DEPENDENCY BETWEEN GROSS DOMESTIC PRODUCT AND UNEMPLOYMENT IN THE CZECH REPUBLIC

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ABSTRACT

Unemployment is one of very important and closely monitored macroeconomic indicators. Unemployment rate gives indication what proportion of workforce is currently without job. In many cases prediction of unemployment would help to plan fiscal policy, programs of active employment policy and other tools of social politics. Importance of reliable prediction was proved during crisis period. Such that, modelling of labour market – employment and unemployment – may have benefits for many institutions. In the paper, there were analyzed various macroeconomic indicators in the correlation analysis, including delayed variables. Such the correlation analysis may help to build macroeconomic model using main macroeconomic variables, for example GDP, household consumption, government consumption, investments, inflation, wages, rate of employment and participation rate. It is widely accepted that GDP is one of the strongest predictor for forecasting of unemployment trend but with some delay because labour market reacts later according to legislative framework in the country. Relation between GDP and unemployment rate for the case of the Czech Republic is introduced considering time delay. Importance of GDP and GDP growth rate was not approved statistically based on real data analysis but the direction of relation was confirmed. Moreover, the regression model is proposed and estimated with the variable number of unemployed individuals as dependent variable. Forecasts and applications with two scenarios based on the regression model capture real trend of reported number of unemployed people, i.e. decreasing number of unemployed in the year 2011.

JEL CLASSIFICATION & KEYWORDS

■ J24 ■ J64 ■ C20 ■ GDP ■ UNEMPLOYMENT ■ DEPENDENCY ■ CZECH REPUBLIC

INTRODUCTION

Unemployment is very important macroeconomic indicator that indicates how many people or what proportion of workforce has no job. It also helps politicians and economists manage efficiency of economy and businesses and maintain social and political stability.

Unemployment rate as one of typical indicators of labour market gives indication what proportion of workforce is currently without job but job actively seeks. Condition of activity, i.e. involuntariness of the situation of unemployed individual and his/her active approach is necessary to be classified as 'unemployed'. Another condition is the availability, i.e. ability to start a new job immediately.

Employment rate is the complement to the unemployment rate, is shows what proportion of workforce works.

Participation rate is another indicator of labour market that represents what proportion of people in the age of 15 years or more are economically active, which means either employed or unemployed.

Continuing economical crisis started at the end of the year 2008 and proved close relation between performance of economy measured for example by gross domestic product (GDP) and GDP growth rate and labour market. Unemployment in the Czech Republic, as well as in other developed countries, increased with some delay after the decline of financial indicators and restrictions on financial markets. Financial crisis became evident on labour markets.

Statistical dependency among selected macroeconomic indicators in the Czech Republic including delayed versions of some indicators is analyzed in the paper. It is expected that labour market depends on performance of economy and its changes and labour market's reaction is delayed by one or two quarters. Further, proposed and estimated regression model is used to forecast trend in unemployment in the Czech Republic for short period of time. Forecasting of unemployment would help in many cases to institutions in planning fiscal policy and active employment programs. Regression model introduced in the second part of the article shows quality of forecasted values versus real values.

Data

Data for analysis come from the Czech Statistical Office (CZSO): GDP, consumption and investments in constant prices & seasonally adjusted, employment and unemployment from quarterly organized Labour Force Sample Survey (LFSS) conducted by the Czech Statistical Office, inflation rate as an increase in average annual consumption price index (CPI) indicating percentage change in last 12-months average over preceding 12-months average, wages as average monthly gross wage. Results from the survey (LFSS) differ in comparison with statistics published monthly by the Ministry of Labour and Social Affairs, which summarizes data from local labour bureaus. Both data sources of unemployment are used in the Czech Republic and two unemployment rates (general unemployment rate from the survey, registered unemployment rate from labour bureaus) are calculated.

Calculation introduced in the article are based on both

- annual data (1996–2010, 15 observations),
- quarterly distributed data (Q1/1996–Q1/2011, 61 observations).

Level of dependency is measured by Pearson's correlation coefficient. This coefficient measures linear type of relation between two variables. Statistical tests (test for statistical significance of correlation coefficient, t-tests, F-test) are calculated on significance level $\alpha = 0.05$.

Trend of GDP, consumption, investment, employment and unemployment in the Czech Republic

Macroeconomic indicators GDP, consumption and investments are measured and calculated by quarters and show seasonal oscillations, therefore seasonally adjusted time series were used in the analysis.

Gross domestic product and its parts

GDP in constant prices shows clear slowdown since 2008, which is exactly the period when economic crisis was detected. Final consumption consists of household consumption and consumption of government. Its growth decelerates since second half of the year 2008 as well. Investments in constant prices even decreased from 247 bn CZK in Q4/2008 to 182 bn CZK in Q4/2009. GDP was formed by final household consumption (49%), government consumption (22%), investments (22%) and net export (7%) in Q1/2011.

Wages and inflation

Wages are represented by nominal value which shows seasonal fluctuations. Growing trend continues till the first half of the year 2011 but with larger oscillations in last two years.

Inflation is measured as an increase in average annual consumption price index in the version that indicates percentage change in last 12-months average over preceding 12-months average. The highest value was reported in Q4/2008 (6.47 %) and so far lowest in Q2/2010 (0.60 %).

Labour market

Number of unemployed people according to LFSS reached its minimal value in Q1/1996

193 thousand people) and maximal value in Q1/2000 (494 thousand people). Number of unemployed people increased after favourable period of economic growth lasting till the middle of 2008. The increased in visible since the beginning of the year 2009 (i.e. with some delay compared to GDP) with local maximum in Q1/2010 (423 thousand of unemployed people). Impact of economic crisis is very well recognizable in the period of 2009-2010 and according to last trends in economy this economically unfavourable situation continues.

Absolute number of employed people was increasing from the middle of the year 2004 till the end of the year 2008. Since then number of employed people was decreasing during 2009 and then stabilized at the level of 4,900 thousand people.

Figure 1: Trend of GDP, Consumption, Investments, Wages and Unemployment (Q1/1996–Q1/2011, Czech Republic)
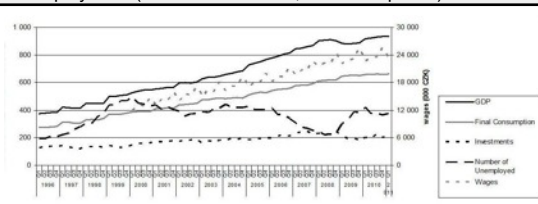
Source: Czech Statistical Office

Statistical analysis

First, the correlation analysis of annually districted data is presented, following by the correlation analysis of quarterly distributed data.

For the correlation analysis, only main macroeconomic indicators were selected – unemployment rate, employment rate, participation rate, GDP growth rate, inflation rate and investments growth rate:

- GDP growth rate year over year (y/y) or quarter over quarter (q/q), which is very important characteristics of economy performance, and GDP growth rates delayed by 1, 2 and 3 years or quarters, denoted by (y-1 or q-1), (y-2 or q-2) and (y-3 or q-3),

- investments growth rate year over year (y/y) or quarter over quarter (q/q) and growth rate delayed by 1, 2 and 3 years or quarters, denoted by (y-1 or q-1), (y-2 or q-2) and (y-3 or q-3).

Growth rates characterize change of selected indicators instead of the level, which is more appropriate in order to evaluate dependency with number of employed or unemployed people or employment of unemployment rates.

Correlation coefficients presented in following tables and denoted by * are statistically significant on the significance level $\alpha = 0.05$.

Correlation analysis of annual data

Table 1: Pearson's correlation coefficient of annually distributed data (1996-2010)			
	Unemployment rate	Employment rate	Participation rate
GDP seasonally adjusted – growth rate y/y	0,123	-0,222	-0,203
GDP seasonally adjusted – growth rate y/y (y–1)	-0,421	0,118	-0,256
GDP seasonally adjusted – growth rate y/y (y–2)	-0.893*	0,215	-0.643*
GDP seasonally adjusted – growth rate y/y (y–3)	-0.630*	0,024	-0.665*
Inflation rate	-0,600*	0,841*	0,624*
Investments seasonally adjusted – growth rate y/y	0,298	-0,144	0,11
Investments seasonally adjusted – growth rate y/y (y-1)	-0,206	0,314	0,108
Investments seasonally adjusted – growth rate y/y (y-2)	-0,321	0,164	-0,226
Investments seasonally adjusted – growth rate y/y (y-3)	0,008	-0,497	-0,454
Source: own calculation			

Annual view revealed statistically significant linear relation between unemployment rate and GDP growth rate delayed by 2 years and 3 years (with negative relation) and unemployment rate and inflation rate.

Employment rate is statistically significantly correlated with inflation rate (in positive way).

Participation rate is correlated with GDP growth rate delayed by 2 and 3 years and with inflation.

Investments are not correlated with selected characteristics of labour market.

It was confirmed that higher GDP growth rate determines lower unemployment rate after 2 and 3 years (negative correlation coefficient) and surprisingly also lower participation rate after 2 and 3 years. For participation rate, it was not expected negative result because economic boom and investment should motivate people to work and should

attract more people to join economically active part of population. Easy explanation would be that society is rich and people do not need to work so intensively. This indicator is probably determined by other influences as well, including demographic characteristics of population.

Higher inflation rate means lower unemployment and higher employment and participation rate. This is caused by overall performance of economy – expanding or booming economy 'warms up', inflation grows and, simultaneously, labour demand increases.

In case of investments growth rate, it was expected that more investments means lower unemployment rate next year or year after that.

Correlation of quarterly distributed data

Table 2: Pearson's correlation coefficient of quarterly distributed data (Q1/1996-Q1/2011)

	Unemployment rate seasonally adjusted	Employment rate seasonally adjusted	Participation rate seasonally adjusted
GDP seasonally adjusted – growth rate q/q	0,076	0,083	0,193
GDP seasonally adjusted – growth rate q/q (q–1)	0,048	0,092	0,173
GDP seasonally adjusted – growth rate q/q (q–2)	0,025	0,101	0,157
GDP seasonally adjusted – growth rate q/q (q–3)	0,021	0,122	0,174
Inflation rate	-0,431*	0,639*	0,048
Investments seasonally adjusted – growth rate q/q	0,107	-0,038	0,053
Investments seasonally adjusted – growth rate q/q (q-1)	0,058	-0,005	0,051
Investments seasonally adjusted – growth rate q/q (q-2)	0,013	-0,004	0,008
Investments seasonally adjusted – growth rate q/q (q-3)	-0,009	0,06	0,067
Source: own calculation			

Quarterly distributed data confirmed statistically significant correlation between inflation rate and rate of unemployment and employment only. No statistically significant relation was confirmed among GDP growth rates and labour market characteristics or investments growth rates and labour market characteristics; these relations are very weak.

In this case, it was expected that some of dependencies prove to be statistically significant and, specifically, that delay by one or two quarters prove to be most powerful.

In the following table, data for shorter period of time are used.

Using shorter period of time, it can be seen that unemployment rate is statistically significantly correlated with GDP growth rate delayed by 3 quarters and with inflation rate.

Table 3: Pearson's correlation coefficient of quarterly distributed data (Q1/2007-Q1/2011)

	Unemployment rate seasonally adjusted	Employment rate seasonally adjusted	Participation rate seasonally adjusted
GDP seasonally adjusted – growth rate q/q	0,017	0,029	0,22
GDP seasonally adjusted – growth rate q/q (q–1)	-0,21	0,191	-0,063
GDP seasonally adjusted – growth rate q/q (q–2)	-0,423	0,379	-0,155
GDP seasonally adjusted – growth rate q/q (q–3)	-0.552*	0.501*	-0,167
Inflation rate	-0,765*	0,717*	-0,115
Investments seasonally adjusted – growth rate q/q	0,02	-0,06	-0,197
Investments seasonally adjusted – growth rate q/q (q-1)	-0,072	0,065	-0,027
Investments seasonally adjusted – growth rate q/q (q-2)	-0,062	0,06	-0,006
Investments seasonally adjusted – growth rate q/q (q-3)	-0,205	0,246	0,231
Source: own calculation			

Employment rate is statistically significantly correlated also with GDP growth rate delayed by 3 quarters but with positive correlation, and with inflation rate. This means that increasing GDP growth rate causes with delay of 3 quarters decreasing unemployment rate and increasing employment rate, i.e. higher proportion of workforce works compared to those who seek job.

Statistical significance between investments growth rates and employment or unemployment rates was not approved.

Regression model

Using regression for analysis of GDP is always very problematic. Here is an example of quite simple linear regression model and its ability to forecast unemployment. Proposed model:

$$y_t = \beta_1 x_{1t} + \beta_2 x_{2t} + \beta_3 x_{3t} + \beta_4 x_{4t} + u_t, \qquad (1)$$

where

y	number of unemployed individuals [000]	Source: CZSO, LFSS
$x1$	unit vector	
$x2$	inflation rate [%]	Source. CZSO
$x3$	average gross monthly wage - full time equivalent [000 CZK]	Source. CZSO
$x4$	GDP growth rate (q/q) based on constant prices, seasonally adj. [%]	Source: CZSO

This model was estimated using OLS method based on quarterly distributed data 2004–2010:

$$y_t = 657{,}22 - 27{,}256\, x_{2t} - 11{,}471\, x_{3t} + 4{,}604\, x_{4t}\ .\quad (2)$$

Economic interpretation is obvious: if inflation (i.e. variable x2) grows by 1 percentage point, number of unemployed people decreases by 27,256 individuals. Assumption made for effect of inflation (negative correlation) is confirmed. If average monthly wage (i.e. variable x3) increases by 1 thousand CZK, number of unemployed people decreases by 11,471 individuals, which also meets the assumption regarding relation between unemployment and wage (negative correlation). If GDP growth rate (variable x4) increases by 1 percentage point, number of unemployed people increases by 4,604 individuals. Expectation would be that higher GDP growth rate influences decrease of unemployment, which was not confirmed.

Statistical verification shows that constant, inflation rate and wages are statistically significant, whereas GDP growth rate is not.

Table 4: t-tests in regression model

| Coefficient	Variable	Estimate	Standard error	T-value	Critical value
beta1	x1	657,216	85,761	7,663	
beta2	x2	-27,256	4,969	5,485	2,064
beta3	x3	-11,471	3,825	2,999	
beta4	x4	4,604	6,325	0,728	
Source: own calculation					

Coefficient of determination is R^2 = 68.98 %.

Result of Durbin-Watson test for autocorrelation of residuals DW = 0.606 suggests that some delayed variable(s) (by 1 quarter) should be included into the model.

MSE = 1,512.9.

Quality of estimated model could be assessed also by comparison of real observation and estimates:

Figure 2: Comparison of real observations and estimated value of unemployed people (Q1/2004–Q4/2010, Czech Republic)
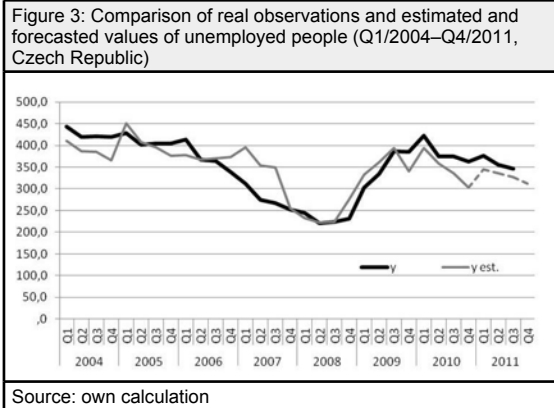

Source: own calculation
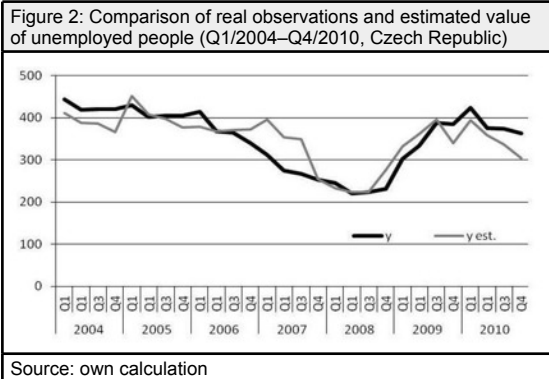
Forecast

Prediction calculated from the estimated regression model shows that number of unemployed individuals should firstly increase in Q1/2010 and later decrease in the rest of the year 2011. Real value from Q1/2011 is 376 thousand

Table 5: Number of unemployed people (in thousands), forecast for the year 2011

Quarter / year	Real observation	Forecast	Difference
Q1/2011	376,2	344,1	32,1
Q2/2011	354,6	336,1	18,5
Q3/2011	346	327,2	18,8
Q4/2011		311,3	
Source: own calculation			

unemployed people compared with forecasted value 344 thousand; for the second quarter 2011: 355 thousand unemployed people compared with forecast 336 thousand; for the third quarter 2011: 346 thousand unemployed people compared with forecasted value of 327 thousand.

Thus, decreasing trend forecasted based on estimated model corresponds with real trend, when number of unemployed individuals according to the Labour Force Sample Survey was decreasing as well. Differences among real values and forecasted values oscillate among 5.2 % and 8.4 %, whereas average relative deviation between real and estimated time series in the period 1/2004-Q4/2010 was 9.1 %. In this case, shape of trend is captured but real labour market remains higher regarding number of unemployed people.

Figure 3: Comparison of real observations and estimated and forecasted values of unemployed people (Q1/2004–Q4/2011, Czech Republic)

Source: own calculation

Application

Estimated regression model can be used not only for forecasting trend of analyzed variable in the future but also for calculating predicted value in case of some scenario.

Let assume first scenario of strong recession that is predicted for Europe by some economists:

• level of inflation will remain on low levels as a consequence of restrictive fiscal and monetary policy in the Czech Republic,

• wages will stagnate or slightly decrease as a consequence of tight situation on the labour market, where unemployment is high and employers apply strong cost control tools,

• GDP growth rate is negative, i.e. GDP declines.

Table 6: Scenario 1 (strong recession)

Variable	Estimated variable	Predicted value
constant	657,2164	1
inflation rate	-27,2561	0,8
average gross monthly wage	-11,471	23
GDP growth rate (q/q)	4,6041	-1
number of unemployed		366,973
Source: own calculation		

Predicted number of unemployed people is 367 thousand, which is somewhere between Q4/2010 and Q1/2011, i.e. high number of unemployed.

Let assume second scenario of improvement of economic indicators and start of new economic growth:

• level of inflation grows as economy starts high-performance again,

- wages grows and employers seek new employees massivelly,
- GDP growth rate is positive.

Table 7: Scenario 2 (economic growth)		
Variable	Estimated variable	Predicted value
constant	657,2164	1
inflation rate	-27,2561	2
average gross monthly wage	-11,471	26
GDP growth rate (q/q)	4,6041	4
number of unemployed		322,874
Source: own calculation		

Predicted number of unemployed people is 323 thousand, i.e. decreasing trend of number of unemployed continues and labour market reports more positive indicators.

Conclusion

In the analysis of unemployment in the Czech Republic in was decided to present correlation analysis and regression model with forecast and some application.

In the correlation analysis, it was expected that unemployment rate is influenced by business cycle and economic development represented mainly by GDP and GDP growth rate. It was also expected that labour market and employment and unemployment react with some delay, approximately 1 or 2 quarters.

These expectations were not statistically confirmed using quarterly distributed data for Q1/2007-Q1/2011 when crisis attacked the Czech Republic and Czech economy. It was proved that GDP growth affects unemployment and employment rate with the delay of 3 quarters, which is longer than expected. Statistical significance of investments was not confirmed. In the annual view there is significant relation between unemployment rate and GDP delayed by 3 years, which could be hardly justified by economic arguments. In most cases correlation coefficients between unemployment and GDP growth rate were negative, which confirms economic assumption that GDP grows and unemployment decreases afterwards.

Forecasts based on estimated regression model calculated from quarterly distributed data Q1/2004-Q4/2010 with inflation, wage and GDP growth rate were compared with real data from first three quarters of the year 2011. It shows that such models could be used with some caution. This model captured trend of decreasing number of unemployed people very well but values were positioned lower than reality.

Application in the form of two scenarios was introduced to show the ability of the regression model to predict values of number of unemployed people. Resulting prediction corresponds with expectations of theory regarding unemployment in case of recession or economic growth.

Generally, predicting unemployment is very difficult and statistical models often do not have correct and usable results. Macroeconomic indicators often correlate with each other and each analysis is affected by multicolinearity.

Acknowledgment

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Abbreviations

GDP – gross domestic product

LFSS – labour force sample survey

q/q – quarter over quarter

y/y – year over year