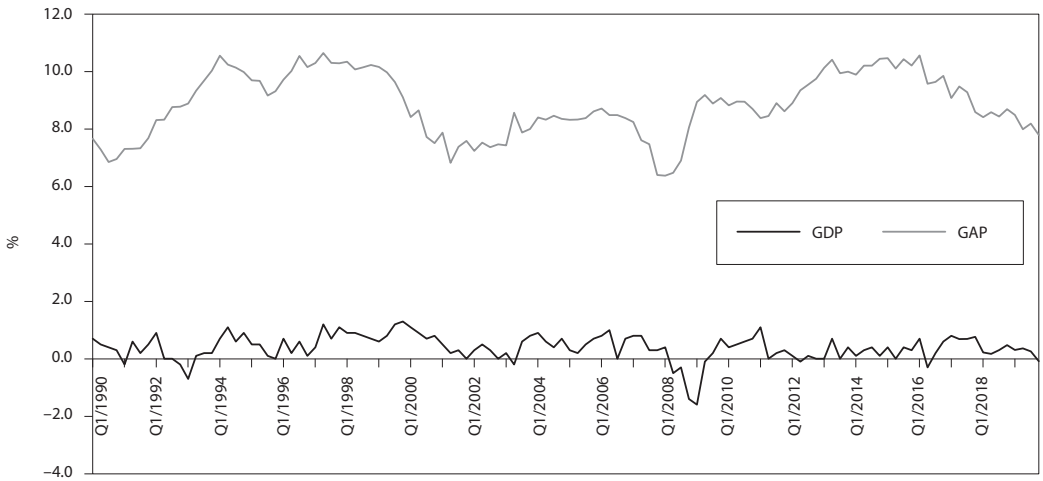
[11] Data for 2018, viz <*https://databank.worldbank.org/data/download/GDP.pdf*>.
[12] <*www.eurostat.eu*>.
[13] For these and the following data see <*www.insee.fr*>.
[14] See INSEE (2014).

In 2012 and 2013 the French economy was marked by stagnation (0.3%, 0.6 % year-on-year GDP growth respectively). Subsequent recovery in France came slowly, more than 2% of the year-on-year GDP was not achieved until 2017; however 2018 was again marked by a slowdown to 1.7% of year-on-year growth and 2019 to 1.0%, which was preceded by a decrease in the value of the signal gap during 2017 and 2018 (see Figure 3).

In the long-term high unemployment rate and relatively low inflation rate the signal gap values are significantly higher than in the Czech Republic. Nevertheless, their fall in several quarters is a signal of an approaching slowdown of economic growth, recession respectively.

The CCF values even in the case of France showed a linear dependence with a time lag of four time units, which is incidentally also apparent from the progress of analysed series illustrated in the graph.

Figure 3 Trend of the GDP growth rate and signal gaps – France 1990–2019



Source: <*www.insee.fr*>

An appropriate model was again showed to be the ARIMA model (0, 1, 1) with one regressor, this time in the form of

$$Y_t = 0.256X_{t-4} + (1-0.592B)\varepsilon_t\,, \tag{5}$$

where individual symbols have the same significance as in the previous model. The model again passed all the stages of verification successfully and the characteristics of the model's quality also came out positively.

The analysis of the data of France shows that the hypothesis concerning the prediction potential of the signal gap is valid and a recession is approaching with a delay with decreasing signal gap values (values approaching 6 p. p.). So unlike the Czech Republic, these are not signal gap values approaching zero, in view of the long-term high unemployment rate (often exceeding 10%) and very low inflation rate. However, here too the decrease is apparent of the signal gap values before the approaching economic slowdown.

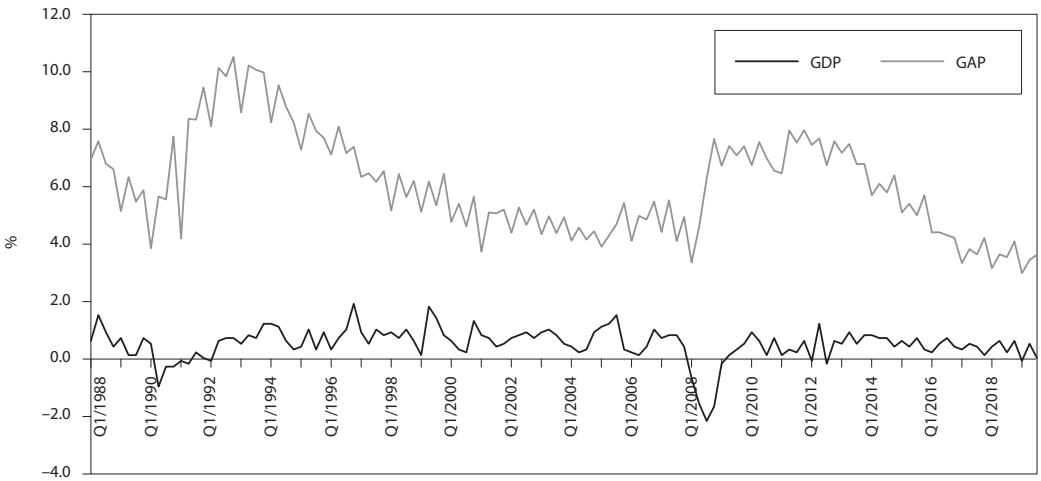
3.3 Great Britain

In the case of Great Britain, we worked with 128 observations, which are quarterly data for the period of 1988–2019; this was the longest time series in our analyses.

The economy of Great Britain is the fifth biggest world economy[15] and is the biggest financial centre in the world. Financial services are the most important export commodity and services account for almost 80% of GDP.

The economic development of Great Britain after 1990 is characterised gradually by the decreasing GDP growth rate (from growth rates exceeding 3% in the second half of the 1990s to a growth rate not exceeding 2% in years 2016–19; the average annual growth rate of GDP for the entire analysed period is 2.1%), a relatively unstable inflation rate (average annual inflation rate 2.6%), sooner a higher unemployment rate (with the lowest value of 3.9% in 2019 and the highest exceeding 10% after the crisis in 1991) and rising general government debt (from a value of 34.2% of GDP in 2002 to 86.0% of GDP in 2019).[16]

Figure 4 Trend of the GDP growth rate and signal gaps – Great Britain 1988–2019



Source: <*www.ons.gov.uk*>

In terms of quarterly GDP growth rates, the critical stages were the period from mid 1990 to mid 1992 (negative inter-quarter growth rate), the period from the second quarter of 2008 to the second quarter of 2009, the year 2012 with a fall in GDP in the second and fourth quarter and the year 2019 with a fall in GDP in the second quarter. This was preceded by decreasing signal gap values between 1989 and 1990, during 2007 respectively, during 2018 respectively (see Figure 4).

After economically successful years (from 1982, with peak growth in 1988) the start of the 1990s were marked with a transition from crisis. Some economic decisions of the final years of Margaret Thatcher's government led the economy into a vicious circle, which made it even difficult for big businesses and higher income sections of the population to get out of. A number of successful companies up to this time also went bankrupt, lower income groups, which were forgotten by the relative economic boom of the first decades of Thatcher, fell into poverty. The consequence of the crisis led to a rise in unemployment (from 7.0% in the first six months of 1990 to more than 10.0% from the second half of 1992 at a very low inflation rate).

The years 1993–2007 are a period of economic growth at a gradually falling unemployment rate and continuous low inflation rate. So there is a gradual narrowing of the signal gap, which ushers

[15] For data for 2018, see <*https://databank.worldbank.org/data/download/GDP.pdf*>.
[16] For these and the following data see <*www.ons.gov.uk*>.

in the approaching crisis. The threat of the financial and mortgage crisis imported from the US was averted up to a certain extent by the preventive measures of the British government. This also put a stop to the wave of distrust in the British banking sector whose shocks would have seriously damaged the entire economy. Nevertheless, GDP fell by 4.2% in 2009 and recovery came slowly. State intervention helped to reduce the period of crisis, but to a certain extent complicated the transition to the stage of recovery – the British economy again showed a fall in GDP in the two quarters of 2012.[17]

Warning signals (here in the form of the narrowing signal gap – see Figure 4) about an approaching recession in 2018 were displayed with a fall in GDP in the second quarter of 2019 (by 0.1% as opposed to the previous three months). This development, among other, was reflected in stockpiling, with the March deadline for Great Britain's exit from the European Union and the anticipation of problems in preparation for Brexit at the end of October 2019. Incidentally, the British economy had already slowed down from mid 2016, when the Brits decided in a referendum that the country would leave the European Union (on 23 June 2016).

The progress of the series (and CCF values) also, in the case of Great Britain, confirmed the dependence between the series with a time delay. We identified an appropriate model in the form of:

$$Y_t = 0.106X_{t-4} + (1-0.361B)\varepsilon_t \,. \tag{6}$$

This again is the ARIMA model (0, 1, 1) with one regressor. The model passed all stages of testing confirming its adequacy.

The analysis of the data of Great Britain also demonstrates that the hypothesis concerning the prediction potential of the signal gap is valid and a delayed recession is coming with decreasing signal gap values (values approaching 3 p. p.). Given a higher unemployment rate and a sooner higher inflation rate, these are not signal gap values approaching zero (similar as in the case of France).

3.4 Republic of Korea

We obtained data for the national economy of the Republic of Korea for the period of 1999–2019; we have data for 1999 from the third quarter, therefore we are working with 82 observations. The reason for having a shorter time series than in the previous cases is because of the unavailability of quarterly data on unemployment before 1999.

The economy of the Republic of Korea (hereinafter "Korea") is the twelfth biggest world economy[18] and is a developed country focused primarily on the car and electrical engineering industry. Korea's economy is marked by a specific business environment (the position of big companies, so-called chaebõls,[19] which have a large microeconomic impact and are significantly interlinked with political power). After learning from the crisis in the late 1990s, the Korean government maintains a low level of public debt (36% of GDP in recent years) and also a reserve fund which it uses in case of a crisis. These measures also had an effect on the small impact of the global crisis in years 2008–2009, when the Korean economy, as only one of a few, grew during these years of crisis (year-on-year growth of GDP 3.0% in 2008 and 0.8 % in 2009).[20]

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[17] There was a similar difficult post-crisis trend in the Czech Republic for example. The reason was the application of inappropriately selected instruments of state economic policy, nevertheless different than in Great Britain.

[18] For data for 2018, see <*https://databank.worldbank.org/data/download/GDP.pdf*>.

[19] Chaebõl is a specific type of group operating in various sectors and based on the interconnection of business and financial controls; it is usually owned by a single businessman and members of his family – e.g. Samsung, Hyundai, Daewoo, Samyang; see Chang and Lee (2006).

[20] For these and the following data see <*https://kosis.kr/eng*>.

At the end of 1997 Korea (just like other Asian countries) was affected by the financial crisis (in 1998 GDP fell by 5.1%). The economy suffered a high foreign debt, lacked foreign exchange reserves and the government had to ask the International Monetary Fund for an emergency loan. The crisis resulted in the bankruptcy of a number of companies (including some chaebõls such as Daewoo), as the banks refused to finance them. The government therefore carried out a number of reforms of the financial and labour market, and the public sector.[21] The measures were effective and by 1999 Korea recorded an 11.5% growth of GDP.

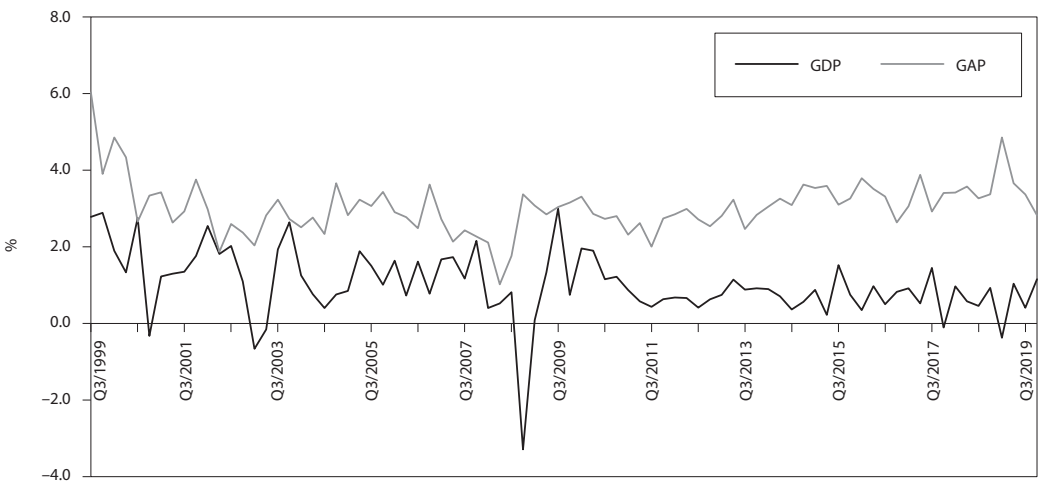
The Korean economy has been recording a high and relatively stable GDP growth rate (an annual average of 4.4%); the price trend has also been similarly stable (the average annual inflation rate is 2.3%) as has unemployment (the annual unemployment rate ranges between 3.1–4.4%).

If we look at the quarterly data in the period of 1999–2019, it is apparent (see Figure 5) that the low signal gap value at the end of 1999 ushered in a fall of GDP in the last quarter of 2000 (by 0.3%); the same was the case in 2002, when the low signal gap value warned of a possible economic slump which came in the first and second quarter of 2003 as a reaction to the recession in the US. This period is characterised in Korea, among other, by the rapid growth of household consumption and associated debt levels.

The period of 2004–07 marks a stage of prosperity in Korea with a GDP growth rate exceeding 4% per annum. Recovery came as a consequence of the growing success of exports (particularly electrical engineering) and was also supported by the economic growth of China as the traditional economic partner. The years of the economic boom is seen in the extent of the signal gap (see Figure 5).

The year 2008 brought a fresh warning for the Korean economy that without reforms to the business environment, a prosperous economy cannot be sustained. Therefore the government proceeded with fiscal and tax changes, support for small and medium enterprises, for low-income households and for building the infrastructure. At the end of 2009 the crisis had already been overcome.[22] Decreasing signal gap values in 1997 (see Figure 5) again provide a very good indication of an approaching crisis.

Figure 5 Trend of the GDP growth rate and signal gaps – Korea 1999–2019



Source: <*http://kostat.go.kr*>

[21] See Khayyat (2015), Chang and Lee (2006).
[22] See OECD (2018).

A fall in quarterly GDP reappeared in the first quarter of 2019 as a consequence of lower export performance, which was reflected in a slowdown of the global economy,[23] growing protectionist tendencies and falling export prices. In addition, the low GDP growth rate was accompanied by a fall in prices (deflation in the first and third quarter of 2019).

A significant correlation with a time delay of four units was again confirmed (a significant CCF value) even in the case of Korea. The trend of the series in a given period is shown in Figure 5.

After a thorough analysis also in the case of Korea, we opted form the ARIMA model (0, 1, 1) with one regressor in the form of:

$$Y_t = 0.221X_{t-4} + (1-0.948B)\varepsilon_t \,. \tag{7}$$

It is interesting that the same model was used for all the countries, albeit with different parameter values. Of course, this does not have to be the general rule.

The analysis of the data for the Korean national economy also demonstrated that the hypothesis concerning the prediction potential of the signal gap is valid and a delayed recession is coming with decreasing signal gap values (values approaching 2 p. p.).

CONCLUSIONS

Economic development in each country is the outcome of the effect of a series of economic factors. Among the most significant short-term indicators informing about the progress of the stages of the economic cycle of the national economy is indisputably the unemployment and inflation rate. The difference in the values of these indicators, here called the signal gap, has a tendency to fall (a tendency to approach zero respectively) in the stage of the economic cycle peak, when the economy has exhausted its further growth resources and is followed by a slowdown in economic development, i.e. a transition to the stage of recession (or crisis). The article on the quarterly data of the Czech Republic, France, Great Britain and the Republic of Korea for the period from the 1990s to 2019, i.e. for the period when each of the analysed countries went through, among other, a global financial and economic crisis in years 2008–09 and a subsequent recession, demonstrates that such a hypothesis applies. The model then makes it possible to determine with what delay recession arrives with decreasing signal gap values (values approaching zero respectively).

The analyses based on the CCF and regressive dynamic models showed in all the analysed countries that recession comes in four quarters after the lowest signal gap value. Therefore a significant linear dependence in time points t a t – 4 exists between the GDP and GAP time series. This means that the GDP time series "precedes" the GAP series by 4 time units. We successful described this dependence using an appropriate linear dynamic model, specifically the so-called transfer function model. We analysed the data of the four selected countries and in all cases the most appropriate turned out to be the ARIMA model (0, 1, 1) with one regressor. This regressor was the GAP series with a time delay of four time units (four quarters). This means that if we know the GAP series value in time point t, we can use it in the stated models and obtain a very good estimate of the GDP quarterly values for the next year. If we carry out this procedure for each of the four quarters of the last known year, we obtain a solid prediction of the possible trend (including any qualitative changes) for the next year.

The analysis of the inflation and unemployment rates data used and the verification of the hypothesis of their convergence as a signal of change in the stage of the economic cycle therefore show a certain potential of how to use the signal gap as an indicator of the turning point in economic development. This at least in a situation of gradual cyclical economic development – both used rates and their

[23] See, among other, the situation in other countries analysed here.

convergence are the outcome of the changing economic potential in a standard economic cycle. The results of the analysis can therefore be used in short-term forecasts of economic development and in analyses of the economic cycle. It turns out that the indicators of the inflation rate and the unemployment rate must continue to be considered not only as separate and important indicators of the state of the economy, but it is also necessary to evaluate the development of the difference in their values over time. We thus obtain considerable information about the phase of the economic cycle.

Nevertheless, the article was written during the period of the aggressive onset of the coronavirus crisis which is currently a dominant process of intervention of the highest intensity and its impact on the economy cannot, at present, be accurately described in a model. At this time it is not even known, from a medical and economic point of view, what the further development and intensity of the impact of this viral pathogen will be. Neither are the outlines of the individual stages of the cycle known and how they will build up after the coronavirus pandemic. Despite this – or perhaps because of this – it would be expedient, once the crisis subsides, to also apply the above analysis to the new data from the post-pandemic period. It is evident that to analyse indicators entering the signal gap and later analyse the gap alone may turn out to be a useful tool for detecting changes in the economic cycle even after the stage of the unusually strong intervention of a pandemic.

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