

# The Effect of Agglomeration on the Regional Price Levels in the Czech Republic

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## Abstract

The common element of the Strategy of Regional Development is the effort to identify, quantify and propose solutions to undesirable differences in the level of socio-economic development of regions. The limiting factor for regional comparison is that the measurements are performed primarily in nominal and not real variables; that does not take into account regional differences in price levels, which can be between metropolitan areas and other regions considerable. In terms of regional price levels can be monitored in addition to relating to the development of local demand (net disposable income of households) and supply (production and labor costs) as well as the consequences of agglomeration effects. One characteristic of "core - periphery" model is that it is preferable to migrate to an area due to the price effect. The aim of the paper is to propose a possible methodology for calculating regional price index RPI at the NUTS3 level based on consumer price index (CPI) which enables spatial comparison of regional price levels to detect the influence of agglomeration (population density of the region, share of population living in a big town) on the differences in price levels of regions at NUTS3 in the Czech Republic. The fundamental hypothesis of the paper is that metropolitan areas are characterized by higher prices of goods and services in comparison with peripheral areas. This hypothesis was confirmed by statistical methods.

## Key words

Regionalization, Regional Price Level, Regional Price Index, Agglomeration, NUTS3.

## Introduction

The quantification and evaluation of regional disparities remains one of the most up-to-date topics of regional politics. The restricting factor for regional comparison is the fact that the measurements are performed mainly in nominal rather than in real quantities; it means that the regional differences in price levels are not taken into account. The differences between metropolitan and other regions, however, can be significant. Yet, price levels are of key importance when making decisions about consumption and economic entities localization, and therefore they can significantly influence regional disparities. The influence of public and private investments on market structures function and on price formation in economic sectors, local monopolization, demand as a factor of the private sector development belong among basic factors which influence the real economic disparities from the viewpoint of relative price differences. The first aim of the article is the construction of a Regional Price Index (RPI) based on the Consumer Price Index (CPI) which will enable the comparison of regional price levels. Regional price levels depend on the development of local demand (Net Disposable Household Income), on supply (production and labour costs) and also on agglomeration effect results.

The second aim of the article is, on the basis of the Regional Price Index (RPI), to detect the influence of agglomeration (density of population in the region and the share of population living in big towns and cities) on the differences in regional price levels at the level of NUTS3 counts in the Czech Republic. The fundamental hypothesis of the paper is that metropolitan areas are characterized by higher prices of goods and services in comparison with peripheral areas. In economic theory dealing with regional and spatial aspects of an economy a lot of literature belonging into the area of so called New Economic Geography appeared in the 90s of the 20th century. It represents a relatively formalized approach to spatial economics bringing new views on international trade, into national economy structures and regional development. New Economic Geography is based on the assumption of imperfect competition and growing returns to scale while the key role is represented by

transaction costs. Spatial economics deals mainly with the results of economic activity agglomeration, with inter-regional differences in economic development or the spatial dimension of innovations. At present there is a general consent with the fact that the essence of geographical unit differences (in the concentration and localization of production, local economic development, wage levels or innovation quality) can be found in economic mechanism rather than in regional factors of production.

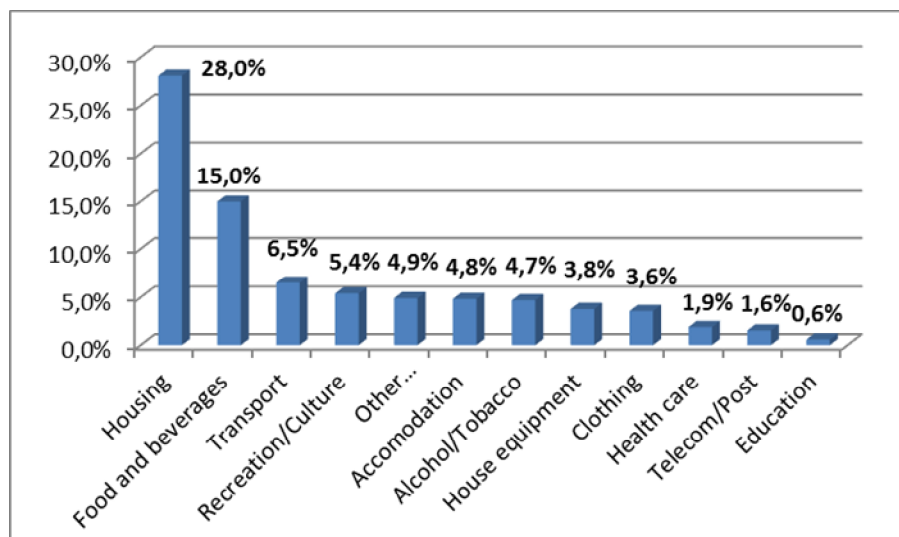
## **Methodology of CPI Regionalization**

The construction of the Regional Price Index (RPI) at the NUTS3 level in the Czech Republic is based on the Consumer Price Index (CPI). The Consumer Price Index measures in a representative way the relative changes in final consumer prices of goods and services paid by inhabitants in individual years. Consumer price index development is analysed by means of consumer baskets (sets of items including individual weights assigned to them). As a part of a complex revision in the years 2010-2011, the choice of the items, the weight system, the set of respondents, data collection methodology and the way of calculation were revised. December 2011 was selected as the basic period for the calculation. The calculation of revised indexes started in January 2012 (ČSÚ, 2014). The number of items in a consumer basket is 692 (including ten sub-indexes) segmented into 12 classes. 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 (Šímanová J., Kocourek A. a J. Kraft, 2014):

- With respect to a small area and low differentiation of the surface of the Czech Republic, the consumer behaviour 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.
- 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.
- 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 centres, purchase of a car, services of travel agencies, etc.) can be also disqualified from the RPI consumer basket.
- Prices of representative goods and services are mostly probed in regional or district centres (in approx. 45 % of all district centres in the Czech Republic), consequently they are incapable of regarding the sub-regional price.

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.). 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. 1. The sum of their shares has naturally the value of 80.8 %.



**Fig. 1: Structure of the Consumer Basket for RPI**

Source: Šimanová J., Kocourek A. a J. Kraft, 2014

For calculation of Regional Price Index 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. 1). Using these data, the RPIs will be calculated and the hypothesis of the influence of agglomeration on the differences and development of regional price levels will be tested by instruments of Multiple linear regression model.

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

$$RPI_r = \frac{\sum_{i=1}^N p_i^r q_i}{\sum_{i=1}^N p_i^a q_i} = \sum_{i=1}^N \frac{p_i^r}{p_i^a} \frac{p_i^a q_i}{\sum_{i=1}^N p_i^a q_i} = \sum_{i=1}^N \frac{p_i^r}{p_i^a} w_i \quad (1)$$

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.

## Methodology of Agglomeration effects Assessment

In the recent years the attention has been focused on the investigation of regional and spatial aspects of economies. The basis of the „New Economic Geography“ (NEG) is the Core-Periphery Model (CP Model), which was created by Paul Krugman (1991) by means of extension of the former model of international trade Krugman, 1980) which was based on the existence of growing returns to scale, imperfect competition, and transport costs by production factors mobility. The basic CP model was elaborated and extended Fujita et al. (1999), Fujita and Thisse (2002) and Baldwin and Forslid (2001). New Economic Geography builds on five basic assumptions (Krugman, 1991):

- Growing returns to scale,
- imperfect competition,
- existence of trade costs,
- endogenous company location,
- endogenous demand location (this effect explains the circular cumulating process of agglomeration).

When transport costs decrease to a certain level it becomes advantageous for a company to centralize its production at a place where the strongest demand is located and export to other markets. The place where there is demand attracts new companies. Each newly coming company has to offer higher wages to get additional employees. Higher wages subsequently stimulate immigration of additional employees who strengthen the local demand further. In that case labour can be characterised as “agglomeration force” (Baldwin a Wyplosz, 2004). The basic causes of agglomeration, so called “**local market size effects**”, include apart from labour force migration also the influence of reverse and forward linkages between firms, or production factor accumulation (e.g. patents from research and development). D. Puga (1999) proved that consumer preferences of product variability and higher share of industrial products in consumer expenditures contribute to higher degree of agglomeration. Agglomeration causes concentration of production with growing returns to scale and high potential of production in central regions while in periphery regions production remains closer to perfect competition with lower potential of production (Martin, 2003). As an effect hindering agglomeration D. Puga (1999) defined the existence of so called “**crowding effect**”, when the increase in the concentration of companies and labour force leads to the increase in prices of factors and goods which are immobile and whose supply is fixed (real estate and land). This effect together with the increase in local competition (so called dispersion forces) decelerates the process of agglomeration.

The theoretical foundation of the recent literature on agglomeration (approximated by density) is provided by Ciccone & Hall (1996), who consider density as a source of aggregate increasing returns and define it as the intensity of labour, human and physical capital relative to physical space. The basic empirically verifiable relationship of New Economic Geography is the strong and positive dependence of the flows of production factors and their prices on the so-called “**market-potential function**” (Harris, 1954), which is usually understood as the (distance-weighted) sum of the personal income in surrounding regions. The so-called “**real market potential of the region**” depends on the level of trade openness between the place of production and the market, on the share of consumer spending of a market in the total income, and finally on the market price index (based on the rate of product differentiation, and thus also on the rate of substitution).

Rice and Venables (2004) focus on regional income inequalities and their determinants. The authors consider the NUTS 3 sub-regions of Great Britain and explore the hypothesis that the proximity to economic mass, measured by driving time between regions, raises earnings. They confirm their hypothesis and find that the impact on productivity is the highest for economic centres within 40 minutes driving time. An alternative hypothesis under scrutiny is that the spatial variation of earnings is due to exogenously determined spatial characteristics such as the population size. In order to avoid the endogeneity bias stemming from the size of the current population inhabiting the counties of Great Britain and their average earnings, the authors instrument for it using the population of the NUTS 3 area in 1851. Anastassova V. (2006) examines the impact of employment density (agglomeration) on the hourly earnings of workers across districts of Great Britain. The empirical analysis for the two years of observation, 1998 and 2003, shows that there is a stable positive relationship between agglomeration as measured by employment density and the average earnings at the regional level. Doubling the agglomeration raises wages by 4% at both district and county level.

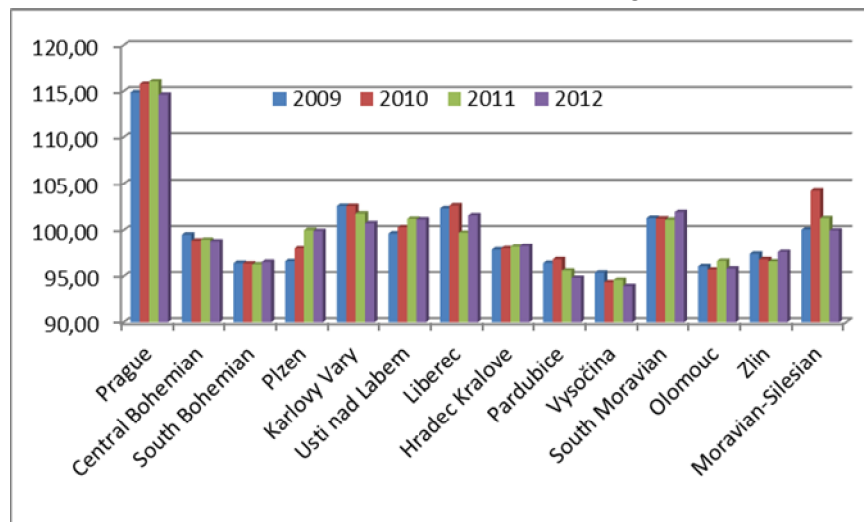
This article aims to find out whether and how regional price levels are related to the agglomeration structure in the Czech Republic in NUTS3 regions. High fragmentation of the

settlement structure in the Czech Republic (6,250 municipalities, out of which about 80% has less than 1,000 inhabitants) is the cause of very intensive linkages between each other and between cities and rural areas, which are the natural background of regional centres. The following indicators of independent variables of regional demographic statistics were selected for the analysis:

- density of population,
- share of population living in district towns,
- share of population living in towns > 50000 inhabitants,
- share of population in age of 15-59 years,
- average population per town,
- population,
- population in district towns.

## Results

The resultant values of RPIs for each region and year are shown in fig. 2. As expected, the highest RPIs are recorded for Prague region, while the lowest values are reached by region Vysočina, South Bohemian, Pardubice and Olomouc Regions.



**Fig. 2: Regional price index in NUTS regions of the Czech Republic 2009 - 2012**

Source: Šímanová J., Kocourek A. a J. Kraft, 2014

To capture the effect of agglomeration on regional price levels Multiple linear regression model was applied using Statgraphics Centurion XVI with the dependent variable RPI (Regional Price Index). The primary data source was the data from the Czech Statistical Office processed by Regional Information Service (RIS, 2014). Significantly different values of NUTS3 region Prague were excluded from the analysis. There are strong agglomeration forces in this region based on the large market potential of the region, on the accumulation of population with high education, on the concentration of scientific capacity, on transport links with the whole Europe and other factors. Prague also attracts more than ten thousand newcomers every year who by their purchasing power strengthen the regional economic force. The next three largest Czech agglomerations occur in the Central Bohemian, the Moravian-Silesian and South Moravian Regions.

The output shows the results of fitting a multiple linear regression model to describe the relationship between RCI and 7 independent variables. The equation of the fitted model is:

$$RPI = 91,835 + 0,0247079 * \text{density of population} + 0,170295 * \text{share in towns} > 50000 - 0,000210504 * \text{average population per town} \quad (2)$$

Since the P-value in the ANOVA table is less than 0,05, there is a statistically significant relationship between the variables at the 95,0% confidence levels. It has been demonstrated that RPI significantly depends only on three out of the seven surveyed variables, namely: density of population, share of population living in towns > 50,000 Inhabitants and average population per town. For the other parameters statistically significant dependence was not proved or the variables showed mutual dependence (autocorrelation). The R-Squared statistic indicates that the model as fitted explains 55,2895% of the variability in RCI. The adjusted R squared statistic, which is more suitable for comparing models with different numbers of independent variables, is 52,4951%. The standard error of the estimate shows the standard deviation of the residuals to be 1,78513. This value can be used to construct prediction limits for new observations. The mean absolute error (MAE) of 1,39503 is the average value of the residuals. The Durbin-Watson (DW) statistic tests the residuals to determine if there is any significant correlation based on the order in which they occur in your data file. Since the P-value is greater than 0,05, there is no indication of serial autocorrelation in the residuals at the 95,0% confidence level.

## Conclusion

The aim of this paper was to evaluate, on the basis of statistical analysis, the influence of demand location, which is related to agglomeration effects on the regional price levels in NUTS3 regions in the Czech Republic in the years 2009 – 2012. The fundamental hypothesis that metropolitan areas are characterized by higher prices of goods and services in comparison with peripheral areas was confirmed by statistical methods. From the results of statistical analysis the following conclusions can be drawn:

- For the four independent variables (share of population living in district towns, share of population 15-59 years, population and population living in district towns) statistically significant impact on the regional price levels was not demonstrated.
- Regional density of population has a positive impact on the regional price levels, which means that growing population in regions with an unchanging area generates pressure to increase regional price levels. The regions with the highest density of population in the Czech Republic are the Moravian-Silesian, Usti nad Labem, Liberec, South Moravian and Zlin Regions.
- The share of the population living in cities with over 50,000 inhabitants has a significantly positive impact on regional price levels. Here, the analysis supports the theoretical conclusions, when growing demand in large regional agglomeration centres increases regional price levels due to the existence of so-called “crowding effect”.
- For one independent variable (average number of people in cities) a negative impact on regional price levels was demonstrated. The results show that growing cities enable not only increase in demand, but also increase in competition on the side of supply and reduction of transaction costs and thus create pressure on reduction of regional price levels. This conclusion again fully corresponds with the theoretical definition of the “local market size effects”.

With the results acquired further possibilities of investigation of influences on regional price levels arise. These mainly include supply factors such as concentration of big/small companies in a region, concentration of industrial activities in a region, the share of the number of employed persons in the number of inhabitants in a region, etc.

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