



On Measuring Regional or Global Growth and Inflation

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Fourth World KLEMS Conference
Madrid, 23-24 May 2016



Outline



- **Concepts for international comparison**
 - **Exchange rates (XR)**
 - **Purchasing power parities (PPPs)**
- **Comparisons of World GDP over time**
 - **Global Inflation**
 - **Global Growth**



Key Concepts and Notation



Gross Domestic Product of country j

(in national currency units) $GDP^j = \sum p_n^j \cdot x_n^j$

Nominal GDP : GDP of country j expressed in reference currency units using exchange rates

$$NGDP^j = \frac{GDP^j}{XR^j}$$

Real GDP : GDP of country j expressed in reference currency units using PPPs

$$RGDP^j = \frac{GDP^j}{PPP^j}$$



Purchasing Power Parities (PPPs)



PPPs are amounts of currencies, of different countries, that have the same purchasing power as one unit of a reference currency (e.g. US\$) with respect to a selected basket of goods and services (the scope). Methods were surveyed by Balk (2008), (2009).



Price Level Index (PLI)



Defined as the ratio of PPP to the exchange rate

$$PLI^j = \frac{PPP^j}{XR^j}$$

PLIs are transitive, but not invariant to choice of reference country.



Normalisation of PLIs



Adjust the PPPs by a positive scalar such that world real GDP at the new PPPs is equal to world nominal GDP at XRs:

$$\sum_j \frac{GDP^j}{PPP^j / \mu} = \sum_j \frac{GDP^j}{XR^j}$$

This represents current Eurostat National Accounting practice. PPPs are calculated according to the GEKS method.



Global Inflation and Growth (1)



Total real GDP in periods s and t (later) is given by

$$RGDP^s = \sum_{j=1}^M RGDP_j^s = \sum_{j=1}^M GDP_j^s / PPP_j^s$$

$$RGDP^t = \sum_{j=1}^M RGDP_j^t = \sum_{j=1}^M GDP_j^t / PPP_j^t$$

It is important to realize that these two aggregates are in the prices of periods s and t respectively. The ratio of these two aggregates is similar to the ratio of country-specific nominal GDP in two periods.



Global Inflation and Growth (2)



The objective is to decompose the total real GDP ratio into a price index (measuring inflation) and a quantity index (measuring growth),

$$\frac{RGDP^t}{RGDP^s} = WI(s, t)WG(s, t).$$

Indices may be direct or chained. We prefer a symmetric (in time periods) to an asymmetric decomposition.



Global Inflation and Growth (3)



Using the logarithmic mean it appears that

$$\frac{\sum_{j=1}^M GDP_j^t / PPP_j^t}{\sum_{j=1}^M GDP_j^s / PPP_j^s} = \exp \left\{ \sum_{j=1}^M \Psi^j \ln \left[\frac{GDP_j^t / PPP_j^t}{GDP_j^s / PPP_j^s} \right] \right\}$$
$$= \exp \left\{ \sum_{j=1}^M \Psi^j \ln \left[\frac{RGDP_j^t}{RGDP_j^s} \right] \right\}$$

where the weights, adding up to 1, are defined by

$$\Psi^j = \frac{L \left[\frac{RGDP_j^s}{\sum_{k=1}^M RGDP_k^s}, \frac{RGDP_j^t}{\sum_{k=1}^M RGDP_k^t} \right]}{\sum_{j=1}^M L(.,.)} \quad \text{where } L(a,b) = \frac{a-b}{\ln a - \ln b} \text{ is the logmean.}$$



Global Inflation and Growth (4)



Using NA data country-specific nominal GDP change can be decomposed into price and quantity indices

$$\frac{GDP_j^t}{GDP_j^s} = P_j^{GDP}(s, t) \cdot Q_j^{GDP}(s, t) \quad \forall j$$

Then World Inflation and World Growth are measured by:

$$WI(s, t) = \exp \left\{ \sum_{j=1}^M \Psi^j \ln \left(P_j^{GDP}(s, t) \cdot \frac{PPP_j^s}{PPP_j^t} \right) \right\}$$

$$WG(s, t) = \exp \left\{ \sum_{j=1}^M \Psi^j \ln \left(Q_j^{GDP}(s, t) \right) \right\}$$



Global Inflation and Growth (5)



It appears that if the period t PPPs are obtained by extrapolating the period s PPPs then world inflation reduces to the price index of the numeraire country. Since there are M choices for the numeraire, an unweighted geometric mean makes sense.



Global Inflation and Growth (6)



- **The entire derivation can be repeated for total nominal GDP. This delivers XR-based global price and quantity indices. They will differ numerically from the PPP-based indices, but provide decompositions of the same ratio (due to the normalization).**
- **In both cases the global price index is not invariant to the choice of the reference country.**
- **Instead of Sato-Vartia one could use Fisher.**
- **Table 1 is based on ICP data: 2005, 2011, 141 countries.**



ICP Inflation and Growth



Table 1: Regional and Global Growth and Inflation, 2005 to 2011

| ICP REGION | $\frac{NGDP^{2011}}{NGDP^{2005}}$ = $\frac{RGDP^{2011}}{RGDP^{2005}}$ | EXCHANGE RATE BASED DECOMPOSITION | | | | PPP BASED DECOMPOSITION | | | |
|----------------------|---|------------------------------------|-----------------|--------------------------------|-------------|------------------------------------|-----------------|--------------------------------|-------------|
| | | PRICE CHANGE (FISHER) ¹ | GROWTH (FISHER) | PRICE CHANGE (SV) ² | GROWTH (SV) | PRICE CHANGE (FISHER) ³ | GROWTH (FISHER) | PRICE CHANGE (SV) ⁴ | GROWTH (SV) |
| ASIA AND THE PACIFIC | 2.4571 | 1.5696 | 1.5655 | 1.5691 | 1.5659 | 1.5618 | 1.5732 | 1.5614 | 1.5736 |
| AFRICA | 2.3873 | 1.7972 | 1.3284 | 1.7972 | 1.3284 | 1.7956 | 1.3295 | 1.7957 | 1.3294 |
| CIS | 2.4351 | 1.9570 | 1.2443 | 1.9571 | 1.2442 | 1.9583 | 1.2435 | 1.9585 | 1.2433 |
| EUROSTAT-OECD | 1.2881 | 1.2107 | 1.0639 | 1.2107 | 1.0639 | 1.2025 | 1.0712 | 1.2025 | 1.0712 |
| LATIN AMERICA | 2.5821 | 1.9736 | 1.3083 | 1.9738 | 1.3082 | 1.9617 | 1.3163 | 1.9617 | 1.3163 |
| IRAN | 2.6458 | 2.1138 | 1.2517 | 2.1138 | 1.2517 | 2.1138 | 1.2517 | 2.1138 | 1.2517 |
| WEST ASIA | 2.2883 | 1.5730 | 1.4548 | 1.5729 | 1.4548 | 1.5795 | 1.4487 | 1.5800 | 1.4483 |
| GEORGIA | 2.2907 | 1.6377 | 1.3988 | 1.6377 | 1.3988 | 1.6377 | 1.3988 | 1.6377 | 1.3988 |
| WORLD | 1.6495 | 1.3946 | 1.1828 | 1.3946 | 1.1828 | 1.3152 | 1.2542 | 1.3156 | 1.2538 |

¹Equation (19).²Equation (22). ³Equation (25). ⁴Equation (29).



Why SV is preferred to Fisher



- **Simpler functional form.**
- **Decomposable (into 3 components; or contributions of groups of countries). See Table 2 and Table 3 (in paper).**
- **The *inconsistency-in-aggregation* appears to be practically negligible.**



Components of Global Inflation



Table 2: Components of Global Inflation, 2005 to 2011

| ICP REGION | EXCHANGE RATE BASED (EQ. (21)) | | PPP BASED (EQ. (28)) | |
|----------------------|--------------------------------|--------|----------------------|--------|
| | Domestic Price | XR | Domestic Price | PPP |
| ASIA AND THE PACIFIC | 1.3936 | 1.1259 | 1.4371 | 1.0865 |
| AFRICA | 1.9626 | 0.9157 | 1.9658 | 0.9135 |
| CIS | 2.1325 | 0.9177 | 2.1549 | 0.9089 |
| EUROSTAT-OECD | 1.1101 | 1.0906 | 1.1249 | 1.0690 |
| LATIN AMERICA | 1.6760 | 1.1777 | 1.6927 | 1.1589 |
| IRAN | 2.5035 | 0.8444 | 2.5035 | 0.8444 |
| WEST ASIA | 1.5581 | 1.0095 | 1.6190 | 0.9760 |
| GEORGIA | 1.5237 | 1.0748 | 1.5237 | 1.0748 |
| WORLD | 1.3204 | 1.0561 | 1.4595 | 0.9014 |



Extension to GDP components



Based on the identity

$$\mathbf{M + GDP = E + I + G + X}$$

Unlike XRs, there are separate PPPs for the components.

Using generalisation of procedure proposed by Balk (2010, Appendix B).

Table 4 illustrates.



GDP components



Table 4: Components of Global GDP Inflation and Growth, 2005 to 2011

| COMPONENT | EXCHANGE RATE BASED ¹ | | | PPP BASED ² | | |
|----------------------------|----------------------------------|--------------|-----------------|------------------------|--------------|-----------------|
| | XR CHANGE | PRICE CHANGE | QUANTITY CHANGE | PPP CHANGE | PRICE CHANGE | QUANTITY CHANGE |
| TOTAL | 1.0561 | | | 0.8966 | | |
| PRIVATE CONSUMPTION (E) | | 1.1121 | 1.1381 | 0.9536 | 1.1337 | 1.1764 |
| INVESTMENT (I) | | 1.0630 | 1.0535 | 1.0124 | 1.0726 | 1.0727 |
| GOVERNMENT CONSUMPTION (G) | | 1.0566 | 1.0391 | 0.9276 | 1.1124 | 1.0751 |
| EXPORTS (X) | | 1.0506 | 1.0664 | 1.0133 | 1.0352 | 1.0461 |
| IMPORTS (M) | | 1.0467 | 1.0665 | 1.0121 | 1.0325 | 1.0463 |

$$\frac{NGDP^{2011}}{NGDP^{2005}} = \frac{RGDP^{*2011}}{RGDP^{*2005}} = 1.6495$$

¹Antilogs of terms of equation (47). ²Antilogs of terms of equation (52).



**The paper is available as
Discussion Paper No. 552
School of Economics
The University of
Queensland**