



Consistency and Extrapolation of ICP Benchmarks: The Case of Asia¹

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Abstract

The International Comparison Program (ICP) is an international statistical program designed to provide globally comparable economic aggregates and purchasing power parities (PPPs) of currencies. However, with comparisons being carried out every 6 to 12 years, there is a need for extrapolation of the results between the benchmarks. This paper investigates possibility of using detailed consumer prices index (CPI) and gross domestic product (GDP) deflators' information for extrapolating main expenditure category PPPs for household consumption.

Keywords: purchasing power parities; consumer price index; PPP extrapolation; GDP deflators

1. Introduction

The 2005 and 2011 ICP rounds have a similar framework for international comparisons including the specification of products to be priced in the participating countries and with the same target of finding a representative national average price for each product priced. Further, specifications of a large number of items included in Household Consumption are identical across the 2005 and 2011 rounds. The basic principle of representativity of the items priced while maintaining comparability of the products is also strictly adhered to in these two rounds.

Given the consistency in the approach followed in these two rounds in Asia, it has become possible to obtain measures of price movements over the period 2005 to 2011 for each of the participating countries. For the same period, observed price movements in the form of CPI (for Household Consumption) are available from the publications of the national statistical offices (NSOs) for broadly defined commodity groups (12 Classification of Individual Consumption by Household [COICOP] categories). As a result for each commodity group, two independent measures of price change over the period 2005 to 2011 have become available. The movements in prices of goods and services in household consumption are strongly interrelated reflecting the macroeconomic fundamentals prevailing in the countries under consideration. Hence, the expectation is that the 2005 and 2011 ICP based and the CPI based measures of price changes would be broadly aligned except for random (non-systematic) measurement errors and noise. Putting it another way, if CPIs are consistent with the ICP based inflation, it would allow us to extrapolate PPPs between the benchmarks, based on the CPI movements. The same principle applies in the case of using GDP deflators as inflation measures.

2. Sources and Methods

In this study we concentrate on the Household Consumption Expenditure categories from the 2005 and 2011 Asian comparisons for eight countries, selected based on availability of CPI detail. We start with detailed ICP information from the ICP rounds. As these two Asian comparisons had item lists that were overlapping to a great extent, the first step was to create a consistent set of prices for all 22 common countries spanning 2005 and 2011. If necessary, prices for the products with minor changes to specifications were adjusted to conform to the same description. If specifications changed significantly, the respective products were split into two. Thus, the two comparison were linked at the item as well as

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basic heading levels. The linked basic heading PPPs were produced using the CPD [Country-Product Dummy] index, ran over the joint 2005-2011 period.

The regression equation for the CPD can be written as:

$$\ln p_{cp} = y_{cp} = x_{cp}\beta + \varepsilon_{cp} \quad (1)$$

where p_{cp} is the price of product p in country c ;

Dc_j and Dp_i are country and product dummies, respectively;

Np and Nc are number of products and countries, respectively;

$$\text{and } x_{cp} = [Dc_2 \dots Dc_{Nc} Dp_1 Dp_2 \dots Dp_{Np}]$$

$$\beta = [\alpha_2 \dots \alpha_{Nc} \gamma_1 \gamma_2 \dots \gamma_{Np}]^T$$

Once the basic heading PPPs are estimated, reference PPPs are computed based on the standard methodology, as described in Asian Development Bank (2014), p.266.

The aggregation was done using the regular EKS of Fisher procedure:

$$EKS(F)_{j,k} = \left(\prod_{l=1}^m \frac{F_{j,l}}{F_{k,l}} \right)^{\frac{1}{m}} \quad (2)$$

where $F_{j,k}$ - Fisher index for country j and country k
 m - number of all countries

Using the joint 2005-2011 comparison for 22 countries it is possible to produce estimates of *internationally comparable inflation* that are time-space consistent. That would mean that the two spatial comparisons [2005 and 2011] could be made consistent in time and space.

After estimating basic heading PPPs, the next step was to produce an aggregation using only the 12 COICOP categories: the maximum practical number of categories reported by countries for their CPIs. The CPI information is usually available for a limited number of categories, and it was necessary to show that the level of aggregation produces relatively accurate estimates of indices when compared to a full aggregation with the maximum detail (108 basic headings for Household Consumption).

Estimating ICP-CPI inconsistencies, cleaned from index number differences

Comparing CPIs to changes in PPPs over time involves many factors other than price differentials. Most importantly, CPIs are mostly [but not always] estimated using Laspeyres indices, based on different years. At the same time, the ICP in Asia uses the EKS (Fisher) index. The biggest difference is, of course, is the fact that PPPs are spatial indices and CPIs are temporal ones. Thus, the goal is to bridge the two benchmarks (2005 and 2011) using the 12 COICOP category CPI components. Those CPI components will be applied to the corresponding PPP categories, in order to predict the next (or the previous) benchmark.

3. Feasibility of the Analysis and Some Results

To determine the feasibility of the analysis, it is important to establish that indices obtained by aggregating the 12 COICOP categories are close approximations for the full ICP 108 category aggregation. We note that the Laspeyres index is hierarchical allowing computation of the higher level index using lower level aggregations and thus, CPI can be fully restored from components given enough detail. For Fisher or Törnqvist indices which are non-hierarchical, such is not the case.

Using the CPI data from eight Asian economies, we first compare COICOP-12 8-country aggregation to the full ICP-108 BH 22-country aggregation. As it turns out, using COICOP-12 8-country aggregation provides reasonably good approximation of the full comparison: the standard errors are about 1% (standard errors are estimated versus geometric means, in order to eliminate the effect of base country). It is interesting, that using EKS of Törnqvist² indices approximates the full comparison better than EKS of Fisher indices in both years. We will see that this is true of some other computations as well.

Table 1. CONSISTENCY OF PPPS ESTIMATED AT DIFFERENT LEVELS OF AGGREGATION

	BAN	HKG	IND	MAL	PHI	SIN	SRI	THA	SD
PPPs: single-year estimation (HKG = 1)									
2005									
ICP, 22 countries 108 BHs, EKS (Fisher)	3.387	1.000	2.072	0.276	3.277	0.188	5.100	2.404	
8 countries, COICOP12, EKS (Törnqvist)	3.481	1.000	2.143	0.278	3.298	0.188	5.236	2.427	
COICOP12-8 vs. ICP108-22 (geomean=1)	0.986	1.014	0.980	1.007	1.007	1.014	0.987	1.004	1.25%
8 countries, COICOP12, EKS (Fisher)	3.500	1.000	2.141	0.279	3.312	0.188	5.304	2.439	
COICOP12-8 vs. ICP108-22 (geomean=1)	0.985	1.018	0.985	1.007	1.007	1.015	0.979	1.004	1.40%
2011									
ICP, 22 countries 108 BHs, EKS (Fisher)	4.281	1.000	2.586	0.270	3.188	0.191	7.099	2.181	
8 countries, COICOP12, EKS (Törnqvist)	4.339	1.000	2.649	0.272	3.220	0.191	7.278	2.203	
COICOP12-8 vs. ICP108-22 (geomean=1)	0.998	1.012	0.987	1.002	1.001	1.012	0.987	1.002	0.88%
8 countries, COICOP12, EKS (Fisher)	4.345	1.000	2.654	0.272	3.219	0.190	7.317	2.202	
COICOP12-8 vs. ICP108-22 (geomean=1)	0.997	1.012	0.986	1.004	1.002	1.016	0.982	1.002	1.10%

The joint 2005-2011 aggregation produces internationally consistent inflation measures, both for components and the aggregates. However, we need to ascertain that those inflation measures are consistent with the benchmarks. For this purpose we compare the joint 2005-2011 PPPs with single-year PPP estimates, produces separately for 2005 and 2011.

Table 2. JOINT VS. SINGLE-YEAR ESTIMATION

	BAN	HKG	IND	MAL	PHI	SIN	SRI	THA	SD
ICP2005, EKS, 108 BH	3.387	1.000	2.072	0.276	3.277	0.188	5.100	2.404	
ICP2005, EKS, 108 BH Joint	3.287	1.000	2.025	0.273	3.201	0.187	5.019	2.387	
ICP2011, EKS, 108 BH	4.281	1.000	2.586	0.270	3.188	0.191	7.099	2.181	
ICP2011, EKS, 108 BH Joint	4.405	1.000	2.637	0.273	3.255	0.192	7.217	2.207	
2005, Joint vs. Individual	0.985	1.015	0.992	1.003	0.991	1.009	0.999	1.007	0.96%
2011, Joint vs. Individual	1.015	0.986	1.006	0.997	1.007	0.990	1.002	0.998	0.87%

We observe here a quite high degree of consistency of the results, with SDs being within 1%, which means that the inflation measures produces by the joint aggregation are consistent with the ICP benchmarks. Therefore, contrasting implicit ICP inflation to national inflation measures is quite feasible.

Extrapolation with CPI

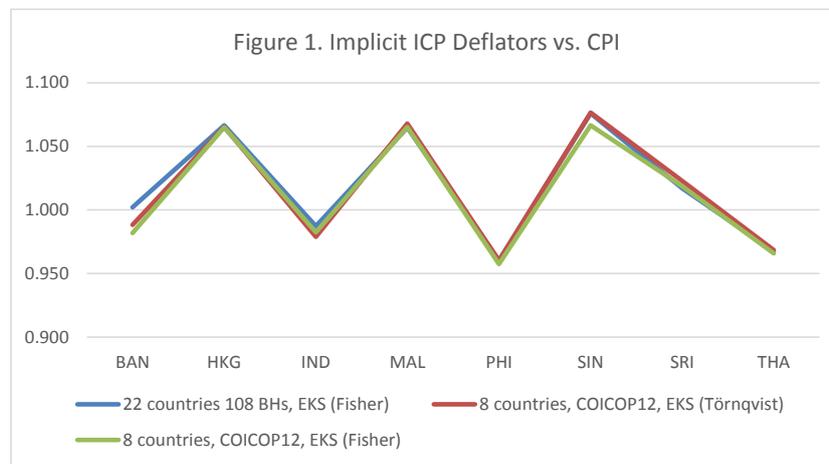
Now, one can compare implicit internationally consistent deflators from the joint 2005-2011 ICP estimates to the respective national CPIs. Table 3 and Figure 1 explicitly show two groups of countries: a higher income one [Hong Kong, China; Singapore; and Malaysia] which exhibit price levels higher than predicted with the CPI [6.7%, 7.6% and 6.5%, respectively] and lower income one [India, Thailand, Sri Lanka, Bangladesh and the Philippines] which are close to their predicted values [-1.3%, -3.2%, 1.7%, 0.2% and -4.0%, respectively]. Thus, the ICP inflation in Singapore was 28.8%, whereas its national CPI was 19.7%. In the Philippines at the same time the numbers were 27.6% and 32.9%,

² EKS of Törnqvist indices has the same formula (1) as EKS of Fisher indices, except for the Törnqvist binary indices being used instead of the Fisher binary indices.

respectively. Some of these discrepancies could be traced to weight effect and index number differences. Thus, one must be cautious in using CPI for extrapolation in such instances.

Table 3. CPI VS. IMPLICIT ICP DEFLATORS

	BAN	HKG	IND	MAL	PHI	SIN	SRI	THA	SD
CPI, official	1.678	1.176	1.655	1.177	1.329	1.197	1.774	1.199	
22 countries 108 BHs, EKS (Fisher)	1.681	1.255	1.634	1.253	1.276	1.288	1.804	1.160	
8 countries, COICOP12, EKS (Törnqvist)	1.658	1.253	1.620	1.257	1.276	1.288	1.815	1.161	
8 countries, COICOP12, EKS (Fisher)	1.648	1.253	1.626	1.253	1.272	1.276	1.807	1.158	
difference from official CPI									
22 countries 108 BHs, EKS (Fisher)	1.002	1.067	0.987	1.065	0.960	1.076	1.017	0.968	4.33%
8 countries, COICOP12, EKS (Törnqvist)	0.988	1.065	0.979	1.068	0.960	1.076	1.023	0.968	4.52%
8 countries, COICOP12, EKS (Fisher)	0.982	1.065	0.983	1.065	0.957	1.067	1.019	0.966	4.40%



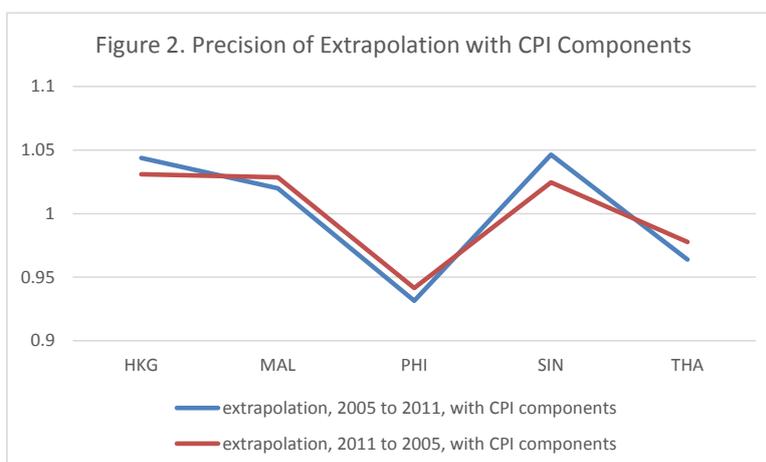
A more precise approach to extrapolate between benchmarks would be to apply detailed CPI by 12 COICOP categories both to 2005 and 2011 ICP benchmarks and compare the results to the actual benchmarks. That would eliminate both differences in index numbers between ICP and CPIs, as well as index number differences among CPIs [such as using a particular base year in computation].

Table 4. ICP-CPI CONSISTENCY: EXTRAPOLATION VS. ACTUAL BENCHMARK

extrapolation, 2011 to 2005, with CPI components	BAN	HKG	IND	MAL	PHI	SIN	SRI	THA	SD
ICP, 22 countries 108 BHs, EKS (Fisher)	3.387	1.000	2.072	0.276	3.277	0.188	5.100	2.404	
8 countries, COICOP12, EKS (Törnqvist)	3.278	1.000	2.093	0.277	2.980	0.187	5.035	2.280	
COICOP12-8 vs. ICP108-22 (geomean=1)	1.009	0.977	0.967	0.974	1.075	0.982	0.990	1.030	3.40%
8 countries, COICOP12, EKS (Fisher)	3.292	1.000	2.101	0.277	2.971	0.187	5.076	2.282	
COICOP12-8 vs. ICP108-22 (geomean=1)	1.007	0.978	0.965	0.977	1.079	0.985	0.983	1.031	3.55%
extrapolation, 2005 to 2011, with CPI components									
ICP, 22 countries 108 BHs, EKS (Fisher)	4.281	1.000	2.586	0.270	3.188	0.191	7.099	2.181	
8 countries, COICOP12, EKS (Törnqvist)	4.606	1.000	2.739	0.274	3.574	0.191	7.537	2.348	
COICOP12-8 vs. ICP108-22 (geomean=1)	0.976	1.051	0.992	1.034	0.937	1.050	0.990	0.976	3.78%
8 countries, COICOP12, EKS (Fisher)	4.646	1.000	2.751	0.275	3.595	0.191	7.626	2.364	
COICOP12-8 vs. ICP108-22 (geomean=1)	0.973	1.056	0.993	1.035	0.937	1.056	0.983	0.974	4.07%

We can see from Table 4 that the precision of the extrapolation has increased: SDs are now at 3.40% to 3.78% level when the indices are computed with the Törnqvist index, and somewhat higher with the Fisher. However, we still observe distinct clusters of countries. Thus, in extrapolating forward from 2005 to 2011, the same group of economies - Singapore; Hong Kong, China; and Malaysia – has actual

ICP benchmark prices higher than those extrapolated by 5.0%, 5.1% and 3.4%, respectively. Extrapolating backward produces similar results, except that now those countries' price levels are underestimated, and, crucially, Sri Lanka and India are underestimated as well. The results, expressed as the 2011 to 2005 inconsistencies, are plotted on Figure 2.

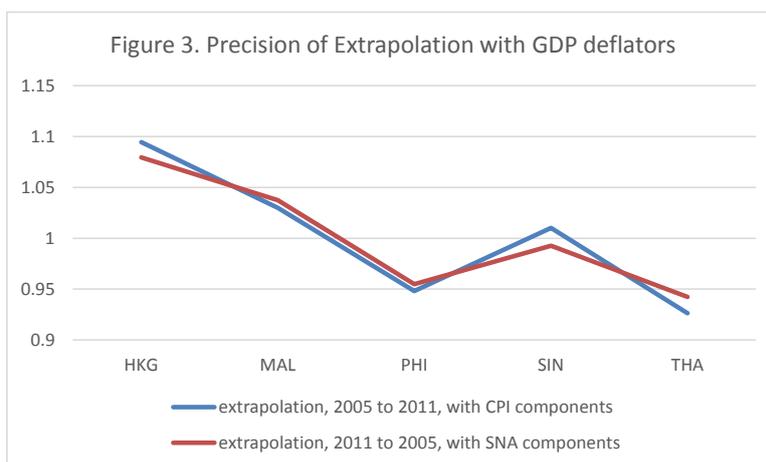


These inconsistencies are irreducible, i.e., they take into account the index number differences between CPI and ICP, as well as those among national CPIs. The remaining inconsistencies may be related to the changes in average quality of observed products, changes in scope of price collection, or other systematic biases.

Extrapolation with GDP deflators

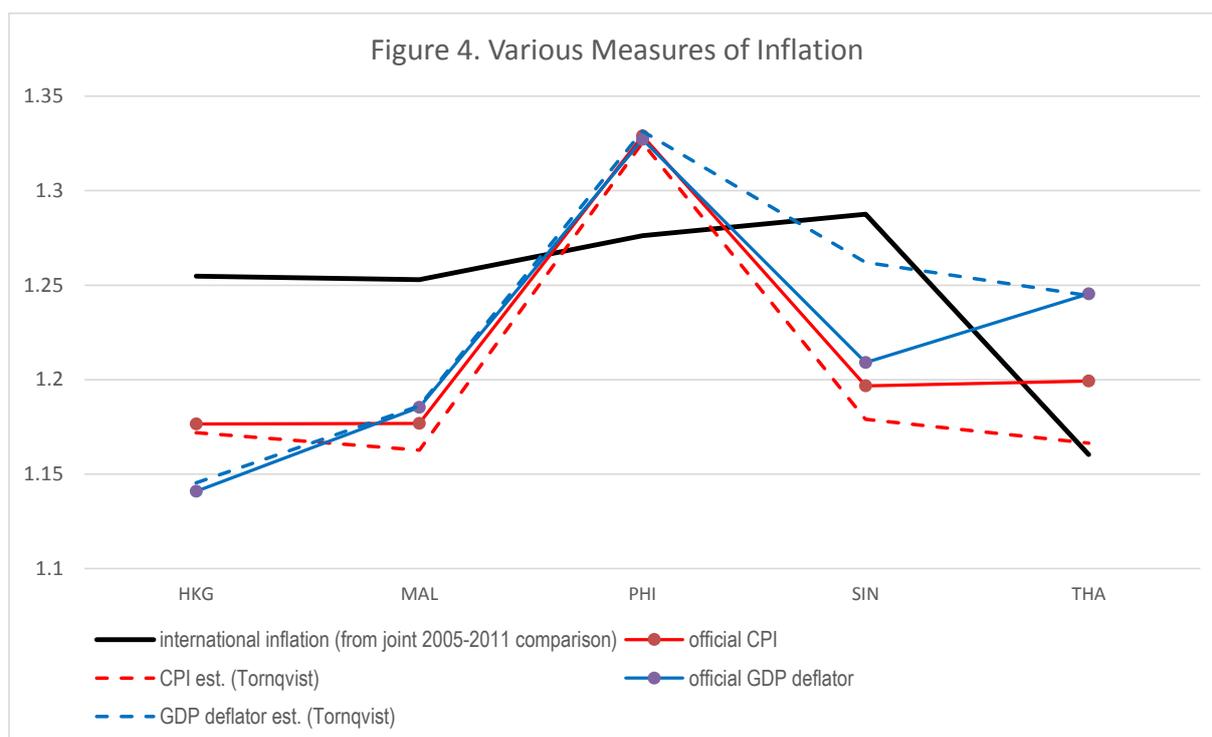
It would be much more informative to extrapolate the ICP benchmarks with proper GDP deflators: in the end, the PPPs convert the respective national accounts categories into real terms. However, it is much more difficult to obtain detailed GDP deflators. In this paper, we use the 12 COICOP category deflators for five countries – Hong Kong, China; Malaysia; Philippines; Singapore; and Thailand - to study their effect on the accuracy of extrapolation.

Overall, the results plotted on Figure 3 look similar to the previous graph that uses CPI extrapolation, with one important difference: Hong Kong extrapolations are no longer in line with Singapore and Malaysia, with price level higher than predicted by 8% to 9%. In general, using GDP component deflators did not prove to be more precise than when using CPI components: for the same group of 5 economies, SDs were 5.1%-5.9% versus 3.6%-4.7%. This counterintuitive result shows that there is a need for further investigation into the nature and methodology of the GDP deflators before they can be recommended to be used in PPP extrapolations.



Comparative Inflations: ICP, CPI and GDP Deflators

Finally, for the same five economies in the preceding section, we can contrast various measures of inflation: the internationally time-space consistent inflation from the joint 2005-2011 aggregation; the official CPI and GDP deflators; as well as CPI and GDP deflators estimated with the Törnqvist index. The comparative inflations are plotted in Figure 4.



4. Conclusions

The current study shows that it is possible to use CPIs and GDP deflators to extrapolate ICP benchmarks. The accuracy of extrapolation is 3.4 to 4.1% (with CPI components), depending on the method, and 5.1% to 5.9% (with GDP component deflators). These discrepancies are irreducible further, i.e., they are net of influences of index numbers. However, there are two distinct clusters: a higher income one [Hong Kong, China; Singapore; and Malaysia] showing price levels higher than predicted with the CPI [6.7%, 7.6% and 6.5%, respectively]; and lower income one [India, Thailand, Sri Lanka, Bangladesh and the Philippines] having price levels closes to their predicted values [-1.3%, -3.2%, 1.7%, 0.2% and -4.0%, respectively]. Further work is needed to incorporate more countries in the study. It is also noted that further investigation into the nature and methodology of the GDP deflators is needed before they can be recommended to be used in PPP extrapolations.

References:

Asian Development Bank, 2014, *Purchasing Power parities and Real Expenditures: 2011 International Comparison program in Asia and the Pacific*, Manila.