

Productivity adjustment in ICP – TAG Note

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Revision note: This note collects the main argument for revising the computation of the productivity adjustment factors (PAFs) based on updated data and a changed approach for estimating the contribution of capital input to labour productivity that accounts for natural resource rents. Compared to the last version discussed in the TAG, this version includes the latest PAF estimates based on PWT 9.1 for 2011, an estimation of the impact of revised PAFs on ICP2011 GDP PPPs, and first estimates of 2017 PAFs, based (primarily) on extrapolated investment PPPs. These new results do not give rise to new proposals or revising earlier decisions.

1. The ICP 2011 methodology for public services

Comparing relative prices in comparison-resistant areas are among the most-enduring challenges of ICP. The approach chosen for ICP 2011 for construction and for government, health and education – referred to as ‘public services’ for short – can best be described as **input price measurement**, in contrast to the standard practice of measuring the price of goods and services – i.e. output prices. In the case of construction projects, but also for many public services, there are superior alternatives to input price measurement, and these are applied in the Eurostat-OECD PPP program.¹ However, implementing these alternatives at a global level is not feasible because of the strenuous data demands. The discussion on productivity adjustment is thus one of reaching a **second-best** solution that moves us closer to our target concept, while recognizing that this can requires strict assumptions.

ICP price measurement in public services restricts itself to measuring wages of civil servants, teachers and medical workers.² This means that not only will differences in TFP drive a wedge between input and output prices, but differences in capital intensity will, too. In ICP 2011, we

¹ These alternatives involve detailed surveys of the price of construction projects and, for health and education, extensive data on quantity indicators of services delivered; see the Eurostat-OECD PPP Manual for details.

² Intermediate inputs and operating surplus are covered by reference PPPs.

did not address TFP differences (in effect assuming that there are no TFP differences) and there seems to be no reason to revisit that choice.

ICP 2011 did include a productivity adjustment based on differences in capital intensity with the methodology explained on pages 208–209 of the ICP 2011 global report and a detailed report for the TAG in 2013. In brief, we estimate a productivity adjustment factor based on a country's (economy-wide) level of capital per worker and its estimated contribution to output based on the share of capital income in GDP:

$$P_i = \frac{1}{2}(\alpha_i + \bar{\alpha}) \ln\left(\frac{k_i}{\bar{k}}\right), \quad (1)$$

Where k_i is the stock of capital assets (structures, machinery, equipment and other assets) per worker in country i , α_i is the share of capital income in GDP in country i and an upper bar indicates the cross-country arithmetic average. P_i can then be compared to a reference country b to arrive at the adjustment factor for relative wages in public services:

$$F_i = [\exp(P_i - P_b)]^{-1} \quad (2)$$

In equation (2), a higher F_i indicates a lower contribution from capital intensity differences and thus leading to an upward adjustment of the wage PPPs.

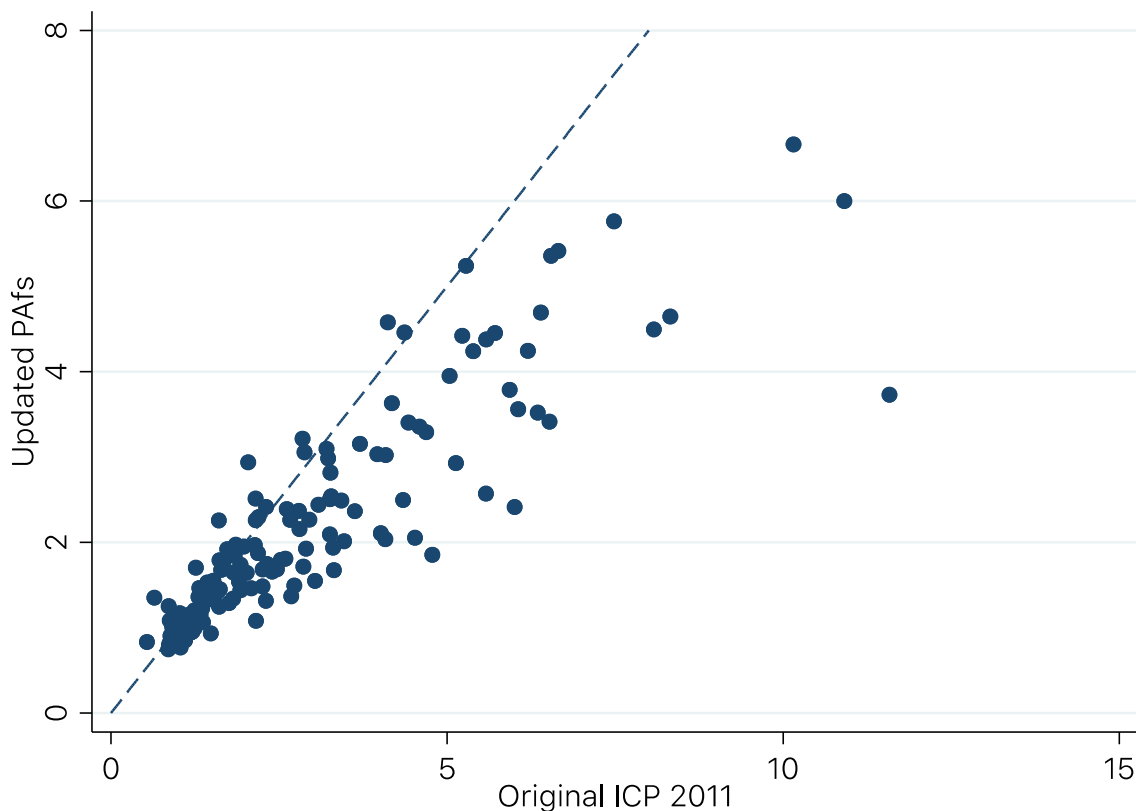
2. Implementing the productivity adjustment

The productivity adjustment from equation (1) requires two pieces of information, the capital stock per worker and the share of capital income in GDP. The capital stock per worker is, in turn, based on estimates of the current-cost net capital stock at national prices and the PPPs for investment products from ICP. The data on current-cost net capital stock for ICP 2011 were drawn from PWT, version 8.1, as was the share of labour income in GDP. The share of capital income in GDP was computed as one minus the labour share.

The most recent versions of PWT, with version 9.1 as the latest, saw substantial improvements in the source material on the basis of which current-cost net capital stocks are estimated, in particular by more extensively relying on national sources of investment by asset. These data have become more widely adopted, most prominently in the World Bank's *Changing Wealth of Nations 2018* report as their measure for produced capital.

In addition, estimating the capital share in GDP as one minus the labour share in GDP has an important shortcoming in resource-rich countries. In those countries, such as several in Western Asia, rents from natural resources such as oil and gas make up a substantial fraction of GDP – see, again, the World Bank’s *Changing Wealth of Nations 2018* report. A more accurate estimate of the capital share in GDP would thus be one minus the labour share minus the share of natural resource rents (available in the World Development Indicators).

Figure 1, Productivity adjustment factors, USA=1



Combining new source data for capital stocks and a new computation of the share of capital income in GDP leads to substantial changes to the productivity adjustment factors (PAFs), as shown in Figure 1. In particular, as most observations are below the 45-degree line, the productivity adjustment factors become smaller. This may be a desirable feature in itself as we should want to err on the side of smaller, rather than larger adjustments. But, more importantly, the updated PAFs reflect more accurate and reliable source data and represent an improvement from that perspective.

3. Implications for ICP

The first implication of this discussion is that it would be advisable for the PAFs for public services in ICP 2017 to be computed based on newer capital data and a measure of capital shares that accounts for resource rents. There is no alternative to using the newer capital data, as the data used in ICP 2011, from PWT 8.1, do not extend beyond the year 2011. The recommendation to change the capital share calculation is mostly to arrive at more suitable (and smaller) PAFs, especially in resource-rich countries.

The updated PAFs should also be used for to revise ICP 2011 PPPs to ensure time-series consistency. Not revising ICP 2011 would introduce a source of differences between the two ICP rounds that can be avoided fairly simply. Given that revising ICP 2011 PPPs based on revised expenditure data is already planned, incorporating revised PAFs would be a modest additional change.

The effect of revising the PAFs can be gauged by computing new GDP PLIs for 2011 based on the revised PAFs and comparing these to the published ICP 2011 PLIs. Recall from the ICP 2011 methodology that:

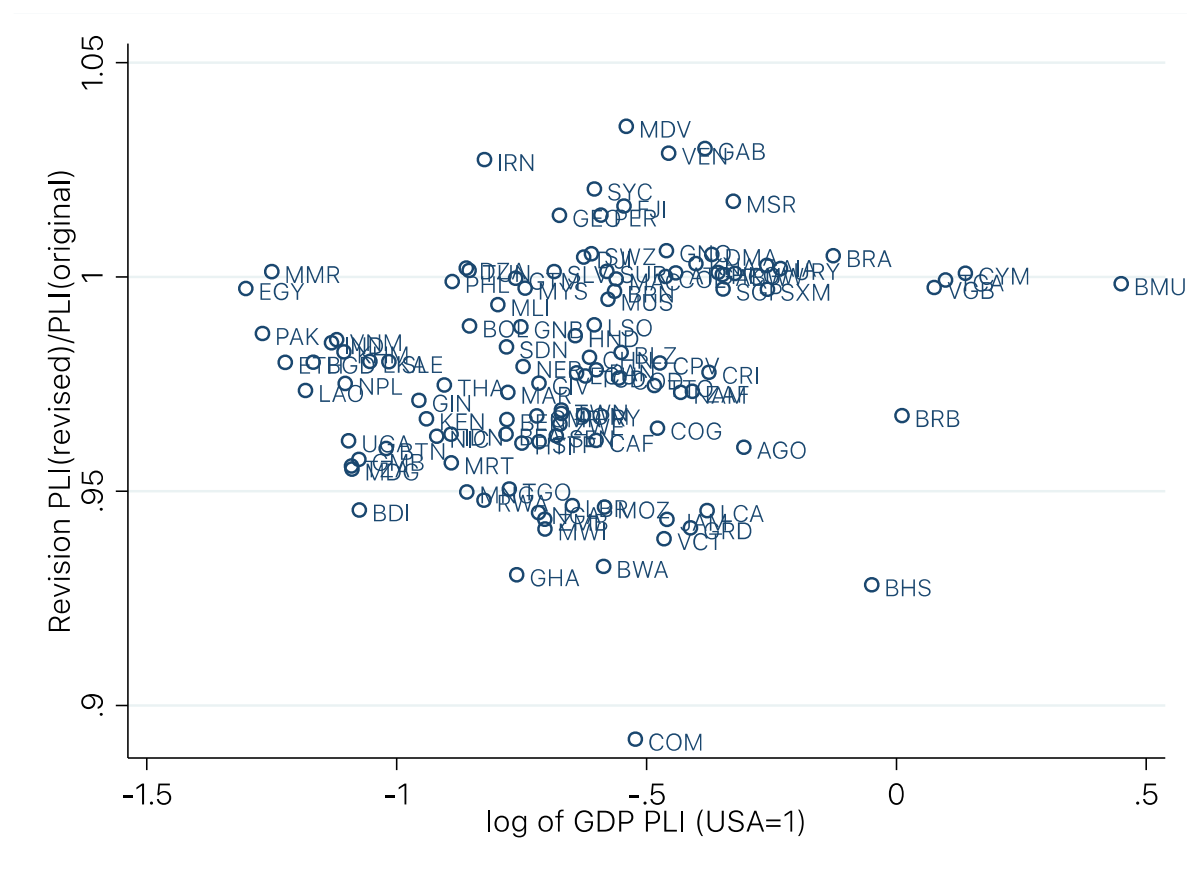
- a) The PAFs are rounded to the nearest .5 or .0 as small differences based on equations (1) and (2) are not expected to be informative. The PAFs plotted in Figure 1 are not rounded, but in the subsequent calculations, the rounded PAFs are used.
- b) The GDP PLIs within Africa, Asia-Pacific and Latin America and the Caribbean regions are affected by this revision, the GDP PLIs for Eurostat-OECD, CIS and Western Asia are not as no productivity adjustment is applied within these regions.
- c) The CAR method is applied based on revised PAFs for all regions. Global GDP PLIs with USA=1 are unchanged in the Eurostat-OECD and CIS regions, but the Western Asia PLIs are all changed by the same fraction.

Table 1 shows the results by region. Following items b and c, the revision in Eurostat-OECD and CIS is zero for all countries and the revision in Western Asia is 0.5 percent in all countries. The average downward revision in the other regions is on the order of 1–3 percent, which is the result of an average decrease in the PAF of 20 percent – from 3.3 to 2.5 – and an average share of labour compensation of public-sector workers of 8.6 percent of GDP.

Table 1. Revision of GDP PLIs (USA=1), average and standard deviation by region of PLI(revised)/PLI(original)

Region	Average	Standard deviation
Eurostat-OECD EUO	1.000	0
CIS CIS	1.000	0
Western Asia WAS	1.013	0
Africa AFR	0.970	0.025
Asia-Pacific ASI	0.987	0.019
Caribbean CAR	0.983	0.027
Latin America LAT	0.989	0.020
Singleton S	1.021	0.009

Figure 2. PLI revision in Africa, Asia-Pacific, Latin America and Caribbean and Singleton



The revision varies across countries and some are revised up and others down. Figure 2, below, plots the revision against the (log of the) original PLI for countries in those regions. The 38 countries in this group where the PAF is unchanged from before, had an average PLI revision of 0 percent, with a range between -1.3 percent +2.7 percent. The 6 countries with a higher PAF (Fiji, Gabon, Maldives, Myanmar, Peru and Venezuela) had the largest upward revisions, ranging between +1.3 and +3.5 percent. The 68 countries with a lower PAF had an average revision of -3.3 percent, ranging from -11.0 to -0.4 percent. More in general, those

countries with larger revisions to their PAF show larger revisions to their GDP PLI. For example, the PAF for Nigeria changed from 4.5 to 2.5 and its GDP PLI changed from 0.49 to 0.46, a decrease of 5.5 percent. The PAF for Brazil is unchanged at 1.5 and its PLI changes from 0.881 to 0.885, an increase of 0.3 percent. See the Appendix Table below for the result for all countries in Figure 2.

4. Preliminary 2017 PAFs

The PAFs that can be used for ICP 2017 will be based on the globally-linked basic-heading level PPPs for gross fixed capital formation, which are not yet available. But estimates are available of current-cost net capital stocks, employment and labor shares for the year 2017 from PWT 9.1. This also includes estimates of the required PPPs based on extrapolations from 2011 or later benchmarks and the Eurostat annual PPP time series that is available until 2017. This allows for a first look at the PAFs for 2017 and provides a baseline for the eventual PAFs based on ICP 2017 PPPs.

A comparison between 2011 and 2017 can be made for 171 countries. Of those, 123 show no change in their estimated PAF. This primarily reflects the decision to round PAFs to the nearest 0.5 or 0, so if the capital stocks per worker relative to the world average did not change by much, this results in the same PAF in 2017 as in 2011. There are 9 countries where the PAF declined and 39 where the PAF increased. Of those where the PAF changed only 7 countries saw a change larger than 0.5.

Over the full set of 171 countries, capital per worker grew at an average annual rate of 2.2 percent. In the group of countries where the PAF increased, capital per worker was nearly constant, with an average annual rate of change of -0.1 percent. In the group of countries with a decrease in the PAF, the growth of capital per worker was 5.2 percent. The same comparative growth picture is seen when looking at growth of GDP per capita, with average annual growth of 1.1 percent for all countries, -0.1 for increasing-PAF countries and 2.5 for decreasing-PAF countries. Note that these are growth rates based on capital stocks (and GDP) deflated by national price deflators, so independent of investment PPPs for 2011 or 2017. This indicates that the changes in PAFs can be fairly well anticipated and explained.

Appendix Table. GDP PLI and PAF in Africa, Asia-Pacific, Latin America, Caribbean and Singleton countries

		GDP PLI			PAF		
		Original	Revised	Revised/Original	Original	Revised	Revised/Original
AGO	AFR	0.74	0.71	0.96	3	2	0.67
BDI	AFR	0.34	0.32	0.95	7.5	4.5	0.60
BEN	AFR	0.46	0.44	0.97	5	3.5	0.70
BFA	AFR	0.46	0.44	0.96	6	4	0.67
BWA	AFR	0.56	0.52	0.93	2	1	0.50
CAF	AFR	0.55	0.53	0.96	9.5	6	0.63
CIV	AFR	0.49	0.48	0.98	4.5	3.5	0.78
CMR	AFR	0.49	0.47	0.97	5	3.5	0.70
COD	AFR	0.57	0.56	0.98	7.5	6	0.80
COG	AFR	0.62	0.60	0.96	3	2	0.67
COM	AFR	0.59	0.53	0.89	5	2	0.40
CPV	AFR	0.62	0.61	0.98	2.5	2	0.80
DJI	AFR	0.53	0.54	1.00	3	3	1.00
DZA	AFR	0.42	0.42	1.00	1.5	1.5	1.00
EGY	AFR	0.27	0.27	1.00	3	2.5	0.83
ETH	AFR	0.29	0.29	0.98	6.5	5.5	0.85
GAB	AFR	0.68	0.70	1.03	1	1.5	1.50
GHA	AFR	0.47	0.44	0.93	4	2	0.50
GIN	AFR	0.38	0.37	0.97	6	4.5	0.75
GMB	AFR	0.34	0.33	0.96	5	3	0.60
GNB	AFR	0.47	0.47	0.99	5	4.5	0.90
GNQ	AFR	0.63	0.64	1.01	1	1	1.00
KEN	AFR	0.39	0.38	0.97	5	3.5	0.70
LBR	AFR	0.52	0.49	0.95	8	4.5	0.56
LSO	AFR	0.55	0.54	0.99	3	2.5	0.83
MAR	AFR	0.46	0.45	0.97	2	1.5	0.75
MDG	AFR	0.34	0.32	0.96	8	4.5	0.56
MLI	AFR	0.45	0.45	0.99	5.5	5.5	1.00
MOZ	AFR	0.56	0.53	0.95	11.5	6.5	0.57
MRT	AFR	0.41	0.39	0.96	4	2.5	0.63
MUS	AFR	0.56	0.56	0.99	1.5	1.5	1.00
MWI	AFR	0.50	0.47	0.94	10	5	0.50
NAM	AFR	0.65	0.63	0.97	2	1.5	0.75
NER	AFR	0.47	0.46	0.98	5.5	4.5	0.82
NGA	AFR	0.49	0.46	0.94	4.5	2.5	0.56
RWA	AFR	0.44	0.42	0.95	7	4	0.57
SDN	AFR	0.46	0.45	0.98	3.5	2	0.57
SEN	AFR	0.51	0.49	0.96	4.5	3	0.67

		GDP PLI			PAF		
		Original	Revised	Revised/Original	Original	Revised	Revised/Original
SLE	AFR	0.36	0.36	0.98	4.5	4	0.89
STP	AFR	0.49	0.47	0.96	3	2	0.67
SWZ	AFR	0.54	0.55	1.01	1.5	1.5	1.00
SYC	AFR	0.55	0.56	1.02	1	1	1.00
TCD	AFR	0.54	0.52	0.98	5.5	4.5	0.82
TGO	AFR	0.46	0.44	0.95	4.5	2.5	0.56
TUN	AFR	0.43	0.43	1.00	1.5	1.5	1.00
TZA	AFR	0.34	0.32	0.96	6	3.5	0.58
UGA	AFR	0.33	0.32	0.96	5.5	3.5	0.64
ZAF	AFR	0.66	0.65	0.97	2	1.5	0.75
ZMB	AFR	0.49	0.47	0.94	4	2	0.50
ZWE	AFR	0.51	0.49	0.97	5	3.5	0.70
BGD	ASI	0.31	0.31	0.98	4	3	0.75
BRN	ASI	0.57	0.57	1.00	1	1	1.00
BTN	ASI	0.36	0.35	0.96	3	2	0.67
CHN	ASI	0.54	0.53	0.98	2.5	2	0.80
FJI	ASI	0.58	0.59	1.02	2	2.5	1.25
HKG	ASI	0.70	0.70	1.00	1	1	1.00
IDN	ASI	0.41	0.40	0.96	2.5	1.5	0.60
IND	ASI	0.32	0.32	0.98	3	2.5	0.83
KHM	ASI	0.33	0.33	0.98	5.5	4.5	0.82
LAO	ASI	0.31	0.30	0.97	4	3	0.75
LKA	ASI	0.35	0.34	0.98	2.5	2	0.80
MAC	ASI	0.57	0.57	1.00	1	1	1.00
MDV	ASI	0.58	0.60	1.04	1.5	2	1.33
MMR	ASI	0.29	0.29	1.00	4.5	4.5	1.00
MNG	ASI	0.42	0.40	0.95	2.5	1.5	0.60
MYS	ASI	0.48	0.47	1.00	1.5	1.5	1.00
NPL	ASI	0.33	0.32	0.98	5.5	4	0.73
PAK	ASI	0.28	0.28	0.99	3.5	3	0.86
PHL	ASI	0.41	0.41	1.00	2.5	2.5	1.00
SGP	ASI	0.71	0.70	1.00	1	1	1.00
THA	ASI	0.40	0.39	0.97	2	1.5	0.75
TWN	ASI	0.51	0.50	0.97	1.5	1	0.67
VNM	ASI	0.33	0.32	0.99	3.5	3	0.86
ABW	CAR	0.71	0.71	1.00	1	1	1.00
AIA	CAR	0.77	0.77	1.00	1.5	1.5	1.00
ATG	CAR	0.64	0.64	1.00	1.5	1.5	1.00
BHS	CAR	0.95	0.88	0.93	2	1	0.50
BLZ	CAR	0.58	0.57	0.98	3	2.5	0.83

		GDP PLI			PAF		
		Original	Revised	Revised/Original	Original	Revised	Revised/Original
BMU	CAR	1.57	1.57	1.00	1.5	1.5	1.00
BRB	CAR	1.01	0.98	0.97	2	1.5	0.75
CUW	CAR	0.72	0.72	1.00	1.5	1.5	1.00
CYM	CAR	1.15	1.15	1.00	1	1	1.00
DMA	CAR	0.69	0.69	1.01	3	3	1.00
GRD	CAR	0.66	0.62	0.94	2.5	1.5	0.60
JAM	CAR	0.63	0.60	0.94	2.5	1.5	0.60
KNA	CAR	0.67	0.67	1.00	1.5	1.5	1.00
LCA	CAR	0.68	0.65	0.95	2.5	1.5	0.60
MSR	CAR	0.72	0.73	1.02	1.5	1.5	1.00
SUR	CAR	0.56	0.56	1.00	1.5	1.5	1.00
SXM	CAR	0.77	0.77	1.00	0.5	0.5	1.00
TCA	CAR	1.10	1.10	1.00	1.5	1.5	1.00
TTO	CAR	0.62	0.60	0.97	2	1.5	0.75
VCT	CAR	0.63	0.59	0.94	2.5	1.5	0.60
VGB	CAR	1.08	1.08	1.00	1.5	1.5	1.00
BOL	LAT	0.43	0.42	0.99	3.5	3	0.86
BRA	LAT	0.88	0.89	1.00	1.5	1.5	1.00
COL	LAT	0.63	0.63	1.00	2	2	1.00
CRI	LAT	0.69	0.67	0.98	2	1.5	0.75
DOM	LAT	0.51	0.50	0.97	2.5	1.5	0.60
ECU	LAT	0.53	0.52	0.98	2	1.5	0.75
GTM	LAT	0.47	0.47	1.00	2.5	2.5	1.00
HND	LAT	0.53	0.52	0.99	3	2.5	0.83
HTI	LAT	0.47	0.45	0.96	5	2.5	0.50
NIC	LAT	0.40	0.38	0.96	4	2.5	0.63
PAN	LAT	0.55	0.54	0.98	2	1.5	0.75
PER	LAT	0.55	0.56	1.01	2	2.5	1.25
PRY	LAT	0.53	0.52	0.97	3	2	0.67
SLV	LAT	0.50	0.50	1.00	2.5	2.5	1.00
URY	LAT	0.79	0.79	1.00	1.5	1.5	1.00
VEN	LAT	0.63	0.65	1.03	1	1.5	1.50
GEO	S	0.51	0.52	1.01	2.5	2.5	1.00
IRN	S	0.44	0.45	1.03	1	1	1.00