Estimation of Regional Price Levels in the Districts of the Czech Republic

Aleš Kocourek [1] | *Technical University in Liberec, Liberec, Czech Republic*
Jana Šimanová | *Technical University in Liberec, Liberec, Czech Republic*
Jiří Šmída | *Technical University in Liberec, Liberec, Czech Republic*

Abstract

The aim of this article is to suggest and to apply a method for estimation of the regional price levels in Czech districts. Its purpose is to enable an assessment of spatial differences in the regional price levels and thereby to provide an instrument for more precise and more realistic comparison of standard of living of households across the regions of the Czech Republic. Authors use data from the extensive price surveys carried out by the Czech Statistical Office and regionalize them by an original approach derived from the Eurostat-OECD International Comparison Program and certified by the Ministry of Regional Development of the Czech Republic. The results reflect regional differences in market prices of goods, services, as well as housing and rentals. The findings underpin the need of a more accurate specification of economic and social disparities on a regional level originating in the recent shifts of regional policies from localities-and-areas-centered to local-people-centered.

Keywords

Consumer Behavior, Household Expenditure, Price Level, Regionalization, Törnqvist Index

JEL code

R11, R21

INTRODUCTION

The regional policies of the European Union (EU) are targeted among others at sustainable development of regions and improving the citizen's quality of life (Terem et al., 2015). The regional convergence has been one of the major issues of economic analyses, while almost a third of the EU budget is set aside for the cohesion policy (EC, 2015). The primary indicator for assessment of regional economic performance is the regional gross domestic product compared on the European level in so-called purchasing parity standard (PPS). The PPS is calculated by the Eurostat within the Eurostat-OECD International Comparison Program on the national level and as such it does not take into account the differences in price levels across the regions (Čadil and Mazouch, 2011). Although the regional price levels may constitute an important factor when assessing the economic development of a region, this issue has until recently not received much attention either in the world, in the EU, or in the Czech Republic (Čadil et al., 2014).

[1] Technical University of Liberec, Studentská 1402/2, 461 17 Liberec 1, Czech Republic. Corresponding author: e-mail: ales.kocourek@tul.cz, phone: (+420)724437341.

The first attempts to measure the regional price levels in the Czech Republic have been carried out by Musil et al. (2012) and Čadil et al. (2014). The aim of this paper is to update and rectify their results using slightly more advanced methods of calculation and data processing. The purpose of this paper is to introduce a transitive superlative indicator of regional price levels (Regional Price-level Index, *RPI*) as an instrument for estimating the real standard of living in the Czech regions. Čadil et al. (2014) discuss the possibility of using their regional price-level indicator to adjust the regional nominal gross domestic product, we, however, aim mainly at the regional households and their real socioeconomic position.

The paper is divided into three major parts: At first, we discuss several approaches to regional price-level estimates applied in the world, in some EU countries, and also in the Czech Republic. In the second part, we introduce our method of data processing and calculation derived from the Eurostat-OECD International Comparison Program. Then, we comment our results and compare them to those published by Musil et al. (2012) and Čadil et al. (2014).

1 IMPORTANCE AND TOPICALITY

The need to measure regional price levels originated in the new concept of regional policies which should be generally focused more on the people living in the region than on the area of the region (Gibbons et al., 2011). The problem is that the nominal income indicators provide distorted information about social and economic position of inhabitants of a region because they do not reflect the regional differences in the costs of living. After all, even Kahoun (2011) and Viturka (2007) admit the price levels can vary locally and regionally, especially due to different prices of services and real estate.

In the last ten years, the issue of regional price levels has been addressed by several authors, whose works are often based on regionalization of national price indexes. In the European countries, the attempts to regionalize the price indexes are usually hindered by insufficient or random investigation of prices in the respective regions. At present, the regional price levels are systematically measured and published in the USA, in the UK, and in Australia.

- The Bureau of Labor Statistics in the United States is the most ambitious one in the area of regional price levels. They use the hedonic regression extensively to determine the regional consumer baskets under the condition of constant households' utility across the country. They also apply the methods of the rent equivalent to estimate the prices of services connected with housing. Their consumer basket includes 800 representatives. The results are published every two years. Regional price index is calculated for 366 metropolitan areas which are defined by an urban center of more than 50 000 inhabitants. They also calculate the price levels for whole individual states using weighted geometric mean of the corresponding metropolitan indexes (Aten and d'Souza, 2008; Aten et al., 2013).
- In 2011, the Australian Bureau of Statistics extended the list of areas for price survey by 22 cities and since then, they publish the regional price index for 30 city districts. The consumer basket contains 500 representatives divided into 8 headings. Results are published every second year (RDL.WA, 2011; Waschka et al., 2003).
- The Office of National Statistics in the United Kingdom has been publishing the results of the spatial price comparison every two years since 2000. Their consumer basket consists of 380 representatives surveyed in 65 regions. The collection of data is carried out by a commercial marketing company Research International (Fenwick and O'Donoghue, 2003; Ball and Fenwick, 2004).

In Germany, the published estimates of regional price levels are based on price survey carried out in 50 German cities in 1994. The first German author, who exploited the price investigation from the viewpoint of regional price levels, was Ströhl (1994). His followers, Schultze (2003), Kosfeld et al. (2008), Kosfeld and Eckey (2010), and Roos (2006a, 2006b) look for possible ways of price level estimation in the regions where they have explanatory data at their disposal. They frequently apply econometric modelling

and complement the calculation of regional price levels with a real estate price index (Roos, 2003; Kosfeld et al., 2008; Kosfeld and Eckey, 2010). Other, often one-off attempts to calculate the regional price levels have been carried out in Italy (Pittau, Zelli; and Massari, 2006), China (Brandt and Holz, 2006) or (Gong and Meng, 2008), Austria (Matzka and Nachbagauer, 2009) or also in Slovakia (Radvanský and Fuchs, 2009).

In the Czech Republic, the regional price levels were estimated by Musil et al. (2012) on a common consumer basket and by Čadil et al. (2014) on a set of regional consumer baskets. They applied the Eurostat-OECD International Comparison Program methods with a certain simplification. They used a national concept (rather than domestic) and calculated the regional price levels for the Czech regions (NUTS 3) based on the historical data from 2007 (Musil et al., 2012; Čadil et al., 2014).

2 METHODS AND DATA SOURCES

The process of *RPI* construction was certified by the Ministry of Regional Development of the Czech Republic in December 2015. It is based on the Eurostat-OECD International Comparison Program methods and its core is therefore similar to the approach applied by Musil et al. (2012) and Čadil et al. (2014). The major differences appear in the following five aspects.

2.1 Area Segmentation for Regional Price Level

Without any doubt, the segmentation of the area into smaller spatial units is always more appropriate as it provides more detailed information and offers a possibility to target the regional policies more accurately. In the Czech Republic (as elsewhere), reliable estimates are limited by the data available from price surveys (for the purpose of the construction of the national consumer price index) and from household expenditure surveys (Household Budget Survey).

- The Czech Statistical Office performs price surveys in 35 districts and in the Capital of Praha, i.e. on the level of selected LAU 1 (formerly NUTS 4). These data are the main source for the *RPI* calculation and therefore their localization will be respected. Raw monthly data from price surveys in 2011–2013 were used.
- Household expenditures in the classification of individual consumption by purpose (CZ-COICOP) are recorded only on the level of cohesion regions (NUTS 2). Thus, the Household Budget Survey represents the only official data source on regional household expenditure structure.

The primary spatial level selected for our calculations are the former districts (LAU 1). The expenditure weights for these lower territorial administrative units will be approximated (see 2.3 for details).

2.2 Price Data Adjustment

The prices are investigated by the Czech Statistical Office in 35 districts (LAU 1) and the Capital of Praha for approximately 700 price representatives. The main purpose of this price investigation is the construction of time indexes (national consumer price index). Thus, the diversity of varieties[2] investigated for each price representative is an advantage here, because it increases the robustness of the basic set for the calculation of the consumer price index.

We use the same price data, but for a brand new purpose – to calculate the regional price levels. Therefore, the spatial diversity of the investigated varieties of each price representative is undesirable and

[2] Here, *variety of a price representative* is a concrete and in the reporting unit permanently investigated product or service respecting specific conditions of the offer at the place of investigation which do not deviate from the characteristics (general description) of the price representative.

can significantly bias the results. In each region, identical or qualitatively very similar goods should be surveyed so that the spatial comparability is ensured. In this respect, the headings containing the price representatives of a wide range of qualitatively different varieties are the most questionable – typically these are clothing and footwear (Heading 03) and furnishing, household equipment, and routine maintenance of the house (Heading 05).

The procedure of raw data adjustment (from monthly surveys carried out in 2011–2013) was divided into three steps:

- Qualitative adjustment: All prices surveyed for each price representative were clustered into several varieties using a specialized text-mining software based on the principles of Levenshtein distance chain metric. This procedure analyzed the text information in "notes" attached to each of the 1 717 102 surveyed prices from years 2011–2013. Obtained varieties were then checked and rectified manually. The 560 price representatives[3] surveyed by the Czech Statistical Office regionally were split into 4 673 varieties.
- Quantitative adjustment: The three-sigma rule was applied repeatedly in each year and each region (LAU 1) on each variety of a price representative to remove the outliers. This procedure is inspired by Eurostat (2012) and represents a tool for removing errors in the data file and ensuring higher qualitative homogeneity of each variety.
- Completing the data matrix: Similarly to Eurostat (2012), where products in each basic heading are classified as representative or non-representative, we decided to choose for each price representative one characteristic variety (which was surveyed in the most of the districts). In those regions, where the characteristic variety of a price representative was not surveyed, its price was estimated using the least square method according to the prices of non-characteristic varieties of the same price representative (similar to the method of bridging – see Eurostat, 2012), according to the price of characteristic and non-characteristic varieties in other regions (similar to approach of Musil et al., 2012) and/or according to the development of the price in time (methods of panel data analysis). If filling the gaps of the data matrix failed for a particular price representative in any region (LAU 1), it was completely removed from further computation (which was the case for 68 price representatives).

2.3 Expenditure Weights

The selection of expenditure weights influences the results, index interpretation, and also its application. If national weights are used, indexes have a form of comparison on the basis of fixed consumer basket and the index does not reflect individual consumer habits of regional households. The disadvantage of such a procedure is that if expenditure shares (or more generally weights) are related to another set of households, it is not possible to speak about an index on the basis of regional cost of living. The method of fixed basket decreases regional distinctiveness of the result.

The comparison on the basis of regional weights brings more illustrative results, better reflecting the regional specifics in consumer behavior, but it requires transitivity of price indexes. The most widely used method of transitivity implementation is Éltető-Köves-Szulc method (EKS). The EKS method ensures transitivity by means of geometric averages of all direct and indirect price comparisons (for more details see Eurostat, 2012).

The only source of official information about regional household expenditures in relation to their income in the Czech Republic is the Household Budget Survey. The data are investigated on a set of

[3] Out of the 700 price representatives included in the Czech consumer basket; some are investigated centrally (such as prices of electricity, gas, etc.) and some record regionally constant price (such as cigarettes, post stamps, etc.).

2 850 households selected by quota sampling. Regional results are published only on NUTS 2 level (which in the case of Moravskoslezský region and the Capital of Praha corresponds with the regional level NUTS 3) and therefore the weights on the level of NUTS 3 and LAU 1 had to be estimated. We applied the Small Area Estimation method (see e.g. Pfeffermann, 2002; or Rao and Molina, 2015) based on multiple linear regression to the weight structure of twelve CZ-COICOP Headings. The results show the regional differences in structure of household expenditures in all districts of the Czech Republic. Unfortunately, the expenditures of households are underestimated by the Household Budget Survey in some cases. Typically, CZ-COICOP Heading 02 (Alcoholic Beverages and Tobacco) has the weight of 2.6% according to Household Budget Survey, but 9.6% according to the national CPI basket. Therefore, the estimated regional weight structure of the twelve CZ-COICOP Headings had to be adjusted so that it reflects the regional differences, but also matches the CPI basket when aggregated to the national level (Kramulová and Musil, 2013).

The weight decomposition of the CZ-COICOP Headings of regional baskets down to the level of the individual price representatives was then carried out by linear approximation based on shares of the representatives in the national basket used for consumer price index calculations.

Following the payment method suggested by Melser and Hill (2007), we decided to replace the imputed rent in the CZ-COICOP Heading 04 of the consumer basket with expenditures on households' own dwelling financed by mortgages. The intention is to incorporate into the index the real expenditures on the repayment of mortgages, which affect the purchasing power of Czech households with increasing significance. The mortgage repayments are characterized by higher regional variability as they are influenced by the price of real property including land (plots). In the years 2011–2013, approximately CZK 115 billion was allocated annually for the repayment of mortgages according to authors' calculations. Data for these calculations were provided by the Czech National Bank, the Ministry of Regional Development, and the Ministry of Finance of the Czech Republic. The General Financial Directorate of the Ministry of Finance of the Czech Republic was the source of data about applied interests as a part of income tax return of physical persons which enabled detailed segmentation of the mortgage repayments to the regional level of LAU 1. For details on application of the payment method see Kraft et al. (2015).

2.4 Period and Frequency of Investigation

The current approaches to regional price level estimation and the results published e.g. by Slesnick (2002) or Tabuchi (2001) show, the regional differences in prices are rather stable over time. To ensure the consistency of the data in the Czech Republic (the rent deregulation started in 2011 and the data on household expenditures in CZ-COICOP classification are available for the NUTS 2 since 2011), we suggest computing the regional price levels for a period 2011–2013. Since the procedure of qualitative data adjustment is very time-consuming and capacity-demanding, we recommend to repeat the procedure in at least three-year (but preferably longer) periods. The longer time span offers more data and thus increases robustness of the results.

2.5 Aggregation Method

The method of price aggregation of individual price representative into one overall number is generally a formula for the calculation of a price index. An index which is intended to be used as a spatial index should include information about weights from different areas, it means it should be superlative.

Generally, three superlative indexes are distinguished: Fisher, Törnqvist, and Walsh index. Fisher ndex is a geometric average of Laspeyres and Paasche indexes. Törnqvist index is a geometric average of geometric Laspeyres and geometric Paasche indexes. Walsh index compares expenditures on the purchase of an average consumer basket which is a geometric average of consumer baskets of regions *A* and *B* (Melser and Hill, 2007).

Unlike Fisher index, the Törnqvist index (and also geometric Laspeyres and Paasche index) has an extra quality as it can be decomposed so that the share of each price representative (or of any CZ-COICOP Heading) in the total price level can be easily determined. The use of EKS method when calculating unweighted price parities and the choice of Törnqvist index for aggregation enable better economic interpretation of results due to the relative representation of the expenditure function. The EKS method along with the application of a superlative index reflects the substitutional effect. A price index created in the way described above complies with the condition of transitivity and also satisfies the condition of characteristicity (Eurostat, 2012).

The calculation of the Regional Price-level Index (*RPI*) starts by computing the unweighted price parities. We follow the EKS method simplified by the fact that our price matrix is complete and all price representatives are characteristic in all regions (although in some of the regions their prices had to be estimated). Thus, the unweighted price parity of a region *A* can be written as:

$$p_A = \left(\prod_{k=1}^{36} P_{A,k} \right)^{1/36}, \tag{1}$$

where $P_{A,k}$ is the ratio of the price of the representative (more precisely of a characteristic variety of the price representative) in the region *A* to the price of the same representative in the *k*-th region, where $k = 1,2,\ldots,36$; p_A is the unweighted price parity of the region *A* on the level of a particular price representative (its characteristic variety).

In the next step, the geometric Laspeyres and Paasche price indexes are calculated (Eurostat, 2012). The geometric Laspeyres index (2) is a weighted geometric mean of unweighted price parities of a region *A* using the weights of the region *A*. The Paasche geometric price index (3) is a weighted geometric mean of unweighted price parities of a region *A* using the weights of the benchmark region *B*.

$$P_A^{GL} = \prod_{n=1}^{N} \left(p_A \right)^{s_n^A}, \text{ where } \sum_{n=1}^{N} s_n^A = 1, \tag{2}$$

$$P_A^{GP} = \prod_{n=1}^{N} \left(p_A \right)^{s_n^B}, \text{ where } \sum_{n=1}^{N} s_n^B = 1, \tag{3}$$

where *A* is the particular region, *B* is the benchmark region (here characterized by an average regional expenditure structure corresponding to the national expenditure structure of the *CPI*), P^{GL} is geometric Laspeyres index and P^{GP} is geometric Paasche index, p_A is the unweighted price parity of the region *A* on the level of a particular price representative, s_n is the share of a particular price representative *n* (from a basket of *N* representatives) on the total household expenditures.

The regional price level is calculated into the shape of an index number using the Törnqvist price index:

$$RPI_A = P_A^T = \sqrt{P_A^{GL} P_A^{GP}}, \tag{4}$$

where $RPI_A = P_A^T$ is Törnqvist regional price-level index for a region *A*.

The properties of the *RPI* enable to recalculate its values to the level of region NUTS 3 and cohesion region NUTS 2 as a geometric weighted average of district (LAU 1) indexes, where the weight is the proportion of the particular LAU 1 total household expenditures on the total household expenditures in the corresponding NUTS 3 or NUTS 2 region.

Since the coverage of regions (NUTS 3 or NUTS 2) by the price surveys of the Czech Statistical Office is rather uneven, it was necessary to estimate the price levels of the remaining districts. We followed a procedure similar to Roos (2006b), but estimated the partial regional price levels for each of the twelve

CZ-COICOP Headings (RPI_{COI}). We processed data of fifty potential predictors available for the period 2011–2013 for all 78 districts (LAU 1) of the Czech Republic (including the Capital of Praha). Unfortunately, neither average wage, nor net disposable household income were available at the time of estimation on the LAU 1 level. Data on average income after taxation were provided by the General Financial Directorate of the Czech Republic at the regional breakdown corresponding to LAU 1.

For higher robustness, the *RPI* is calculated as a mean value for a three-year period, therefore, also all the predictors are three-years averages. Data for all the predictors were recalculated so that they express the mean share of a certain district when bilaterally compared to all other districts of the Czech Republic. For each CZ-COICOP Heading, we tested a specific group of potential predictors whose relation to a particular RPI_{COI} seemed relevant and reasonable. We used stepwise procedure when building our models to control for multicollinearity (and we ran tests for multicollinearity among the potential predictors) and we also checked whether the sign on each predictor in the model matches with the common sense and logical anticipations. The selected predictors are listed in Table 1.

Table 1 List of Predictors and Their Codes

Code	Explanation
$pop_{15\text{-}60}$	Share of population at the age from 15 to 60 years
$pop_{<5K}$	Share of population living in cities with less than 5 000 inhabitants
$pop_{>20K}$	Share of population living in cities with more than 20 000 inhabitants
pop_{dis}	Share of population living in the district city
dens	Specific population density
income	Share of average income of economically active person in the district to an average income in the Czech Republic
unemp	Share of unemployed persons on economically active population
phys	Count of physicians per 100 000 inhabitants
house	Average market price of a dwelling
$road_{high}$	Number of kilometres of highways/motorways per 10 000 inhabitants
$road_{1st}$	Number of kilometres of 1st class roads per 10 000 inhabitants
BU_{ind}	Number of individual business units based in the district per 1 000 inhabitants
BU_A	Number of business units operating in agriculture, forestry, and fishery per 1 000 inhabitants
BU_G	Number of business units operating in wholesale and retail trade per 1 000 inhabitants
BU_H	Number of business units operating in transportation and storage per 1 000 inhabitants
BU_I	Number of business units operating in the field of accommodation and food service activities per 1 000 inhabitants
BU_L	Number of business units operating in the field of real estate activities per 1 000 inhabitants
BU_R	Number of business units operating in the field of arts, entertainment, and recreation per 1 000 inhabitants

Source: Own construction

The outcomes of our estimations are summed up in the following set of equations (5)–(16). The statistical significance of all the parameters was proved at the 95% confidence level by *t*-test and the statistical reliability of the model was verified by *F*-test at the same confidence level. All models of the partial regional price-level indexes for CZ-COICOP Headings (RPI_{COI}) also passed the Durbin-Watson test on residual autocorrelation.

$$RPI_{COI01} = 0.991 - 0.020dens + 0.048income - 0.018BU_A \quad (5)$$

$$RPI_{COI02} = 1.069BU_{ind} - 0.026BU_I - 0.044BU_R \quad (6)$$

$$RPI_{COI03} = 0.041income + 1.002BU_{ind} - 0.043BU_G \quad (7)$$

$$RPI_{COI04} = 0.721 + 0.292house - 0.023BU_L \quad (8)$$

$$RPI_{COI05} = 0.961 + 0.148pop_{dis} - 0.107BU_G \quad (9)$$

$$RPI_{COI06} = 1.952 - 0.977pop_{15-60} + 0.013pop_{>20K} + 0.055income - 0.062phys \quad (10)$$

$$RPI_{COI07} = 0.906 - 0.040road_{1st} + 0.135BU_H \quad (11)$$

$$RPI_{COI08} = 1.035 - 0.022pop_{<5K} - 0.011dens \quad (12)$$

$$RPI_{COI09} = 1.060 + 0.003dens - 0.601unemp \quad (13)$$

$$RPI_{COI10} = 0.527 + 0.268pop_{dis} + 0.193income \quad (14)$$

$$RPI_{COI11} = 0.931 + 0.101income - 0.034road_{high} \quad (15)$$

$$RPI_{COI12} = 0.933 + 0.113pop_{dis} - 0.052BU_A \quad (16)$$

The aggregation of the twelve fractional regional price-level indexes for each CZ-COICOP Heading (RPI_{COI}) to the overall value of regional price-level index followed a procedure analogical to aggregation of the *RPI* itself.

Achieved values of adjusted coefficients of determination ($R^2_{adj.}$) and of standard errors of estimates (SEE) are summed up in the Table 2. Their values indicate varying, but still acceptable statistical qualities of the twelve regression models as well as of the whole *RCI* estimates.

Table 2 Adjusted Coefficients of Determination (R2adj.) and Standard Errors of Estimates (SEE)

	RPI	*COI01*	*COI02*	*COI03*	*COI04*	*COI05*	*COI06*	*COI07*	*COI08*	*COI09*	*COI10*	*COI11*	*COI12*
$R^2_{adj.}$	**0.801**	0.358	0.272	0.299	0.743	0.232	0.247	0.598	0.225	0.354	0.645	0.364	0.451
SEE	**0.012**	0.016	0.015	0.040	0.032	0.021	0.034	0.029	0.009	0.026	0.073	0.046	0.037

Source: Own construction

The signs of the predictors in the equations (5)–(16) induce the following findings: Income (*income*) and housing prices (*house*) tend to increase the price levels, while unemployment (*unemp*) and also share of economically active population ($pop_{15\text{-}60}$) pull the prices down (larger share of population in economically active age tends to decrease the demand for health-care services). All of them represent the demand-side factors.

Share of population living in the district city (pop_{dis}) or in large cities ($pop_{>20K}$), as well as the overall number of individual business units (BU_{ind}) represent the agglomeration factors and increase the price levels. Intensity of competition in particular industries and sectors (*phys*, BU_A, BU_G, BU_H, BU_I, BU_L, or BU_R) and the quality of infrastructure in the districts ($road_{high}$ and $road_{1st}$) are identified as the supply-side factors contributing to lower price levels (Kraft, 2015).

Only the specific density of population falls in some cases to the group of agglomeration factors increasing the price levels, while in other cases its supply-side features prevail, decreasing the regional price levels (higher specific density of population probably makes it easier and cheaper to supply the products and services to the customers).

3 RESULTS

The results of our calculations are recorded in the Table 3 bellow. They indicate that the differences in the regional price levels are to the highest extent influenced by the CZ-COICOP Heading 04 (Housing, Water, Gas, Electricity, and Other Fuels), Heading 10 (Education), and Heading 11 (Restaurants and Hotels) – i.e. immobile commodities.

Table 3 Regional Price-Level Index (RPI) and Its Breakdown to CZ-COICOP Headings

Code	District	***RPI***	*COI01*	*COI02*	*COI03*	*COI04*	*COI05*	*COI06*	*COI07*	*COI08*	*COI09*	*COI10*	*COI11*	*COI12*
CZ0100	Praha	1.171	1.012	1.007	1.057	1.424	1.007	1.047	1.158	1.009	1.099	1.472	1.117	1.130
CZ0201	Benešov *	1.022	1.003	1.029	1.029	1.063	1.014	0.997	1.039	0.996	1.019	1.051	0.905	0.989
CZ0202	Beroun *	1.044	1.016	1.007	1.011	1.116	1.000	0.993	1.103	0.994	1.013	1.050	0.945	1.020
CZ0203	Kladno	1.046	1.004	0.995	0.982	1.108	0.988	1.055	1.030	0.985	1.005	1.214	1.044	1.082
CZ0204	Kolín	1.039	1.037	1.020	1.060	1.062	0.976	1.029	1.008	1.005	1.060	1.091	1.019	1.041
CZ0205	Kutná Hora *	1.017	1.009	1.011	1.001	1.057	0.999	1.023	0.997	1.000	0.989	0.987	1.013	0.998
CZ0206	Mělník *	1.038	1.007	1.009	1.002	1.114	1.001	0.981	1.067	1.003	1.000	1.002	0.999	1.004
CZ0207	Mladá Boleslav *	1.027	1.022	0.989	0.995	1.091	0.985	0.997	0.971	1.002	1.025	1.039	1.041	1.013
CZ0208	Nymburk	1.022	1.022	1.016	1.026	1.096	1.011	0.942	0.984	1.011	0.986	1.048	0.930	0.958
CZ0209	Praha-východ *	1.102	1.059	1.024	1.060	1.244	1.000	1.059	1.131	0.992	1.041	1.264	1.076	1.041
CZ020A	Praha-západ *	1.123	1.056	1.024	1.065	1.308	1.008	1.072	1.137	0.984	1.040	1.291	1.137	1.054
CZ020B	Příbram	1.028	1.010	0.990	1.054	1.037	1.005	1.074	1.029	0.998	1.034	1.022	1.026	1.040
CZ020C	Rakovník *	1.002	0.999	0.993	0.983	1.024	0.992	0.978	1.000	0.998	0.995	0.976	1.008	0.975
CZ0311	České Budějovice	1.027	1.033	0.987	1.043	1.035	1.026	0.979	1.020	1.000	1.053	1.046	1.067	0.985
CZ0312	Český Krumlov *	0.978	0.982	0.972	1.017	0.954	1.037	0.957	0.966	0.990	0.993	1.010	1.009	0.966
CZ0313	Jindřichův Hradec *	0.977	0.992	0.987	0.999	0.966	1.012	1.005	0.905	0.998	1.012	0.984	1.011	0.959
CZ0314	Písek *	0.992	1.002	0.998	1.014	0.984	1.017	1.042	0.932	1.006	1.011	1.015	1.018	0.983
CZ0315	Prachatice *	0.973	0.969	0.993	1.013	0.946	1.027	0.967	0.956	0.994	1.019	1.002	1.005	0.920
CZ0316	Strakonice	0.977	1.032	0.980	0.939	0.955	1.022	0.970	0.917	1.011	0.985	0.924	0.982	0.976
CZ0317	Tábor	1.000	1.002	0.995	1.069	0.977	0.990	0.976	1.001	0.994	0.986	0.959	1.076	1.028
CZ0321	Domažlice *	0.978	0.995	0.980	0.984	0.946	0.991	0.985	0.986	0.991	1.004	0.962	0.999	0.982
CZ0322	Klatovy	0.959	0.977	0.990	0.960	0.914	1.018	1.006	0.945	1.005	0.993	0.987	1.029	0.943
CZ0323	Plzeň-město	1.037	1.013	1.006	0.992	1.071	0.986	0.975	1.039	1.001	0.993	1.262	1.073	1.077
CZ0324	Plzeň-jih *	0.995	1.003	1.003	0.994	0.991	0.998	0.984	0.980	0.989	1.018	0.974	1.008	0.968
CZ0325	Plzeň-sever *	1.003	1.001	1.016	1.002	1.017	0.998	1.001	0.990	0.981	1.011	0.982	0.967	0.984
CZ0326	Rokycany *	1.010	1.007	1.006	1.004	1.016	0.996	0.993	1.085	0.991	1.018	1.014	0.889	0.996
CZ0327	Tachov *	0.963	0.982	0.985	0.977	0.932	0.992	0.942	1.044	1.003	0.982	0.978	0.779	0.952
CZ0411	Cheb	0.970	0.999	1.013	0.929	0.907	0.990	0.980	0.997	1.006	1.018	0.975	1.020	0.997
Z0412	Karlovy Vary	0.995	0.993	1.015	1.131	0.947	1.029	0.971	1.052	1.002	1.016	1.118	0.921	1.019
CZ0413	Sokolov *	0.963	0.979	0.993	0.972	0.896	0.986	0.967	0.999	0.998	0.986	0.898	0.982	1.006
CZ0421	Děčín	0.993	1.007	0.962	0.989	0.915	1.019	1.013	1.048	1.016	1.008	0.914	1.016	1.105
CZ0422	Chomutov *	0.947	0.992	0.975	0.968	0.848	0.984	0.999	0.981	1.013	0.975	0.918	0.996	1.004
CZ0423	Litoměřice *	0.992	0.998	1.007	0.997	0.975	1.003	0.997	1.012	1.000	0.989	0.968	0.958	1.001
CZ0424	Louny *	0.971	1.001	0.993	0.981	0.929	0.990	0.978	0.960	1.006	0.970	0.946	1.002	0.988
CZ0425	Most *	0.943	0.981	0.984	0.962	0.836	0.970	1.031	0.986	1.006	0.968	0.905	0.986	1.023
CZ0426	Teplice	0.999	1.010	1.001	0.968	0.969	0.975	1.015	1.074	1.000	0.984	0.938	1.011	1.024

End of Table

Table 3 Regional Price-Level Index (RPI) and Its Breakdown to CZ-COICOP Headings

Code	District	***RPI***	*COI01*	*COI02*	*COI03*	*COI04*	*COI05*	*COI06*	*COI07*	*COI08*	*COI09*	*COI10*	*COI11*	*COI12*
CZ0427	Ústí nad Labem	0.972	0.976	0.995	0.939	0.938	0.909	0.984	1.038	1.016	0.983	1.027	0.943	1.023
CZ0511	Česká Lípa *	0.984	0.994	1.006	0.997	0.953	0.998	0.991	0.979	1.006	0.984	0.946	0.989	1.010
CZ0512	Jablonec n. Nisou *	1.001	0.991	1.013	1.020	0.984	1.011	1.038	0.988	1.002	1.014	1.013	1.001	1.042
CZ0513	Liberec	1.043	0.994	1.008	1.067	1.076	1.030	1.049	1.042	1.009	1.027	1.083	1.052	1.061
CZ0514	Semily *	1.008	0.997	0.987	1.028	1.036	1.017	0.987	0.982	0.998	0.998	1.042	1.022	0.992
CZ0521	Hradec Králové	1.056	1.016	1.023	1.001	1.164	0.977	1.051	1.040	1.027	0.987	1.028	1.064	0.980
CZ0522	Jičín *	1.008	1.005	1.009	1.005	1.024	0.998	0.983	0.992	1.001	1.009	1.003	1.010	0.999
CZ0523	Náchod	0.983	1.001	1.005	0.988	0.985	0.977	1.064	0.977	0.994	0.979	0.943	0.950	0.941
CZ0524	Rychnov n. Kněž. *	0.998	1.002	0.999	1.000	1.000	0.997	0.998	0.983	0.998	1.015	0.989	1.015	0.976
CZ0525	Trutnov *	0.993	0.994	0.988	1.006	0.993	1.006	1.009	0.957	1.002	1.000	0.992	1.004	1.002
CZ0531	Chrudim	0.977	1.017	1.002	0.951	0.957	0.973	0.985	0.966	0.993	1.022	0.983	1.027	0.913
CZ0532	Pardubice	1.045	1.016	1.027	1.070	1.055	1.012	1.047	1.049	1.007	1.039	1.148	1.099	1.067
CZ0533	Svitavy *	0.978	0.997	0.994	0.982	0.965	0.994	0.965	0.931	0.998	0.990	0.942	1.007	0.977
CZ0534	Ústí nad Orlicí *	0.986	1.000	0.995	0.989	0.973	0.986	0.986	0.948	1.001	1.007	0.976	1.015	0.992
CZ0631	Havlíčkův Brod *	0.978	0.999	0.994	0.992	0.952	1.011	0.997	0.941	1.001	1.003	0.960	1.006	0.967
CZ0632	Jihlava	0.985	0.997	1.007	1.008	0.948	0.999	1.076	1.039	1.008	0.984	0.896	0.953	0.999
CZ0633	Pelhřimov *	0.984	0.997	1.008	1.001	0.959	1.011	0.996	0.969	0.997	1.018	0.992	0.964	0.964
CZ0634	Třebíč *	0.976	0.996	0.991	0.987	0.944	1.011	0.995	0.971	0.997	0.979	0.953	1.010	0.966
CZ0635	Žďár nad Sázavou	0.967	1.000	0.992	0.998	0.943	0.993	0.939	0.969	0.993	0.975	0.973	0.900	0.961
CZ0641	Blansko *	1.001	0.997	0.985	0.984	1.024	1.001	0.994	0.977	0.991	1.007	0.937	1.006	0.989
CZ0642	Brno-město	1.091	1.021	1.014	0.989	1.221	1.015	1.016	0.991	0.999	1.036	1.165	1.164	1.118
CZ0643	Brno-venkov *	1.026	1.010	1.005	1.005	1.074	1.006	1.018	1.037	0.983	1.012	1.020	1.004	0.997
CZ0644	Břeclav *	0.989	0.992	0.996	0.988	0.990	1.002	0.975	1.020	0.993	0.989	0.970	0.924	0.964
CZ0645	Hodonín	0.992	1.001	1.005	0.984	0.986	1.018	0.990	0.972	0.999	0.981	0.953	0.997	1.008
CZ0646	Vyškov *	1.004	0.999	1.006	1.001	1.023	1.011	0.991	1.002	0.998	1.006	0.972	0.938	0.990
CZ0647	Znojmo	0.981	1.009	1.000	1.006	0.940	1.030	1.005	0.947	0.990	0.981	0.829	1.000	1.018
CZ0711	Jeseník *	0.969	0.976	1.010	1.024	0.918	1.034	0.964	0.982	0.990	0.963	0.982	0.992	0.960
CZ0712	Olomouc	1.008	0.986	0.994	1.004	1.017	1.000	0.960	1.042	0.999	0.997	0.954	1.084	0.995
CZ0713	Prostějov *	0.993	1.001	0.988	0.989	0.973	0.993	1.018	1.003	0.994	0.999	0.960	1.015	1.002
CZ0714	Přerov	0.989	0.992	1.013	0.969	0.996	0.993	0.973	0.961	1.003	0.958	0.987	1.063	0.983
CZ0715	Šumperk	0.970	0.971	1.008	1.018	0.962	1.028	1.010	0.946	1.002	0.962	0.800	1.022	0.923
CZ0721	Kroměříž *	0.993	1.002	0.991	0.993	0.979	1.006	0.986	1.006	1.004	0.991	0.970	0.995	0.998
CZ0722	Uherské Hradiště	1.014	1.002	1.017	0.967	1.037	1.015	1.009	0.980	0.977	1.010	0.923	1.020	1.049
CZ0723	Vsetín	1.001	0.991	1.000	1.004	1.038	1.010	1.024	0.989	0.998	0.945	0.932	0.907	1.024
CZ0724	Zlín	1.037	1.007	1.002	0.987	1.112	0.983	0.972	1.030	0.998	0.989	1.110	0.989	1.042
CZ0801	Bruntál	0.938	0.938	0.992	0.986	0.901	0.992	0.990	0.915	1.015	0.939	0.874	0.945	0.948
CZ0802	Frýdek-Místek *	0.998	0.997	0.995	0.983	1.002	0.988	1.001	0.985	0.999	1.013	0.951	1.011	0.996
CZ0803	Karviná	0.975	0.990	0.995	1.011	0.959	0.987	1.026	0.962	1.001	0.944	0.921	0.954	0.993
CZ0804	Nový Jičín	0.979	0.957	0.984	0.980	0.948	1.001	1.031	0.966	1.023	1.016	1.050	0.997	1.036
CZ0805	Opava	1.009	0.984	1.004	0.905	1.061	0.970	0.926	1.045	1.001	0.964	0.957	1.053	0.985
CZ0806	Ostrava-město	1.006	0.992	1.006	1.007	1.015	0.978	1.039	1.043	1.019	1.015	1.074	0.955	0.984

Note: Results for districts with asterisks * are based on estimates.
Source: Authors' calculations, based on CZSO (2014)

Table 4 shows the regional price levels in higher territorial administrative units (region NUTS 3 and cohesion region NUTS 2). Apparently, the price levels are higher in the districts with the most populated, economically strong centers, such as Praha, Brno, Hradec Králové, Pardubice or Liberec (Bednářová, 2015).

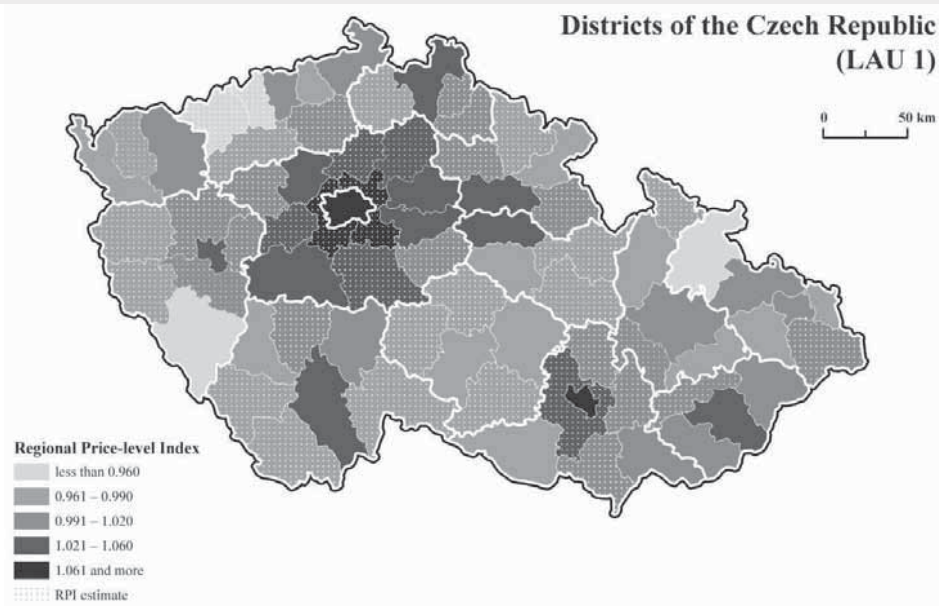
Table 4 Regional Price-Level Index (RPI) at NUTS 3 and NUTS 2 Spatial Segmentation

Code	Region (NUTS 3)	RPI	Code	Cohesion Region (NUTS 2)	RPI
C010	Hlavní město Praha	1.171	CZ01	Praha	1.171
CZ020	Středočeský kraj	1.048	CZ02	Střední Čechy	1.048
CZ031	Jihočeský kraj	0.997	CZ03	Jihozápad	0.998
CZ032	Plzeňský kraj	1.001			
CZ041	Karlovarský kraj	0.977	CZ04	Severozápad	0.975
CZ042	Ústecký kraj	0.974			
CZ051	Liberecký kraj	1.014	CZ05	Severovýchod	1.009
CZ052	Královéhradecký kraj	1.012			
CZ053	Pardubický kraj	1.001			
CZ063	Kraj Vysočina	0.977	CZ06	Jihovýchod	1.013
CZ064	Jihomoravský kraj	1.030			
CZ071	Olomoucký kraj	0.992	CZ07	Střední Morava	1.003
CZ072	Zlínský kraj	1.015			
CZ080	Moravskoslezský kraj	0.989	CZ08	Moravskoslezsko	0.989

Source: Authors' calculations, based on CZSO (2014)

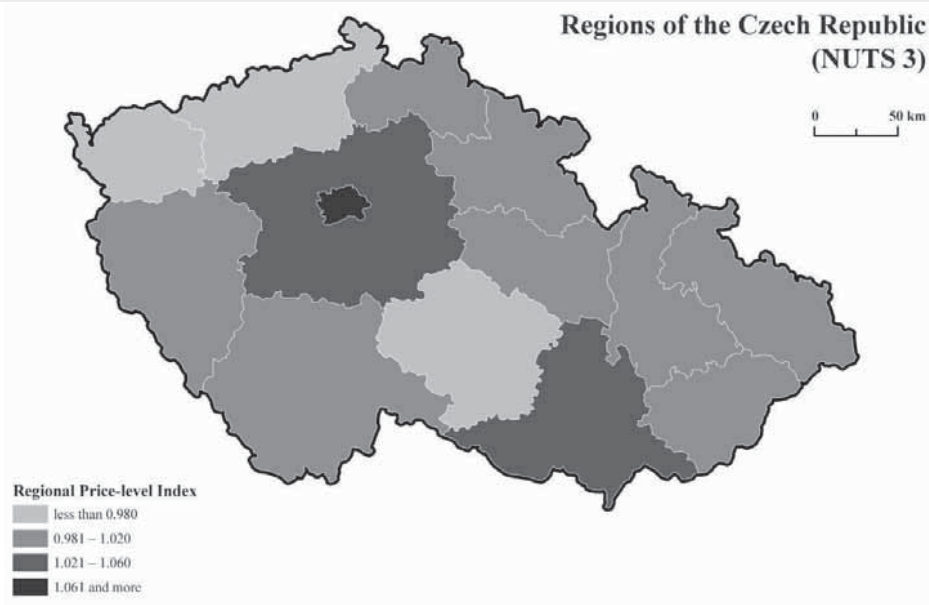
The regional price-level results also reflect themselves well in the structurally affected and economically weak regions (lower price levels in Chomutov, Most, Ústí nad Labem, Šumperk, Bruntál, Karviná, Nový Jičín). Ostrava, Opava or Vsetín remain very close to the mean value (Kocourek et al., 2016). Figure 2 indicates the regional price levels for NUTS 3, while their sources in the districts of the Czech Republic are depicted in Figure 1.

Figure 1 Regional Price Levels at LAU 1 of the Czech Republic in 2011–2013



Source: Authors' own calculations and processing based on ARCDATA (2014), CZSO (2014)

Figure 2 Regional Price Levels at NUTS 3 of the Czech Republic in 2011–2013



Source: Authors' own calculations and processing based on ARCDATA (2014), CZSO (2014)

It is apparent, our results indicate smaller regional variability in price levels than those published by Musil et al. (2012) and Čadil et al. (2014). The standard deviation of our regional price levels is 0.0480 (at the NUTS 3 level), while Musil et al. (2012) recorded 0.0599 and Čadil et al. (2014) even 0.0640. Among reasons explaining these differences, the following are worth mentioning:

1. We performed careful qualitative adjustment of the raw data, which ensures the goods and services are comparable across the regions or districts of the Czech Republic. Therefore, the distortion of results caused by different quality of goods and services surveyed in different localities is minimized and this fact certainly reduces the differences in measured regional price levels.
2. Musil et al. (2012) and Čadil et al. (2014) use data from price surveys as if they represented the price levels in the whole regions (NUTS 3), while we keep the data ascribed to the district (LAU 1) where they were actually collected. On the other hand, this triggers the need to estimate the regional price levels in those districts, where the price surveys have not been carried out.
3. Musil et al. (2012) are using a common consumer basket, therefore the results show smaller standard deviation than when regional consumer baskets are employed as in Čadil et al. (2014). Nevertheless, even Čadil et al. (2014) argues, that particular system of regional weights does not affect the results significantly.
4. The more pronounced differences between our results and those published earlier (Musil et al., 2012; Čadil et al., 2014) have been recorded in Karlovarský kraj, and Královéhradecký kraj. The less significant differences appeared in Plzeňský kraj, Ústecký kraj, Středočeský kraj and the Capital of Praha. They are most probably caused by a different approach applied to CZ-COICOP Heading 04 (esp. to imputed rent) and also by the rent deregulation triggered in 2011.
5. A part of the differences may be also attributed to slightly different procedure of the regional price level computation. We based our approach on the price representatives (similarly to computation of consumer price index, for example) and not on the wider concept of basic headings (typical for purchasing power parities).
6. Some minor changes may be attributed to the year of origin of the data sources too.

CONCLUSION

Regional price level can represent a valuable information when making decisions on the level of regional economic and social policy. Its ambition is a more precise definition of economic and social disparities in spatial comparison. The issue of low validity of interregional comparison by means of nominal income indicators, which do not include costs of living in the regions, was pointed out by Kahoun (2011), Gibbons et al. (2010), Viturka (2007) and others. In the strategy of regional development of the Czech Republic, however, the nominal net disposable income is one of the crucial indicators determining the social position of inhabitants of a region.

The purpose of Regional Price-level Index is to enable an assessment of spatial differences in the costs of living of an average household. In terms of spatial comparison, the index should include all relevant expenditures which can indicate interregional differences and which are purchased by households. These are mainly goods and services which cannot be provided supra-regionally (common food, local services) and market prices of rentals and real estate. The immobile commodities (housing, education, accommodation, catering) represent the main source of regional price-level differences.

The purpose of the *RPI*, however, becomes also a source of its shortcoming. It should be used and applied carefully, as it is clear, that the average household is not a household of the unemployed, or pensioners. The social status is usually connected with a consumer behavior, differing significantly from the consumer behavior of an average household. Therefore, it shall be strictly used together with or applied to average income indicators (average wage in a certain region, average net disposable household income, etc.).

The real income indicator would make the level and development of social and economic disparities on regional and sub-regional levels more precise. (Viturka, 2007; Martinčík, 2008; Kahoun, 2011). According to the preliminary results of Kocourek and Šimanová (2015) and Kocourek et al. (2014), the real regional disparities in the income of households in the Czech Republic are smaller than so far published nominal ones, which is consistent with findings of Čadil et al. (2014).

Therefore, it seems very useful (if not necessary) to measure or at least estimate the price levels on the most detailed scale available. Significant differences in cost of living can be identified even within the former districts in the Czech Republic (LAU 1). From this point of view, a price level homogeneity on the level of NUTS 3 or NUTS 2 is a very strong and hardly justifiable precondition (Abrhám and Horváthová, 2010).

Although on the lower levels of territorial division (LAU 1 and smaller) the income indicators are also very difficult to measure or reliably estimate, even the regional price-level index alone can provide a very valuable information.

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