# Regional price differences and their impact on regional macro-aggregates

Petr Musil, Jana Kramulová, Jaroslav Sixta

University of Economics, Prague, Czech Republic

## Introduction

Comparison of price levels has been an interesting topic since 1960s, when the International Comparison Program (ICP) was established in 1968 [6]. Around 180 countries are involved now in this program. It exists also ECP (European Comparison Program), which is the regional program for Europe (with 37 countries involved). In this program countries are multilaterally compared [7]. The PPP/PPS (Purchasing Power Parity / Purchasing Power Standard) methodology formed by OECD and EUROSTAT is used for computing the results (see below). The estimates of PPS in the European Union are based on average prices in countries, local differences within countries are not taken into account.

This paper aims at the estimate of regional price levels and their impact on regional macro aggregates within one country – the Czech Republic. Economic development of regions is usually assessed by GDP per inhabitant in purchase power standard (PPS). Regional GDP [1] is estimated in the Czech Republic by output and income approach, but expenditure approach is not used [4]. Theoretically, it is the question of produced and used product. Practically, it means that the main differences among the regions can be found in household consumption. For example prices in the capital city (e.g. rents, personal services) are supposed to be higher than in the rest of country.

The paper shows approach based on households using data on final household expenditure. Other components of GDP, such as government consumption, NPISH expenditures and others, are not included in calculations, and EKS method is used with several adjustments (see below). Regional indicators concerning households are recalculated and compared with the original ones. Average income or net disposable income are adjusted to local price level and should provide more reliable data on living conditions in regions. The results can potentially be used to adjust regional policy decisions.

The structure of the paper is following. In the first section regional structure of the Czech Republic is presented. The second section describes our methodology. In the third section the main data sources are briefly introduced and the main problems are pointed out. The fourth section is devoted to the discussion of our results. In the final section the paper is concluded.

## 1. Regional structure of the Czech Republic

The Czech Republic is divided, according to NUTS classification, into 8 NUTS 2 regions and 14 NUTS 3 regions. Our computations were performed for NUTS 3 regions, but can be simply modified (using bottom-up method) to NUTS 2 level, because NUTS 2 regions are formed by one, two or three NUTS 3 region, as shown in table 1.

**Table 1 – NUTS regions in the Czech Republic**

| NUTS 2 region | NUTS 3 region |
|---|---|
| Praha | Praha |
| Střední Čechy | Středočeský kraj |
| Jihozápad | Jihočeský kraj |
| | Plzeňský kraj |
| Severozápad | Karlovarský kraj |
| | Ústecký kraj |
| Severovýchod | Liberecký kraj |
| | Královéhradecký kraj |
| | Pardubický kraj |
| Jihovýchod | Kraj Vysočina |
| | Jihomoravský kraj |
| Střední Morava | Olomoucký kraj |
| | Zlínský kraj |
| Moravskoslezsko | Moravskoslezský kraj |

Source: EUROSTAT

NUTS 2 regions level is broadly used by the European Union and its regional policy [3], because most of the Cohesion Policy Objectives are assessed by GDP per inhabitant in PPS (having EU-27 average as comparative value) directly on the NUTS 2 level. In current programming period 2007-2013 the critical level for the first objective "Convergence – solidarity among regions" covering 81.5 % of total budget, is 75 % of the EU-27 average of GDP per inhabitant in PPS. That's why the appropriate computation of this indicator is so important, because for this programming period the total amount of €347 billion is intended for lowering the regional disparities in the EU. Also analysis of other indicators (such as wages or disposable income) is necessary for assessing the regional disparities properly.

## 2. Methodology

The methodology of regional price levels comparison is in the Czech Republic inspired by PPP Programme that is carried out by OECD and Eurostat. Its main objective is to allow comparison of macroeconomic indicators especially GDP. In the past GDP was converted by the exchange rate to widespread currency (e.g. US dollar), but the problem of this approach was in the fact that exchange rate is mainly influenced by currency's supply and demand, intervention of central banks, speculations etc. Next disadvantage is a narrow coverage because not all products are negotiable. Therefore values of indicators are now expressed in common artificial currencies such as PPS (purchase power standard) for EU countries or OECD dollars for OECD countries. These artificial currencies have the same purchasing power in all member states (EU countries or OECD countries). EU and OECD use purchase power parities (PPPs) to obtain GDP in common price level. Actually PPPs are relative prices between countries does not matter at which level of aggregation.

Calculation of PPPs is based on the final expenditure on GDP. Each component of expenditure approach is divided into "basic headings" that represent minimum level for which expenditure weights are available. Member countries should select products that are representative for each product heading (at least one product per a basic heading). Moreover countries are supposed to collect prices of products that are representative for other countries to make a comparison, but of course not all unrepresentative products

are available in domestic market. For each product heading PPPs are calculated in following steps (for more details see[2]):

- The calculation of a matrix of Laspeyres type PPPs.
- The calculation of a matrix of Paasche type PPPs.
- The calculation of a matrix of Fisher type PPPs.
- Completing the matrix of Fisher type PPPs.
- The calculation of a matrix of EKS PPPs.
- Standardising of a matrix of EKS PPPs.

Laspeyres type of price and volume indices uses weights from basic period, Paasche from current period and Fisher index is a geometric mean of both indices mentioned above – Laspeyres and Paasche. In the term of PPPs calculation Laspeyres index refers to the base country and Paasche to the partner country. For each basic heading Laspeyres index (country *B* to country *A*) is calculated as follows:

$$L_{B/A} = \left[\prod_{i=1}^{n} \frac{P_{Bi}}{P_{Ai}}\right]^{\frac{1}{i}} \qquad (1)$$

where *P* is price of a given product. Only products that are representative for country *A* are taken into account. This calculation is done for all countries in order to obtain PPPs matrix of Laspeyres type. Paasche index (country *B* to country *A*) is calculated according to the following formula:

$$P_{B/A} = \left[\prod_{i=1}^{n} \frac{P_{Ai}}{P_{Bi}}\right]^{\frac{1}{i}} = \frac{1}{L_{A/B}} \qquad (2)$$

Prices of products that are representative for partner country are included in the calculation. Moreover, there is a relation between Laspeyres and Paasche indices and PPPs matrix of Paasche type can be completed by using Laspeyres indices. Next a PPPs matrix of Fisher type is estimates in the form of geometric mean of corresponding Laspeyres and Paasche indices.

Generally, Fisher indices are reversal ($F_{B/A}.F_{A/B}=1$), but not transitive ($F_{B/A}/F_{C/A} \neq F_{A/C}$). The resulting matrix can be incomplete because of some prices missing. A product which is representative in one country may not be available in other country and therefore the price in this country does not exist. Missing indices are estimated by bridging i.e. using some other country as a bridge. Let's suppose in equation (3) that $F_{A/B}$ cannot be calculated, but it can be estimated using countries *C* and *D* as a bridge:

$$F_{A/B} = \left(\frac{F_{A/C}}{F_{B/C}} \frac{F_{A/D}}{F_{B/D}}\right)^{\frac{1}{2}} \qquad (3)$$

Generally, missing index is estimated as a geometric mean of all the indirect indices. To ensure transitivity EKS (Éltetö-Köves-Szulc) method is employed. EKS PPPs is derived as an unweighted geometric mean of the Fisher type PPP calculated between the pair of countries directly and all the PPPs that can be calculated between the pair indirectly when other countries are used as a bridge – see equation (4). Precisely the formula is as follows:

$$EKS_{B/A} = \left[\prod_{i=A}^{n} \frac{F_{B/i}}{F_{A/i}}\right]^{\frac{1}{\sum n}} \qquad (4)$$

Final step, equation (5), is the standardisation, i.e. provided by a joint basis when a price of one basic heading of one region is related to all other countries:

$$EKS_A = \frac{EKS_{A/A}}{[\prod_{i=A}^{n} EKS_{i/A}]^{\frac{1}{\sum i}}} = \frac{EKS_{A/B}}{[\prod_{i=A}^{n} EKS_{i/B}]^{\frac{1}{\sum i}}} = \cdots = \frac{EKS_{A/n}}{[\prod_{i=A}^{n} EKS_{i/n}]^{\frac{1}{\sum i}}} \qquad (5)$$

Description above explains how to calculate PPPs for each basic heading. Next PPPs can be aggregated to any level of an aggregation. Laspeyres type of PPPs uses expenditure weights from base country while Paasche type of PPPs from partner country. Fisher type is again their geometric mean. To ensure transitivity the EKS method is applied on Fisher type of PPPs. Finally matrix is standardised.

Our estimate of regional price levels is based just on the data on final household consumption, which is the main component of expenditure approach (about 50%). Data sources for other components are scarce especially for external trade. In addition, main differences are supposed to be in the prices of rents and services for households. Calculation is done at the level of representatives for which expenditure weights are available. Missing data were estimated, e.g. for Pardubický kraj there is no price available for 5-star hotel, because no 5-star hotel is located there. If there was this hotel, the price would be similar to prices in other regions. Therefore this price was estimated as an arithmetic average of prices in other regions. Generally bridging is not used and most of the missing prices were estimated in this way. Authors are convinced that this approach is better than using bridging automatically. All products are supposed to be representative in all regions. It means that Laspeyres, Paasche and Fisher type of PPPs are the same. Moreover, there is no need to use the EKS method, because all indices are transitive.

## 3. Data sources

Data on prices and expenditure weights for PPP programme are provided by National Statistical Institutes (NSI). Countries can choose if prices of all goods are collected within single year or over three years. In the second case products in consumer basket are divided into six parts and every half-year prices of one sixth of products are surveyed. In order to estimate all prices of products every year temporal adjustment factors must be provided for products for which prices are not collected in the selected year. Prices should be representative for the whole country therefore either the data are collected in the capital city and adjusted by spatial factors or another approach is used in the form that data collection is not limited to capital city. Selection of stores should respect shopping manners in each country. In order to ensure comparability between countries a description of representatives is more detailed than it is for representatives in the sample for consumer price index.

Several data sources are used in the calculation. Data from monthly consumer price survey are included instead of PPP survey due to following reasons. One third of prices are collected during one year while the rest of prices are estimated using temporal adjustment factors, but consumer price survey provides data each month. Minimum level of aggregation in PPP calculation is the Basic heading, Final Household Consumption Expenditure is divided into 148 Basic headings. About 700 representatives are observed in consumer price survey and more detailed weights are available, while using 148 basic headings would lead to loss of information. Data on rents were provided by Institute for Regional Information (hereinafter IRI)

that collects data on rents at very detailed regional stratification (263 territorial units within the Czech Republic). A so-called model flat is defined (same flat dimensions, age etc.) and the prices for this model flat are collected in all regions. Therefore the differences in the regional structure of housing fund are not taken into account. Web data sources and experts' estimates were also used.

## 4. Results and discussion

Prague is supposed to be the most powerful region in the Czech Republic. About one quarter of GDP is produced there and GDP per capita is twice higher than the country average (see table 2). However, net disposable income per capita (NDI) is higher than the average by approximately 30%. It is probably caused by commuters whose salaries are paid in Prague, but distributed (at least partly) to other regions [5]. Taking into account the differences in price levels, NDI per capita in Prague is higher by 15%. This calculation is close to PPCS (Purchasing Power Consumption Standard).

**Table 2 – Results of PPP computations and their impact on regional macro-aggregates**

| Region | PPS | Net disposable income per capita | Net disposable income per capita in PPS | GDP per capita | GDP per capita in PPS |
|---|---|---|---|---|---|
| Hlavní město Praha | 115.1 | 230 578 | 200 371 | 759 758 | 660 226 |
| Středočeský kraj | 102.5 | 187 150 | 182 629 | 330 739 | 322 749 |
| Jihočeský kraj | 98.3 | 168 100 | 170 999 | 307 045 | 312 340 |
| Plzeňský kraj | 98.9 | 172 868 | 174 852 | 328 653 | 332 424 |
| Karlovarský kraj | 99.6 | 156 050 | 156 725 | 262 925 | 264 062 |
| Ústecký kraj | 93.5 | 152 960 | 163 593 | 285 765 | 305 630 |
| Liberecký kraj | 102.0 | 162 996 | 159 797 | 274 191 | 268 809 |
| Královéhradecký kraj | 96.7 | 168 919 | 174 677 | 301 849 | 312 139 |
| Pardubický kraj | 97.6 | 165 325 | 169 321 | 297 475 | 304 665 |
| Vysočina | 97.0 | 165 652 | 170 703 | 297 835 | 306 916 |
| Jihomoravský kraj | 104.1 | 171 168 | 164 499 | 325 239 | 312 566 |
| Olomoucký kraj | 97.1 | 160 623 | 165 383 | 262 406 | 270 183 |
| Zlínský kraj | 101.4 | 168 523 | 166 217 | 288 497 | 284 549 |
| Moravskoslezský kraj | 97.9 | 157 100 | 160 522 | 297 281 | 303 756 |
| ČR | 100.0 | 174 360 | 174 360 | 354 808 | 354 808 |

Source: Czech Statistical Office and own computations of authors

Regional GDP can be interpreted as the indicator of economic performance rather than the indicator of economic development. Standard of living can be assessed according to NDI per capita in PPS. Indicators in PPS make the regional comparison more reliable, differences among regions are minor as it was expected.

## Conclusion

The aim of this paper was to estimate the regional price levels and their impact on regional macro aggregates within the Czech Republic. The PPP/PPS methodology formed and used by OECD and EUROSTAT doesn't take local differences within countries into account. In this paper the official methodology was adjusted and used for computation of regional price levels.

The results are shown in the table 2. It is very clearly seen that the differences can be quite significant. This topic is important not only from the point of view of quality of life, but also from the point of view of regional policy. The main decision criterion is a certain percentage of regional GDP per capita. European Union distributes quite a big amount of money to the regions that are below this level and the appropriate computation is therefore very important. It is necessary to assess the regional GDP according to right price level.

In the computations presented in this paper, there are still some simplifications, e.g. constant basket for all the Czech regions, replacement of missing values in data matrices etc. Dealing with them will be the task of further research.

## References


[1] EUROPEAN COMMISSION (1996). *European system of national accounts*. (ESA 95). [Online 2012-04-13]. Source: http://circa.europa.eu/irc/dsis/nfaccount/info/data/esa95/en/esa95en.htm

[2] EUROPEAN COMMISSION (2006). *Eurostat-OECD Methodological Manual on Purchasing Power Parities*. Paris. ISBN 978-92-64-01132-8.

[3] EUROPEAN COMMISSION (2012). *Regional Policy – Inforegio*. [Online 2012-04-13]. Source: http://ec.europa.eu/regional_policy/index_en.cfm

[4] HRONOVÁ, S., FISCHER, J., HINDLS, R., SIXTA, J. (2009). *Národní účetnictví: nástroj popisu globální ekonomiky*. Praha: C. H. Beck. 326 p. ISBN 978-80-7400-153-6.

[5] CHLAD, M., KAHOUN, J. (2011). Factors Influencing the Rating of Regional Economic Performance or Reasons why Prague has Become the 6th Best Economically Performing Region of the EU. *Statistika*. Vol. 48, iss. 2, pp. 4-23.

[6] INTERNATIONAL BANK FOR RECONSTRUCTION AND DEVELOPMENT/THE WORLD BANK (2008). *Global Purchasing Power Parities and Real Expenditures - 2005 International Comparison Program*. Washington. 230 p.

[7] NATIONAL STATISTICAL INSTITUTE BULGARIA (2009). *European Comparison Programme - Methodological Notes*. [Online 2012-04-13]. Source: http://www.nsi.bg/otrasal-metodologiaen.php?otr=39


## Acknowledgement


This paper was supported by the University of Economics, Prague; project No. IGA 12/2011 "Estimation of regional price levels".