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Evidence that capital formation is overestimated in low- and middle-income countries in ICP 2011

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ABSTRACT
Using the International Comparison Program (ICP) 2011’s cross-country data on input prices and project cost shares, I show that the ICP 2011 construction prices are substantially underestimated in the 143 low- and middle-income countries where these prices were estimated from input prices. As a consequence, the ICP 2011’s estimate of PPP-adjusted construction is overestimated on average by about 100% and gross fixed capital formation is overestimated by 25–30% in these countries. These nonrandom data errors are of sufficient magnitude to cause serious estimation bias in cross-country growth analyses.

KEYWORDS
ICP 2011; construction prices; PPP; construction data; capital data

JEL CLASSIFICATION
E30; O47

I. Introduction
The International Comparison Program (ICP) periodically collects or estimates the prices of goods and services to create estimates of GDP adjusted for Purchasing Power Parity (PPP). In these exercises, the ICP has had particular difficulty estimating construction prices in low- and middle-income countries. Breton and Garcia (2015) present evidence that these prices are underestimated in ICP 2005.

The ICP changed its estimation approach and used three different methodologies to estimate construction prices in ICP 2011 (World Bank Group 2015). Construction prices in the 47 Eurostat-OECD countries were estimated from standardized project cost estimates. Construction prices in the nine CIS countries were estimated using a model of construction project costs. In the remaining 143 countries, the ICP estimated construction prices from the prices of construction inputs, using a method that linked these construction prices to the project-based estimates using the input prices in 10 Eurostat-OECD countries.1

The ICP has made the construction input prices collected in the 153 countries in 2011 available to researchers. In this article, I examine whether the new approach linking input-based and project-based construction prices provides reasonable results. My investigation indicates that in the 143 low- and middle-income countries with input-based prices, construction prices are substantially underestimated. As a consequence, PPP-adjusted construction in these countries is overestimated by about 100% and PPP-adjusted capital formation is overestimated by 25–30%.

Section II shows the relationship between construction prices and GDP/capita in the ICP 2011 data. Section III presents two methodologies for creating construction prices from input prices and shows the results. Section IV concludes.

II. Review of ICP 2011 construction prices
Figure 1 shows the relationship between the ICP 2011 construction prices and GDP/capita for the 149 countries in the ICP data that had sufficient data and a sufficiently large population to provide meaningful results. The prices are shown as an index, with the average construction price in the 10 Eurostat-OECD countries as the base. The relationship is shown separately for the construction prices that were created using project-based and input-based methodologies.

The construction prices estimated from project estimates are much higher than those estimated...
from input prices. The difference is consistently large, regardless of the level of GDP/capita. The trends in the data indicate that the project-based construction prices in the low- and middle-income countries are 60–70% of the prices in the high-income Eurostat-OECD countries, while the input-based construction prices are only 30–35% of these prices. This substantial difference indicates that there may have been a problem in the methodology that linked the project-based and input-based prices.

III. Input-based price estimates

ICP 2011 estimated construction prices for three types of construction in most low- and middle-income countries from the prices of construction materials, labour and equipment (World Bank Group 2015). For each type of construction, they weighted the average price of inputs in each category by the category’s reported share of total project costs in each country to create an average construction price. They then weighted the prices in these three categories by the category’s share of total construction to create each country’s overall average construction price.

The average prices in the three input categories in 143 countries were estimated from prices for 38 construction materials, seven labour categories and numerous types of equipment. The prices of missing items were estimated prior to the estimation of the average price. Input prices were not weighted to create the average price in each category, but only inputs deemed relevant for a particular kind of construction were included in the calculation of its average price.

The ICP has not provided all of the data and the details of the methodology that would be required to replicate their input-based prices. In this investigation, I have used arithmetic averages of indexed prices and trends in these indexed prices to estimate the relative average price of nonresidential construction as a function of GDP/capita for 88 countries. These calculations are not precise, but they are sufficiently accurate to show that the ICP’s new approach somehow created input-based construction prices that are far too low.

Figure 2 shows the trends in the average indexed price of materials, labour and equipment in the 88 countries as a function of GDP/capita. The labour price is the average hourly price of labour. The equipment price is the ICP’s estimate of national equipment prices for all types of equipment, not just for construction-related equipment.

The countries used in the comparison are those that had a population of at least 1 million and prices for enough materials and types of labour to estimate a reliable average price. I excluded Singapore and four Middle Eastern countries with high GDP/capita from the comparison to ensure that the prices at high levels of GDP/capita are representative of the Eurostat-OECD countries.
The three categories of components have very different price patterns. Equipment prices are similar across countries. Labour prices (per hour) are extremely low in the low-income countries and rise substantially with increases in GDP/capita. Materials prices are lowest in countries with a GDP/capita of about $18,000. These countries produce construction materials at reasonable scale with relatively low labour costs, so they can supply materials at lower cost than either the lower- or higher-income countries.

The input-based construction prices were estimated in each country by weighting the average materials’ prices and the unit labour and equipment prices (i.e. cost/hour) using the reported share of each input category in total project costs (World Bank Group 2015). Figure 2 shows my estimates of this weighted average price, using the reported or estimated share of each type of input in total project costs in each country.

The weighted average input price in each country is similar to the average materials price because materials compose the largest share of total project costs. The weighted input prices in the low- and middle-income countries (i.e., in countries with GDP/capita <12,000 USD) are 60–75% of the weighted input price in the 10 Eurostat-OECD countries. This relationship is very similar to the price relationship in the project-based price estimates in Fig. 1, but surprisingly, not at all like the ICP’s input-based prices.

Table 1 shows the ICP 2011’s initial estimates of the materials, equipment and labour shares of total project costs (ICP Global Office 2011) and the average reported shares for nonresidential construction for low-, middle- and high-income countries in the input data (ICP 2011; 2015). Material costs depend on the mix of materials and prices used in each country. The labour and equipment cost shares are determined by the unit prices (i.e. cost/hour) and the total hours for these types of components.

Despite the considerably lower unit labour prices in the low- and middle-income countries, their reported average labour share of total project costs is not that much lower than the share in the high-income countries (21–24% vs. 32%). The low unit labour prices in the low- and middle-income countries implicitly are offset by their low labour productivity. This is consistent with Breton and Garcia’s (2015) estimate that Colombian labour productivity in multi-story building construction is 25–30% of US productivity.

Since labour productivity is much lower in low- and middle-income countries, the ICP’s methodology of weighting unit labour prices, rather than productivity-adjusted labour costs, underestimates labour costs in the low- and middle-income countries relative to the 10 Eurostat-OECD countries. I develop an alternative estimate of construction prices using the same input prices and project cost...
shares and a different methodology. I estimate a country’s total project cost by increasing the average materials’ price by the reported nonmaterials’ share of total project costs:

(1) Project cost = average materials price/materials’ share of project costs

This methodology implicitly assumes that all countries use the same mix of materials to create a nonresidential structure. The data in Table 1 show that the average project cost in the high-income countries is $1/0.55 = 1.82$ times the materials’ cost. In the low- and middle-income countries, the average project cost is $1/0.63 = 1.59$ and $1.0/0.62 = 1.61$ times the materials’ cost.

I then create an index of each country’s total project cost relative to the average project cost in the 10 Eurostat-OECD countries. This approach accounts for labour and equipment productivity differences across countries, but it assumes there is no substitution of lower-cost labour for materials in the low- and middle-income countries. Since some substitution of labour for materials is likely in these countries, this methodology likely overestimates the relative cost of materials (and simultaneously, the cost of labour and equipment). As a consequence, the ICP’s weighted input methodology and this materials-based methodology likely bracket the actual construction price in low- and middle-income countries relative to the high-income countries.

Figure 3 shows the published ICP 2011 prices, the weighted input prices and the materials-based input prices, as a function of GDP/capita. In the middle-income countries (i.e. GDP/capita between 1000 and 12 000 USD), the materials-based input prices exceed the weighted input prices by 2–10% of the Eurostat-OECD price. In the low-income countries, the two methods produce virtually identical prices. More importantly, the average of these two input-based estimates is about double the published ICP 2011 prices for these countries and almost identical to the to the project-based construction prices in Fig. 1.

Figure 3 also shows the project-based prices for 8 of the 10 Eurostat-OECD countries in which input prices were collected. Since these countries have much higher GDP/capita than the low- and middle-income countries, it is not evident how these project-based prices were linked to the input-based prices in the low- and middle-income countries. It appears that the linking method did not extrapolate the Eurostat-OECD prices to countries with a lower GDP/capita in a valid manner.

The ICP’s underestimate of construction prices in the low- and middle-income countries leads to an overestimate of PPP-adjusted construction, which causes an overestimate of capital formation. Figure 4 shows the ICP’s estimates of gross fixed capital formation real expenditures as a share of total real expenditures for these countries (World Bank Group 2015) and revised estimates based on the average of the two input-based construction prices shown in Fig. 3.

Figure 3. ICP 2011 construction prices vs. input-based estimates.

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2Denmark and Australia have GDP/capita above $60 000.
The revision reduces average gross fixed capital formation from 23% of GDP to 17.5% in the low-income countries and from 22.5% of GDP to 18% in the middle-income countries. These estimates are only approximate because the ICP’s GEKS-based real expenditures are not additive within countries, but they indicate that gross fixed capital formation in these countries is overestimated by 25–30%. This overestimate is large enough to have serious implications for economic analyses that involve low- and middle-income countries.

IV. Conclusions

ICP 2011 estimated construction prices using several methodologies. An analysis of these prices shows that in countries with the same levels of GDP/capita, the ICP construction prices created from input prices are much lower than those created from project prices.

Using the ICP 2011 cross-country data on input prices and project cost shares, I show that the ICP 2011 input-based construction prices are only half what they should be. As a result, ICP 2011 overestimates PPP-adjusted construction by over 100% in the low- and middle-income countries where construction prices were estimated from input prices. This overestimate leads to a 25–30% overestimate of gross fixed capital formation as a share of GDP in these countries.

A 50% reduction in the ICP 2011’s estimate of construction investment in low- and middle-income countries would reduce estimates of aggregate capital stocks and capital/output ratios estimated using the ICP data. The lower share of construction in gross fixed capital formation would raise the average capital depreciation rate. The reduced size of the capital stock would raise the estimated TFP in the low- and middle-income countries. As a consequence, economic growth analyses involving low- and middle-income countries that use the ICP 2011 capital formation data are likely to have biased results.

Disclosure statement

No potential conflict of interest was reported by the author.

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