DECOMPOSITION OF THE PHILLIPS CURVE, THE CASE OF THE CZECH REPUBLIC

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Abstract

The potential relationship between inflation and unemployment rate in the Czech Republic is analyzed in light of short run Phillips curve, with use of sub-indices of consumer prices of individual groups of COICOP (Classification of Individual Consumption by Purpose), which represent the level of inflation in the economy trough weighted average. In some countries short-run trade-off between inflation and unemployment was confirmed by some studies; however this is not always the case. Causal relationship might not be necessarily valid for all years and the Czech Republic is not the exemption. As a result the assumptions of short-run Phillips curve for the Czech Republic might be limited in their effect. Using the latest available data, above mentioned relationship will be analyzed. This study proves that using COICOP as an alternative representative instead of CPI might yield miscellaneous outcomes. Some COICOP inflation contributions confirm causal short run relationship with unemployment rate, other COICOP inflation contributions create a worse relationship, or a relationship does not exist at all.

Keywords: inflation rate, unemployment rate, COICOP, Phillips curve

1 INTRODUCTION

Followed by Phelps (1967) and Friedman (1968) interpretation of the Phillips curve, which introduced the concept of the natural rate of unemployment, the simple relationship between inflation and unemployment rate introduced originally by Phillips (1958), apparently weakened. In light of this development, the empirical Phillips curve is widely discussed phenomenon, where under certain conditions it is possible to find a potential relationship between inflation and unemployment rate. This inflation or unemployment rate is possible to expect and anticipate. Recent studies have proved an observable short-term Phillips curve by estimating a time-varying natural rate of unemployment, followed by examination of deviations of unemployment from its natural rate with regards to inflation. See for instance, King and Watson (1994), King and Morley (2007) or Lee and Nelson (2007), where evidence of measurable Phillips curve is provided. In many studies the analysis has been conducted primarily for the United States, United Kingdom, Japan and other major world economies. The reason behind it is that bigger world economies have been in existence for a long time and that there is a sufficient amount of data (see e.g. Dittmar and Gavin, (2000). Since Czech Republic is a young country, there is not enough data, but by using quarterly data published by the Czech Statistical Office (CZSO), it is possible to capture at certain time periods these short or medium-long terms at the moments.

Expecting future inflation or unemployment rate can be either intuitively from the graph, or using linear or polynomial regression. Because of short cycles in the Czech Republic, which took place during its short development, there is unfortunately not enough data for polynomial regression and linear approach can be applied only. For the purpose of this study data with quarterly frequencies will be used, published by CZSO. To express the inflation rate, consumer price indices (CPI) will be used, related to the average of basic year 2005 and to express the partial inflation rate (COICOP inflation contributions), the partial consumer price

indices will be used, related to the average of basic year 2005. Weighted average of these partial consumer prices from COICOP classification is the rate of inflation in the economy. To express the unemployment rate there will be used the common unemployment rate in %. Particular observations start on first quarter 2000 and end on third quarter 2012.

The work is divided into two parts. The first part evaluates development of the inflation rate and the unemployment rate in the Czech Republic using the weighted consumer price indices and the overall unemployment rate. It will be apparent that the potential relationship between the rate of overall inflation in the economy and the rate of overall unemployment may exist in certain economic cycles. The second part of the study will focus on the decomposition of the rate of inflation. Using the sub-indices of consumer prices according to the classification of individual consumption by purpose, the closest relationship of the examined sub-indices with the overall unemployment rate will be analyzed with regards to the short run Phillips curve relationship. Results indicate that there are groups in individual consumption, for which the assumptions of Phillips curve are appropriate and for which are the less appropriate. In some situations, the relationship between the level of rate of sub-inflation and the rate of unemployment might be very tight, elsewhere it might take stochastic form**.** Tightness of the dependence between sub-indices of consumer prices according to COICOP and the unemployment rate will be measured as well. This individual tightness of dependence will be compared with the tightness of dependence between a weighted rate of inflation in the economy (CPI) and the overall unemployment rate. Results suggest how sub-indices of consumer prices can be separately used to find a relationship between the inflation rate and the unemployment rate and resulting implications.

2 THE DEVELOPMENT OF OVERALL INFLATION AND OVERALL UNEMPLOYMENT RATE IN THE CZECH REPUBLIC

The development of Phillips curve in the Czech Republic from first quarter 2000 to third quarter 2012 is shown in Figure 1, where INFLAT is Consumer Price Index (+100 %, the average of 2005 is 100 %) and UNEMP is unemployment rate in %. The rate of inflation, expressed by the CPI was in contradiction with an average of 2005 at 88.6% level. The unemployment rate was 9.5 % at that time. As time went on, the unemployment declined with slight fluctuations, the price level gradually grew over time until the end of 2003. For more information about this partial development of the Phillips curve see Figure 14 in Appendix. Since 2004, there was a process of acceleration of the Czech economy. The product has grown, the economy prospered and the unemployment rate gradually declined to a very favourable, but long-term unsustainable level. From 8.7 % in 2004 the unemployment rate declined to 4.4 % at the end of 2008. The inflation rate, expressed by the CPI grew slowly from 97.6 % to 112.2 % of level of the average in 2005, (more information about this period can be found in Figure 14 in Appendix). At the end of 2008 came the economic crisis. Overheated economy of the Czech Republic slowed and the domestic product began to decline. For this reason, the unemployment began to rise again from the initial low level to 5.8 % in first quarter, to 6.3 % in second quarter, to 7.3 % in third quarter and to 7.2 % in the fourth quarter of 2009. During this period the price level slightly decreased. It decreased from 113.6 % in first quarter of 2009 successively to 112.7 % in fourth quarter of 2009 in confrontation with an average of 2005, (See Figure 14 in Appendix for more information). The last cycle, the recovery from the crisis is a situation of Czech Phillips curve from first quarter of 2010 to the present. Last published value from CZSO is third quarter of 2012. The situation from the first quarter of 2010 has the character of the accelerating inflation (see Dittmar and Gavin, 2000).
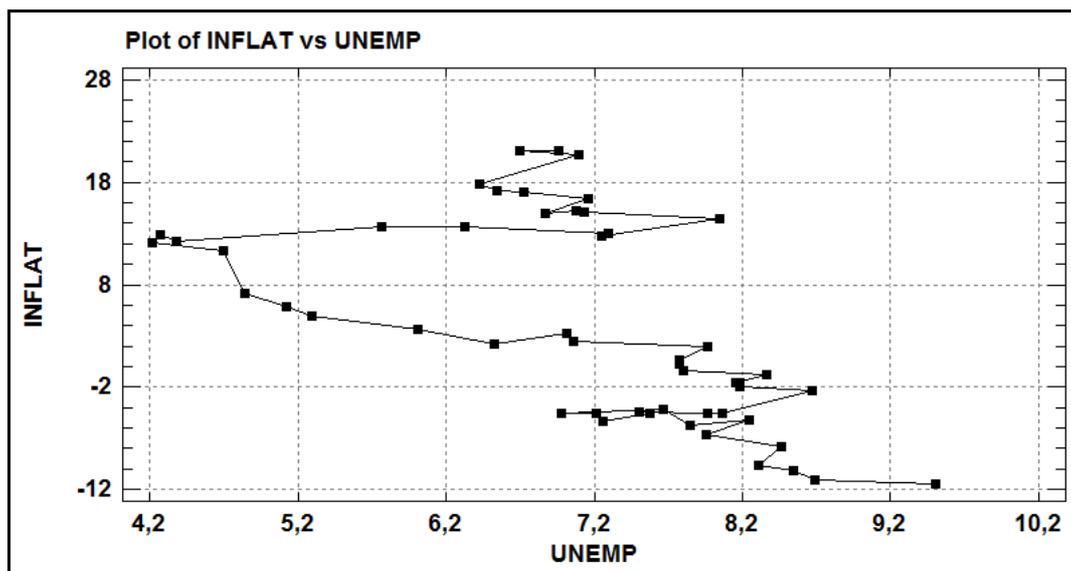
Fig. 1 – The development of Phillips curve for the Czech Republic from first quarter 2000 to third quarter 2012, where INFLAT is Consumer Price Index (+100 %, the average of 2005 is 100 %) and UNEMP is unemployment rate in %. Source: CZSO, author's construction

Consumer price indices, which were used in the construction of Figure 1, are weighted averages of sub-indices of consumer prices, resulting from the classification of individual consumption by purpose, accepted by CZSO. The following groups belongs to COICOP:

- Food and non-alcoholic beverages,
- Alcoholic beverages, tobacco,
- Clothing and footwear,
- Housing, water, energy, fuels,
- Furnishings, households equipment and maintenance,
- Health,
- Transport,
- Post and telecommunication,
- Recreation and culture,
- Education,
- Restaurants and hotels and
- Miscellaneous goods and services.

These will be used in sub-analysis in order to determine, which of the contributions of the consumer price index is the most commonly associated with the unemployment rate according to the Phillips approach. As will be seen later, using COICOP inflation might yield miscellaneous outcomes with respect to the sub-groups mentioned. Some COICOP inflation contributions create a better relationship with unemployment rate, other COICOP inflation contributions create a worse relationship, or a relationship does not exist at all.

3 THE COICOP INFLATION CONTRIBUTIONS

Using X-Y scatterplots there have been successively constructed Phillips curves for the unemployment rate in the Czech Republic and the individual sub-indices of the consumer prices, attributable to a specific group of classification of individual consumption. From the general assumptions follows, that there should be an indirect relationship between unemployment rate and inflation rate (or the level of the consumer price index). With a declining unemployment rate, the inflation rate will rise in the short term. With help of correlation coefficients, the power of dependence might be measured, i.e. how much the rate of unemployment is tied to a specific group of goods and services. We will use both the Pearson and Spearman correlation coefficient to measure the strength of dependence, where the individual values will always be shown in the table for each group of COICOP. The table shows Pearson product moment correlations between each pair of variables, respectively Spearman rank correlations between each pair of variables. These correlation coefficients range between -1 and +1 and measure the strength of the linear relationship between the variables, (see e.g. Granger, (1969)). In parentheses is also shown the number of pairs of values used to compute each coefficient (n). The third number in each location of the table is a P-value which tests the statistical significance of the estimated correlations. P-values below 0,05 indicate statistically significant non-zero correlations at the 95,0% confidence level. In contrast to the more common Pearson correlations, the Spearman coefficients are computed from the ranks of the data values rather than from the values themselves. Consequently, they are less sensitive to outliers than the Pearson coefficients, (compare the variance of observations in the figures).

In Figure 2 we can see the development of partial Phillips curve for the Czech Republic from the first quarter 2000 to the third quarter 2012, where the inflation rate is represented by partial consumer price indices of food and non-alcoholic beverages. When compared with Figure 1, significant differences might be seen. The level of dependence computed with help of Pearson or Spearman correlation coefficient is shown in Table 1. The dependence is indirect, thus the assumptions of Phillips curve for the short period are partially met.
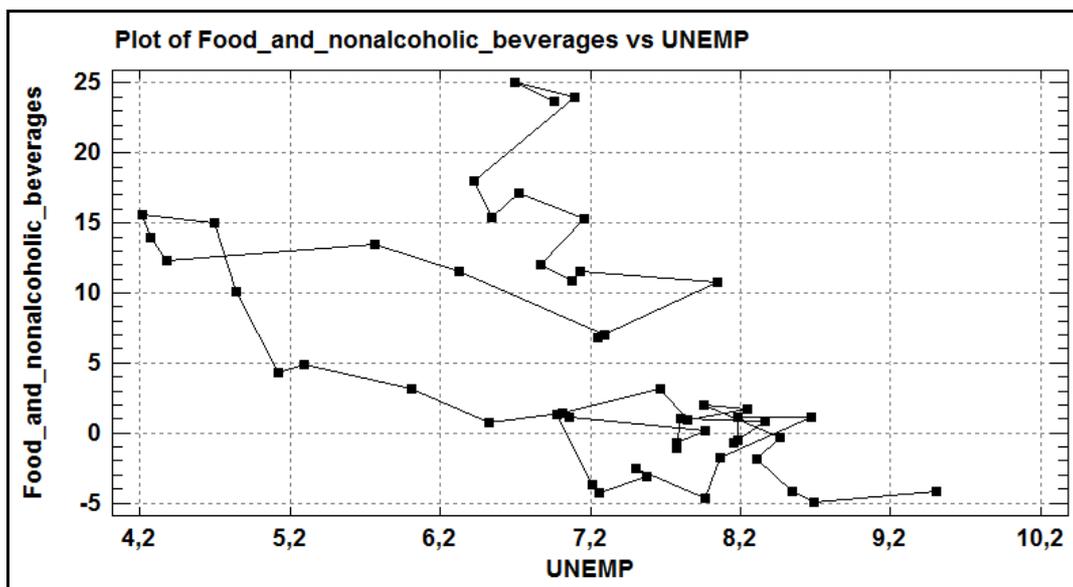

Fig. 2 – The development of partial Phillips curve for the Czech Republic from first quarter 2000 to third quarter 2012, COICOP classification Food and non-alcoholic beverages.
Source: CZSO, author's construction

Tab. 1 – Food and non-alcoholic beverages, correlations rank. Source: author's calculation

Pearson / Spearman Rank Correlations	UNEMP	Food and non-alcoholic beverages
UNEMP	Corr. P / S	-0,5726 / -0,6944
	n	(51)
	p-value P / S	0,0000
Food and non-alcoholic beverages	-0,5726 / -0,6944	Corr. P / S
	(51)	n
	0,0000	p-value P / S

The dependence is indirect, where both of correlation coefficients became negative, and statistically significant at the 5% level. The shape of the Phillips curve from Figure 2 is similar to the shape from Figure 1. It's caused by the food and non-alcoholic beverages in the consumer basket of COICOP, which are demanded by every person in the population and have quite a lot of weight. Between overall inflation rate and inflation rate in food and non-alcoholic beverages is a tight relationship, so the Phillips curve in Figure 2 resembles to Figure 1 and the partial inflation can be used to find a relationship between unemployment and inflation in a specific group of COICOP. The Phillips curve for inflation rate determined by a group of individual consumption of alcoholic beverages and tobacco is located in Figure 3. The level of inflation rate is higher than in Figure 2, but the shape of Phillips curve is similar as well, (compare it also with similar development in Figure 1). The calculated level of dependence using Pearson or Spearman correlation coefficient is shown in Table 2, which indicates indirect dependence.
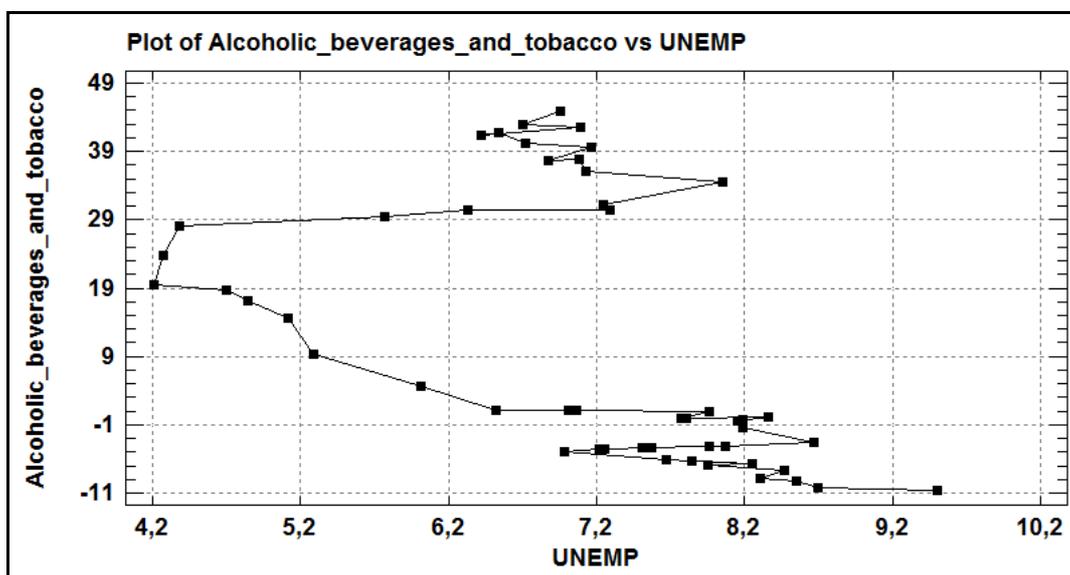

Fig. 3 – The development of partial Phillips curve for the Czech Republic from first quarter 2000 to third quarter 2012, COICOP classification Alcoholic beverages and tobacco. Source: CZSO, author's construction

Absolutely different Phillips curve we can find in Figure 4, where is located the Phillips curve for inflation rate determined from a group of individual consumption of clothing and footwear. The values of correlation coefficients are not necessary to find out that there is a direct dependency.

Tab. 2 – Alcoholic beverages and tobacco, correlations rank. Source: author's calculation

Pearson / Spearman Rank Correlations	UNEMP	Alcoholic beverages, tobacco
UNEMP	Corr. P / S n p-value P / S	-0,4989 / -0,6691 (51) 0,0002 / 0,0000
Alcoholic beverages, tobacco	-0,4989 / -0,6691 (51) 0,0002 / 0,0000	Corr. P / S n p-value P / S

Pearson and Spearman correlations rank for partial group clothing and footwear from COICOP classification are depicted in Table 2 and Table 3. Statistically significant correlation coefficients indicate the direct dependence and thus it is not possible to individually use the rate of inflation in clothing and footwear as an input variable for detecting a relationship with unemployment rate. If it were possible to combine this finding with the theory of the consumer benefit (see e.g. Hicks, (1956)), the explanation of why there is a direct dependency would be in the fact, that clothing and footwear are expendable goods and services.
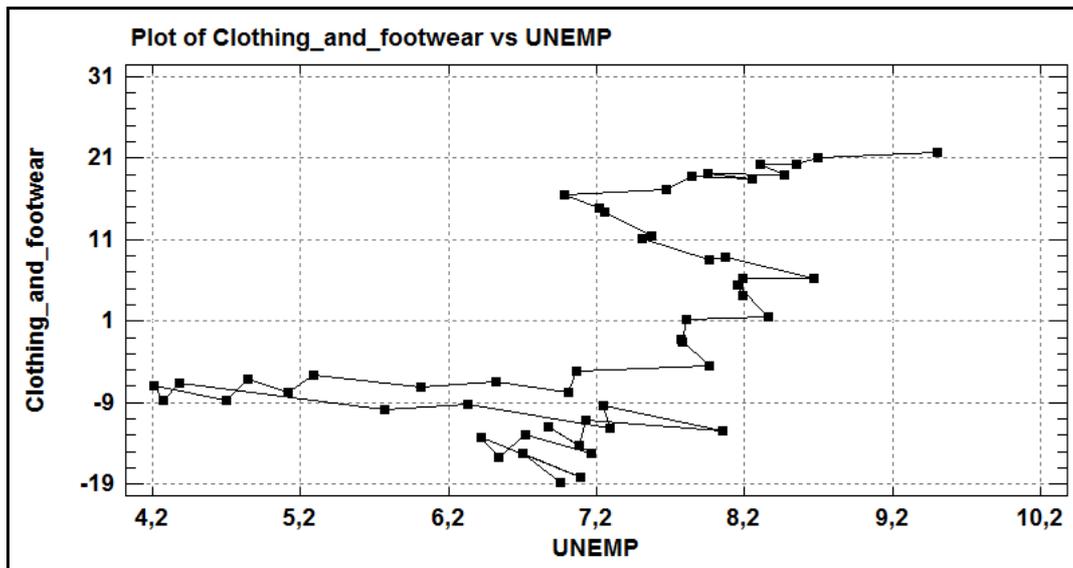

Fig. 4 – The development of partial Phillips curve for the Czech Republic from first quarter 2000 to third quarter 2012, COICOP classification Clothing and footwear.
Source: CZSO, author's construction

Tab. 3 – Clothing and footwear, correlations rank. Source: author's calculation

Pearson / Spearman Rank Correlations	UNEMP	Clothing and footwear
UNEMP	Corr. P / S n p-value P / S	0,5770 / 0,6508 (51) 0,0000 / 0,0000
Clothing and footwear	0,5770 / 0,6508 (51) 0,0000 / 0,0000	Corr. P / S n p-value P / S

Clothing and footwear will not be the only one group of COICOP classification, in which there will be found a direct dependency with the overall unemployment rate. On Figure 5 we can see the development of partial Phillips curve for the Czech Republic from first quarter 2000 to third quarter 2012, where the inflation rate is represented by partial consumer price indices of housing, water, energy and fuels. Correlations rank, written in Table 4 represent the statisticaly significant independence between overall unemployment rate and partial consumer price indices of housing, water, energy and fuels. Phillips curve in Figure 5 has similar shape as in the Figure 1, 2 and 3.
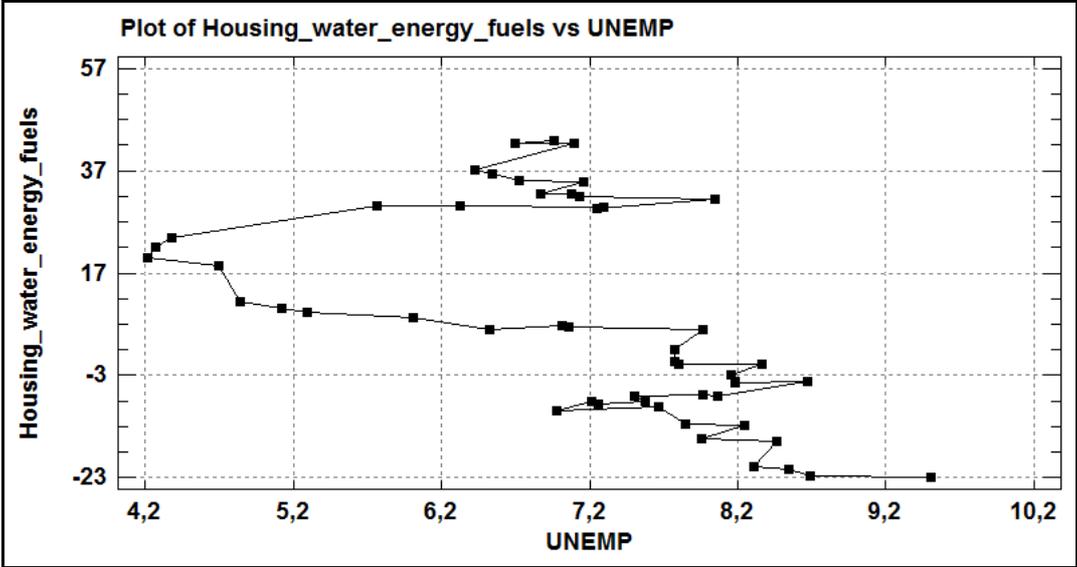

Fig. 5 – The development of partial Phillips curve for the Czech Republic from first quarter 2000 to third quarter 2012, COICOP classification Housing, water, energy and fuels.
Source: CZSO, author's construction

Tab. 4 – Housing, water, energy and fuels, correlations rank. Source: author's calculation

Pearson / Spearman Rank Correlations	UNEMP	Housing, water, energy and fuels
UNEMP	Corr. P / S	-0,5450 / -0,6744
	n	(51)
	p-value P / S	0,0000 / 0,0000
Housing, water, energy and fuels	-0,5450 / -0,6744	Corr. P / S
	(51)	n
	0,0000 / 0,0000	p-value P / S

The Phillips curve, shown in Figure 6 illustrates the situation, where the inflation rate in furnishings, households equipment and maintenance was chosen as the inflation rate. The shape of this Phillips curve corresponds to the shape from Figure 4 – Clothing and footwear. The furnishings, households equipment and maintenance may be considered as expendable goods and services, just as clothing and footwear. The dependence is direct, both of correlation coefficients become positive (see Table 5), and both are at the 5% significance level statistically significant. The furnishings, households equipment and maintenance is the last group from COICOP, for which the the Phillips curve relationship was disrupted.
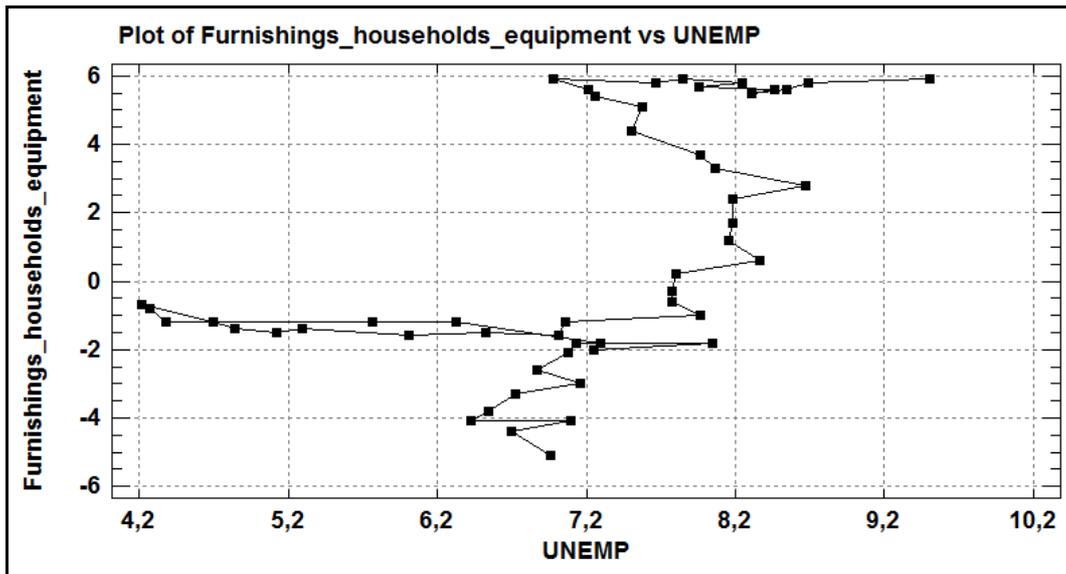
Fig. 6 – The development of partial Phillips curve for the Czech Republic from first quarter 2000 to third quarter 2012, COICOP classification Furnishings, households equipment and maintenance. Source: CZSO, author's construction

Tab. 5 – Furnishings, households equipment, correlations rank. Source: author's calculation

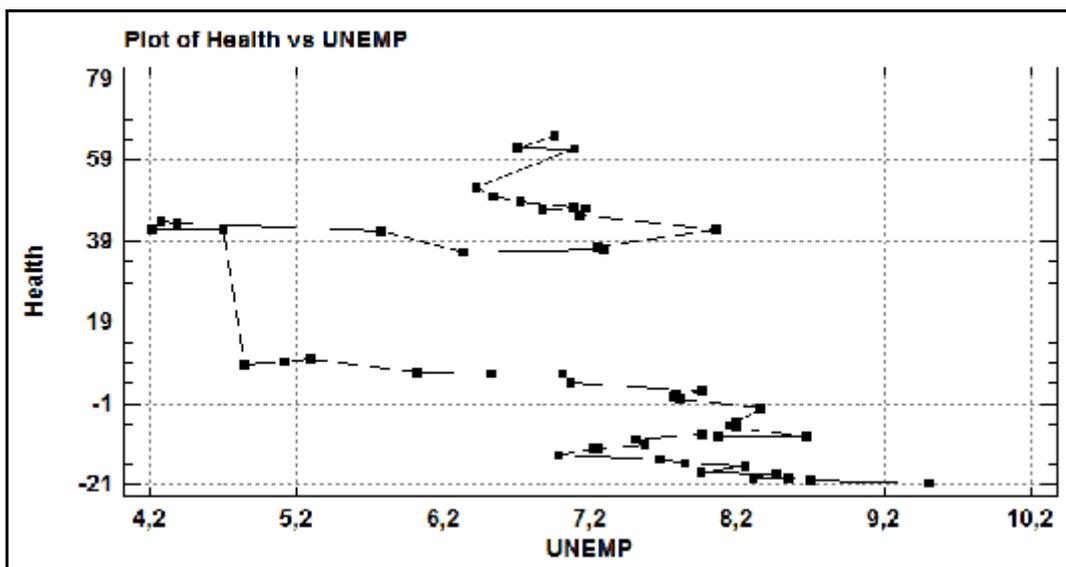| Pearson / Spearman Rank Correlations	UNEMP	Furnishings, households equipment
UNEMP	Corr. P / S	0,5359 / 0,6018
	n	(51)
	p-value P / S	0,0001 / 0,0000
Furnishings, households equipment	0,5359 / 0,6018	Corr. P / S
	(51)	n
	0,0001 / 0,0000	p-value P / S

Fig. 7 – The development of partial Phillips curve for the Czech Republic from first quarter 2000 to third quarter 2012, COICOP classification Health.
Source: CZSO, author's construction

Figure 7 represents the situation with consumer price indices in health as the level of inflation, Figure 8 illustrates the situation with consumer price indices in transport as the level of inflation and Figure 9 represents the situation with consumer price indices in post services and communications as the level of inflation. In Table 6, 7 and 8 we can see the correlation coefficients at the high level and are statistically significant at the 5% significance level. The great variance of observations in Phillips curve with transport as the level of inflation caused that the correlation coefficients are relatively lower. There are many outlier observations.

Tab. 6 – Health, correlations rank. Source: author's calculation

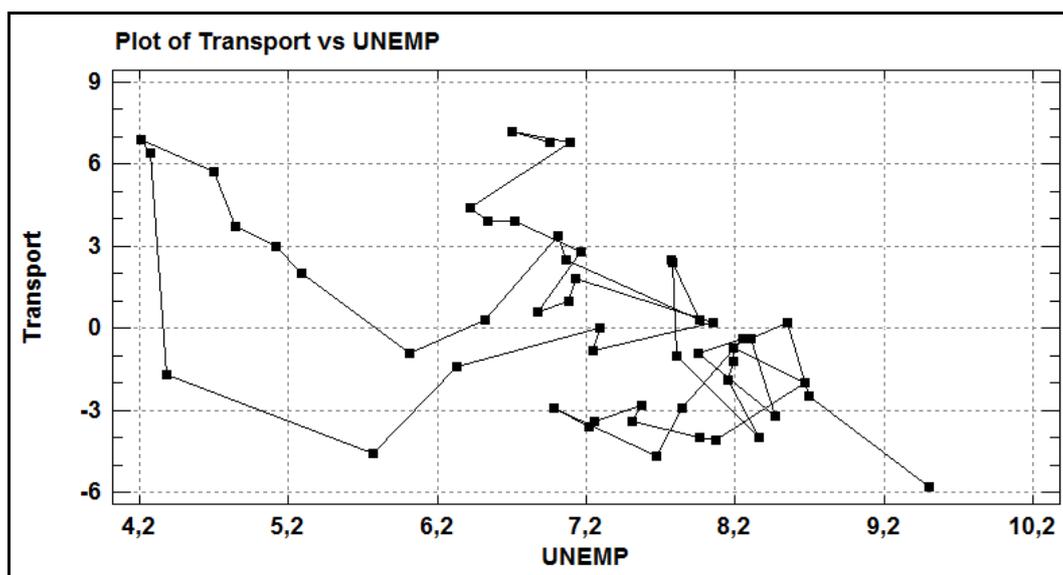| Pearson / Spearman Rank Correlations	UNEMP	Health
UNEMP	Corr. P / S	-0,5705 / -0,7123
	n	(51)
	p-value P / S	0,0000 / 0,0000
Health	-0,5705 / -0,7123	Corr. P / S
	(51)	n
	0,0000 / 0,0000	p-value P / S

Fig. 8 – The development of partial Phillips curve for the Czech Republic from first quarter 2000 to third quarter 2012, COICOP classification Transport.
Source: CZSO, author's construction

Tab. 7 – Transport, correlations rank. Source: author's calculation

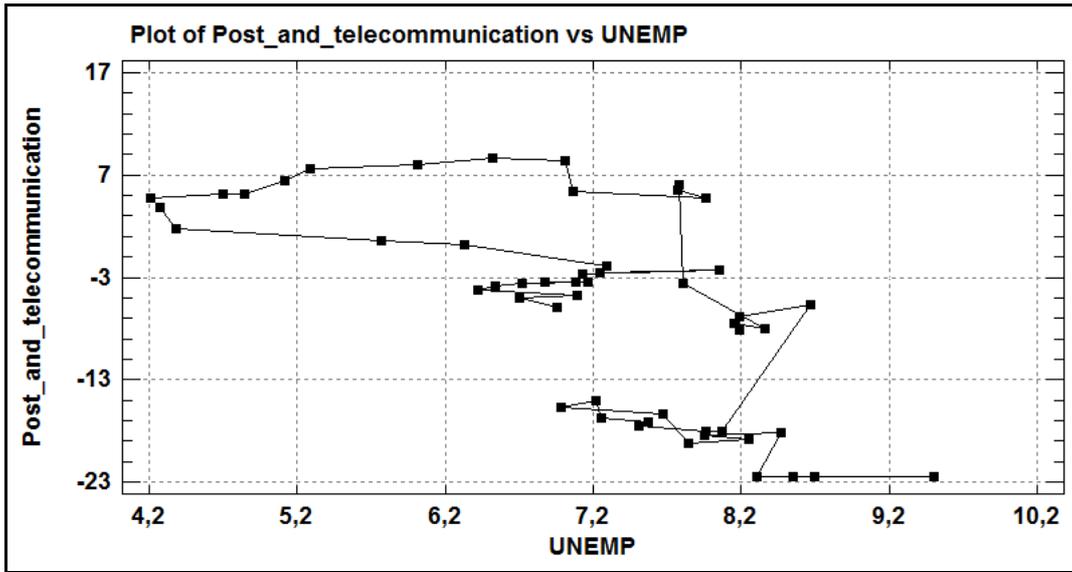| Pearson / Spearman Rank Correlations	UNEMP	Transport
UNEMP	Corr. P / S	-0,5454 / -0,5425
	n	(51)
	p-value P / S	0,0000 / 0,0001
Transport	-0,5454 / -0,5425	Corr. P / S
	(51)	n
	0,0000 / 0,0001	p-value P / S

Fig. 9 – The development of partial Phillips curve for the Czech Republic from first quarter 2000 to third quarter 2012, COICOP classification Post and telecommunication.
Source: CZSO, author's construction

Tab. 8 – Post and telecommunication, correlations rank. Source: author's calculation

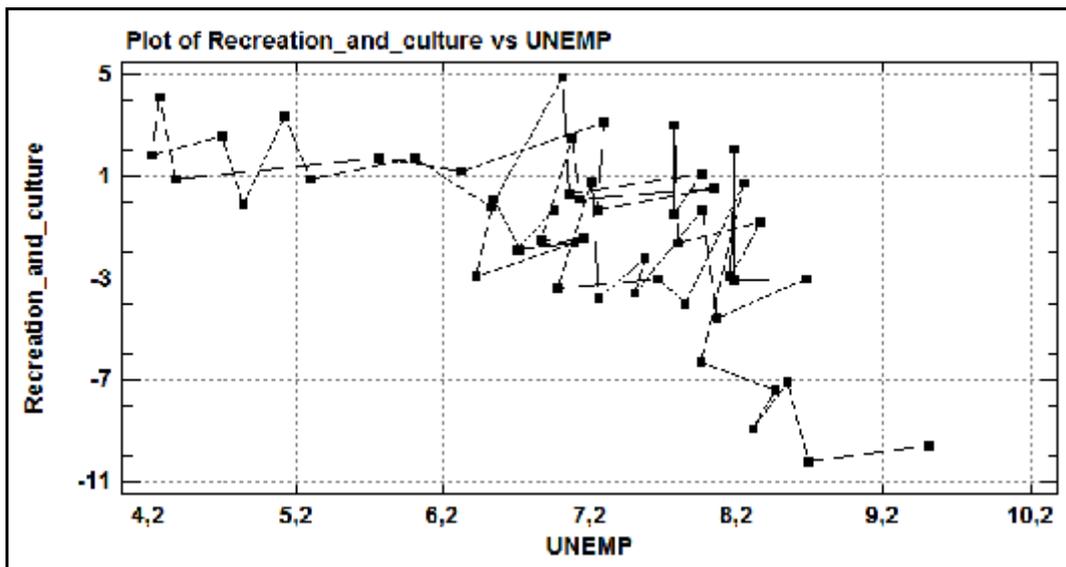| Pearson / Spearman Rank Correlations	UNEMP	Post and telecommunication
UNEMP	Corr. P / S	-0,6575 / -0,6927
	n	(51)
	p-value P / S	0,0000 / 0,0000
Post and telecommunication	-0,6575 / -0,6927	Corr. P / S
	(51)	n
	0,0000 / 0,0000	p-value P / S

Fig. 10 – The development of partial Phillips curve for the Czech Republic from first quarter 2000 to third quarter 2012, COICOP classification Recreation and culture.
Source: CZSO, author's construction

Since many authors consider the recreation services and cultural affairs as expendable service, it seems that we might assume a direct relationship between the consumer price indices in recreation services and culture. However, Figure 10 suggests indirect dependence and therefore the correlation coefficients will be negative. From the shape of the Phillips curve follows, that there is no significant relationship between the rate of inflation in recreation and culture and the unemployment rate, even in the short or medium-term period. Possible explanation might be strong seasonal fluctuations in the prices of recreational services.

Tab. 9 – Recreation and culture, correlations rank. Source: author's calculation

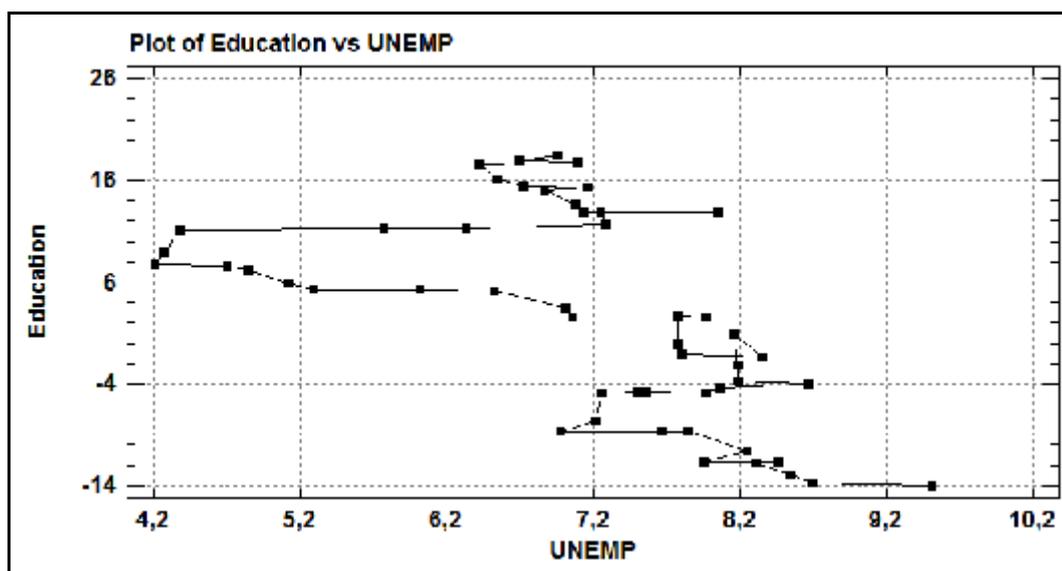| Pearson / Spearman Rank Correlations	UNEMP	Recreation and culture
UNEMP	Corr. P / S	-0,6020 / -0,5789
	n	(51)
	p-value P / S	0,0000 / 0,0000
Recreation and culture	-0,6020 / -0,5789	Corr. P / S
	(51)	n
	0,0000 / 0,0000	p-value P / S

Fig. 11 – The development of partial Phillips curve for the Czech Republic from first quarter 2000 to third quarter 2012, COICOP classification Education.
Source: CZSO, author's construction

Tab. 10 – Education, correlations rank. Source: author's calculation

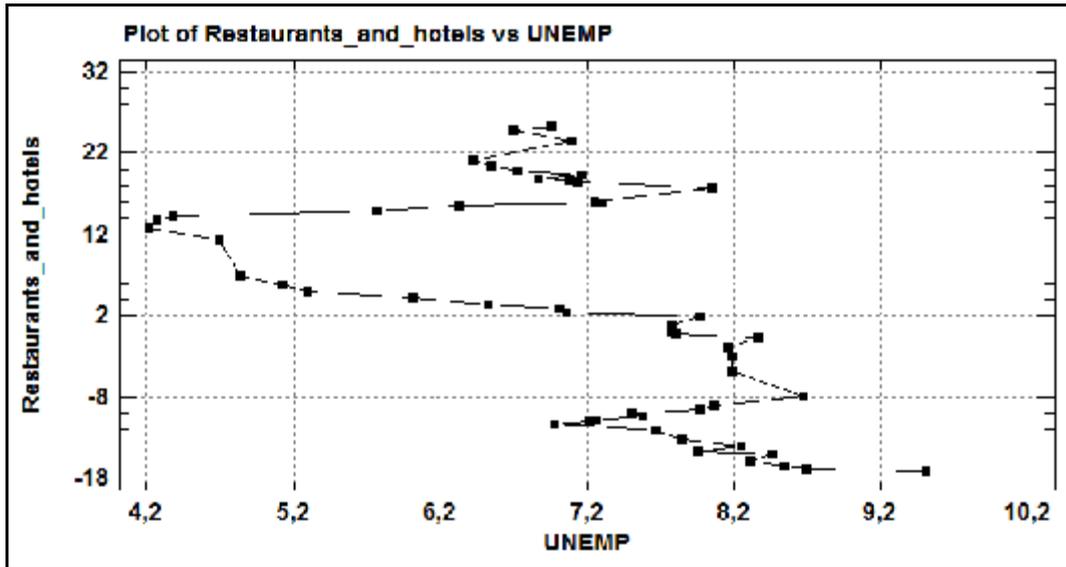| Pearson / Spearman Rank Correlations	UNEMP	Education
UNEMP	Corr. P / S	-0,5765 / -0,6710
	n	(51)
	p-value P / S	0,0000 / 0,0000
Education	-0,5765 / -0,6710	Corr. P / S
	(51)	n
	0,0000 / 0,0000	p-value P / S

Fig. 12 – The development of partial Phillips curve for the Czech Republic from first quarter 2000 to third quarter 2012, COICOP classification Restaurants and hotels.
Source: CZSO, author's construction

Tab. 11 – Restaurants and hotels, correlations rank. Source: author's calculation

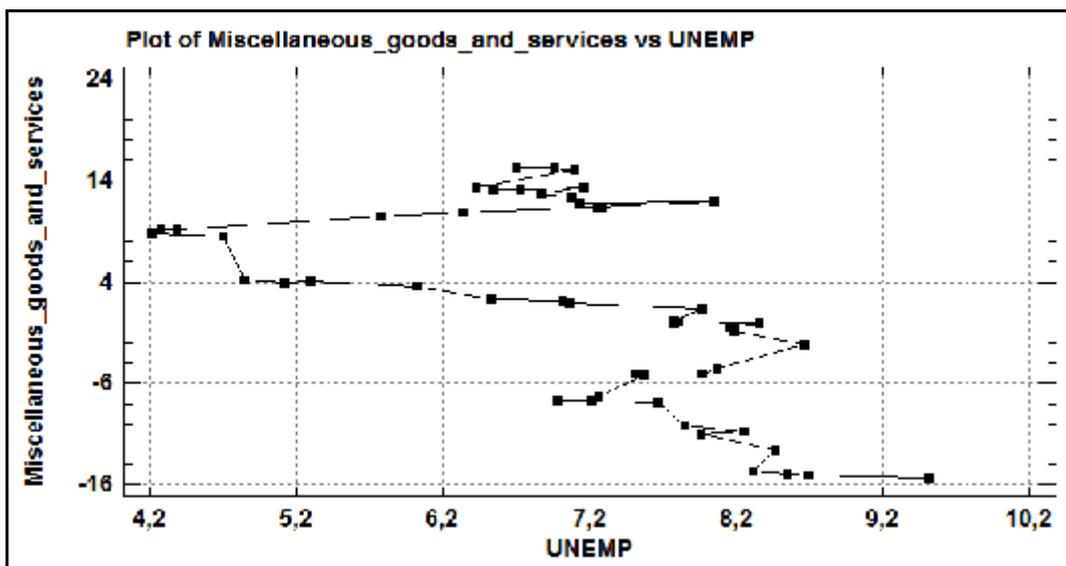| Pearson / Spearman Rank Correlations	UNEMP	Restaurants and hotels
UNEMP	Corr. P / S	-0,5711 / -0,6727
	n	(51)
	p-value P / S	0,0000 / 0,0000
Restaurants and hotels	-0,5711 / -0,6727	Corr. P / S
	(51)	n
	0,0000 / 0,0000	p-value P / S

Fig. 13 – The development of partial Phillips curve for the Czech Republic from first quarter 2000 to third quarter 2012, COICOP classification Miscellaneous goods and services.
Source: CZSO, author's construction

Statistically significant correlation coefficients for recreation and culture are shown in Table 9. The last three contributions to the weighted average of the rate of inflation in the economy are consumer price indices in education (See Phillips curve in Figure 11), in the restaurants and hotels (See the Phillips curve in Figure 12) and last but not least is the group of miscellaneous goods and services (see Phillips curve in Figure 13). Phillips curve shapes are not very different from each other and the values of correlation coefficients are equal, (See Table 10 for group of education, Table 11 for group of restaurants and hotels and Table 12 for group of miscellaneous goods and services).

Tab. 12 – Miscellaneous goods and services, correlations rank. Source: author's calculation

Pearson / Spearman Rank Correlations	UNEMP	Miscellaneous goods and services
UNEMP	Corr. P / S n p-value P / S	-0,5821 / -0,6687 (51) 0,0000 / 0,0000
Miscellaneous goods and services	-0,5821 / -0,6687 (51) 0,0000 / 0,0000	Corr. P / S n p-value P / S

4 CONCLUSION

The aim of this study was to assess the potential short-run relationship between inflation and unemployment rate in the Czech Republic, but with the use of sub-indices of consumer prices of individual groups of COICOP (Classification of Individual Consumption by Purpose), which represent in the weighted average the level of inflation in the economy. With help of the sub-indices of consumer prices, according to the classification of individual consumption by purpose, was analyzed, which sub-index of consumer prices has the closest relationship with the overall unemployment rate in line with assumptions of the Phillips curve. The closest causal short run relationship represents the situation, where we put together the unemployment rate and sub-indices of consumer prices of "alcoholic beverages and tobacco", "housing, water, energy and fuels", "health", "education", "restaurants and hotels" and "miscellaneous goods and services". This might be explained by the fact that previously mentioned are considered as essential goods and services. The sufficient relationship represents the situation, where we put together the unemployment rate and sub-indices of consumer prices of "food and non-alcoholic beverages" and "post and telecommunications". The situation, where the relationship does not exist is, where we put together the unemployment rate and sub-indices of consumer prices of "clothing and footwear" and "furnishings, households equipment and maintenance", because there are positive correlation coefficients and the relation is direct. Further the relationship is non-existent for the group of "transport" and "recreation and culture", because in these situations the Phillips curve doesn't look like the Phillips curve and there is no noticeable short-term relationship between unemployment rate and the rate of inflation (respectively sub-indices of consumer prices of specific group of COICOP). We have seen that there were situations, when the relationship between the level of rate of sub-inflation and the rate of unemployment was very tight, elsewhere there were situations, when the relationship was represented by "stochastic trend". Findings from this paper will be used for our future research. On the basis of the relations that result from the current data for the Czech Republic, there will be examined the economic substance of each group of classification of individual consumption by purpose. It is possible that some group will deviate from statement, which is generally accepted in the literature.
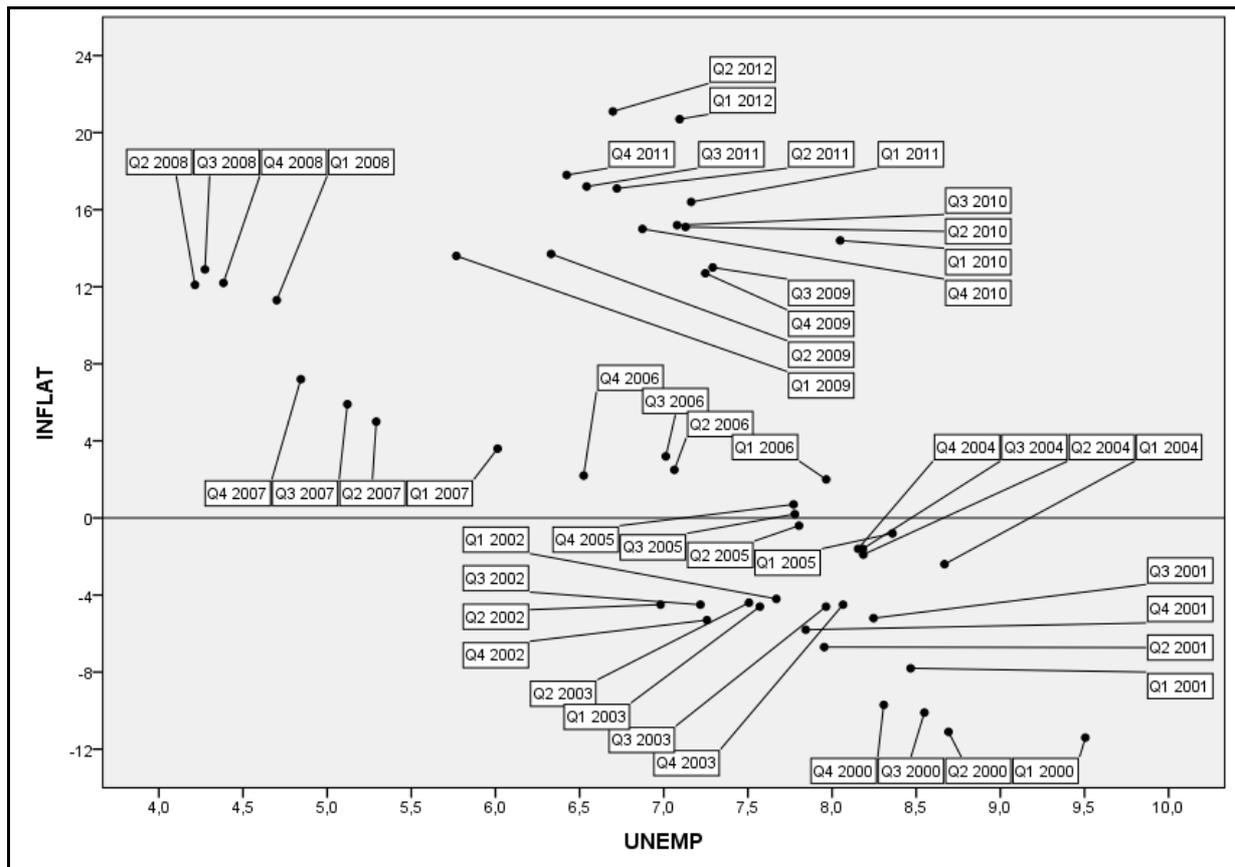
Appendix

Fig. 14 – The development of Phillips curve for the Czech Republic from first quarter 2000 to second quarter 2012. Source: Šimpach, Chytilová (2012 a)

References
1. Dittmar, R., Gavin, W.T., (2000): What Do New-Keynesian Phillips Curves Imply for Price-Level Targeting? *Federal Reserve Bank of St. Louis Review*, p. 21-30.
2. Friedman, M., (1968): "The Role of Monetary Policy." *American Economic Review* (March) 58 (1), 1-17.
3. Granger, C.W.J., (1969): „Investigating causal relations by econometric models and cross-spectral methods", *Econometrica* 37 (3), p. 424–438.
4. Hicks, J.R. (1956): *„A revision of demand Theory"*, Oxford : Clarendon, 196 p.
5. King, T.B. and Morley, J., (2007): "In Search of the Natural Rate of Unemployment," *Journal of Monetary Economics*. May, 54: 550-564.
6. King, R. G. and Watson, M.W., (1994): "The Post-War US Phillips Curve: A revisionist econometric history," *Carnegie-Rochester Conference Series on Public Policy* 41.
7. Lee, J. and Nelson, Ch.R., (2007): "Expectation Horizon and the Phillips Curve: The Solution to an Empirical Puzzle," *Journal of Applied Econometrics*, 22: 161- 178.
8. Phelps, E., (1967): "Phillips Curves, Expectations of Inflation, and Optimal Inflation over Time, *Economica* 135: 254-281.
9. Phillips, A.W., (1958): "The Relation Between Unemployment and the Rate of Change of Money Wage Rates in the United Kingdom", 1861-1957. *Economica*, no. 5, p. 283-293.
10. Šimpach, O., Chytilová, H., (2012, a): ARIMA and Phillips curves in finding the czech potential rate of unemployment. Karviná 09.11.2012. In: *Mezinárodní vědecká*

        konference doktorandů a mladých vědeckých pracovníků [CD-ROM]. Opava : Slezská univerzita, 2012, s. 320–332.

11. Šimpach, O., Chytilová, H., (2012, b): Estimation of the Phillips Curve, the Case of the Czech Republic. Bratislava 22.11.2012 – 22.11.2012. In: *EDAMBA 2012 [CD-ROM]*. Bratislava : EKONÓM, 2012, s. 1246–1257.

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