Correlation Analysis of Population Structure, Labor Market and Effect of Economic Crisis in the Czech Republic

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Abstract. Unemployment is very important macroeconomic indicator. It reacts to changes of other indicators in economy. An analysis of interaction among employment and unemployment and GDP, investments and inflation is introduced in the article with a special attention to population ageing. The objective is to present relation of population structure reflecting ageing process and labor market and to prove or reject hypothesis that unemployment rate, employment rate and participation rate are related to GDP growth and their reaction is delayed by one or two quarters. In the analysis it is possible to monitor effects of economic crisis as well.

The paper presents several correlation analyses applied on both annually and quarterly distributed data in the Czech Republic. Correlation was found between proportion of seniors in the population and employment rate and participation rate, these indicators seems to have long-term character and depends, at least partially, on the population structure and reflects dynamics and trends of population development. Unemployment, on the other hand, is not correlated with population structure, it depends on macroeconomic indicators. This indicator has rather short-term character and depends on actual situation in the economy. Relationship between the unemployment rate and GDP growth rate was proved for data started in Q1/2007 and for delay of two and three quarters. This period covers economic crisis in the Czech Republic that started in 2008.

Keywords: population structure, population ageing, unemployment, employment, participation rate, gross domestic product, GDP growth rate, inflation, investments, macroeconomic indicators; economic crisis.

JEL Classification: C61, C63
AMS Classification: 90C30

1 Introduction

The unemployment belongs to important and closely monitored indicators (Arltová et al [1]). It is formed on labor market where labor supply and labor demand interfere (Miskolczi, Langhamrová [19]). Economic crisis in the Czech Republic since 2008 and continuing till today demonstrates close relation between economic performance measured by GDP and unemployment. Shortly after the decline of financial indicators (represented by GDP) and restriction of conditions on financial markets, the unemployment increased. Number of involuntarily unemployed people grew and the unemployment rate increased as well.

Statistical dependency among selected macroeconomic and demographic indicators in the Czech Republic including delayed indicators is analyzed in the paper. It is expected that labor market’s reaction, specifically worsening of unemployment is delayed by one to two quarters after the decrease of economic performance (Langhamrová, Fiala [10], Miskolczi, Langhamrová [20]). Simultaneously, it is expected that labor market is influenced by the population dynamics, particularly population ageing. This becomes an important issue in all developed countries, including the Czech Republic. Size and structure of population and, specifically, selected part of the population such as people in the age 20 to 64 years old affect the labor market from the long-term view (Fiala, Langhamrová [4], Miskolczi, Langhamrová [21]).

Potential results help in understanding the interactions between GDP or other macroeconomic indicators and employment and unemployment and support the ability to predict further economic development, labor market.

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characteristics and social stability of economy. Population characteristics such as proportion of people of certain age should be also one of the predictors of employment or unemployment rate (Mach [14]). It affects size and structure of economically active people on the labor market.

2 Methods and Resources

Definition: Population structure of age groups 0-19, 20-64 and 65 years of age and more years were used. These groups are denoted as:
- pre-productive part of population (0-19 years),
- productive part of population (20-64 years),
- post-productive part of population (65 and more years, 65+).

Data: Quarterly distributed data for analysis originated from Labor Force Sample Survey (LFSS) from the Czech statistical office were used: gross domestic product (GDP), consumption (C) and investments (I) in constant prices, inflation rate (as an increase in average annual consumer price index – CPI indicating percentage change in last 12-month average over preceding 12-month average), wages as average monthly gross wage.

Methods: Level of dependency is measured by Pearson’s correlation coefficient. This coefficient measures linear type of relation. Statistical test for significance of correlation coefficients is calculated on significance level \( \alpha = 0.05 \). Its critical value is \( t_{1-\alpha/2}^{n-2} \).

\[
T = \frac{r}{\sqrt{1-r^2}} \sqrt{n-2}
\] (1)

The test is very sensitive for large number of observations, where it gives positive result even for low values.

3 Selected macroeconomic indicators

GDP in constant prices shows clear seasonal oscillations; therefore GDP, consumption and investments seasonally adjusted were added to analysis as well. All indicators grow till the fourth quarter of 2008 which is exactly the period when economic crisis attacked the Czech Republic.

Number of unemployed people reached maximal value in Q1/2000 (494 thousand people) and minimum in Q2/2008. Unemployment follows strong seasonal pattern which would be better recognizable from monthly distribution. Seasonality is almost hidden in quarterly distributed data and impact of business cycle could be visible – see following figure with visible decline at the end of the year 2008 (Langhamrová et al. [12]).

![Figure 1 Trend of GDP growth rate and unemployment rate (Q1/1996-Q2/2012). Source: Czech Statistical Office](image)

Some level of unemployment is considered as unavoidable in any economy and certain degree of unemployment is perceived as normal or even healthy – it may indicate difference between supply and demand structure (from various reasons) and individuals who seek better job opportunity or companies seeking better employees
It is necessary to distinguish between voluntary and involuntary status of unemployed person. Based on voluntariness and reasons, there are following types of unemployment (Holman [6], Jírová [7]):

- **Frictional unemployment** – is attributed to individual’s decision, is given by people’s change of job, as a consequence of migration, for example. This type of unemployment is always present in economy even in state of full employment. Usually, it is a short-term event.
- **Structural unemployment** – is implication of different requirements corresponding with education structure, qualification, skills’ set; it implies form mismatch between supply (i.e. unemployed individuals) and demand (i.e. required skills needed for available positions). It usually lasts longer than frictional unemployment. Structural unemployment could be influenced by active tools of employment policy, for example by retraining schemes.
- **Cyclical unemployment** – reflects economic business cycles and fluctuations – booms and recessions. Economic crisis is main reason why unemployment in 2009 and 2010 increased.

Unemployment evolves with a strong seasonality (Kotýnková [8]). Usually, the highest unemployment is recorded in winter period (when seasonal jobs end) and beginning of the new calendar year (some contractual jobs end at 31st of December), third peak is visible in September (when graduates start to search a job after the last holidays). The lowest season comes in spring and summer due to seasonal jobs in agriculture, construction, tourism and other services.

![Number of unemployed persons (in thousand) (Q1/1996-Q2/2012).](image)

**3.1 Unemployment in the Czech Republic**

- Development in period 1990 – 1996 is characterized by significant changes of legal framework, declining number of economic active people and growth of unemployed people. Result of heterogeneous forces was almost constant level of unemployment 4 %. People and companies learnt what means 'invisible hand of the market’ after radical political changes in 1989 in the Czech Republic.
- In 1997 – 1999 faced the Czech Republic economic crisis, GDP and investments declined and rate of unemployment grew up to the level of 10 %. Large groups of people born in 1970’s (boom generation) came to labor market and intensify disproportion between labor supply and labor demand. Consequently, seniors often chose early retirement, which was even option supported by the Czech government (Sirovátka [24]).
- During following years in 2000 – 2004 oscillated rate of unemployment between 8 % and 11 %. For the first time, term globalization is widely discussed even in connection with unemployment.
- In 2004 joined the Czech Republic the European Union. However, some EU countries closed their labor market to newly joined countries for next several years (Langhamrová, Langhamrová [11]).
- In 2004 – 2008 the unemployment rate declined from 10 % to 5 %, economic boom was reported in all European countries.
- Economic crisis started at the end of 2008. In 2009 – 2010 crisis affected world’s economies and labor markets. Rate of unemployment in the Czech Republic was increasing since November 2008 and number of job positions available was declining very fast. Maximal unemployment in the Czech Republic was recorded in the first quarter of 2010: 8.05 % and 422.7 thousand unemployed people according to LFSS.
Among unemployed persons always women are more unemployed, they form 52.7 % to 56.5 % of total number of unemployed people. Difference between males and females varied between 10 and 50 thousand unemployed persons which represents 10 % to 23 % of unemployed males. Minimal difference happened in 1996, maximal in 2003.

### 3.2 Population structure

Population in the Czech Republic evolves slowly; its size is approximately 10.5 million of people. Historically, there is a large population group (boom) born in 1970’s due to massive political support of families. Currently, typical trend is similar to other developed countries in Europe: population is ageing, both from the top of the population pyramid, i.e. absolute ageing (mortality declines, people live longer, both life expectancy and healthy life years prolongs) and from the bottom of the population pyramid, i.e. relative ageing (fertility declines, less children born in the population means decreasing proportion of children in the population and increasing proportion of seniors, regardless what is the definition of the age group, Miskolczi et al. [17]).

Last demographic projection till 2100 assumes that the total fertility rate might decline to the level of 1.45 (low scenario) or 1.61 (high scenario) and life expectancy at birth will grow from the current level 75.0 years for males to the level 84.2 in low or 88.4 years in high scenario (Miskolczi et al. [18]). For females, the increase would be from the level 80.9 years to the level of 88.8, respectively 92.9 years. Net migration is not important compared to the population size; it comprises approximately 10 thousand people annually and is expected to be 25 thousand at maximum. Under these assumptions, the total population size is expected to decrease to the level of 6.1 million in low scenario up to the level of 9.1 million in high scenario by 2100. (Projection of the population of the Czech Republic [22])

### 4 Statistical analysis

Correlation analysis among proportion of three large population groups (0-19 years old, 20-64 years old and 65 and more years old) and labor market characteristics was prepared (Miskolczi [15], Šichtařová [23]). Unsophisticated statistical method was used here. The reason is that more sophisticated and complicated methods collapsed because all selected indicators are either short or depend on each other (for example simultaneous equation models, Miskolczi [16]).

First analysis shows that high correlation is present in case of employment rate and participation rate. Higher proportion of pre-productive part of population is connected with higher employment and participation rate. Higher proportions of productive and post-productive parts of population lead to lower employment and participation rates. These relations are based on growing proportion of seniors (process of population ageing) and productive people (as a consequence of population wave(s)) and decreasing employment and participation rate because of erosion of labor force. Thus, this could be explained rather with seemingly correlated data then factual correlation. Unemployment fluctuates and is not correlated with indicators of population structure. It suggests that unemployment is not affected by the long-term impacts and should be analyzed based on short-term indicators such as GDP and other macroeconomic indicators (consumption, investment).

<table>
<thead>
<tr>
<th></th>
<th>Unemployment rate seasonally adjusted</th>
<th>Employment rate seasonally adjusted</th>
<th>Participation rate seasonally adjusted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proportion of pre-productive part of population (0-19)</td>
<td>-0.211</td>
<td>0.831</td>
<td>0.975</td>
</tr>
<tr>
<td>Proportion of productive part of population (20-64)</td>
<td>0.273</td>
<td>-0.850</td>
<td>-0.943</td>
</tr>
<tr>
<td>Proportion of post-productive part of population (65+)</td>
<td>0.016</td>
<td>-0.628</td>
<td>-0.874</td>
</tr>
</tbody>
</table>

**Table 1** Pearson’s correlation coefficients (Czech Republic, annually distributed data 1996-2011).

Source: own calculation.

Correlation coefficients presented in Table 2 among GDP growth rate (for same quarter and delayed by one/two/three quarters) are very low and are not statistically significant on the selected significance level, with the exception of GDP growth rate & participation rate in the same quarter and delayed by one quarter. The strongest relation can be seen for all participation rate and GDP growth (all delays).

Relation among employment and unemployment rate and inflation rate is statistically significant on given level. Relations among investments growth rate and selected indicators of labor market are weak and statistically insignificant.
<table>
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<th>Participation rate seasonally adjusted</th>
</tr>
</thead>
<tbody>
<tr>
<td>GDP seasonally adjusted – growth rate q-o-q</td>
<td>0.105</td>
<td>0.125</td>
<td>0.267*</td>
</tr>
<tr>
<td>GDP seasonally adjusted – growth rate q-o-q (q−1)</td>
<td>0.071</td>
<td>0.136</td>
<td>0.244*</td>
</tr>
<tr>
<td>GDP seasonally adjusted – growth rate q-o-q (q−2)</td>
<td>0.050</td>
<td>0.138</td>
<td>0.220</td>
</tr>
<tr>
<td>GDP seasonally adjusted – growth rate q-o-q (q−3)</td>
<td>0.046</td>
<td>0.156</td>
<td>0.230</td>
</tr>
<tr>
<td>Inflation rate</td>
<td>-0.411**</td>
<td>0.638**</td>
<td>0.094</td>
</tr>
<tr>
<td>Investments seasonally adjusted – growth rate q-o-q</td>
<td>0.165</td>
<td>-0.047</td>
<td>0.091</td>
</tr>
<tr>
<td>Investments seasonally adjusted – growth rate q-o-q (q-1)</td>
<td>0.074</td>
<td>0.007</td>
<td>0.078</td>
</tr>
<tr>
<td>Investments seasonally adjusted – growth rate q-o-q (q-2)</td>
<td>0.002</td>
<td>0.034</td>
<td>0.047</td>
</tr>
</tbody>
</table>

**Table 2** Pearson’s correlation coefficients (Czech Republic, quarterly distributed data Q1/1996-Q2/2012).
Source: own calculation. Note: q-o-q = quarter-over-quarter.

The same procedure applied for shorter period of observations gives different results (see Table 3). The period was selected after careful consideration when the economic crisis is visible at most, i.e. in the period of 2008-2010.

Unemployment rate is statistically significantly correlated with GDP growth rate delayed by two quarters and three quarters indirectly. Employment rate is statistically significantly correlated also with GDP growth rate delayed by two and three quarters but in a direct way. These are expected results as the declining GDP, which reflects economic crisis, affects unemployment that grows after some time and employment that also declines. The delay can be explained by the time needed for businesses to accommodate to the worsening situation and necessary to meet all requirements given by the Labor Code during process of employees’ layoffs. (Labor Code No. 262/2006 Sb.) More, nominal wages are slow to adjust downwards. This can lead to prolonged disequilibrium on the labor market and delay in the reaction and finding a new equilibrium. (Froyen [5], Holman [6])

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<th>Participation rate seasonally adjusted</th>
</tr>
</thead>
<tbody>
<tr>
<td>GDP seasonally adjusted – growth rate q-o-q</td>
<td>-0.105</td>
<td>0.184</td>
<td>0.350</td>
</tr>
<tr>
<td>GDP seasonally adjusted – growth rate q-o-q (q−1)</td>
<td>-0.334</td>
<td>0.321</td>
<td>0.053</td>
</tr>
<tr>
<td>GDP seasonally adjusted – growth rate q-o-q (q−2)</td>
<td>-0.501*</td>
<td>0.465*</td>
<td>0.015</td>
</tr>
<tr>
<td>GDP seasonally adjusted – growth rate q-o-q (q−3)</td>
<td>-0.599*</td>
<td>0.557*</td>
<td>0.025</td>
</tr>
<tr>
<td>Inflation rate</td>
<td>-0.768**</td>
<td>0.723**</td>
<td>0.069</td>
</tr>
<tr>
<td>Investments seasonally adjusted – growth rate q-o-q</td>
<td>0.091</td>
<td>-0.046</td>
<td>0.152</td>
</tr>
<tr>
<td>Investments seasonally adjusted – growth rate q-o-q (q-1)</td>
<td>-0.168</td>
<td>0.147</td>
<td>-0.034</td>
</tr>
<tr>
<td>Investments seasonally adjusted – growth rate q-o-q (q-2)</td>
<td>-0.277</td>
<td>0.239</td>
<td>-0.069</td>
</tr>
</tbody>
</table>

**Table 3** Pearson’s correlation coefficients (Czech Republic, quarterly distributed data Q1/2007-Q2/2012).
Source: own calculation. Note: q-o-q = quarter-over-quarter.

Relation among employment and unemployment rate and inflation rate is statistically significant on given level and it is the strongest correlation in the table. Increase of inflation and, at the same time of employment and decline
of unemployment, could be explained as consequences of the same process: business cycle. In a period of economic growth prices usually increase because previously low inflation and artificially low interest rates and the associated increase in the money supply lead to reckless, speculative borrowing, resulting in overall economic activity, investments (and malinvestments). In economically active period besides inflation and interest rates also employment grows and unemployment declines because people are willing to work for increasing wages and labor demand is sufficiently extensive. On the other hand, unsustainable growth and debts lead to the recession when the inflation restriction will be accompanied by the interest rates decline, employment decline and unemployment growth.

Statistical significance between investments growth rate and employment or unemployment was not approved but unemployment rate is correlated indirectly – growth of investments affects decline in unemployment with the delay of two quarters and employment rate directly, also with the delay of two quarters. Other macroeconomic indicators such as final consumption of households, government, foreign trade – export, import are highly correlated with GDP and thus were not included to a set of analyzed indicators.

5 Conclusion

It was expected that indicators of population structure correlate with labor market characteristics because population size, age and gender structure, structure according to education and other characteristics are important and affect situation in the labor supply.

As results show, employment and participation rate are correlated with proportions of population groups split by age but this correlation does not have reasonable explanation without further analysis. Only in a general consideration it shows that employment is impacted by the population structure, which can be considered as a long-term characteristic. Unemployment rate is not correlated with proportion of age groups and is further investigated. It is rather influenced by business cycle and economic development that is represented mainly by GDP and GDP growth. These are short-term characteristics.

It was also expected that labor market, level of employment and unemployment react with some delay, approximately one to two quarters. The expectations were partially statistically confirmed on quarterly segmented data for the period Q1/2007 – Q2/2012 when crisis approached the Czech Republic economy. It was proved that GDP growth affects unemployment and employment rate and that the delay is two or three quarters, i.e. longer than expected. This fact may be explained by the legislative requirement given by the Labor Code of the Czech Republic and the time needed for businesses to decide about layoffs of their employees. Similarly to GDP growth, investments’ impact is also visible with the delay of two quarters, although this relation is not statistically significant.

Statistical tests prepared for entire period (i.e. 66 quarters) were not statistically significant. Economic development during other than critical phases of business cycle (during expansion and peaks) and labor market characteristics are not highly correlated.

Another indicator of labor market – participation rate – develops independently from GDP or investment trends. It was approved that its behavior is directly connected neither with GDP or investment for the same period nor delayed.

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References
