Towards the compilation of PPPs and real expenditures on an annual basis

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Objectives

- **Our focus here is on the tasks listed for TF on Building PPP Time Series for the Interim Period**
  - **Provide an analytical framework for extrapolation of series using CPI or National Accounts Deflators**
  - **Check the availability and quality of national accounts deflators, consumer price indices (CPIs) and other price indices by GDP component**
  - **Examine consistency of CPI weights and national account weights, and assess the weights' effects on PPPs**
  - **Present extrapolation results from 2011 to 2014**
    - **Assess results of extrapolation at GDP level and at disaggregated level against benchmark results for selected regions**
  - **Moving forward?**

Annual Compilation of PPPs - strategies

Possible approaches to the problem:

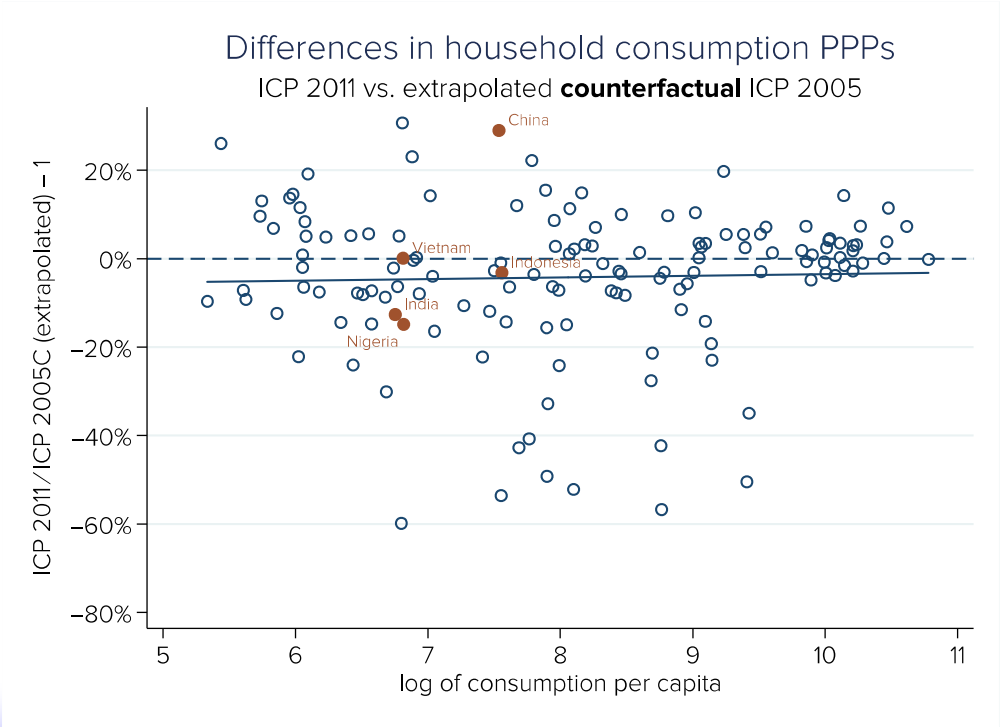
- **Annual full ICP benchmark**
  - **Too expensive and infeasible**
- **Extrapolation at the aggregate level**

$$PPP_j^{t+1} = PPP_j^t \times \frac{GDPDef_j^{t,t+1}}{GDPDef_R^{t,t+1}}$$

  - **Past experience shows serious discrepancies between benchmarks and extrapolations at the aggregate level**
- **Extrapolation at disaggregated level**
- **Rolling price survey approach – ultimate goal?**

Extrapolation at aggregate level

- ICP surprises: $\Delta\, log\, PPP_{ij} \neq \Delta\, log\, P_i - \Delta\, log\, P_j$
  - ICP 1993 to ICP 2005, ICP 2005 to ICP 2011
- Methodological changes matter (Deaton & Aten, 2016; Inklaar and Rao, 2016)
  - No remaining systematic bias between 2005 & 2011
- But root mean squared difference of 15 percent is worrisome



Extrapolation at disaggregated level

- If not global extrapolation, how detailed should extrapolation be?
  - Need an analytical framework
- Asymmetric data availability
  - Data available for PPP computation (deflators and national accounts weights) differ significantly across different regions and countries within regions
  - The level of disaggregation of CPI and other deflators differ across countries
- Global linking issues
  - Extrapolation of BH level PPPs for global linking
  - Global linking procedures

Level of disaggregation – analytical framework

- For purposes of exposition, we consider the case of two countries and two time periods
- To be consistent with Deaton (2012) we assume that PPPs and CPIs are all computed using the Tornqvist index
- The formulae are then given by:

$$\ln PPP_2^s = \frac{1}{2}\sum_{i=1}^{N}(s_{i1} + s_{i2})(\ln p_{i2}^s - \ln p_{i1}^s)$$

$$\ln P_2 = \sum_{i=1}^{N} s_{i2}\left(\ln p_{i2}^{t+1} - \ln p_{i2}^{t}\right)$$

$$\ln P_1 = \sum_{i=1}^{N} s_{i1}\left(\ln p_{i1}^{t+1} - \ln p_{i1}^{t}\right)$$

Level of disaggregation – analytical framework (continued)

- **Extrapolation bias is given by:**

$$\ln PPP_2^{t+1} - \ln PPP_2^t = \ln P_2 - \ln P_1 - \frac{1}{2}\sum_{i=1}^{N}(s_{i2} - s_{i1})\left[\ln\left(\frac{p_{i2}^{t+1}}{p_{i2}^{t}}\right) + \ln\left(\frac{p_{i1}^{t+1}}{p_{i1}^{t}}\right)\right]$$

- **No bias if expenditure shares are identical**
- **Direction of bias depends on the covariance between expenditure shares and relative price movements (Deaton, 2012)**
- **No bias if relative price movements are identical**

Level of disaggregation – analytical framework (continued)

- No bias if expenditure shares are identical if relative price movements are similar over the two periods.

- Suppose prices of all products (e.g. within a commodity group) change by rate α in country 1 and rate β in country 2, then

$$\ln PPP_2^{t+1} - \ln PPP_2^t - (\ln P_2 - \ln P_1)$$
$$= -\frac{1}{2}\sum_{i=1}^{N}(s_{i2} - s_{i1})[\alpha + \beta]$$
$$= -\frac{1}{2}(\alpha + \beta)\sum_{i=1}^{N}(s_{i2} - s_{i1}) = 0$$

The last step follows since expenditure shares add to one in each year.

Level of disaggregation – analytical framework

- **The result suggests that if we use deflators for extrapolation then it is desirable if it is done at a level of disaggregation when price movements within the group tend to be similar – *in ICP this could refer to basic heading***
  - **This result gives sufficient condition but not necessary condition**
- **We have been able to show that this result hold even if we consider Fisher index formula or any other formula that satisfies proportionality axiom in current and reference country prices**
- **Note that this result pre-supposes:**
  - **Deflators and weights are accurate**
  - **Deflators correspond to the item group consisting of the same products**

Extrapolation of PPPs

Aims:

- **Estimate global PPPs for 2012-2014**
- **Use the approach to back-cast PPPs to 2005**
- **Assess the performance of extrapolations at detailed level and at the GDP level against comparisons based on full data**
- **Interim updating, including basic data quality assessment**
- **Framework for integrating asymmetric data**

Approach:

- **Make use of all the data available for this purpose**
- **Use differential levels of data available from different countries**

Extrapolating PPPs - continued

Data for the Study: We make use of data for all the regions provided by the ICP Global Office and Eurostat

1. Extrapolation database
   - CPIs, NA Deflators, NA expenditures, population and exchange rates for years 2005-16

2. Alternative data for CPI and DEF
   - Alternative datasets at varying degree of augmentation and validation

3. Western Asia 2012-2013 data
   - GCL average prices, Aggregate level and Basic Heading PPP and EXP, for 2012-13

4. ICP 2011 Data for Researchers

5. ICP 2005 Data for Researchers

Scope of the data

- **Country coverage: 172 countries**
  - **All GDP-level countries from ICP 2011, except Cuba and 5 Caribbean countries***
- **Expenditure detail: 151 basic headings**
  - **All basic headings,** except balancing items**
- **Extrapolation:**
  - **135 countries with CPIs for multiple COICOP categories**
  - **139 countries with NA deflators by expenditure category**
  - **172 countries with either total CPI or GDP deflator**

* Curaçao, Montserat, Sint Maarten, Turks and Caicos Islands and the British Virgin Islands
** Including some further estimations based on ICP 2011 data

Quality of deflator data

- **We examine the difference:**
  - **between National Accounts deflator and aggregate built up from detailed information on NA deflators for major expenditure categories**
  - **between CPI and aggregate built up from CPI inflation rates by COICOP category**
- **We use Tornqvist index to compute overall inflation rates**

$$\ln P_{t,t+1} = \frac{1}{2}\sum_{i=1}^{N}(s_{it} + s_{it+1})\left(\ln p_{i2}^{t+1} - \ln p_{i2}^{t}\right)$$

Difference between actual and counterfactual in 2012 and 2013 (%)

CPI

	2012	2013
10TH PERCENTILE	-0.75	-0.61
25TH PERCENTILE	-0.37	-0.25
MEDIAN	0.00	-0.00
MEAN	-0.12	0.05
75TH PERCENTILE	0.20	0.23
90TH PERCENTILE	0.55	0.61

GDP Deflator

	2012	2013
10TH PERCENTILE	-3.33	-1.89
25TH PERCENTILE	-0.71	-0.61
MEDIAN	0.38	0.08
MEAN	0.28	0.47
75TH PERCENTILE	1.30	1.34
90TH PERCENTILE	2.33	3.01

Negative numbers means that counterfactual inflation is lower than the actual reported inflation

Implementing our extrapolation approach

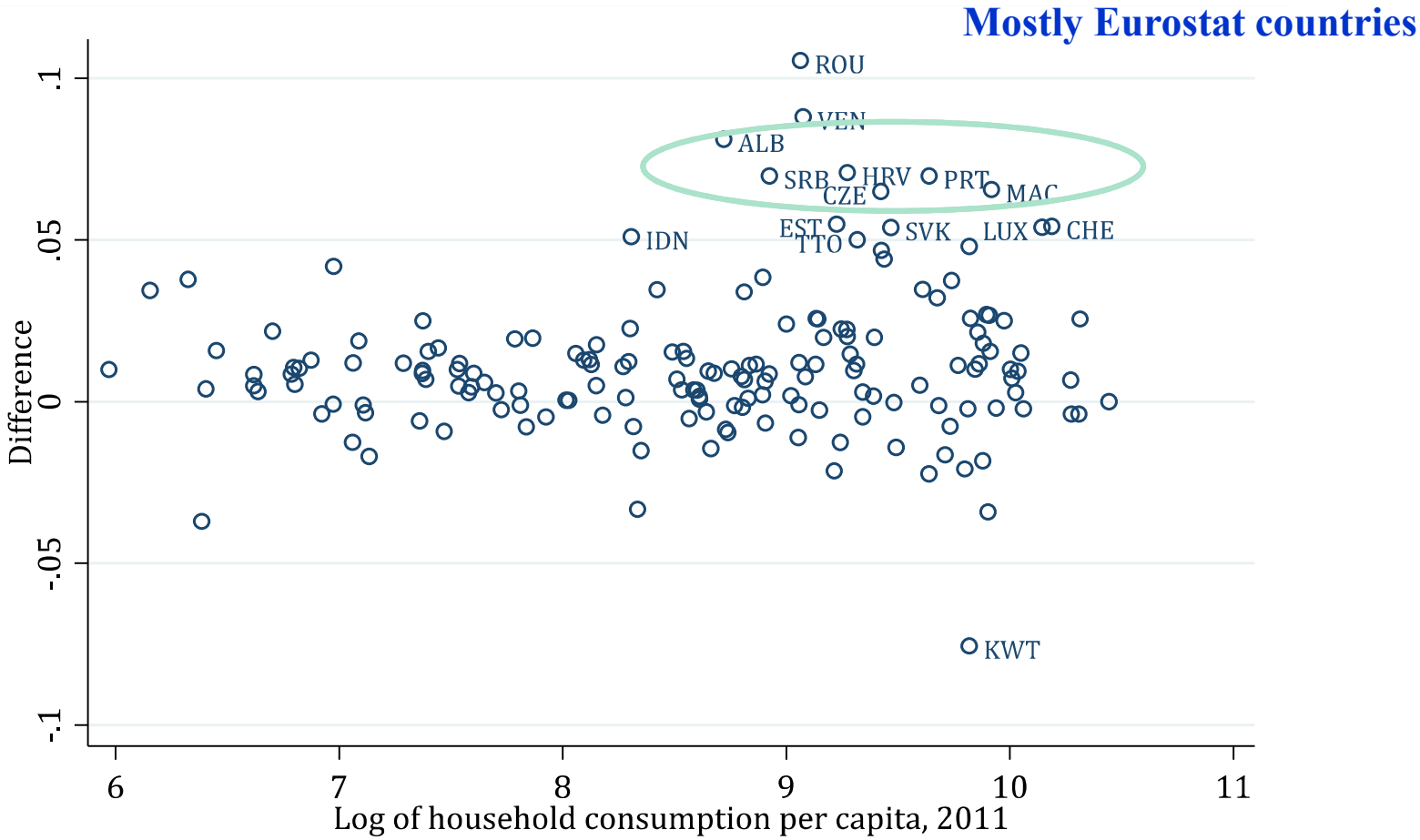
- **Extrapolate linked BH PPPs using most detailed inflation rate relative to US. This procedure is equivalent to:**
  - **Extrapolating the within-region BH PPPs using the inflation rate of each country relative to the regional base country;**
  - **Extrapolating the items prices of the global core list (GCL) using the inflation rate of the corresponding BH; and**
  - **Deriving new B linking factors based on weighted CPD models**
  - **This holds since all items within a BH are extrapolated using same inflation rate**
- **Insert regional PPPs for Western Asia and Eurostat using extrapolated linking factors**
- **Implement CAR method and treat special countries**

Alternative sets of updates

We consider three sets for purposes of comparison:

- **Full-updated ICP**
  - **BH Level extrapolation; new regional data; linking across regions**
- **Global extrapolation**
  - **Use aggregate relative inflation to extrapolate aggregate PPPs (e.g., CPI for household consumption and NA deflator for GDP)**
- **Partial updated ICP**
  - **Like full-update but omit new regional data**

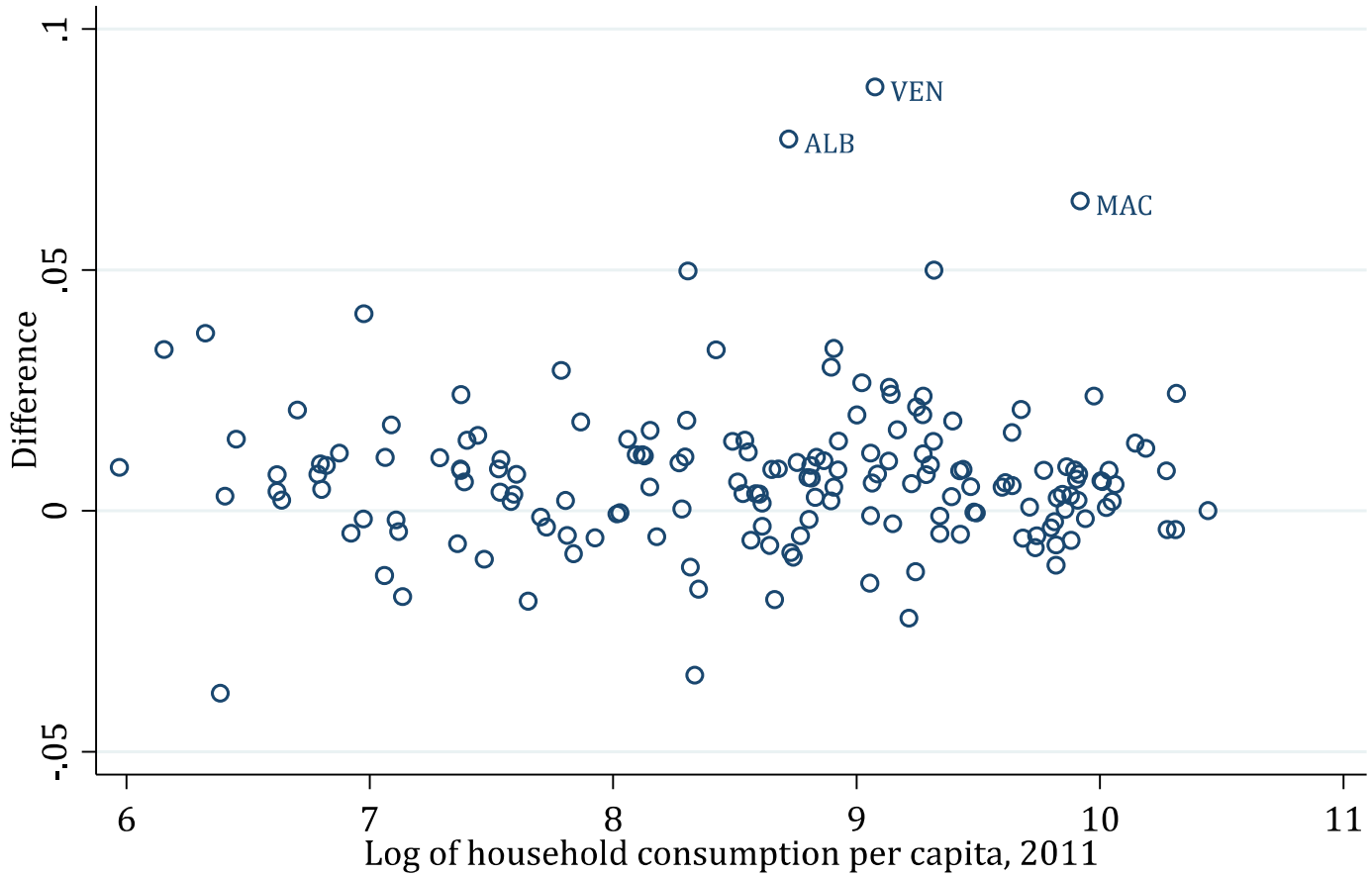
Difference between global extrapolation and detailed updating of PPPs: Household Final consumption Expenditure, 2013



Notes: Global extrapolation uses the change in CPI (or household consumption deflator) relative to the US to estimate PPPs for subsequent years. Detailed extrapolation uses the CPIs at the most detailed level to extrapolate basic-heading level PPPs, reflects changing basic heading expenditure levels, and links regions above basic heading level according to the ICP 2011 methodology. This also includes benchmark PPPs from Eurostat and the more detailed extrapolation for Western Asia.

Difference between global extrapolation and detailed updating of PPPs: Household Final consumption Expenditure, 2013

Excluding new data from Eurostat and CIS



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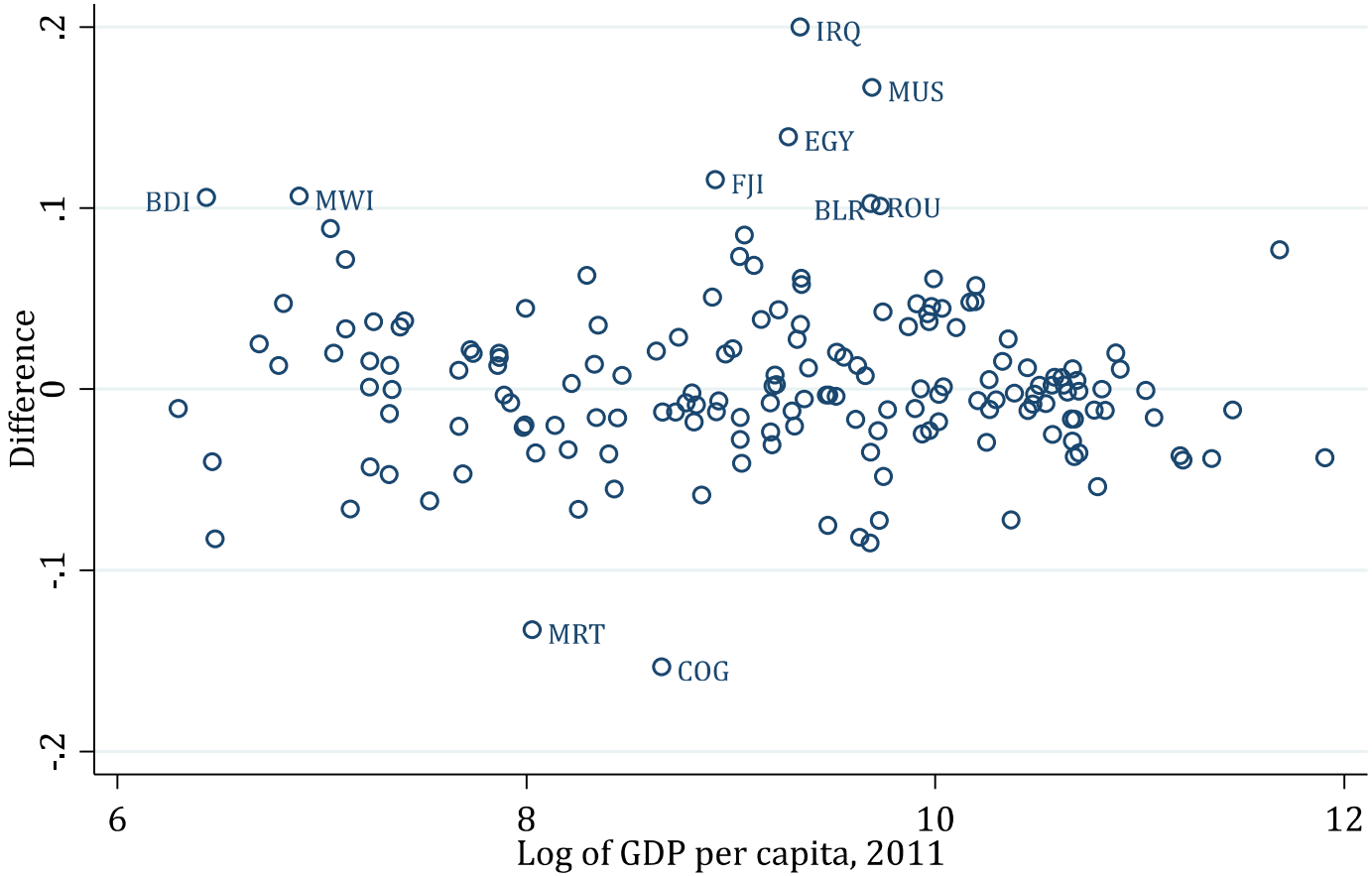
Difference between global extrapolation and detailed updating of PPPs: GDP, 2013



Notes: Global extrapolation uses the change in GDP deflator (or CPI) relative to the US to estimate PPPs for subsequent years. Detailed extrapolation uses the CPIs at the most detailed level to extrapolate basic-heading level PPPs, reflects changing basic heading expenditure levels, and links regions above basic heading level according to the ICP 2011 methodology. This also includes the benchmark PPP from Eurostat and the more detailed extrapolation for Western Asia.

HHC: Summary

	Full update	Partial update
Average difference	0.012	0.007
Root mean squared difference	0.026	0.017
Coefficient on log(expenditure/capita)	0.003	0.000
	0.002	0.001

* Partial update omits new regional data for Eurostat & Western Asia

- No systematic difference between global and detailed updates
- RMSD is small (compared to ICP 2005 vs. ICP 2011)
- Partial update has smaller differences

GDP: Summary

	Full update	Partial update
Average difference	0.004	0.001
Root mean squared difference	0.047	0.043
Coefficient on log(expenditure/capita)	-0.002	-0.003
	0.003	0.003

* Partial update omits new regional data for Eurostat & Western Asia

- No systematic difference between global and detailed updates
- RMSD is small (compared to ICP 2005 vs. ICP 2011)
- Partial update has smaller differences

Differences between Benchmarks and Extrapolations – EUO and CIS, 2014

Column1	T_EUO_det_gdp	T_EUO_glb_gdp	T_EUO_det_hh	T_EUO_glb_hh
Mean difference	**0.015**	**-0.001**	**0.044**	**0.036**
	0.010	**0.010**	**0.013**	**0.011**
Root mean squared difference	**0.072**	**0.067**	**0.097**	**0.083**
Coefficient on log(expenditure/capita)	-0.007	0.002	-0.018	-0.007
	0.008	**0.008**	**0.022**	**0.021**

	T_CIS_det_gdp	T_CIS_glb_gdp	T_CIS_det_hh	T_CIS_glb_hh
Mean difference	**-0.109**	**-0.131**	**0.044**	**0.007**
	0.035	**0.028**	**0.028**	**0.023**
Root mean squared difference	**0.146**	**0.153**	**0.090**	**0.066**
Coefficient on log(expenditure/capita)	-0.017	-0.011	0.044	0.042
	0.045	**0.034**	**0.055**	**0.042**

Differences between Extrapolations from 2011 to 2005 with 2005 and 2005C ICP

	Ticp_det_gdp	Ticp_glb_gdp	Ticp_det_hh	Ticp_glb_hh
Mean difference	-0.141	-0.211	-0.259	-0.317
	0.019	0.019	0.018	0.018
Root mean squared difference	0.269	0.310	0.336	0.385
Coefficient on log(expenditure/capita)	0.017	0.031	0.059	0.080
	0.008	0.008	0.015	0.015

	Tir_det_gdp	Tir_glb_gdp	Tir_det_hh	Tir_glb_hh
Mean difference	-0.061	-0.137	-0.117	-0.189
	0.020	0.020	0.019	0.019
Root mean squared difference	0.248	0.275	0.258	0.298
Coefficient on log(expenditure/capita)	0.003	0.019	0.003	0.032
	0.009	0.009	0.017	0.017

Conclusions

- Demonstrated feasibility of the extrapolation approach
- Possible to utilize data of differential levels of availability and reliability
- Results clearly show, with a few exceptions, that extrapolation based on detailed deflators is superior (closer to the benchmark) than using global deflators
  - Eurostat-OECD countries and CIS for 2014
  - All ICP countries for 2005 – extrapolations are closer to the counterfactual in Inklaar and Rao (2016) than the actual benchmark
  - Bigger differences for global extrapolation – treatment of export and import prices; government health and education
- Quality of basic CPI Data and National Accounts deflators is critical for extrapolations

Thank you!