

International Comparison Program

[03.01]

A New Approach to International Construction Price Comparison

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I. INTRODUCTION

1. The International Comparison Program (ICP) is responsible for the production of Purchasing Power Parities (PPPs) for both national GDP and for sub-components of GDP. PPPs are alternatives to market exchange rates and are intended to reflect price level differences across countries more accurately. One of the sub-components of GDP is Construction, part of Gross Fixed Capital Formation. This note reviews development work over the last eighteen months and recommends an approach to the calculation of construction PPPs for the ICP 2011 round.
2. Construction is described in the report of the ICP 2005 results as ‘comparison resistant’. It is difficult to identify a range of comparable and representative construction products/ projects and virtually impossible to observe purchaser prices in a national average location at the same time in all countries. As a result, the methods adopted for the calculation of PPPs are mostly based on theoretical products/ projects and require adjustments to bring them to a common basis. Designing the data collection, collecting the price data and processing it requires specialist skills and knowledge.
3. The work outlined in this note applies to construction work undertaken by formal construction contractors using modern materials; a separate note has been prepared on so-called ‘informal’ construction, particularly construction work on informal residential buildings. Like other price indicators, the calculation of PPPs requires a list (or lists) of items, and weights and prices for these items. The challenge is to identify appropriate lists and reliable sources of prices and weights.
4. The approach adopted is based on 50 basic and common resources for construction work selected to correspond with the main inputs to national construction output. Prices for the inputs are collected in a national price survey and weights for the inputs are based on model projects and resource mixes provided by survey respondents. Inputs are converted to outputs using mark-ups collected in the price survey and price levels for basic headings are derived by selecting representative projects. The approach builds on the paper presented to the Technical Advisory Group (TAG) in October 2010 and addresses three issues raised by the TAG:
 - the availability and consistency of input-output tables;
 - the need to have PPPs for basic headings; and
 - the use of grossing-up factors.

II. OBJECTIVE

5. The purpose of the International Comparison Program (ICP) is to produce PPPs for major components of the economy. Construction, as part of Gross Fixed Capital Formation, is one component. Construction PPPs are currency convertors that permit comparisons of construction volumes across countries to be made. The intention is to compare quantities – not values – of construction output each year. The rationale is that market exchange rates do not accurately represent relative price levels. PPPs for construction represent prices paid by end users, the customers for construction works.

III. REVIEW OF ALTERNATIVES

6. The proposed approach is to combine simple sets of weighted baskets of construction resources representing construction output in each country and the prices for each resource in each country collected in a purpose-designed price survey. The survey will also collect mixes of resources and mark-up percentages for three basic headings, residential buildings, non-residential buildings and civil engineering. Quantity weights for materials and products will be derived from model projects representing basic headings and basic heading PPPs will be aggregated to ‘all construction’ PPPs using national data. The original idea was to use value weights from input-output tables but in the event this proved impractical, largely because tables are not always available, not up-to-date, inconsistent in content or presentation, or some combination of these. Input-output tables also generally do not permit PPPs for basic headings to be calculated.
7. A number of methods for deriving construction PPPs have been developed over the years. Some of these are still in use and some have been abandoned; all, including the proposed approach, have shortcomings, none of them are perfect. This section briefly reviews the main features of these methods. They are:
 - Project (bill of quantity) based approaches used by Eurostat and OECD, adopted by member, associate and candidate countries of the EU and member and associate countries of the OECD. There are issues concerning the representativity of the projects selected and the extent to which all construction is represented but the main concern is probably with the cost of the exercise and the reliance on one source of data (although that source may well have a wider view).
 - The method used by the CIS states. This involves the collection of unit prices for construction inputs which are then applied to model projects with quantity weights for materials and products and labour (but not for equipment). The models are representative of ‘standard’ project types although they are less complete than the OECD/ Eurostat bills of

quantities; the projects are then weighted to represent basic headings and all construction output.

- The Basket of Construction Components (BOCC) approach used in the 2005 ICP round involves a combination of basic inputs and more complex work items that were to be weighted on the advice of local experts. There were difficulties with the establishment of weights and confusion over the mixture of basic and complex items.
 - Square metre rates are estimates of the total price of projects expressed as an amount per unit of built floor area. There is, however, uncertainty across countries about the rules of floor area measurement and what is included/ excluded in the rates.
8. The CIS method is closest to the proposed approach but is less explicit about resource mixes and mark-ups. The Eurostat/ OECD method involves a large amount of effort and cost in implementation and, for that reason alone, probably cannot be considered for the ICP survey. The BOCC method was unsuccessful in 2005 largely because the relationship between simple and complex items was unclear and it was not possible to obtain reliable system weights. Square meter rates are useful but inadequate as a basis for the calculation of PPPs. All of the project based methods have the problem of reflecting tender rather than outturn prices and the extent of ‘cost drift’ varies significantly across countries. The main advantages of the proposed approach are that it is relatively simple to collect the necessary price and other supporting data, including mark-ups, and it is relatively inexpensive to implement; in addition, it is possible to include some of the same price data as the BOCC method (the basic items) so that results can be calculated for both methods.
9. It should be noted that construction output, or tender/ bid, prices reflect construction prices at a point in the future when resources will be purchased and work undertaken; they are, therefore, price forecasts – the actual base date depends on the duration and nature of the project. Resource prices, the prices collected in the propose approach, are current at the date they are collected.

IV. ESTABLISHING WEIGHTS

10. Two types of weights are required: weights for the items that represent the three basic headings (residential buildings, non-residential buildings and civil engineering) and weights that represent the contribution that each basic heading makes to all construction. The items representing basic headings can be the resource inputs or work items that make up construction projects or they can be whole construction projects.
11. Existing methods (notably the Eurostat and OECD methods and the BOCC method used in ICP 2005) are based on work items. They have been rejected for this round, in the case of Eurostat and OECD, largely because they are too expensive to implement, and, in the case of BOCC, largely because reliable weights were difficult to find to convert work items into projects.

12. While model projects provide a sound basis for the calculation of material resource inputs, the corresponding labour and equipment resource inputs are dependent on the skills and technology available in a country and other factors, and average values can vary widely from country to country and, within countries, across types of work. There can be trade-offs between the skill levels and the price of labour (highly skilled labour is usually expensive but the quantity of workers required is relatively low, and vice versa) but that is not always the case. There will also be trade-offs between the quantities of labour and equipment inputs (capital/ labour substitution) but there is relatively little information on that in most countries.
13. In most countries and in most types of work (although not necessarily in civil engineering work), materials and products represent the greatest proportion of construction value (typically, 50 – 70%) and, in building work, labour represents the next greatest (20 – 40%) and equipment the smallest proportion (5 – 20%). In civil engineering work, the relative significance of labour and equipment can be reversed and materials and products may not be the most significant component. Civil engineering also tends to be the most variable of the basic headings, particularly in smaller or less developed countries, where a dominant type of work can influence the mix – roads and tunneling, for example, will have relatively low material content.
14. Input-output and Supply and use tables provide a useful indication of the labour input to all construction work via ‘compensation of employees’ in value-added and, in some countries, where there are multiple columns for construction, the labour inputs to different types of work can be calculated. But tables are not available for all countries and are often not up to date, and, even when they are, they usually only provide information on all construction, not basic headings. And tables provide even less, and less reliable, information on the equipment inputs to construction.
15. In the Consultants’ pilot survey, questions were asked about the proportion by value that the three main resource inputs represented of the three main types of construction work (residential, non-residential and civil engineering). Table 1 sets out the proportions provided by respondents; these have been through one round of validation but are still subject to revision.

Country	Residential construction			Non residential construction			Civil engineering		
	M	E	L	M	E	L	M	E	L
Australia	60	5	35	70	5	25	30	20	50
USA	42	3	55	45	5	50	40	40	20
UK	52	8	40	45	15	40	35	35	30
Egypt	85	5	10	75	10	15	40	50	10
Lebanon	70	5	25	75	5	20	20	60	20
UAE	65	15	20	65	15	20	65	15	20
Yemen	70	10	20	60	20	20	40	50	10
Tanzania	70	10	20	65	20	15	55	35	10
South Africa	40	5	55	40	15	45	45	35	20
Thailand	70	7	23	70	7	23	na	na	na
Brunei	75	10	15	75	10	15	60	20	20
China	75	15	10	78	12	10	70	20	10

Country	Residential construction			Non residential construction			Civil engineering		
	M	E	L	M	E	L	M	E	L
Macau	50	30	20	50	30	20	60	20	20
Hong Kong	62	3	35	65	5	30	55	25	20
India	70	10	20	70	10	20	60	20	20
Indonesia	65	20	15	60	25	15	65	20	15
Japan	55	10	35	55	10	35	55	18	27
South Korea	70	5	25	68	7	25	33	26	41
Malaysia	65	10	25	65	10	25	35	35	30
Philippines	60	5	35	70	5	25	30	20	50
Pakistan	45	20	35	45	20	35	35	35	30
Singapore	70	10	20	70	10	20	na	na	na
Vietnam	70	8	23	70	8	23	60	32	8

16. The percentages in the table are only partially validated and there are still a few slightly surprising figures (e.g. the labour proportions in South Africa, Egypt and China). Reliable data of this kind is not readily available and difficult to collect, even from experienced professionals; the consultants are currently in bilateral discussions with a number of survey respondents.
17. Generally, the value of materials and products is more consistent internationally than either equipment or labour. The range in the table is 40 – 85% but the majority of material and product values fall between 50 and 75%. There is much greater variability both between and within the values for equipment and labour. The main reasons for this are the capital: labour mix adopted in local industries, the cost of local labour and local levels of productivity.
18. In the CIS survey, quantities are provided for materials and products and one type of labour (and no equipment). Factors are provided by countries to adjust labour quantities relative to a base quantity. Based on 2005 data, the proportions of labour in total project value for a sample of projects varied between 13 and 37% in nine countries, similar to the range in the pilot survey. The percentages, however, look low for some types of work in some countries, particularly non-residential building work in all but Belarus and Russia.
19. The CIS method utilizes 104 model projects (23 residential, 61 non-residential and 20 civil engineering). Not all of the projects are representative of construction work in all countries and an asterisk system is used to indicate representivity – projects considered unrepresentative are omitted from the calculation of that country’s PPPs. Some, at least, of the CIS projects will be suitable as a basis for the calculation of quantity weights for materials and products in the proposed approach.
20. Eurostat and OECD projects can also provide quantity weights for examples of the three basic headings. The bills of quantities will be analyzed and quantities of materials and products extracted. The Consultants have other sources of quantity weights including an analysis of 83 UK housing projects and a model of a non-residential commercial building project used in Rick Best’s PhD thesis.

21. Broad resource input weights for the three basic headings can, therefore, be derived from expert responses to the ICP construction survey. These will need to be thoroughly checked and validated but offer probably the best source of overall value weights. Quantity weights for materials and products representing different types of construction work can be derived from a range of model projects and value weights for labour inputs can be derived from Input-output and Supply and use tables for at least some countries. All of these various sources provide a sound basis for calculating PPPs for construction basic headings.
22. The value of construction work in each basic heading will vary from country to country and from year to year. In larger more mature economies there may be long term regular patterns in construction investment but, in smaller and less developed economies, the mix can vary substantially from year to year. Countries go through phases of construction investment depending on some combination of the state of the general economy, government policy, the volume and nature of development aid programmes, and other factors.
23. Construction output data is usually available from national statistical offices or other government departments that indicates the mix by value of the different types of construction produced each year, and this type of data is usually relatively up to date and in categories that can be matched to the three basic headings. This data will need to be collected from government departments, preferably for a number of years. Assessments will also need to be made of what output is included in, and excluded from, official figures.

V. PRICING RULES FOR MATERIALS AND PRODUCTS

24. Prices provided should be those paid by construction contractors to their suppliers. In the case of materials and products, that will typically be the prices paid, after discounts, to manufacturers or intermediaries (agents or merchants), including all non-recoverable taxes; in the case of equipment, it should be the rental charges paid to hire companies or internal hire rates; and, in the case of labour, the cost to the contractor of employing the workers. Informal payment arrangements for labour are common in construction - for example some payment is in the form of wages, subject to taxes and on which employers' costs are incurred while other payments are in cash - and respondents should bear this in mind when determining what an 'average' wage is. There is space for notes on pricing after the material, plant and labour sections and it is important that these are completed by respondents.
25. Prices should be provided for items that are commonly available and commonly used in the country; they should not be provided for items that match the item description precisely if that involves pricing a 'special' item, either not generally available in the country or only available at a premium price.

26. Countries are requested to provide survey seeks annual and national ‘average’ prices in national currency. Annual averages mean prices that are an average over the survey year (mid-year prices are acceptable) and that average different price levels across the country, across different types and sizes of projects. While striving to select appropriate average prices, country respondents should remain mindful of the following rules:

- Geographical location: Construction prices can vary across countries, as a result of local resource and distribution costs, geographic, seismic or climatic conditions, local market conditions, etc, particularly in large countries and sometimes these variations can be significant. Respondents should consider the extent of geographical variations when pricing items and make a judgement on what is a realistic national average.
- Site context: Construction prices can vary depending on detailed site conditions, for example, constrained city centre sites, greenfield sites adjacent to urban areas and remote sites that are difficult to access; when pricing items, respondents should assume reasonable site contexts with good access.
- Size of projects: The size of projects can influence the cost of resources, particularly materials and equipment – large quantities and long periods of hire, for example, can reduce unit costs and vice versa.

27. Prices should be provided for medium-sized projects, that is, projects which are not unusually small or unusually large.

28. Purchaser prices for materials and products, equipment hire and labour will be sought from expert construction respondents in each country. A single average price will be sought for each item but respondents will also be asked to indicate to what extent these can vary as a result of regional location. Respondents will also be asked to provide mark-ups for each of the basic headings to cover general and preliminary items and contractors’ overheads and profit.

29. In addition to input prices and mark-ups, the survey form will ask for m2 output prices for different types of work representing the three basic headings. It will also ask for respondents’ views on their countries price levels relative to a stated selection of neighbouring countries. These will be used as checks on the main survey data.

VI. COLLECTING AND VALIDATING PRICES

30. The prices required are mid-year national average prices, as paid by the purchasers, for all construction and three sub-headings (basic headings) of construction work, residential, non-residential and civil engineering. The pilot survey collected input prices (the prices paid by contractors) for 38 materials and products (including fuel and electricity), seven types of labour and five types of equipment; the proportions that the three groups represented of the total value of construction and of the basic headings; and the mark-ups required to add to input prices to produce output prices. The survey also collected m2 output prices for different types of projects

representing the basic headings, and respondents' views on their price levels relative to neighbouring countries'. Appendix A comprises the list of construction materials and products, equipment and labour proposed for the main survey.

31. The input prices, weighted as appropriate, are intended to be the primary basis of construction PPPs, but the m2 prices and the respondents' views on relative prices will also help to confirm, or inform the checking of, the input prices. A first round of validation of the pilot survey data has been undertaken based on an analysis of responses and identification of price outliers, and 17 out of 23 countries have responded. The initial validation provided initial PLIs and asked respondents to comment on their own price level and their price level relative to other countries; it also asked for confirmation, clarification or completion of particular items of information. A second round of validation will be undertaken where it is considered necessary to obtain further information.
32. The survey forms, except for Tanzania and Yemen, were completed by construction experts from Davis Langdon, an international firm of construction consultants; the Tanzanian and Yemeni surveys were completed by local consultants. Generally the quality of responses was very good and most sections were completed fully and properly. All the forms required some adjustment of some prices as a result of respondents' changes to item descriptions and units. The pilot survey also identified shortcomings in the survey forms that are being addressed.
33. After adjustment, price and other data were entered into a spreadsheet model that produced summary tables and initial PPPs and PLIs. Gaps are taken care of using established calculation tools, e.g. the Quaranta programme or similar. Unweighted geometric means of item price relatives were calculated for materials, labour and equipment for each of the three basic headings, and mark-ups were added to produce basic heading PPPs; these were then aggregated to produce 'all construction' PPPs. PPPs were also calculated based on m2 rates and efforts were made to rank countries based on respondents' views of their price levels relative to their neighbours (this latter was less successful than it should have been because the question in the survey was poorly framed – this will be addressed in the revised form).
34. Validation questionnaires, including summary tables, tables and diagrams of PLIs, and prices identified as outliers, were sent to each respondent. Outliers were set as item prices that were more than 2.5 times, or less than 0.4 times, the price level for that country. That produced an average of 8.1% of priced items as outliers (11% of materials, less in the other groups) or between zero and 10 items per country. Reducing the outlier range to 2.0 to 0.5 produced 15.2% outliers, between zero and 16 items per country; a range of 1.5 to 0.67 gave 34% outliers, 5 to 29 items per country. The validation to date, has reduced outliers to 6.0% of priced items and a maximum of 9 items per country).
35. M2 prices and respondents' views of relative prices will mainly be used to inform the validation process. The consultants will also review the availability and reliability of published construction price data. Generally, however, the countries with good supplementary data will tend to be the countries where major construction contracting and consultancy firms are active and where it should be possible to obtain good survey responses. The section on survey respondents' views of

price levels in neighboring countries should help confirm the relative position of countries and may help provide price level indicators where little or no price data can be obtained.

VII. PRICE METHODOLOGY

Selecting Items

36. As with other PPP calculations, the exercise requires a set of ‘product baskets’ to be identified to serve as the basis for weights and prices. The criteria for selection of material and product items in the baskets are that they should be:
- common across most countries in terms of use in construction
 - significant in terms of value used in construction in most countries
 - simple to describe and likely to be understood in most countries.
37. Numbers of items and individual items were selected by reference to input-output tables and lists of items used in published construction price features.
38. The table below sets out the three categories of items selected for materials and products, and for equipment and labour. Items in the table marked with an asterisk are identical to basic items in the ICP 2005 BOCC survey documentation; this will allow an ‘overlap’ with the 2005 method.

VIII. IMPLEMENTATION

39. The pilot survey demonstrates that, with a carefully designed survey and expert respondents, useful price and other data can be collected successfully. To ensure reliability, some manual adjustment of data and at least two validation rounds are probably necessary.
40. The basic method of calculating PPPs is well understood and will be adopted for construction PPPs: price relatives for selected items are weighted and aggregated using geometric means. Weights for material and product resource inputs will be taken from project models; relative weights for other inputs and mark-ups will be taken from the price survey, and basic heading PPPs will be produced. Basic heading PPPs will be aggregated to all construction PPPs using weights from national statistical offices. The Consultants have developed and tested spreadsheet models for these calculations
41. The main survey is planned for July 2011. Prior to that:
- The survey forms and instructions will be finalized and translated;
 - Briefing notes will be compiled for regional coordinators and national statistical offices; and
 - Notes on selection criteria will be prepared for national construction experts.
 - All of these activities are in hand.

42. In parallel, the consultants will identify suitable model projects representing construction work internationally under the three basic headings and compile material and product quantities for each of them. They will also collect data on the relative proportions of the basic headings in all construction output; and the coverage of formal and informal construction in the national accounts.

APPENDIX A. List of resources

CONSTRUCTION MATERIALS AND PRODUCTS

Aggregate for concrete *	Clean, hard, strong crushed stone or gravel free of impurities and fine materials in sizes ranging from 9.5 to 37.5mm in diameter.
Sand for concrete and mortar *	Fine aggregate washed sharp sand
Softwood for carpentry	Sawn softwood sections for structural use pre-treated (to national standards) e.g. 50mm x 100mm
Softwood for joinery	Dressed softwood sections for finishing eg 18mm x 120mm
Exterior plywood *	Exterior quality plywood 15.5mm thick in standard sheets
Interior plywood *	Interior quality plywood 12mm thick in standard sheets
Chipboard sheet	Interior quality chipboard 15mm thick in standard sheets
Petrol/ Gasoline	Standard grade for use in motor vehicles
Diesel fuel	Diesel fuel for use in construction equipment
Oil paint	Oil based paint suitable for top coat finishes to timber surfaces
Emulsion paint	Water based paint suitable for internal plaster surfaces
Ordinary Portland cement *	Ordinary Portland cement in bags or bulk delivery
Ready mix concrete *	Typical common mix 1:2:4 cement:sand:20-40mm aggregate, 20N/mm ²
Precast concrete slabs	Precast concrete paving slabs 600 x 600 x 50mm thick
Common bricks	Ordinary clay bricks (suitable for render or plaster finish) eg 215mm x 100mm x 65mm thick (715 bricks/m ³)
Facing bricks	Medium quality self finished clay bricks for walling, eg 215mm x 100mm x 65mm thick (715 bricks/m ³)
Hollow concrete blocks	Hollow dense aggregate concrete blocks, 7N/mm ² , eg 440mm x 215mm x 140mm thick (76 bricks/m ³)
Solid concrete blocks	Solid dense aggregate concrete blocks, 7N/mm ² , eg 440mm x 215mm x 140mm thick (76 bricks/m ³)
Clay roof tiles	Clay plain smooth red machine-made or similar tiles per m ² of roof surface area eg 265mm x 125mm tiles
Concrete roof tiles	Concrete interlocking tiles per m ² of roof surface area eg 420mm x 330mm tiles
Float/ sheet glass	Standard plain glass, clear float, 4mm thick
Double glazing units	Factory made hermetically sealed, medium sized units 0.5 to 2.0 m ² with 4mm glass, 12mm seal
Ceramic wall tiles	152 x 152x5.5mm thick white or light coloured for medium quality domestic use
Plasterboard	12.5mm paper faced taper edged plasterboard in standard sheets
White wash hand basin	Average quality white vitreous china domestic wash hand basin for domestic use, wall hung (excluding taps, trap and pipework)
High yield steel reinforcement *	Reinforcing bars up to 16mm diameter (excluding cutting and bending)
Mild steel reinforcement *	Reinforcing bars up to 16mm diameter (excluding cutting & bending)
Structural steel sections *	Mild steel I beams approximately 150mm deep and approximately 19 kg/m

Sheet metal roofing	Twin skin roofing panel comprising colour coated steel or aluminium profiled sheeting outer layer, 100mm insulation, internal liner sheet,
Metal storage tank	Metal storage tank capacity 15m ³ , thickness of steel, 5mm, typical size, 3.75m x 2m x 2m
Cast iron drain pipe	150mm diameter with mechanical coupling joints
Copper pipe	15mm copper pipe suitable for mains pressure water.
Electric pump	Electric pump for pumping water, temperature range, 5 – 80oC, flow rate 10 litres/second, head pressure, 150 Pa
Electric fan	Electric exhaust fan for interior installation, flow rate, 1,000 litres/ second, head pressure, 250 Pa
Air-conditioning equipment	Air cooled liquid chiller, refrigerant 407C; reciprocating compressors; twin circuit; integral controls cooling load 400kW
Stand-by generator	Diesel generating set for stand-by use, three phase 24V DC, 250KVA output
Solar collector	PV solar panels peak output 650W, supply panels only, typically 4.5m ² total area
Electricity	Typical average commercial tariff

CONSTRUCTION EQUIPMENT

Wheeled loader and excavator	1.0m ³ loader capacity, 2.35m wide shovel, 6.0m max. dig depth
Tracked tractor	Crawler dozer 159kW with 'U' blade
Skid steer loader	Tipping load, 2,000kg, travel speed, 11.1km/hr
Tandem vibrating roller	Self propelled 5 tonne double vibratory
Compact track loader	Rated operating capacity, 864kg, travel speed, 11.4km/hr

CONSTRUCTION LABOUR

General (unskilled) labourers [1] *
Bricklayer [2] *
Plumber [2] *
Carpenter [2] *
Structural steel worker [2] *
Electrician [2] *
Machine (equipment) operator [2] *

[1] this group of construction workers undertakes simple and routine tasks in support of activities performed by more skilled workers. They have usually received little or no formal training. Examples of tasks that they might undertake include loading and unloading materials, digging and filling holes and trenches, spreading gravel and related materials, cleaning and tidying sites and site facilities.

[2] this group of skilled construction workers has received training in their trade comprising one or more of an apprenticeship, on the job training or training in a technical college or similar institution.