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Background Note on
Productivity Adjustments
as a Special Case of a General
Regional Linking Problem

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Introduction

This note follows on my presentation at the Paris meeting. It is clear that in the 2011 ICP different methods will be used in different regions to handle some fairly significant expenditure headings. For general government the OECD countries plan to use salary comparisons for specified occupational groups while it is likely that some or all other regions will make some adjustment of salaries for productivity differences. For education the OECD will use quality adjusted student quantities deriving PPPs by dividing household and government individual expenditures by these quantities. At present other regions plan a similar but not identical approach; it will not be identical because the PISA test scores are limited to a small percent of countries in other regions; and because student time on task appears to be significantly less than in OECD countries. At present treatment of government individual health expenditures in the 2011 ICP is not decided but it seems likely that it will differ across regions. Dwelling services may be another expenditure heading where treatment differs across regions. Further it is the possible that within regions there may be different methods used in sub-regions, which would add still another layer to the linking problem. The two main points of this note concern use of different methods of price and output estimation for the same basic heading across regions, a) the effects will show up when the regions are linked at the global level and b) it may still be feasible to preserve regional results while improving comparability for the heading.

The aggregation in the 2005 ICP was done across 5 regions, where the CIS countries were joined to the OECD through Russia. The method, which for the record I supported, added up expenditures in the currency of a reference country/region average for each basic heading in both exchange rate and PPP converted values. The ratio became the regional price level for the basic heading. Regional aggregation involved running a GEKS across the 5 regions and all basic heading, which we will term the RA method. The proposal here is to do the aggregation across countries and then re-distribute the regional totals so as to preserve final ICP results within each region. This method, which preserves fixity in the regions, is termed the CAR method and would be applied after modifying the effects of using different methodologies in different regions.
Section 1 of this note illustrates the modification in the case of the productivity adjustment for compensation for government individual and general services, and the application of the CAR method. The data used are from the 2005 ICP and a more detailed description is provided in my presentation in Paris. Section 2 discusses the costs and benefits of the RA and CAR approaches. Section 3 suggests the same basic headings that are likely to need special treatment to insure regional comparability in the 2011 ICP.

1. An illustration of the CAR approach applied to education, health and government

Comparison resistant services in ICP 2005 posed a problem because a productivity adjustment was made in 3 of the 6 regions, leading to likely non-comparability. The issue emerged because salary comparisons for the same occupation exhibited 100-fold differences between low and high-income countries within Asia-Pacific and Western Asia. Indirect volume estimates derived from such PPPs would produce unacceptably high volumes for countries like Cambodia or Yemen. The method adopted in Asia certainly moves in the right direction in that most agree that output per government, health or education worker is likely to increase with more capital per worker. However the consequence of these adjustments is that for countries like Bolivia or Tajikistan, where no productivity adjustment was made, per capita incomes will be less comparable with countries at similar development levels in Africa, Asia or Western Asia.

The approach suggested here is illustrated for the 2005 ICP research data set. First, a productivity adjustment factor is estimated for all countries for the compensation headings for government individual education and health, and general government expenditures. Then an aggregation is performed with the adjusted PPPs, and regional totals of total GDP are estimated. Finally the CAR method redistributes the regional totals according to the results for each country in each region. The illustration uses as much salary information as available to the global office and makes a rough allowance for productivity differentials across the regions based on physical capital stock. Human capital was also introduced into the production function but the relationship was weak and there were fewer observations so it was not used in the final estimating equation.
Estimates of Productivity by Country

A Cobb-Douglas production function was used across all the regions. Physical capital, \( K_p \), and labor force estimates, \( L \), are from the Penn World Table.\(^1\) In equation (1) below the dependent variable is the log of GDP/L and in the first equation only \( K_p/L \) is on the right side. The coefficients were significant at the 1% level.

\[
(1) \quad \ln GDP/L = 4.56 + .704*\ln K_p/L \quad R^2 = .799 \quad n= 105
\]

The first step is move the estimates of equation (1) from 105 to 146 countries. The output per worker estimates were made based upon the above estimating equation for the 106 countries in the PWT data set countries. These estimates were extended to the remaining countries based upon the relationship of the estimated ln of output per worker for the 106 countries to per capita GDP from an initial GEKS estimate. This estimating equation had an \( R^2 \) of .465 with sensible coefficients, though if this method were adapted in ICP 2011 a tighter estimating procedure needs to be devised. Applying the equation coefficients to the per capita GDPs of the remaining 40 countries yielded estimates of the ln of output per worker. Another limitation on this illustration of course is that these estimates refer to the whole economy, not labor in comparison resistant services. It is possible that individual countries or regions might employ these adjustment estimates but that is not the purpose of the present exercise. One clear reason is that it is already agreed that the OECD and CIS countries will not make any adjustment within their regions for the 2011 ICP.

Hopefully the second step will not be necessary in the future but was thought prudent because of the rough nature of the product per worker estimates in this exercise. The output per worker estimates were converted to adjustment factors that ranged from 1 to 4 going from high to low-income countries. The admittedly very rough groupings were as follows. Output per worker > $40,000 were assigned 1.0, $30-40,000 1.2, $20-30,000 1.5, $15-20,000 2.0, $10-15,000 2.5, $5-10,000 3.3 and under $5,000 4. These factors were used to adjust the parities obtained from

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\(^1\) Sources: pwt.econ.upenn.edu has the labor force data. The physical capital series is preliminary and not yet on the web. In addition country studies of China, India and Indonesia were used to supplement the PWT estimates. The India and Indonesia estimates are based on Pierre van den Eng (2008) and the China estimate is based on Yanrui Wu (2009). The experiments with human capital used the Barro-Lee data set, which has since been updated and it may be that for the 2011 ICP it will be feasible to introduce human capital into the productivity adjustment.
wage comparisons to obtain new input parities for the compensation headings of comparison
resistant services.\textsuperscript{2}

The third step taken is run aggregations using unadjusted and adjusted compensation
figures to illustrate the impact on the results. The results of this exercise are reported in Table 1.
Two aggregation methods have been used, both producing similar results, one GEKS and the
other a weighted CPD, labeled CPDW. The share of each region of global GDP is calculated
with and without adjustment for each of the two methods. These shares simply add up the total
GDP of each country in a region divided by the global total for all the countries. The total GDP is
also provided for each method. As can be seen, without the productivity adjustment the world
total is larger than with adjustment because less output of these services is attributed to many of
the lower income countries.\textsuperscript{3}

\begin{table}[h]
\centering
\begin{tabular}{|l|c|c|c|c|}
\hline
Region & GEKS No Adj & GEKS Adj & CPDW No Adj & CPDW Adj \\
\hline
Africa & 0.0313 & 0.0285 & 0.0309 & 0.0288 \\
Asia-Pacific & 0.2384 & 0.2196 & 0.2371 & 0.2250 \\
CIS & 0.0421 & 0.0390 & 0.0400 & 0.0380 \\
OECD & 0.6236 & 0.6529 & 0.6271 & 0.6471 \\
S. America & 0.0509 & 0.0468 & 0.0510 & 0.0476 \\
W. Asia & 0.0138 & 0.0133 & 0.0139 & 0.0136 \\
World $Bil & 60071 & 55202 & 60085 & 55249 \\
\hline
\end{tabular}
\caption{Estimated Effect of a Productivity Across the 146 ICP 2005 Regions}
\end{table}

But more importantly the shares of each region are also substantially affected. The
OECD share goes up because few of its countries are affected by the adjustment while the shares
of all the other regions go down, with Africa by more than 5%. The effect is larger for GEKS
than for CPDW. These effects are similar to what would result if one used the PPP for non-
priced services for the compensation headings of comparative resistant services, another exercise
reported in the Paris paper.

\textsuperscript{2} For the OECD, CIS and South American regions, the basic heading compensation parities were from the research
input of the 2005 ICP. For Africa, Asia-Pacific and Western Asia, where the research input compensation parities have
already been adjusted, the wage estimating equations discussed in the Paris presentation were used.

\textsuperscript{3} This exercise used only the 3 compensation headings in the Annex Table for collective consumption and government
purchases of individual education and health services. Since the PPP for public purchases of health services was
partially used for household purchases of hospital services, Table 1 would provide a more complete comparison if
household purchases of hospital services had also been included.
2. Costs and Benefits of the RA and CAR Approaches

The purpose of the exercise reported above is to propose a method to allow regions to retain whatever method they choose for the regional exercise while at the same time linking the regions in a way to improve comparability. What are the costs of the CAR approach? One clear cost of CAR is that it does not preserve row comparability across regions. This not only applies to the basic headings for which adjustments are made, but to other headings as well that include these headings.

In principle the RA method does preserve row comparability across regions, clearly a desirable property. However, if in practice the regions estimate some basic headings by different methods then row comparability is also lost not only for these basic headings but also lost other headings included with them in an aggregation. This greatly weakens the case for using RA in 2011.

Another tradeoff is that RA appears to emphasize the relationship between countries within each region while country aggregation involves a more global approach. However, since CAR would only be used to obtain regional totals while preserving the inter-country results with each region, there is really nothing lost compared to RA. Further there is much interest comparisons between the 10 or 20 largest economies of the world and this is much more transparent in the CAR approach. In 2005 it was found for example, that the relative positions of countries like China and India in comparison to large OECD countries was significantly different using RA versus CA.

A final consideration in giving up on RA for 2011 is that the ICP does not want to create unnecessary problems for users in understanding differences between the published ICP versions of 2005 and 2011. My response is that moving to adjustments for problem headings and using CAR may create some discontinuities but the gain of improving the overall comparisons is well worth it.
3. Are there other Basic Heading where Comparability would be Improved by Global Adjustments and use of CAR?

a. The usual suspects

The illustration in Section 2 covered general government, health, and perhaps education and dwelling services. The illustration suffered from a number of short-cuts that would need to be improved if used in ICP 2011, especially estimating the productivity adjustment on the basis of all workers, and applying the same adjustment to all three headings. In 2011 general government compensation will remain a problem heading, and likely health too. It is too early tell with regard to education compensation. It is recommended that more specific information be collected for these headings that would improve the adjustments. For education this is in process. When collecting information on compensation for occupations in general government it would be desirable to also collect the number of workers. The same is true for education and health.

b. Dwelling Rents

Another important heading is dwelling services. Much of the discussion at the 3 previous TAG meetings has rightly focused on improving expenditure estimates for house rents, market and imputed. However, there is a serious problem of getting good estimates of PPPs for dwelling services. The TAG has recommended, the direct estimate using samples of market rents, the indirect estimate using direct quality adjusted quantities and some combination of the two. The major problem is that direct quantity estimates from censuses of housing have very few measures associated with the quality of dwellings. This is illustrated in Chart 1.
The sample of 8 countries in Chart 1 have data from rental surveys for which hedonic regressions have been estimated using size of dwelling, number of bathrooms and similar variables in addition to the 3 captured in direct quantity comparisons. Holding constant size of dwelling across all the countries, Chart 1 illustrates two plots of points corresponding to the per capita GDP of each country with US =100 with the rent per month on the vertical axis. The upper line of squares shows how the plot of average rents of dwellings with water, electricity and flush toilet of given m² rises with the per capita income of the countries, not controlling for other amenities. The set of diamonds shows how rent rises per dwelling of a given size in the same countries for a dwelling identified using the quantity method, namely a dwelling with water, electricity and a flush toilet, but no other amenities.

Why do the two plots of points have such different slopes yielding much higher rent differentials at higher levels of GDP per capita? I would suggest it is because many quality features of dwellings are associated with number of bathrooms and other features of dwellings in higher income countries that are not captured in direct quantity comparisons. For example, in the hedonic rent studies with which I am familiar, the coefficient on additional half or full bathrooms appears to add much more to estimated rents than one might expect given the extra capital cost involved. My interpretation is that as we move from the availability of an inside flush toilet to
more than one bathrooms there will also be many other less measureable quality features of the dwelling yielding higher rents.

The consequence is that PPPs for rental dwelling estimated indirectly via direct quantity comparisons are likely too low and volumes too high compared to estimation from market rents. The effect will be systematic across income levels because more higher income countries have available rent surveys. In the past this may have been offset in practice by a systematic understatement of dwelling expenditures in lower income countries. If we improve rent expenditures in the 2011 ICP, then the problem will become even more apparent.

Given the heterogeneity of available national statistical bases there is no simple solution to this problem, but there is a simple message. In much the same way that expenditure surveys and commodity flow tables are used as checks on each other in national accounts, collecting more information on the headache headings in the ICP can provide similarly useful checks on PPP and volume estimates. One possible area of research is to use available rental surveys in OECD and non-OECD countries to better understand how the sample of housing qualities varies across country income levels. We know, for example, that there are urban rental surveys in a number of South American countries. In India there is a sample of rented dwelling with some characteristics collected for the Industrial Workers and Middle Class price indexes. Even if available surveys only represent a selected sample of housing in a country, they can still provide unbiased estimates of the type of relationship illustrated in Chart 1.

c. The Balance of Exports and Imports

In principle the ICP should make separate price comparisons for exports and imports but in practice this has not attempted in any previous rounds nor is it planned for 2011. One aspect of the problem should be noted, namely the asymmetry of the present treatment between countries where exports exceed imports and countries with trade deficits. Given the US$ as a reference currency a country with a price level of GDP of 50% and a trade surplus will be credited a much smaller percentage of GDP for its efforts than in national currencies; and the opposite if there is a trade surplus.

Paul McCarthy has noted some of the issues involved with net expenditures of residents abroad (NEA). In the 2005 ICP 2/3 of the countries reported values for this heading. For these
purchases of non-residents have not been allocated to their appropriate consumption headings or assigned their appropriate PPPs. Similarly purchases by residents abroad are assumed to take place at the exchange rate. For the 1/3 of the countries reporting no value for NEA purchases of non-residents have been distributed among the consumption headings of a country typically using the commodity flow approach, while purchases abroad are assumed to take place at the exchange rate.

My recommendation would be to handle both the net foreign balance and NEA outside of the aggregation to GDP, and rather aggregate to Domestic Absorption (DA). This is a more meaningful aggregate PPP in my view. One could still move DA to GDP using the exchange rate, so the comparisons are still complete and I would argue more transparent with respect to these two headings that are presently handled in an ad hoc manner. Since this suggestion has been rejected each time it is offered, history will probably repeat itself. But if my suggestion is accepted outside the OECD countries then this would be another set of headings that might require special linking across the regions.

d. Other and nec Headings

The following headings individually are often small but together make up a significant share of GDP, namely: Financial Services, nec.; Other Services nec.; Social protection; Insurance; and FISIM. Because some of these headings can be negative, the simple average and the average of absolute values were calculated over all countries as respectively as 1.94 and 5.52% of GDP. Many countries have values of the former over 3% of GDP and a handful over 4%. Regarding the sum of absolute values, several countries have values over 10% with Moldova over 16%. Given the relative importance of these headings more attention should be paid to the comparability of reference PPPs across regions.
References
