

Dikhanov, Yuri; Palanyandy, Chellam; Capilit, Eileen

Working Paper

Updating 2005 Purchasing Power Parities to 2009 in the Asia and Pacific Region: Methodology and Empirical Results

ADB Economics Working Paper Series, No. 246

Provided in Cooperation with:

Asian Development Bank (ADB), Manila

Suggested Citation: Dikhanov, Yuri; Palanyandy, Chellam; Capilit, Eileen (2011) : Updating 2005 Purchasing Power Parities to 2009 in the Asia and Pacific Region: Methodology and Empirical Results, ADB Economics Working Paper Series, No. 246, Asian Development Bank (ADB), Manila, <https://hdl.handle.net/11540/2049>

This Version is available at:

<https://hdl.handle.net/10419/109385>

Standard-Nutzungsbedingungen:

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

Terms of use:

Documents in EconStor may be saved and copied for your personal and scholarly purposes.

You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.

If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.



<http://creativecommons.org/licenses/by/3.0/igo>

ADB Economics Working Paper Series



Updating 2005 Purchasing Power Parities to 2009 in the Asia and Pacific Region: Methodology and Empirical Results

Yuri Dikhanov, Chellam Palanyandy, and Eileen Capilit
No. 246 | January 2011



ADB Economics Working Paper Series No. 246

Updating 2005 Purchasing Power Parities to 2009 in the Asia and Pacific Region: Methodology and Empirical Results

Yuri Dikhanov, Chellam Palanyandy, and Eileen Capilit

January 2011

Yuri Dikhanov is Senior Economist at the World Bank; Chellam Palanyandy is Lead Professional, and Eileen Capilit is Economics and Statistics Analyst at the Development Indicators and Policy Research Division, Economics and Research Department, Asian Development Bank. The authors thank Prasada Rao, Alan Heston, Paul McCarthy, Virginia Ganac, and Douglas Brooks for their valuable comments. The paper also benefited from the discussions with the 2005 ICP National Implementing Agencies of India, Indonesia, Malaysia, the Philippines, and Thailand during country visits in 2008. This paper represents the views of the authors. The authors accept responsibility for any errors in the paper.

Asian Development Bank

Asian Development Bank
6 ADB Avenue, Mandaluyong City
1550 Metro Manila, Philippines
www.adb.org/economics

©2011 by Asian Development Bank
January 2011
ISSN 1655-5252
Publication Stock No. WPS113108

The views expressed in this paper
are those of the author(s) and do not
necessarily reflect the views or policies
of the Asian Development Bank.

The ADB Economics Working Paper Series is a forum for stimulating discussion and eliciting feedback on ongoing and recently completed research and policy studies undertaken by the Asian Development Bank (ADB) staff, consultants, or resource persons. The series deals with key economic and development problems, particularly those facing the Asia and Pacific region; as well as conceptual, analytical, or methodological issues relating to project/program economic analysis, and statistical data and measurement. The series aims to enhance the knowledge on Asia's development and policy challenges; strengthen analytical rigor and quality of ADB's country partnership strategies, and its subregional and country operations; and improve the quality and availability of statistical data and development indicators for monitoring development effectiveness.

The ADB Economics Working Paper Series is a quick-disseminating, informal publication whose titles could subsequently be revised for publication as articles in professional journals or chapters in books. The series is maintained by the Economics and Research Department.

Contents

Abstract	v
I. Background	1
II. Major Objectives	2
III. Benchmark versus Extrapolated PPPs	3
IV. Scope and Coverage of Price Survey	6
A. Periodicity and Geographic Coverage	7
B. Item Coverage	7
V. Methodology for the 2009 PPP Updates	9
A. Building the Core Product Lists	9
B. Adjusting from the Core to the Full List	19
C. Adjusting Capital City Prices to National Average Prices	22
D. Calculating PPP for Construction	25
E. Aggregation Methods	27
VI. Limitations and Possible Constraints	33
VII. Conclusions	34
References	35

Abstract

Purchasing power parities (PPPs) estimated on an annual basis are used in many analyses and are highly demanded by researchers in various fields, ranging from poverty and comparative living standards, to competitiveness and military expenditures. However, the regular PPP exercises are conducted every 5–6 years, or even less frequently (12 years passed between the 1993 and 2005 exercises). The financial and human resources that go into a benchmark PPPs exercise are very significant. Hence, PPPs for nonbenchmark years are usually extrapolated using national accounts' deflators. This simplistic updating, however, results in outcomes that are not consistent with benchmark estimates, with the inconsistencies increasing as the year of extrapolation moves further away from the benchmark.

This paper discusses alternative methods and approaches for estimating PPPs for nonbenchmark years in the Asia and Pacific region. Collectively called 2009 PPP Update, the methods and approaches constitute an extension of the 2005 PPP benchmark for the Asia and Pacific region, with additional data collected in 2009 and some interproduct and intracountry price correlations made against the 2005 exercise.

The 2009 PPP Update concentrates on a core list of items for household consumption, and investment on machinery and equipment. The methodology to create a statistically efficient and reduced product list for the 2009 PPP Update is discussed. In most economies, prices are being collected in capital cities only and adjusted to the national levels using price data from consumer price indices (CPI) or other information. For gross fixed capital formation in construction, the paper suggests a simplified regression method. For government consumption, the same methodology as in the 2005 ICP was adopted.

I. Background

The International Comparison Program (ICP) is designed to compare the levels of economic activity across countries by converting values into a common currency and at a common price level. National accounts aggregates, including gross domestic product (GDP), which is the broadest measure available of economic activity within a country, are converted into a single currency using purchasing power parities (PPPs). The advantage of converting values in national currencies into a common currency using PPPs is that it overcomes the shortcomings inherent in using market exchange rates for this process. Market exchange rates take no account of differences in price levels between countries and so tend to underestimate the levels of economic activity in poorer countries. PPP-based conversions provide estimates of GDP that are directly comparable across countries.

In the 2005 round of the ICP, benchmark PPPs were estimated allowing comparison of activity levels for 146 countries around the world. The Asian Development Bank coordinated the 2005 ICP activities for 23 economies in the Asia and Pacific region. Preliminary work has commenced for the 2011 ICP round, which will provide another benchmark for international comparisons, with about 180 countries participating.

A major use of PPP data around the world is to assist in analyzing the incidence of poverty and to assess whether policies designed to alleviate poverty are achieving their aims. Poverty analysis is connected with the United Nations' Millennium Development Goals (MDGs). The first of the MDGs is to halve absolute poverty in the world between 1990 and 2015. PPPs play a crucial role in assessing the extent to which progress is being made toward meeting this goal. Having reliable PPPs to update the international poverty lines for economies worldwide would be an important step in evaluating progress toward such goals. PPPs are also used for other purposes such as in analysis of an economy's comparative advantage on prices and expenditures of goods or services; evaluation of investment costs and industry growth potential across countries; assessment of per capita expenditures in education and health, etc. Hence, considerable demand exists for PPPs and real GDP aggregates to be available on an annual basis.

The most common method currently being adopted is the extrapolation of annual PPPs using time series national accounts data, generally the changes in the ratio of the GDP deflator for each country to the GDP deflator for the numeraire country, e.g., the United States (US). This extrapolation method is simple, straightforward, and practical but usually results in a sizable amount of underestimation or overestimation when compared to actual

benchmark estimates. The magnitude of inconsistency becomes bigger when more than a couple of years are extrapolated. The main reasons for this inconsistency are (i) national GDP deflators' expenditure structures that do not reflect comparable baskets of goods and services among the countries, (ii) inconsistencies in index numbers used, and (iii) some quite restrictive assumptions that underlie the extrapolation process.

Given the constraints and limitations of the current extrapolation methodology, this paper attempts to update the benchmark PPPs from the 2005 ICP for the Asia and Pacific region to 2009 (hence, the term "2009 PPP Update") using the 2005 ICP results but with a smaller set of prices than was used in the 2005 round. More specifically, the study collects a subset of the full 2005 ICP product list prices, and only from the capital city, adjusting these to the national level.¹ The 2009 PPP Update is intended to provide a compromise between the statistical problems associated with extrapolating PPPs from a benchmark and the costs of conducting a full benchmark collection.² The practicalities of doing so are explored in this paper using the 2005 ICP data of 21 economies that include Bangladesh; Bhutan; Brunei Darussalam; Cambodia; the People's Republic of China (PRC); the Fiji Islands; Hong Kong, China; India; Indonesia; the Lao People's Democratic Republic; Malaysia; the Maldives; Mongolia; Nepal; Pakistan; the Philippines; Singapore; Sri Lanka; Taipei, China; Thailand; and Viet Nam.

II. Major Objectives

Compared with the full ICP round, the 2009 PPP Update is a relatively small-scale exercise. It covers around 279 products, or approximately 40% of the original list for household final consumption items in the 2005 ICP Asia-Pacific. Further, individual economies would need to collect prices for only a subset of the products and only in the capital cities in most cases, with some extra major cities being included in some large economies. This is unlike the full ICP rounds when price collections were carried out in the entire economy. The aim is for the 2009 PPP Update to be much less resource-intensive than a regular ICP benchmark exercise. Given the complexities involved in undertaking this exercise for all components of GDP, the main focus will be on collecting price data for the household consumption and government consumption aggregates and the construction and machinery and equipment components of gross fixed capital formation. As was the case in the 2005 ICP Asia-Pacific, the PPPs for a number of household basic headings as well as for inventories, acquisition of valuables, exports, and imports of goods and services will be based on reference PPPs.

¹ The following references were used throughout this study: ADB (2007), Capilit (2009), and Dikhanov (2009).

² The alternative ways to improve the operational aspects of ICP price collection on which to base future ICP data operations are presented in Ward et al. (2008).

The focus of this paper is on methodologies used to update the 2005 PPPs for the Asia and Pacific region to 2009. More specifically the paper addresses the following:

- (i) Identify a core list of household consumption products (core product list) from the 2005 ICP Asia-Pacific product list for pricing in 2009 and to be used in the 2009 PPP computation.
- (ii) Establish scaling factors to adjust PPPs generated from the 2009 PPP Update core product list to the 2005 PPPs from the 2005 ICP Asia-Pacific product list.
- (iii) Build scaling factors for adjusting capital city prices to national average prices using either CPI information from the national sources and/or information from the price data collected for the 2005 ICP Asia-Pacific.
- (iv) Minimize frequency of price collections for household shop items to once every quarter.
- (v) Increase CPI–ICP harmonization by attempting to integrate the core product list into the regular national price collection activities to the extent possible in order to facilitate price collection for the 2009 PPP Update as well as in the upcoming 2011 ICP round.
- (vi) Establish a framework for using CPI information for estimating subnational or intracountry price level PPPs for subregions within an economy.

Another important aspect of the 2009 PPP Update methodology is to test the extent to which the process could prove to be a viable method in the future to meet users' requirements for up-to-date and more frequent PPP data, rather than having to wait for the next set of ICP benchmarks to become available. If the 2009 PPP Update procedures being tested prove to be successful, they could provide a useful means of updating ICP benchmarks at a relatively low cost compared with a full ICP round.

III. Benchmark versus Extrapolated PPPs

A global ICP round such as the 2005 ICP is a costly and time-consuming exercise, hence a full ICP round is conducted infrequently. The 6-year gap between the 2005 and 2011 ICP rounds is filled, in the short term at least, by extrapolating PPPs from 2005 using data from economies' time series national accounts. However, it is important to note that the PPPs obtained by extrapolating from a benchmark using time series data will almost certainly differ from those calculated in a full ICP round. Both conceptual and

practical problems contribute to these differences. Dalgaard et al. (2002) showed that it is conceptually impossible to match PPPs extrapolated using time series national accounts with PPPs from a benchmark ICP. They concluded that "... it is not reasonable to say that PPP benchmarks and national price and volume data are 'inconsistent' when they fail to satisfy simultaneous transitivity across space and time" (Dalgaard et al. 2002, 4). Ideally, to minimize any such differences, PPPs would be extrapolated from 2005 using detailed price data at the level of the 155 basic headings. However, as economies do not have consistent time series price indices at this very detailed level, extrapolation for nonbenchmark or in-between ICP benchmark years is generally based on the deflator for GDP only. At best, it would be based on using deflators for a handful of major components of GDP. The process involves the calculation of the change in the ratio between the GDP deflator for each economy with that of the numeraire economy (say, Hong Kong, China or the US) for each year with 2005 being the benchmark year. The percentage change in the ratio of a country's GDP deflator to Hong Kong, China's GDP deflator for each year is used to extrapolate the benchmark 2005 PPPs for each economy (it can also be used for back casting to calculate PPPs for years prior to 2005). The PPPs estimated for each year using this procedure are divided into the corresponding year's value of GDP for each economy to produce a PPP-based GDP volume (or "real expenditure").

While this method will generally provide useful indicators of what the benchmark PPPs would be had they been calculated for each year from 2005, the PPPs estimated using this process will differ from those obtained from a benchmark ICP. In practice, the accumulated inconsistencies between ICP benchmarks extrapolated using this procedure could reach significant levels in several years even for economies with similar structures and at similar stages of economic development. Apart from the theoretical incomparability, many other practical sources of differences arise. These include the following:

- (i) **Methods of elementary aggregation.** In the ICP, the first level of aggregation corresponds to the PPPs at the basic heading level and are estimated using the country product dummy (CPD) method. However, the CPIs at the commodity or class levels are estimated using methods such as that of Dutot, Carli, and Jevons, which are entirely different in principle from the single-period CPD approach. Hence, merely applying the trend and ratios from the CPI-aggregated results to the basic heading PPPs potentially creates significant inconsistencies.
- (ii) **Base years and linking of time series data.** Economies have different base years for expenditure weights and have different ways of linking their time series. Hence, estimates derived from these varying bases and linking procedures, when used in extrapolating benchmark PPPs, could potentially result in overestimation or underestimation of PPPs for a given

country depending on how close their base year is with the base country and/or with the benchmark year.

- (iii) **Weighting patterns.** The weighting patterns for the deflators in the national accounts differ from those underlying the PPP benchmarks.
- (iv) **Quality adjustment methods.** The prices underlying the national accounts deflators are adjusted to remove changes in quality over time, but the procedures for doing so differ between economies. Hedonics, widely considered the most common technique for direct quality adjustment, are used by some countries to adjust price indices for quality changes in electronics, computers, and cars, while some others just “borrow” the indices for such products from countries that compute them such as the US. Some countries do not do any quality adjustment. Hence, the magnitude of quality adjustments varies among countries. It is estimated that the US CPI, when measured using the pre-1998 methodology, could be 1.3% higher today due to the effects of various adjustments (for a thorough discussion see Johnson 2006).
- (v) **Rate of change in economic structures.** A basic assumption underlying the extrapolation process is that the structures of the economies involved change at the same rate. This, however, does not happen in practice. The rate of change of economic structures depends largely on the level of development of respective economies.
- (vi) **Adoption of System of National Accounts.** Some countries are still using the 1968 System of National Accounts (SNA); some base their national accounts on the 1993 SNA; still others base their estimates on partial adoption of the 1993 SNA. The impact from this source, however, will arise more from the different levels of GDP recorded rather than from significant differences in the GDP deflators used to extrapolate the PPPs.
- (vii) **Terms of trade effect.** The change in goods and services available in a national economy brought about by the shifting of external price relationships is referred to as the terms of trade effects. In principle, the method to overcome the inconsistency caused by the terms of trade effect would be to take the ratio of GDP (in current prices) to real gross domestic income (RGDI) as the price extrapolator for each year because RGDI takes account of the terms of trade effect.³ RGDI measures the purchasing power of the total incomes generated by domestic production (including the impact on those incomes of changes in the terms of trade)

³ Derivation of real gross domestic income is explained in the 1993 SNA paragraph 16.152; see United Nations (1993).

and is equal to the volume of GDP plus the trading gain (or less the trading loss) resulting from changes in the terms of trade. The data required to calculate RGDI are GDP, exports of goods and services, and imports of goods and services (all expressed in both current price values and volumes), which are all readily available in most economies, therefore a consistent adjustment could be calculated for all economies. However, not all economies calculate RGDI, and those that do often use alternative methods, giving rise to inconsistencies between their estimates.

A good overview of some inconsistencies between ICP benchmarks and extrapolated GDP figures can be found in Varjonen (2002). Varjonen reports inconsistencies arising between benchmark and extrapolated PPPs to range from minus 13.6% for Turkey to plus 11.7% for Greece during the 1990–1999 period (see Varjonen 2002, Table 2). Another paper that focuses on the differences between benchmark and extrapolated PPPs is by Dalgaard and Sørensen (2000). The authors highlight some large discrepancies between the benchmark and extrapolated series for some countries but note that revisions to national accounts data after the benchmark PPPs were calculated are at least partly responsible for their magnitude.

Related developments in the Asia and Pacific region since the completion of the 2005 round have been directed at examining the feasibility of achieving a closer integration of CPI and ICP activities to enable PPPs to be extrapolated at a more detailed level than total GDP, with the goal of minimizing the extent of such discrepancies. Ward et al. (2008) propose some ways to address the gap in between ICP benchmark years.

Despite the above limitations, some useful results can be obtained by extrapolation, provided that the years extrapolated are not too removed from the base year (i.e., 2005 currently). It is in this context that the 2009 PPP Update attempts to provide a more firmly based set of PPPs than could be obtained using the simple, broad-level extrapolation procedures that would address and/or avoid the limitations described above.

IV. Scope and Coverage of Price Survey

The composition of the price series in the ICP differs from that in an economy's CPI because the key requirement in producing PPPs is for the products priced to be representative and comparable between economies (spatial comparison), while in the CPI, the main requirement is for each product priced to be of consistent quality over time, as it aims to capture national price movements of products to reflect temporal or time series changes within the economy. Therefore, products priced in economies' CPIs provide limited coverage of the products whose prices are required for the 2009 PPP Update, which entailed price collection specifically for the 2009 PPP Update.

A. Periodicity and Geographic Coverage

To limit the costs of the 2009 PPP Update, price collection for household consumption items was done quarterly and in the capital cities only. This enabled significant cost reduction and resource requirements in comparison to benchmark ICP when some price collections are conducted at higher frequencies (weekly, bimonthly, or monthly depending on the variability of the items) and with national coverage, based on sampling procedures to ensure national representativity. For nonhousehold components (Machinery and Equipment [M&E] and Construction and Compensation of Employees), a one-time price collection in the capital city was recommended. Construction data was collected in July 2009 while prices for equipment were collected in the last quarter of 2009. Compensation data for 2008 was provided in August 2009, and 2009 compensation data was submitted in February 2010.

B. Item Coverage

In establishing the core list for household and equipment, the World Bank developed an MS Excel-based prototype that automatically selects the optimum combination of products for each basic heading using the combinatorial approach explained in Section V-A1 of this paper. The prototype was enhanced by ADB to suit the specific requirement of the Asia and Pacific region for the 2009 PPP Update, and eventually used to determine the core product lists for household, and for machinery and equipment. The item coverage for each sector is described as follows:

- (i) **Household consumption items.** Out of the 656 products from the 2005 ICP full list, 269 were initially selected for the 2009 core list, and countries were requested to price each of these items as had been priced in 2005. After the first quarter price collection, the list was increased to 279 products, as additional products needed to be priced since some of the products were no longer available in a number of countries (e.g., clinical thermometer with mercury scale, which was priced in 2005, was no longer available in all countries and warranted adding digital thermometer to the list.)
- (ii) **Construction.** Ten out of the 34 basic inputs were considered relevant for calculating PPPs for this sector and are categorized as follows:
 - a. Materials: aggregate for concrete, plywood, portland cement, reinforcing steel, sand used for concrete and cement mortar
 - b. Hire of equipment: Backhoe, vibratory plate compactor, sand filter
 - c. Labor services: Skilled (seven types) and unskilled labor (one type)

- (ii) **Machinery and equipment.** A total of 61 products are included in the core list and breakdown by major component is as follows: General Purpose Machinery (10); Special Purpose Machinery (26); Electrical and Optical Machinery (19); Motor Vehicles and Trailer (6). Initially, an indirect methodology for PPP calculation of M&E based on information on M&E imports, freight and insurance costs, trade margins, applicable duties (taxes/customs duties/subsidies), and installation costs was considered. With this methodology, the changes in relative PPPs would be calculated as the change in real exchange rates adjusted for the cost components. It is assumed that the share of applicable duties remains the same between 2005 and 2009, while the share of the other costs for M&E imports would be estimated from trade and balance of payments statistics, and from commodity flow matrix, if countries use the commodity flow method to estimate gross fixed capital formation. This method is described in depth in World Bank (2007). However, after an assessment of data submitted by countries, actual price collection using the core list approach was resorted to, as most countries were unable to provide all the required and/or needed information.
- (iii) **Compensation of employees.** Information on compensation was collected for the same set of 50 government positions in 2005. This covers 18 positions to evaluate individual expenditure by the government (13 for health services and five for education service); and 32 for collective government services.
- (iv) **Inventories, valuables, exports, and imports.** In the 2005 ICP, the PPPs used for these aggregates were reference PPPs. For inventories and valuables, the applicable reference PPPs were a combination of those for durable and nondurable goods and gross fixed capital formation (excluding reference PPP basic headings). Similar reference PPPs from a number of household basic headings, updated to 2009, are used in the 2009 PPP Update. Meanwhile, the reference PPPs for exports and imports of goods and services were based on exchange rates.
- (v) **GDP values and weights.** The 2009 PPP Update uses the latest available data on the major GDP components in 2009: actual final consumption expenditure by household, collective consumption expenditure by government, gross capital formation (including changes in inventories and net acquisitions of valuables), and balance of exports and imports of goods and services. Breakdowns of the major components into the 155 basic headings will be estimated using the latest available data at the most detailed level possible. Where available, data from household expenditure surveys would be used to estimate basic heading values for

household final consumption expenditure if the national accounts data are not available in sufficient detail. If up-to-date information are not available, the basic heading structure from the 2005 ICP Round would be applied below the level at which the national accounts are compiled. For example, if 2009 data were available for total food in household final consumption expenditure, then the 2005 basic heading structure for the components of food would be used to allocate the 2009 value to basic headings.

V. Methodology for the 2009 PPP Updates

Since the 2009 PPP Update is based on a subset of prices and price collection is limited to only capital cities, several steps are involved to ensure the reliability of the 2009 PPPs. The succeeding sections describe the methods for (i) building the core product lists for household and machinery and equipment, (ii) adjusting from core to full list, (iii) adjusting the capital city prices and/or basic heading PPPs to the national level, (iv) calculating PPPs for construction using core elementary components, and (v) the aggregation methods.

A. Building the Core Product Lists

The process adopted in the 2009 PPP Update is designed to minimize the amount of data collection and, therefore, involves pricing a subset of the products included in the 2005 product lists. The full product list for the 2005 ICP Asia-Pacific consisted of 656 goods and services for household consumption expenditure, 34 basic inputs and complex items for construction, and 262 comparable products for gross fixed capital formation on machinery and equipment. In order to achieve the low-cost objective, core or reduced lists consisting of 269 household consumption goods and services, 11 basic inputs for construction, and 61 products for gross fixed capital formation on machinery and equipment were identified for the 2009 PPP Update.

In deriving the reduced list (about 40% of the total items from the full list), an important consideration in identifying the products for inclusion in the reduced lists was that those chosen should be optimal, in the sense that each item within each basic heading delivers the minimum deviations from the full list for the whole group of economies. In practice, it meant that, for household final consumption expenditure, each economy would need to collect prices for between 165–245 products only (the 2009 product lists were based on a subset of those products actually included in the full 2005 list). A similar process was followed in identifying the reduced product lists for machinery and equipment, and a slightly different approach was used for gross fixed capital formation on construction (see Section D).

1. The Combinatorial Approach

To demonstrate the approach for selecting the core lists, rice was chosen because it is one of the basic headings with the largest number of products in the 2005 ICP Asia-Pacific. From Table 1 we can see that rice has 19 individual products, and the price matrix is fairly sparse with only four products having 10 or more economies pricing them. The goal was to select about 30% of the total number of products for each basic heading to derive the core list, which meant that six products would represent the rice basic heading.

Table 1: Average Prices¹ of Rice Products by Product and by Economy in Local Currency Units

Item Code	Item Description	CV ²	No. of Countries Pricing the Item	BAN	BHU	BRU	PRC	FIJ	HKG	INO	IND
1101111011	Coarse #3	0.15	3		19.28						12.27
11011110110	White rice #3	0.19	12	38.28	44.72	38.96				48.05	30.45
11011110111	White rice #4	0.26	4	27.63	22.75					39.24	
11011110112	White rice #5	0.13	6	31.13						30.94	
11011110113	White rice #6	0.06	4	29.00						28.84	
11011110114	White rice #7	0.11	3	30.67					57.44		
11011110115	White rice #8	0.16	5	23.37					65.89		
11011110116	White rice #9	0.07	4	28.92				50.85	64.88		
11011110117	White rice #10	0.14	5	29.82				50.48	70.90		
11011110118	Premium rice #1	0.19	10	49.65	38.07		42.18		75.46	25.61	
11011110119	Premium rice #2	0.20	12	56.85					110.00		68.36
11011110120	Premium rice #3	0.10	4	46.50							
11011110121	Premium rice #4	0.12	13	26.73		27.54		48.54	55.22	30.93	31.79
1101111013	Coarse #2	0.33	3								
1101111014	Coarse #6	0.17	5	11.43			12.62				10.68
1101111015	Coarse #5	0.18	3	10.94							12.13
1101111017	Brown rice	0.29	5	12.03	22.67						
1101111018	White rice #1	0.15	9	45.50			34.58				
1101111019	White rice #2	0.15	7	25.83							27.11
CV of CPD ³ residuals by country				0.19	0.21	0.04	0.08	0.08	0.06	0.24	0.19
Number of items priced by country				17	6	2	3	3	7	6	7

¹Actual prices submitted by countries for the 2005 International Comparison Program.

²Coefficients of variation.

³Country-product-dummy.

BAN = Bangladesh; BHU = Bhutan; BRU = Brunei Darussalam; PRC = People's Republic of China; FIJ = Fiji Islands; HKG = Hong Kong, China; INO = Indonesia; IND = India; CAM = Cambodia; LAO = Lao People's Democratic Republic; SRI = Sri Lanka; MLD = Maldives; MON = Mongolia; MAL = Malaysia; NEP = Nepal; PAK = Pakistan; PHI = Philippines; SIN = Singapore; THA = Thailand; TAP = Taipei, China; VIE = Viet Nam.

Source: Authors' estimates using the 2005 ICP Asia-Pacific.

Table 1 also shows the coefficients of variation (CVs) of the CPD residuals by economy and by product in the rice basic heading, which indicate how coherent the prices are across economies and products with CPD residuals (CVs) less than 20%. Products to be included in the core list could be selected based on a similarity measure, for example, CV by product from Table 1⁴ whereby products with lower CVs will be included in the core list. However, selecting individual products in this way may present some bias and would not allow for the effects of within-core group correlation, when individual products may contribute more if they were considered in a group. Hence, a combinatorial process was used whereby all possible permutations were computed, even though evaluating all possible permutations would be very intensive computationally. The number of combinations (k) from a set of size n would be given by the following formula:

CAM	LAO	SRI	MLD	MON	MAL	NEP	PAK	PHI	SIN	THA	TAP	VIE
			26.01									
21.28	17.86	19.49			38.90			34.36		26.92		23.67
		30.09										
		22.71				31.99						31.81
		21.00										
		27.11										
					40.32					32.05		
												81.43
							22.13					90.35
27.79				39.54	48.60					29.00		
24.92					73.02	52.34	47.08	31.97	75.37	48.26	86.22	
24.20											104.77	31.61
			36.46		32.64		19.05	18.91	36.66	21.48		
	25.97	11.70			20.93							
		11.88					13.93					
		12.91										
		10.69							52.05		44.37	
26.04		25.18		36.75		27.50		25.29			65.84	21.53
23.49	21.52	21.10				21.16		31.10				
0.18	0.35	0.19	0.08	0	0.11	0.14	0.16	0.2	0.32	0.09	0.18	0.15
6	3	11	2	2	6	4	4	5	3	5	6	4

⁴ A very important consideration in the selection process was to provide sufficient overlap for computing CPD-based PPPs. Thus, a low value for the CV for a group of products could not guarantee meeting this criterion.

$$C_k^n = \binom{n}{k} = \frac{n!}{k!(n-k)!} \quad (1)$$

The use of combinatorial approach is exhaustive such that, in the case of rice, a total of 27,132 combinations were simulated to derive the best combination that would include a core list of six products (30%) out of 19 products from the full list. The approach singled out products $S=\{10, 12, 13, 17, 18, 19\}$ as being the best set for the 2009 PPP Update with a standard deviation for S being 8.1% from a total of 48 quotes only. Table 2 shows the products priced under rice by economy.⁵

Table 2: Core List of Products to be Priced for Rice for the 2009 PPP Updates by Product and by Economy

Product Code	Description	BAN	BHU	BRU	PRC	FIJ	HKG	INO	IND	CAM	LAO	SRI
11011110118	Premium rice #1	X	X		X		X	X		X		
11011110120	Premium rice #3	X								X		
11011110121	Premium rice #4	X		X		X	X	X	X			
1101111017	Brown rice	X	X									X
1101111018	White rice #1	X			X					X		X
1101111019	White rice #2	X							X	X	X	X

Product Code	Description	MLD	MON	MAL	NEP	PAK	PHI	SIN	THA	TAP	VIE
11011110118	Premium rice #1		X	X					X		
11011110120	Premium rice #3									X	X
11011110121	Premium rice #4	X		X		X	X	X	X		
1101111017	Brown rice							X		X	
1101111018	White rice #1		X		X		X			X	X
1101111019	White rice #2				X		X				

Note: X corresponds to products priced in 2009.

Source: Authors' estimates using the 2005 ICP Asia-Pacific.

⁵ Note that basic heading PPPs were normalized (divided) with respect to the regional geometric mean in order to remove the base country effect.

It is interesting to note that even though 12 economies priced Product 2 (White rice #3) as shown in Table 1, it was not a part of the selection. Its omission reflects the randomness of the selection process, which can be considered unbiased and depended purely on the contribution of the product to the rice basic heading PPP rather than on the number of economies pricing that product. The ratio of the core list PPPs to the full list basic heading PPP, by economy at the household final consumption expenditure level, is shown in Table 3 below.

**Table 3: Purchasing Power Parity Ratios of Core to Full List¹
by Economy**

Economy	BAN	BHU	BRU	PRC	FIJ	HKG	INO	IND	CAM	LAO	SRI
Ratios	1.08	1.06	0.97	1.05	1.14	1.03	0.87	1.12	1.1	0.93	0.93

Economy	MLD	MON	MAL	NEP	PAK	PHI	SIN	THA	TAP	VIE
Ratios	0.94	1.01	1.07	0.88	0.9	1.02	1.14	0.95	1.01	0.92

¹ Core list includes the 269 items that were derived from from the 2005 International Comparison Program household product list of 656 items.

BAN = Bangladesh; BHU = Bhutan; BRU = Brunei Darussalam; PRC = People's Republic of China; FIJ = Fiji Islands; HKG = Hong Kong, China; INO = Indonesia; IND = India; CAM = Cambodia; LAO = Lao People's Democratic Republic; SRI = Sri Lanka; MLD = Maldives; MON = Mongolia; MAL = Malaysia; NEP = Nepal; PAK = Pakistan; PHI = Philippines; SIN = Singapore; THA = Thailand; TAP = Taipei,China; VIE = Viet Nam.

Source: Authors' estimates using the 2005 ICP Asia-Pacific.

The indicative number of household goods and services from which prices would be collected by basic heading and by economy are presented in Table 4.

Table 4: Number of Products Priced by Basic Heading and by Economy, 2005 (Full List) and 2009 (Core List)¹

BH_Code	Product Description	2005	2009	Ratio (2009/2005)	BAN	BHU	BRU	PRC	FIJ
1101111	Rice	19	6	0.32	6	2	1	2	1
1101112	Other cereals, flour, and other cereal products	13	4	0.31	3	2	3	3	4
1101113	Bread	6	2	0.33	2	2	2	1	2
1101114	Other bakery products	10	3	0.30	3	3	3	2	1
1101115	Pasta products	5	3	0.60	3	2	3	3	3
1101121	Beef and veal	7	3	0.43	3	1	2	2	2
1101122	Pork	6	2	0.33	0	2	0	2	2
1101123	Lamb, mutton, and goat	5	3	0.60	1	2	0	3	3
1101124	Poultry	9	3	0.33	2	1	2	3	2
1101125	Other meats and meat preparations	7	4	0.57	2	3	2	4	2
1101131	Fresh, chilled, or frozen fish and seafood	15	6	0.40	3	1	4	4	2
1101132	Preserved or processed fish and seafood	7	3	0.43	1	3	3	3	2
1101141	Fresh milk	4	2	0.50	2	2	1	2	1
1101142	Preserved milk and other milk products	8	3	0.38	3	2	2	3	2
1101143	Cheese	4	2	0.50	1	1	2	2	0
1101144	Eggs and egg-based products	4	2	0.50	1	2	1	2	2
1101151	Butter and margarine	3	2	0.67	1	1	2	0	2
1101153	Other edible oils and fats	10	3	0.30	2	1	3	3	2
1101161	Fresh or chilled fruit	10	3	0.30	3	3	3	3	3
1101162	Frozen, preserved, or processed fruit and fruit-based products	3	2	0.67	1	0	2	2	2
1101171	Fresh or chilled vegetables other than potatoes	11	3	0.27	3	3	3	3	3
1101172	Fresh or chilled potatoes	3	2	0.67	2	2	2	1	1
1101173	Frozen, preserved, or processed vegetables and vegetable-based products	6	4	0.67	3	4	4	4	1
1101181	Sugar	3	2	0.67	1	1	2	2	0
1101182	Jams, marmalades, and honey	3	2	0.67	2	2	2	2	2
1101183	Confectionery, chocolate and ice cream	5	3	0.60	2	2	3	3	3
1101191	Food products n.e.c.	10	3	0.30	3	3	3	3	3
1101211	Coffee, tea, and cocoa	8	2	0.25	2	1	2	1	2
1101221	Mineral waters, soft drinks, fruit and vegetable juices	7	2	0.29	2	2	1	2	2
1102111	Spirits	2	2	1.00	0	2	0	1	2
1102121	Wine	5	3	0.60	0	1	0	3	1
1102131	Beer	4	2	0.50	0	2	0	2	2
1102211	Tobacco	6	2	0.33	2	2	1	2	1
1103111	Clothing materials, other articles of clothing and clothing accessories	5	3	0.60	3	3	2	3	3
1103121	Garments	54	17	0.31	14	15	10	8	14
1103141	Cleaning, repair, and hire of clothing	2	2	1.00	2	2	2	2	0
1103211	Shoes and other footwear	8	2	0.25	2	2	2	2	2
1103221	Repair and hire of footwear	2	2	1.00	2	2	0	2	2
1104311	Maintenance and repair of the dwelling	6	2	0.33	2	2	2	2	2
1104411	Water supply	1	1	1.00	1	1	0	1	1
1104421	Miscellaneous services relating to the dwelling	1	1	1.00	1	0	1	1	0
1104511	Electricity	1	1	1.00	1	1	1	1	1
1104521	Gas	2	2	1.00	2	1	1	2	1
1104531	Other fuels	3	3	1.00	2	2	0	0	2
1105111	Furniture and furnishings	15	5	0.33	5	3	3	2	2
1105121	Carpets and other floor coverings	3	3	1.00	1	2	3	0	1
1105211	Household textiles	7	2	0.29	2	2	1	1	1
1105311	Major household appliances whether electric or not	13	4	0.31	3	1	3	4	3
1105321	Small electric household appliances	10	3	0.30	3	3	3	3	3
1105331	Repair of household appliances	3	3	1.00	3	1	3	3	3
1105411	Glassware, tableware, and household utensils	8	2	0.25	2	2	2	1	2
1105521	Small tools and miscellaneous accessories	8	2	0.25	2	2	2	2	2

	HKG	INO	IND	CAM	LAO	SRI	MLD	MON	MAL	NEP	PAK	PHI	SIN	THA	TAP	VIE
	2	2	2	4	1	3	1	2	2	2	1	3	2	2	3	2
	3	3	2	2	2	3	3	3	3	3	3	3	3	3	2	3
	2	2	2	1	2	2	2	2	2	2	2	2	2	2	2	2
	3	2	3	3	3	3	2	3	3	2	3	3	2	3	3	3
	3	3	2	3	3	3	2	3	3	3	3	3	3	3	3	3
	1	3	1	2	2	2	0	2	2	1	3	2	1	2	1	3
	2	2	2	2	2	2	0	2	2	1	0	2	2	2	2	2
	2	3	3	0	0	1	0	3	3	3	3	1	1	0	3	0
	3	3	1	2	1	2	1	2	2	1	3	3	2	2	2	3
	2	4	2	3	2	2	1	3	3	0	2	2	2	2	2	3
	5	6	6	4	2	5	2	0	6	1	6	5	2	4	5	5
	2	3	3	3	1	3	2	2	3	3	3	3	3	3	3	3
	1	1	2	1	1	2	1	2	1	2	2	1	1	1	1	1
	3	3	3	2	2	1	2	2	3	3	3	3	3	3	3	3
	2	2	1	2	2	1	1	2	2	2	2	2	2	2	2	2
	2	2	1	1	1	2	1	2	2	1	2	2	1	2	2	2
	2	2	1	2	1	2	2	2	2	1	2	2	2	2	2	2
	2	3	3	2	1	2	3	3	3	2	3	2	3	3	3	2
	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
										2	2	2	2	2	2	2
	2	2	2	1	1	2	2	2	2	2						
	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
	2	2	2	2	2	2	2	1	2	2	2	2	2	2	2	2
										4	4	4	4	4	4	4
	3	4	3	2	1	4	2	4	4	2						
	2	2	1	2	2	2	2	1	2	1	2	2	2	2	2	2
	2	2	2	2	1	2	2	2	2	2	2	2	2	2	2	2
	3	3	2	2	1	2	3	2	3	2	3	2	2	3	3	3
	2	2	3	2	2	3	3	3	3	3	3	2	3	3	2	3
	2	1	1	1	1	2	2	2	2	1	2	2	2	2	2	2
	1	2	2	2	2	2	2	2	2	2	2	2	2	2	1	2
	1	2	1	2	2	2	0	2	1	2	0	2	1	2	1	2
	2	2	1	2	1	2	0	1	1	1	0	3	1	2	3	3
	2	2	1	2	2	2	0	2	1	0	0	2	2	2	2	2
	2	2	2	2	2	2	1	2	2	2	1	2	2	2	2	2
										3	2	2	3	3	3	3
	3	3	2	3	3	3	2	3	3	3						
	17	17	16	14	8	15	11	17	17	16	17	15	15	15	17	15
	2	2	2	2	1	2	0	1	2	2	2	2	2	2	2	2
	2	2	2	2	2	2	1	2	2	2	2	2	2	2	2	2
	2	2	2	2	1	2	0	2	2	2	2	2	2	2	2	2
	2	2	2	2	2	2	2	2	2	2	2	2	2	1	2	2
	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1
	0	1	1	1	0	1	1	1	0	1	1	0	1	1	1	1
	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	2	1	2	1	1	1	1	1	2	1	2	1	1	1	2	1
	1	2	3	2	1	2	1	2	1	2	3	2	1	1	0	3
	3	5	4	4	4	5	3	5	5	5	5	5	4	5	4	5
	2	2	3	2	2	0	1	3	3	2	3	2	1	2	2	3
	2	1	2	2	2	1	2	1	2	2	2	2	2	2	2	2
	3	3	4	3	4	4	4	3	4	3	4	4	1	4	3	4
	3	3	3	3	3	3	2	3	3	3	3	3	3	3	3	3
	2	3	3	3	3	3	2	2	3	3	3	3	3	3	3	3
	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2

continued.

Table 4: *continued.*

BH_Code	Product Description	2005	2009	Ratio (2009/2005)	BAN	BHU	BRU	PRC	FIJ
1105611	Non-durable household goods	13	4	0.31	4	4	3	4	4
1105621	Domestic services	2	1	0.50	1	1	1	1	0
1106111	Pharmaceutical products	35	11	0.31	8	4	8	10	11
1106121	Other medical products	8	4	0.50	4	2	2	4	4
1106131	Therapeutical appliances and equipment	10	3	0.30	3	0	2	3	0
1106211	Medical services	6	2	0.33	2	0	2	1	2
1106221	Services of dentists	4	2	0.50	2	0	1	2	2
1106231	Paramedical services	7	3	0.43	3	0	2	1	2
1107111	Motor cars	5	3	0.60	2	1	1	2	0
1107131	Bicycles	1	1	1.00	1	0	1	1	1
1107221	Fuels and lubricants for personal transport equipment	8	8	1.00	4	3	5	7	5
1107231	Maintenance and repair of personal transport equipment	12	4	0.33	4	2	4	4	4
1107311	Passenger transport by railway	5	3	0.60	2	0	0	3	0
1107321	Passenger transport by road	6	2	0.33	2	1	2	2	1
1107331	Passenger transport by air	4	2	0.50	2	1	2	2	1
1108111	Postal services	2	2	1.00	2	2	2	2	1
1108211	Telephone and telefax equipment	5	2	0.40	2	2	1	1	1
1108311	Telephone and telefax services	7	4	0.57	4	3	2	3	3
1109111	Audio-visual, photographic, and information processing equipment	11	3	0.27	3	3	3	2	3
1109141	Recording media	9	3	0.33	2	2	2	3	3
1109151	Repair of audio-visual, photographic, and information processing equipment	2	2	1.00	2	0	2	0	2
1109211	Major durables for outdoor and indoor recreation	4	2	0.50	1	0	2	2	2
1109311	Other recreational items and equipment	10	3	0.30	2	1	3	1	3
1109331	Gardens and pets	5	3	0.60	1	0	2	3	1
1109351	Veterinary and other services for pets	1	1	1.00	0	0	1	1	0
1109411	Recreational and sporting services	3	3	1.00	1	0	3	2	2
1109421	Cultural services	4	2	0.50	2	2	2	2	2
1109511	Newspapers, books, and stationery	8	2	0.25	2	1	1	2	2
1109611	Package holidays	4	1	0.25	1	0	1	1	0
1110111	Education	6	6	1.00	6	2	5	6	2
1111111	Catering services	17	5	0.29	4	2	3	4	3
1111211	Accommodation services	4	3	0.75	3	2	2	3	2
1112111	Hairdressing salons and personal grooming establishments	6	4	0.67	4	4	3	4	4
1112121	Appliances, articles, and products for personal care	16	5	0.31	5	5	5	2	5
1112311	Jewellery, clocks, and watches	6	2	0.33	2	1	1	1	2
1112321	Other personal effects	4	2	0.50	2	2	2	2	2
1112621	Other financial services n.e.c.	5	2	0.40	1	1	2	2	1
1112711	Other services n.e.c.	2	1	0.50	1	1	1	1	1
	Total	647	269	0.42	215	165	192	215	192
	Total number of basic headings to be priced	90			85	76	81	86	80

¹Core list includes the 269 items that were derived from from the 2005 International Comparison Program household product list of 656 items.

BAN = Bangladesh; BHU = Bhutan; BRU = Brunei Darussalam; PRC = People's Republic of China; FIJ = Fiji Islands; HKG = Hong Kong, China; INO = Indonesia; IND = India; CAM = Cambodia; LAO = Lao People's Democratic Republic; SRI = Sri Lanka; MLD = Maldives; MON = Mongolia; MAL = Malaysia; NEP = Nepal; PAK = Pakistan; PHI = Philippines; SIN = Singapore; THA = Thailand; TAP = Taipei, China; VIE = Viet Nam.

Note: While a total of 656 household items were priced in 2005, nine items were ultimately referenced as parities cannot be established within each of the four basic headings (BH), which include narcotics and motor cycles.

Source: Authors' estimates using the 2005 ICP Asia-Pacific.

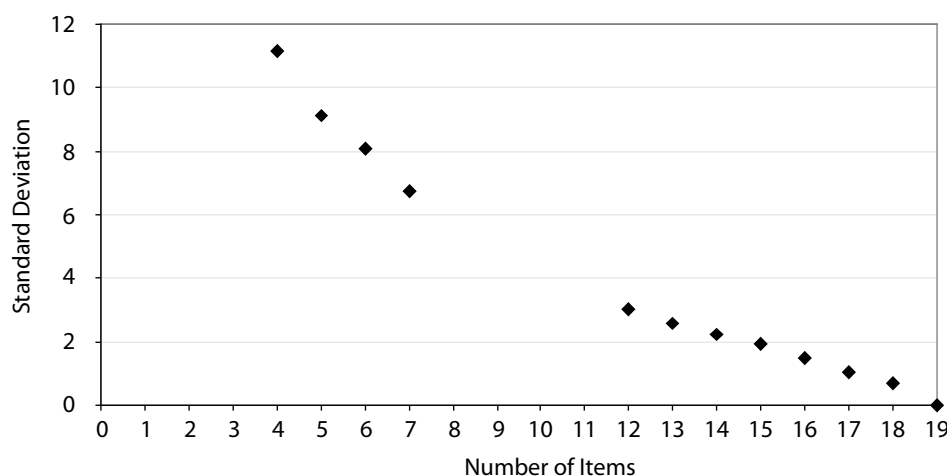
	HKG	INO	IND	CAM	LAO	SRI	MLD	MON	MAL	NEP	PAK	PHI	SIN	THA	TAP	VIE
	4	4	4	3	3	4	2	3	4	4	4	4	4	4	4	4
	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1
	7	10	9	7	4	9	7	8	11	11	11	7	8	10	8	11
	4	4	4	4	2	4	4	3	4	4	4	4	4	3	4	3
	3	3	3	3	1	3	3	3	3	3	3	3	3	3	3	3
	2	1	2	2	0	2	2	1	2	2	2	2	2	2	2	2
	2	1	2	1	0	2	2	1	2	2	2	2	2	2	2	1
	3	3	3	3	0	3	2	3	3	3	3	3	3	3	3	3
	2	3	3	1	2	3	0	0	2	3	3	2	2	2	2	2
	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	4	7	7	6	7	7	2	5	3	6	6	7	5	4	5	5
										4	4	4	4	4	4	4
	4	4	3	4	4	4	3	4	4	3						
	1	2	3	0	0	1	0	3	3	0	2	3	1	2	3	2
	2	2	1	1	1	2	0	2	2	1	2	2	1	2	2	2
	2	2	2	2	2	1	2	2	2	2	2	2	2	2	2	2
	2	2	2	2	2	2	2	2	2	2	2	2	1	2	2	2
	2	2	2	2	2	2	1	2	2	2	2	2	1	2	1	2
	1	4	0	2	3	2	3	3	3	3	3	2	2	3	4	3
										3	3	2	3	3	3	3
	3	3	3	3	3	3	2	3	3	3						
	3	3	3	3	3	3	3	3	3	3	3	3	2	3	3	3
										2	2	1	2	1	2	2
	1	2	2	2	2	1	2	2	2	2						
	2	2	2	1	2	2	0	2	2	1	2	2	1	2	2	2
	3	3	3	2	2	2	3	2	3	2	3	3	3	3	3	3
	3	0	3	2	2	3	2	3	3	1	3	3	3	3	3	3
	1	0	1	0	0	1	0	1	1	1	1	1	1	1	1	0
	3	3	3	3	2	2	1	3	3	1	2	3	3	3	3	3
	2	2	2	2	1	2	2	2	2	2	2	2	2	2	2	2
	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
	1	1	1	0	0	1	0	0	1	0	1	1	1	1	1	1
	6	6	6	6	2	6	4	6	6	6	6	6	5	6	5	6
	4	5	5	4	4	5	2	5	5	5	5	4	3	4	3	4
	2	3	3	3	3	2	1	3	3	3	3	3	2	1	2	3
										4	4	4	4	4	4	4
	4	4	4	4	3	4	4	4	4	4						
	5	5	5	5	5	5	4	5	5	5	5	5	5	5	5	5
	2	2	2	2	2	2	2	2	2	2	1	2	2	2	2	2
	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
	2	2	2	1	1	2	1	2	1	2	2	2	1	1	2	1
	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	225	245	233	214	175	232	166	226	245	217	244	239	211	233	235	243
	89	88	89	86	82	89	75	87	89	86	85	89	90	89	89	88

2. Size of the Core List

For the 2009 PPP Update, the aim was to develop a core list of products that would best reflect the outcomes achieved by using the full product list from the 2005 ICP round. Initial analysis showed it would be necessary to price about 30% of the 2005 products within household consumption by comparing the standard deviations of the (CPD-based) basic heading PPPs. However, as is the case in the benchmark rounds, countries are not expected to price all 279 products included in the 2009 PPP Update list. The plan was for each economy to collect prices only for those products that were priced in the 2005 ICP round and included in the 2009 PPP Update list, which would mean that each economy would technically have to price around 165–245 products.

The 30% ratio was estimated as the trade-off point between the returns starting to diminish as the number of products in the core list increases. As an illustration, Figure 1 shows the behavior of the standard deviation of the basic heading PPP estimates (based on an analysis using the CPD method) depending on the number of items in the core list using the rice basic heading as an example. It shows that for rice with 19 products, there is diminishing returns after about 30% of products are included in the core list. Please note that selecting 1–3 products does not produce an outcome with the same number of countries as the original 19 product basic heading so those selections are not shown in the graph. This further implies that the required binary matching and CPD transitivity only occurs after selecting a combination of at least four rice products, albeit the deviation is relatively high at about 11% when only four products are included.

Figure 1: Standard Deviation of the Basic Heading PPP Estimates Depending on the Number of Items in the Core List



While the starting point for the core list is to obtain 30% of the total products for each basic heading (BH) in the 2005 ICP, the process did not produce a consistent proportion across all basic headings. Apart from the 30% criterion, the core products within each basic heading should produce a deviation of less than 15% between the normalized basic heading parities based on the reduced (i.e., 2009 PPP Update) list and the normalized basic heading parities based on the full (2005) list. The outcome was that

it proved necessary to include more than 30% or all products for some basic headings in which only a few products were specified in 2005. The number of core products per economy and per basic heading is shown in Table 4. Seventy-two of the 90 household basic headings have core products that account for more than 30% of the 2005 full list, while 17 basic headings with one, two, or three products had a 100% coverage. All six educational products were also included, as this basic heading has a relatively high weight and also exhibited a higher degree of variability compared to other basic headings of similar size. Hence, the final list turned out to be about 40% of the 2005 ICP list, incorporating 269 products. As a result, between 165 products (Bhutan) and 245 products (Indonesia and Malaysia) are priced by countries in 2009.

The overall precision for household final consumption expenditure is estimated to have a CV of 1.6%, with most countries being less than 1% but a handful being between 3% and 4%. The important point to note is that these variations are within the range of error normally associated with the ICP. The precision for each category (basic headings aggregated to higher level) by country is presented in Table 5. For instance, the overall precision for GDP is 1.4%, while that for household final consumption expenditure is 1.6% (measured as the CV).

Countries exhibiting high deviations for household final consumption expenditure include Cambodia (-3.3%) and Pakistan (+3.3%) while most countries are within 1% boundaries. Again, those deviations quoted are for unadjusted parities. Once they are adjusted using the coefficients (adjustment factor) for each basic heading, the deviations become zero for all countries. The unadjusted deviations are here to show what the overall results would be like if the only product list available were the core product list, and the 2005 results were not available as a benchmark. As can be seen, the overall precision would still be acceptable, given that the precision of the ICP exercise is generally considered to be around $\pm 5\%$.

B. Adjusting from the Core to the Full List

In order to obtain a meaningful comparison with the 2005 results, coefficients (or adjustment factors) at the basic heading levels were calculated for the 2009 PPP Update. These will then be used to adjust the core list PPPs so they are consistent with the full list PPPs for each basic heading. In this sense, the 2009 PPP Update would be using the maximum available information from the 2005 ICP. Table 5 also shows the estimated CVs and the corresponding adjustment ratios from the core to the full list at the category level. This table basically indicates the relationship between the core and full lists for household. The same core to full adjustment will be implemented for the machinery and equipment basic heading in lieu of the unavailability of sufficient information that will satisfy PPP adjustments using real exchange rates adjusted for taxes, subsidies, and transportation/installation costs. Note that no adjustment is necessary (or the adjustment factor is equal to one) for balance of exports and imports; and changes in inventories and net acquisitions of valuables since it uses a reference PPP that is equivalent to the 2009 average exchange rate of the local currency versus the numeraire currency.

Table 5: Coefficients and Adjustment Factors from the Core to the Full Lists¹ by Major Expenditure Category and by Economy

Expenditure Category/Country	Coefficient of Variation	HKG	SIN	TAP	BRU	BAN	BHU
Gross Domestic Product	0.014	1.007	1.001	1.001	1.011	0.994	0.994
Actual Final Consumption Expenditure*	0.017	1.004	0.992	0.997	1.011	0.990	0.994
Household Final Consumption Expenditure	0.016	0.999	0.988	0.993	1.002	0.988	0.997
Food and Non-Alcoholic Beverages	0.024	1.012	1.022	0.985	0.994	1.022	1.009
<i>Bread and cereals</i>	0.047	1.028	1.038	0.991	0.989	1.035	1.020
<i>Meat and fish</i>	0.036	1.039	1.049	1.042	0.978	1.000	1.055
<i>Fruits and vegetables</i>	0.060	1.000	0.989	0.960	1.019	1.040	0.990
<i>Other food and non-alcoholic beverages</i>	0.042	0.957	0.990	0.941	0.986	0.992	0.993
Clothing and Footwear: of which	0.037	1.011	0.994	1.039	0.938	0.977	0.974
<i>Clothing</i>	0.034	1.005	1.024	1.031	0.920	0.983	0.988
Housing, Water, Electricity, Gas and Other Fuels	0.015	0.995	1.000	0.998	0.995	0.982	1.002
Health and Education	0.033	1.014	1.029	1.019	1.056	0.970	0.980
<i>Health</i>	0.040	1.001	1.041	1.011	1.043	0.919	0.984
<i>Education</i>	0.038	1.024	1.022	1.033	1.058	1.009	0.975
Transportation and Communication: of which	0.057	1.006	0.913	1.011	1.019	0.916	0.972
<i>Transportation</i>	0.052	1.046	0.938	1.015	0.993	0.892	0.997
Recreation and Culture	0.053	0.948	0.930	0.982	1.025	0.966	0.998
Restaurants and Hotels	0.067	0.983	1.018	0.919	1.030	0.941	0.999
Other Consumption Expenditure Items	0.028	1.020	1.007	1.004	0.989	0.981	1.000
Individual Consumption Expenditure by General Government: of which	0.048	1.043	1.035	1.038	1.076	1.017	0.975
Health	0.050	1.059	1.069	1.045	1.061	1.006	0.973
Education	0.063	1.063	1.038	1.069	1.095	1.024	0.964
Collective Consumption Expenditure By General Government	0.054	1.072	1.030	1.049	1.069	1.016	0.961
Gross Fixed Capital Formation: of which	0.000	1.000	1.000	1.000	1.000	1.000	1.000
Machinery and Equipment	0.000	1.000	1.000	1.000	1.000	1.000	1.000
Construction	0.000	1.000	1.000	1.000	1.000	1.000	1.000
Change in Inventories and Net Acquisitions of Valuables	0.010	1.004	0.998	1.000	0.998	0.999	1.002
Balance of Exports and Imports	0.000	1.000	1.000	1.000	1.000	1.000	1.000
Household Final Consumption Expenditure	0.016	0.999	0.988	0.993	1.002	0.988	0.997
Government Final Consumption Expenditure	0.051	1.060	1.032	1.045	1.072	1.016	0.968
Actual Final Consumption Expenditure*	0.017	1.004	0.992	0.997	1.011	0.990	0.994
All Goods	0.016	1.007	0.990	1.001	0.997	0.999	1.001
Non-Durables	0.019	1.005	1.011	0.994	0.998	1.005	1.012
Semi-Durables	0.022	0.999	0.990	1.024	0.972	0.995	0.950
Durables	0.033	1.012	0.954	0.988	1.002	0.951	1.032
Services	0.027	1.003	0.991	0.995	1.027	0.969	0.984

¹The 2005 International Comparison Program data was used to estimate the ratios of the purchasing power parity (PPP) of the core and the full list by each major expenditure category. PPP ratios were derived for each basic heading and will be used to adjust the final 2009 PPP core estimates to full-list PPP.

BAN = Bangladesh; BHU = Bhutan; BRU = Brunei Darussalam; PRC = People's Republic of China; FIJ = Fiji Islands; HKG = Hong Kong, China; INO = Indonesia; IND = India; CAM = Cambodia; LAO = Lao People's Democratic Republic; SRI = Sri Lanka; MLD = Maldives; MON = Mongolia; MAL = Malaysia; NEP = Nepal; PAK = Pakistan; PHI = Philippines; SIN = Singapore; THA = Thailand; TAP = Taipei, China; VIE = Viet Nam.

Source: Authors' estimates using the 2005 ICP Asia-Pacific.

IND	MLD	NEP	PAK	SRI	MON	CAM	FIJ	INO	LAO	MAL	PHI	PRC	THA	VIE
1.025	1.007	0.990	0.974	1.013	0.994	1.022	1.019	0.975	0.986	1.006	0.994	0.991	0.983	0.987
1.030	1.002	0.990	0.968	1.014	0.993	1.029	1.020	0.975	0.996	1.005	0.995	0.992	0.980	0.991
1.028	0.993	0.990	0.967	1.011	0.998	1.033	1.017	0.982	1.003	1.002	0.996	0.996	0.983	1.001
1.007	0.972	0.994	0.951	1.001	1.006	1.051	1.050	0.998	1.013	0.990	0.983	0.964	0.970	0.988
1.054	1.010	0.955	0.959	0.944	1.049	1.101	1.062	0.930	0.937	1.035	0.997	1.037	0.952	0.923
0.955	0.919	1.040	1.016	1.010	0.986	0.992	0.976	1.032	1.031	0.953	0.996	0.936	0.997	1.032
1.002	0.928	1.024	0.864	0.968	1.061	1.065	1.126	1.000	1.095	0.967	1.010	0.906	0.989	0.970
0.999	1.016	0.993	0.959	1.080	0.959	1.034	1.053	1.036	1.063	1.003	0.908	0.996	0.951	1.032
1.055	0.997	1.037	0.999	0.984	0.935	1.012	1.012	0.957	0.958	0.969	0.993	1.019	1.004	1.006
1.040	0.995	1.016	1.010	0.990	0.974	1.003	0.987	0.934	0.992	0.958	0.994	1.039	1.017	1.000
1.000	0.980	0.991	0.977	1.015	1.022	1.029	1.001	0.985	0.993	1.009	0.998	1.029	0.999	1.023
1.037	1.043	0.952	0.965	1.014	0.998	1.027	1.030	0.952	0.977	1.048	1.016	0.974	0.965	0.974
1.035	1.026	0.929	0.946	0.978	1.012	1.053	1.033	0.974	1.009	1.068	1.057	0.986	0.969	1.000
1.040	1.051	0.993	0.989	1.054	0.977	0.999	1.029	0.923	0.948	1.032	0.984	0.959	0.961	0.944
1.095	1.056	0.981	0.957	1.064	0.962	1.042	0.931	0.972	1.038	0.968	0.946	1.019	0.989	1.024
1.099	1.068	0.953	0.916	1.052	0.990	1.028	0.935	0.967	1.026	0.975	0.977	1.017	0.999	1.049
1.091	0.952	1.093	1.097	0.977	0.949	0.981	1.062	0.933	1.000	0.972	1.058	1.038	0.992	1.012
1.025	1.148	0.923	0.978	0.925	1.127	0.989	1.054	1.091	0.924	1.019	1.081	0.960	0.955	0.892
1.036	0.994	1.018	0.965	1.048	0.975	1.007	1.030	0.909	0.977	1.021	1.009	0.995	0.998	1.030
1.051	1.056	0.986	0.980	1.047	0.965	1.003	1.055	0.893	0.940	1.041	0.977	0.956	0.951	0.922
1.049	1.054	0.974	0.985	1.047	0.979	1.008	1.039	0.900	0.939	1.044	0.988	0.932	0.946	0.936
1.071	1.071	0.984	0.973	1.071	0.963	1.000	1.049	0.867	0.924	1.048	0.967	0.926	0.948	0.896
1.058	1.061	0.988	0.974	1.056	0.971	1.005	1.039	0.884	0.935	1.039	0.972	0.937	0.957	0.908
1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1.015	0.992	0.993	0.977	1.001	0.996	1.026	1.021	0.982	1.002	1.000	0.997	0.997	0.993	1.004
1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1.028	0.993	0.990	0.967	1.011	0.998	1.033	1.017	0.982	1.003	1.002	0.996	0.996	0.983	1.001
1.055	1.059	0.987	0.976	1.052	0.968	1.005	1.046	0.887	0.938	1.040	0.974	0.944	0.954	0.915
1.030	1.002	0.990	0.968	1.014	0.993	1.029	1.020	0.975	0.996	1.005	0.995	0.992	0.980	0.991
1.026	0.985	0.994	0.969	1.003	0.995	1.035	1.035	0.971	1.004	1.000	0.997	0.992	0.989	1.009
1.019	0.981	0.986	0.950	1.010	1.002	1.042	1.040	0.976	1.009	0.998	0.992	0.987	0.982	1.006
1.034	0.985	1.029	1.015	0.989	0.961	0.998	1.024	0.980	0.997	0.994	1.014	0.991	1.014	0.998
1.054	0.993	1.025	1.072	0.981	1.007	1.005	1.016	0.938	0.987	1.008	0.997	1.010	0.971	1.034
1.043	1.022	0.984	0.963	1.037	0.993	1.024	0.999	0.981	0.978	1.010	0.990	0.991	0.971	0.970

C. Adjusting Capital City Prices to National Average Prices

Since prices for the 2009 PPP Update were only collected in the capital cities, these have to be adjusted to the national level using either one of the following methods:

- (i) Computing the adjustment factors from national CPIs where the CPI data allows it and where the need exists for intra-economy adjustments to obtain national average prices; or
- (ii) Computing adjustment factors from the economies' price submissions for the 2005 ICP round.

For economies that are geographically small, homogenous, and are considered to be city-state, intra-economy adjustment is not necessary as price collection for the 2009 PPP Update has a similar coverage as the 2005 ICP. These include the economies of Brunei Darussalam; Hong Kong, China; the Maldives; Singapore; Taipei, China.

1. Grouping Countries

To minimize the costs incurred by economies participating in the 2009 PPP Update, prices would be collected in most economies in the capital cities only. As a result, the prices collected have to be adjusted to the national level to ensure the greatest possible consistency with those from the 2005 ICP. For this process, the 21 participating economies were grouped into three clusters:

Group 1 are the geographically large and diverse economies where special subnational studies are explored and where sufficient information are found to be available for estimating adjustment factors from the CPI, which is further described in the ensuing section. It consists of the People's Republic of China; India; Indonesia; Malaysia; Philippines; Thailand; Viet Nam.

Group 2 consists of economies whose current statistical infrastructure and/or capacity do not support the method suggested for Group 1. Hence, adjustments will be based on the 2005 ICP relationship of the capital city to national prices. Nine economies belong to this group: Bangladesh; Bhutan; Cambodia; the Fiji Islands; the Lao People's Democratic Republic; Mongolia; Nepal; Pakistan; and Sri Lanka.

Group 3 are the geographically small and homogenous economies where no adjustments are needed. Brunei Darussalam; Hong Kong, China; the Maldives; Singapore; Taipei, China were identified under this group.

2. Price Adjustment Process

Price data collected for the 2009 PPP Update for household will be adjusted to the national level for the 16 economies included in Groups 1 and 2 because the prices for the core products were priced only in the capital city in each economy. On the other hand, with the exception of Brunei Darussalam and the Maldives, the economies in Group 3 are basically “city-states” and so the capital city and the total economy are one and the same. This implies that adjustment from capital to national is not necessary for Group 3 economies. It would be necessary to adjust the prices collected in the capital city for the 2009 PPP Update to national average prices either at the product, basic heading, or group level, depending on available information. Evidence has shown that the price levels in major cities are not the same as those in the rest of an economy, even if the changes in prices in the capital city are highly correlated with those in other parts of the economy. To further complicate the issue, the relationship between capital city prices and those in other parts of the economy vary depending on the basic heading being considered. For example, rents and locally produced food products tend to be lower outside the capital city but fuel and processed food prices are often higher. The implication is that calculating national average prices cannot be based on a common adjustment across all basic headings. Adjustments could be done from either: data mining from the national 2009 CPI, or based on the price data submitted for the 2005 ICP.

The national CPI database provides a potential data source that can assist in calculating the adjustments to the capital city prices collected for the 2009 PPP Update to bring them to the national annual average prices required for the ICP. The CPI systems in the countries in Group 1 and Group 2 are expected to include a sufficiently large number of products, covering all geographic locations in the country that would make it possible to use the relationships between capital city prices and those collected in the other (noncapital city) locations to adjust the capital city prices to annual national average prices. The critical elements in this process were:

- (i) Determining whether each economy’s CPI had common specifications across regions within the economy (or, if they vary, to what extent do they do so), for 2009; and
- (ii) Evaluating the extent of overlap in product specifications between the regions in each economy (at the minimum between capital city and national) so that the CPD method could be used to estimate PPPs either at the commodity, basic heading, or major group level. Identical products between regions in the economy will be determined and will form the basis for calculating the PPPs in the capital city and at the national level.

For those economies that have a sufficient overlap in CPI product specifications between the capital city and other locations, the following procedures are adopted.

- (i) Establish product overlap in the CPI database.
- (ii) Classify products into corresponding class, basic heading, or commodity level, or at that level where binaries can be established across regions, states, or between the capital city and national level.
- (iii) Calculate corresponding first-level unweighted PPPs.
- (iv) Apply the same CPI weights of major aggregates (class or major group level) by region, state, or capital city, and the total for the national level, and compute the higher-level (usually major CPI groups) weighted PPPs by region, state, capital city, and national level.
- (v) From the estimates in item (iv), calculate the PPP ratios at the capital city and national levels.
- (vi) Apply the ratios derived based on item (v) to the corresponding 2009 capital city average prices at product, class, or group level.

To illustrate the procedures described above, assume an adjustment has to be made on the price of Product A collected in the 2009 PPP Update. Also, assume that exactly the same Product A is found in the CPI. If the national average price in the CPI for Product A is 45 currency units in 2009, and the average price for Product A in the capital city was 50 currency units, then the capital city average price for Product A collected from the 2009 PPP Update would be multiplied by 0.90 (i.e., $45/50$) to adjust it to the national average price level. The assumption underlying this process is that the price relativities between the capital city and other regions in the economy in the CPI reflect the prices that would have been collected in the ICP if a price collection had included all the noncapital city locations that were surveyed in the 2005 ICP. If the CPI data only allows for group or class level ratios to be established, then the adjustment factor (or ratios) would be applied to the corresponding 2009 group or class level PPP for the capital city. The main advantage of this approach is that any changes in the price structure within an economy between 2005 and 2009 are taken into account rather than assuming that the 2005 relationships between the capital city and national price levels still hold. This could be particularly important for products that are subject to large price variations over time and between regions, such as many food products and fuels.

A simplified process would be adopted for those economies in which the CPI data are not available at a sufficiently detailed level for locations outside the capital city to enable the more detailed procedure (described above) to be used. It involves calculating the

relationship between the average price in 2005 for each 2009 PPP Update product in the capital city, comparing it with the national average price used in the 2005 ICP, and then adjusting the 2009 price for that product in the capital city using this ratio. In this case, adjustments would be made at the product level (and not the group or class level) since ICP product specifications are uniform across a country (unlike in the CPI). An example would be a product having a national average price of 68 currency units in the 2005 ICP, while the average price for that product in the capital city was 80 currency units. In this case, the 2009 price for the capital city would be multiplied by 0.85 (i.e., 68/80) to adjust it to a national average price to be used in the 2009 PPP Update. This procedure would likely be used for economies with the exception of Group 3. In cases where a product selected for pricing in the capital city for the 2009 PPP Update was not priced in the capital city in 2005, an imputation using price from outside the capital city would be made prior to establishing the ratios. The limitation of using the 2005 relationships between the prices from the capital city and the national average prices for the economy as a whole to adjust the prices collected for the 2009 PPP Update assumes that these relationships have not changed between 2005 and 2009.

D. Calculating PPP for Construction

The 2009 exercise for construction was also treated as an extension of the main 2005 benchmark. Since only prices for 10 basic inputs are collected for construction in the 2009 PPP Update, adjustment factors based on the 2005 ICP prices are used. The adjustment factors that will be applied to the 2009 PPP Update are obtained by implementing the major assumptions for the 2009 PPP Updates as follows:

Each construction basic heading is determined by a combination of materials, rents of equipment, and labor cost factors. Using regression in logs, the process can be expressed as follows:

$$PPP_j^i = C_{mat}^j * P_{mat}^i + C_{eqp}^j * P_{eqp}^i + C_{lab}^j * P_{lab}^i + c \quad (2)$$

where C_k and P_k are respectively the regression coefficients and component PPPs for construction BHj; k is the component (material, equipment, and labor); and materials, labor and equipment cost factors are determined by a combination of the respective individual elementary components via the CPD procedure (regression) for each construction basic heading:

$$y_{nc} = \ln p_{nc} = \alpha_1 D_1 + \alpha_2 D_2 + \dots + \alpha_C D_C + \eta_1 D_1^* + \eta_2 D_2^* + \dots + \eta_N D_N^* + u_{nc} \quad (3)$$

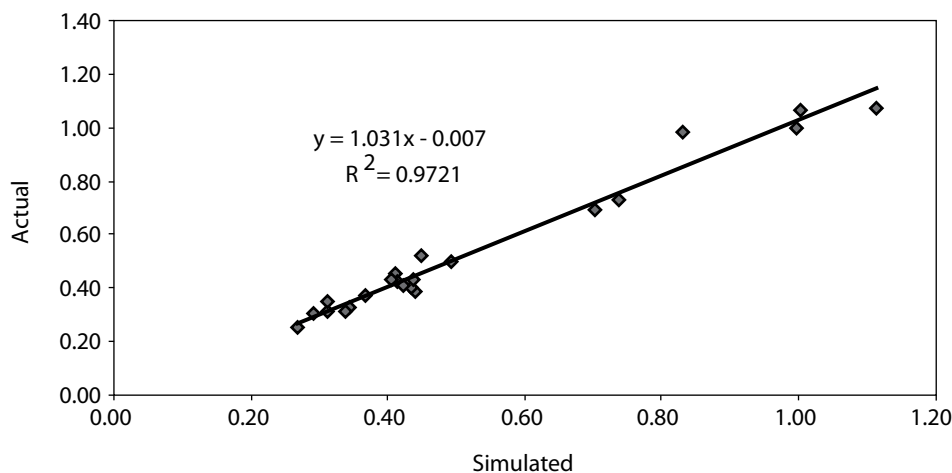
where D_c ($c=1,2,\dots,C$) and D_n^* are, respectively, country and commodity dummy variables.

Table 6: Regression Results for Construction by Basic Heading

Basic Heading	Elasticities (%)			Standard Errors (%)			R ²
	Materials	Equipment	Labor	Materials	Equipment	Labor	
Civil engineering works	48.4	11.2	27.5	7.5	2.8	1.4	0.9714
Residential buildings	57.6	4.1	37.3	7.3	2.8	1.4	0.9754
Nonresidential buildings	55.1	4.2	38.7	7.1	2.7	1.4	0.9778
Total Construction	51.7	6.9	34.4	7.2	2.7	1.4	

Source: Authors' estimates using the 2005 ICP Asia-Pacific.

PPPs for each of the three basic heading in construction, namely, civil engineering works, residential, and nonresidential buildings, derived using this shortcut method are estimated for 2005, as well as the adjustment coefficients to go from 10 elementary components to the actual 2005 construction PPPs. Those coefficient factors will be used to adjust the construction PPPs based on 10 basic inputs in 2009. The fit of the model, that is, the relationship between the 2005 actual price level indices (PLI) for construction versus the PLI derived from using the shortcut method (without the adjustment), is shown in Figure 2. Note that the adjustment would place individual estimates on the regression line. One can think of the adjustment as a correction due to variations across nations in tax policies, various administrative fees, and other expenses. In this sense, the adjustment parallels that in household consumption categories.

Figure 2: 2005 Price Level Indices for Construction, Actual versus Simulated (Hong Kong, China=100)

Source: Authors' estimates using the 2005 ICP Asia-Pacific.

E. Aggregation Methods

As is the case with price indices in general, each index formula (or method) has a number of advantages and disadvantages, so selecting one method rather than another is at least partly based on the requirements of the analysis being undertaken.

Several alternative methods are available to estimate PPPs at the basic heading level (elementary aggregation) and to aggregate to levels above the basic heading (higher-level aggregations). The two most commonly used methods to calculate PPPs at the basic heading level are the CPD method in two versions, CPD and CPRD (with consideration on representative products); and some versions of the Eltetö–Köves–Szulc (EKS⁶) method (more specifically the Jevons method, as it is using geometric means of price ratios). Above the basic heading, there is even more variety of methods, as various families of indices, both additive and nonadditive, can be used at that level. In the last couple of rounds of the ICP, one non-additive (EKS) and two additive methods, Geary–Khamis (GK) and Iklé–Dikhanov–Balk (IDB), were used for different stages of aggregation, all of which are described below.

1. The Country–Product–Dummy (CPD) Method

The CPD method is a generalized multilateral method that uses regression techniques to obtain transitive PPPs for each basic heading. The data for a given basic heading consist of all the prices available for the various product specifications for the entire collection of countries in the region. It treats the calculation of PPPs as a matter of statistical inference, an estimation problem, rather than an index number problem.⁷ The underlying hypothesis is that, apart from random disturbance, the PPPs for individual products within a basic heading are closely correlated between any given pair of countries. In other words, it is assumed that the pattern of relative prices of the different products within a given basic heading is the same in all countries. It follows from here that each country has its own overall price level for the basic heading, which fixes the levels of absolute prices of the products in the basic heading for the country. Those are valid assumptions as basic headings are normally defined as groups of similar products. By treating the prices observed in the countries for the basic heading as random samples, the PPPs between each pair of countries and the common pattern of relative prices can be estimated using classical least-square methods.

In the 2005 ICP, the starting point of the CPD approach was a matrix of prices (in national currencies) for products priced within each country in the region concerned. There were gaps in the matrix because it was not possible (and neither necessary nor generally desirable) for all countries to price every product in the list. The underlying model is

⁶ Diewert (2010) observed that Gini was the first who discovered certain principles of the EKS method, hence he suggested calling it the Gini–Eltetö–Köves–Szulc method (GEKS).

⁷ A version of the CPD, the weighted country product representative dummy (CPRD), has rather attractive economic properties. However, it may be unstable to noise in weights.

multiplicative (but additive in logarithms). It assumes that prices vary by product within countries at the same rate across all countries, and that prices vary between countries at the same rate across all products. In practice, one country has to be chosen as a base, and all other product/country combinations are measured in terms of their variation from this base. An error term (also multiplicative in this case) is required to handle differences in the observed country/product prices from those generated by the model.

The CPD index⁸ can be presented in two equivalent forms, with or without an intercept. The variant with an intercept was described in the 2005 ICP Handbook (World Bank 2008).⁹

The starting point is a multiplicative CPD model, which can be illustrated by a general example. Let us assume that there are m countries and that their product list contains n products. Then, for each product in each country, the observed price is p_{ij} for $j = 1, 2, \dots, m$ and for $i = 1, 2, \dots, n$. Note that the prices p_{ij} are expressed in each country's national currencies. The multiplicative CPD model is expressed as

$$p_{ij} = \kappa \alpha_j \beta_i v_{ij} \quad (4)$$

where p_{ij} is the price of product i in country j and v_{ij} is the error term.

The CPD model is converted from a multiplicative one to an additive one by expressing the terms in the model as logarithms:

$$\ln p_{ij} = \ln \kappa + \ln \alpha_j + \ln \beta_i + \ln v_{ij} \quad (5)$$

The observed price data are expressed in national currencies. Dummy variables with values of 1 or 0 are used to represent each country (j) and product (i). The regression coefficients are estimated by ordinary least squares. It is necessary to specify a base country and base product for the model, so if the base country is country 1 and the base product is product 1, then $\alpha_1 = \beta_1 = 1$, and it follows that $\ln \alpha_1 = \ln \beta_1 = 0$. Any other country can be made the base country simply by dividing every country's PPP by the new base country's PPP.

Differences between observed prices and the modelled prices provide an indication of possible problems with the prices provided by a country. Large differences indicate that prices for the same product vary significantly between countries or that the product is either misspecified or not representative of the economy. The distribution of these differences provides the underlying basis for the Dikhanov table¹⁰ as an editing tool. The

⁸ Introduced by Summers (1973). For a thorough discussion see Prasada Rao (2004) and Diewert (2004).

⁹ The variant with an intercept is presented in Chapter 10 of the 2005 ICP Handbook, but Rao (2004) and Diewert (2004) use one without an intercept.

¹⁰ The Dikhanov table, developed by Yuri Dikhanov of the World Bank, was an innovation introduced in the 2005 ICP to assist in editing and validating prices collected by economies. For a thorough discussion, see Chapter 7 of the 2005 ICP Handbook.

distributions can be graphed to provide a simple means of identifying potential problem prices for a product across countries or for a set of products within a country.

Two of the major advantages of the CPD method include the estimation of sampling errors for the PPPs and the calculation of pattern of residuals that can be used to indicate potential problems with the consistency (or inconsistency) of prices collected by an economy for a particular basic heading.

2. The EKS Method

The EKS formula is a means of aggregating basic heading PPPs to broader levels, such as total household final consumption expenditure, up to and including GDP itself. It was first used to produce transitive PPPs from a set of nontransitive bilateral parities that were obtained as simple geometric averages from individual price ratios for a pair of countries.¹¹ The EKS method differs from the CPD method in several important respects. First, it is based on a binary approach rather than a multilateral one. The binary PPPs of all pairs of countries do not automatically produce transitive estimates, and hence, an extra step is required to convert the binary comparisons into multilateral, transitive ones. Transitivity is the property whereby the direct PPP between any two countries yields the same result as an indirect comparison via a third country. For example, if there are three countries A, B, and C, transitivity means that the same relationship between A and B will be observed no matter whether it is calculated by directly comparing A and B or whether they are each compared via C, i.e., $PPP_{A/B} = PPP_{A/C}/PPP_{B/C}$. The EKS method treats participating countries as a set of independent units, each with an equal weight. The binary PPPs are made transitive by a procedure that minimizes the differences between them and the multilateral PPPs it produces. For each pair of countries, the EKS method provides PPPs that are similar to the PPPs that would be obtained if each pair of countries had been compared separately. The EKS formula is used to produce transitive PPPs from a set of bilateral PPPs.

In the first stage of the EKS method, PPPs are derived for each broad aggregate (e.g., household final consumption expenditure) above the basic heading level for each pair of economies in a region, using one as the base economy followed by the same calculation using the other as the base economy. The PPP for each of the expenditure aggregate is calculated as the geometric mean of the two PPPs resulting from this process.

The eventual outcome is a matrix of PPPs for each pair of economies, for each aggregate for which PPPs are required, up to the level of GDP. Each matrix consists of nontransitive PPPs for each aggregate, which are then made transitive by applying the EKS formula. If three economies (A, B, and C) are involved, then the transitive PPP for economies A and B for a given aggregate is:

¹¹ The EKS method can be used both at the basic heading and above. At the basic heading level it becomes the Jevons index.

$$PPP^{A/B}_{transitive} = \left[\left(\frac{P^A}{P^B} \right) \times \left(\frac{1}{P^B/P^A} \right) \times \left(\left(\frac{P^C}{P^B} \right) \times \left(\frac{P^A}{P^C} \right) \right) \right]^{\frac{1}{3}} \quad (6)$$

In general cases, for n economies, the EKS PPP is expressed as:

$$PPP_j^i = \Pi_{\forall k} \left[\frac{P_k^i}{P_k^j} \right]^{\frac{1}{n}} \quad (7)$$

The EKS formula above produces transitive PPPs that are as close as possible to the nontransitive PPPs originally calculated in the binary comparisons. For the EKS formula to work, it is necessary for PPPs to be available for all economies for each basic heading. If the PPP for any basic heading is missing (e.g., because of data collection problems or data consistency issues), then a PPP has to be imputed either by using the PPP of a similar basic heading or from a broader (but related) aggregate.

The aggregation process is identical for each level of aggregation in the national accounts. For example, all 155 basic headings have to be combined to obtain a PPP for GDP, while the 29 basic headings that make up food and nonalcoholic beverages within household final consumption expenditure would be combined using a similar process to calculate a PPP for food and nonalcoholic beverages. The transitive PPPs are used as deflators to convert aggregates expressed in national currency into real expenditures expressed in a common currency in a similar way that price indices are used as deflators in the time series national accounts.

At the basic heading level, a variation on the EKS method, which allows for different weights to be applied to product prices depending on whether they are classified as “representative” or “nonrepresentative”, is referred to as the EKS* method. The EKS* method was not used in the 2005 ICP Asia-Pacific because of the difficulties involved in the economies’ ability to distinguish between representative and nonrepresentative products consistently across the region. The CPD was used instead.

One of the characteristics of the EKS method is that the real expenditures obtained using the EKS-based PPPs are not additive, which means the real expenditures for the final expenditure components of GDP will not add to that for GDP (similar to the nonadditivity issue associated with calculating chain volumes in time series national accounts). As a result, the EKS-based PPPs have to be calculated separately for each expenditure aggregate because it is not possible to obtain volumes for any aggregate directly by summing the volumes for more detailed aggregates. On the other hand, the EKS method has the major advantage of producing unbiased estimates, which is considered to

outweigh the drawback of nonadditivity in the real expenditures. Some of the methods that produce additive real expenditures (e.g., the Geary–Khamis [GK] method) have the shortcoming that the results are biased, particularly when countries at different stages of economic development are being compared. The Ikle–Dikhanov–Balk (IDB) index results, on the other hand, come close to the EKS and are additive.

3. The Geary–Khamis Method

The GK method is an average-price method to compute PPPs and real final expenditures above the basic heading. It entails valuing a matrix of quantities using a vector of international prices. The vector is obtained by averaging national prices across participating countries after they have been converted to a common currency with PPPs and weighted by quantities. The PPPs are obtained by averaging within participating countries the ratios of national and international prices weighted by expenditure. The international prices and the PPPs are defined by a system of interrelated linear equations that require solving simultaneously. An advantage of the GK method is that it produces PPPs that are transitive and real final expenditures that are additive. It has a number of disadvantages. One is that a change in the composition of the group can change significantly the international prices, as well as the relationships between countries. Another is that the international price structure is biased toward large countries.

The traditional presentation for the GK system (in terms of international prices π and PPP) can be written as follows:

$$\pi_i = \sum_j p_j^i v_j \kappa_j^i \quad (8)$$

$$v_j = \sum_i \frac{\pi_i}{p_j^i} \omega_j^i \quad (9)$$

where $\omega_j^i = \frac{p_j^i q_j^i}{\sum_k p_j^k q_j^k}$, $\kappa_j^i = \frac{q_j^i}{\sum_l q_l^i}$ and $v_j = 1/PPP_j$, and p and q are prices and quantities.

In matrix form:

$$\pi = (\mathbf{K} \circ \mathbf{P}) \mathbf{v} \quad (10)$$

$$\mathbf{v} = (\mathbf{\Omega} \div \mathbf{P})^T \pi \quad (11)$$

Thus, finding international prices and PPPs would involve solving one of the combined systems: $\lambda \pi = (\mathbf{K} \circ \mathbf{P})(\mathbf{\Omega} \div \mathbf{P})^T \pi$, or $\lambda \mathbf{v} = (\mathbf{\Omega} \div \mathbf{P})^T (\mathbf{K} \circ \mathbf{P}) \mathbf{v}$, where $\langle \circ \rangle$ and $\langle \div \rangle$ are the element-by-element (*Hadamard*) matrix multiplication and division operators, respectively, i.e., $\mathbf{K} \circ \mathbf{P} = [\kappa_j^i p_j^i]$ and $\mathbf{\Omega} \div \mathbf{P} = [\omega_j^i / p_j^i]$.

4. The Iklé–Dikhanov–Balk Method

The IDB method is one of the average-price methods for computing PPPs and real final expenditures above the basic heading level. Hence, it entails valuing a matrix of quantities using a vector of international prices that is also obtained by averaging national prices across participating countries after they have been converted to a common currency with PPPs. The IDB weighting scheme is based on real expenditure structures. The PPPs are obtained by averaging within participating countries the ratios of national and international prices weighted by expenditure. The international prices and the PPPs are defined by a system of interrelated linear equations that have to be solved simultaneously. The IDB method produces PPPs that are transitive and real final expenditures that are additive. However, the IDB method is less biased than the GK method, and in the real world comparisons it was found to produce results similar to the EKS (see Deaton 2009, 17–8). The IDB index in terms of [π -PPP] presentation can be presented as follows (for a thorough discussion see Dikhanov 1997):

$$\pi_i = \sum_j p_j^i v_j \frac{\delta_j^i}{\sum_j \delta_j^i} \quad (12)$$

$$v_j = \sum_i \frac{\pi_i}{p_j^i} \omega_j^i \quad (13)$$

In matrix form:

$$\pi = (\Delta \circ P) v \quad (14)$$

$$v = (\Omega \div P)^T \pi \quad (15)$$

where $\Delta = \left[\frac{\delta_j^i}{\sum_j \delta_j^i} \right]$ is the matrix of country real expenditure shares.

5. Choice of Method

Each of the method has its strengths and weaknesses among, which include:

(i) Elementary Aggregation

- a. The outcomes from the CPD/CPRD method (which produces transitive PPPs) are neutral to size of countries. A major advantage of the CPD method is that it is a “statistical” method, implying that sampling errors can be calculated directly,

and the outputs include a set of “expected” prices that enable comparison with the observed prices, thereby highlighting potential errors. Thus, the CPD/CPRD serves also as a powerful diagnostics tool, being at the core of main diagnostics methods used in the ICP procedures.

(ii) Above Basic Heading Aggregation

- a. The GK and IDB methods are transitive and additive but they are also biased to different degrees. In the GK case, the international price structure is dominated by the larger countries in the comparison (also called the Gerschenkron effect). For example, in the Asia and Pacific region, the resulting GK international price structure would be dominated by the price structures of the PRC and India, which accounted for almost two thirds of the region’s GDP. On the other hand, in the IDB case, the international price structure would be more neutral, as it gives each country equal weight, and, as a result, the IDB PPPs is usually close to the EKS PPPs in the real world comparison (see Deaton 2009, 17–8).
- b. The EKS method is transitive and unbiased and gives each country equal weight in the aggregation. However, as the real expenditures obtained from the EKS-based PPPs are nonadditive, it is less suitable for analyses of output structures.

In the 2005 ICP round, the Asia and Pacific region used the CPD method to obtain basic heading PPPs and the EKS to aggregate above the basic heading level in lieu of their “neutrality and unbiasedness” to prices of large economies, which is not the case for the other methods. For consistency with the 2005 aggregation, the same methods are used in estimating PPPs for the 2009 PPP Update.

VI. Limitations and Possible Constraints

The products identified for pricing in 2005 consisted of a sample of the different types of goods and services that were available at that time and were considered to be both representative of expenditures in economies in the Asia and Pacific region (or at least within groups of these economies), and to be comparable among them. The starting point for the 2009 PPP Update is this product list, but one of the processes necessary in the ICP is to update the product lists used in the previous round. A small proportion of the products included in the lists for one ICP round have to be changed during the course of implementing the 2009 PPP Update. The extent of change varies between different product groups. For example, the specifications of many staple foodstuffs will not change significantly between ICP rounds. On the other hand, the specifications for electronic products are unlikely to remain the same from one ICP round to the next, given that

the rapid rate of technological change affecting these types of products renders them obsolescent; in many cases, within a year or two.

Some products may no longer be available in the market (e.g., mercury thermometers, 21-inch television sets), and some may still be available but no longer sold in large quantities because they are based on outmoded technology (e.g., radio cassettes). Therefore, new replacement products need to be identified for inclusion in the update list (e.g., compact discs in place of radio cassettes; digital thermometer in place of mercury thermometer) and it may also be necessary to update the specifications for those products that still exist but whose characteristics have changed since the previous round (e.g., refrigerators, television sets, motor vehicles). A simplified process was used in identifying products to be priced for the 2009 PPP Update, although the starting point was still the 2005 ICP Asia-Pacific product list. Any products that were no longer relevant were removed from the list of potential products to be priced. As was the case in the 2005 round, the number of products included in the product lists varied significantly from one basic heading to another, based largely on the size of each basic heading and the diversity of products it covered. In a number of cases, existing products were retained but their specifications were updated to bring them into line with changes in their characteristics since they had been specified for the 2005 round. Care was taken to ensure that all economies were provided with the best possible opportunity to price at least one product in each basic heading, which is a minimum requirement for the ICP.

The 2005 product list covered all geographic areas of the participating economies. In the 2009 PPP Update, prices are collected only in the capital city in each economy to minimize the costs incurred. However, if a specified product is not available in the capital city, then for these cases it would be necessary to collect prices in the vicinity of the capital city or in a neighboring city close to the capital city. Only a limited number of such cases are anticipated as it is more likely that capital cities would carry more varieties of products than markets outside the capital city.

VII. Conclusions

The paper discussed a cost-effective way of estimating PPPs during interbenchmark years as a possible alternative to extrapolations. It has suggested using a core product list for pricing and to be applied in capital cities only. It has also addressed using CPI data to adjust capital city prices to national prices. These are innovations introduced as a variant to the conventional method of extrapolating PPP based on GDP growth rates for in-between benchmark years.

The 2009 PPP Update would provide a number of benefits to the economies involved. Apart from building up the infrastructure for the 2011 ICP round, it also enables statistical capacity building in both prices and national accounts. For economies with sufficiently detailed and codified data in their CPI data set, it is possible to use the CPI price observations and CPI weights to obtain subnational PPPs for household final consumption expenditure, which can be used to adjust capital city prices to the national level. This paper briefly set out the steps and processes involved in the 2009 PPP Update calculation. Reliable and updated PPPs are important in analyzing the extent to which progress is being made in meeting the poverty-related MDGs, and subnational PPPs will be useful for those interested in assessing subnational differences in poverty.

The final results of the PPP updates are expected to be available by mid-2011. While the results may not be the “official” PPP estimates for 2009 for the Asia and Pacific region, the 2009 PPP Update shows that interbenchmark PPPs calculated using a core or reduced product list and at a reduced cost is feasible. The methodology presented here establishes the viability of “updates” as an alternative to extrapolations. Conducting an update for 2011 (based on 2005) and comparing the results with the benchmark results of the 2011 round would be a good way to ascertain the methodology and accuracy of the 2009 PPP Update results.

References

- ADB. 2007. *2005 International Comparison in Asia and the Pacific—Purchasing Power Parities and Real Expenditures*. Asian Development Bank, Manila. Available: www.adb.org/Documents/Reports/ICP-Purchasing-Power-Expenditures/default.asp.
- Capilit, E. 2009. “Improving Product Parity for the 2009 Purchasing Power Parity for Asia and the Pacific—Background Paper.” Asian Development Bank, Manila. Available: www.adb.org/Statistics/icp/files/6482-3DRW/2009-PPP-Update-Improving-Product-Parity.pdf.
- Dalgaard, E., and H. S. Sørensen. 2000. “Consistency Between PPP Benchmarks and National Price and Volume Indices.” Paper presented at the 27th General Conference of the International Association for Research in Income and Wealth, Stockholm. Available: www.h.scb.se/scb/Projekt/iariw/program/5PPPconsistency.pdf.
- Deaton, A. 2009. “Understanding PPPs and PPP-based National Accounts.” Available: pwt.econ.upenn.edu/papers/deaton%20heston%20complete%20nov10.pdf.
- Diewert, E. 2010. *New Methodological Developments for the International Comparison Program*. Available: faculty.arts.ubc.ca/ediewert/dp0808.pdf.
- Dikhanov, Y. 1997. *Sensitivity of PPP-Based Income Estimates to Choice of Aggregation Procedures*. World Bank, Washington, DC. Available: siteresources.worldbank.org/ICPINT/Resources/icppapertotal.pdf.
- . 2009. “ICP Asia Pacific 2009 Update—Background Paper.” World Bank, Washington, DC. Available: www.adb.org/Statistics/icp/files/6482-3DRW/RETA-6482-Paper-Dikhanov.pdf.
- Johnson, D. S., S. B. Reed, and K. J. Stewart. 2006. *Price Measurement in the United States: A Decade after the Boskin Report*. US Bureau of Labor Statistics, Washington, DC. Available: <http://www.bls.gov/opub/mlr/2006/05/art2full.pdf>.

- Prasada Rao, D.S. 2004. The Country-Product-Dummy Method: A Stochastic Approach to the Computation of Purchasing Power Parities in the ICP. CEPA Working Papers Series No. WP032004, School of Economics, University of Queensland.
- United Nations. 1993. "About the System of National Accounts 1993." Available: unstats.un.org/unsd/sna1993/.
- Varjonen, S. 2002. *Improving the Quality of PPP Series*. Organisation for Economic Co-operation and Development. Available: www.oecd.org/dataoecd/51/21/1961624.pdf.
- Ward, M., et al. 2008. Integration of Consumer Price Indices and the International Comparison Program for the Asia and Pacific Region: How can They be Achieved? ADB Economics Working Paper Series No. 143, Economics and Research Department, Asian Development Bank, Manila.
- World Bank. 2007. *ICP 2003–2006 Handbook*. Washington, DC. Available: web.worldbank.org/WBSITE/EXTERNAL/DATASTATISTICS/ICPEXT/0,,contentMDK:20962711~menuPK:2666036~pagePK:60002244~piPK:62002388~theSitePK:270065,00.html.
- . 2008. *Global Purchasing Power Parities and Real Expenditure: 2005 International Comparison Program Methodological Handbook*. Washington, DC. Available: siteresources.worldbank.org/ICPINT/Resources/icp-final.pdf.

About the Paper

Yuri Dikhanov, Chellam Palanyandy, and Eileen Capilit discuss alternative methods and approaches for estimating purchasing power parity (PPP) for nonbenchmark years. These approaches are implemented in the 2009 PPP Update in the Asia and Pacific region by treating the 2009 PPP Update as an extension of the 2005 benchmark, with minimum additional data collection based on core lists of products, and using certain interproduct and intracountry price correlations from the 2005 exercise.

About the Asian Development Bank

ADB's vision is an Asia and Pacific region free of poverty. Its mission is to help its developing member countries substantially reduce poverty and improve the quality of life of their people. Despite the region's many successes, it remains home to two-thirds of the world's poor: 1.8 billion people who live on less than \$2 a day, with 903 million struggling on less than \$1.25 a day. ADB is committed to reducing poverty through inclusive economic growth, environmentally sustainable growth, and regional integration.

Based in Manila, ADB is owned by 67 members, including 48 from the region. Its main instruments for helping its developing member countries are policy dialogue, loans, equity investments, guarantees, grants, and technical assistance.

Asian Development Bank
6 ADB Avenue, Mandaluyong City
1550 Metro Manila, Philippines
www.adb.org/economics
ISSN: 1655-5252
Publication Stock No. WPS113108



Printed in the Philippines