

A SIMPLE MODEL FOR CALCULATION OF A NATURAL RATE OF UNEMPLOYMENT

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Abstract

The natural rate of unemployment belongs to the most important concepts of microeconomics, however, in contrast to other indicators it is very difficult to be determined. To set the rate a mathematic model based on the Macroeconomic Forecast of the Ministry of Finance of the Czech Republic and the empirical relationship called Okun's law can be created. The essential prerequisite for that is to eliminate differences resulting from different utilization of production capacities and changing rate of economic activity of the population in the course of time.

The proposed model is not very complicated, it works with several simplified assumptions, but its advantage is the possibility for continual involvement of more and more complicated parameters of the real economy. Nevertheless, even in its basic form the model provides good results, which are in compliance with theoretical starting points and observed facts.

Key words: natural rate of unemployment, potential product, Okun's Law, labour market

JEL Code: C29, E32, J64

Introduction

A natural rate of unemployment introduced into economic theory by Milton Friedman (Friedman, 1968) is one of the key concepts of mainstream economics. It is defined as an equilibrium in the aggregate labour market and, from the view of determination of unemployment, it is a total of frictional and structural unemployment (Mankiw, p. 158).

From the view of the definition, the natural rate of unemployment does not represent any problem, but its quantitative determination is much more difficult. The above mentioned equilibrium in the labour market, i.e. equilibrium of a supplied and demanded amount corresponds with hypothetical perfectly competitive conditions, which means with such a labour market, in which there is elastic adjustment of labour costs, in other words of a wage rate to mutual ratio between supply and demand. However, there are many reasons, why there

is no perfect competition in the labour market. For the same reasons there are no elastic changes in wage rates either. Hence from this point of view, determination of a natural rate of unemployment is only determination of a hardly predictable level.

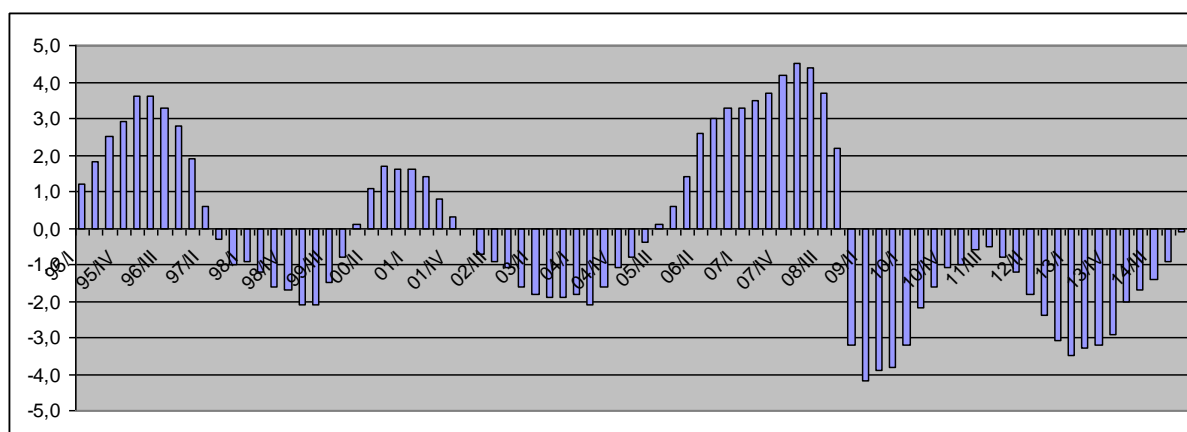
There is one more tool, with which the natural rate of unemployment can be determined quite precisely. It is the so-called potential product.

A potential product is determined (Okun, 1962) as output of economy (i.e. a real product), produced during so-called full employment, which corresponds with until then the not yet defined natural rate of unemployment. Said like this, it might seem as a tautology or proof in a circle, however, luckily, the reality is different. The size of a real product can be absolutely reliably determined by statistical methods. A qualified estimate of a product gap, or difference between a real product and a potential one can be made. The Ministry of Finance of the Czech Republic issues a regular quarterly called Macroeconomic Forecast. It summarizes the current state of development of basic macroeconomic indicators in the Czech Republic containing a qualified estimate of development in the field of economic performance (including the product gap in individual quarters), prices and situation in the Czech labour market. This enables us to carry out independent analyses, since in the situation, when we know the volume of the real product and the size of the product gap, then using suitable tools e.g. Okun's law, even a potential product, or respectively the level of the natural rate of unemployment corresponding to the potential product can be determined.

1 Methodology

Figure 1 together with the attached table shows values of a product gap in the Czech Republic in individual quarters in 1995-2015. Cyclical development of Czech economy is absolutely obvious from this figure.

Fig. 1: Product gap in the Czech Republic in 1995-2015 (in % of potential product, by quarters)



Source: <http://www.mfcr.cz/cs/public-sector/macro-economics/macro-economic-forecast/2015/macro-economic-forecast-July-2015-22137> (adjusted by the authors)

Tab. 1: Product gap in the Czech Republic in 1995-2015 (in % of potential product, by quarters)

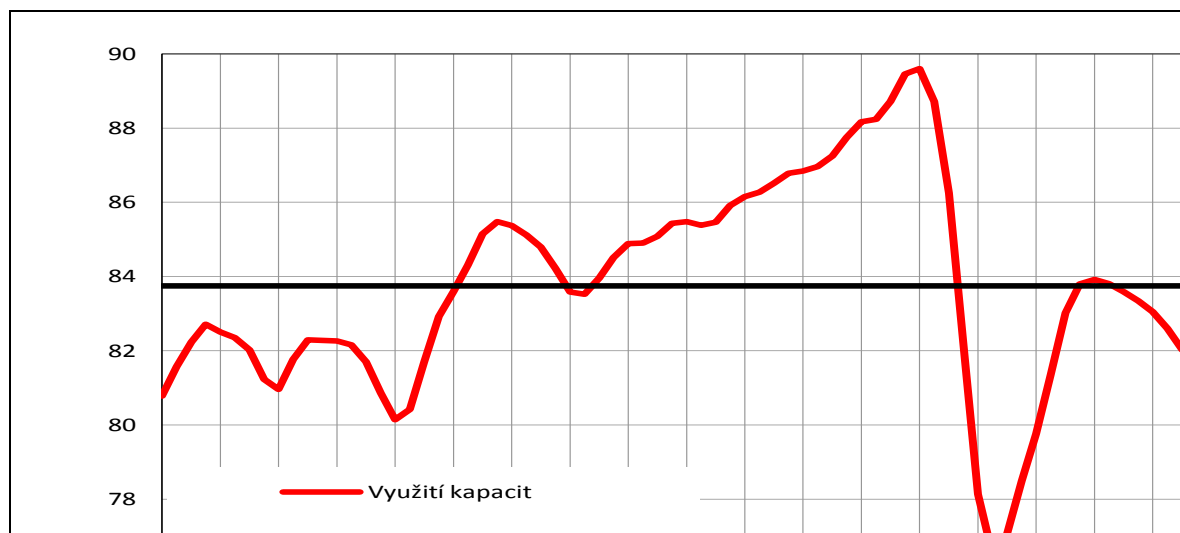
quarter	95/I	95/II	95/III	95/IV	96/I	96/II	96/III	96/IV	97/I	97/II	97/III
Prod. gap	1.2	1.8	2.5	2.9	3.6	3.6	3.3	2.8	1.9	0.6	-0.3
quarter	97/IV	98/I	98/II	98/III	98/IV	99/I	99/II	99/III	99/IV	00/I	00/II
Prod. gap	-1.0	-0.9	-1.2	-1.6	-1.7	-2.1	-2.1	-1.5	-0.8	0.1	1.1
quarter	00/III	00/IV	01/I	01/II	01/III	01/IV	02/I	02/II	02/III	02/IV	03/I
Prod. gap	1.7	1.6	1.6	1.4	0.8	0.3	0.0	-0.7	-0.9	-1.1	-1.6
quarter	03/II	03/III	03/IV	04/I	04/II	04/III	04/IV	05/I	05/II	05/III	05/IV
Prod. gap	-1.8	-1.9	-1.9	-1.8	-2.1	-1.6	-1.1	-0.8	-0.4	0.1	0.6
quarter	06/I	06/II	06/III	06/IV	07/I	07/II	07/III	07/IV	08/I	08/II	08/III
Prod. gap	1.4	2.6	3.0	3.3	3.3	3.5	3.7	4.2	4.5	4.4	3.7
quarter	08/IV	09/I	09/II	09/III	09/IV	10/I	10/II	10/III	10/IV	11/I	11/II
Prod. gap	2.2	-3.2	-4.2	-3.9	-3.8	-3.2	-2.2	-1.6	-1.1	-1.0	-0.6
quarter	11/III	11/IV	12/I	12/II	12/III	12/IV	13/I	13/II	13/III	13/IV	14/I
Prod. gap	-0.5	-0.8	-1.2	-1.8	-2.4	-3.1	-3.5	-3.3	-3.2	-2.9	-2.0
quarter	14/II	14/III	14/IV	15/I							
Prod. gap	-1.7	-1.4	-0.9	-0.1							

Source: http://www.mfcr.cz/assets/cs/media/Macro-economic-Forecast_2015-Q3_Tables-and-graphs.xlsx

Theoretically, now it would be enough to determine the moments when the product gap equals zero (and the real product complies with the potential one) and then to deduct the rate of unemployment at these moments e.g. on the web pages of Czech Statistical Office. However, the reality is much more difficult, as there are two following key factors involved:

- Besides labour, capital is also involved in the product production and as can be seen from figure 2, the rate of its utilization differed in individual quarters, sometimes very significantly. The product gap would have to be adjusted to these fluctuations, so that the final figure would reflect exclusively the influence of labour factor.

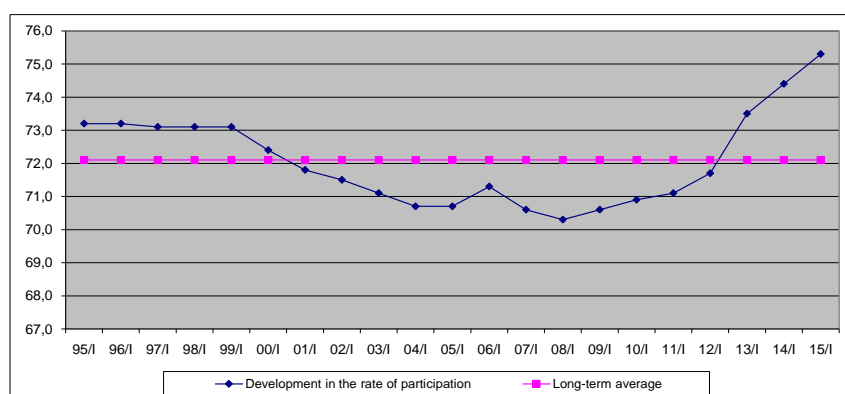
Fig.2: Utilization of production capacities in the industry in the Czech Rep. in 1995-2015



Source: http://www.mfcr.cz/assets/cs/media/Macroeconomic-forecast_2015-Q3_Tables-and-graphs-grafy.xlsx

- The indicator “rate of unemployment” captures utilization of the factor of production “labour” only partially. Besides this, the indicator “rate of participation”, or in other words, a rate of economic activity of population must also be considered. In the period investigated, 1995-2015, this rate was changing by up to 5 percentage points (see fig.3). It was also necessary to eliminate fluctuations in the rate of participation, in other words, the data found had to be converted into the rate of participation unified for the whole period 1995-2015.

Fig.3: Rate of participation in the Czech Republic in 1995-2015



Source: http://www.mfcr.cz/assets/cs/media/Macroeconomic-forecast_2015-Q3_Tables-and-graphs.xlsx (adjustments by the authors)

From the above mentioned we can create a simple mathematical model combining all considered factors, such as the size of the product gap, how it is influenced by unequal

utilization of the capital and also the influence of a changing rate of economic activity of population. The following assumptions were considered for creation of the adequate model:

- a) Constant yields from economies of scale were applied for GDP creation while marginal productivity of labour and marginal productivity of capital were equal.
- b) For the monitored period 1995-2015 utilization of capital was considered to be at a single level of 83.8% of installed capacities, i.e. at the level shown in fig.2 as average utilization of the capital for the whole period. The differences in real utilization of capital compared to the average value were in compliance with the assumption a) compensated by coefficient X , which is determined as an adverse value of the ratio of a real and average value of utilization of capital in the given quarter.
- c) In the monitored period 1995-2015 the rate of participation was considered at a single average level of 72.1% and differences in the real rate of participation compared to the average level were in compliance with the assumption a) compensated by coefficient Z , which is determined as an adverse value of the ratio of real and average value of the rate of participation in the given quarter.

The final mathematical formula, with which a quarterly product gap adjusted to a variable utilization of capital and the different rate of economic activity of population can be determined, is as follows:

$$CPG = PG \cdot X \cdot Z \quad (1)$$

where CPG is a compensated product gap, or the product gap adjusted to the influence of variable utilization of the capital and the changing rate of participation; PG is a real product gap stated in macroeconomic prediction and also in fig.1; X is the coefficient compensating variable utilization of capital to the medium value of 83.8% and Z is the coefficient compensating the rate of participation changing in time to the medium value of 72.1%.

After getting the values of the compensated product gap, openly published data on the rate of unemployment can be used for the values gained in this way and subsequently Okun's law can be used to calculate the natural rate of unemployment. Okun's law can be mathematically expressed in various ways; let's start e.g. with the statement (Helísek, 2000):

$$Y/Y^* = 1 + c(u^* - u) \quad (2)$$

where the Y stands for a real product, the Y^* stands for a potential product, the c is an empirically found coefficient of linear dependence (fluctuates usually in interval 0.02 - 0.03; its bottom border, or 0.02 is considered for further calculations), the u^* stands for a natural

rate of unemployment and the u for the real rate of unemployment. By simple adjustment of equation (2) we will get the formula:

$$(Y/Y^*) - 1 = 0,02 (u^* - u)$$

where $(Y/Y^*) - 1$ stands for the product gap expressed as a decimal figures, more accurately the compensated product gap (CPG) calculated with the help of equation (1). After subsequent multiplying of CPG by 100 we will get the CPG in percents as it is commonly stated. As the rate of unemployment is also commonly stated in percents, the investigated natural rate of unemployment can be calculated with the formula:

$$u^* = 0,5 CPG + u \quad (3)$$

2 Results of the analysis

Using the data from macroeconomic predictions and the data from the Czech Statistical Office and equations (1), (2) and (3), the following results (see tab. 2) regarding the level of the natural rate of unemployment in the Czech Republic can be arrived at:

Tab. 2: Product gap and real and natural rate of unemployment in the Czech Republic in 1995-2015.

Q	95/I	95/II	95/III	95/IV	96/I	96/II	96/III	96/IV	97/I	97/II	97/III
u	4.3	4.0	4.1	3.7	3.7	3.8	4.0	4.1	4.3	4.5	5.0
u*	4.92	4.92	5.35	5.14	5.50	5.61	5.61	5.52	5.27	4.81	4.85
Q	97/IV	98/I	98/II	98/III	98/IV	99/I	99/II	99/III	99/IV	00/I	00/II
u	5.4	5.9	5.9	6.8	7.3	8.4	8.4	9.0	9.0	9.5	8.7
u*	4.90	5.45	5.30	5.99	6.43	7.31	7.32	8.24	8.60	9.55	9.24
Q	00/III	00/IV	01/I	01/II	01/III	01/IV	02/I	02/II	02/III	02/IV	03/I
u	8.6	8.3	8.5	8.0	8.3	7.8	7.7	7.0	7.2	7.3	7.6
u*	9.44	9.08	9.29	8.69	8.70	7.95	7.71	6.64	6.74	6.75	6.80
Q	03/II	03/III	03/IV	04/I	04/II	04/III	04/IV	05/I	05/II	05/III	05/IV
u	7.5	8.0	8.1	8.7	8.2	8.2	8.2	8.4	7.8	7.8	7.8
u*	6.60	7.05	7.16	7.80	7.15	7.41	7.66	8.01	7.60	7.85	8.09
Q	06/I	06/II	06/III	06/IV	07/I	07/II	07/III	07/IV	08/I	08/II	08/III
u	8.0	7.1	7.0	6.5	6.0	5.3	5.1	4.8	4.7	4.2	4.3
u*	8.68	8.37	8.46	8.09	7.60	6.99	6.88	6.80	6.86	6.33	6.13
Q	08/IV	09/I	09/II	09/III	09/IV	10/I	10/II	10/III	10/IV	11/I	11/II
u	4.4	5.8	6.3	7.3	7.3	8.1	7.1	7.1	6.9	7.2	6.7
u*	5.54	4.04	3.97	5.17	5.26	6.39	5.95	6.29	6.34	6.69	6.40
Q	11/III	11/IV	12/I	12/II	12/III	12/IV	13/I	13/II	13/III	13/IV	14/I
u	6.5	6.4	7.1	6.7	7.0	7.2	7.4	6.7	6.9	6.7	6.8
u*	6.25	6.00	6.49	5.79	5.79	5.69	5,64	5.06	5.32	5.28	5.82
Q	14/II	14/III	14/IV	15/I							
u	6.0	5.9	5.7	6.0							
u*	5.17	5.23	5.28	5.95							

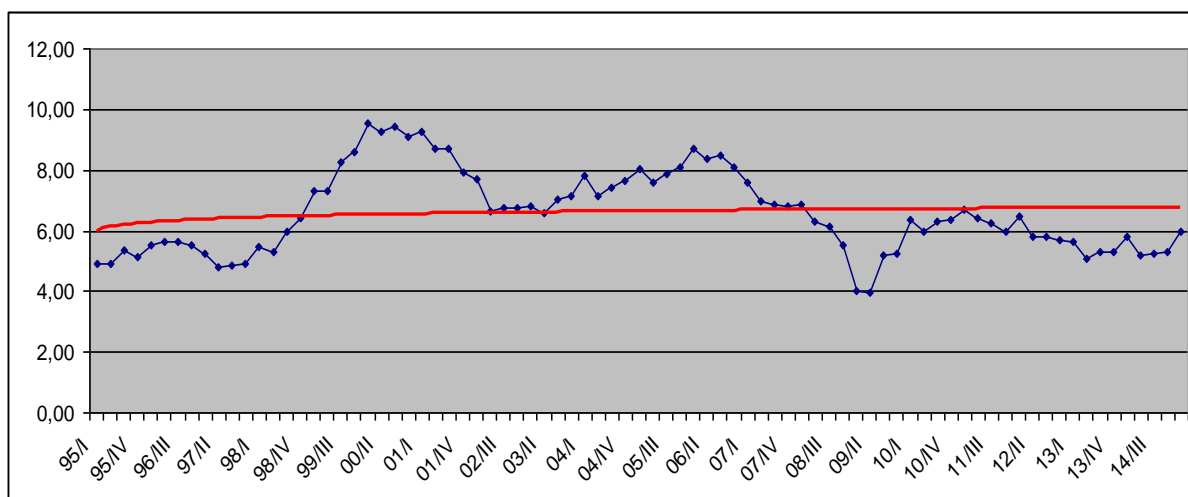
Source: Authors' own calculations according to <http://www.mfcr.cz/cs/public-sector/macroeconomics/macroeconomic-forecast>

It is obvious that the calculated values of the natural rate of unemployment show relatively significant fluctuations. This is in apparent discrepancy with the idea of the natural rate of unemployment showing a persistently stable level, changing only in a very long-term perspective as a consequence of hystereses in the labour market (Tobin, 1980), so-called "maintenance relations" (Minford 1985) or a so-called "reporting effects" (Dornbush-Fischer, 1994). However, the Czech economy in its transformation period in the 1990s was not a standard market economy, from which the mentioned economists derive their conclusions. In the 1990s, industrial structure of the economy in the Czech Republic was experiencing major structural changes (decline in the heavy industry, later liquidation of big enterprises such as CKD, Poldi etc.) and the situation in the labour market naturally reflected that. As structural unemployment is an integral part of the natural rate of unemployment, this easily explains its steep increase in the 2nd half of the 1990s, when traditional jobs in the heavy industry disappeared first, being replaced by new job opportunities mainly in tertiary sector. This gave rise to structural unemployment which started to decline significantly only about two years later, when requalification of at least a part of labour force was completed.

Further it is necessary to keep in mind that there is certain inertia in mutual interactions of macroeconomic indicators and thus the situation in the labour market does not reflect the development of GDP in the real time, but only with a significant delay, usually of several months. For example at the beginning of recession, when GDP is falling, the rate of unemployment remains apparently indifferent; this phenomenon is caused by existing labour legislation, which does not allow laying off redundant workers immediately, but only after expiry of the notice period. On the contrary, during economic recovery companies first increase their output by more efficient use of production capacities with unchanged labour force and only after an interval given by recruitment procedures, they start to hire new workers. Therefore empirical dependence of the product gap and the rate of unemployment according to Okun's law does not correlate immediately and leads to apparent disproportions.

All these are the reasons why it is necessary to consider as the main indicator not so much the connecting curve in fig.4 but rather the trend line resulting from it, which in the long-term, 20 years' time horizon shows a stable level of about 6.1 - 6.8%.

Fig.4: Development of the natural rate of unemployment in the Czech Republic in 1995-2015



Source: Authors' own calculations

A very slow growth in the natural rate of unemployment in the Czech Republic (in 20 years by approx. 0.7 percentage points) is in excellent harmony with a generally accepted tendency to its growth, especially thanks to the generous social policy of the state leading to voluntary unemployment which represents a substantial portion of frictional unemployment. Abuse of this social policy, when formal registration at the labour office and getting unemployment benefits is accompanied with so-called illicit work (Schwarzarbeit) leads to the same result, too.

Conclusion

A simple mathematical model for calculation of the natural rate of unemployment applied in this paper leads to the results which, it is true, represent only approximation of real values of the natural rate of unemployment, but which, as was shown in fig. 4, nevertheless reflect theoretical assumptions about the growth in the natural rate of unemployment in long-term time horizon. Obviously, it would be possible to create a more sophisticated model leading to more accurate results, particularly from the view of assumption a) in chapter 1-Methodology; in other words, to take into account the real development of yields from economies of scale in the production (or in individual industries, as these obviously differ from each other in the shape of their production function), the real course of the curve of growing output in the given industries (particularly regarding to whether the relevant production is labour or capital demanding) and in the extreme case also the development of marginal productivity of individual factors of production. Nevertheless, on the basis of the gained values of the natural rate of unemployment, it can be stated, that the model has proved

worth and the results gained by this model have their informative value and are sufficiently valid.

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