

A faint, dotted world map is centered in the background of the slide.

Productivity Adjustment Approach for ICP 2021 cycle



International Comparison Program

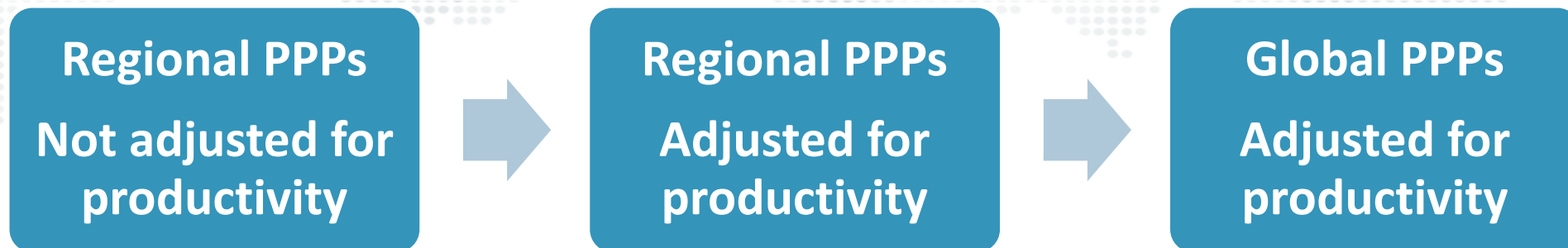
October 24-28, 2022

Outline

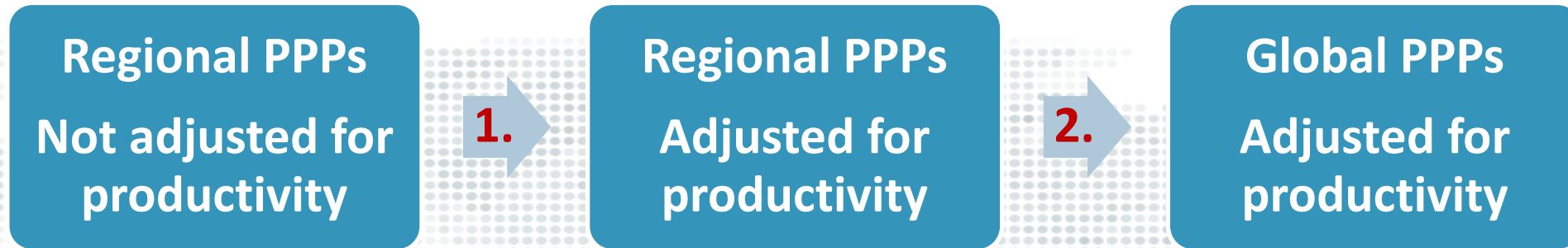
- **Estimating global PPPs for Government Services**
- **Calculating Productivity Adjustment Factors**
- **Regional PAFs calculation file**
- **ICP 2021 and 2017 data revisions**

Estimating global PPPs for Government Services [1]

- **Government Services PPPs** are estimated based on an **input approach**, using the compensation of government employees for all participating economies
- Given the differences in productivity across the world, **Productivity Adjustment Factors (PAFs)** are applied to regional PPPs before estimating the global PPPs
- Without productivity adjustments the real consumption of government services would be overestimated in economies with relatively lower salaries and vice-versa
- The estimation of global PPPs for Government Services follows these steps:



Estimating global PPPs for Government Services [2]



- **Step 1.** Calculation of Productivity Adjustment Factors (by the RIAs)
 - Regional PPPs for government compensation headings are adjusted by PAFs, to obtain Regional PPPs adjusted for productivity
- **Step 2.** Linking Government Compensation headings (by the Global Office)
 - Linking Factors and Regional PPPs, before and after PAFs, are used to estimate the Global PPPs for government compensation headings

Government Services and the ICP Classification

| | | |
|----------------|---|-----------------------|
| 1300000 | INDIVIDUAL CONSUMPTION EXPENDITURE BY GOVERNMENT | Main Aggregate |
| ... | ... | ... |
| 1302000 | HEALTH | Category |
| 1302200 | PRODUCTION OF HEALTH SERVICES | Group |
| 1302210 | <u>Compensation of employees</u> | <u>Class</u> |
| 1302211 | Compensation of employees - Ind. Hth. Govt | Basic Heading |
| ... | ... | ... |
| 1304000 | EDUCATION | Category |
| 1304200 | PRODUCTION OF EDUCATION SERVICES | Group |
| 1304210 | <u>Compensation of employees</u> | <u>Class</u> |
| 1304211 | Compensation of employees - Ind. Edu. Govt | Basic Heading |
| ... | ... | ... |
| 1400000 | COLLECTIVE CONSUMPTION EXPENDITURE BY GOVERNMENT | Main Aggregate |
| 1401000 | COLLECTIVE SERVICES | Category |
| 1401100 | COLLECTIVE SERVICES | Group |
| 1401110 | <u>Compensation of employees</u> | <u>Class</u> |
| 1401111 | Compensation of employees - Coll. Govt | Basic Heading |

A world map composed of a grid of small dots, rendered in a light gray color, serving as a background for the slide. The dots are arranged in a way that clearly outlines the continents of North America, South America, Europe, Africa, and Asia.

Calculating Productivity Adjustment Factors

Productivity Adjustment Factors

- **Productivity Adjustments Factors** are calculated for each country, to adjust the government compensation PPPs to the same level of productivity.
- PAFs are based on two indicators:
 - **Labor compensation share in total GDP**
 - **Capital stock per employee, PPP adjusted**
- PAFs always have a base country as a reference, i.e. Brazil = 1 or USA = 1
- PAFs are estimated first at the regional level, in order to obtain adjusted regional PPPs and later estimated at the global level in order to calculate global PPPs

PAFs: Data sources

Penn World Tables

- **Number of persons employed (in millions)**
- **Share of labor compensation in GDP**
- **Current-cost net capital stock of:**
 - Electrical and optical equipment
 - Machinery (excluding elect. & opt. eq.)
 - Transport equipment
 - Residential and non-residential structures
 - Other assets

Regional Implementing Agencies

- **Regional PPPs:**
 - 1501111 - Fabricated metal products, except machinery and equipment
 - 1501115 - General purpose machinery
 - 1501116 - Special purpose machinery
 - 1501112 - Electrical and optical equipment
 - 1501120 - Transport equipment
 - 1501200 - Construction
 - 1501300 - Other products
- **Expenditures in LCU:**
 - 1501111 - Fabricated metal products, except machinery and equipment
 - 1501115 - General purpose machinery
 - 1501116 - Special purpose machinery

PAFs: Data gap filling

- In case there is missing data in the PWT, i.e. **Number of persons employed** or **Share of labor compensation in GDP**, RIAs are invited to fill those gaps with official data from other sources. However, if no data is available, the following adjustments are made:
 - If the **share of labor compensation in GDP** is not available from any data source, leave the field in blank. The formulas will fill the data gaps with the regional average.
 - If the **number of persons employed** is not available from any data source, please estimate it by calculating the regional average of labor force participation and multiply it over the total active population for that economy.

PAFs: Preliminary calculation

- Calculate regional PPPs for the capital stock component **“Machinery (excluding electrical and optical equipment)”**. This is done by using the ICP PPPs and expenditures of the 3 BHs highlighted before and applying the EKS method:

| PPPs for “Machinery excluding electrical and optical equipment” | 1.000 | 6.745 | 16.886 | 32.379 | 0.720 |
|---|-------|-------|--------|--------|-------|
| Fabricated metal products, except machinery and equipment | 1.000 | 8.588 | 15.671 | 37.619 | 0.751 |
| General purpose machinery | 1.000 | 6.628 | 17.838 | 31.224 | 0.776 |
| Special purpose machinery | 1.000 | 6.240 | 16.348 | 31.586 | 0.648 |

| EXPs for “Machinery excluding electrical and optical equipment” | | | | | |
|---|-------|-------|-------|-------|-------|
| Fabricated metal products, except machinery and equipment | ##### | ##### | ##### | ##### | ##### |
| General purpose machinery | ##### | ##### | ##### | ##### | ##### |
| Special purpose machinery | ##### | ##### | ##### | ##### | ##### |

- Note:** This step is already included in the PAF calculation file, but in order to run the EKS calculation it is necessary to install an excel extension.

PAFs: Calculations [1]

- **Step 1.** Calculate the **PPP of Capital stock** using EKS

| Regional PPPs | Base country | Country A | Country B | Country C | Country D |
|--|--------------|--------------|---------------|---------------|--------------|
| Machinery (excluding elect. & opt. eq.) | 1.000 | 6.745 | 16.886 | 32.379 | 0.720 |
| Electrical and optical equipment | 1.000 | 8.682 | 18.760 | 41.428 | 0.867 |
| Transport equipment | 1.000 | 9.304 | 20.401 | 52.660 | 1.032 |
| Construction | 1.000 | 10.138 | 15.177 | 51.202 | 0.800 |
| Other products | 1.000 | 7.703 | 18.214 | 40.215 | 0.827 |
| PWT capital stock | Base country | Country A | Country B | Country C | Country D |
| Other machinery | 1,740,248 | 12,487,005 | 4,237,952 | 1,843,731 | 59,495 |
| Electrical and optical equipment | 83,349 | 2,691,965 | 1,091,307 | 151,962 | 15,473 |
| Transport equipment | 462,072 | 8,349,639 | 1,748,368 | 777,982 | 21,422 |
| Residential and non-residential structures | 9,341,424 | 43,777,364 | 67,313,888 | 13,751,510 | 392,664 |
| Other assets | 236,130 | 191,608 | 757,854 | 72,659 | 3,883 |
| PPPs of Capital stock | 1.000 | 9.493 | 15.454 | 48.091 | 0.802 |

PAFs: Calculations [2]

- **Step 2.** Calculate the **Capital stock per employee, PPP adjusted** of each economy

$$\text{Capital stock per employee, PPP adjusted} = \frac{\text{Capital stock}_i}{\text{Employment}_i} \times \frac{1}{\text{Capital stock PPP}_i} = KS_i^{adj}$$

- **Notes:**

- The capital stock is the sum of all PWT capital components
- The capital stock PPP was calculated on Step 1
- For the next step we need the regional average of KS_i^{adj} which is obtained by calculating its geomean. We will call it: $KS_{r.avg}^{adj}$

PAFs: Calculations [3]

- **Step 3.** Calculate the **Productivity Ratio** of each economy relative to the regional average

$$\textit{Productivity Ratio}_i = \left(\frac{KS_i^{adj}}{KS_{r.avg}^{adj}} \right)^{1 - \left(\frac{LS_i + LS_{r.avg}}{2} \right)} = PR_i$$

- **Notes:**

- LS_i is the share of labor compensation for economy i and $LS_{r.avg}$ is the simple average of all LS_i in the region

PAFs: Calculations [4]

- **Step 4.** Calculate the **Productivity Adjustment Factors** for each economy i relative to the base economy b

$$\textit{Productivity Adjustment Factor}_i = \frac{PR_i}{PR_b} = PAF_i$$

- **Notes:**

- If $PAF_i < 1$ then the productivity of economy i is *lower* than the base economy b
- To calculate PPPs adjusted by PAFs, we take the original unadjusted PPPs for economy i and divide them by PAF_i



Regional PAFs calculation file

Regional PAFs calculation file: Inputs sheet



| source | code | series | Country A | Country B | Country C | Country D | Country E | Country F | Country G |
|--------|----------|--|-------------|--------------|------------|---------------|---------------|--------------|--------------|
| PWT | emp | Number of persons employed (in millions) | 0.05 | 15.54 | 0.01 | 1.04 | 5.66 | 20.03 | 1.02 |
| PWT | labsh | Share of labour compensation in GDP at current national prices | 0.65 | 0.35 | 0.00 | 0.00 | 0.00 | 0.54 | 0.55 |
| PWT | kstock | Capital Stock | 24,030.0 | 85,896,479.2 | 4,656.2 | 7,208,088.9 | 4,322,499.6 | 28,153,915.3 | 20,360,324.8 |
| PPP | r1501110 | Metal products and equipment (Class) | 0.388 | 17.446 | 0.684 | 137.129 | 8.551 | 7.163 | 494.726 |
| PPP | r1501111 | Fabricated metal products, except machinery and equipment (BH) | 0.376 | 15.671 | 0.837 | 123.997 | 8.879 | 7.811 | 485.444 |
| PPP | r1501112 | Electrical and optical equipment (BH) | 0.352 | 18.760 | 0.643 | 138.167 | 8.657 | 6.280 | 521.752 |
| PPP | r1501115 | General purpose machinery (BH) | 0.367 | 17.838 | 1.418 | 146.930 | 9.098 | 7.054 | 504.226 |
| PPP | r1501116 | Special purpose machinery (BH) | 0.569 | 16.348 | 0.470 | 131.868 | 8.410 | 7.954 | 421.725 |
| PPP | r1501120 | Transport equipment (Class) | 0.610 | 20.401 | 0.964 | 124.089 | 8.787 | 6.791 | 482.337 |
| PPP | r1501200 | Construction (Group) | 1.195 | 15.177 | 1.762 | 41.474 | 10.663 | 6.566 | 181.682 |
| PPP | r1501300 | Other products (Group) | 0.434 | 18.214 | 0.732 | 95.918 | 8.528 | 7.011 | 393.086 |
| PWT | Nc_Con | Current-cost net capital stock of residential and non-residential structures | 22,311 | 74,672,189 | 4,448 | 6,718,032 | 3,811,730 | 24,828,083 | 19,024,139 |
| PWT | Nc_Mach | Current-cost net capital stock of machinery and equipment (incl. electrical eq.) | 1,232 | 8,193,957 | 138 | 350,390 | 330,319 | 2,524,527 | 896,757 |
| PWT | Nc_Omach | Current-cost net capital stock of other machinery (w/o electrical eq.) | 863 | 7,330,186 | 113 | 333,169 | 324,786 | 2,247,578 | 666,457 |
| PWT | Nc_Traeq | Current-cost net capital stock of transport equipment | 477 | 2,342,822 | 58 | 77,315 | 173,032 | 766,343 | 296,940 |
| PWT | Nc_Elec | Current-cost net capital stock of electrical and optical equipment | 369 | 863,771 | 25 | 17,221 | 5,533 | 276,948 | 230,300 |
| PWT | Nc_Other | Current-cost net capital stock of other assets | 10 | 687,511 | 12 | 62,352 | 7,419 | 34,963 | 142,489 |
| EXP | e1501111 | Fabricated metal products, except machinery and equipment (BH) | 59,823,000 | ##### | 619,906 | 3,480,232,580 | ##### | ##### | ##### |
| EXP | e1501115 | General purpose machinery (BH) | 111,753,000 | ##### | 1,549,766 | ##### | ##### | ##### | ##### |
| EXP | e1501116 | Special purpose machinery (BH) | 27,918,000 | ##### | 11,158,312 | ##### | 2,140,653,575 | ##### | ##### |

Regional PAFs calculation file: Computation sheet

Main calculation table

| | | | | | | | |
|--|--------------|--------------|---------------|---------------|--------------|---------------|----------------|
| Capital stock PPPs | 1.000 | 9.536 | 15.478 | 48.373 | 0.798 | 44.684 | 155.707 |
| Employment | 18.303 | 10.931 | 15.545 | 4.026 | 0.890 | 6.534 | 4.677 |
| Capital stock, LCU | 11,797,693 | 90,662,507 | 85,896,479 | 15,081,027 | 556,680 | 13,960,730 | 11,542,097 |
| Share of labour compensation | 0.570 | | 0.346 | 0.617 | 0.278 | 0.461 | 0.606 |
| Regional calculations: | | | | | | | |
| Share of labor compensation, gap filled (LS _i) | 0.570 | 0.504 | 0.3 | | | | 6 |
| Share of labor compensation, gap filled, regional average (LS _{r,avg}) | 0.504 | | | | | | |
| Capital stock per employee, PPP adjusted (KS ^{adj} _i) | 644,583 | 869,802 | 357,006 | 77,436 | 784,689 | 47,813 | 15,849 |
| Capital stock per employee, PPP adjusted, regional average (KS ^{adj} _{r,avg}) | 130,050 | | | | | | |
| Productivity Ratio, to region average (PR) | 2.097 | 2.566 | 1.787 | 0.796 | 2.988 | 0.596 | 0.392 |
| Productivity Adjustment Factor, to region base (PAF) | 1.000 | 1.223 | 0.852 | 0.380 | 1.425 | 0.284 | 0.187 |

If zero then delete and leave blank

Calculation of Capital stock PPPs

| | | | | | | | |
|--|--------------|--------------|---------------|---------------|--------------|---------------|----------------|
| Capital stock PPP | 1.000 | 9.536 | 15.478 | 48.373 | 0.798 | 44.684 | 155.707 |
| Machinery (excl. elec. & opt. eq.) (3 BHs) | 1.000 | 6.745 | 16.886 | 32.379 | 0.720 | 31.535 | 119.562 |
| Electrical and optical equipment (1 BH) | 1.000 | 8.682 | 18.760 | 41.428 | 0.867 | 35.738 | 108.776 |
| Transport equipment (2 BHs) | 1.000 | 9.304 | 20.401 | 52.660 | 1.032 | 52.150 | 144.632 |
| Construction (3 BHs) | 1.000 | 10.138 | 15.177 | 51.202 | 0.800 | 47.127 | 165.327 |
| Other products (1 BH) | 1.000 | 7.703 | 18.214 | 40.215 | 0.827 | 37.306 | 123.399 |

Calculation of "Machinery" PPPs

| | | | | | | | |
|--|-----------|------------|------------|------------|---------|------------|-----------|
| Expenditures (from PWT) | | | | | | | |
| Current-cost net capital stock of other machinery | 1,740,406 | 10,422,643 | 7,330,186 | 1,151,914 | 54,951 | 1,843,660 | 1,326,564 |
| Current-cost net capital stock of electrical and optical equipment | 90,527 | 2,004,134 | 863,771 | 131,541 | 25,455 | 251,767 | 268,680 |
| Current-cost net capital stock of transport equipment | 470,076 | 2,718,341 | 2,342,822 | 1,037,839 | 12,825 | 818,848 | 66,592 |
| Current-cost net capital stock of residential and non-residential structures | 9,191,413 | 75,310,742 | 74,672,189 | 12,695,895 | 461,622 | 10,493,611 | 9,711,824 |
| Current-cost net capital stock of other assets | 305,270 | 206,646 | 687,511 | 63,839 | 1,827 | 552,845 | 168,437 |

| | | | | | | | |
|--|--------------|--------------|---------------|---------------|--------------|---------------|----------------|
| PPPs for Machinery excluding electrical and optical equipment | 1.000 | 6.745 | 16.886 | 32.379 | 0.720 | 31.535 | 119.562 |
| Fabricated metal products, except machinery and equipment | 1.000 | 8.588 | 15.671 | 37.619 | 0.751 | 48.766 | 155.042 |
| General purpose machinery | 1.000 | 6.628 | 17.838 | 31.224 | 0.776 | 26.768 | 106.145 |
| Special purpose machinery | 1.000 | 6.240 | 16.348 | 31.586 | 0.648 | 28.555 | 116.576 |

| | | | | | | | |
|--|-------|-------|-------|-------|-------|-------|-------|
| EXPs for Machinery excluding electrical and optical equipment | | | | | | | |
| Fabricated metal products, except machinery and equipment | ##### | ##### | ##### | ##### | ##### | ##### | ##### |
| General purpose machinery | ##### | ##### | ##### | ##### | ##### | ##### | ##### |
| Special purpose machinery | ##### | ##### | ##### | ##### | ##### | ##### | ##### |

Regional PAFs calculation file: Main table

| | Base | Country | Country | Country | Country | Country | Country |
|---|--------------|--------------|---------------|---------------|--------------|---------------|----------------|
| | Country | Country | Country | Country | Country | Country | Country |
| | A | B | C | D | E | F | G |
| Capital stock PPPs | 1.000 | 9.536 | 15.478 | 48.373 | 0.798 | 44.684 | 155.707 |
| Employment | 18.303 | 10.931 | 15.545 | 4.026 | 0.890 | 6.534 | 4.677 |
| Capital stock, LCU | 11,797,693 | 90,662,507 | 85,896,479 | 15,081,027 | 556,680 | 13,960,730 | 11,542,097 |
| Share of labour compensation | 0.570 | | 0.346 | 0.617 | 0.278 | 0.461 | 0.606 |
| Regional calculations: | | | | | | | |
| Share of labor compensation, gap filled (LS_i) | 0.570 | 0.504 | 0.346 | 0.617 | 0.278 | 0.461 | 0.606 |
| Share of labor compensation, gap filled, regional average ($LS_{r.avg}$) | 0.504 | | | | | | |
| Capital stock per employee, PPP adjusted (KS^{adj}_i) | 644,583 | 869,802 | 357,006 | 77,436 | 784,689 | 47,813 | 15,849 |
| Capital stock per employee, PPP adjusted, regional average ($KS^{adj}_{r.avg}$) | 130,050 | | | | | | |
| Productivity Ratio, to region average (PR) | 2.097 | 2.566 | 1.787 | 0.796 | 2.988 | 0.596 | 0.392 |
| Productivity Adjustment Factor, to region base (PAF) | 1.000 | 1.223 | 0.852 | 0.380 | 1.425 | 0.284 | 0.187 |



THANK YOU