

# Application of Regional Price Levels on Estimation of Regional Macro-Aggregates Per Capita in PPS

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## Abstract

Comparison of Czech regions is almost always based on nominal indicators, i.e. an assumption of the same price levels is included in the analysis, though it is obvious that this assumption is quite strong or even not fulfilled. Results of such an analysis could be seriously affected and simultaneously lead to misinterpretation. The aim of this paper is to estimate regional price levels in the Czech Republic NUTS 3 regions and to estimate their impact on regional macro-aggregates such as the net disposable income. Eurostat uses for this issue the methodology introduced in the common OECD and Eurostat Manual on purchasing power parities (PPP) resulting in purchasing power standard (PPS) estimation at international level. From the theoretical point of view PPS could be estimated also at the regional level, i.e. each region would be considered as an “independent unit”. In practice, in most EU countries the problem with poor regional data availability arises. The official methodology is used in this paper with several modifications described. Finally macro indicators adjusted to regional price levels are compared with the “original” data.

## Keywords

*Czech NUTS 3 regions, price levels, GDP, net disposable income, EKS method, PPS*

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## INTRODUCTION

One of the important economic and statistical issues is to study the economic conditions in the different parts of the world. When comparing countries worldwide according to economic performance, usu-

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ally GDP per capita in purchasing power standard (PPS) is used. But estimating of PPS in the European Union is based on average prices in countries that means on national prices, therefore local differences within one country are not taken into account. This causes problems and expected inaccuracy, when we want to compare regions. Recently the attention has moved from observation of international differences to interregional differences. Also the question of regional convergence or divergence stands at the forefront of the economic analyses.

That is why we are focusing on the topic of regional price levels. Surprisingly this topic has not drawn any attention in the Czech Republic so far. We will below briefly discuss the situation in some other countries.

The main aim of this paper is to estimate regional price levels for the Czech Republic NUTS 3 regions, the partial aims are then to estimate some of the main macroeconomic indicators for Czech NUTS 3 regions and then to appraise the results obtained. The main contribution of this paper is the adjustment of the official Eurostat / OECD methodology that is more suitable for national level. We decided to work with the level of 14 NUTS 3 regions, because that is according to our opinion the lowest level for which the data needed are available in sufficient extent. But even at this level we were facing several problems when searching for some data.

This paper is divided into several sections. Firstly we perform a short overview of development of economic comparison at the national level and introduce several attempts of regional price levels estimates in different countries. In section 2 the official Eurostat / OECD methodology is described as well as our adjustments needed to be done for the comparison at the regional level. After that the most important data sources are introduced and finally the obtained results are discussed.

## 1 IMPORTANCE OF THE TOPIC

Comparison of price levels has been an interesting and important topic since 1960s, when the International Comparison Program (hereinafter ICP) was established in 1968 (see International Bank for Reconstruction and Development / The World Bank, 2008). While in 1970 only 10 countries were involved in this program, in 2011 it was already around 200 countries. Table 1 shows both regional dispersion and income dispersion of the countries involved in this program in 2011.

**Table 1** International Comparison Program 2011 – involved countries

ICP region group / Income group	High	Upper middle	Lower middle	Low	Total
Africa	1	8	15	28	52
Asia & Pacific	5	2	11	5	23
Commonwealth of Independent States	0	4	4	2	10
Latin America & Caribbean	9	21	10	1	41
OECD – Eurostat	35	12	0	0	47
Pacific Islands	1	3	9	2	15
Western Asia	6	1	7	0	14
Singleton Countries	0	1	2	0	3
Dual Participation	x	x	x	x	-5
<b>Total</b>	<b>x</b>	<b>x</b>	<b>x</b>	<b>x</b>	<b>200</b>

Source: International Comparison Program (2011), authors' adaption

Apart from ICP also ECP (European Comparison Program) exists, which is the regional program for Europe. Czech Republic (CZ) was involved in 1993 (comparison CZ and EU countries based on bilateral comparison between CZ and Austria) and in 1996 (multilateral comparison). Since 1999 Czech Republic has been a regular part of this yearly comparison (Czech Statistical Office, 2012). Table 2 shows 47 countries included into this program divided into five groups (four of them constituted by Eurostat and one by OECD). Each Eurostat group has its group leader.

**Table 2** European Comparison Program 2011 – five groups of countries with group leaders

Eurostat				OECD
Northern group	Western group	Eastern group	Southern group	OECD
<b>Finland</b>	<b>Netherlands</b>	<b>Austria</b>	<b>Portugal</b>	Australia
Denmark	Belgium	Bosnia and Herzegovina	Albania	Canada
Estonia	Czech Republic	Bulgaria	Cyprus	Chile
Iceland	France	Croatia	FYR of Macedonia	Israel
Latvia	Germany	Hungary	Greece	Japan
Lithuania	Ireland	Montenegro	Italy	Korea
Norway	Luxembourg	Romania	Malta	Mexico
Poland	Switzerland	Serbia	Spain	New Zealand
Sweden	United Kingdom	Slovakia	Turkey	Russian Federation
		Slovenia		United States

Note: Group leaders in bold.

Source: Eurostat-OECD Methodological Manual on Purchasing Power Parities (PPPs), 2012 (preliminary version), authors' adaption

In this ECP program countries are multilaterally compared on the basis of Éltető-Köves-Szulc (EKS) method (brief explanation of the method procedure see below, for more information see Jílek, Moravová, 2007, pp. 227–229, or European Commission, 2006).

Apart from the national comparisons, also attempts of regional comparisons of price levels exist. This effort can be seen e.g. in Great Britain (Hayes, 2005), United States of America (Aten, D'Souza, 2008), China (Brandt, Holz, 2006) or very often Germany (Blien et al., 2009, Dreger et al., 2010, Roos, 2006). In the Czech Republic, as it was already mentioned, no attention has been paid to this topic so far. Lower level of discussion of this topic can be in the fact, that for analysis of this type, a big amount of data is necessary. That may be especially in larger countries quite difficult.

Importance of this topic can be seen not only in the endeavour to measure economic phenomenon properly, but also in consequences that arise from decisions based on regional indicators' values. These are e.g. regional policy decisions that are usually based on GDP per capita in PPS. Also the convergence / divergence discussions (see Čadil, Mazouch, 2011) usually come out of regional or national GDP per capita in PPS.

The PPP / PPS (Purchasing Power Parity / Purchasing Power Standard) is computed in accordance with the methodology formed by OECD and EUROSTAT. This methodology is introduced in Section 2.

## 2 METHODOLOGY

### 2.1 Eurostat / OECD Methodology

Comparison of economic development of countries was formerly based on the conversion of macroeconomic indicators to widespread currency (usually US dollar) by the exchange rate. This method is relatively simple, but the exchange rate is affected by the currency's supply and demand, intervention of central bank, speculation etc. Moreover, some services cannot be traded (e.g. defense, public administration) so the coverage of this approach is limited to negotiable products. Therefore OECD and Eurostat developed the PPP methodology that eliminates these problems. Artificial currencies (units) were introduced which have the same purchasing power in all involved countries: PPS (purchasing power standard) for comparison of EU countries and OECD dollar for OECD countries. Macroeconomic indicators expressed in PPS or OECD dollar can be easily compared and resulting differences comfortably assessed.

This comparison can be done at any level of aggregation. Expenditure approach is used in the calculation. Each component of GDP is divided into so called "basic headings" that represent minimum level for which expenditure weights are available. Each member state is supposed to choose products that are representative for every single basic heading (at least one product per basic heading). In addition to this member countries have to collect prices of representative products as well as prices of products that are

not representative but available at domestic market, however they are representative in other country. Otherwise international comparison could not be done. Data collection can be done within the whole country or in the capital city only. In the second case, which is more frequent, countries are supposed to provide spatial adjustment factors to obtain national prices.

The procedure of PPPs calculation can be described in 6 steps stated below. This procedure must be done for any product heading. The methodology is in detail described by European Commission (EC, OECD, 2006, Annex V).

The first step is the calculation of a Laspeyres type PPPs matrix. In general, Laspeyres type of price and volume indices uses weights from basic period. In the term of PPPs calculation, where we compare space instead of time, Laspeyres index refers to the base country. The computation formula (1) of Laspeyres index (country *B* to country *A*) for each basic heading can therefore be expressed as follows:

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

where *p* is a price of a certain product. It is important to add, that only products that are representative for country *A* are taken into account. This calculation is done for all countries in order to obtain Laspeyres type PPPs matrix.

The second step represents computation of a Paasche type PPPs matrix. Generally Paasche type of index operates with weights from current period, in PPPs calculation Paasche index refers to the partner country. Paasche index (country *B* to country *A*) is calculated according to the following formula (2):

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

in this case only prices of products that are representative for partner country are included in the calculation. Due to a relation between Laspeyres and Paasche indices Paasche PPPs matrix can be simply completed by using Laspeyres indices what facilitates the calculation.

The third step consists in the calculation of a Fisher type PPPs matrix as a geometric mean of corresponding Laspeyres and Paasche indices. In general, Fisher indices are reversal (3) but not transitive (4).

$$F_{B/A} \times F_{A/B} = 1, \quad (3)$$

$$F_{B/A} / F_{C/A} \neq F_{A/C}. \quad (4)$$

The fourth step stands in completing of the Fisher type PPPs matrix. Actually the problem can occur as the computed matrix can be incomplete due to missing prices. Product that is representative in the base country may not be available in the partner country and therefore the price in this country does not exist. For estimating the missing indices the procedure of so called bridging can be used, that means another country is used as a bridge. For example in equation (5)  $F_{A/B}$  cannot be calculated directly, but it can be estimated when countries *C* and *D* are used as a bridge:

$$F_{A/B} = \left( \frac{F_{A/C} \cdot F_{A/D}}{F_{B/C} \cdot F_{B/D}} \right)^{\frac{1}{2}}. \quad (5)$$

Generally missing index is estimated as a geometric mean of all the indirect indices.

The fifth step lies in the calculation of EKS PPPs matrix. EKS (already mentioned Éltető-Köves-Szulc) method is used in order to estimate transitive indices. EKS PPPs are calculated as an unweighted according to formula (6):

$$EKS_{B/A} = \left[ \prod_{i=A}^n \frac{F_{B/i}}{F_{A/i}} \right]^{\frac{1}{\sum^n}} . \quad (6)$$

The final, sixth, step, is standardization of EKS PPPs matrix. Equation (7) shows the standardisation, provided by a joint basis when a price of one basic heading of one region is related to all other countries:

$$EKS_A = \frac{EKS_{A/A}}{\left[ \prod_{i=A}^n EKS_{i/A} \right]^{\frac{1}{\sum^i}}} = \frac{EKS_{A/B}}{\left[ \prod_{i=A}^n EKS_{i/B} \right]^{\frac{1}{\sum^i}}} = \dots = \frac{EKS_{A/n}}{\left[ \prod_{i=A}^n EKS_{i/n} \right]^{\frac{1}{\sum^i}}} . \quad (7)$$

This calculation of PPPs is done for each product heading that represents the minimum level of aggregation for which calculation is done. PPPs can be aggregated by Laspeyeres type of PPPs that uses weights from base country or Paasche type of PPPs which is based on weights from partner country. Fisher type of PPPs is their geometric mean. EKS method is used in order to ensure transitivity, than standardisation procedure is employed.

## 2.2 Adjustments of the official methodology for Czech regions comparison

Our estimate of regional price levels in Czech NUTS 3 regions is inspired by just described PPP methodology. Comparison of regions within one country is expected to be similar to comparison of countries, but several differences were indentified. At first less data on regions than on countries is available. At national level data on production, expenditure and income approach is available however at regional level only limited data usually exists. EU countries are not obliged to transmit figures about expenditure approach and therefore the Czech Republic does not compile regional GDP from expenditure side at all (just output and income approaches are regularly published). Generally the main difficulty represents the foreign trade field because export and import from/to all regions would have to be estimated. Custom systems Intrastat and Extrastat, which are the main data sources for external trade at the national level, are not useful at regional level. Therefore we decided to base our estimate on final household consumption which is the main component of expenditure approach (covers approx. 50%) and for which substantial differences are expected. Other components of GDP, such as gross (fixed) capital formation or government consumption are not included into the computation.

As was already stated, PPP methodology is used with several adjustments. First adjustment consists in the level of calculation. According to PPP methodology the minimum level is so called basic heading. Instead of the level of basic product headings (about 148 items for household consumption) we performed our computation at the level of representatives (about 700 items) which represents significantly higher level of disaggregation and is much more detailed than product headings breakdown. Another adjustment refers to handling with missing data. These are estimated in a different way. Although PPP methodology employs bridging i.e. other countries are used as a bridge, different method is used in our case. When missing prices occur, this usually means that product is not available in the particular region and citizens have to purchase the specified product in any other region (e.g. eye surgery). Missing prices are in our approach estimated as an arithmetic average of prices in other regions. All products are supposed to be representative in all regions as regions within country are more similar to each other than countries (the same currency, similar shopping manners etc.). Consequently Laspeyres, Paasche and Fisher type of PPPs are the same and all indices are transitive.

Concerning the structure of household expenditure we can mention one more adjustment. As already stated, estimate of regional PPP is based on the level of representatives (about 700). Final household consumption expenditures are available in the classification CZ COICOP (Classification of Individual Consumption According to Purpose) at 4-digit level as the most detailed level of aggregation. More

detailed data can be found in household budget survey only. Calculation is based on national accounts data; within CZ COICOP 4-digit level linear interpolation is used in order to obtain weights at the level of representatives. It is clear that the structure of household consumption is not completely the same in all regions. Therefore regional structure has to be estimated. In comparison with official methodology different concept of household consumption is employed. PPP methodology is based on domestic concept which includes all expenditures of households in domestic economy regardless a purchase is made by resident or non-resident whereas “our” regional consumption basket is based on national concept. The main reason of this is on one hand a scarce of data on domestic concept, on the other hand certain regionalization of data in national concept has been done in academic environment. As rents and selected services for which main differences in prices are expected are not negotiable among regions, final results may not be affected significantly.

### 3 DATA SOURCES

Fulfilment of the data matrix proved to be more difficult than we expected at the beginning of our research. We needed to search for the data in different sources, including research estimates. All the data are stage by stage being made more and more precise.

National Statistical Institutes are worldwide supposed to provide data for PPP programme. Data on weights are derived from annual national accounts. Concerning prices countries have a choice to collect prices of all products within a single year or to collect data over three years. The first option is quite resource-demanding therefore most countries prefer the second possibility which means that consumer basket is divided into six parts. Every half a year one sixth of prices is surveyed. Prices of remaining two thirds of products that are not surveyed that year are estimated by using temporal adjustment factors. There are two opportunities how to ensure that all prices will be representative for the whole country. The first one is that the data are collected in the capital city and adjusted by given spatial factors. Second possibility expects that the data collection is not limited to capital city. It is obvious that the surveyed stores should be selected with respect to shopping manners in each country (or region). In comparison to the representatives’ sample for consumer price index the description of them in this case is much more detailed, because it is crucial for the comparability of countries (or regions).

Calculation of regional price level is based on several data sources. The main data source in our case is the consumer price survey that is in the Czech Republic conducted monthly. Generally this survey replaces PPP survey because of following reasons. More detailed data on weights and prices are available in consumer price survey (about 700 representatives in comparison with 148 basic heading in PPP survey). There is no need to use temporal adjustment factors because survey is carried out monthly. Annual average prices are used in order to eliminate possible swings in monthly data. But unfortunately not the whole consumption basket is covered by this data source so we were forced to use also other ones. For example data on paid 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). In this survey a so called model flat is defined (that has same flat dimensions, age, level of depreciation etc.) and the prices for this model flat are collected in all regions. It means that differences in the regional structure of housing fund are not taken into account. Imputed rent is included in the model as well. For each region average imputed rent per m<sup>2</sup> is calculated and it is considered as price of living in own occupied dwelling. Web data sources and experts’ estimates were also used. Because of data availability we chose 2007 as the year of this analysis. Due to very complicated and long-lasting searching for data and especially long-lasting data matrix completing it was so far not possible to establish a longer time series.

#### 4 RESULTS

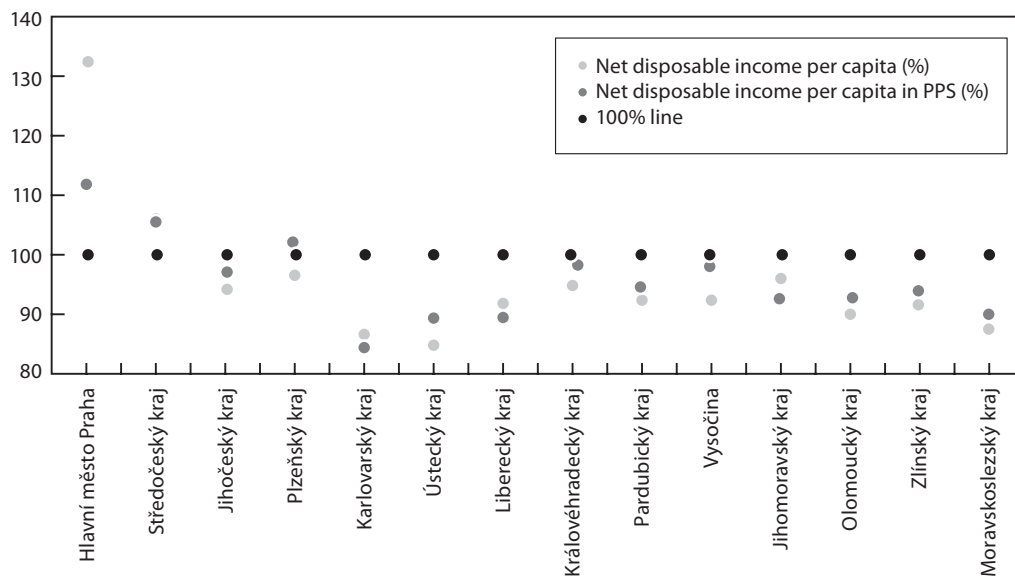
Final household consumption expenditures represent the main use of net disposable income (hereinafter NDI) of households (about 95%). Net disposable income per capita is sometimes considered as an indicator of well-being. Table 3 shows preliminary results for 2007.

**Table 3** Comparison of results obtained by official and adjusted methodology (2007)

Region	PPP	Net disposable income per capita	Net disposable income per capita in PPS	Net disposable income per capita (%)	Net disposable income per capita in PPS (%)
Hlavní město Praha	119.7	230 578	192 703	132.2	110.5
Středočeský kraj	101.9	187 150	183 697	107.3	105.4
Jihočeský kraj	97.9	168 100	171 690	96.4	98.5
Plzeňský kraj	97.1	172 868	178 062	99.1	102.1
Karlovarský kraj	101.4	156 050	153 909	89.5	88.3
Ústecký kraj	94.9	152 960	161 171	87.7	92.4
Liberecký kraj	101.4	162 996	160 690	93.5	92.2
Královéhradecký kraj	96.4	168 919	175 158	96.9	100.5
Pardubický kraj	98.2	165 325	168 414	94.8	96.6
Vysočina	95.6	165 652	173 252	95.0	99.4
Jihomoravský kraj	103.4	171 168	165 462	98.2	94.9
Olomoucký kraj	96.9	160 623	165 776	92.1	95.1
Zlínský kraj	100.8	168 523	167 143	96.7	95.9
Moravskoslezský kraj	96.7	157 100	162 533	90.1	93.2
<b>Czech Republic</b>	<b>100.0</b>	<b>174 360</b>	<b>174 360</b>	<b>100.0</b>	<b>100.0</b>

Source: Authors' calculation

**Figure 1** Net disposable income per capita in PPS (in %) with one national price level and regional price levels (2007)



Source: Authors' calculation

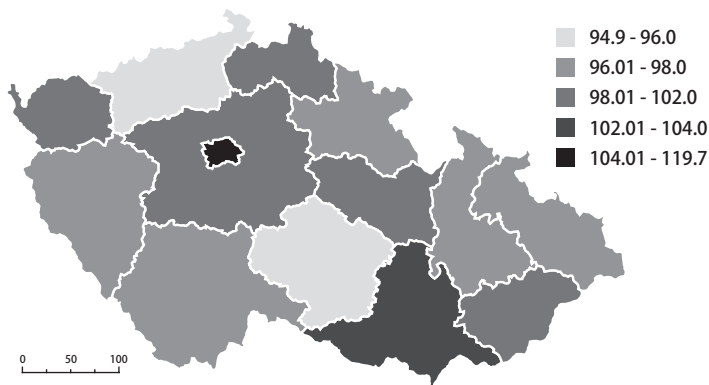
The highest price level is located in the capital city as it was expected which is caused mainly by higher prices of living and some other services (e.g. transportation, personal services). On the other hand it can be marked as a surprise that relatively high price level is in small regions that are not considered as highly developed (Liberecký kraj or Zlínský kraj). Reason for this can be uneven size of the regions according to classification CZ-NUTS 3. In these small regions regional centre (town), where prices are usually higher than in the countryside, play more important role than in large regions.

Our main finding is that differences between regional indicators adjusted to regional price levels are smaller than between the “original” indicators; nevertheless Praha is still the richest region. On the other hand the advantage of Praha decreases just to 10.5%. Figure 1 shows these results. We can see, that the main decrease in NDI in percentage points is in the case of Praha, on the other hand the main increase is in Ústecký kraj.

Originally calculation and usage of PPS is based on GDP however at regional level inappropriate interpretation can lead to misunderstanding. Regional GDP represents regional gross value added (GVA) produced in region plus net taxes on products regardless inputs used in production. Compensation of employees who work in Prague but live in other regions belongs to Praha’s GDP though it can be spent in other regions as well. This is probably the main reason for difference between the share of Prague on GDP per capita and share of Prague on net disposable income per capita (compare Chlad et al., 2009). Regional economies can be compared from the point of view of regional GDP, but comparison based on GDP per capita is at least questionable. Moreover place of living in population census in some countries (not in the Czech Republic) is based on administrative data sources (see Šanda, 2012). Some people have corresponding address at place where they actually live, but their official address is elsewhere (moreover place of birth). Sometimes GDP per capita is considered as an indicator of well-being though in this consideration there are many reservations (see Stiglitz et al., 2009).

On Figure 2 the regional dispersion of regional price levels is depicted. As it was stated, highest price levels can be found in regions with two biggest cities, the lowest are in Zlínský kraj, kraj Vysočina and also in Ústecký kraj, which is in a long-term sight affected by structural changes and high unemployment.

**Figure 2** PPPs in the Czech NUTS 3 regions in % (2007)



Source: Authors' calculation



## CONCLUSION

In this paper we tried to introduce the topic of regional price levels. PPS methodology used for international comparisons is based on one national price level. However, this is no more useful for regional comparisons. We showed that when OECD / Eurostat methodology is adjusted, the results obtained may be different, especially for such regions as Praha or its agglomeration region. Regional indicators can be recalculated in accordance to adjusted methodology and after that compared with the original ones. We showed in this paper as an example the net disposable income that was adjusted to local price level. This approach as we consider should provide more reliable data on living conditions in regions. The results while taking regional price levels into account converge a lot (e.g. NDI in PPS).

We performed our computations for the year 2007 which was suitable according to available data sources. This issue (of data sources) also makes it difficult to obtain a longer time series, which would be important for intertemporal comparison and especially for assessment of regional price levels development, but it is so far almost impossible to construct this time series. Another problem connected with this is, that year-on-year differences could be expected in the extent of statistical error.

This issue is important not only from the point of view of statistics and its accuracy but the results can also potentially be used to adjust regional policy decisions. In fact, these are very often based on GDP per capita in PPS that may be biased when taking into account just one national price level for all the regions.

Possibilities for broadening of our analyses and questions for further research we see especially in the computation of some other years to perform later possibly at least basic comparison in time. On the other hand changes in methodologies and survey techniques make this quite challenging. For example data for the year 2001 and before don't exist at all.

Regional price indices (and especially consumer price index CPI) represent other important related issue that would be desired by local governments for regional policy as well as public. Development of regional price levels in time is determined by changes in price and structure of regional macro-aggregates.

Interesting would definitely be also international comparison, i.e. introduction of this adjusted methodology to other countries to see the differences in results there.

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