Regional Price Index in the Czech Republic: Revised

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Abstract
The paper is focused on rectifying and proposing a possible methodology for calculating Regional Price Index (RPI) in the Czech Republic at the NUTS3 level based on Consumer Price Index (CPI). The fundamental application of RPI is mainly spatial price comparison and adjustment of nominal regional indicators such as nominal net disposable household income (NDHI), which are used in economic and political practice for the detection of interregional disparities. The comparison of nominal values of indicators such as NDHI across regions does not reflect the real social-economic status of the region and its inhabitants. Therefore, it is crucial to adjust the nominal income indicators with the cost of living regional index. The article assesses the possibility of using the price probes of the Czech Statistical Office for regionalization of the CPI and calculates the RPIs for each NUTS3 region of the Czech Republic. Application of the RPI makes it possible to verify the fundamental hypothesis of the paper that the higher levels of NHDI tend to be compensated by the higher levels of costs of living.

JEL classification: C 21, R 13, R31
Keywords: regional price index, real indicators, nominal indicators, net disposable household income

1. Introduction

The paper is aimed at the issue of regional price disparities in the context of assessment of the standard of living in the regions of the Czech Republic, or more specifically on the possible trade-off between the levels of prices and of nominal incomes in the regions. The main subject of the research lies in the construction of a Regional Price Index (RPI) based on the generally well-known and widely used Consumer Price Index (CPI). The RPI will be then applied as an instrument of rectification of nominal indicators used as measures of social-economic ranking of regions in the Czech Republic.

The fundamental research hypothesis claims, the higher levels of income of households (measured by the Net Disposable Household Income; NDHI) generally tend to be compensated for by higher consumer prices. Therefore, comparison of nominal values of NDHI across regions does not illustrate the real social-economic position of the region's inhabitants.

The quantification and evaluation of regional disparities remains one of the most up-to-date topics of regional politics. According to Czech and foreign authors, the role of the supply side is often overestimated in the regional policy at the expense of the demand side, or more specifically of real income per capita. The effect of the level of real living costs is perceived by the current theories of regional development as an impact of localization of corporations. It is presumed (to a great extent controversially) that the consumer prices are lower and the real estate prices are higher as a result of economies of agglomeration (e. g. Šimanová & Trešl,

2011). According to Viturka (2007), the price factors belong to the group of middle-important determinants of regional competitiveness. Kahoun (2011) considers the fact that the regional differences in price levels remain neglected, highly limiting for accountable regional comparison, especially because the difference in price levels between the Czech regions are significant. (Kahoun, 2011)

Following the EKS (Éltetö-Köves-Szulc) and PPS (purchase parity standard) method, Čadil et al. (2012) estimated the regional price levels in 2007 – 2009 for NUTS3 in the Czech Republic. The authors state rather high price homogenity across the regions of the Czech Republic in comparison to other member countries of the European Union. Nevertheless, they do not reflect other aspects of regional price levels, e.g. the impact on the real income disparities of inhabitants, real interregional disparities. (Čadil et al., 2012)

In the German NUTS3 regions, the regional price index was calculated in 1996 – 2004 on the basis of CPI and HRI (housing rent index). The spatial CPI patterns were found relatively stable in time. The real regional disparities were proved to diminish at a higher pace than the nominal ones, especially across East German regions. (e. g. Kosfeld & Eckey, 2008) (Kosfeld et al., 2010) (Schulze, 2003) In the United Kingdom, the issue of real regional disparities has been tackled by Overman and Gibbons (2012), who focus solely on the prices of housing. During their research in 1998 – 2008, a significant trade-off between the level of wages and the costs of living was identified. Therefore, they recommend the economic policies should target the individual inhabitant and should attempt to improve his/her individual position, which will result in raising the situation of the whole region more efficiently than focusing on a geographically determined region. (Overman & Gibbons, 2012) In the USA, the researchers from the Bureau of Economic Analysis are deeply engaged in the issue of metropolitan and nonmetropolitan price indices among others also in the context of real income of population. They discovered a higher variability in real incomes in the nonmetropolitan areas than in the metropolitan ones. (Aten et al., 2013)

1.1 Modulation and Data mining

The consumer basket used for the CPI in the Czech Republic consists of nearly 800 items, segmented into 12 classes. Each item is assigned an individual weight so that the sum of all the weights gives 1000. The data on prices of all the representatives are probed in 35 districts regularly three times a month. The only exceptions to this rule are such commodities, prices of which are investigated centrally from one or a few data sources. These commodities are usually formed in sub-indices, but most of them are not relevant for calculation of RPI anyway (see presumption 2 and 3 below). The crucial role in spatial comparison of price levels will be most probably played by the immobile (local) services and by costs of living.

When constructing the RPI (based on the CPI) on the level of NUTS3 in the Czech Republic, it is necessary to take into account the following simplifying presumptions:

1) With respect to a small area and low differentiation of the surface of the Czech Republic, the consumer behavior and practice will be considered homogenous across all the regions of the Czech Republic. Thus, the weights in the consumer basket for RPIs will be identical with the weights of the total CPI.

2) Some of the items in the consumer basket have demonstrably and unequivocally null price variation across the regions of the Czech Republic (such as stamps, newspapers, journals, cigarettes, public administration services, train connections, etc.) and can be with no risk disqualified from the RPI consumer basket.

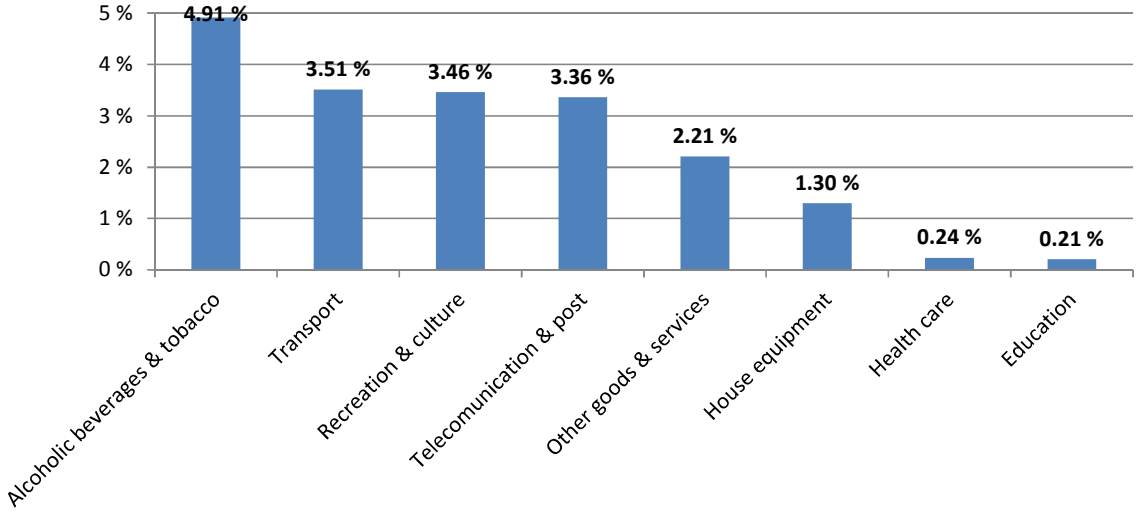
3) Other commodities (mostly services) prices of which are generally investigated centrally and consumption of which usually runs across regions (such as

accommodation in hotels, recreation or leisure centers, purchase of a car, services of travel agencies, etc.) can be also disqualified from the RPI consumer basket.

4) Prices of representative goods and services are mostly probed in regional or district centers (in approx. 45 % of all district centers in the Czech Republic), consequently they are incapable of regarding the sub-regional price. (Šimanová et al., 2014)

Following the presumptions 2 and 3 above, the list of price representatives was reduced by 123 items, the regional price variability of which was found negligible. These items together create 19.2 % of the total CPI consumer basket (e.g. telephone services, cigarettes, financial services, etc.). The overview of disqualified representatives summed up by their classes and the total of their weights provides the following fig. 1.

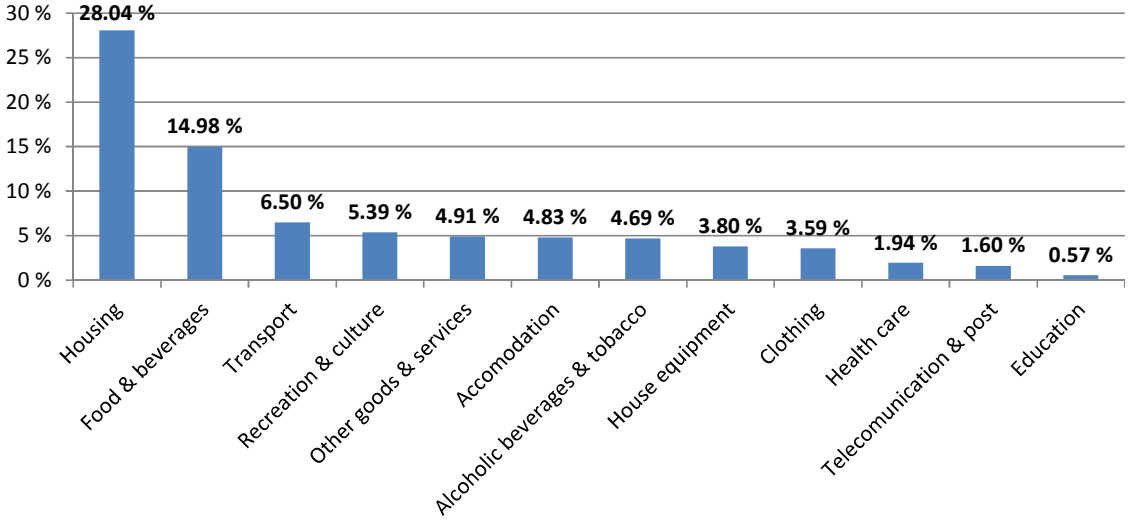
Figure 1
Price Representatives Disqualified from the RPI Consumer Basket



Source: (Šimanová et al., 2014)

All other items of the consumer basket form the base set of price representatives for calculation of RPIs. Their aggregated listing including the share of the weights of the classes on the total CPI basket illustrates the fig. 2. The sum of their shares has naturally the value of 80.8 %.

Figure 2
Structure of the Consumer Basket for RPI



Source: (Šimanová et al., 2014)

For calculation of RPI in this paper only the selection of 113 price representatives was used. They form 47 % of the weight of the base set of CPI consumer basket and their structure corresponds to the distribution of commodity classes in the CPI basket. The highest share show the price representatives associated with the costs of living (nearly 30 % – see fig. 2).

Laspeyres modified price index will be used for calculation on RPI (Roos, 2006):

$$RPI_r = \frac{\sum_{i=1}^{N} p_i^r q_i}{\sum_{i=1}^{N} p_i^a q_i} = \sum_{i=1}^{N} \frac{p_i^r}{p_i^a} \frac{p_i^a q_i}{\sum_{i=1}^{N} p_i^a q_i} = \sum_{i=1}^{N} \frac{p_i^r}{p_i^a} w_i \,, \tag{1}$$

where p_i is the price and q_i is the quantity of good or service i consumed in a region r, a stands for the regional average, in this case the average price of the whole Czech Republic used in CPI calculation. As can be seen in (1), Laspeyres index is the sum of all relative prices between the region of interest and the national average price, weighted by the expenditure shares w_i of each individual item of the consumer basket of the Czech Republic (see presumption 1). (Roos, 2006)

The prices of individual representatives are calculated using moving average for each year and region in the years 2009 – 2012 (the original probe has been carried out by the Czech Statistical Office in the framework of national price investigation for CPI). The data on costs of living originate from the same source, specifically from the regional sample survey of the Czech Statistical Office in 2009 – 2012. The individual weights in the consumer basket are – following the presumption 1 – constant for all the years and originate from the revision of consumer basket performed by the Czech Statistical Office in 2010.

Using these data, the RPIs will be calculated and the hypothesis of potential trade-off between the regional level of consumer prices and the regional level of nominal net disposable household income (NDHI) will be tested by instruments of correlation analysis.

In the second step, the authors are about to test the variability of the regional real NDHI and the regional nominal NDHI and to prove the application of RPIs on the nominal NDHIs significantly rectifies the regional differences on the given 5% level of significance.

Since the data seem to be heavily skewed, Brown-Forsythe test on homoscedasticity based on median will be applied rather than Levene's variance check based on arithmetic mean. (Maršíková & Kocourek, 2012) (Brown & Forsythe, 1974)

The test statistic W has the following form:

$$W = \frac{(N-k)}{(k-1)} \frac{\sum_{i=1}^{k} N_i (Z_i - Z_{..})^2}{\sum_{i=1}^{k} \sum_{j=1}^{N_i} (Z_{ij} - Z_{i.})^2}, \tag{2}$$

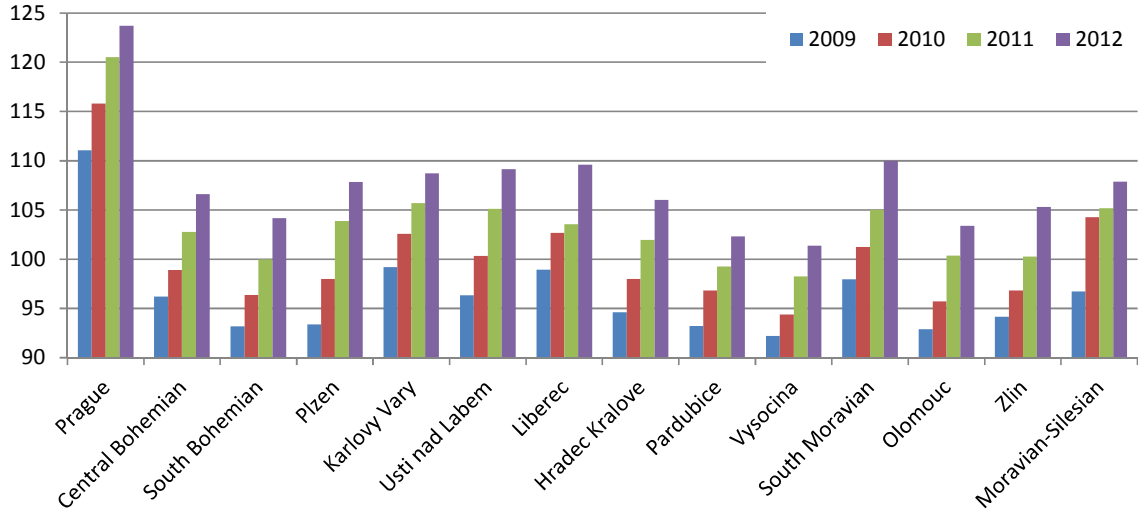
where W is the result of the test, k is the number of groups (in this case 2 – nominal NDHI and real NDHI), N is the count of all cases in all groups (here 112), N_i is the number of cases in the i-th group (here 56), Y_{ij} is the value of the NDHI for the j-th case in the i-th group, $Z_{ij} = \left| Y_{ij} - \tilde{Y}_{i.} \right|$, $\tilde{Y}_{i.}$ is the median of i-th group, $Z_{..} = \frac{1}{N} \sum_{i=1}^{k} \sum_{j=1}^{N_i} Z_{ij}$, and $Z_{i.} = \frac{1}{N_i} \sum_{j=1}^{N_i} Z_{ij}$. The significance of W statistic is tested against $F(\alpha, i-1, N-i)$, where $\alpha = 0.05$.

3. Conclusions and policy implications

The resultant values of RPIs for each region and year are shown in fig. 3. As expected, the highest RPIs are recorded for Prague region, while the lowest values are reached by region Vysocina, South Bohemian, Pardubice and Olomouc region. The fig. 3 also demonstrates, the differences among the individual regions are rather stable and do not change much over time (although the time series is too short for making any definitive conclusions). The value of 100 has been assigned to the year 2010 and to the general (i.e. average) consumer price index of the whole Czech Republic.

Figure 3

RPIs in NUTS3 Regions of the Czech Republic, 2009 – 2012

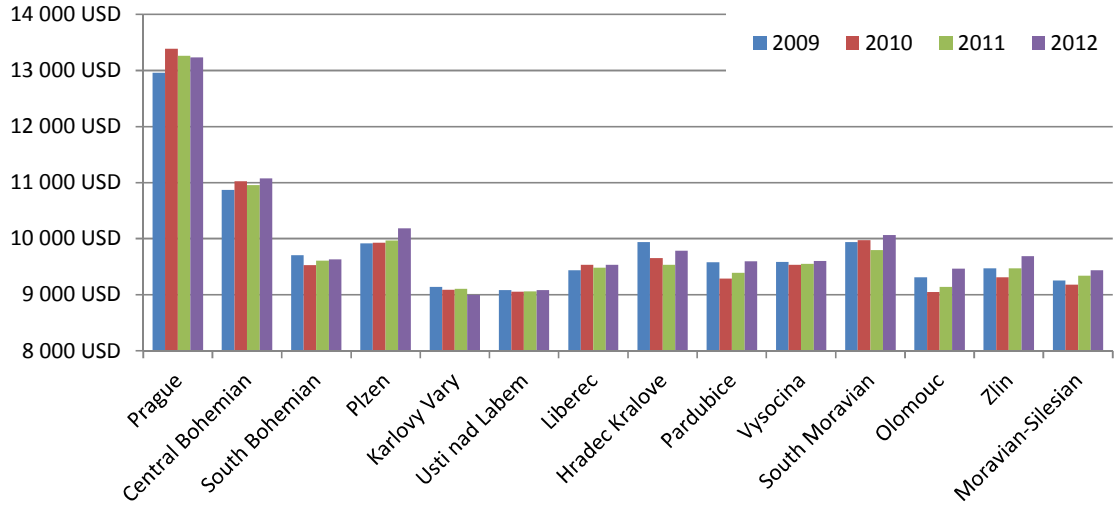


Source: authors' calculations

In the following step of the analysis, the results of RPIs were confronted with the regional values of nominal NDHIs per capita (shown in fig. 4 in USD using Atlas method exchange rate average for 2009 – 2012, i.e. 1 USD = 18.8587 CZK). Both figures suggest there might

me some trade-off between the regional NDHI per capita and the RPI, the higher nominal NDHI per capita seems to be compensated for by the higher values of RPI.

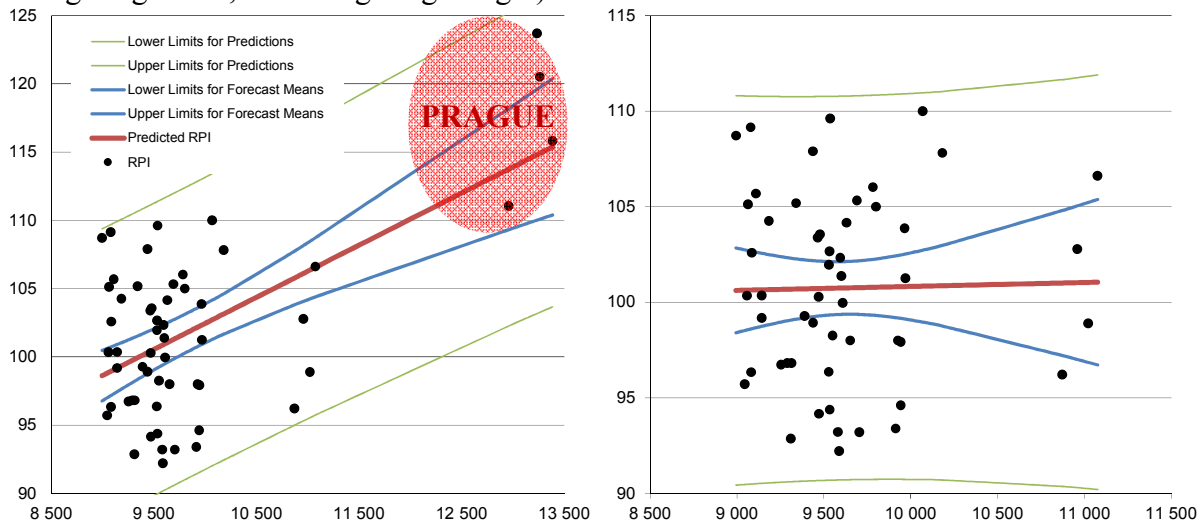
Figure 4
NDHIs in NUTS3 Regions of the Czech Republic, 2009 – 2012



Source: authors' calculations

The outcomes of the correlation analysis are summarized in fig. 5. The left part of the figure demonstrates a rather strong (correlation coefficient = 60.7735 %) and significant (*P*-value = 0.0000) direct trade-off, but also shows a group of extreme outliers formed by the results of Prague region. Due to these outliers the data set does not conform to the requirement of normal distribution (elementary presumption of correlation analysis) and the results therefore cannot be accepted. After excluding Prague region from the data set, significant trade-off between the regional RPIs and NDHIs disappears at the 5% level of significance. The slope of the correlation line in the right part of the fig. 5 does not differ significantly from zero (*P*-value = 0.8834) and the correlation coefficient drops to 2.08364 %.

Figure 5
Correlation of RPIs and NDHIs in the NUTS3 Regions, 2009 – 2012 (including Prague left, excluding Prague right)



Source: authors' calculations

The second hypothesis of this article is focused on validations of the statistically significant influence of regional price levels on the extent of recorded interregional social-economic disparities. For this purpose, the nominal values of regional NDHIs per capita were refined by the RPIs. The resultant values of real NDHIs per capital were calculated for all regions and years 2009 – 2012. The results of Brown-Forsythe test on homogeneity of variance are summed up in the table 1. Since the *P*-value exceeded the 5% level, the null hypothesis of homogeneity of variances cannot be rejected. Thus, we can conclude the RPIs do not reassess the regional disparities significantly. The interregional differences measured by nominal NDHI per capita are wider than the real disparities, but not significantly higher.

Table 1
Results of the Brown-Forsythe test on homoscedasticity (incl. Prague)

Nominal NDHI variance	875,057.46	Real NDHI variance	547,967.23
Statistic *W*	0.03089	Critical *F* (0.05, 1, 110)	3.92739
P-value	0.86082	Alpha	0.05000

Source: authors' calculations

Nevertheless, the results of the Brown-Forsythe test are again biased by extreme values (outliers) recorded by capital region of the Czech Republic, Prague. Once these values are removed from the analysis, the conclusions of the Brown-Forsythe test change dramatically (see table 2). The *P*-value indicates, the variance of nominal NDHIs across the non-metropolitan (Prague excluded) regions of the Czech Republic is significantly smaller than the variance of real NDHIs.

Table 2
Results of the Brown-Forsythe test on homoscedasticity (excl. Prague)

Nominal NDHI variance	241,382.00	Real NDHI variance	437,224.68
Statistic *W*	4.74628	Critical *F* (0.05, 1, 110)	3.93425
P-value	0.03167	Alpha	0.05000

Source: authors' calculations

The Levene's test gives in this case very similar results.

The correlation analysis across all regions of the Czech Republic verified the statistically significant trade-off between the RPIs and NDHIs, when higher NDHIs imply higher RPIs. This finding is, however, fundamentally biased by the outliers of Prague region. Following the requirement of normal distribution of the data, the outlying records were removed and in the statistical sample of 13 regions of the Czech Republic (excluding Prague), the hypothesis of significant trade-off among NDHI and RPI was **not confirmed**. In other words, the regions of the Czech Republic do not show any strong linkage between the levels of net disposable household income per capita and the regional levels of consumer prices (at the 5% level of significance).

In the second step of the analysis, the variability of the statistical set of regional nominal NDHIs per capita was tested against the variability of the regional real NDHIs per capita. The significant impact of application of RPI was verified at the 5% level of significance, but was again sensitive to the outliers. The nominal indicator of social-economic position of an

average individual in the NUTS3 region of the Czech Republic recorded significantly lower variability than the real indicator when the metropolitan region of Prague was excluded from the analysis. Thus, the differences in prices across regions increase the interregional disparities and to some extent deteriorate the social-economic situation of inhabitants of problematic regions of the Czech Republic.

Spatial assessment of the relative regional price differences has the potential of improving the understanding of some of the market problems and represents an important mean of more precisely targeted interventions of economic policy. The regional price levels play a crucial role in consumers' decision making, in localization of economic subjects, and as such can influence the extent of regional disparities.

More precise definition of localities as well as methods of assessing the real economic and social disparities (using the regional price index) is desirable for increasing the efficiency of applied instruments of regional policies. It seems useful to focus the policies of regional development on the real social-economic situation of the individuals and implicitly on the position of geographically determined region.

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Appendix

Indicate any attachments beginning annex part on a separate page. The labeling and numbering of annexes same rules apply as for tables and figures (section 2. Format guidelines).