# Centre for Efficiency and Productivity Analysis

**Working Paper Series**
**No. WP10/2021**

Price Levels, Size, Distribution and Growth of the World Economy:
Insights from recent International Comparisons of Prices and Real Product

Alan Heston, D.S Prasada Rao

**Date: July 2021**

**School of Economics**
**University of Queensland**
**St. Lucia, Qld. 4072**
**Australia**

**ISSN No. 1932 - 4398**

# Price Levels, Size, Distribution and Growth of the World Economy: Insights from recent International Comparisons of Prices and Real Product

Alan Heston(*)
*University of Pennsylvania*

D.S. Prasada Rao(*)
*The University of Queensland*

*Abstract*

We highlight and extend findings of the recent International Comparison Program (ICP) for the years 2011 and 2017 that provides PPP based national accounts for 173 countries. The growth and distribution of world GDP are examined and some convergence is found. The ICP price level story is consistent with that of previous ICP rounds of the 1970s. Using new methods, international prices were compared between the 1975 ICP and 2017. Updating the results to 2019, it is clear China is number one and that gains of the lower income countries are another casualty of covid-19.

Key words: Purchasing power parities; price levels; global growth; inequality; price structures

JEL Classification: E01, E31, I31, O57

20 July, 2021

The authors wish to thank the Global ICP Unit at the World Bank for providing unpublished detailed international comparisons results intended for researcher use. The authors have benefited from comments and suggestions from the participants of the ICP Technical Advisory Group Meeting held during 17-19 May, 2021. The authors acknowledge expert research assistance from Dr. Dongjie Wu. Rao's research has been supported by the Australian Research Council grant for Discovery Project No. DP170103559.

(*) Contact information:
Alan Heston - alheston@gmail.com; D.S. Prasada Rao – d.rao@uq.edu.au

## Section 1. Introduction

Our research is largely motivated and driven by the release of the results from the 2017 International Comparison Program (ICP), *Purchasing Power Parities and the Size of the World Economies* by the World Bank (2020) in May last year. The World Bank report presents snapshots of the world economy taken in 2011 and 2017 that are rich in detail of the real size, structure and distribution of real gross domestic product of 176 economies from all regions of the world.

One reason the 2017 ICP report is particularly noteworthy is that in combination with the 2011 comparison, it is the first time in its 50 years' existence[1] that successive rounds have used almost identical survey frameworks and methodologies, a feature that is exploited in this paper. Remarking on this point Deaton and Schreyer (2020a) say, "Good news first. The 2017 results are a recognizable update of the 2011 update, and not a radical remapping of the world's economic geography. This is important because previous updates sometimes changed the relative size of countries and continents. The 2005 estimates, for example, made the world look much more unequal than previously believed; they also sharply increased some measures of poverty." In a longer piece Deaton and Schreyer (2020b) point out how with respect to health outcomes and distribution, there are limitations on what the ICP can tell us about well-being, an important caveat that applies to this paper as well.

Another reason is that Covid-19 has forced a change in the schedule of future ICP rounds and has made the current report more significant. The plan had been approved in 2017 within the ICP governance framework that the ICP should move to a series of 3 year rolling benchmark comparisons, with 2020 being the first round to be carried out under that plan. However, it became clear by the middle of last year that many national statistical offices were already overwhelmed by their routine field responsibilities and the additional data collection and processing would be beyond their capacity. The implication is that 2017 will be the last ICP round of the pre-Covid global economy and the last benchmark before 2021 or 2022.

Past releases of macroeconomic data from various phases of the ICP have attracted the attention of researchers, journalists and international organizations. Major news outlets as well as magazines like the Economist provide commentaries and publish lead articles highlighting the findings. Blogs and serious research papers analyze the ICP results focusing on, but not limited to: relative levels of per capita income, relative price levels; country and regional shares in the world economy; regional and global inequality; and global poverty (see Deaton and Heston, 2010; Deaton, 2010; Chen and Ravallion, 2010; Deaton and Dupriez, 2011; Feenstra et al., 2017). A few studies discuss and comment on the consistency of international price and real income countries over time (Feenstra et al., 2013; Deaton and Aten, 2017; Inklaar and Rao, 2017; Inklaar et al., 2021). Release of the 2017 ICP (World Bank, 2020) has generated similar level of interest and comment (Deaton and Schreyer, 2020a; Deaton and Schreyer, 2020b; Atamanov et al., 2020). Evident from these limited studies, though ICP produces a wealth of

[1] See World Bank (2020) and Asian Development Bank (2020) for a brief history and evolution of ICP which started in 1968 as a small research project at the University of Pennsylvania.

information, the focus in the past has mainly been on levels and disparities in per capita real expenditures and on the explanation of price level differences at the GDP level. In this paper we break away from these past trends and delve deeper into ICP data to elicit patterns of growth and inflation in different regions of the world and examine shifts in national and international relative price structures. Our objective here is to develop analytical tools and implement them to provide new insights into the size, growth and distribution of the world economy. The paper analyses the drivers of differences in price levels across countries as well as shifts in relative price structures and places these findings in the perspective of the half century of the project.

Section 2 is devoted to a description and analysis of the snapshots of the world economy for the years 2011 and 2017. The main focus of the section is on decomposing changes in real GDP and identifying the growth and inflation components. The analytical approach used here is applied for analysis at the country, regional and global level. The level of per capita real income and distributional components of economic welfare are presented, with the analysis extended to components of GDP including individual consumption by households, government expenditure and gross fixed capital formation. In section 3 we conduct in-depth analysis of the price levels and their determinants with particular focus on price levels for tradables and non-tradables. In section 4 we develop a framework to study relative price structures at the national and global level. The notion of international average prices is developed and implemented to study relative price structure at the global level. The results reported here show an impressive degree of consistency between the 2011 and 2017 comparisons and are largely similar to those reported in 1975. Given the continuing debate regarding the size of the Chinese economy, we devote section 5 to recount the historical attempts at measuring real GDP of China and conclude that China is the largest economy in 2020. This section also provides extrapolations based on the recently released data from the Penn World Table and growth rates from IMF's *World Economic Outlook.* The last section offers a summary highlighting the important contributions and findings from the paper.

## Section 2. Size and Distribution of Global GDP - reaches $120 trillion in 2017

The number of countries participating in the 2017 and the 2011 benchmarks were 176, including most major economies in the world, with only a few small economies absent, like Cuba, N. Korea, Syria, Venezuela and Yemen. If the GDPs of these countries were included, the total world GDP in 2017 after converting each country's GDP, in its own local currency unit, into US dollars using PPPs from 2017 ICP would reach the $120 trillion of the section heading. It has been conventional for the ICP to use the US dollar as its reference currency, a practice that has no effect on the relative position of countries in the income chain. If the rupee or euro were used as the reference currency the total global GDP in Table 1 would of course be different, but the relative sizes of Brazil and Germany, for example, would remain the same. We start our analysis with the 25 largest economies in the world from the ICP (World Bank, 2020) according to the size of their real GDP in 2017, shown in Table 1.

**Table 1: Total and per capita GDP for 25 largest Economies in 2017**

(Per capita and total figures in current US dollars)

| Country Name | Real GDP 2017 (billions of dollars) | Real GDP 2011 (billions of dollars) | Real GDP 2011 at 2017 prices (billions of dollars) | per capita Real GDP 2017 ($) | per capita Real GDP 2011 ($) |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| Netherlands | 948.2 | 777.9 | 882.1 | 55349 | 46599 |
| Argentina | 1037.8 | 797.3 | 1017 | 23621 | 19295 |
| Taiwan, China | 1112.6 | 944.7 | 914.2 | 47223 | 40736 |
| Poland | 1145 | 869.8 | 957.9 | 29802 | 22576 |
| Thailand | 1203 | 912.8 | 975.5 | 17781 | 13785 |
| Australia | 1233.9 | 971.2 | 1050 | 50153 | 43474 |
| Egypt, Arab Rep. | 1263.4 | 905.5 | 1035.8 | 13327 | 11245 |
| Iran, Islamic Rep. | 1298.1 | 1584.8 | 1157.1 | 16012 | 21089 |
| Saudi Arabia | 1565.9 | 1586.7 | 1328.3 | 48015 | 56321 |
| Canada | 1778 | 1430.8 | 1583.2 | 48658 | 41663 |
| Spain | 1844 | 1486.4 | 1727.5 | 39627 | 31803 |
| Korea, Rep. | 2105.9 | 1625.3 | 1775.5 | 41001 | 32547 |
| Turkey | 2265.5 | 1443.3 | 1610.7 | 28209 | 19445 |
| Mexico | 2470.1 | 1911.3 | 2107.2 | 20023 | 16547 |
| Italy | 2529.5 | 2173.2 | 2558.6 | 41785 | 36183 |
| Indonesia | 2893.6 | 2229.5 | 2127.3 | 11049 | 9213 |
| France | 2994.5 | 2446.5 | 2812.4 | 44651 | 37448 |
| Brazil | 3017.7 | 2970.6 | 3025.6 | 14520 | 15040 |
| United Kingdom | 3037 | 2350.8 | 2686.5 | 45988 | 37146 |
| Russia | 3829.5 | 3268.5 | 3616.4 | 26079 | 22863 |
| Germany | 4381.8 | 3415 | 3988.1 | 53012 | 42542 |
| Japan | 5173 | 4573.2 | 4795.7 | 40827 | 35775 |
| India | 8050.5 | 5482.9 | 5336.3 | 6149 | 4508 |
| United States | 19519.4 | 15542.6 | 17129.6 | 59984 | 49811 |
| China | 19617.4 | 13883 | 12911.7 | 14150 | 10329 |

Source: World Bank (2020) and authors' calculations

The point to note in Table 1 is that in 2017 China has overtaken the United States, by a small margin, as the largest economy in the world followed by India, Japan and Germany. Among these countries, the United States is the richest with real per capita income $49,811, nearly five times that of China. Columns (2) and (3) show real GDP in 2011 expressed in 2011 prices (PPPs) and in 2017 prices. Differences in these figures highlight the role of relative prices in the compilation of real GDP in 2011 and 2017. For purposes of making level and relative real GDP comparisons across countries in 2011 we suggest the use of column 2 as it gives a picture based on prices in 2011.

### 2.1 PPP converted real GDP of a country over time – a decomposition

Continuing on with Table 1, we observe real GDP of Germany, for example, in 2011 and 2017, to be 4.381 and 3.415 trillions of US dollars respectively indicating an increase of 28.31 percent. This change is partly due to growth in the German economy, domestic inflation and also due to differences in PPPs used for conversion. Let us start with the real GDP measure, denoted by *RGDP*, of Germany in the two years given by:

$$RGDP^{US}_{2017,Germany} = \frac{GDP^{US}_{2017,Germany}}{PPP^{US}_{2017,Germany}}; \quad and \quad RGDP^{US}_{2011,Germany} = \frac{GDP^{US}_{2011,Germany}}{PPP^{US}_{2011,Germany}} \tag{1}$$

From Table 1,

$$\frac{RGDP^{US}_{2017,Germany}}{RGDP^{US}_{2011,Germany}} = \frac{4381.8}{3415} = 1.2831$$

In general, for any country *j*, we derive the following decomposition of change in real GDP. Let $Def_{2011,2017,j}$ represent the domestic GDP deflator for year 2017 with 2011 as the base year – these deflators are available from national accounts; the term $CGDP_{2011,2017,j}$ represent the GDP of country *j* in 2017 expressed in constant 2011 prices; and $GR_{2011,2017,j}$ represent domestic growth rate of GDP for country *j*[2]. Then

$$\frac{RGDP^{USA}_{2017,j}}{RGDP^{USA}_{2011,j}} = \frac{GDP_{2017,j}/PPP^{USA}_{2017,j}}{GDP_{2011,j}/PPP^{USA}_{2011,j}} = \frac{\frac{GDP_{2017,j}}{PPP^{USA}_{2017,j}}\Big/Def_{2011,2017,j}}{\frac{GDP_{2011,j}}{PPP^{USA}_{2011,j}}\Big/Def_{2011,2017,j}} \times \frac{Def_{2011,2017,j}}{Def_{2011,2011,j}}$$

$$= \frac{GDP_{2017,j}/Def_{2011,2017,j}}{GDP_{2011,j}/Def_{2011,2011,j}} \times \frac{Def_{2011,2017,j}}{Def_{2011,2011,j}} \times \frac{PPP^{USA}_{2011,j}}{PPP^{USA}_{2017,j}} = \frac{CGDP_{2011,2017,j}}{CGDP_{2011,2011,j}} \times Def_{2011,2017,j} \times \frac{PPP^{USA}_{2011,j}}{PPP^{USA}_{2017,j}} \quad (2)$$

$$= GR_{2011,2017,j} \times Def_{2011,2017,j} \times \frac{PPP^{USA}_{2011,j}}{PPP^{USA}_{2017,j}} = \text{country growth rate} \times \text{domestic price change} \times \text{effect of PPP change}$$

This decomposition is shown for a few selected countries in Table 2 below. Gleaning from the table, factors behind the 28.3 percent change in real GDP from 2011 to 2017 in Germany are: 9.9 percent growth of GDP at constant prices (column 4); 9.6 percent domestic inflation (column 7); and the PPP change effect of 6.5 percent (column 6). For all the other countries in the table PPP exchange rate has downward push which means that PPPs for these countries in 2017 are greater than those in 2011.

Table 2: Decomposition of change in real GDP for selected countries, 2011 and 2017

| Countries | RGDP 2011 | RGDP 2017 | Change from 2011 to 2017 | Real Growth | Inflation | Exchange Rate change effect | National Inflation Rate |
|---|---|---|---|---|---|---|---|
| | (billion $) | (billion $) | (2)/(1) | | (3)/(4) | | |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| United States | 15542.58 | 19519.42 | 1.256 | 1.140 | 1.102 | 1.000 | 1.102 |
| China | 13882.96 | 19617.38 | 1.413 | 1.519 | 0.930 | 0.842 | 1.104 |
| India | 5482.87 | 8050.53 | 1.468 | 1.509 | 0.973 | 0.753 | 1.292 |
| Germany | 3415.02 | 4381.79 | 1.283 | 1.099 | 1.168 | 1.065 | 1.096 |
| South Africa | 639.19 | 733.69 | 1.148 | 1.099 | 1.044 | 0.743 | 1.405 |
| **World** | 93463 | 119089 | 1.274 | 1.223 | 1.042 | 0.879 | 1.185 |

Notes: RGDP denotes real GDP obtained by summing GDPs of all countries within a region after conversion using PPPs.Figures in columns 1 and 2 are based on ICP 2011 and 2017 results in World Bank (2020). Figures in the remaining columns are based on authors' computions using methodology in Balk, Rambaldi and Rao (2020).

Equation (2) has an interesting implication when PPPs in, say, 2017 are extrapolated from PPPs in 2011 using movements in relative deflators – a procedure used in the compilation of *World Development Indicators*. The extrapolation mechanism used is simply:

$$PPP^{US}_{2017,j} = PPP^{US}_{2011,j} \times \frac{Def_{2011,2017,j}}{Def_{2011,2017,USA}} \quad (3)$$

[2] Domestic growth rate is simply the ratio of GDP in 2017 and 2011 expressed in 2011 constant prices.

This is an intuitive approach which updates PPPs using price movements in the country relative to USA. Substituting (3) into equation (2) leads to the following simple and somewhat surprising formula:

$$\begin{aligned}\frac{RGDP^{USA}_{2017,j}}{RGDP^{USA}_{2011,j}} &= GR_{2011,2017,j} \times Def_{2011,2017,j} \times \frac{PPP^{USA}_{2011,j}}{PPP^{USA}_{2017,j}} \\ &= GR_{2011,2017,j} \times Def_{2011,2017,j} \times \frac{PPP^{USA}_{2011,j}}{PPP^{USA}_{2011,j}} \times \frac{Def_{2011,2017,USA}}{Def_{2011,2017,j}} \\ &= GR_{2011,2017,j} \times Def_{2011,2017,USA}\end{aligned} \tag{4}$$

When PPPs are updated using relative inflation rates, the last term in equation (4) shows that real GDP of a country in 2017 can simply obtained by updating its 2011 real GDP with country specific growth rate and then applying inflation observed in the US.

In between the ICP benchmark comparisons, it is a common practice among poverty economists at the World Bank and elsewhere to update the international poverty line expressed in US dollars, such as $1.90 in 2011, to 2015 using US inflation rate. This approach is indeed the right approach simply because there are no independent PPPs for 2015 other than those updated using the approach described in equation (4).

## 2.2 Decomposition of changes in Real GDP of the world and different regions - measures of global and regional growth and inflation

Having identified the components of change in real GDP of a country, we turn to the problem at the global and regional levels. A bit of background to the task on hand. The World Economic Outlook (WEO), a flagship publication of the IMF, presents estimates of global and regional growth in output and inflation and it often includes projections for the coming years. Up until 1992 the IMF weighted the national growth rate of each country by its GDP share in the world, converted at exchange rates (three-year average) to dollars. This exchange rate based weighted average produced low rates for Asia, though the media, other observers and China experts all said the IMF was understating what was happening in East Asia's economies. Further, observers in Europe thought the low growth in Europe at the time was receiving too much weight because of their overstated GDP when converted at exchange rates. The IMF decided that it was time for a change in this approach and in 1993 began using PPP converted real GDP to weigh country growth rates. Other international organizations such as the United Nations and the World Bank regularly publish estimates of global growth and inflation using weights based on PPP converted GDPs of countries.

To motivate the discussion and results presented here, it is instructive to ask and reflect on a few basic questions regarding global measures of growth and inflation. In the case of a single country, GDP or the size of the economy is the basis for measuring growth which we all know is measured by the growth of GDP at constant prices. Likewise, inflation is measured using the GDP deflator. The product of GDP growth and deflator must equal the observed change in GDP of the country in current prices. In the case of global growth, what is the measure of GDP for the world? If the global growth and inflation are measured as weighted

averages of country specific measures, would these measures be consistent with the observed change in world GDP irrespective of how it is measured? If global growth is computed as a weighted average of country specific growth rates – the current approach of the IMF – what type of average is appropriate? Should the base or current period weights be used? We found it difficult, if not impossible, to find answers to these questions from *World Economic Outlook* (WEO) (IMF, 2021) or the *UN World Economic Situation and Prospects (UN, 2021)* or from the *Global Economic Prospects* (World Bank, 2021) which are the most authoritative sources of global growth and inflation measures.

In what follows, we describe a systematic approach to this measurement making use of some recent research of Balk, Rambaldi and Rao (2020), focusing on this measurement over the period from 2011 to 2017[3]. First, the world real GDP in year 2017 is the sum of real GDP, PPP converted GDP, over all the countries included, 176 in this case.

$$RGDP_{2017,W} = \sum_{j=1}^{176} \frac{GDP_{2017,j}}{PPP^{US}_{2017,j}} \tag{5}$$

Then change in the world real GDP over the period 2011 to 2017 is represented by the following ratio:

$$\frac{RGDP_{2017,W}}{RGDP_{2011,W}} = \frac{\sum_{j=1}^{176} GDP_{2017,j} \big/ PPP^{USA}_{2017,j}}{\sum_{j=1}^{176} GDP_{2011,j} \big/ PPP^{USA}_{2011,j}} \tag{6}$$

The last row of Table 2 shows the world real GDP in years 2017 and 2011 to be, respectively, 119.089 and 93.463 trillions of dollars implying an increase of 27.42 percent over the period.

The second step is to decompose the change in world real GDP shown in equation (6) into meaningful components. Can we apply decomposition shown in equation (2) at the global level? Based on a clever application of the Sato – Vartia index (Sato, 1976; and Vartia, 1976) by BRR (2020), equation (6) can be equivalently expressed as:

$$\frac{RGDP_{2017,W}}{RGDP_{2011,W}} = \prod_{j=1}^{176} \left[ GR_{2011,2017,j} \right]^{w_j} \times \prod_{j=1}^{176} \left[ Def_{2011,2017,j} \right]^{w_j} \times \prod_{j=1}^{176} \left[ \frac{PPP^{USA}_{2011,j}}{PPP^{USA}_{2017,j}} \right]^{w_j} \tag{7}$$

$$= \text{Global growth} \times \text{Average of domestic inflation rates} \times \text{PPP change effect}$$

$$= \text{Global growth} \times \text{Global inflation}$$

where the weights used are logarithmic averages[4] of shares of each country in the world real GDP in years 2011 and 2017.

[3] This discussion applies to any selection of the years but we preferred to anchor this discussion on ICP results from 2011 and 2017.

[4] $L(a,b)$ is the logarithmic average of numbers $a$ and $b$ given by: $L(a,b) \equiv \frac{a-b}{\ln a - \ln b}$ *if* $a \neq b$; *and* $L(a,a) \equiv a$.

Equation (7) provides guidance to IMF and other organizations involved in the compilation and dissemination of global growth and inflation data. First, the left-hand side of the equation suggests that the world real GDP is computed, after identifying all the countries that belong to the computation, is the sum of real GDP across all the countries. Second, the right side of the equation suggests that current practice, by international organizations, of using weighted average of growth rate is analytically sound only when: (i) geometric averages are used; and (ii) the weights are based on a symmetric logarithmic average of respective real GDP shares of countries in the two years. Third, decomposition in equation (7) suggests that in addition to the use of an average of domestic inflation rates (the second component), it is necessary to account for the effect of changes in PPPs of currencies over the two years. *Without the last term, the product of average growth and domestic inflation rates will not equal change in the global real GDP.*

Using the framework described in equation (7), Tables 3 and 4 present our decomposition of change in real world GDP into global growth and inflation components for the years 2011 and 2017. The World Bank (2020) ICP report allows us to apply this decomposition methodology at the regional level. The richness of the published ICP results we alluded to allows us to implement the decomposition to three different sets of country groupings: (i) geographical regions; (ii) administrative groupings of countries (OECD-Eurostat; Asia-Pacific; Africa etc); and (iii) income-based groupings formed after ranking countries by their real per capita incomes. Membership of these three different groupings of countries are detailed in the Appendix on the Classification of the World's Economies in World Bank (2020).

Table 3: Real GDP, Growth and Inflation by Regions, 2011 and 2017

| ICP Region | RGDP 2011 | RGDP 2017 | Change from 2011 to 2017 | Real Growth | Inflation | Exchange Rate change effect | National Inflation Rate |
|---|---|---|---|---|---|---|---|
| | (billion $) | (billion $) | (2)/(1) | | (3)/(4) | | |
| Panel A: Geographic Regions | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| East Asia & Pacific | 27925 | 37235 | 1.333 | 1.363 | 0.979 | 0.887 | 1.104 |
| Europe & Central Asia | 24027 | 30362 | 1.264 | 1.104 | 1.145 | 0.975 | 1.174 |
| Latin America & Caribbean | 7675 | 9198 | 1.198 | 1.103 | 1.087 | 0.703 | 1.545 |
| Middle East & North Africa | 6943 | 7131 | 1.027 | 1.195 | 0.859 | 0.700 | 1.227 |
| North America | 16973 | 21297 | 1.255 | 1.138 | 1.102 | 1.002 | 1.100 |
| South Asia | 6923 | 10123 | 1.462 | 1.478 | 0.989 | 0.756 | 1.308 |
| Sub-Saharan Africa | 2997 | 3743 | 1.249 | 1.244 | 1.004 | 0.692 | 1.451 |
| **World** | **93463** | **119089** | **1.274** | **1.223** | **1.042** | **0.879** | **1.185** |
| | | | | | | | |
| Panel B: Adminsitrative (Agency) Region | | | | | | | |
| Eurostat-OECD | 50588 | 63438 | 1.254 | 1.124 | 1.116 | 0.992 | 1.125 |
| Asia and the Pacific | 27535 | 38650 | 1.404 | 1.460 | 0.961 | 0.824 | 1.166 |
| CIS | 827 | 994 | 1.203 | 0.994 | 1.210 | 0.563 | 2.150 |
| Caribbean | 119 | 128 | 1.074 | 1.021 | 1.052 | 0.901 | 1.168 |
| Latin America | 4703 | 5364 | 1.141 | 1.057 | 1.080 | 0.609 | 1.772 |
| Africa | 3823 | 4607 | 1.205 | 1.234 | 0.977 | 0.712 | 1.371 |
| Western Asia | 5868 | 5908 | 1.007 | 1.194 | 0.844 | 0.673 | 1.254 |
| **World** | 93463 | 119089 | 1.274 | 1.223 | 1.042 | 0.879 | 1.185 |

Notes: RGDP denotes real GDP obtained by summing GDPs of all countries within a region after conversion using PPPs. Figures in columns 1 and 2 are based on ICP 2011 and 2017 results in World Bank (2020). Figures in the remaining columns are based on authors' computions using methodology in Balk, Rambaldi and Rao (2020).

The real GDP of the world, covered by the 176 ICP countries, increased from 93.4 to 119.09 trillion dollars over the period representing an increase of 27.4 percent. Of this change, global growth, which is a weighted average of growth of GDP in the countries, is of the order of 22.3 percent. The WEA measure of global inflation, shown in the last column, shows 18.5 percent. The WEA measures of global growth and inflation do not match-up with the change in the size of the world economy in column (3). This inconsistency goes unnoticed as the analytical framework for global growth and inflation computations used by the IMF are not explained in any detail.

The decomposition provided in Table 3 provides a coherent accounting of change in real GDP over the period 2011 to 2017. The global inflation measure, in column 5, which is the product of the effects of changes in PPP exchange rates and domestic inflations which are shown in columns (6) and (7). It is instructive to compare columns (5) and (7) for Europe and Central Asia, Sub-Saharan Africa and the World. For Europe, regional inflation in column (5) was 14.5% compared to regional average of domestic inflation in column (7) at 17.4% I - a relatively small difference which is largely due to the small magnitude associated with the PPP exchange rate change effect. This means PPPs remained relatively stable for countries in Europe. In contrast, Sub-Saharan Africa also has a significant and large exchange rate depreciation effect, over 30% which in turn results in significant difference between average of domestic inflation rates, a price rise in the region of 45.1 percent and the global inflation figure of 0.4 percent. For other regions and the world, the results are in between these two extremes.

Our analysis of change in real GDP of the world and its regions, presented in Table 3, has implications for the IMF in its compilation and dissemination of global and growth and inflation. First, we emphasize the need to clearly identify the countries that are included in global growth computations. We believe that IMF could focus on 150 or so largest countries that roughly account for 99.99 percent of the world economy in PPP terms. Second, as shown in column (2) of Table 3 it is important to publish the size of the world economy in the years under comparison computed using PPPs in these years. Finally, publication of a complete decomposition of the change in real GDP into growth and inflation measures that clearly include a measure of the effect of changes in PPPs during the period would be helpful to end-users.

The change in real GDP and its components for income-based groups presented in Table (4) are indeed interesting.

Table 4. Decomposition for country groups based on per capita real GDP, 2011 and 2017

| Country Groups by per capita real GDP | RGDP 2011 | RGDP 2017 | Change from 2011 to 2017 | Real Growth | Inflation | Exchange Rate change effect | National Inflation Rate |
|---|---|---|---|---|---|---|---|
| | (billion $) | (billion $) | (2)/(1) | | (3)/(4) | | |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| High income | 47587 | 58383 | 1.227 | 1.123 | 1.092 | 1.024 | 1.067 |
| Lower middle income | 13528 | 18991 | 1.404 | 1.383 | 1.015 | 0.732 | 1.386 |
| Upper middle income | 31610 | 40739 | 1.289 | 1.306 | 0.987 | 0.767 | 1.287 |
| Low income | 738 | 976 | 1.324 | 1.412 | 0.937 | 0.717 | 1.307 |
| **World** | **93463** | **119089** | **1.274** | **1.223** | **1.042** | **0.879** | **1.185** |

Notes: RGDP denotes real GDP obtained by summing GDPs of all countries within a region after conversion using PPPs.Figures in columns 1 and 2 are based on ICP 2011 and 2017 results in World Bank (2020). Figures in the remaining columns are based on authors' computions using methodology in Balk, Rambaldi and Rao (2020).

In terms of the price inflation, Table 4 mirrors Table 3. Most high-income countries were in Europe and North America where there were relatively small differences in columns (5) and (7). In contrast the other income groups all show substantial exchange rate depreciation though tied to the price increases. It is not that surprising that the high-income group had the slowest real growth (column 4) over the 2011 to 2017 period because a number of those countries like Japan, have found it difficult to achieve high rates of growth in recent decades. But one remarkable result is that the two lowest income groups grew the most rapidly, even besting the upper middle GDP group on average by 10% for the period. We see evidence of income convergence in the real growth rates of the low, lower middle and upper middle-income countries. How the severe economic shocks posed by the pandemic will affect this encouraging growth performance has to be a major concern.

### 2.3 Change in global economic welfare

We make use of Sen (1976, 1979)'s measure of economic welfare to examine change in global welfare over the period 2011 to 2017. Sen's measure of welfare is given by:

$$W = \mu \times (1 - G)$$

where μ and $G$ are respectively the mean or average income and the Gini measure of inequality. In order to compare global welfare over these two years, it is necessary to consider mean income in constant prices.

Table 4 shows the components of Sen's global welfare. The world per capita real GDP, or per capita income in PPP terms, has increased from $14,551 to $16,575 both expressed in 2017 prices, a 13.9 percent over the six-year period. International income inequality, a population weighted inequality measure[5], based on the Gini coefficient shows a decline from 0.4848 to 0.4721.[6] The Sen's measure of global welfare increased from $7497 to 8750, a 16.7 percent increase during the same period

[5] This measure is referred to as the "concept 2" measure of world inequality (Milanovic, 2002) which is the measure obtained with each country represented by its mean income and population size. The concept 3 measure of world inequality is more data intensive as it accounts for inequality within each country.

[6] The Lorenz curve for the distribution of income in 2017 dominates, by a small margin, the Lorenz curve for 2011 indicating an unambiguous decline in inequality. These figures are available from the authors upon request.

Table 5: Sen's Measure of Global Welfare, 2011 and 2017

| | 2011 | | 2017 | |
|---|---|---|---|---|
| Per capita real GDP in 2017 $ | 14551 | | 16575 | |
| Gini | 0.4848 | | 0.4721 | |
| Sen's Welfare Measure | 7497 | | 8750 | |
| Theil's measure | 0.4364 | | 0.4169 | |
| Decomposition of Theil's measure - Geographic Regions | | % | | % |
| Within region | 0.1274 | 29.19 | 0.1091 | 26.17 |
| Between region | 0.3090 | 70.81 | 0.3078 | 73.83 |
| Decomposition of Theil's measure - Income groups | | | | |
| Within region | 0.0514 | 11.78 | 0.0406 | 9.71 |
| Between region | 0.3850 | 88.22 | 0.3765 | 90.29 |

Source: Authors' calculations based on World Bank (2020)

In Table 5, we also present Theil's additively decomposable measure of inequality. Like the Gini measure, Theil's measure also shows a decline. We draw attention to two features of the contribution of within and between region inequalities. The within region inequality has declined irrespective of how countries are grouped and the contribution of between region inequality has risen which indicates a small increase in divergence in incomes of regions. As expected, within group inequality in the case of income groupings is quite small contributing around 10 percent to total inequality whereas between-group inequality is around 90 percent. We have compiled results similar to those presented in Table 5 for each of the regions which are available from the authors upon request.

### 2.4 Distribution of GDP expenditure components

Thus far we have focused on real GDP per capita incomes and inequality in the distribution of income. However, if the focus is on the material wellbeing, per capita GDP may not be the best measure. Instead, the levels of individual consumption expenditure by households (ICEH) are better suited for this purpose. Recognizing the role of government in the provision of services to the general population especially in the areas of health and education, we make use of a slightly expanded actual consumption expenditure by households (ACEH) measure which includes expenditure by households as well as that by the government on behalf of the households. While consumption measures are indicative of the current levels of material wellbeing, gross capital formation levels hold important information on the levels of capital stock and productive capacity of the economies in different countries.

Table 6: Levels and Inequality in per capita GDP and its components – ICP 2011 and 2017

(Geographical Grouping of Countries)

| Inequality Measure | GDP | | Individual Consumption Expenditure by Households (ICEH) | | Actual Consumption Expenditure by Households (ACEH) | | Government Expenditure | | Gross Capital formation | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **2011** | **2017** | **2011** | **2017** | **2011** | **2017** | **2011** | **2017** | **2011** | **2017** |
| per capita real expenditure | 14551 | 16575 | 7335 | 8934 | 8881 | 10797 | 2970 | 3352 | 3504 | 4204 |
| Gini | 0.4848 | 0.4721 | 0.5100 | 0.4701 | 0.5063 | 0.4770 | 0.5318 | 0.5415 | 0.4524 | 0.4779 |
| Theil | 0.4364 | 0.4169 | 0.4559 | 0.3859 | 0.4541 | 0.4013 | 0.5728 | 0.6064 | 0.4404 | 0.4940 |
| Within | 0.1274 | 0.1091 | 0.1318 | 0.0997 | 0.1289 | 0.1021 | 0.1624 | 0.1553 | 0.1596 | 0.1492 |
| Between | 0.3090 | 0.3078 | 0.3241 | 0.2862 | 0.3251 | 0.2993 | 0.4104 | 0.4510 | 0.2808 | 0.3448 |
| % share of inequality between | 70.81 | 73.83 | 71.09 | 74.16 | 71.60 | 74.57 | 71.65 | 74.37 | 63.76 | 69.80 |

Note: Per capita expenditures are expressed in constant 2017 US dollars.

In Table 6 we seek to illustrate the richness of the ICP results. We focus on the distributional characteristics of ICEH, ACEH, government expenditure as well as gross fixed capital formation.

The first row of the table shows that, on average, consumption expenditure is the main component of GDP[7]. The difference between ICEH and ACEH reflects the contribution made by the general government and these figures suggest that this contribution can be significant. Our interest is primarily on the distribution of these expenditures. The general expectation is that distribution of household expenditure would be less unequal compared to GDP, we find this to be true for the year 2017 where both Gini and Theil's measures are lower for ICEH and ACEH compared to the GDP distributional measures. We find a significant reduction in inequality for GDP, ICEH and ACEH components over the years 2011 and 2017. In contrast, the government expenditure as well as gross capital formation show a significant increase in inequality.

The last three rows of Table 6 show the within and between-region inequality for various aggregates. Regardless of the aggregate under consideration, we find the share of between region inequality as a percentage of the overall Theil's measure increasing over the period 2011 to 2017. The results presented here show scope for further analysis and interpretation which is left for future research.

We conclude this section on an optimistic note on the performance of the world economy over the study period. The size of the world economy measured in PPP terms has reached 120 trillion dollar mark in 2017 from 93.46 trillion in 2011. An encouraging aspect is that this change is largely driven by the observed 22.3 percent growth in the world economy and the comibned effect of domestic inflation rates and changes in PPPs of countries was only 4.2 percent. We find evidence of enhanced global economic welfare due to simulataneous economic growth and reduced global inequality. Our analysis of growth performance at the regional level shows encouraging signs from South Asia, East Asia and Pacific as well as Sub-Saharan Africa. Growth performance of income-based country groupings shows signs of catch-

[7] We remind the reader that these components are not strictly additive as the GEKS aggregation procedure used in the ICP is not additively consistent.

up by low and middle income countries. Our analysis of growth and inequality in per capita consumption (ICEH and ACEH measures), government expenditure and gross capital fomation reveals contrasting differences for different components of GDP. While individual consumption measures exhibit a picture similar to that of GDP, inequality in per capita government expenditure and capital formation has increased over time – an aspect that deserves further research.

## Section 3. Analysis of Price Levels, Balassa-Samuelson and the ICP

What takes all the resources, field work and data processing within the ICP is captured in the price level measures, the subject of this section. What emerged when the first ICP was presented for 10 countries with the reference year of 1970 was that the price level of a country rises with its per capita income (Kravis et al., 1975). The formula for the price level of India with respect to the United States is defined as:

$$PLI_{Ind,US} \equiv \frac{PPP_{Ind,US}}{XR_{Ind,US}} \tag{8}$$

where PPP is the purchasing power parity of the rupee to the dollar and XR is the exchange rate of the rupee to the dollar. The price level (or PL) of GDP for India in 2017 was 0.315 meaning that the bundle of goods and services that cost $100 in the United States would cost a little under $32 in India. Again, if a different currency were the reference all the price levels would change but the purchasing power of each country relative to each other would remain the same.

As the number of participating countries in the ICP has risen to 176 this finding has been robust, as we illustrate below for 2011 and 2017. A derivative data set, the Penn World Table (PWT), which has been widely used in the growth and trade literature, was built upon this finding. The most frequently accepted explanation of this result, the differential productivity model, was formulated independently by Balassa (1964) and Samuelson (1964). It builds on the proposition that the price of non-tradable goods (about half of GDP) tends to be lower than that of tradable goods for low-income countries and rises above tradable goods in high income countries. This proposition in turn builds on the observation that productivity differentials between high and low-income countries are greater for tradables, like steel, than for non-tradables, like restaurant meals. There are other explanations like Bhagwati (1984) or Clague (1986) of why price levels rise with income but for present purposes we just want to make clear this relationship has become an expected and major finding of the ICP rounds. However, we discuss below the more recent paper by Zhang (2017) that argues that unmeasured differences in quality of tradable goods for higher income countries may explain the apparent violation of one price for traded goods.

### 3.1 Tradables and non-Tradables

The Balassa-Samuelson effect is anchored on the differential productivity hypothesis that assumes that productivity increases more rapidly for tradable goods than non-tradables. In

fact, a strong case could be made that Roy Harrod (1939. Ch. 4) had clearly spelled out the B-S explanation in his Cambridge Economics Handbook on International Trade. World War II interrupted the continuity of the flow of ideas in many fields including economics and Harrods work on comparative price levels as well as his growth model that pre-dated Domar. His discussion of the tradability of A, B, and C goods anticipates some more recent literature and should warrant for Sir Roy the label H-B-S as the attribution for what has been most usually termed the Balassa-Samuelson effect. The output per person in grain or steel production has increased faster than in personal services is a typical example offered. But increasingly this is countered with examples like financial services where there has been rapid growth in productivity and textiles where productivity growth has tended to plateau.

In this section we look at the price level indexes of tradables and non-tradables for 2011 and 2017 and see if the generalizations that seemed to hold before 2000 still appear valid. In order to conduct the analysis reported below, we had to compute separate sets of PPPs for tradables and non-tradables as these are not compiled by the World Bank as a part of ICP. The ICP results are all based on expenditures and PPPs at the basic heading (or elementary index) level, the ICP makes use of a classification with 155 basic headings. For our analysis, we have classified these 155 basic headings into: commodities; services and construction related non-tradable basic headings[8]. We had to restrict our coverage to 173 countries for which detailed 155 basic heading level data are available, list available from the authors. As the price level indexes defined in (8) require PPPs, we have computed PPPs using the Gini-Elteto-Koves-Szulc (GEKS) method separately at the GDP level, for tradables and for the group of non-tradables, using the United States as the reference country.

We begin with simple logarithmic relationships between the price level of tradables and per capita GDP in 2011 and 2017 re-examining what Kravis and Lipsey (1988) had found for the 1980 ICP round of 60 countries. They found that the price level of tradables for the lowest 15 real per capita GDP countries was 80 and highest 15 countries was 112. We give below the log-log regression coefficients of the PL of tradables against per capita GDP for 2011 and 2017.

*Relationship between PL of Tradables (PL_TR) and per capita income (NGDP_PC)*[9]

$$\begin{aligned} 2011: \quad & \ln PL\_TR = \underset{(0.0071)}{0.0938} \ln NGDP\_PC - \underset{(0.0639)}{0.8714} \qquad R^2 = 0.568 \\ 2017: \quad & \ln PL\_TR = \underset{(0.0067)}{0.0855} \ln NGDP\_PC - \underset{(0.0617)}{0.8409} \qquad R^2 = 0.480 \end{aligned} \tag{9}$$

[8] Details of the classification used in the study are available from the authors. While there may be discussion about a few basic headings as to whether they belong to the class of tradables or non-tradables, we believe that the results reported here are robust to small differences in such classification. An alternative definition of tradables has been suggested that was illustrated with 2011 ICP basic headings for consumption (Vo, 2021). For each basic heading, the log of the basic heading parity for country B is subtracted from the log of country A. The sum of log differences is taken over all possible pairs of countries in a basic heading and a cut off chosen separating tradable and non-tradeable items. High values of the difference measure would be grouped into non-tradables. We have not tried this measure here.

[9] Unless and otherwise stated, throughout the section we use per capita income or per capita GDP in nominal terms, i.e., converted using exchange rates.

Clearly the price level for tradables rises with income though as Kravis and Lipsey have noted, "despite the near unanimity found in the literature on real exchange rates the law of one price prevails for tradables." (1988, p.475). That is conventional trade theory would have expected the coefficient on GDP to be zero, not positive and significant.

Zhang (2017) provides even stronger evidence that the price level of tradables rises with income across countries based upon the 2005 ICP results. As noted, Zhang offers an alternative to the differential-productivity explanation of Balassa-Samuelson by empirically breaking down the ICP basic headings that are "pure" services and the rest. His idea is that B-S derive their result as an average of non-tradable and tradable goods, whereas Zhang breaks down non-tradables into services totally produced by local labor and the rest. He then regresses the price level of tradables on income and still finds a significant positive relationship with income even after removing pure non-tradables. In this, Zhang appears to be describing Harrod's type C. goods.

While it is expected that the coefficient on per capita GDP against tradables should be near zero that is clearly not the case for either of the recent ICP benchmarks. But the expectation from the differential productivity hypothesis that the coefficient on income for non-tradables should be larger than tradables and that relationship appears to hold. In both 2011 and 2017 the slope coefficients on income are more than twice as large for non-tradables as for tradables.

### *Relationship between PL of non-Tradables (PL_NTR) and per capita income (NGDP_PC)*

The essential relationship that flows from the above results and from the differential productivity hypothesis is that the ratio of the price level of non-tradables to tradables rises with the per capita GDP of countries. This is shown in Figures 2a and 2b. The simple relationship for both years is strong with the correlation at least 0.6 in both years and becomes stronger with the addition of other variables[10]. We conclude that the basic pattern of price levels between tradables and non-tradables and GDP is consistent with that found in earlier ICP rounds.

$$\begin{aligned} &2011: \quad \ln PL\_NTR = \underset{(0.0176)}{0.2645} \ln NGDP\_PC \underset{(0.1535)}{-3.0941} \qquad R^2 = 0.649 \\ &2017: \quad \ln PL\_NTR = \underset{(0.0166)}{0.2745} \ln NGDP\_PC \underset{(0.1497)}{-3.3185} \qquad R^2 = 0.603 \end{aligned} \tag{10}$$

[10] When square of per capita income is included, $R^2$ increased to 0.73.

Figure 2: Ln(PL NonTr/PL Tr) and Ln PC nominal GDP

Figure 2a - 2011

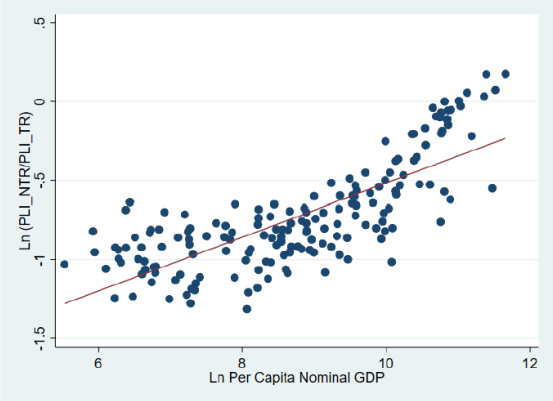
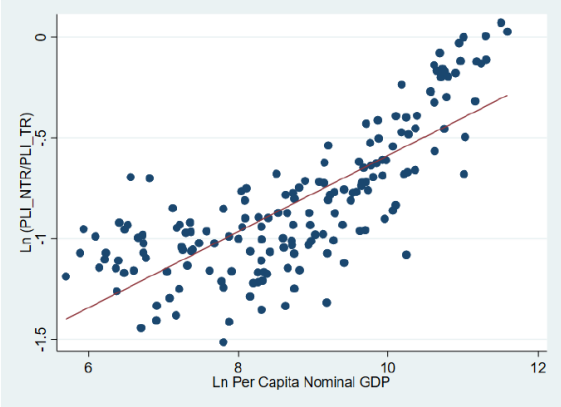



Figure 2b - 2017




## 3.2 The price level – income relationship

In examining the relationship for 2011 and 2017 we followed the literature and regressed log of the price level of GDP against log of per capita GDP converted at PPPs, usually termed real GDP in contrast to the exchange rate converted GDP. (Figures 2a and 2d). As expected, the relationship between income and price level was strong and positive for both 2011 and 2017. While this is the customary form of the equation or figure illustrating the price level to income relationship, it could as well use the log of nominal income on the right-hand side as for example in Deaton and Heston (2010, Figure 1). What difference does it make? See Figures 3a vs. 3b and 3c vs 3d. The slopes are slightly higher in 2017 than 2011 but all the slopes fall between .210 and .218. In either form of the equation, the correlation is noticeably larger using the nominal per capita GDP. The reason for the higher correlation is that the nominal GDPs have a larger variance than do the real GDPs which is visual in the scatter diagrams.

The intuition for this result is that when using real GDP on the right-hand side, much of the effect of conversion to PPPs has been embodied in the conversion. Is there any reason to use one versus the other? Certainly not because of differences in slope coefficients. One reason to use nominal GDPs is unlike real GDP it does not have the price level on both sides of the equation. A second reason is that many studies attempt to explain the price level per se, where a measure of GDP per capita is one among several explanatory variables. Using nominal GDP allows better estimates of the effect of variables like openness to trade because it does not introduce the price level into one of the other explanatory variables. In any event the results above strongly suggest that the 2011 and 2017 ICP results have a consistent story to tell, which is in turn the story of the last 50 years (KHS, 1982 Figure1-1). This gives us further confidence in the various constructs like similarity indexes that we have provided for the countries in this paper.

Figure 3a

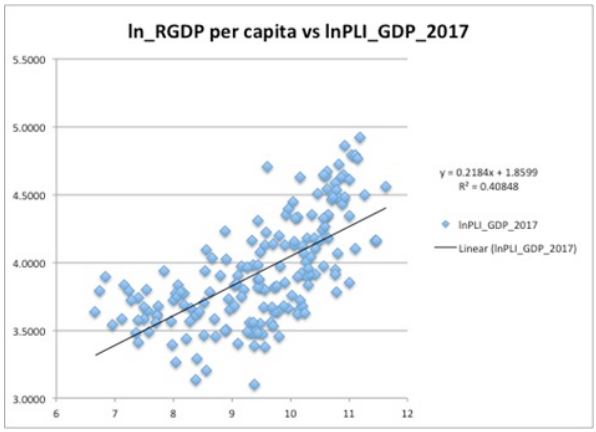



Figure 3b

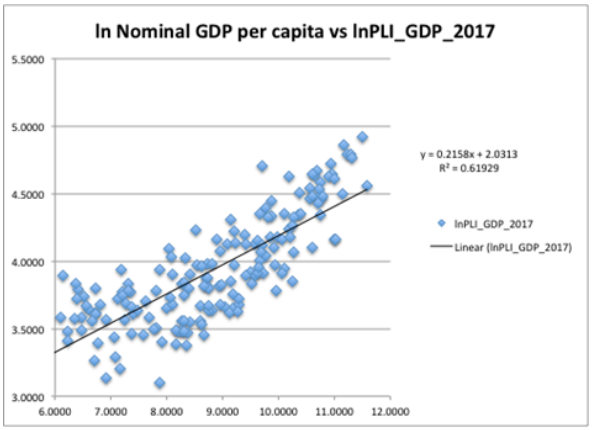



Figure 3c

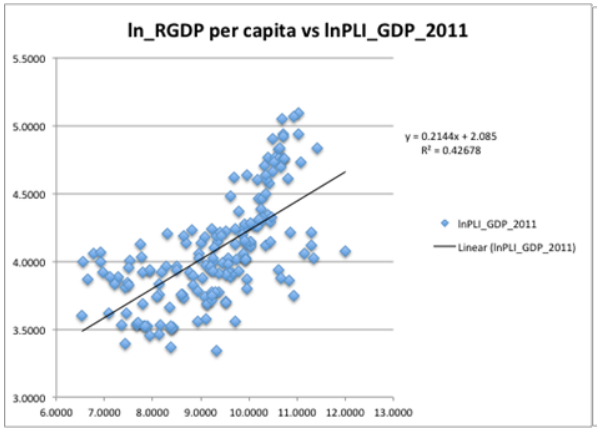
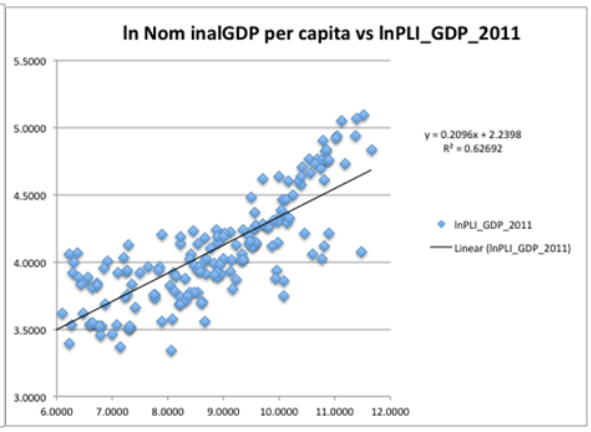



Figure 3d




Some additional analysis of the price level and income relationship is reported below because it appeared promising and suggestive of areas for further research. One surprise was that the addition of squared value of the nominal GDP per capita substantially improved $R^2$ for the equation. That is when (4) is estimated:

$$\text{Ln PLGDP} = \alpha + \beta\,(\ln \text{GDP}) + \eta\,(\ln \text{GDP})^2 \qquad (11)$$

$R^2$ for 2011 is 0.677 vs 0.575 without the squared term. For 2017 $R^2$ is 0.729 vs. 0.620. The quadratic form is convex with $\alpha$ and $\eta$ being positive and $\beta$ negative. The relationship is stronger for 2017 than 2011. We introduced the quadratic form primarily because to our knowledge it has not been used before in the literature explaining the national price level. Addition of the squared income variable is also consistent with Zhang (2017)'s hypothesis that quality of tradable goods is not fully measured as income increases across countries. We will consider another version of (11) that adds a quantity and price variable related to the involvement of countries in international trade.

The most obvious measure is termed openness that is the national currency total of exports plus imports divided by GDP. Openness by itself is not significant in most earlier studies and the same is true for the 2011 and 2017 benchmarks. Kravis and Lipsey (1983) have argued that the reason for this is that the effect of openness differs according to the relative level of per capita GDP. We have replicated their treatment, namely to use both openness (OP) and OP*GDP as variables with mixed results. Another measure of trade volume added to (11) was the share of tradables with the expectation that PL will be lower the larger the share of tradables.

As explained above the price level of tradables (PL_TR) to the price level of non-tradables (PL_NTR) is negatively related to GDP per capita. This means that if we introduce (PL_TR/PL_NTR) into (11), the collinearity is high and we cannot have both (PL_TR/PL_NTR) and PL_GDP in the same equation. When we introduce (PL_TR/PL_NTR) on the right-hand side on its own, the correlation is suspiciously high (>.85) and the coefficients are near 0.9. The main concern with (PLT/PLNT) as an explanatory variable is that for each country the PL of GDP is almost an arithmetically weighted average of PLT and PLNT. Almost because the GDP price level includes all basic headings and PLT and PLNT does not include basic headings that can be negative, and the variables in the correlations are in logs. When the relationship is estimated across countries other factors will further remove the relationship from being incestuous. We think at a minimum further research on the national price level should give the difference in price level of tradables and non-tradables a high place. One variation we have not explored here but has been tried by Kravis and Lipsey is to use PL_T and PL_NT from the production side.

$$\begin{aligned} 2011: \quad & \ln PL\_GDP = -0.928 \ln(PL\_TR / PL\_NTR) + 0.199 \qquad R^2 = 0.887 \\ & \qquad\qquad\qquad\quad (0.026) \qquad\qquad\quad (0.020) \\ 2017: \quad & \ln PL\_GDP = -0.888 \ln(PL\_TR / PL\_NTR) + 0.130 \qquad R^2 = 0.857 \\ & \qquad\qquad\qquad\quad (0.028) \qquad\qquad\quad (0.023) \end{aligned} \tag{12}$$

The relationships examined in this section suggest the 2011 and 2017 ICP results are explained in good part by the per capita income of countries as in earlier ICP rounds. We have also examined the price levels of tradables and non-tradables following earlier work of Kravis and Lipsey (1988) and Heston et al, (1994). As in earlier work, we find the price level of non-tradables rises faster with income than the price level of tradables. We believe that this would be a promising line of future research especially if estimates of the tradables: non-tradables price levels could be derived independently of ICP expenditure based basic heading price levels, say from the output side or in the approach implicit in equation (12). Finally, while the price level of tradables is lower than non-tradables and rises more slowly, it still shows a significant rise, contrary to the usual assumption in textbooks. It would certainly be valuable if this departure from one price could be explained, perhaps because of more non-tradable elements in traded items of higher income countries, and the like.

## Section 4. International Price Structures

We shift our focus from price level indexes for GDP and its components to relative price structures. Instead of making comparisons of price levels across countries, this section is devoted to the problem of comparing relative prices of different goods and services within a country and at the global level which has not been addressed in the ICP reports or in the research that usually ensued the release of ICP data. We develop the analytical framework and measures necessary to undertake this analysis.

### 4.1 Relative price structures at the national level

We begin with an intuitive exposition of the process to identify country-specific relative price structures in an international context making use of ICP data. The key information for this purpose is contained in the price level indexes, discussed in the previous section. Price level indexes for GDP and its major expenditure components: individual consumption by households; general government; and gross fixed capital formation are presented in Table 7.

The current practice among researchers and analysts as well as ICP reports (for example World Bank, 2020 and Asian Development Bank, 2020) is to focus on each of the columns with the aim of identifying factors driving price levels at the GDP level and its components. A typical example is the analysis reported in the previous section where we focused on PLI's in column (1) and on specially constructed PLI's for tradables and non-tradables. Column (1) shows that price levels, for GDP, across countries increase with real per capita GDP. For countries like India, Kenya and Thailand price levels are around a third.

Table 7: Price Level Indices for Major National Accounts Aggregates, 2017

US Price Level Index = 1.00

(selected countries)

| | GDP | Individual Consumption by Households | General Government | Gross Fixed Capital Formation |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| Australia | 1.1234 | 1.1716 | 0.9655 | 1.1755 |
| Brazil | 0.6789 | 0.7240 | 0.5653 | 0.6307 |
| China | 0.6146 | 0.6091 | 0.5433 | 0.6774 |
| Egypt, Arab Rep. | 0.1817 | 0.1896 | 0.1126 | 0.3532 |
| Germany | 0.8354 | 0.8873 | 0.7069 | 0.8467 |
| Hong Kong SAR, China | 0.7657 | 0.7952 | 0.7083 | 0.7922 |
| India | 0.3148 | 0.2968 | 0.3521 | 0.3661 |
| Kenya | 0.3858 | 0.3997 | 0.2690 | 0.4857 |
| Luxembourg | 0.9515 | 1.0891 | 1.1387 | 0.7621 |
| Mexico | 0.4687 | 0.5210 | 0.2420 | 0.5799 |
| South Africa | 0.4786 | 0.4876 | 0.3474 | 0.5435 |
| Spain | 0.7103 | 0.7926 | 0.5998 | 0.6020 |
| Switzerland | 1.1955 | 1.3769 | 1.3495 | 0.9828 |
| Thailand | 0.3757 | 0.3887 | 0.2712 | 0.4254 |
| United States | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| WORLD | 0.6667 | 0.6978 | 0.5405 | 0.6935 |

Source: World Bank (2020), Tables 2.1, 2.3, 2.4 and 2.5

While acknowledging the importance of analyzing of PLI's down the columns, we believe that there are important insights to be gained by looking at price level indices across rows and examine price levels for different aggregates for a given country or at the world level. While making comparisons of indices in any given row, it is important to keep in mind that all these indices are relative to levels in USA. Elements of first row suggest that price levels in Australia are roughly 12 to 17 percent higher than those in USA for all the major aggregates except for general government where the price level is only 97 percent. This means that in Australia general government services are delivered relatively less expensively compared to USA. More importantly for Australia, price levels for general government are lower than the price levels for the remaining three aggregates. We observe similar patterns for several countries in Table 7 but not for all countries. For example, in India the price level for general government is higher than that for GDP, a surprising finding. Switzerland and Luxembourg show lower price levels for GFCF than for GDP. A possible explanation is that prices of services are higher in these countries while there are virtually no barriers to entry of capital equipment and much of construction can use foreign labor so it is in effect traded. A quick glance at the differences across countries in their price levels of the main aggregates shows substantial variation and suggests the potential for exploring ICP data below the GDP level. The last row suggests that the world price levels for GDP, household consumption and GFCF are roughly two-thirds of that in USA but for government consumption price level is about 50 percent.

Table 7 is an illustrative example using four major aggregates and a set of selected countries. Users may request[11] and obtain PPPs, price levels and real expenditures at a highly disaggregated level down to 155 elementary or basic headings. Comparisons of price levels across countries for any given commodity group or basic heading or across commodity groups for any given country or at the world level, similar to those reported in Table 7, are feasible but less reliable at the basic heading level largely due to sampling issues and the use of unweighted formula in computing PPPs at that level.

### 4.2 Price structures using world price levels

International commodity prices and global price structures are increasingly important in a globalized world. We shift our focus from the analysis at the country level, reported in the previous section to the global level[12]. Measuring world price level for a given aggregate is more complicated than measuring price level at the country level where it is defined as the ratio of PPP to the exchange rate in equation (8). For example, for India, it is given by

$$PLI_{Ind,US} = \frac{PPP_{Ind,US}}{XR_{Ind,US}}$$

Since there are no PPPs and exchange rate counterparts at the world level, price level index at the world level cannot be defined using equation (8). However, a slightly different form of

[11] Requests may be directed to the Global ICP Unit at the World Bank.
[12] Our exposition on global price structures is equally applicable to regions or any other grouping of countries.

equation (8) can be used for this purpose. As an illustration, PLI for India can be equivalently expressed as the ratio of nominal (exchange rate converted) GDP to real (PPP converted GDP) since

$$PLI_{Ind,US} = \frac{PPP_{Ind,US}}{XR_{Ind,US}} = \frac{GDP_{Ind} \big/ XR_{Ind,US}}{GDP_{Ind} \big/ PPP_{Ind,US}} = \frac{\text{Nominal GDP of India}}{\text{Real GDP of India}} \tag{13}$$

This alternative representation of PLI is easy to implement at the world level:

$$PLI_{W,GDP} = \frac{\text{Nominal GDP of the world}}{\text{Real GDP of the world}} \tag{14}$$

where the numerator and denominator in (14) are simply the sum total of nominal and real GDP's of all the countries. The PLI measure in (14) can be applied to any aggregate of interest in which case the PLI needs to be appropriately indexed. All the ICP related reports (see for example, World Bank, 2020 and Asian Development Bank, 2020) make use of (14) in computing price level indexes.

Intuition suggests that world PLI would be a weighted average of country specific PLIs. A simple manipulation of (14) shows that he world PLI can be written as:

$$PLI_{W,GDP} = \sum_{j=1}^{176} PLI_{j,GDP} \times s_{j,GDP} \quad where \; s_{j,GDP} = \frac{GDP_j \big/ PPP_j}{\sum_{j=1}^{176} GDP_j \big/ PPP_j} \tag{15}$$

Equation (15) shows that PLI of each country is weighted by its share in world real GDP leading to world PLI.

In columns (1) and (2) of Table 8, we present world PLIs for major aggregates and sub-aggregates of GDP for the years 2011 and 2017. For example, the world PLI at the GDP level in 2011 was 0.777 implying that it was roughly 78 percent of the price level of USA, and in 2017 world PLI was only 67 percent of PLI of USA. While comparisons of world PLI's down each column are meaningful, comparisons across rows are not meaningful. Such comparisons require a different set of tools, tools discussed in section 2 above, which were used in measuring global growth and inflation. But our focus here is on the comparison of price levels for different commodity groups/aggregates in any given year. For example, what can we say about the world price structure in, say, 2017?

From Column (2) for the year 2017, world PLI for individual consumption expenditure by households (household consumption) was 0.701 compared to 0.667 at GDP level. It is then tempting to conclude that PLI's of countries for household consumption are generally higher than PLI's for GDP. However, from equation (8) we see that the world PLI is influenced by PLI's from different countries as well as country-specific shares in global totals used as weights. Difference in PLIs for GDP and household consumption, 0.667 and 0.701 respectively, is driven by differences in PLIs for GDP and household consumption across countries as well as differences in country shares in world GDP and world household consumption.

In order to measure pure price level differences, we re-compute world PLIs for different aggregates using a common set of weights based on GDP shares of countries in PPP terms[13]. We present these in columns (3) and (4) where PLI's presented are driven only by differences in PLI's for different commodity groups. In order to examine the world price structure, we express world price levels for different aggregates relative to the GDP world price level. These normalized world price levels are shown in columns (5) and (6). As expected, price levels for government consumption, construction and several of the services have ratios less than 1 indicating that price levels of these aggregates at the world level are lower than the price level for GDP. World price structures for the years 2011 and 2017 are similar indicating a degree stability in the structures during this period.

Table 8: World Price Levels for selected Expenditure Groups, 2011 and 2017

| | World PLI, 2011 | World PLI, 2017 | World PLI with common GDP Weights, 2011 | World PLI with common GDP Weights, 2017 | Normalized World PLI with GDP Weights, 2011 | Normalized World PLI with GDP Weights, 2017 |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| GROSS DOMESTIC PRODUCT | 0.777 | 0.667 | 0.777 | 0.667 | 1.000 | 1.000 |
| INDIVIDUAL CONSUMPTION EXPENDITURE BY HOUSEHOLDS | 0.837 | 0.701 | 0.821 | 0.703 | 1.058 | 1.053 |
| FOOD AND NON-ALCOHOLIC BEVERAGES | 0.900 | 0.811 | 0.993 | 0.900 | 1.279 | 1.349 |
| FOOD | 0.885 | 0.806 | 0.995 | 0.904 | 1.281 | 1.354 |
| NON-ALCOHOLIC BEVERAGES | 1.026 | 0.857 | 0.981 | 0.876 | 1.263 | 1.313 |
| ALCOHOLIC BEVERAGES, TOBACCO AND NARCOTICS | 0.799 | 0.788 | 0.820 | 0.867 | 1.055 | 1.299 |
| TOBACCO | 0.573 | 0.562 | 0.666 | 0.720 | 0.857 | 1.079 |
| CLOTHING AND FOOTWEAR | 0.828 | 0.749 | 0.890 | 0.839 | 1.146 | 1.257 |
| CLOTHING | 0.843 | 0.770 | 0.903 | 0.862 | 1.162 | 1.292 |
| FOOTWEAR | 0.759 | 0.655 | 0.858 | 0.785 | 1.105 | 1.176 |
| HOUSING, WATER, ELECTRICITY, GAS AND OTHER FUELS (Category) | 0.742 | 0.592 | 0.750 | 0.623 | 0.965 | 0.933 |
| ACTUAL RENTALS FOR HOUSING | 0.799 | 0.726 | 0.648 | 0.555 | 0.834 | 0.831 |
| ELECTRICITY, GAS AND OTHER FUELS | 1.015 | 0.822 | 1.081 | 0.943 | 1.391 | 1.413 |
| FURNISHINGS, HOUSEHOLD EQUIPMENT AND ROUTINE HOUSEHOLD MAINTENANCE | 1.010 | 0.856 | 0.963 | 0.844 | 1.240 | 1.266 |
| GOODS AND SERVICES FOR ROUTINE HOUSEHOLD MAINTENANCE | 1.049 | 0.699 | 1.053 | 0.747 | 1.356 | 1.119 |
| HEALTH - HHC (Category) | 0.632 | 0.551 | 0.604 | 0.497 | 0.777 | 0.745 |
| TRANSPORT | 1.091 | 0.906 | 1.036 | 0.888 | 1.335 | 1.330 |
| OPERATION OF PERSONAL TRANSPORT EQUIPMENT | 1.196 | 1.044 | 1.163 | 1.025 | 1.497 | 1.537 |
| TRANSPORT SERVICES | 0.710 | 0.647 | 0.871 | 0.810 | 1.121 | 1.214 |
| COMMUNICATION | 0.690 | 0.494 | 0.756 | 0.560 | 0.974 | 0.840 |
| RECREATION AND CULTURE - HHC (Category) | 1.005 | 0.877 | 0.879 | 0.766 | 1.132 | 1.148 |
| EDUCATION - HHC (Category) | 0.359 | 0.277 | 0.543 | 0.455 | 0.699 | 0.683 |
| RESTAURANTS AND HOTELS | 0.947 | 0.784 | 0.879 | 0.740 | 1.132 | 1.109 |
| MISCELLANEOUS GOODS AND SERVICES (Category) | 0.911 | 0.766 | 0.821 | 0.723 | 1.058 | 1.083 |
| PERSONAL CARE | 0.835 | 0.773 | 0.783 | 0.761 | 1.008 | 1.140 |
| INDIVIDUAL CONSUMPTION EXPENDITURE BY GOVERNMENT | 0.538 | 0.454 | 0.550 | 0.494 | 0.709 | 0.740 |
| COLLECTIVE CONSUMPTION EXPENDITURE BY GOVERNMENT | 0.687 | 0.606 | 0.701 | 0.641 | 0.903 | 0.960 |
| GROSS CAPITAL FORMATION | 0.785 | 0.689 | 0.825 | 0.697 | 1.062 | 1.044 |
| GROSS FIXED CAPITAL FORMATION | 0.785 | 0.693 | 0.820 | 0.695 | 1.056 | 1.041 |
| MACHINERY AND EQUIPMENT | 1.162 | 1.098 | 1.160 | 1.116 | 1.493 | 1.673 |
| CONSTRUCTION | 0.493 | 0.379 | 0.651 | 0.495 | 0.839 | 0.741 |
| OTHER PRODUCTS | 1.049 | 0.926 | 0.991 | 0.912 | 1.276 | 1.367 |

Source: World Bank's Researchers' ICP Database and authors' own calculations

We have compiled the world price structure at the detailed basic heading level, comprising 155 basic headings. These results are available from the authors upon request.

Our analysis of price structures thus far has been confined to the current ICP practice of measuring price levels through ratios of PPPs to exchange rates. A feature to note about this approach is the role of exchange rates in measuring price levels. The fact that exchange rates are the same irrespective of the aggregate under consideration implies that the global price

[13] It is possible to decompose the difference into the contribution from differences in PPPs (and price levels) and from differences in weights.

structure we defined and implemented in this paper reflects differences in PPPs for different aggregates.

### 4.3 Price structures based on international average prices

Our objective here is to develop an alternative approach that does not rely on exchange rates to examine relative price structures at the global level. Our approach mimics the current use of world commodity prices in international macroeconomic analysis. Towards this goal, we pursue the intuitive notion of international commodity prices which are basically averages of commodity prices expressed in US dollars using exchange rates. As we wish to avoid the use of exchange rates in this process, we implement the notion of international average prices of commodities used by Geary (1958) in his work for the Food and Agriculture Organization. His methodology was further developed eventually leading to the Geary-Khamis aggregation method.[14]

The basic idea we pursue here is to compute international average prices for different commodities or commodity groups which are in turn used to examine the structure of relative prices. The idea of an international average price for a good or service is nothing new in a globalized world. Average price of a commodity in a city, or a country or in the world is simply defined as the total expenditure or money spent on the commodity divided by the total quantity purchased. In the context of international comparisons, total expenditure on a commodity in the world is not that straightforward to measure as expenditures in different countries are expressed in respective local currency units. We need to convert expenditures into a common currency unit. In the spirit of ICP, we make use of PPPs of currencies for conversion instead of exchange rates.

Let $\left(e_{ij}, q_{ij} : i = 1,2,...,N; j = 1,2,...,M\right)$ denote expenditure and quantity of *i-th* commodity in *j-th* country, and $PPP_j$ represent purchasing power parity of currency of country *j* used for conversion, then international average price of commodity *i*, $\Pi_i$, is defined as:

$$\Pi_i = \frac{\sum_{j=1}^{M}\left(\frac{e_{ij}}{PPP_j}\right)}{\sum_{j=1}^{M} q_{ij}} \qquad i = 1,2,...,N \tag{16}$$

Numerator of (16) is the sum of expenditures on a given commodity across all the countries after conversion using PPPs. The PPP's used for conversion here refers to the whole economy and hence the GDP level PPPs.

Equation (16) is straightforward to apply in the case of single commodities but a little bit more complex when it comes to composite commodities like household consumption. Here we follow the procedures established in the early stages of ICP (see Kravis, Heston and Summers, 1982 for details) and define prices and quantities as the PPPs and real expenditures for that aggregate.

[14] The Geary-Khamis method (Geary 1958 and Khamis, 1972) was the main aggregation method used in early phases of the ICP and it was replaced by the Gini-Elteto-Koves-Szulc (GEKS) method during the 2005 ICP round.

The international average prices in (16) are identical to what was proposed by Geary (1958) except that Geary had an additional equation that determined PPPs as a function of international average prices.[15] In our study we simply use PPPs compiled as a part of the ICP.

Table 9 presents international average prices computed using equation (16) for the years 2011 and 2017 along with Geary international prices for the corresponding expenditure categories in 1975 drawn from KHS (1982). One striking result is that the relative price of food is 24% higher in 2011 and 34% higher in 2017 than in 1975. There is certainly a story to tell here about the substitution of more expensive foods, the relative cost of fish and meats (see beef in Table 9) and the increase in food away from home that we leave to others to tell. It is expected and reassuring to observe the rise in the relative prices of health services since 1975.

We observe stability and closeness in international prices in 2011 and 2017. This may in part be due to the use of identical survey and aggregation methodologies in the two benchmark years. Notable differences are observed for construction, communication and personal care. What is quite surprising to us is the similarity in relative price structures observed in 1975 and 2017. A striking difference is observed for construction. Price of construction was 7 percent higher than GDP in 1975 but dropped to 60 percent in 2017. This difference is largely attributable to the methodology used for making price and real quantity comparisons for construction in the 2011 and 2017 rounds of ICP. The KHS (1982) approach for construction in 1975 comparisons was based on bills of quantities – an approach similar to what is currently in use by Eurostat and OECD. In contrast, the 2011 and 2017 ICP rounds make use of prices of construction materials and labor and builds an input side price measure for comparisons.

Though the results in Table 9 show an impressive degree of consistency over time, a part of the discrepancy between price structures can be attributed to differences in aggregation methodology used in 1975 and in more recent 2011 and 2017 comparisons. The 1975 comparisons for each of the aggregates in Table 9 were based on the Geary-Khamis method, an additively consistent approach. In contrast, the aggregates in 2017 and 2011 are based on GEKS procedure which is non-additive.

[15] Geary defined PPPs used in equation (10) using: $PPP_j = \frac{\sum_{i=1}^{N} e_{ij}}{\sum_{i=1}^{N} \Pi_i q_{ij}} \quad j = 1, 2, ..., M$. This equation ensures that real expenditure, expenditure converted using PPP, is the same as the value of the commodities at international average prices.

Table 9: International Average Prices, 1975, 2011 and 2017

| Item Name | International Average Prices, 2011 | International Average Prices, 2017 | Geary International Average Prices, 1975 |
|---|---|---|---|
| | column (1) | column (2) | column (3) |
| GROSS DOMESTIC PRODUCT | 1 | 1 | 1 |
| INDIVIDUAL CONSUMPTION EXPENDITURE BY HOUSEHOLDS | 1.0547 | 1.0481 | 0.96 |
| FOOD AND NON-ALCOHOLIC BEVERAGES | 1.4142 | 1.5228 | na |
| FOOD | 1.4129 | 1.5286 | 1.14 |
| NON-ALCOHOLIC BEVERAGES | 1.3235 | 1.413 | na |
| ALCOHOLIC BEVERAGES, TOBACCO AND NARCOTICS | 1.0118 | 1.2495 | 1.26 |
| TOBACCO | 0.7383 | 0.9272 | 1.23 |
| CLOTHING AND FOOTWEAR | 1.1285 | 1.2199 | 1.14 |
| CLOTHING | 1.144 | 1.2526 | 1.17 |
| FOOTWEAR | 1.0556 | 1.0712 | 1.01 |
| HOUSING, WATER, ELECTRICITY, GAS AND OTHER FUELS (Category) | 0.8793 | 0.8347 | 0.94 |
| ACTUAL RENTALS FOR HOUSING | 0.8112 | 0.8689 | 0.87 |
| ELECTRICITY, GAS AND OTHER FUELS | 1.31 | 1.3015 | 1.22 |
| FURNISHINGS, HOUSEHOLD EQUIPMENT AND ROUTINE HOUSEHOLD MAINTE | 1.2632 | 1.2857 | 1.07 |
| GOODS AND SERVICES FOR ROUTINE HOUSEHOLD MAINTENANCE | 1.3138 | 1.0832 | na |
| HEALTH - HHC (Category) | 0.7258 | 0.6859 | 0.61 |
| TRANSPORT | 1.3577 | 1.3859 | na |
| OPERATION OF PERSONAL TRANSPORT EQUIPMENT | 1.3886 | 1.521 | 1.27 |
| TRANSPORT SERVICES | 1.0248 | 1.1523 | 0.61 |
| COMMUNICATION | 0.9201 | 0.7795 | 0.89 |
| RECREATION AND CULTURE - HHC (Category) | 1.0882 | 1.1337 | 1.03 |
| EDUCATION - HHC (Category) | 0.496 | 0.4384 | 0.53 |
| RESTAURANTS AND HOTELS | 1.109 | 1.0806 | na |
| MISCELLANEOUS GOODS AND SERVICES (Category) | 1.056 | 1.0788 | na |
| PERSONAL CARE | 0.9928 | 1.1293 | 1.06 |
| INDIVIDUAL CONSUMPTION EXPENDITURE BY GOVERNMENT | 0.6201 | 0.6358 | 0.91 |
| COLLECTIVE CONSUMPTION EXPENDITURE BY GOVERNMENT | 0.857 | 0.9051 | 0.91 |
| GROSS CAPITAL FORMATION | 1.1011 | 1.0768 | 1.23 |
| GROSS FIXED CAPITAL FORMATION | 1.0868 | 1.069 | 1.23 |
| MACHINERY AND EQUIPMENT | 1.6367 | 1.7427 | 1.45 |
| CONSTRUCTION | 0.7039 | 0.6002 | 1.07 |
| OTHER PRODUCTS | 1.2533 | 1.2655 | 1.22 |

Note: Figures in column (3) are drawn from Summary Multilateral Table 6.3 (KHS, 1982, p. 179). Columns (1) and (2) are computed using formulae in Appendix A3 and the detailed data supplied by the World Bank.

The choice of aggregation method may have contributed in part to the differences in international average prices. With the view of eliminating any influence of the aggregation method, we have also computed international average prices at the basic heading level where the same method, the country-product-dummy method, was used in the 1975, 2011 and 2017 benchmark years.

International average prices for the 155 basic headings computed using equation (10) for the years 2011 and 2017 are presented in the Appendix Table. The basic heading classification has undergone some changes since 1975. We attempted to map the 2017 basic headings to the 1975 classification by finding the best match based on the description. We have been able to find 93 matches where we believe comparisons of international average prices can be made.

Table 10 presents results for a few basic headings which were selected with the aim of showing that international average prices remained similar for some commodity groups but have shown dramatic shifts for some others. For example, why is it that international prices for non-residential buildings remained similar over the 50-year period whereas residential buildings show a dramatic reduction, by almost 50 per cent? As pointed out earlier, this could be due to the input cost approach for construction used in the 2011 and 2017 ICP, whereas in 1975 the

final prices of specific types of buildings were priced. But why should residential and non-residential structures be different, an interesting question to research. Road transport equipment raises questions across all three years although the decline from 1975 is consistent with the general decline in trade barriers during the period. Our calculations for all the basic headings are available to researchers who wish to explore some of these questions in more detail.

Table 10: International Average Prices, 2011 and 2017; GK International Prices, 1975 (selected basic headings)

| Item - ICP 2011, 2017 | International Average Prices, 2011 | International Average Prices, 2017 | GK International Prices , 1975 | Name of item in 1975 |
|---|---|---|---|---|
| Rice | 0.8936 | 1.2771 | 1.09 | Rice |
| Beef and veal | 1.4987 | 1.3117 | 0.93 | Fresh beef and veal |
| Mineral waters, soft drinks, fruit and vegetable juices | 1.2616 | 1.2957 | 1.35 | non-alcoholic beverages |
| Garments | 1.1826 | 1.2837 | 1.1 | Men's clotjhing; Women's clothing - 1.29; Boys and girls clothing - 1.32; men's and boys' underwear - 1.48; women's and girls' underwear - 1.13; Haberdashery, millinery - 0.97; clothing rental and repair |
| Major household appliances whether electric or not | 1.2293 | 1.3741 | 1.44 | Refigerators and freezers; Washing appliances - 1.49; cooking appliances - 1.24; heating appliances - 1.33; cleaning appliances - 1.5; other household appliances - 2.01 |
| Medical services | 0.8666 | 0.8384 | 0.54 | Physicians' services |
| Passenger transport by railway | 0.9248 | 1.0982 | 0.26 | Rail transport |
| Pharmaceutical products | 1.1061 | 1.0812 | 0.93 | Drugs, medical prepartions |
| Hairdressing salons and personal grooming establishments | 0.5554 | 0.5029 | 0.56 | Barber and beauty shops |
| Intermediate consumption, government | 1.2533 | 1.2655 | 1.21 | Commodities of government |
| Road transport equipment | 0.446 | 0.9513 | 1.53 | Trucks, buses, trailers |
| Residential buildings | 0.5336 | 0.5302 | 1.09 | one and two-family dwellings; multi-family dwellings - 1.07 |
| Non-residential buildings | 1.6198 | 1.92 | 1.49 | Industrial buildings; commercial buildings - 1.15; office buildings - 1.12; |
| Civil engineering works | 0.9845 | 0.8229 | 0.86 | Roads, streets, highways |

## 5. Bringing the Story to 2020

In this section we focus on establishing a pre-pandemic base for a few of the largest world economies and the distribution of the world economies by per capita GDP. We treat China in some detail because the 2011 and 2017 ICPs were the most systematic purchasing power studies of China carried out to date.

### 5.1 Toward better measures of the Chinese economy

Because of its large population and political isolation there was much curiosity but little hard information about the Chinese economy from 1950 to 1979. China was not recognized by the major Western countries and was not a member of the United Nations and other international organizations. During the India-China war in 1962 the media often referred to the Chinese hordes pouring over Himalayan passes, a very frustrating term for military experts who wanted to know how many battalions were in a horde. This lack of statistical information was frustrating to Western countries, and particularly the United States.

The US CIA did commission a RAND study to compare the Chinese and US GDP (Hollister 1958) that valued Chinese physical output at US prices as had been done for Russia, but also valued US output from the production side at Chinese prices. The difference between these valuations of output at own prices versus at US prices was greater than two, with China appearing twice as large at US prices than at its own.

When China took Taiwan's seat at the United Nations and in 1971, the world became even more curious about the Chinese economy especially as it began to open up with its reforms, special economic zones and entry into the international trade organizations. The earliest PPP exercise from the expenditure side for China emerged from a post reform exchange tour by a group of US economists in 1980, one of whom, Irving Kravis, was a joint director of the first three rounds of the ICP in its research phase. While he did obtain cooperation of the Chinese statistical office in obtaining estimates of the national expenditures and some national prices, Kravis did much of the price matching to the 1975 US ICP prices. It is a measure of how much such Chinese numbers filled a void by the extent his report (Kravis, 1981) came in for comment and spurred further research on the Chinese economy. In addition to studies by the World Bank, IMF, the OECD and other research centers, the China statistical offices made a gesture toward participating in the ICP in the 1993 ESCAP benchmark, and their Beijing-Hong Kong comparison was published. (ESCAP, 1999).

Angus Maddison had like Colin Clark always included China in his historical economic studies and on behalf of the OECD Maddison (1998) prepared a long run study of the Chinese economy that included purchasing power estimates tied to the ICP results around 1990. China was included in the 2005 ICP although the price collection was limited to 11 cities and their immediate surroundings. The 2005 results were thought by the Bank to be much more than an improvement on earlier work and they were adopted by the international community as a basis for contributions to the IMF. However, the China ICP numbers for 2005 were widely questioned by poverty researchers and others like Chen and Ravallion (2010) because of how China was linked into the global economy. Maddison, while alive, (2013) was especially vocal on his preference for his own estimates that underlie his projection that China's GDP would pass the United States in 2030.

Against these uncertainties about the earlier purchasing power estimates, the results of the 2011 and 2017 ICP rounds are thought to be the best window we have on the size of the Chinese economy compared to India, Japan, the United States and other major countries.

China's economic size in the ICP compared to the US was accepted by the international institutions, not so by some scholars, and not by China. China's position has always been easy to rationalize but hard to understand. In the 1980s China reported very high economic growth rates although they wanted to maintain that their per capita output remained very low and they needed international assistance. In addition, China sought any trade concessions being provided for lower per capita income countries. From a public relations perspective this was the best of both worlds, their growth was high impressing their citizens and the world, while their financial responsibilities to the world remained low.

It is unclear why China had wished to continue to appear poorer than they were. One way to suggest the paradox presented by China's statistics is to indicate how extrapolations of their output over ICP rounds compare with their actual position in the ICP ranking of countries. In both China and India national growth rates are much higher than implied by the relative positions of their GDPs in 2011 and 2017.

If the extrapolations had been from 2011 to 2017, the 2017 GDP estimate for China would have been 19 percent above the US in 2017 in contrast to the 2017 benchmark where

the two are essentially the same size. Why might this large difference occur? An obvious problem is that the national growth rates depend on the prices underlying national accounts deflators, whereas each ICP benchmark relies on prices of final output. One line of explanation of the results is that China is thought to have often priced at more expensive outlets than other countries in Asia leading to estimates of their price level that are too high and total GDP that is lower than likely. However, Feenstra, Xu, and Antoniades (2017) have provided a more nuanced view of pricing in China albeit based on comparisons of scanner prices of the same groups of grocery items and scraped prices. These two lines of evidence are not necessarily in conflict since most items where selection of outlet or brand name affect the price collected for the ICP are not readily available for price scraping or with standardized bar codes. The results of the 2017 ICP for China and other countries need even more detailed examination now that the present economic effects of the pandemic and its consequences for future ICP comparisons of world production present us with more unknowns.

### 5.2 From 2017 to the Pandemic

Due to variation in health infrastructure, national traditions in communal actions, and domestic public health policies, world economies have been affected quite differently in 2020. China is a notable example of a country with a large initial setback followed by an extended recovery while on the other hand the United States experienced early setbacks, followed by recoveries and then deeper setbacks with substantial recovery only in 2021. When the world economy finally recovers from the pandemic, it will be useful to have a benchmark, like the end of 2019 from which to judge the impact of COVID-19 and variants on the world economies and regions. We call attention to the release of the Penn World Table 10.0 produced by the Groningen Growth and Development Center (GGDC, January, 2021), which integrates the results of the 2017 ICP and updates PWT to 2019.

There are a number of differences between PWT and the ICP notably in the method in which the world is put together, by country in the former and by region in the latter, in making estimates from both the expenditure and output side in PWT, and some smaller methodological matters. However, we think it useful to prepare a distribution of world expenditures by income groups. The 183 countries in PWT have been grouped by level of per capita GDP in 2019 into 5 bins of 36 or 37 countries. The total GDP and population have been given in Table 11 along with the share of each group in the world. Column 5 provides the average GDP per capita of each quintile, an overall familiar and still disturbing picture. The bottom two quintiles with almost half the world's population have less than 20% of the world's GDP. Unfortunately, when we have comparable numbers for 2021 it does not appear likely that the picture will show any improvement for the lower income countries.

Table 11 World GDP by Country Quintiles Grouped by PC GDP, 2019

| | Total GDP | Total pop | GDP share | Population share | Per capita GDP |
|---|---|---|---|---|---|
| Quintile | 1 | 2 | 3 | 4 | 5 |
| Top | 52186114 | 965 | 41.4 | 12.7 | 54101 |
| 4 | 18655614 | 615 | 14.8 | 8.1 | 30327 |
| 3 | 32252176 | 2248 | 25.6 | 29.7 | 14348 |
| 2 | 21113464 | 2962 | 16.8 | 39.1 | 7129 |
| 1 | 1742539 | 792 | 1.4 | 10.4 | 2201 |
| World | 125949906 | 7581 | 100.0 | 100.0 | 16614 |

We now turn to the issue of the size of the economies and the largest economy in the world and examine relative positions of some of the largest economies in the world in 2020.

The 2019 real GDP for these economies are drawn from the "*rgdpna*" column of PWT 10.0. Growth rates used in column (2) are drawn from IMF's *World Economic Outlook*, 2021. These growth rates are probably subject to revisions over the coming months but are indicative of differential effects on Covid-19 ravaged economies and their ability to respond to the challenges posed by the pandemic. The last column shows that China has cemented its position as the largest economy in size as measured by real PPP-converted GDP and it is 6.5 percent larger than the USA. Prior to the pandemic, India aspired to double the size of its economy within five years but this goal has no doubt experienced a setback. However, if the Indian economy recovers and manages growth rates that come anywhere close to its goal, then the Indian economy would become a major economic power in the coming years.

Table 12: Projected Real GDP in 2020 of Selected Large Economies

(in 2019 US dollars and PPP terms)

| Country | GDP in 2019 (in US PPP dollars) | Growth rate 2019-2020 | GDP in 2021 in 2019 US dollars) |
|---|---|---|---|
| | (1) | (2) | (3) |
| China | 20,571,246 | 1.9 | 20,962,100 |
| Germany | 4,312,350 | -6 | 4,053,609 |
| India | 9,164,505 | -10.3 | 8,220,561 |
| Indonesia | 3,110,751 | -1.5 | 3,064,090 |
| Japan | 5,098,248 | -5.3 | 4,828,041 |
| Korea, Republic | 2,192,752 | -1.9 | 2,151,090 |
| United Kingdom | 3,015,784 | -9.8 | 2,720,237 |
| United States | 20,563,592 | -4.3 | 19,679,358 |

Notes: Figures in column (1) are from PWT 10.0; Growth rates (in column 2) are from World Economic Outlook, IMF, 2021

## 6. Summary

This paper focused first on the major 2017 ICP Report released by the World Bank in May, 2020, which coincided with the declaration that covid-19 was a pandemic, thereby limiting its visibility. Second, we tested whether the findings of the 2011 and 2017 ICP benchmarks supported the major findings from previous ICP reports going back to 1970. And third we introduced some analysis of the price structure of countries over time and within benchmarks, a type of comparison not previously attempted.

### 6.1 The 2011 and 2017 ICP Benchmarks

A feature of the 2017 report was in addition to reporting by administrative institutions like the OECD as in earlier ICP reports, most of the aggregation was by geographic region. Further, the distribution of world GDP was provided by income groups displaying the substantial inequalities existing between countries. In comparing the 2011 and 2017 results in current prices, a decomposition of real growth and price changes was provided that allowed separation between exchange rate and price changes. In this section, we observe that there is scope for improvements in the analysis and presentation of global growth and inflation estimates by the IMF in its annual *World Economic Outlook publications*. In particular, our exposition suggests that it is important to clearly indicate what constitutes the global economy and the countries covered in the computation. The WEO purpose would be better served by inclusion of world real GDP or GDP in PPP terms in its flagship publication. We have provided estimates of global growth, domestic price change effect as well as the PPP exchange rate change effect – three components of change in real GDP over time.

The frequently asked question regarding the relative rankings of the US and China was discussed in section 5 of the paper. Starting with the prediction of Angus Maddison that China will overtake USA in 2030, we trace the historical developments in the measurement of real GDP of China in PPP terms. Evidence from the report released by World Bank (2020) suggests that in 2017 and in PPP terms USA and China are at the same level. Given the uneven growth prospects for USA and China, our discussion in Section 5.2 suggests that real GDP in China in 2020 is likely to be 6.5 percent larger than real GDP in USA.

### 6.2 Consistency of findings of the 2017 ICP Report and earlier ICPs

Because the 2011 and 2017 benchmarks used essentially the same methodologies our assumption is that they are the standard against which to compare earlier ICP results.

Much of the paper focused on the strong support the two latest benchmarks provide for the basic finding of the ICP, namely the positive relationship between the price level of GDP and the per capita level of GDP. First put forward in 1975 in the first ICP report referring to 1970 benchmark, this relationship has now stood up to empirical verification for almost 70 years. Sometimes it is termed the "Penn" effect because the first ICP report originated there. In 1964 Balassa and Samuelson had independently published a differential productivity explanation of the price level-income relationship based upon the distinction between tradable

goods whose prices across countries tend to the exchange rate and non-tradable goods whose prices tend to the level of productivity of labor in tradable goods. Several simple models that had been developed using earlier ICP vintages were tested with 2011 and 2017 data and the results were similar. Further models that introduced squared values of the log of per capita GDP seemed to improve the fit.

Another finding that had been stressed by Kravis and Lipsey (1988) based on the 1975 and 1980 ICPs is that the price level of tradables clearly rises with the incomes of countries. It is a common assumption in many international trade models that the price level of tradables should be constant across countries. However, the empirical findings of Kravis and Lipsey were that the price level of tradables rises with country income and the sign is significant and the price of non-tradables rises faster than tradables. Using the 2011 and 2017 data, we offer further support to the findings of these earlier studies. However, Zhang (2017) carried out a more detailed analysis based on the 2005 ICP and his work partly supported Kravis and Lipsey but he offered an explanation for why there should be a positive relationship between the price level of tradables and income.

### 6.3 The structure of international prices across benchmarks

In this paper we also looked at country prices in relation to the international prices across all the countries for the detailed basic headings and summary categories. ICP 1975 was the only benchmark that had attempted to estimate international prices and it turns out those results were not base country invariant. But a method has been developed in this paper that permitted estimation of comparable international prices for all basic headings in 2011 and 2017 and for most of the headings in 1975. These results seem quite plausible and other researchers may build on this work to address issues that we have not been considered here. Our analysis of the international price levels suggests that there are number of areas, including construction where further research aimed at improving the estimation of PPPs and real expenditures is needed. The results support received views on that the relative prices of health, transport, and most other services have risen 40 years, and that relative prices of most appliances and automobiles have fallen.

In conclusion, the paper has called attention to the release of the 2017 benchmark comparison of the International Comparison Project in May,2020 at the World Bank where a major rollout and festivities were planned but as with so many other activities canceled by COVID-19. Because the 2017 ICP methodology was the same as that in the 2011 ICP, the new report (World Bank, 2020) could confidently compare the two benchmarks, which was not usually the case with earlier ICP rounds. Before Covid-19 variants, it had been planned to make revisions of the ICP methodology in 2020 including its frequency but that has now been postponed at least until 2021, another reason to call special attention to the 2017 report.

## References


Asian Development Bank 2020, *2017 International Comparison Program for Asia and the Pacific: Purchasing Power Parities and Real Expenditures — Results and Methodology*, Manila.

Atamanov, Aziz, Christoph Lakner, Daniel Gerszon Mahler, Samuel Kofi Tetteh Baah and Judy Yang, 2020, "The Effect of New PPP Estimates on Global Poverty: A First Look", *Global Poverty Monitoring Technical Note 12,* World Bank, Washington DC.

Balassa, B. 1964. "The Purchasing-Power Parity Doctrine: A Reappraisal." Journal of Political Economy 72, no. 6 (December): 584–596. http://www.jstor.org/stable/1829464.

Balk, B., A. Rambaldi, and D. S. P. Rao. 2020. "Macro- economic Measures for a Globalized World: Global Growth and Inflation." Macroeconomic Dynamics, 1–47. https://doi.org/10.1017/ S1365100520000152.

Bhagwati, Jagdish 1984. "Why Are Services Cheaper in Poor Countries," *Economic Journal,* June, 94, 279-86.

Chen, S and M. Ravallion. 2010, "The Developing World is Poorer than We Thought, But No Less Successful in the Fight Against Poverty", The Quarterly Journal of Economics, Volume 125, Issue 4, November 2010, Pages 1577–1625, https://doi.org/10.1162/qjec.2010.125.4.1577

Clague, Christopher, 1986."Determinants of the National Price Level: Some Empirical Results," *Review of Economics and Statistics*, May, 320-23.

Deaton, Angus. 2010. "Price Indexes, Inequality, and the Measurement of World Poverty." American Economic review, 100(1): 5–34.

Deaton, A., and A. Heston. 2010. "Understanding PPPs and PPP-Based National Accounts." American Economic Journal: Macroeconomics 2, no. 4 (October): 1–35. https://doi. org/10.1257/mac.2.4.1.

Deaton, Angus, and Olivier Dupriez. 2011. "Global Poverty and Global Price Indexes." American Economic Journal: Applied Economics 3 (April 2011): 137–166

Deaton, Angus and Bettina Aten. 2017. Trying to Understand the PPPs in ICP 2011: Why Are the Results So Different?. American Economic Journal: Macroeconomics 9:1, 243-264.

Deaton, Angus and Paul Schreyer 2020a. "Why the world's richest countries are not all rich," *Financial Times*, October 5.

_____2020b. "GDP, wellbeing, and health: thoughts on the 2017 round of the International Comparison Program", Discussion Paper, November 20

Economic and Social Commission for Asia and the Pacific 1999. ESCAP Comparisons of Real Gross Domestic Product and Purchasing Power Parities, 1993, United Nations.

Feenstra, Robert C., Hong Ma, J. Peter Neary and D.S. Prasada Rao, (2013) "Who Shrunk China" Puzzles in Measurement of Real GDP", *Economic Journal,* Vol. 123, Issue 573, pp. 110-1129.

Feenstra,, Robert C. , Mingzhi Xu, and Alexis Antoniades 2017. "What is the Price of Tea in China? Towards the Relative Cos of Living in Chinese and American Cities," Working Paper 23161

Geary, R. C. 1958. "A Note on Comparisons of Exchange Rates and Purchasing Power Between Countries." Journal of the Royal Statistical Society: Series A 121: 97–99.

Harrod, Roy F. 1939, *International Economics*, Cambridge Economic Handbooks VIII, London: Nisbet.

Heston, Alan, Daniel Nuxoll and Robert Summers 1994. "The Differential Productivity Hypothesis and Purchasing Power Parities: Some New Evidence,"*Review of International Economics*. NBER, U. of Chicago Press.

Hollister, William 1958. *Gross National Product-China*, Free Press, Glencoe.

Inklaar, Robert, Ryan Marapin, Jop Woltjer and Marcel Timmer, 2021, " Inconsistencies in comparing relative prices over time: patterns and facts", Paper presented at the meeting of the Technical Adv isory Group of the ICP, 17-19, May, 2021, World Bank, Washington D.

Inklaar, Robert and D.S. Prasada Rao. 2017. Cross-Country Income Levels over Time: Did the Developing World Suddenly Become Much Richer?. American Economic Journal: Macroeconomics 9:1, 265-290.

International Monetary Fund, 2021, *World Economic Outlook*, Washington DC

Joint Economic Committee 1962, *Dimensions of Soviet Economic Power: hearings, together with compilation of studies prepared for the Joint Economic Committee*, 87th Congress, US GPO.

Joint Economic Committee 1967, *An Economic Profile of Mainland China* 2 vols. 90th Congress, US GPO.

Khamis, H. (1972), A New System of Index Numbers for National and International Purposes, Journal of the Royal Statistical Society, Series A, 135(1), 61-85.

Kravis, Irving B. 1981," An Approximation of the Relative Real per Capita GDP of the People's Republic of China", *Journal of Comparative Economics* 5.

Kravis, I. B., Z. Kenessey, A. W. Heston, and R. Summers. 1975. A System of International Comparisons of Gross Product and Purchasing Power. Washington, DC: World Bank. http://documents.worldbank.org/curated/en/199981467988893189/A-system-of-international-comparisons-of-gross-product- and-purchasing-power.

Kravis, Irving B., Alan Heston, and Robert Summers 1982, *World Product and Income*, World Bank, Johns Hopkins Press, Baltimore.

Kravis, Irving B. and Robert E. Lipsey 1983. "Toward an Explanation of National Price Levels." *Princeton Studies in International Finance*, No. 52, November.

Kravis, Irving B. and Robert E. Lipsey 1988. "National Price Levels and the Prices of Tradables and Nontradables," *American Economic Review*, 1988, v78(2), 474-478.

Maddison Angus 1998. Chinese Economic Performance in the Long-Run, Published by the OECD Development Centre, Paris.

Maddison, Angus 2013. "Six Transformations in China: 960-2030", Ch2 in World Economic Performance: Past, Present and Future. D.S. Prasada Rao and Bart van Ark editors. Edward Elgar, Cheltenham, UK.

Milanovic, B. 2002, "True World Income Distribution, 1988 And 1993: First Calculation based on Household Surveys Alone", The Economic Journal, 112: 51-92. https://doi.org/10.1111/1468-0297.0j673

Samuelson, P. 1964. "Theoretical Notes on Trade Problems." Review of Economics and Statistics 46, no. 2: 145–154. http://www.jstor.org/ stable/1928178.

Sato, K., 1976, "The Ideal Log-Change Index Number," Review of Economics and Statistics, 58, 223–228.

Sen, A.;1976, "Real National Income", The Review of Economic Studies, Volume 43, Issue 1, 1 February 1976, Pages 19–39,

Sen, A. 1979, "The Welfare Basis of Real Income Comparisons. Journal of Economic Literature. 1979;17 (March)

Stiglitz, J. E., A. Sen, and J. Fitoussi. 2009. Report by the Commission on the Measurement of Economic Performance and Social Progress. Paris: Government of France.

United Nations, 2021, World Economic Situation and Prospects, 2021, United Nations, Neww York.

Vartia, Y., 1976, "Ideal Log-Change Index Numbers," Scandinavian Journal of Statistics, 3, 121–126.

Vo, Long Hai, 2021, "Understanding International Price and Consumption Disparities" available at SSRN: https://ssrn.com/abstract=3759091 or http://dx.doi.org/10.2139/ssrn.3759091

World Bank 2020, *Report Purchasing Power Parities and the Size of World Economies: Results from the 2017 International Comparison Program*, Washington DC.

World Bank, 2021, *Global Economic Prospects*, World Bank, Washington DC.

Zhang, Qi (2017) “The Balassa–Samuelson relationship: Services, manufacturing and product quality”, *Journal of International Economics*, pp. 55-82.

Appendix Table: International Average Prices, 2011 and 2017; GK International Prices, 1975 - at the detailed basic heading level

| Item - ICP 2011, 2017 | International Average Prices, 2011 | International Average Prices, 2017 | GK International Prices , 1975 | Name of item in 1975 |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| Rice | 0.8936 | 1.2771 | 1.09 | Rice |
| Other cereals, flour and other cereal products | 2.2106 | 2.4906 | 1.05 | Meal, other cereals |
| Bread | 1.072 | 1.3696 | 0.72 | Bread |
| Other bakery products | 1.1159 | 1.3354 | 1.27 | Biscuits, cakes etc |
| Pasta products and couscous | 1.7855 | 1.4069 | 1.17 | Macaroni, sphagetti |
| Beef and veal | 1.4987 | 1.3117 | 0.93 | Fresh beef and veal |
| Pork | 1.3738 | 1.2981 | 1.59 | Fresh pork |
| Lamb, mutton and goat | 1.1533 | 0.9852 | 1.06 | Fresh lamb, mutton |
| Poultry | 1.6805 | 1.3016 | 1.59 | Fresh poultry |
| Other meats and meat preparations | 1.5826 | 1.641 | 1.52 | other fresh meat |
| Fresh, chilled or frozen fish and seafood | 0.8396 | 1.0856 | 1.45 | Fresh and frozen fish |
| Preserved or processed fish and seafood | 1.2504 | 1.5533 | 1.13 | canned fish |
| Fresh milk | 1.6354 | 2.0365 | 1.13 | Fresh milk |
| Preserved milk and other milk products | 1.5872 | 1.5239 | 1.17 | Milk products |
| Cheese and curd | 1.3939 | 1.6653 | | |
| Eggs and egg-based products | 1.9677 | 1.6469 | 1.57 | Egg, egg products |
| Butter and margarine | 1.4063 | 2.118 | 1.68 | Butter |
| Other edible oils and fats | 2.2492 | 2.0987 | 1.28 | Margarine, edible oil |
| Fresh or chilled fruit | 1.2441 | 1.2861 | 1.12 | Other fresh fruits |
| Frozen, preserved or processed fruit and fruit-based products | 1.8508 | 2.0589 | 1.23 | Other fresh fruits |
| Fresh or chilled vegetables, other than potatoes and other tuber vegetables | 0.9298 | 0.9987 | 0.71 | Fresh vegetgables |
| Fresh or chilled potatoes and other tuber vegetables | 1.1084 | 0.9203 | 1.14 | Tubers including potatoes |
| Frozen, preserved or processed vegetables and vegetable-based products | 1.6044 | 1.6872 | 1.29 | Vegetables other than fresh |
| Sugar | 1.5673 | 2.0125 | 1.02 | Sugar |
| Jams, marmalades and honey | 1.7161 | 1.917 | 1.03 | Jam, syrup, joney |
| Confectionery, chocolate and ice cream | 1.1484 | 1.4545 | 1.1 | Chocolate, ice cream |
| Food products n.e.c. | 1.3486 | 1.5642 | 1.17 | Salt, spices and sauces |
| Coffee, tea and cocoa | 1.5187 | 1.7813 | 1.96 | Coffee; Tea - 1.11 and Cocoa - 1.05 |
| Mineral waters, soft drinks, fruit and vegetable juices | 1.2616 | 1.2957 | 1.35 | non-alcoholic beverages |
| Spirits | 1.4665 | 1.4365 | 1.61 | Spirits |
| Wine | 0.9266 | 1.2521 | 1.06 | Wine, cider |
| Beer | 1.0775 | 1.2708 | 1.16 | Beer |
| Tobacco | 0.7383 | 0.9272 | 1.1 | Cigarettes |
| Narcotics | 0.7641 | 1.1102 | 2.31 | Cigars, tobacco, snuff |
| Clothing materials, other articles of clothing and clothing accessories | 0.9419 | 1.1231 | 1.97 | Clothing materials |
| Garments | 1.1826 | 1.2837 | 1.1 | Men's clotjhing; Women's clothing - 1.29; Boys and girls clothing - 1.32; men's and boys' underwear - 1.48; women's and girls' underwear - 1.13; Haberdashery, millinery - 0.97; clothing rental and repair |
| Cleaning, repair and hire of clothing | 0.9724 | 0.7716 | 0.57 | Clothing rental and repair |
| Shoes and other footwear | 0.8686 | 0.7953 | 0.93 | Men's footwear ; Women's footwear - 1.14; Children's footwear - 0.86 |
| Repair and hire of footwear | 1.3659 | 1.8191 | 0.85 | Footwear repairs |
| Actual rentals for housing | 0.8727 | 0.6508 | 0.85 | Rents |
| Imputed rentals for housing | 1.1629 | 1.46 | | |
| Maintenance and repair of the dwelling | 1.208 | 1.242 | 1.11 | Indoor repai and upkeep |
| Water supply | 0.9855 | 1.0759 | | |
| Miscellaneous services relating to the dwelling | 1.2401 | 1.1972 | | |
| Electricity | 1.1344 | 1.1442 | 1.14 | Electricity |
| Gas | 0.7922 | 0.84 | 1.4 | Gas |
| Other fuels | 1.0882 | 1.1215 | 0.81 | Other fuels |
| Furniture and furnishings | 0.3922 | 0.2215 | 0.69 | Furniture and fixtures |
| Carpets and other floor coverings | 0.8112 | 0.8689 | 1.17 | Floor coverings |
| Repair of furniture, furnishings and floor coverings | 1.2644 | 1.3111 | | |
| Household textiles | 0.8042 | 0.7576 | 1.26 | Househokd textiles, etc |

Continued on next page

| Item - ICP 2011, 2017 | International Average Prices, 2011 | International Average Prices, 2017 | GK International Prices , 1975 | Name of item in 1975 |
|---|---|---|---|---|
| Major household appliances whether electric or not | 1.2293 | 1.3741 | 1.44 | Refigerators and freezers; Washing appliances - 1.49; cooking appliances - 1.24; heating appliances - 1.33; cleaning appliances - 1.5; other household appliances - 2.01 |
| Small electric household appliances | 0.3849 | 0.3886 | | |
| Repair of household appliances | 0.9452 | 1.2719 | | |
| Glassware, tableware and household utensils | 0.7835 | 0.8029 | 1.11 | Household utensils |
| Major tools and equipment | 1.2065 | 1.1773 | | |
| Small tools and miscellaneous accessories | 1.6545 | 1.0481 | | |
| Non-durable household goods | 1.0402 | 1.4571 | 1.23 | Non-durable household goods |
| Domestic services | 1.0825 | 1.0028 | 0.29 | Domestic services |
| Household services | 0.9404 | 0.887 | 0.96 | Household services |
| Pharmaceutical products | 1.1617 | 1.3244 | 0.93 | Drugs, medical preparations |
| Other medical products | 1.066 | 1.1381 | 1.32 | Medical supplies |
| Therapeutic appliances and equipment | 1.0855 | 1.3768 | 0.83 | Therapeutic equipment |
| Medical services | 0.8666 | 0.8384 | 0.54 | Physicians' services |
| Dental services | 0.9289 | 0.9777 | 0.54 | Dentists' services |
| Paramedical services | 0.9752 | 1.1138 | 0.57 | Nurses' services |
| Hospital services | 1.1703 | 0.8386 | 0.42 | hospitals |
| Motor cars | 1.2929 | 1.3966 | 1.43 | Personal automobiles |
| Motor cycles | 1.3623 | 1.6577 | 1.18 | Other personal transport |
| Bicycles | 1.6438 | 1.4314 | | |
| Animal drawn vehicles | 0.6315 | 1.2151 | | |
| Fuels and lubricants for personal transport equipment | 1.1095 | 1.4003 | 1.64 | Gasoline, oil, grease |
| Maintenance and repair of personal transport equipment | 0.496 | 0.4384 | 0.65 | Automobile repairs |
| Other services in respect of personal transport equipment | 1.1339 | 1.0691 | | |
| Passenger transport by railway | 0.9248 | 1.0982 | 0.26 | Rail transport |
| Passenger transport by road | 0.6264 | 0.7406 | 0.28 | Bus transport |
| Passenger transport by air | 1.2006 | 1.3665 | 0.86 | Air transport |
| Passenger transport by sea and inland waterway | 1.0826 | 1.1093 | | |
| Combined passenger transport | 0.9829 | 1.5055 | | |
| Other purchased transport services | 1.3223 | 1.5424 | 0.46 | Local transport |
| Postal services | 0.8609 | 0.8555 | 0.95 | Postal services |
| Telephone and telefax equipment | 1.2122 | 1.1942 | | |
| Telephone and telefax services | 1.0921 | 1.0523 | 0.89 | Telepho,e gtelegraph |
| Audio-visual, photographic and information processing equipment | 1.1281 | 1.056 | 1.26 | Radio, televisions, phonographs |
| Recording media | 1.0998 | 1.0508 | | |
| Repair of audio-visual, photographic and information processing equipment | 1.1299 | 1.0577 | | |
| Major durables for outdoor and indoor recreation | 1.135 | 1.291 | 1.23 | Durable recreational equipment |
| Maintenance and repair of other major durables for recreation and culture | 1.7681 | 1.7919 | | |
| Other recreational items and equipment | 0.519 | 0.5345 | | |
| Garden and pets | 0.7481 | 0.8926 | | |
| Veterinary and other services for pets | 1.0622 | 0.8582 | | |
| Recreational and sporting services | 0.5088 | 0.5829 | | |
| Cultural services | 0.9791 | 0.7924 | | |
| Games of chance | 0.7516 | 0.7884 | | |
| Newspapers, books and stationery | 1.2221 | 1.5056 | 0.93 | Books, papers, magazines |
| Package holidays | 0.8967 | 0.9968 | | |
| Education | 0.902 | 1.1311 | | |
| Catering services | 0.9808 | 1.2265 | 0.96 | Catering services |
| Accommodation services | 0.3591 | 0.4104 | 0.55 | Hotels and lodgings |
| Hairdressing salons and personal grooming establishments | 0.5554 | 0.5029 | 0.56 | Barber and beauty shops |
| Appliances, articles and products for personal care | 1.4692 | 0.4591 | 1.15 | Other personal care goods; Toilet articles - 1.17 |
| Prostitution | 0.7398 | 0.5069 | | |
| Jewellery, clocks and watches | 1.3297 | 0.8018 | | |
| Other personal effects | 0.856 | 0.892 | | |
| Social protection | 0.6857 | 0.3765 | | |
| Insurance | 0.4724 | 0.5898 | | |
| Financial Intermediation Services Indirectly Measured (FISIM) | 1.0836 | 1.0484 | | |
| Other financial services n.e.c. | 0.941 | 0.9825 | | |
| Other services n.e.c. | 0.8173 | 1.4043 | | |
| Net purchases abroad | 1.245 | 1.0493 | 1.28 | Expensiture of Residents abroad |

Continued on next page

| Item - ICP 2011, 2017 | International Average Prices, 2011 | International Average Prices, 2017 | GK International Prices , 1975 | Name of item in 1975 |
|---|---|---|---|---|
| Housing | 0.9123 | 0.9388 | | |
| Health | 0.8697 | 0.8136 | | |
| Recreation and culture | 0.481 | 0.3241 | | |
| Education | 0.4874 | 0.7957 | | |
| Social protection and other services | 0.4684 | 0.9971 | | |
| Housing | 0.5532 | 0.9869 | | |
| Pharmaceutical products | 1.1061 | 1.0812 | 0.93 | Drugs, medical prepartions |
| Other medical products | 0.5118 | 0.5648 | 1.32 | Medical supplies |
| Therapeutic appliances and equipment | 0.6548 | 0.5975 | 0.83 | Therapeutic equipment |
| Out-patient medical services | 0.5241 | -5.2525 | | |
| Out-patient dental services | 0.753 | 0.8197 | | |
| Out-patient paramedical services | 0.786 | 0.8138 | | |
| Hospital services | 0.5906 | 0.6924 | | |
| Compensation of employees | 1.105 | 1.0672 | 0.81 | White collar; unskilled blue collar - 0.43; skilled blue collar - 0.61; professional - 0.83 |
| Intermediate consumption | 0.8996 | 0.6322 | | |
| Gross operating surplus | 1.0366 | 1.005 | | |
| Net taxes on production | 0.8527 | 0.7915 | | |
| Receipts from sales | 0.8745 | 0.9408 | | |
| Recreation and culture | 1.7899 | 2.317 | | |
| Education benefits and reimbursements | 1.5545 | 1.6441 | | |
| Compensation of employees | 1.4244 | 1.7486 | | |
| Intermediate consumption | 1.5779 | 1.6473 | | |
| Gross operating surplus | 1.8843 | 1.8016 | | |
| Net taxes on production | 1.6271 | 1.7234 | | |
| Receipt from sales | 0.6065 | 0.5999 | | |
| Social protection | 0.629 | 0.5796 | | |
| Compensation of employees | 0.9629 | 0.6832 | 0.81 | White collar; unskilled blue collar - 0.43; skilled blue collar - 0.61; professional - 0.83 |
| Intermediate consumption | 1.2533 | 1.2655 | 1.21 | Commodities of government |
| Gross operating surplus | 1.4837 | 1.5439 | | |
| Net taxes on production | 2.0279 | 2.4264 | | |
| Receipts from sales | 1.7254 | 1.1078 | | |
| Fabricated metal products, except machinery and equipment | 0.7159 | 0.7918 | | |
| Electrical and optical equipment | 1.5047 | 1.4198 | 1.3 | Electrical transmission equipment |
| General purpose machinery | 1.517 | 0.8263 | 1.29 | General industrial machinery |
| Special purpose machinery | 0.6347 | 1.1507 | 1.31 | Special Industrial machinery |
| Road transport equipment | 0.446 | 0.9513 | 1.53 | Trucks, buses, trailers |
| Other transport equipment | 1.5205 | 1.9819 | 1.87 | Other transport equipment |
| Residential buildings | 0.5336 | 0.5302 | 1.09 | one and two-family dwellings; multi-family dwellings - 1.07 |
| Non-residential buildings | 1.6198 | 1.92 | 1.49 | Industrial buildings; commercial buildings - 1.15; office buildings - 1.12; |
| Civil engineering works | 0.9845 | 0.8229 | 0.86 | Roads, streets, highways |
| Other products | 0.8709 | 0.8616 | | |
| Change in inventories | 1.1808 | 1.201 | 1.21 | Increase in stocks |
| Acquisitions less disposals of valuables | 0.9917 | 0.9548 | | |
| Balance of exports and imports | 0.6315 | 0.6467 | 1.28 | Exports minus imports |
| | | | | |

Notes:
Columns G and H show international prices for basic headings in 2011 and 2017 ICP
Figures in Column I are from Appendix Table 6.3 in KHS (1982) pp. 212-215
Column K shows GK international prices for related item categories