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Interview with the President of Islamic Development Bank
Dr. Ahmad Mohamed Ali

For the benefit of our readers can you briefly tell us about the
Islamic Development Bank (IDB), its overarching objectives,
and how its operations are financed?
The IDB is a multilateral development financing institution
headquartered in Jeddah, Saudi Arabia. Its overarching objectives are
to foster economic and social development and alleviate poverty
in its member countries, as well as in Muslim communities in non-
member countries through financing productive projects and en-
terprises based on the principles of Shari’ah or Islamic law.

The IDB was founded following a resolution passed by the finance ministers of
the Organization of the Islamic Conference (OIC) and it started operation in 1975.
Our membership currently stands at 56 countries spreading across many continents
of the world.

Over the years, the IDB has grown into a group with several affiliates to meet the
diverse financial needs of the member countries. The affiliates are: the Islamic Corpora-
tion for the Insurance of Investment and Export Credit (ICIEC), the Islamic Corpora-
tion for the Development of the Private Sector (ICD), the International Islamic
Trade Finance Corp. (ITFC), and the Islamic Research and Training Institute (IRTI).

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Dollar a Day Revisited
Martin Ravallion, and Shaohua Chen,
Research Group
Development Economics
World Bank

Along with household surveys, a key input to measuring global poverty is data on
prices at country level. Only then can we say whether one can buy more with (say) 5
yuan per day in China than 10 rupees per day in India. The only credible source of
internationally comparable price data for this purpose is the International Compari-
son Program (ICP), which started around 1970 with the task of assessing price levels
across countries for the purposes of making international real income comparisons.

This article summarizes the results of our recent update of the World Bank’s
global poverty measures, which date back to the early 1980s. Focusing on the results
of the 2005 ICP, the article draws heavily on two research papers, which provide
more detail (Ravallion et al., 2008; Chen and Ravallion, 2008).

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“International data represents a classic public good. Mobilizing adequate funding
is a challenge. In the face of the current global food crisis and financial meltdown
in which the developing countries have been hit hardest and more importantly in the face
of the potential risk of increased poverty
and hunger, robust data is critical to guide
policy and monitor progress. Overcoming
the public goods problem is, therefore, more
than an economic challenge. It is also a
moral imperative.”

Dr. Ahmad Mohamed Ali

www.worldbank.org/dataicp
Dear Readers,

First and foremost, I wish all of you a Happy 2009! This issue carries a number of informative articles that, I am sure, the readers will find insightful and thought-provoking. The interview with the President of the Islamic Development Bank, Dr. Ahmad Mohamed Ali, focuses on the challenges the development community faces in building a robust knowledge base that is essential to support analysis and inform development policy. Dr. Ali touches upon many critical issues ranging from the current global food crisis to the all-too-familiar public goods problem, to filling the knowledge gap with a sense of urgency and sustained commitment.

Martin Ravallion and Shaohua Chen revisit the Dollar-a-day international poverty line on the basis of the newly released consumption PPP estimates and a new set of national poverty lines for low- and middle-income countries. Their article provides a succinct exposition of the World Bank’s poverty estimation methodology and presents revised global and regional poverty measures for 2005. The article also highlights the importance of producing sub-national PPP estimates, a challenge that President Ali also highlights in his interview.

Kim Zieschang’s feature article revisits the exchange rate approach to regional aggregation of GDP price and volume series and sheds light on the role PPPs play within this approach. His article shifts the focus of the debate from exchange rate- vs. PPP-based aggregation of GDP to an integration of the two approaches with each playing a well-defined role.

This issue contains two articles on the uses of PPP data. The first article by Robert Inklaar and Marcel Timmer presents comparisons of output, inputs and productivity at a detailed industry level for a set of OECD countries. The article provides a brief overview of the methodology used, the content of the database that the authors compiled, and the uses of industry level PPPs in growth and convergence research. The database is constructed using both the production and income approaches and as such provides an alternative perspective to the expenditure approach, which the ICP follows. A set of summary tables are presented to show the highlights of their findings.

The second article by Derek Blades reflects on John O’Connor’s piece on “Business uses of PPPs: Challenges and Opportunities”, which appeared in the August 2008 issue. His comments focus on how the ICP can meet the growing needs of the business community. I hope that it will spark more discussions and debates as this is an area where ICP needs to fill a critical knowledge gap.

The methodology section presents two articles. First, Lars Svennebye and Paulus Konijn discuss an output approach to construct education PPPs, which is based on direct measurement of volumes. The output approach is presented as a preferred alternative to the input approach that was used in past comparisons relying on the costs of inputs to measure the value of output. The article provides comparison of PPP results based on the two alternative approaches.

Yuri Dikhanov compares and contrasts two ICP data validation tools, namely the Quaranta tables and the Dikhanov tables, with particular emphasis on the later. The Dikhanov table was introduced in the 2005 ICP round as part of the overall quality improvement effort.

Finally, it is with deep sadness that I inform our readers the sudden death of Michael Ward. He was a true professional and a respected scholar. I had the privilege of working with him when he was at the World Bank. He was a terrific colleague, and best of all a true friend and a valued mentor. A regular contributor to the Bulletin, Michael was preparing a piece for this issue at the time of his unexpected passing away. Derek Blades and David Roberts, who have known Michael well, have reflected on his life and work, and his contribution to the development of statistics in the developing world and beyond.

Yonas Biru
Integrating Regional GDP Aggregates Based on Exchange Rates and Inter-Country Comparisons Based on Purchasing Power Parity

Introduction

International statistical publications present world and regional growth trends as weighted averages of country GDP volume indices. The weights themselves are GDP shares in the world or region, with country GDP converted from national currency to a common unit of measure. There are two approaches to this conversion to a common unit. The first and most straightforward is to apply currency market exchange rates to convert GDP to the currency unit of a numeraire country, often chosen as the United States. The World Bank’s World Development Indicators (WDI) publication adopts this approach. The second method is to convert to a common unit with purchasing power parities (PPPs). See, for example, the IMF’s International Financial Statistics (IFS) or World Economic Outlook (WEO). PPPs clearly play a central role in the latter presentations of world and regional aggregates of time series of GDP price and volume and can have a material impact on world and regional growth estimates.

The appeal of the PPP conversion approach is its focus on national size measured in relative GDP volume to weight countries together into a regional aggregate. It is sometimes argued further that regional aggregation using exchange rates does not take into full account the prices of nontraded goods and services or nontransportable nonfinancial assets, while PPP-based aggregation does. Despite this apparent difference in coverage, however, exchange rates and purchasing power parities seem to converge over the long run.

On the other hand, there is little question that exchange rate conversion must be followed in constructing the cost constraints determining observed or potential transactions in goods, services, and assets between residents of different countries. Statistical standards such as the System of National Accounts and the Balance of Payments Manual consider purchases of transportable goods and services by nonresidents of the originating economy as external trade. Idiosyncratic legal restrictions aside, nonresidents, especially as tourists, generally can purchase anything a resident can purchase. Consider further transactions in non-transportable assets, as when, for example, the resident of one country purchases housing in another country. The residency of the house or apartment does not change, and the housing services it produces are considered production of the economy where the house is located. However, neither the cost of the housing asset nor the implicit rental value of its services is likely to be valued by the new owner in the currency of the country where the house is located. He will convert them into his home currency using the exchange rate.

Using exchange rates to convert prices to a common currency unit thus has some appeal considering the need for symmetry of the income flows generated in these cross border transactions. Where do purchasing power parities fit within the exchange rate approach? They still support GDP volume comparisons between countries and the associated international comparisons of productivity and living standards.

This note reconsiders the exchange rate approach to regional aggregation of GDP price and volume series and the role PPPs continue to play within that approach. What it says about GDP, of course, applies as well to any price-times-volume aggregate for which we want a regional aggregate of national price and volume indices.

Exchange rate aggregation of temporal GDP growth and inflation statistics

Consider a collection of $M$ countries,

- each of which produces a vector of outputs
  
  \[ y_a = [y_{a1}, y_{a2}, \ldots, y_{aT}] \]
  
  at a price vector
  
  \[ p_a = [p_{a1}, p_{a2}, \ldots, p_{aT}], m = 1, 2, \ldots M \]

  continued
where each country values its output in prices expressed in distinct national currency units, for which there are currency markets producing exchange rates that allow one currency to be converted into another,

where each country’s gross domestic product \( GDP'_k \) is GDP in numeraire country \( k \)’s currency, and

where \( e'_{ik}GDP_k \) is GDP in numeraire country \( k \)’s currency, with \( e_{ik} \) the exchange rate.

The share of country \( m \) in world output valued in a numeraire currency thus is

\[
W_m = \frac{e'_{ik}GDP_m}{\sum_{m=1}^{M} e'_{ik}GDP_m} = \frac{\sum_{m=1}^{M} e_{im} \frac{p'_m y'_m}{y'_m}}{\sum_{m=1}^{M} e_{im} \sum_{m=1}^{M} p'_m y'_m},
\]

which is invariant to the choice of \( k \), the country of the numeraire currency, assuming the system of bilateral exchange rates is transitive, meaning that for every \( i, j, k \) \( e'_i e'_j = e'_k \). This is generally assured through currency market arbitrage.

Using normal price index methods, the (say, Laspeyres) GDP volume index for the region comprising all \( M \) of the countries is

\[
P^{L}_{m} = \sum_{m=1}^{M} \left[ \sum_{m=1}^{M} \frac{w'_m p'_m y'_m}{y'_m} \right].
\]

where

\[
w'_m p'_m y'_m = \sum_{m=1}^{M} \frac{p'_m y'_m}{y'_m}.
\]

The corresponding (say, Paasche) regional price index is

\[
P^{P}_{m} = \left[ \sum_{m=1}^{M} \frac{e'_ik}{} \sum_{m=1}^{M} \frac{p'_m}{p'_k} \right]^{1\gamma} = \left[ \sum_{m=1}^{M} \frac{w'_m}{w'_k} \right]^{1\gamma}.
\]

where \( P^{k}_{m} \) is the country \( j \) Paasche GDP price index (deflator). Note that this index differs from the typical presentation of regional aggregate price series, which ignores the exchange rate conversion, merely aggregating reported national GDP deflators without adjusting them for change in exchange rate relative to numeraire currency. This will make a quantitative difference in the estimate of regional inflation when measured in numeraire currency units as compared with the usual practice.

In fact, the index number literature tends to prefer geometric aggregation of price indices, and the IFS and WEO use geometric aggregation across countries for their world and regional GDP price and volume tables. Following IFS practice, we consider Laspeyres geometric index numbers for aggregating across countries here. Using this formula produces a nice decomposition result, since the price index in the currency units of numeraire country \( k \) directly factors into regional domestic inflation and regional exchange rate components, as

\[
P^{k}_{m} = \prod_{m=1}^{M} \left( \frac{p^{k}_{m}}{p^{k}_{0}} \right)^{\gamma} = \prod_{m=1}^{M} \left( \frac{p^{k}_{m}}{p^{k}_{0}} \right)^{\gamma} = \prod_{m=1}^{M} \left( \frac{p^{k}_{m}}{p^{k}_{0}} \right)^{\gamma} = \left[ \prod_{m=1}^{M} \left( \frac{p^{k}_{m}}{p^{k}_{0}} \right)^{\gamma} \right].
\]

Thus we can derive regional aggregate GDP price (deflator) and volume indices without using purchasing power parity calculations. However, the regional GDP price index (deflator) is not the usual regional price index, because, unlike the usual index, it measures prices in the same currency units. As shown most clearly in the geometric aggregation case, this index is driven by national inflation rates as well as by change in the vector of exchange rates relative to a given numeraire currency.

Figure 1 provides an example of
this for a group of countries comprising a subset of developing Asia in the IMF’s IFS database. The differences in these components reflect the economic history of the region, which was the epicenter of a financial crisis and capital flight in 1997–1998. Prior to 1998 there was inflation in the domestic currency GDP price index component, essentially offset by depreciation in the exchange rate component. During 1998–2007 the exchange rate stabilized and the US dollar GDP index began to parallel domestic inflation.

It is useful to point out the similarity between the numeraire currency GDP price index for individual countries and for a regional aggregate of countries, and the “real effective exchange rate” (REER) often watched by analysts in assessing exchange rate alignments. There is more than one version of a REER, depending on the price index for domestic inflation. The most common REER uses the Consumer Price Index as the domestic inflation indicator, rather than the GDP price index (deflator) considered here. REER calculations also weight exchange rates by trade (or sometimes by “tradeables”) rather than GDP shares as in the regional price index decomposition above.

Aggregation of regional GDP growth and inflation statistics using purchasing power parity

Suppose that

there exists a set of purchasing power parity (PPP) conversion factors, say \( p^*_k \), allowing deflation of the relative GDP in the national currencies of each country to produce relative GDP volume.

Let’s again return to the relatively simple Laspeyres regional volume index case. The PPP weighted Laspeyres regional volume index is

\[
P^*_k = \sum_{a=1}^{A} \sum_{j=1}^{J} w^*_a \frac{y^*_j}{y^*_{amb}}
\]

where

\[
w^*_a = \frac{\rho^*_a GDP^a}{\sum_{m=1}^{M} \rho^*_m GDP^m}.
\]

Note that the PPP-weighted aggregate volume index is invariant to the numeraire country of the comparison as long as the PPPs \( \rho^*_k \) are transitive, meaning that for any two countries \( i \) and \( j \), \( \rho^*_i = \rho^*_j \rho^*_i \). PPPs are compiled using a methodology that ensures transitivity holds. PPP weighted world and regional aggregates will be the same as exchange rate weighted aggregates if the vector of exchange rates \( \phi \) is proportional to the vector of PPPs \( \rho \). This generally does not hold empirically, with differences between exchange rates and purchasing power parities persisting, often for long periods.

An economic index number story for exchange rate-based aggregation of GDP across countries

GDP in common currency units obtained via exchange rates and GDP in volume units determined by PPPs are conceptually different. The first is fundamentally nominal, varying across countries according to relative price levels (measured in the numeraire currency unit) and volumes. The second is clearly a quantity measure, varying across countries according to volume variations only.

Economic index number theory constructs the share weights of index components in nominal terms—it does not recognize volume shares because they do not reflect the transitivity holds. PPP weighted world and regional aggregates will be the same as exchange rate conversion rather than PPP conversion when constructing regional aggregates. This argument is elaborated in the Appendix.

On the other hand, advocates of PPP weighting of regional aggregates argue that the PPP is itself an “exchange rate.” There is an allusion in using this language to a long literature focused on the discrepancy between exchange rates and purchasing power parities as an indication of a disequilibrium state in currency exchange markets. If PPPs are “exchange rates,” then we can use them as the value basis for national shares in regional GDP. However, accounting consistency across the world would require that all conversions to a common unit use PPPs, including for asset, income, and transfer transactions.

PPPs do not, however, function as the practical facilitators of actual or potential transactions in goods and services when the purchaser’s resources are in one unit of account and the prices of items he wants to buy are in another, while currency exchange rates do. Even so, the purpose here is not to undermine PPP-based regional aggregation of GDP price and volume indices, but rather to explain, based on an underlying economic story, how PPPs and regional aggregation based on exchange rates can coexist coherently.
The role of PPPs in exchange rate-based regional and world aggregates

When exchange rates are the basis for constructing the weights of world and regional aggregate time series of GDP statistics, what role do PPPs play? PPPs are a system of bilateral price comparisons that factor the ratio of two national GDPs in the respective national currencies for a given accounting period into a relative price (PPP) and a relative volume factor. PPP based country GDP volumes are used in the IMF quota formula, for example, consistently with this definition.

PPPs are directly related conceptually to the relationships between the individual country GDP deflator time series and between the individual country volume index time series within a world or regional aggregate. If we compare the relative volume indices between a given pair of countries from two ICP benchmarks, we arrive at the change in their relative GDP volumes from the first to the second benchmark period. This should be the same as the ratio of their GDP volume indices between the two benchmarks. This function of PPPs, because it involves comparisons of individual country volume and price levels, is valid whether regional aggregates use exchange rate or PPP-based aggregation of GDP and its price and volume components.

However, because these two sets of statistics are computed from non-identical data sets and often with different index and aggregation methodologies, this conceptual consistency condition generally does not hold empirically. The most recent, 2005 ICP has incorporated methodologies that should allow the ICP item and price samples to converge more closely toward the item and price samples used in the national price indices that make up the GDP deflator. There are also certain categories of expenditure on GDP for which ICP methods are stronger than desirable and that may not be fully consistent with national methods for compiling GDP volume over time. As noted in the ICP global report, prominent among these somewhat problematic expenditure groups are government consumption, both in behalf of individuals and collective, and household consumption of housing services and capital formation in housing. At least as important, however, in the lack of cross sectional and time series consistency in published GDP data are the significant improvements in methodology of the 2005 ICP round as compared with the last, 1996 round. These methodological improvements also contribute to the deviations between the change in bilateral GDP volume indices from 1996 to 2005 and the ratio of the associated GDP volume indices over the same period.

PPPs allow comparing country price levels for given accounting periods by dividing PPPs by the associated exchange rate relative to a numeraire country, or relative to a currency basket such as the IMF Special Drawing Right. The resulting price level index shows whether the items in GDP are, as a whole, relatively more expensive in one country compared with another when purchased in the same currency. Like the relative GDP volume indices computable using PPPs as deflators for relative national currency GDP, PPPs evolve between benchmarks according to the ratio of the temporal GDP price indices between the countries compared. The associated price level indices evolve according to PPPs multiplied by exchange rates. Like the volume indices, their mathematical duals, PPPs may not empirically satisfy consistency with the ratios of temporal GDP price indicators for the same reasons relative GDP volumes from PPPs may not evolve according to the ratio of temporal GDP volume indices.

Concluding remarks

In sum, within world and regional aggregates, PPPs and the associated relative GDP volume indices are alternative ways to explain the evolution of the country price and volume components of these aggregates. They are critical for assessing the relative sizes of countries in GDP volume, and indicative relative welfare in terms of, for example, GDP per capita. Although PPPs have been used as well for aggregating country time series into world and regional aggregates, aggregation across countries with exchange rates can be backed with a persuasive economic index number story within which PPPs continue to have a well-defined role, while the regional aggregates maintain important linkages with the international transaction values of goods and services and with international income flows. This supports exchange rate-based conversion to common units as the standard presentation of world and regional aggregates of GDP value, price, and volume time series.

Appendix: An Economic Index Number Approach to Regional Aggregates of GDP Using Exchange Rates

We define \( y_m = [y^{m}_{11}, y^{m}_{12}, \ldots, y^{m}_{1k}] \) and \( p'_m = [p'_{m1}, p'_{m2}, \ldots, p'_{mK}], m = 1, 2, \ldots, M \) as before and define vectors of household utilities \( u'_m \) for each country \( m \) that are supported by net final uses of goods and services \( y'_m \). We posit a regional consumption possibility locus given by the distance function

\[
d(u'_1, \ldots, u'_m; y'_1, \ldots, y'_m) = \min \left[ \lambda : \lambda (y'_1, \ldots, y'_m) \text{ produces welfare} \ (u'_1, \ldots, u'_m) \right]^1
\]

so that the possibilities or level set of uses of goods and services yielding at least the regional welfare \( u'_1, \ldots, u'_m \) is

\[
W(u'_1, \ldots, u'_m) = \{ (y'_1, \ldots, y'_m): d(u'_1, \ldots, u'_m; y'_1, \ldots, y'_m) \ge 1\}.
\]
The regional cost of net final uses of goods and services (GDP by expenditure) is
\[ C(u^*_1, \ldots, u^*_n; e^*_1, p^*_1; \ldots; e^*_n, p^*_n) = \min_{(u_1, \ldots, u_n)} \left\{ \sum_{k=1}^{n} e^*_k p^*_k y^*_k : d(u^*_1, \ldots, u^*_n; y^*_1, \ldots, y^*_n) \leq 1 \right\} \]

The key point of this paper in the cost function context is selection of the set of factors e converting the prices in domestic unit of account to a common unit. The paper argues for exchange rates, because the units whose behavior the cost function summarizes cannot use any other set of conversion factors to effect potential purchase transactions. There is no observed cost function using PPP conversions, unless they equal exchange rates.

The Laspeyres-perspective regional economic price index is
\[ \frac{C(u^*_1, \ldots, u^*_n; e^*_1, p^*_1; \ldots; e^*_n, p^*_n)}{C(u^*_1, \ldots, u^*_n; e^*_1, p^*_1; \ldots; e^*_n, p^*_n)} \]

Using standard approximation theorems, the first order logarithmic approximation to this Laspeyres-perspective economic index is
\[ P_{Las}^1 = \prod_{m=1}^{n} \left( \frac{e^*_m p^*_m}{\bar{e}_m \bar{p}_m} \right) \]

The Paasche-perspective regional price index is
\[ \frac{C(u^*_1, \ldots, u^*_n; e^*_1, p^*_1; \ldots; e^*_n, p^*_n)}{C(u^*_1, \ldots, u^*_n; e^*_1, p^*_1; \ldots; e^*_n, p^*_n)} \]

Using standard approximation theorems, the first order logarithmic approximation to this Paasche-perspective economic index is
\[ P_{Paas}^1 = \prod_{m=1}^{n} \left( \frac{e^*_m p^*_m}{\bar{e}_m \bar{p}_m} \right) \]

Caves, Christensen, and Diewert \(^{14}\) established that the second order logarithmic approximation to the geometric mean of these two economic indices is the geometric mean of the Laspeyres- and Paasche-perspective logarithmic first order approximations—the Törnqvist volume index.

**Footnote**

1. The views expressed herein are those of the author and should not be attributed to the IMF, its Executive Board, or its management. I am grateful for comments from Erwin Diewert, Alan Heston, and Sergey Sergeev.


4. See, for example, the 1993 staff studies reference above.


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www.worldbank.org/data/icp
The IDB’s paid up capital now stands at US$4.8 billion with an authorized capital of US$45 billion. The Bank carries an AAA long-term Issuer Default rating from Fitch Ratings, an AAA rating from Standard & Poor’s and an AAA rating from Moody’s Investors Service. In addition, the Bank has been assigned a 0% risk weight by the Commission of the European Communities and holds observer status to the United Nations’ General Assembly.

The primary shareholders of the Bank are the Governments of Egypt, Iran, Kuwait, Libya, Saudi Arabia, Turkey, the United Arab Emirates and Qatar. The support of its member countries, its paid up capital, and its good ratings enables IDB to tap the global market and mobilize financial resources from around the world to finance its projects and operations.

Would you like to comment on the current food and financial crisis and how the IDB is addressing it?

The current food crisis is a global challenge that requires an urgent and a well-coordinated global response. No one institution can face up to such a monumental challenge alone. Against this backdrop, we believe that forming a consortium of international partnerships, pooling resources, and developing a modality that optimizes the impact of each and every partner is critical to tackle the current crisis unleashed by escalating food prices.

On its part, the Bank quickly swung into action creating an emergency fund of $1.5 billion to meet the urgent needs of its member countries. The fund will be disbursed over a five-year period. In the six months since the fund was launched in mid-2008, the Bank has initiated 10 projects in as many countries, all aimed at responding to their respective needs. In addition, it has financed trade operations in three countries so that they can procure improved seeds, fertilizers and equipments to boost food production.

As for global cooperation, the response of the development community and national governments is encouraging, but given the magnitude of the problem, we need to speed up the global emergency response. In the meantime, we need to build a consensus on long-term strategic solutions. At the same time, we need to challenge the research community to come up with mechanisms that can confront short-term shocks and long-term food insecurity.

Needless to say, this requires a sound knowledge base supported by robust and timely economic and social data. Unfortunately many of our developing member countries that have been hit hard by the current food price hikes lack the necessary capacity to provide reliable and timely statistics. In many cases, there are serious data constraints that limit our ability to undertake a thorough analysis of the problem and formulate appropriate policies.

The current crisis has brought the urgent need for reliable data to the fore. We need to support countries to collect data both by providing financial support and technical assistance. We are committed to be a part of the global effort to build a robust knowledge base and this should be done with a sense of urgency and sustained commitment.

The international community has the necessary platform to galvanize a concerted effort. For example, the International Comparison Program (ICP) can serve as a vehicle for collecting data on food, energy and fertilizer prices and expenditure values that are essential to inform both short- and long-term policy. We need to take appropriate actions to help countries in their efforts to collect relevant data at the household level systematically, and to make it available to researchers without delay. The challenge facing us is to strike a balance between the high cost of regular data collection and the pressing need of updating our knowledge base more frequently than is the case currently. The IDB will carry its fair share playing a lead role in areas where it has clear comparative advantage, and providing support in areas where other institutions are better suited to take the leading role.

Speaking of a reliable knowledge base, there is a widespread recognition that the state of national and international statistics leaves much to be desired. Can you share with our readers IDB’s contribution in narrowing the statistical information gap?

Statistics plays an important role in all the activities of IDB. All our projects undergo rigorous processing involving the use of socio-economic and financial statistics to analyze economic condition of beneficiary countries as well as to undertake cost-benefit-analysis.

As our members are classified as developing countries, with about half of them in the category of least developed countries, the IDB has for long taken cognizance of their development needs and responded accordingly by developing appropriate programs and initiatives to assist them.

To answer the question more specifically, we have put in place a new statistical capacity building (IDB-STATCAP) initiative for member countries, whose aim is to help them build and strengthen their statistical capacities. We have also partnered with other international organizations as sponsor of the ICP, with the objective of building statistical capacity and generate standardized data.

As part of its STATCAP initiative, the IDB has organized meetings, sponsored capacity projects of member countries and regional institutions as well as established statistical working group (SWG). All this is geared to harmonize data published in various publications of OIC.
institutions, avoid duplication of efforts, and streamline the current state of reporting conflicting figures. The SWG is an important platform for knowledge-sharing among OIC institutions, and between OIC institutions and member countries.

On the ICP front, we are working closely with the World Bank to harmonize economic statistics in our member countries and undertake a joint research to address key areas, with particular emphasis on standardizing data collection, processing and reporting procedures.

The IDB has a Data Resource Center, which prepares and distributes flagship statistical publications on annual basis showcasing the progress of member countries on key economic indicators. These publications are made available during the Annual Meetings of the IDB Board of Governors and subsequently sent to member countries’ national statistical institutions, central banks and international organizations. The aim of the publications, among other things, is to fill the knowledge gap in aggregate statistics on member countries that cannot be found in any international publications.

The research community often complains that statistical programs are under-funded. This is attributed to the all too familiar public goods problem. What is IDB doing to overcome this challenge?

Indeed, international data represents a classic public good. Mobilizing adequate funding is a challenge. In the face of the current global food crisis and financial meltdown in which the developing countries have been hit hardest and more importantly in the face of the potential risk of increased poverty and hunger, robust data is critical to guide policy and monitor progress. Overcoming the public goods problem is, therefore, more than an economic challenge. It is also a moral imperative. The international community has responded to the current crisis positively and aggressively. This is both encouraging and reassuring. In the interest of our member countries we need to scale up building our knowledge base in a way that is commensurate with the resources channeled to overcome the crisis.

The IDB will carry its fair share in the interest of its member countries. We are active participants and fund providers for the ICP, a first rate international public good. We are aware that more is needed to strengthen the ICP both as a ship base further. To summarize, overcoming public goods problem is a serious challenge but we, at IDB, are confident the international community and donor agencies will rise up to the challenge.

“The ICP data should serve not only multilateral agencies but also national governments. The program should offer country policy makers sub-national data that are essential to construct national poverty profile, identify who the poor are and where they are located within a national geographic boundary. Future ICP survey rounds should aim at making sub-national data available.”

Poverty alleviation is one of the strategic objectives of IDB and we need poverty-focused statistics to determine the level of poverty rates in member countries. PPP data are essential for setting international and regional poverty lines. The IDB has set up an Islamic Solidarity Fund for Development worth $10 billion. The fund is specifically targeted to combat poverty in least developed member countries. We would definitely need PPP data to support operational decision-making not only for poverty policy but also for broader economic and social development.

The ICP data should serve not only multilateral agencies but also national governments. The program should offer country policy makers sub-national data that are essential to construct national poverty profile, identify who the poor are and where they are located within a national geographic boundary. Future ICP survey rounds should aim at making sub-national data available.
The 2005 ICP

It is well-recognized that market exchange rates, which tend to equate purchasing power in terms of internationally-traded goods, are deceptive for measuring real incomes in developing countries, given that some commodities are not traded. This includes services but also many goods, including some food staples. Furthermore, there is a systematic effect, stemming from the fact that low real wages in developing countries entail that labor-intensive non-traded goods tend to be relatively cheap. As such, market exchange rates can greatly underestimate real incomes in poor countries.

This is known as Balassa-Samuelson effect and it provided the intellectual motivation for the ICP, which has collected prices by commodity from sampled outlets in each country in each “benchmark year” since 1970. The currency exchange rates (derived from these prices) that equate purchasing power over commodities (both internationally-traded and non-traded) are called Purchasing Power Parities, or PPPs. From the first time PPPs were estimated, the so-called “Penn Effect” was evident, namely the empirical observation that the “price-level index”—the ratio of the PPP to the market exchange rate—tends to be lower in poorer countries. [See Summers and Heston (1991) and World Bank (2008a)].

The Bank’s global poverty measures use international poverty lines with constant purchasing power as determined by the household consumption PPPs derived from the ICP.

The results of the new 2005 ICP were released this year (World Bank, 2008a,b), superseding the 1993 ICP, which was the previous benchmark year used for global poverty measurement.

For the purpose of measuring global poverty, an important feature of the 2005 ICP is that it did a much better job of collecting the prices needed to measure living costs (Heston and Summers, 2008). Reliable price surveys are quite difficult to do, particularly in poor countries where non-traded goods constitute a large share of spending. The new surveys done for the 2005 ICP used far more elaborate product descriptions to help identify comparable goods, so that we do not make the mistake of judging people to be better off because they consume lower quality (and hence cheaper) goods. Each of the six regions developed its own product listings based on the goods and services in national CPIs.

There were other improvements in the 2005 ICP. For example, there were better methods for valuing services from government, whereby adjustments were made for differential productivity of government employees, consistent with data on capital per worker. (Prior ICP rounds had assumed that government employees have the same productivity across all countries.) Also, ring comparisons (linking regional PPP estimates through global prices) were done for 18 countries—a marked improvement over past ICP rounds.

The new data imply major revisions to past PPPs for many developing countries, with a marked tendency for the PPPs to be revised upward for the poorest countries, as demonstrated by Ravallion et al. (2008). While some drift must be expected between the PPPs obtained from new benchmark years and those implied by updating the prior PPPs for inflation (relative to the US), the very large revisions implied by the 2005 ICP will presumably be a one-time event, essentially reflecting the technology change arising from much better price surveys.

It must be noted that the Penn effect is still evident in the new ICP data, in that the price level index tends to be lower in poorer countries (see World Bank, 2008a, Figure 5). What the new data suggest, however, is that the extent of this effect has been overstated, such that the PPPs of poor countries are higher than has been thought.

The 2005 ICP provides the best basis yet for setting an international poverty line with constant purchasing power across countries, so that different people with the same real consumption level are treated the same way, no matter where they live. However, while these are clear improvements, the new PPPs still have some limitations. There is a problem of “urban bias” in the ICP price surveys for some countries; Chen and Ravallion (2008) describes our methods of addressing this problem by bringing in extra information on the cost-of-living differentials implied by sub-national poverty lines. As was argued in Ravallion et al. (1991), a further concern is that the weights attached to different commodities in the conventional PPP rate may not be appropriate for the poor. Angus Deaton and Olivier Dupriez have estimated “PPPs for the poor” for a subset of countries with the required data; their preliminary results do not suggest that the implied reweighting has much impact on the consumption PPPs.

The Asian Development Bank (2008) has taken a further step of implementing special price surveys for Asian countries to collect prices on explicitly lower qualities of selected items than those identified in the standard ICP. When carried to poverty measurement, using lower quality goods essentially entails lowering the poverty line.

The revised poverty measures reported here use the household consumption PPPs from the 2005 ICP, after incorporating our adjustments for cases of likely urban bias. In future work we will be examining the sensitivity of these estimates to alternative PPPs.

A new international poverty line

In setting an international poverty line, the World Bank, for the last 20 years, has
measured the extent of “extreme poverty” in the world by the standards of what “poverty” means in the poorest countries. That gave us the widely-used “$1 a day” poverty measures. The original “$1 a day” poverty line—introduced by the 1990 World Development Report—aimed to assess poverty in the world as a whole by the standards of what poverty means in the poorest countries (Ravallion et al., 1991). Until recently, the Bank had used an international poverty line of $1.08 per person per day ($32.74 per month) at 1993 PPP, using the Bank’s PPPs from the 1993 ICP, and Chen and Ravallion, 2001).

This is clearly a conservative basis for measuring global absolute poverty. One could hardly argue that the people in the world who are poor by the standards of the poorest countries are not in fact poor. This gives the global poverty line a salience in focusing on the world’s poorest that a higher line would not have. At the other extreme, suppose one judged poverty in developing countries by (say) US standards, giving a poverty line of about around $13 per day in 2005. Learning that 96 percent of the population of the developing world is poor by such a standard is unlikely to have much relevance, given that US standards of living are not within the foreseeable reach of most people in a typical developing country.

In the light of the new PPPs derived from the 2005 round of price surveys done by the ICP, we have revisited the “dollar a day” line armed with a new set of national poverty lines for low- and middle-income countries (Ravallion, et al., 2008). We have drawn on the World Bank’s country-specific Poverty Assessments and the Poverty Reduction Strategy Papers done by the governments of the countries concerned. We have converted these national poverty lines into a common currency using the household consumption PPP’s estimated from the 2005 ICP.

We find that, across countries, national poverty lines tend to rise with mean consumption above a critical level, but that the relationship is quite flat below that level (see Figure 1). This pattern in the data is consistent with past work (Ravallion et al., 1991). It fits well with the interpretation of a national poverty line as a “social subjective poverty line,” defined as the level of consumption below which people in that country tend to think they are poor, and above which they do not (Ravallion et al., 2008). The interpretation is that in very poor countries levels of living are so low generally that there is little scope for concern about relative deprivation.

We have proposed a new international poverty line of $1.25 a day for 2005, which is the mean of the lines found in the poorest 15 countries in terms of consumption per capita. The level of this poverty line is quite robust to the choice of the poorest 15 countries. However, it makes sense to focus on the poorest 15 since these correspond closely with the critical level of consumption above which the poverty line tends to rise.

In the light of these PPP revisions, simply updating the old international poverty line for inflation in the US gives a poverty line that is well above the lines found amongst the poorest countries at 2005 PPP. Adjusting solely for inflation in the US, the 2005 value of the Bank’s prior international poverty line is $1.45 per day. However, this calculation ignores the fact that the 2005 PPPs for the poorest countries have been revised upwards. Adjusting for this, it brings the new poverty line down to $1.25.

Ravallion et al. (2008) also provide corresponding international poverty lines for a number of alternative PPPs that might be considered more appropriate for measuring poverty. We are currently studying the sensitivity of global poverty measures to alternative PPPs. The following discussion will focus on the $1.25 line and the standard household consumption PPPs from the 2005 ICP.
Box 1: Calculating the World Bank’s global poverty measures

- National poverty lines for a reference group of countries are converted to a common currency using the purchasing power parity (PPP) rate for consumption. Taking an average of these lines gives the international line.
- The international poverty line is converted to local currencies in the benchmark year (2005) using the same PPPs and then converted to the prices prevailing at the time of the relevant household survey using the best available CPI for that country (split urban-rural when feasible).
- Then the poverty rate is calculated from that survey by standard methods.
- Interpolation/extrapolation methods are used to line up the survey-based estimates with these reference years, including 2005.
- Population weighted aggregate measures are then formed by region and globally.

Revised poverty measures for 2005

The aggregate poverty count will not in general be independent of the reference year, even if the underlying data are the same; this is a widely acknowledged feature of international comparisons, whether it is a poverty measure or national output being compared. However, this is a moot point given that the data have changed so much from one ICP round to another. Given these changes, it makes sense that global poverty measurement has followed the common practice in other international comparisons of only doing the PPP conversion at one date, and using existing national price data for inter-temporal comparisons. Box 1 summarizes the steps in measuring global poverty.

Using almost 700 household surveys for 115 developing countries, we estimate that 1.4 billion people—25 percent of the population of the developing world—were poor by the $1.25 a day definition in 2005 (Chen and Ravallion, 2008). Using the old $1.08 line in 1993 prices, we had estimated that slightly less than one billion people were poor in 2005. So the new data suggest that poverty is more pervasive than was previously thought. This reflects the fact that the 2005 ICP indicates that the cost-of-living is higher in developing countries than was suggested by the earlier ICP data.

Table 1 provides a regional breakdown of our estimates of the aggregate poverty measures for 2005, for each of the five poverty lines: (i) $1.00 a day at 2005 PPP, which is very close to the national poverty line used by the Government of India in 2004/05; (ii) $1.25, the mean poverty line of the poorest 15 countries (as discussed above); (iii) $1.45, as obtained by updating the 1993 $1.08 line for inflation in the US; (iv) $2.00, which is the median of the sample of national poverty lines for developing and transition economies (Ravallion et al., 2008); and (v) $2.50, twice the $1.25 line, which is also the median poverty line of all except the poorest 15 countries in the same sample of national poverty lines.

The regional rankings are not robust to the poverty line. Two changes are notable. At lower lines (under $2 per day), Sub-Saharan Africa has the highest incidence of poverty, but this switches to South Asia at higher lines. Second, the poverty rate for the Middle-East and North Africa exceeds that of Latin America at $2 or higher, but the ranking reverses at lower lines. (Intuitively, these differences reflect the higher inequality found in Africa and Latin America.)

At the lowest line of $1.00 per day, 35 percent of the poor live in Sub-Saharan Africa, though this falls to 20 percent at the $2.50 line (Table 1). The share of living in South Asia is fairly stable, at around 40 percent, but the share in East Asia rises markedly as the poverty line rises, from 20 percent for the $1.00 line to 31 percent for $2.50.

Measures such as the poverty rate (the “headcount index”) and the correspond-
ing count of the number of poor are known to have limitations as measures of poverty; for example, if the poorest person becomes worse off then the headcount index will not change. A better measure in this respect is the poverty gap index, which is the mean distance below the poverty line as a proportion of the line where the mean is taken over the whole population, counting the non-poor as having zero poverty gaps. The poverty gap index for the developing world as a whole in 2005 is 7.6 percent for the $1.25 line (Chen and Ravallion, 2008). To put this number in perspective, the GDP per capita of the developing world was $11.30 per day in 2005 (at 2005 PPP). The aggregate poverty gap for the $1.25 line is 0.84 percent of GDP per capita, while it rises to 3.29 percent for the $2 line. World (including the OECD countries) GDP per capita was $24.58 per day in 2005, implying that the global aggregate poverty gap was 0.33 percent of global GDP using the $1.25 line and 1.28 percent using the $2 line.

Comparisons over time

Our results confirm that we are still making progress in reducing global poverty. The percentage living under $1.25 a day fell from 52 percent in 1981 to 42 percent in 1990, and then fell to 25 percent in 2005. The conclusion that poverty has fallen is also robust to the choice of poverty line or poverty measure. This is evident if one calculates the empirical cumulative distribution function (CDF) up to (say) $13 per day, which is the average official poverty line in the US in 2005; Figure 2 plots the CDFs for 1981, 1990 and 2005. First order dominance is indicated. In 2005, 95.7 percent of the population of the developing world lived below the US poverty line; 25 years earlier it was 96.7 percent.

Based on the trend over 1981-2005, we are still on track for attaining the first of the UN’s Millennium Development Goals, namely to halve the 1990 poverty rate by 2015. The trend rate of decline in the $1.25 a day poverty rate over 1981-2005 was 1 percent point per year. (Regressing the poverty rate on time the estimated trend is -0.99 percent per year with a standard error of 0.06 percent). Simply projecting this trend forward to 2015, the estimated headcount index for that year is 16.6 percent (standard error of 1.5 percent). Given that the 1990 poverty rate was 41.6 percent, the new estimates confirm the conclusion of Chen and Ravallion (2007) that the developing world as a whole is on track to achieving the MDG of halving the 1990 poverty rate by 2015. (This also holds at the upper bound of the 95 percent confidence interval for our projected poverty rate for 2015.)

Clearly that is good news, but there are reasons for caution. First, the past trend of poverty reduction will not get us below the one billion mark until about 2015; there will still be a lot of very poor people in the world. And if we did no better than attaining the MDG that would leave a staggering 1.3 billion people in poverty in 2005. Success in the MDG is no basis for complacency in the fight against poverty.

Second, there is a staggering total of 1.2 billion people living between $1.25 and (say) $2.00 a day in 2005 (see Table 1). While many people have reached the $1.25 a day threshold, they are still very poor, and clearly vulnerable to downside shocks. The series of poverty measures reported in Chen and Ravallion (2008) go up to 2005; lags in household survey data availability make it hard to make more recent estimates. However, the steep rise in food, fuel and fertilizer prices since 2007 has almost certainly delayed progress against poverty since 2005, and the global financial crisis currently spilling over to the developing world threatens to delay that progress even further.

Third, the developing world outside China will not attain the MDG without a higher rate of poverty reduction than seen over 1981-2005. Progress has been highly uneven and the composition of world poverty has changed noticeably over time. The number of poor has fallen sharply in East Asia, but risen elsewhere (Fig 3). For East Asia, the MDG of halving the 1990 “$1 per day” poverty rate by 2015 had already been reached a little after 2002. Again, China’s progress against absolute poverty was a key factor; looking back to 1981, China’s incidence of poverty (measured by the percentage below $1.25 per day) was roughly twice that for the rest of the developing world; by the mid-1990s, the Chinese poverty rate had fallen well below average. There were over 600 million fewer people living under $1.25 per day in China in 2005 than 25 years earlier. The persistently high incidence of poverty in Sub-Saharan Africa is notable. The region’s poverty rate both started and ended the period at about 50 percent, which means that the number of poor in Africa rose from about 200 million to 380 million; 100 million people
have been added to Africa’s poverty count since 1990. Thankfully, there are some recent signs of progress. Africa’s poverty rate peaked in 1996 at 59 percent and has been falling since—stemming largely from higher rates of economic growth. But even this recent reduction in the incidence of poverty has not been enough to bring down the number of poor in Africa, given high population growth.

**Looking forward**

The developing countries face a severe challenge in maintaining past progress against poverty. This will require a combination of higher growth rates with policies that can help assure that poor people have the opportunity to participate in, and contribute to, that growth. The developing world overflows with lessons on both successes and failures in fighting poverty, and all countries need to learn pragmatically from those lessons. Better data on poverty is a key ingredient in that task.

There are a number of issues that merit further attention in the analysis of the 2005 ICP data, and subsequent ICP rounds and we have pointed to some of those issues in the article. However, one issue stands out in our view. There appear to be important opportunities for building on the 2005 ICP to develop sub-national PPPs, at least for the largest developing countries. High transport costs and other impediments to inter-regional trade yield sizeable intra-country differentials in the cost of living that are currently “averaged out” in estimating PPPs. The importance of these sub-national cost-of-living differences is widely appreciated in the poverty measurement literature, but PPPs derived from the ICP continue to be derived at the national level only. The large samples of price outlets obtained by the ICP in most developing countries should facilitate the estimation of sub-national PPPs. The integration of these price data with other data bases could facilitate further gains in our knowledge about poverty in the world.

**Figure 1: National poverty lines plotted against mean consumption**

**Figure 3: Numbers of poor by region 1981-2005**

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### References


8. Granted, if all international transactions, including non-goods and services flows, were brought to the same unit of account with PPPs rather than exchange rates, then the accounting identities would clear.

9. Unfortunately, published international statistics do not have quite so neat an underpinning. Compilation of the national GDP deflator is the province of the country statistical office. For most, but not all countries, this will be a Paasche index, but chained at differing frequencies as national accounts are periodically rebased at idiosyncratic intervals in each country. We will assume away these complications as beside the point of this note.

10. Of course, the regional price index can be usefully factored into a national currency inflation component, and an exchange rate component. The first factor is the common presentation in most international statistical publications. Note that the transitivity of exchange rates means that the volume results would not be altered if the numeraire were chosen as an international reserve unit, such as the IMF Special Drawing Right (SDR). The inflation results could be more meaningful with this choice of numeraire, as well as in terms of a so-called hard currency, a country currency having achieved status as a world unit of account and store of value.

11. The countries are: Bangladesh; Cambodia; China, People’s Republic; Mainland China, P.R.; Hong Kong S.A.R; India; Indonesia; Korea; Lao People’s Democratic Republic; Malaysia; Pakistan; Philippines; Singapore; Sri Lanka; Thailand; and Vietnam.

12. Note that this implies that the PPP is not a unitless index. The unit of measure of the PPP is numerator currency / denominator currency, the same unit of measure as for a currency exchange rate.

13. The IMF quota application uses the sum of GDP volumes at purchasing power parity as a scaling factor to compare relative GDP volume levels between countries. However, these scaled GDP volumes are not used in this quota application as “shares” for averaging national GDP volumes together into world or regional aggregates. Indeed, because regional GDP volume is generally not the sum of the national volumes making it up, these ratios are not shares in the economic sense of the term.


15. This generalizes pp. 221–223 of W. E. Diewert, 2001, The Consumer Price Index and index number purpose, Journal of Economic and Social Measurement 27, 167–248 to apply to GDP rather than only household consumption expenditure. (On heterogeneous household aggregates, see also pp. 125–130 of M. Kokoski, B. Moulton, and K. Zieschang, 1999, Interarea price comparisons for heterogeneous goods and several levels of commodity aggregation, in International and Interarea Comparisons of Income, Output, and Prices, A. Heston and R. Lipsey, Eds., National Bureau of Economic Research Studies in Income and Wealth Volume 61.) It allows each national cost function to depend on not only the welfare of the country in question, but also the welfare of other countries in the group. This parallels the expenditure (rather than production or income) approach to GDP taken in this paper and in the publications referenced in the Introduction.

GDP by expenditure for a given country depends on household cost functions (household consumption), the government cost function (government consumption), the investment function (capital formation), the cost function of the Rest of the World in purchasing the output of the country in question as exports, and the negative of the revenue function of the Rest of the World in supplying imports to the given country. This latter treatment of exports and imports follows from the nonresident orientation of the System of National Accounts for exports and imports in GDP by expenditure. On this, see Chapter 18 of the draft Export and Import Price Index Manual at http://www.imf.org/external/np/sta/tgeipi/index.htm.

Zieschang ... continued from page 7
An output method for education PPPs

1. Introduction
Non-market services are regarded as one of the “comparison-resistant” components of GDP. While their share of GDP is significant, there is a widespread feeling that the data sources and methods applied in international comparisons of these services do not bring satisfactory results. Usually these comparisons are made on the basis of prices of inputs. In other words, the cost of inputs is used to measure the value of outputs. However, like in comparisons over time, the problem in spatial comparisons is related to capturing differences in productivity of the inputs.

In the Eurostat/OECD PPP Programme, an input method based on civil servants’ salary levels has been applied up to now. This input price approach rests on the assumption of uniform productivity in all countries, an assumption widely regarded as unrealistic. Furthermore, due to the various data sources being used to estimate salary levels, the international comparability of the data has been questioned.

During 2006 and 2007, a Eurostat/OECD task force looked systematically into alternatives to the input price approach for non-market services, focusing in particular on education. The task force came up with a concrete proposal based on direct measurement of volumes (a quantity approach) with quality adjustment, in line with the concept of education output as defined in Eurostat’s handbook on price and volume measures in national accounts (cf. section 2). This approach has now been formally adopted, and will be implemented for the first time in the 2008 calculation of PPPs and related indicators for the years 2005-2007.

2. An overview of the model:
The Eurostat Handbook on price and volume measures in national accounts (section 4.12) defines education output as “[t]he quantity of teaching received by the students, adjusted to allow for the quality of the services provided, for each type of education.” Furthermore, the Handbook specifies that “[t]he quantity of teaching received by students can be measured by the number of hours they spent at being taught. This measure is referred to as the number of “student-hours” [...]. In the area of education, the output can be defined as the quantity of teaching (that is, the transfer of knowledge, successfully or not) for a pupil, whereas the related outcomes are the skill and knowledge that a pupil achieves”.

Thus, education services are viewed conceptually as the transfer of knowledge from teacher to student. The amount of knowledge transferred is approximated by the number of student-hours, assuming that one student-hour stands for a fixed amount of transferred knowledge. The definition of output also indicates that one should distinguish between different types of schools, for instance, between levels of education, because the fixed amount of knowledge transferred can differ between various types of schools.

The approximation of education output by the number of student-hours assumes that class size, physical facilities such as libraries and laboratories, availability of text books, computers, etc., for respective levels of education, are fairly uniform across the countries being compared. It may be noted, however, that such an assumption, while not unreasonable for OECD/Europe, may not
hold for countries in different regions and different levels of living standard.

Furthermore, we should take account of the fact that not all transfer of knowledge is successful. Success or failure, in this context, depends in part on the quality of the teaching, but also on factors like the student’s individual effort and his or her socio-economic background. The challenge is to determine what can be attributed to such exogenous factors rather than to the quality of teaching itself.

International comparisons of education output should not make a distinction between market and non-market output. The same methods should be applied regardless of whether education is provided on a market or a non-market basis, otherwise the comparison will be distorted by differences in the relative shares of market and non-market activities. Hence, the main aim of the new method is to produce reliable price and volume measures for actual individual consumption (AIC) in education, including household, non-profit organizations and general government consumption. The indicators should relate to all students in all types of educational institutions, whether public or private.

As for the practical implementation of these principles, the Eurostat model is based on student numbers and AIC expenditure in education. In its simplified version, the model produces volume indices that reflect the number of student hours per inhabitant and PPPs based on the expenditure per student, adjusted for differences in the quality of teaching, in each participating country. Volumes are thus estimated directly, while PPPs are indirectly derived by dividing total AIC expenditure in education into the number of students.

As an approximation to “student hours”, the number of students is measured in full-time equivalents (FTEs). While this measure is close to the concept of student hours, FTEs are not necessarily fully comparable across countries, because the number of hours within one FTE can differ from country to country. Nevertheless, the number of students in FTEs is taken as the basis for the calculations.

In order to account for productivity differences across countries, the quantity model outlined above is further refined through the introduction of quality adjustment (QA) based on results from the Program of International Student Assessment (PISA). A QA factor is calculated on the basis of each country’s PISA score relative to the average of all countries. This adjustment factor is then applied to the implicit prices calculated on the basis of expenditures and student numbers. Since students take the PISA tests at the age of 15, only the data for ISCED 1 (primary education) and ISCED 2 (lower secondary education) are made subject to QA.

The quantity-based PPPs with quality adjustment that come out of this model are applied as spatial deflators for education expenditure, similar to the PPPs produced under the input-based approach.

3. Data sources
Aside from the theoretical considerations that speak in favor of output-based PPPs, an important practical advantage of the new approach is that the annual calculation of PPPs and relative volumes will be based on data already available from the common education database of UNESCO, OECD and Eurostat (UOE). Student numbers and expenditures are extracted from the UOE database and applied directly in the calculation of PPPs, thus eliminating the need for a separate data collection in the participating countries.

The UOE database is used for several purposes, for example, in the “Education at a glance” publications of the OECD, and in Eurostat’s education statistics. It represents a stable and reliable source of input data. There are some gaps in the UOE database, however. Notably, four out of 37 countries taking part in the Eurostat PPP exercise are currently not included. In these cases, data provided by the countries specifically for use in the PPP exercise are used instead.

The PISA survey is carried out every third year, most recently in 2006. The country coverage of PISA has expanded considerably over time, and in 2006, only four of the 37 “Eurostat countries” were not included. For these countries, imputations are made based on other, presumably similar countries.

4. Quantity aspects
Eurostat’s new approach to education PPPs is conceptually a quantity model with quality adjustment.

As indicated in Section 2, a rudimentary (though not necessarily inaccurate) quantity indicator could be the total number of FTE students without any breakdown by level of education and without any quality adjustment. The volume per capita is then simply the ratio of the number of students to the total population. However, it seems unreasonable to assume, for instance, that a primary school student in a less developed country should have the same weight in the calculation as an Oxford University student. To minimize distortion due to such differences in the structure of the student population, the input data is stratified according to the International Standard Classification of Education (ISCED): Total expenditure per country, student and ISCED level enters the calculation on the price side, whereas total expenditure per country and ISCED level is applied as weights.

Data on numbers of FTE students per ISCED level are extracted from the UOE database, as are the expenditure
data. However, because of inconsistencies with the national accounts data, the UOE expenditure data cannot be used directly in the calculations. The UOE expenditure structures are only used to determine percentage weights for each ISCED stratum. These weights are subsequently applied to the AIC expenditure data from national accounts to derive expenditure per ISCED level. Dividing these data by the number of students at each ISCED level gives expenditure per student and level of education – the “prices” used in the calculation of PPPs.

One particular problem that needed to be addressed was the fact that input data from the UOE database become available with a certain time lag, and do not fit automatically into Eurostat's annual work plan. More specifically, when Eurostat publishes its first PPP results for the year t-1, the most recent input data available will currently refer to the year t-3. It was decided to deal with this problem by simply extrapolating student numbers with the overall population growth, assuming that the ratio of students to total population will usually remain quite constant from one year to the next. Changes in expenditure from year t-3 to t-1 will thus show up as a change in the price level index, while the volume index will remain constant, except for the effect produced by quality adjustment.

5. Quality indicators

A method based on quantity measures alone would not be satisfactory, given the significant differences in the quality of education services that are assumed to exist. It is clear, however, that the quality of education is a highly sensitive issue and that its measurement is by no means clear cut, but rather full of conceptual and practical difficulties. The Handbook on price and volume measures in national accounts (section 3.1.2.2) recommends using outcomes to adjust for quality: “The quality of the output lies in its results, i.e. in the outcome. The most appropriate way of adjusting for quality is to investigate changes in outcome indicators”. In the field of education, this implies investigating, for example, examination scores.

In view of this recommendation, Eurostat looked into a range of international studies of students' attainment levels in order to identify suitable sources of quality adjustment. A number of such studies are available:

PISA ¹: At the moment, PISA seems to be the most reliable and complete international survey of student performance. PISA is an internationally standardized assessment managed by OECD, which was jointly developed by participating countries and administered to 15-year-olds in schools. This three-yearly survey was implemented in 43 countries in the first assessment in 2000, in 41 countries in the second assessment in 2003 and at least 58 countries have participated in the third assessment in 2006. Tests are typically administered to between 4,500 and 10,000 students in each country. There are three topics of examination in PISA: mathematics, reading, and science.

PIRLS ²: The Progress in International Reading Literacy Study gives qualitative indicators for primary schools. Thirty-five countries participated in PIRLS 2001, testing 150,000 students 9- and 10-year-olds. The latest PIRLS survey was carried out in 2006. It is managed by the International Study Centre (ISC) at Boston College, in partnership with the International Association for the Evaluation of Educational Achievement (IEA).

TIMSS ³: The Trends in International Mathematics and Science Study was carried out in 1995, 1999, 2003 and 2007. It is undertaken by 9-year-olds and 13-year-olds, involving 60 countries in total but not many from the EU. Like PIRLS, it is managed by ISC and IEA.

Among these three surveys, PISA has the widest coverage of topics and countries, and seems the most secure in terms of future continuation. In addition, PISA also provides results that are adjusted for students' economic, social and cultural status (ESCS). For these reasons, Eurostat decided to focus on the PISA in its further efforts on quality adjustment.

6. Using PISA for quality adjustment

The basic approach of PISA is to measure students' level of attainment at age 15 by testing them in the three subjects mentioned above. The tests are the same in each country. The scores are subsequently placed on a scale with 500 as the average of OECD countries and 100 as standard deviation.

The scaling of the PISA scores in this way is in principle arbitrary. Any number could be set as average and any number as standard deviation. These choices have an impact on the perceived differences between countries, but not on their ranking nor on the ratios of a given country's deviation from the average.

The PISA score of a country can be seen as a measure of the level of skills and knowledge of 15-year-olds. This level is not just the result of the most recent year of education, but rather the sum of all formal education received up to the age of 15, the knowledge and skills contributed by the student's family and social environment, and the student's inherited skills.

As the output measure should only reflect the skills and knowledge transferred by the school system, only skills and knowledge that can be attributed to formal education should be taken into account. Thus, at least ideally, we would need to adjust the PISA scores so that the other two components are excluded from the quality adjustment.

To adjust for the impact of family and
social environment, PISA has developed an adjusted PISA score that takes into account the differences in economic, social and cultural status (ESCS). This approach adjusts the original PISA scores by assuming that the ESCS indicator of each country is equal to the OECD average. This way, the scores are adjusted for differences in the impact of ESCS across countries, but not for the average impact. The ESCS adjusted scores are assumed to better reflect the actual contribution of schools to the outcome of formal education, and thus more suitable for our purpose.

These scores would still have to be adjusted for the inherited skills of the student. However, this would require international tests undertaken at different ages, or at least at the age when formal schooling begins. To our knowledge, such tests do not exist. Hence, in our calculations we do not make any adjustment for students’ inherited knowledge, implying by assumption that this factor has the same impact in all countries.

The PISA scores are transformed into a quality adjustment factor by normalizing them to the EU average set to 100. These quality adjustment factors are subsequently used to adjust expenditure per student, though only for ISCED levels 1 and 2. This is because the PISA tests are taken at the age of 15, and the results thus only capture the skills and knowledge acquired up to that age.

7. Results
Using quality-adjusted expenditure per student and ISCED level as price input, and expenditure per ISCED level as weights, the standard EKS procedure produces a set of PPPs that can be applied to deflate AIC in education.

The chart shown below compares the volume indices per capita under the input price approach previously used with the results of the new output approach. The input price approach shows a much larger variation across countries. Assuming that the total amount of education received per student is probably not widely different in the various countries, we consider this as an indication of improved plausibility of the results. In several cases, the new volume indices are clearly more plausible than the results produced under the old approach. One good example of this is Luxembourg, which has a very small tertiary education sector and should therefore be expected to have a relatively low volume index. Other examples include Germany, where the input price approach produces a surprisingly low volume index, and countries like Iceland, Denmark and Sweden, where the opposite is the case.

It should be stressed that the results presented here are not yet official statistics, and that the final results for 2005 may differ from what is shown here. The final results can be extracted from Eurostat’s database as soon as they are finalised.

8. Conclusions
Eurostat considers that the proposed output method, already preferred on the basis of conceptual arguments, appears – on the whole – to produce more plausible results than the current method. The breakdown by ISCED and the introduction of a quality adjustment on the basis of PISA produce further refinement of the results and enhance the acceptability of the approach. In addition, the new methodology reduces the workload on the participating countries, since the input data is collected from already existing databases.

On the other hand, we certainly do not claim that this is the final word on education PPPs. At the general level, one’s view on this approach will certainly be influenced by one’s view on output methods in general. Nevertheless, there seems to be a general agreement among the countries coordinated by Eurostat that the change in methodology is conceptually sound and produces more plausible results than the previous approach.

Further refinement of the approach can realistically be achieved through improved timeliness of the UOE data, and the possible introduction of quality adjustment for tertiary education.

Footnote
  &lang=en&pgid=portalc&schema=PORTAL
Dikhanov Tables

Price data validation and analysis play an important role in the International Comparison Program. In fact the final results of the comparison can only be as good as the basic data. In practice, data validation is built into all operations of ICP. Data validation occurs at several levels and on many occasions, starting from the process of price collection. The price data validation is also one of the most time-consuming processes in the ICP that require constant attention of the regional and national coordinators. The current article deals only with the validation at the international level, which is conducted with the help of regional coordinators of the program. The overall operations of the ICP, including data collection and validation at all levels, are described in the ICP Handbook, and can be accessed via the World Bank ICP website.

In the 2005 ICP round two techniques of data validations were used: Quaranta Tables and Dikhanov Tables. The current article is concerned primarily with the Dikhanov Tables. However the Quaranta Tables are given significant attention as well, for the purposes of showing differences and similarities between the two techniques. These techniques allow for similar analyses; however, they are different in presentation and style, the Dikhanov Tables being more compact and easy to view.

There exist two types of validation in the international comparisons: intra-country and inter-country.1 The intra-country validation could, in principle, be carried out entirely by the country itself without the assistance or intervention of the regional coordinator, although the regional coordinator can, and should, provide a valuable second opinion about doubtful or marginal cases, and to check whether the intra-country validation has been properly carried out. Eventually, the point is reached at which the data for each country have been validated to the maximum extent possible without taking into account the data for other countries. It then becomes possible for the regional coordinator to calculate the Quaranta and Dikhanov Tables. We start with the inter-country validation based on the Quaranta tables, and then proceed to the inter-country validation using the Dikhanov tables, as the principles of analysis of those two tables are similar, and the latter can be thought as an extension of the former.

The Quaranta Tables

The Quaranta Tables consist of a set of tables for a basic heading, one for each product within the basic heading, with the first table in the set being an introductory summary table containing general information relating to the basic heading as a whole such as the exchange rate, basic heading PPP and price level.

In the main set of tables, there is one table for each of the products within the basic heading. The tables all have the same format, with the countries in the rows. The table for each product shows the average price of that product in each of the countries expressed in national currency and then converted into a selected common unit of currency using first the official exchange rate, and then the PPP for the basic heading. Once converted into a common currency, the average prices in different countries can be compared with each other. This enables outliers to be identified using the same kind of criteria, or thresholds, as were used in the Price Input and Output tables.

Whereas the purpose of the earlier intra-country validation was to screen individual prices for possible errors using the Price Input and Output Tables, the purpose of the Quaranta Tables used for the inter-country validation is to screen the estimated national average prices for possible errors by comparing the average prices for the same product in different countries, and also by examining the dispersion of the average prices. This can only be done, of course, after they have been converted into a common unit of currency.

The Quaranta Tables require the PPPs for the basic heading. However, the purpose of the Quaranta Tables is to validate the average prices that are to be
used as inputs into the calculation of the basic heading PPP. The Quaranta Tables have, therefore, to start by using provisional PPPs calculated from the unvalidated average prices. The methodology used to calculate the basic heading PPPs is described in Chapter 11 of the ICP Handbook [http://siteresources.worldbank.org/ICPINT/Resources/270056-1183395201801/icp_Ch11rev.doc].

In general, it is likely that some of the original unvalidated average prices will subsequently be revised as a result of the inter-country validation process, in which case the Quaranta Tables have to be recalculated using revised PPPs based on the revised average prices. Clearly, the revisions might trigger further revisions, so that several iterations of calculation may be required. In any case, the first Quaranta Tables to be calculated may not include all the countries in the region so that the number of countries in the Tables may increase over time, thereby generating further revisions to the PPPs and average prices converted using the PPPs.

Figure 1: Quaranta Table: Computation Order and Dependencies

<table>
<thead>
<tr>
<th>QUARANTA TABLE DIAGNOSTICS - Filters - Mushrooms and Garlic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic Heading Code</td>
</tr>
<tr>
<td>Scope of Coverage</td>
</tr>
<tr>
<td>Averaging Method</td>
</tr>
<tr>
<td>Time Period</td>
</tr>
<tr>
<td>Run Date</td>
</tr>
<tr>
<td>Upper Bound</td>
</tr>
<tr>
<td>Lower Bound</td>
</tr>
<tr>
<td>Aggregation</td>
</tr>
<tr>
<td>Aggregate</td>
</tr>
<tr>
<td>Price Attributes</td>
</tr>
<tr>
<td>Location Attributes</td>
</tr>
<tr>
<td>Product Attributes</td>
</tr>
</tbody>
</table>

Summary Information

| No of Items included in the Analysis | 3 out of 3 |
| Average weight of Basic Heading in Total Expenditure | 3 out of 3 |
| Average Coefficient Variation | 3 out of 3 |
| Weight # | 3,*3 |
| Items | 56.9 |

Country Level Details

<table>
<thead>
<tr>
<th>Country</th>
<th>XR</th>
<th>PPP</th>
<th>XR(%)</th>
<th>Weight #</th>
<th>Items</th>
<th>Var.Co.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Y</td>
<td>1.00</td>
<td>1.6590</td>
<td>165.9%</td>
<td>150</td>
<td>110</td>
<td>56.9</td>
</tr>
<tr>
<td>X</td>
<td>9.12</td>
<td>9.8517</td>
<td>108.0%</td>
<td>210</td>
<td>3,4,3</td>
<td>33.1</td>
</tr>
<tr>
<td>Z</td>
<td>1.00</td>
<td>1.0000</td>
<td>100.0%</td>
<td>300</td>
<td>2,1,2</td>
<td>22.9</td>
</tr>
</tbody>
</table>

Item Level Details

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Y</td>
<td>20.922</td>
<td>6</td>
<td>12.7</td>
<td>20.82</td>
<td>12.61</td>
<td>159.25</td>
<td>12.61</td>
<td>57.0</td>
<td>43.917</td>
<td>6.2</td>
<td>4.52</td>
<td>4.18</td>
<td>64.51</td>
</tr>
<tr>
<td>X*</td>
<td>43.917</td>
<td>6</td>
<td>16.3</td>
<td>4.82</td>
<td>57.37</td>
<td>249.25</td>
<td>4.82</td>
<td>249.25</td>
<td>6.92</td>
<td>4.82</td>
<td>57.37</td>
<td>24.45</td>
<td>249.25</td>
</tr>
<tr>
<td>Z</td>
<td>5.870</td>
<td>5</td>
<td>6.1</td>
<td>5.87</td>
<td>58.7</td>
<td>169.93</td>
<td>5.87</td>
<td>169.93</td>
<td>12.61</td>
<td>5.87</td>
<td>58.7</td>
<td>124.15</td>
<td>169.93</td>
</tr>
</tbody>
</table>

LEGEND:

- **RATIO**
- **ELEMENTARY INDEX NUMBER**
- **GEO MEAN**
- **VARIATION COEFFICIENT**
- **MEAN**
Quaranta Table Definitions [Explanations for Figure 1]

**Country Level Details**

- **XR:** The country’s official or market exchange rate expressed as the number of units of the national currency per dollar or other selected numeraire currency. Regions may choose the currency of any of their own countries as the numeraire currency.
- **PPP:** The purchasing power parity for the basic heading -- the basic heading parity. This is calculated from the national average prices listed in the main set of Quaranta Tables using one or other of the methods described in Chapter 11. The necessary programs are included within the Tool Pack. In the example, the Country Product Dummy method, or CPD, is used to calculate the basic parities. The numeraire currency chosen for the PPPs should be the same as for the exchange rates.
- **PLI(%)**: The price level index for the basic heading. This is defined as the ratio of the basic heading PPP to the XR. It is expressed as a percentage. A PLI for a country that is greater (less) than 100 means that the national prices in a country within the basic heading tend to be higher (lower), on average, than prices in the base country of the group.
- **Weight:** The country’s expenditure weight for the basic heading: i.e., the share of the expenditure in the basic heading to the total expenditure of the selected aggregate in that country, expressed per 10,000.
- **The number of items:** The number of products within the basic heading for which prices have been collected and used to calculate the average prices. The number of “asterisk products” is the number of products that are designated as being representative of each of the countries.
- **Var. Co.:** Three different kinds of coefficients of variation appear in the Quaranta Tables. Here, it is computed for each country from the CUP-ratios for individual products that that country has data for.

**Item, or Product, Level details**

In this set of tables, there is one table for each product within the basic heading for which prices have been collected. Again, the rows in each table refer to the countries. The first column of each table provides the link with the earlier intra-country validation processes, as it records the national average price for the country in question as shown in the final Price Output Sheet [see, e.g., Table 5.2]

- **NC-price:** This is the estimated national average price for the product in the national currency carried forward from the country’s Price Output Sheet.
- **Quotations:** The actual number of price observations on which the national average price is based.
- **Var. Co.:** The variation coefficient for the individual observations on the price of the product also carried forward from the country’s Price Output Sheet.
- **XR-ratio:** The ratio of the XR price to the geometric mean, or GM, of the XR prices for all countries is shown in an extra row below the XR price for the last country.
- **XR-ratio:** The ratio of the XR price to the geometric mean, or GM, of the XR prices for all the countries in the region or group. It is expressed as a percentage.

**CUP-price (Conventional Unit for Price measurement):** The national average price in the first column converted into the numeraire currency using the exchange rate. The geometric mean, GM, of the XR prices for all countries is shown in an extra row below the PPP price for the last country.

**CUP-ratio:** The ratio of the country’s PPP price to the geometric mean, or GM, of the PPP prices for all the countries in which the product has been priced. It is expressed as a percentage.

**Var. Co.:** It is computed for each product from the CUP-ratios for individual countries that have data for that product.

**Summary Information**

- **Average weight of Basic Heading in Total Expenditure:** Computed as a simple unweighted arithmetic average of the expenditure shares in the different countries.
- **Average Variation Coefficient:** Computed as a simple unweighted arithmetic average of the Variation Coefficients for the individual products.
Principles of Diagnostics with XR and PPP Price Ratios

The XR and the PPP price ratios provide valuable information for screening the national average prices. Each of these ratios refers to a particular product in a particular country. A high (low) XR or PPP ratio means that the national average price for the product in question is high (low) compared with the prices of the same product in other countries when they are all converted into the common numeraire currency using the XR or basic heading PPP. The appropriate thresholds for the individual XR or PPP price ratios could, for example, be 67 and 150. These recommended thresholds are shown at the top of the summary Quaranta Table.

An XR price ratio that lies outside these limits may signal a questionable observation. However, a high or low XR price for an individual product in one country may be largely due to the fact that the general price level for that country is high or low when exchange rates are used. It may not signal any abnormality in that particular price. For this reason, XR price ratios are less useful than PPP price ratios for validation purposes.

The PPPs for a basic heading are the rates of conversion that should enable a given amount of currency to purchase an equivalent basket of goods in all countries. Thus, if the patterns of relative prices for the different products within the basic heading were to be similar in different countries, the PPP prices for the same product in different countries would tend to be lumped together and the PPP price ratios (i.e., the ratios of the individual PPP prices to the geometric mean of the PPP prices for all the countries) would cluster around 100. There would be little dispersion between countries in either the PPP prices or the PPP price ratios derived from them.

Conversely, a high level of dispersion in the PPP prices or the PPP price ratios for the same product in different countries implies that the relative price of the product tends to vary a lot from country to country. This could happen, but on the other hand it might signal the fact that one or more of the PPP prices are wrong. Thus, the dispersion in the PPP prices or price ratios for the same product in different countries becomes a key indicator for purposes of inter-country validation. It can be measured by calculating the variation coefficients for the PPP prices or the PPP price ratios.

It may be concluded that if the variation coefficient for the PPP prices or price ratios for the same product in different countries exceeds some pre-determined threshold, fixed at 33 percent for ICP purposes, the national average prices for that product become questionable and require further investigation.

There are three different kinds of variation coefficients recorded in the Quaranta Tables. Those shown in the third column of the product tables are the coefficients for the individual price observations on which each national average price is based. They are taken directly from the country submissions.

The second type of variation coefficient is a product variation coefficient as it measures the relative dispersion of the PPP prices, or alternatively, the PPP price ratios, for the same product in different countries. Consider, for example, the first product in the Table, mushrooms prepackaged. Their PPP ratios (CUP-ratios) are as follows:-

<table>
<thead>
<tr>
<th>Country</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Y</td>
<td>183</td>
</tr>
<tr>
<td>X</td>
<td>65</td>
</tr>
<tr>
<td>Z</td>
<td>85</td>
</tr>
</tbody>
</table>

The resulting variation coefficient is 57 and it is shown in the heading above the table for mushrooms prepackaged. The product variation coefficient is a useful screening device. With an upper threshold of 33.0, a coefficient of 57 for mushrooms prepackaged clearly requires further investigation.

The product variation coefficient for three products in the Quaranta Table is as follows.

<table>
<thead>
<tr>
<th>Product</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-packed mushrooms</td>
<td>57</td>
</tr>
<tr>
<td>Loose mushrooms</td>
<td>30</td>
</tr>
<tr>
<td>Garlic</td>
<td>30</td>
</tr>
<tr>
<td>Average</td>
<td>39</td>
</tr>
</tbody>
</table>

The average provides a useful measure of the relative dispersion of the PPP prices, or PPP price ratios, in the basic heading as a whole. It is shown in the Quaranta Table, in the heading of the first summary table. A figure as high as 39 suggests that some of the PPP prices and price ratios in the basic heading may be suspect.

A third type of variation coefficient is a country variation coefficient. It measures the dispersion in the PPP price ratios for the different products within a single country. For example, the PPP price ratios for country Y are as follows:-

<table>
<thead>
<tr>
<th>Product</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-packed mushrooms</td>
<td>183</td>
</tr>
<tr>
<td>Loose mushrooms</td>
<td>81</td>
</tr>
<tr>
<td>Garlic</td>
<td>68</td>
</tr>
</tbody>
</table>

The resulting country variation coefficient is 57 and it is shown in the summary section of Quaranta Table.

Looking at the country variation coefficients in the summary table, it can be seen that the coefficient for country Y is about twice the size of the coefficients for countries X and Z. This suggests that country Y’s pattern of relative prices is well out of line with the pattern in the other two countries. Another indication of a problem is a very high PLI for country Y – 166 percent. It signals that one or more products of that country
are overpriced. Taken in isolation, the price data for country Y were accepted. However, once the data for other countries are introduced, the average price for prepackaged mushrooms in country Y looks extremely unlikely and implausible, as the product appears to be about almost three times as expensive in Y as in the other two countries. This type of errors could happen due to misspecification, recording wrong product, errors in UOM or errors in product description.

**Dikhanov Tables**

A second and complementary form of inter-country validation uses Dikhanov Tables. Whereas the Quaranta Table is intended to serve as a diagnostic tool for prices at the basic heading level, the Dikhanov Table is geared toward an analysis of the whole tableau of price data in a compact form. Dikhanov Tables, like Quaranta Tables, are included in the ICP Tool Pack. Both sets of tables use a similar approach and start off with similar concepts: studying product price deviations for each country in a two-dimensional space: that of products and countries.²

Even though both types of tables show measures of price variations by product and country, the Quaranta Table is limited to the basic heading level in its analysis³, whereas the Dikhanov Table can be processed at any level from total GDP down to the basic heading. The Dikhanov Table can also be processed for intermediate aggregates, such as goods, services etc. Whereas the Quaranta Table shows some additional information about product prices within a basic heading, such as the number of quotations, the price variance and average prices, as well as the exchange-rate ratios⁴ (see Table 6 or Figure 1 in the previous section), the Dikhanov Table adds an emphasis on the validation across basic headings between basic heading validation, adding facilities to detect anomalies across both countries and basic headings.

In the Quaranta Tables, PPPs are computed using one of the four methods described in Chapter 11: EKS, EKS-*, CPD or CPRD. However, in the Dikhanov Table, only the CPD is used in computations as EKS does not generate the average product price, an important measure that enters in various computations in the Dikhanov Table. In principle, CPRD could also be used in the Dikhanov Table diagnostics, provided that the information about representativity is reliable, but unfortunately first results for ICP 2005 suggest that this is often not the case. It is, therefore, proposed to use the CPD for the Quaranta Table as well, at least initially.

Interpreting the Dikhanov Table statistics becomes more difficult in the CPRD case. An additional consideration in favor of using CPD is the fact that normally the residuals are one or more orders of magnitude larger than any difference between CPD and CPRD. In fact, a large difference between CPD and CPRD would indicate data problems, in particular, in the representativity dimension. Indeed this difference has been used as a diagnostic tool for the representativity validation. In studies, CPRD has been found to be the least biased of the CPD, CPRD, EKS and EKS* elementary indices, with CPD being second in the group, but this analysis presumes having correct information on representativity, which may be lacking in particular during the editing and validation stage. Thus, CPRD is reserved for the final processing in the aggregation as the recommended elementary index number. The Annex to this chapter contains further discussion about the use of the CPD in price diagnostics.

**Connection between the Quaranta and Dikhanov Tables**

The main indicator in the Quaranta Table is the CUP-Ratio. As explained in the previous section, the CUP-Ratio is the double-normalized product price. The first normalization is to convert the price of the product into the numéraire currency by dividing the basic heading PPP (this is the so-called CUP-price). The second normalization is to divide the CUP price by the geometric mean of the CUP prices across all the countries (see Figure 1).

When the CPD is used, the logarithm of the CUP-Ratio from the Quaranta Table turns out to be the CPD residual from the Dikhanov Table as it is defined by expression 5 of Box 1 from below.

Both the Quaranta and the Dikhanov Tables provide statistics based on price deviations, even though in somewhat different ways (see Footnote 3). The modus operandi of the two tables is similar as well: reducing deviations through price validation.

**Description of the Dikhanov Table**

Figure 2 below contains a short description of the Dikhanov Table. An extract of a typical output is also shown with several basic headings and eight countries (only the upper part of the actual table is shown). The Dikhanov Table can be used at different levels of aggregation. Figure 3 below exhibits the scopes of processing for various characteristics (for example, the country-specific characteristics such as the STD of CPD residuals and number of items prices are computed based on all items priced in that country – see the gray out area under Cntr3).

The Dikhanov Table is organized in two sections: the general section at the top of the table and the item section at the bottom. The general section describes overall characteristics pertaining to the whole set of items under investigation: PPP, overall standard deviation of the CPD residuals, Price Level Index, Number of Items and Exchange Rate by country, and the
Figure 2. How to Read the Dikhanov Table

<table>
<thead>
<tr>
<th>Product Code</th>
<th>Basic Heading</th>
<th>Country Name</th>
<th>PPP</th>
<th>STD</th>
<th>PLI</th>
<th>Exchange Rate</th>
<th>ER (LCU/US$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>110111_2101</td>
<td>Amor envasado</td>
<td>-</td>
<td>0.18</td>
<td>0.08</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>110112_2102</td>
<td>Arroz a granel</td>
<td>-</td>
<td>16</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>110111_2101</td>
<td>Huevo de higo</td>
<td>-</td>
<td>0.16</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>110112_2102</td>
<td>Harina de maíz</td>
<td>-</td>
<td>0.17</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>110111_2103</td>
<td>Fúctula de maíz</td>
<td>-</td>
<td>0.10</td>
<td>0.07</td>
<td>0.06</td>
<td>0.03</td>
<td>0.38</td>
</tr>
<tr>
<td>110112_2104</td>
<td>Harina de maíz procesada</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.17</td>
<td>0.17</td>
<td>0.31</td>
</tr>
<tr>
<td>110111_2102</td>
<td>Avena amolida ocado rápido</td>
<td>0.09</td>
<td>0.02</td>
<td>0.31</td>
<td>0.16</td>
<td>0.10</td>
<td></td>
</tr>
<tr>
<td>110112_2102</td>
<td>Avena amollada tradicional</td>
<td>0.26</td>
<td>0.24</td>
<td>0.27</td>
<td>0.27</td>
<td>0.27</td>
<td></td>
</tr>
<tr>
<td>110113_2101</td>
<td>Pan sin envasar</td>
<td>0.20</td>
<td>0.37</td>
<td>0.16</td>
<td>0.32</td>
<td>0.27</td>
<td></td>
</tr>
<tr>
<td>110111_2103</td>
<td>Pan envasado pequeño</td>
<td>0.01</td>
<td>0.14</td>
<td>0.32</td>
<td>0.25</td>
<td>0.20</td>
<td>9</td>
</tr>
<tr>
<td>110111_2104</td>
<td>Pan envasado grande</td>
<td>-</td>
<td>0.23</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>110111_2102</td>
<td>Gallega de agua</td>
<td>0.17</td>
<td>0.02</td>
<td>0.37</td>
<td>0.01</td>
<td>0.20</td>
<td>9</td>
</tr>
<tr>
<td>110111_2102</td>
<td>Gallega de agua con refrigerio</td>
<td>0.18</td>
<td>0.07</td>
<td>0.14</td>
<td>0.25</td>
<td>0.13</td>
<td></td>
</tr>
<tr>
<td>110111_2103</td>
<td>Gallega de agua sin refrigerio</td>
<td>0.19</td>
<td>0.09</td>
<td>0.01</td>
<td>0.22</td>
<td>0.25</td>
<td></td>
</tr>
<tr>
<td>110111_2102</td>
<td>Alfajo envasado</td>
<td>(0.38)</td>
<td>0.13</td>
<td>-</td>
<td>0.18</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>110111_2102</td>
<td>Alfajo suelo</td>
<td>0.58</td>
<td>0.30</td>
<td>0.28</td>
<td>0.34</td>
<td></td>
<td></td>
</tr>
<tr>
<td>110111_2102</td>
<td>Mezle corte</td>
<td>0.03</td>
<td>0.50</td>
<td>0.44</td>
<td>0.49</td>
<td>0.58</td>
<td></td>
</tr>
<tr>
<td>110111_2102</td>
<td>Corte mediano</td>
<td>0.09</td>
<td>0.43</td>
<td>(0.56)</td>
<td>0.48</td>
<td>0.22</td>
<td></td>
</tr>
<tr>
<td>110111_2102</td>
<td>Corte bajo</td>
<td>(0.34)</td>
<td>0.09</td>
<td>0.84</td>
<td>0.11</td>
<td>0.27</td>
<td></td>
</tr>
<tr>
<td>110112_2101</td>
<td>Carné fresco de cerdo - chuleta</td>
<td>0.05</td>
<td>0.13</td>
<td>0.24</td>
<td>0.18</td>
<td>0.69</td>
<td></td>
</tr>
<tr>
<td>110112_2101</td>
<td>Carné fresco de cerdo - pierna</td>
<td>0.24</td>
<td>0.40</td>
<td>-</td>
<td>-</td>
<td>0.20</td>
<td></td>
</tr>
<tr>
<td>110112_2101</td>
<td>Pollo entero sin patas y cabeza</td>
<td>0.01</td>
<td>0.16</td>
<td>0.04</td>
<td>0.31</td>
<td>0.07</td>
<td></td>
</tr>
<tr>
<td>110112_2102</td>
<td>Pollo entero sin patas y cabeza</td>
<td>-</td>
<td>0.12</td>
<td>-</td>
<td>-</td>
<td>0.05</td>
<td></td>
</tr>
<tr>
<td>110112_2102</td>
<td>Pollo troceado - pié y cabeza</td>
<td>0.08</td>
<td>0.12</td>
<td>0.08</td>
<td>0.14</td>
<td>0.24</td>
<td></td>
</tr>
<tr>
<td>110112_2101</td>
<td>Hígado vacuno</td>
<td>(0.45)</td>
<td>0.01</td>
<td>-</td>
<td>0.57</td>
<td>0.64</td>
<td></td>
</tr>
<tr>
<td>110112_2102</td>
<td>Hambúrguesa congelada</td>
<td>0.04</td>
<td>0.32</td>
<td>-</td>
<td>-</td>
<td>0.43</td>
<td></td>
</tr>
<tr>
<td>110112_2102</td>
<td>Jamon corimal</td>
<td>0.21</td>
<td>0.26</td>
<td>(0.67)</td>
<td>0.04</td>
<td>0.31</td>
<td></td>
</tr>
<tr>
<td>110112_2102</td>
<td>Salmónica de Viena - ensalada chico</td>
<td>(0.27)</td>
<td>0.49</td>
<td>-</td>
<td>0.12</td>
<td>0.23</td>
<td></td>
</tr>
<tr>
<td>110112_2102</td>
<td>Salmónica de Viena - ensalada grande</td>
<td>(0.02)</td>
<td>-</td>
<td>(0.45)</td>
<td>0.24</td>
<td>0.03</td>
<td></td>
</tr>
<tr>
<td>110113_2101</td>
<td>Filete de pescado fresco</td>
<td>0.02</td>
<td>0.15</td>
<td>0.17</td>
<td>-</td>
<td>0.24</td>
<td></td>
</tr>
<tr>
<td>110113_2102</td>
<td>Filete de pescado mas caro</td>
<td>0.01</td>
<td>0.01</td>
<td>0.21</td>
<td>0.06</td>
<td>0.16</td>
<td></td>
</tr>
<tr>
<td>110113_2102</td>
<td>Contra costilla fresca</td>
<td>(0.38)</td>
<td>0.30</td>
<td>-</td>
<td>0.60</td>
<td></td>
<td></td>
</tr>
<tr>
<td>110112_2104</td>
<td>Peçso fresco entero</td>
<td>- 0.28</td>
<td>(0.00)</td>
<td>0.07</td>
<td>0.59</td>
<td>0.72</td>
<td></td>
</tr>
<tr>
<td>110112_2105</td>
<td>Suplén en rodajas</td>
<td>(0.04)</td>
<td>-</td>
<td>0.28</td>
<td>-</td>
<td>0.22</td>
<td></td>
</tr>
<tr>
<td>110112_2106</td>
<td>Filete de merluza congelado</td>
<td>0.20</td>
<td>(0.18)</td>
<td>-</td>
<td>0.11</td>
<td>0.16</td>
<td></td>
</tr>
</tbody>
</table>

Overall STD of residuals and number of items for the whole price tableau. (Note that the GDP PPP is estimated here as the CPD PPP utilizing the whole set of prices and products, and, thus, does not take into account basic heading expenditures. The advantage is that the CPD PPP at the aggregate level [a broad aggregate, class of GDP] can be estimated before the actual basic heading weights are known, and it will still provide a ball park estimate of the final PPP for the GDP).

The lower section of the Dikhanov Table describes characteristics of the individual items: CPD Residual, standard deviation of CPD residuals by item, and Number of Countries pricing the item. The CPD computations are done at the level specified by the user (basic heading or higher level aggregate including GDP). In addition, the cells in the report with CPD residuals are color-coded to facilitate visual diagnostics:

- Between -0.25 and 0.25 No color
- Between -0.75 and 0.75 Yellow
- Between -2.0 and 2.0 Red
- Less than -2.0 & more than 2.0 Black

The right two columns of the table refer to the STD of the residuals by item and number of countries that priced a particular item. Note that the thresholds for deviations in the DT are given in logarithmic terms. For example, the deviations in the DT in logarithmic terms [>2] would mean the deviations (in times) [>7.4=exp(2)].

As an example, the information used in the Quaranza Table in Figure 1 was used to build a simple one--basic heading Dikhanov-
Figure 3. Scope of Data Processing in the Dikhanov Table

<table>
<thead>
<tr>
<th>PPP</th>
<th>Ctr1</th>
<th>Ctr4</th>
<th>Ctr5</th>
<th>Ctr6</th>
<th>Ctr7</th>
<th>Ctr10</th>
</tr>
</thead>
<tbody>
<tr>
<td>STD</td>
<td>1.000</td>
<td>1.176</td>
<td>1.206</td>
<td>0.411</td>
<td>2.131</td>
<td>3.315</td>
</tr>
<tr>
<td>N. of items priced</td>
<td>7</td>
<td>10</td>
<td>11</td>
<td>8</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>PLI</td>
<td>1.00</td>
<td>1.27</td>
<td>1.50</td>
<td>1.20</td>
<td>0.97</td>
<td>1.29</td>
</tr>
<tr>
<td>Exchange Rate</td>
<td>1,000</td>
<td>0.927</td>
<td>806.20</td>
<td>0.342</td>
<td>2,191</td>
<td>726.00</td>
</tr>
<tr>
<td>ER (LCU/US$)</td>
<td>2.823</td>
<td>2.711</td>
<td>2,867.78</td>
<td>1,000.00</td>
<td>6,685.2</td>
<td>2322.94</td>
</tr>
</tbody>
</table>

Figure 4. An Example of the Dikhanov Table corresponding to the Quaranta Table from Figure 1

<table>
<thead>
<tr>
<th>PPP</th>
<th>X</th>
<th>Z</th>
<th>Y</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.659</td>
<td>9.852</td>
<td>1.000</td>
<td></td>
</tr>
<tr>
<td>0.43</td>
<td>0.31</td>
<td>0.16</td>
<td></td>
</tr>
</tbody>
</table>

Overall SDT

Country STD

SCOPE OF CPD REGRESSION FOR PPP - GDP level

SCOPE OF CPD REGRESSION FOR CPD RESIDUALS IN ITEM SECTION

SCOPE OF CPD REGRESSION FOR CPD RESIDUALS IN ITEM SECTION

Methodology

d-Nov Table presented below in Figure 4. This example is somewhat artificial however, as (in contrast to the Quaranta Table) the Dikhanov Table is not normally used for one basic heading only.

Again, in this particular case, a one-basic heading analysis using CPD, the PPPs and PLIs for both the Quaranta and Dikhanov Tables would turn out to be identical (compare the first and fourth lines from the Dikhanov Table to the respective values in Figure 1), with the CPD residuals in the Dikhanov Table being equal to the logarithms of the CUP-Ratios in the Quaranta Table (for example, the first entry in this Dikhanov Table – the CPD residual for the first Item for country X – 0.50 is equal to Log (1.825), or 182.5% - the same entry as in Figure 1).

Deviation measures (the overall STDs of residuals and CVs) will differ somewhat due to the differences in computation (0.34 in the Dikhanov Table vs. 39% in the Quaranta Table for the overall measure). Overall deviations for Item 1 and Country Y are:
Running the Dikhanov Table at different aggregation levels

As stated above, the Dikhanov Table can be run at different aggregation levels. Figure 5 below shows two versions of the DT using the same data run at the basic heading level and at the level of GDP, respectively. Only the first 11 products out of 571 are shown, the products being grouped into three basic headings.

Figure 5. The Dikhanov Table Processed at Different Levels

The Tables A and B of Figure 5 differ with respect to the level at which the CPD regressions are run: in Table A the regressions are run basic heading by basic heading, in Table B the whole tableau of price data (i.e., all products from all basic headings) is processed at once.

The Tables A and B of Figure 5 differ with respect to the level at which the CPD regressions are run: in Table A the regressions are run basic heading by basic heading, in Table B the whole tableau of price data (i.e., all products from all basic headings) is processed at once.
Thus, in the first case all statistics in the general section of the table reflect the within-basic heading variation only, whereas in the second case the global variation is shown.

The residuals from CPD regressions are presented as follows

\[ e_{op} = \ln p_{op} - x_{op} \beta = \ln p_{op} - Dc_i - Dp_j. \]

where \( Dc_i \) and \( Dp_j \) are the country and product dummies. The difference between the residuals run at different levels of processing such as the basic heading (BH) and GDP can therefore, be expressed as:

\[ e_{op}(BH) - e_{op}(GDP) = - Dc_i(BH) - Dp_j(BH) + Dc_i(GDP) + Dp_j(GDP). \]

As the country dummy is the log of the PPP the difference between the CPD residuals in tables A and B can be broken down into two parts as follows:

\[ e_{op}(BH) - e_{op}(GDP) = [\ln(PPP_i(GDP)) - \ln(PPP_j(BH))]. [Dp_j(BH) - Dp_j(GDP)]. \]

The first component is the difference between the basic heading PPP and the GDP PPP (the relative price level of the basic heading vis-à-vis the overall price level at the GDP level), while the second component is the difference between the log of the average prices of the product as computed with the CPD regression on all products and those as computed on the products within the basic heading only. Usually, the second component is insignificant.

Looking at the first group of products (the first basic heading), it can be seen that Table A does not provide any useful information for some countries, because all entries with one product in a basic heading will be shown with zero CPD residuals. On the other hand, Table B shows, for example, that Country 7 has a -0.53 residual value, which implies that the price is 77 percent less than expected, a deviation which deserves investigation.

For the second group of products (the second basic heading), Tables A and B in general show a similar picture, with some additional products flagged as problematic in Table B, as that table’s entries reflect within and between basic heading deviations.

Not every problem can be observed when the CPD is run only at the basic heading level (Table A). For example, if a country erroneously priced all their beverages in gallons instead of liters, its basic heading level data on their own could be very consistent (as everything is priced in gallons), but inconsistent with everyone else (who priced in liters). Table A would have the same problem for that basic heading as the Quaranta Table. However, Table B would explicitly show that inconsistency.

In fact, it is useful to run the Dikhanov Table at different levels of aggregation: for example, at the basic heading level; for a higher aggregate level (such as Food), and at the GDP level. Processing the Dikhanov Table at a level higher than the basic heading can help analyze price points for “bad” basic headings with partially erroneous price entries. These “bad” basic headings would be distorted, which would make the processing impossible at the basic heading level. However, processing at a higher level would help identify prices that are consistent within a broader set of products.

It is important to study the overall STD of residuals (the upper right corner of the table): Table A predictably shows a smaller value than Table B (0.27 vs. 0.34). (Again, the overall STD of residuals is run on the whole country-product tableau of the CPD residuals). However, the difference is not large (and it is even smaller for cases with data of poorer quality in which case the within basic heading deviations would dominate the between basic heading ones). The overall STD of residuals for larger regions with more variety tends to be larger than that for smaller and more uniform ones.

It is informative to study STDs of residuals by country and by product as well. The same overall picture can be observed here as well: the STD values in Table B are greater than those in Table A.

In practice, the overall SDT of CPD residuals cannot go much below the values shown in Tables A and B and, certainly, will never approach zero. This is due to various factors, such as the substitution effect, the effects of taxes and subsidies, transportation and climate differences, etc. The substitution effect can be particularly strong, and it works both within and without basic heading. Individual economies may have very particular pricing policies, for example, very low fuel prices in some of the oil-producing countries. This may show up as high residuals, but the prices would not be erroneous.

The process of data validation with the Dikhanov Table would start thus with checking entries with largest deviations, trying to investigate and resolve all issues. Some of the deviations, even very large ones, can be legitimate. For example, the price of gasoline in Venezuela is very low compared to other Latin American countries, so the large deviation (CPD residual) for the product as shown in the Dikhanov Table at the GDP level is not a mistake in data. It is important to run the Dikhanov Table after each iteration of the data editing process.

The Dikhanov Table can be run on sub-regions and subsets of products as well, as some countries may be slow in providing their data on time. However, it would still be important for the regions to validate the available data. Large regions, such as Africa, may also find it convenient to run sub-regional tables.
It is important to compare results of running the Dikhanov Table over time, e.g., quarter to quarter, looking for suspicious changes in price patterns.

In general, the overall STD by country should reflect the quality of price data. The goal of the regional coordinator in collaboration with national price statisticians would be to reduce the overall STD with the understanding that there are limits to its reduction, and that many large CPD residuals may be quite legitimate. However, each large residual needs to be investigated.

Footnote


2. In the Quaranta Table, the methodology in summarizing product price deviations does not exactly correspond to the one in the country dimension (see Figure 1, the average CV at the basic heading level presented in the Summary Information section is calculated as a simple average of the CV's for individual products). The Dikhanov table is consistent in this respect using the same principles in computing standard errors by row (product level) and by column (country level).

3. This is the case for the Quaranta tables described in the previous section and included in the ICP Tool Pack. It is possible, however, to extend the Quaranta table to include processing above the basic heading level, as shown by S. Sergeev (Statistics Austria).

4. The exchange rate ratios in the Quaranta Tables serve to establish a common denominator for prices across basic headings, due to the fact that the Quaranta Table produces PPPs only within the basic heading. On the other hand, the Dikhanov Table uses other ways to obtain a common denominator across basic headings as it explicitly computes PPPs at the GDP level.

5. The proof follows immediately from the following property of the CPD index: if the CPD index exists, then the CPD dummy coefficients for the original price matrix with some empty cells are identical to the coefficients of a new matrix, which is obtained by filling the gaps in the original price matrix with the expected prices using the dummy coefficients for the original matrix.

6. When comparing the Dikhanov and Quaranta Table one has to remember that the Dikhanov Table uses the logs of ratios (logarithmic percentages) instead of the ratios themselves used in the Quaranta Table.

7. The overall STD of CPD residuals in the Dikhanov Table is computed on the whole tableau of the CPD residuals in the item section of the table.

8. Table B of Figure 5 and Figure 2 use the same data and are both processed at the GDP level.

9. The product dummy can be interpreted as the log of average product price for all the countries in the comparison.

10. This situation can be caught in the QT as well when XR-rations are examined.
Comparisons of Industry-level Prices and Productivity

1. Introduction

Differences in GDP per capita across countries are mainly determined by levels in labor productivity at the aggregate economy level. Comparative series of output per worker and per hour worked are nowadays routinely being produced by various statistical organizations and in academia, such as the Penn World Tables, OECD, the Conference Board and the Groningen Growth and Development Centre (GGDC). Various useful analytical applications of productivity levels, however, are at the more detailed level of individual industries. Because of significant methodological and data-related problems, comprehensive sets of industry productivity levels have been scarce until recently. The main reason has been a lack of comparable data on inter-industry transactions, labor and capital service flows and associated purchasing power parities (see van Ark and Timmer, 2001; van Ark, Mad- dison and Timmer, 2008). Recently, Inklaar and Timmer (2008) introduced the GGDC Productivity Level database. It provides comparisons of output, inputs and productivity at a detailed industry level for a set of 30 OECD countries. This article provides a short introduction to the database.

Industry level comparisons can be useful for various purposes, for example, in the light of the debate on sources of growth. In recent years there has been an intense interest in the effects of Information and Communication Technology (ICT) on economic growth. Comparative studies have tried to explain Europe’s slowdown in productivity growth relative to the US since the mid 1990s. They showed that differences in ICT investment played a major role in the transatlantic divergence process, and productivity growth lagged mainly in market services. The interpretation of comparative growth patterns will depend on the initial starting position of the country in terms of levels. For example, if growth is fastest in the country with the lowest initial level, this can be seen as catch-up growth in which follower countries converge to more advanced countries through imitation and spillover of technologies. In this framework one can study the impact of regulation, trade or R&D expenditures on economic growth. The GGDC Productivity Level database complements the EU KLEMS growth and productivity accounts by providing comparative levels and follows it in terms of country and industry coverage, variable definition and basic data (O’Mahony and Timmer, 2008). As such, the level and growth accounts can be used together in comparative analyses of productivity trends.

In addition, comparisons of input levels can shed new light on such issues as the relative ICT capital intensity of various economies. It measures the differences in the penetration of new technology in the production process. Relative levels of energy, materials and services inputs can be important measures in debates on outsourcing of service activities, international differences in production structures, energy use and reduction strategies. It might also provide useful information on international business, looking for a cost-effective location for their activities, or adequate remuneration levels of their employees located all around the world. Finally, the database is constructed using both the production and income approaches to PPPs and GDP, and

*Corresponding author: Marcel P. Timmer, Groningen Growth and Development Centre, Faculty of Economics, University of Groningen, P.O. Box 800, NL-9700 AV Groningen, The Netherlands, e-mail: m.p.timmer@rug.nl, tel. +31 50 363 3653, fax +31 50 363 7337.
as such serves as a useful complement to the expenditure approach in ICP (O’Connor, 2008).

This article provides a global overview of the content and construction of the database, and presents a limited number of results. For more detailed discussion of methodology and empirics, please see Inklaar and Timmer (2008).

2. Methodology

In this section, we present our methodology for comparing levels of output, input and productivity across countries. As we are trying to construct a consistent set of productivity measures for a large number of countries and industries at the same time, various choices have to be made not only concerning the use of particular index number formulae, but also their actual implementation. Here, the basic methodology is laid out.

Basically, our approach has two stages. In the first step, PPPs for output, capital, labor and intermediate inputs for 29 industries are derived based on data for 45 sub-industries. This is done with the price-variant of the multilateral index number approach advocated by Caves et al. (1982), also known as CCD-method. These PPPs are used to implicitly derive quantities of all inputs (capital, labor and intermediate) and outputs. In the second step, productivity comparisons are made for each industry on the basis of input and output quantities in a bilateral Tornqvist model following Jorgenson and Nishimizu (1987). This approach is also known as primal level accounting. Here, we first outline our basic methodology for measuring productivity, followed by our approach to deriving PPPs for outputs and inputs.

The main aim of the GGDC Productivity Level database is to provide productivity comparisons between countries. The accounts provide so-called binary comparisons that are comparisons between a country c and a base country, which is the same in all comparisons. As most interest is in comparing the performance of countries to the world productivity and technology leader, it is natural to choose the U.S. as our base country in the productivity comparisons. The most commonly used single productivity measure for international comparisons of levels is labor productivity. This is generally defined as an output measure divided by a labor input measure, which can be the number of persons employed, employees or hours worked. The output measure can either be the volume of gross output or the volume of value added. Let H be hours worked then value-added based labor productivity (LP_VA) are given by

\[
LP_{_VA} = \frac{Q^{VA}_c}{Q^{VA}_S} \cdot \frac{H}{H_S}.
\]  

Alternative measures of productivity account for more than one input. They are known as the so-called multifactor productivity measures (MFP). The multifactor-based productivity measures are well rooted in economic theory but due to their heavy data requirements, they are much less common in international comparisons of relative levels than single factor-based measures such as labor productivity. MFP and labor productivity measures are not independent of each other. Multifactor productivity measures can be used to explain single factor productivity differences. For example, differences in labor productivity levels can be explained by differences in the ratio of capital to labor, and differences in multi-factor productivity. These, and other, links have been established with the help of the economic theory of production.

The GGDC Level accounts provide estimates for value-added based MFP taking into account both labor and capital services, and gross-output based MFP taking into account labor, capital and intermediate inputs. In this article, we only outline the methodology for value-added based measures. As per Jorgenson and Nishimizu (1987), we define the following translog quantity index of difference in multi-factor productivity based on value added (MFP_VA). This index is defined as follows:

\[
\ln MFP_{_VA} = \ln \frac{Q^{VA}_c}{Q^{VA}_S} - \hat{w}_c \ln \frac{Q^{c}}{Q^{S}_c} - \hat{w}_L \ln \frac{Q^{L}_c}{Q^{L}_S}.
\]  

with \( Q^c \) a quantity index of capital services and \( Q^L \) a quantity index, where \( \hat{w}_c \) is the share of capital services in value added averaged over the two countries \( \hat{w}_c = \hat{w}_c^k + \hat{w}_c^L \) with \( \hat{w}_c^k = \frac{Q^k}{Q^c + Q^k} \) with \( Q^k \) the nominal value of capital compensation in country c (that is, in national currency) and similarly for labor such that \( \hat{w}_L = 1 \).

The formulas indicate that comparable volume measures of output and input for the two countries are needed. When a single output is being compared, physical measures, such as numbers of cars, are possible. However, when comparisons are made at the industry or aggregate level where output is not represented by a single product, output is given in value terms. In that case a correction for differences in relative price levels between countries is needed. This is usually done with a purchasing power parity (PPP), which indicates the relative price of output in one country relative to another country. The derivation of the PPPs is further discussed in Section 3.

Volume indices are calculated implicitly by the ratio of the nominal values and the relevant price indices. For example, aggregate value added quantity in country c is given by
For labor input one can use number of workers or total hours worked as a volume measure. However, for multi-factor productivity comparisons one would also like to include the composition of labor in terms of various labor types with different productivities, e.g., low- and high-skilled labor. This can be done by choosing an appropriate PPP based on relative wages as discussed in section 3:

\[ Q^L = \frac{V^L}{PPP^L} \quad (3) \]

with \( V^L \) the nominal value of labor compensation in country \( c \) (that is, in national currency) and \( PPP^L \) the relative price of labor services in country \( c \). And similarly for aggregate capital input in country \( c \):

\[ Q^K = \frac{V^K}{PPP^K} \quad (4) \]

with \( V^K \) the nominal value of ex-ante capital compensation in country \( c \) and \( PPP^K \) the relative price of capital services in country \( c \).

One of the main applications in productivity comparisons is the so-called level accounting. Level accounts provide a decomposition of differences in value added per hour worked into differences in capital per hour worked (capital intensity), in labor composition (skill intensity) and in MFP. This decomposition is done as follows:

\[ \ln \frac{VA_i}{H_{13}} = \hat{\nu}_i \ln \frac{Q^L_i}{Q^L_{13}} + \hat{\nu}_K \ln \frac{Q^K_i}{Q^K_{13}} + \ln MFP \cdot VA_i \quad (6) \]

where \( \hat{\nu}_i \) and \( \hat{\nu}_K \) are defined as in equation (2).

To calculate quantities of input and output, nominal values are deflated by relative prices (PPPs) as in formula’s (3)-(5). The PPPs for outputs and inputs are derived on the basis of detailed sets of output and input prices. Prices are aggregated using the multilateral translog price indices introduced by Caves, Christensen and Diewert (1982) (CCD-index). Basically, in this methodology one creates an artificial country by averaging over all countries in the data set, and uses this constructed country as a bridge when making binary comparisons between two countries. This creates the so-called transitive PPPs, which are base-country independent. For convenience, the PPPs are normalized with U.S. as 1 in the database.

Let \( i \) be the components of output, then the multilateral output price of country \( c \) (\( PPP^{SO}_c \)) is defined as follows:

\[ \ln PPP^{SO}_c = \sum_i \hat{\nu}_i \ln \frac{PPP^{SO}_i}{PPP^{SO}_c} \]

with \( \hat{\nu}_i = \frac{1}{N} \left[ \frac{1}{N} \ln \left( \frac{Q^K_i}{Q^K_{13}} \right) + \ln MFP \cdot VA_i \right] \)

A similar approach is followed for the relative prices of capital input, labor input and intermediate inputs. In the data file which accompanies this paper, the inputs are further subdivided into eight groups: two groups of labor (high skilled and others), two groups of capital (ICT-capital and non-ICT capital), and four intermediate inputs: energy (E), materials (M) and services (S) and imports (IMP). Aggregation across the different inputs in each group also follows the CCD-methodology exposed above. For value added, two alternative PPPs are provided in the database-- one based on the output and intermediate input PPPs (in a procedure known as double deflation) and one based on the output PPP only (single deflation). In the first case, a CCD-like approach is followed by taking a geometric mean of all possible binary Tornqvist indices for a particular country.

Although the theory of measuring productivity levels is relatively straightforward, there is a high degree of freedom in the actual implementation of the various measures. In the extended version of this paper (Inklaar and Timmer, 2008), a variety of implementation issues is discussed.

3. Data

Basically, our level comparisons are based on deflating nominal inputs and outputs as given in national input-output tables by a set of relative prices. We use a new set of relative prices, which is specifically developed for making cross-country, industry-level productivity comparisons provided by Timmer, Ypma and van Ark (2007). These are complemented by relative prices for capital and labor inputs. Jorgenson and Nishimizu (1978) introduced the methodology to derive PPPs for output, labor and capital input; the latter based on relative wages and investment prices. This system was extended by Jorgenson et al. (1987) to include PPPs for intermediate inputs. In this section, we describe the derivation of our output and input PPPs. We use the basic methodology as outlined by Jorgenson et al. (1987) but deviate in the practical implementation. First, we use a mix of expenditure and production-side price estimates to derive output PPPs. Second, we derive capital PPPs based on the ex-ante rather than the ex-post approach. Third, we derive PPPs for sectoral output and sectoral input and provide these at all levels of aggregation.
Timmer, Ypma and van Ark (2007) presented a new and comprehensive dataset of industry output PPPs, which are defined from the producer’s point of view and are at basic prices. These PPPs have partly been constructed using unit value ratios for agricultural, mining, and manufacturing products, and transport and communication services. For the other market industries, PPPs are based on specified expenditure prices from Eurostat and the OECD, which were adjusted to industry level by using relative transport and distribution margins and adjusting for differences in relative tax rates. PPPs have been made transitive by applying the multilateral EKS-procedure for a set of 30 countries.

This set of gross output PPPs for 1997 covering 45 industries at (roughly) 2-digit industry level is the basic starting point for our current study. The gross output PPPs are allocated to the industries in the input-output tables.

For non-market industries, a special adjustment has been made. In almost all countries, output in the non-market sector is measured by means of inputs. By implication, productivity levels should be the same across all countries. Put otherwise, output PPPs should be a weighted sum of the input PPPs with weights indicating the share of each input in total output. However, when we compared our input PPPs with the output ones as given by the OECD for non-market industries, large differences were found. In particular, the labor PPPs used by the OECD are rather different from our labor PPPs. Therefore, we decided to define the output PPPs for non-market services (industries L, M, N and P) as a weighted sum of our inputs. Consequently, comparative productivity levels in these industries are all one in the benchmark year 1997.

Intermediate input PPPs should reflect the costs of acquiring intermediate deliveries and match the price concept used in the input-output tables, hence at basic prices plus net taxes. The data problems to obtain input PPPs for individual industries are larger than for output. There is often no input price parallel to the output PPPs. Business statistics surveys and productivity censuses provide little, or, no information on quantities and values of inputs in manufacturing, and for non-manufacturing industries the information is largely absent. Moreover, PPPs from the expenditure side by definition do not reflect prices of intermediate inputs as they cover only final expenditure categories. In this study, we use output PPPs as a proxy for relative intermediate input prices under the assumption that the basic price of a good is independent of its use. That is, we use the same gross output PPP of an industry to deflate all intermediate deliveries from this industry to other industries. The aggregate intermediate input PPP for a particular industry can be derived by weighting intermediate inputs at the output PPP from the delivering industries. Imported goods are separately identified and exchange rates are used as conversion factors for imports. Ideally, one would like to have separate estimates of import PPPs based on trade data as there is little evidence that the law of one price holds for all goods even when internationally traded. However, so far this data is not readily available.

Comparisons which use a homogenous (or ‘raw’) labor concept in the denominator of the productivity equation, such as number of workers or total hours worked do not need currency converters for labor input, as the comparison is already given in terms of volume. In the case of a heterogeneous labor concept, for example, workers of different skill types, labor input PPPs are needed to correct total labor compensation for differences in relative prices of different categories of workers. Ideally, this labor input PPP should be based on labor costs including all costs incurred by the producers in employment of labor such as taxes levied, health cost payments, other types of insurance and contributions to retirement fund paid by the employer, financial benefits (such as stocks options) and the value of payments in kind and allowances (such as housing and rent).

The PPP for labor represents the relative price of one unit of labor between two countries. For each type of labor, relative wages can be calculated. In the EU KLEMS Growth Accounts, a distinction is made between 18 different labor types: two gender categories, three age categories and three educational attainment categories: low skilled (pre-primary, primary and lower secondary education, ISCED 0-2), medium skilled (upper secondary education, 3) and high skilled labor (total tertiary education, 5-7). However, in particular for level comparisons, this classification is rough and might be misleading as educational systems within Europe and the US are very different. In particular, the different roles of vocational schooling systems cause problems of comparability across countries. For example, in Germany vocational training is important to enter many occupations, but this is unknown in the US. Based on the work by the NIESR (see Mason, O’Leary and Vecchi, 2007), we made a more detailed comparison and further decomposed the medium skill level into three categories to a total of five.

To convert capital input measured in national prices into common prices, capital input PPPs need to be developed. Capital PPPs give the relative price of the use of a unit of capital in two countries from the purchasers’ perspective. The calculation of the capital input PPP is less straightforward than for output, intermediate input or labor input PPPs. This is due to the conceptualization of capital input as capital services rather than capital stocks. To obtain relative prices for capital input, we follow Jorgenson and Nishimizu (1978). Under the assumption that the relative efficiency of new capital goods is the same in both countries, the relative rental price of asset k between coun-

continued
try C and the base country US ($\text{PPP}_{k,i}^{C}$) is calculated as:

$$
\text{PPP}_{k,i}^{C} = \frac{\text{PPP}_{k,i}^{US}}{\text{PPP}_{k,i}^{C/US}}
$$

(8)

with lower-case p indicating prices, $\text{PPP}_{k,i}^{C}$ the relative current investment price of asset $k$ between country C and the US, and $\text{PPP}_{k,i}^{US}$ the cost of capital as defined in (9). This definition indicates that the relative rental price of a unit of capital between two countries depends on the relative investment price and the user cost of capital input. In the absence of taxation the familiar cost-of-capital equation for asset type $k$ is given by (Jorgenson and Griliches, 1967):

$$
p_k^i = p_{k+}^i + \delta, p_{k-}^i - [p_{k+}^i - p_{k-}^i]
$$

(9)

This formula shows that the user cost is determined by the nominal rate of return ($\delta$), the rate of economic depreciation ($\delta$) and the asset specific capital gains. Investment PPPs are available for 35 capital assets from OECD (2002) for 1999. The PPPs for the 35 assets are aggregated to the eight countries, in this case:

$$
\text{PPP}_{k,\text{C/US}} = \frac{1}{n} \sum c_{PPP}^{SO}
$$

(10)

where output and intermediate inputs are all sectoral measures, excluding intra-industry deliveries. Output is valued at basic prices, intermediate inputs at basic prices plus net taxes, and capital and labor input at purchasers’ prices. Equation (10) is the basis of the level comparisons of output, input and productivity made in this study.

4. Some Empirical Results

The GGDC Productivity Level database provides a wide range of results on comparative prices, input and output quantities, and productivity at the industry level. Here, we present a selection; detailed results can be found in the Appendix Tables to this paper at www.ggdc.net/databases/levels.htm.

In Table 1, we provide a comparison of relative input and output prices for the chemical manufacturing industry by way of illustration of the type of price data contained in the database. The Table shows relative prices (PPP divided by the exchange rate) for output and the various input groups, compared to the US. For example, the data shows that wages for high-skilled workers are relatively high in France, Germany and Belgium, while low in Czech Republic, Hungary and Slovenia. Energy prices are in general much higher in Europe than in the US, and are especially high in Japan. The same is true for services purchased as intermediate inputs. Also, the use of capital services is generally much more expensive outside the US, especially of non-ICT assets.

www.worldbank.org/data/icp
Table 1 Relative prices of output and inputs, chemicals manufacturing sector, 1997, US=1

<table>
<thead>
<tr>
<th>Country</th>
<th>Malatt Savv</th>
<th>Energy</th>
<th>als</th>
<th>es</th>
<th>High</th>
<th>skilled</th>
<th>Other</th>
<th>ICT</th>
<th>ICT</th>
</tr>
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<td>1.04</td>
<td>1.09</td>
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<td>0.76</td>
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<td>1.13</td>
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<td>1.26</td>
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</tr>
<tr>
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<td>1.42</td>
<td>1.37</td>
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<tr>
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<td>0.80</td>
<td>0.83</td>
<td>0.17</td>
<td>0.13</td>
<td>0.95</td>
<td>1.27</td>
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<td>1.15</td>
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<td>1.38</td>
<td>1.58</td>
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<td>1.20</td>
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<td>1.04</td>
<td>1.28</td>
<td>1.66</td>
<td>1.69</td>
<td>1.04</td>
<td>1.53</td>
<td></td>
</tr>
<tr>
<td>Germany</td>
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<td>1.04</td>
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<td>1.00</td>
<td>1.28</td>
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<td>0.79</td>
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<td>0.16</td>
<td>0.94</td>
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<td>1.00</td>
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<td>0.75</td>
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<td>0.95</td>
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<td>1.08</td>
<td>1.05</td>
<td>0.94</td>
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<td>1.70</td>
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<td>1.03</td>
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<td>0.71</td>
<td>0.71</td>
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<td>0.43</td>
<td>1.23</td>
<td>1.51</td>
<td></td>
</tr>
<tr>
<td>Sweden</td>
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<td>1.15</td>
<td>1.12</td>
<td>0.93</td>
<td>1.62</td>
<td></td>
</tr>
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<td>United Kingdom</td>
<td>1.02</td>
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<td>1.00</td>
<td>1.09</td>
<td>1.20</td>
<td>1.11</td>
<td>1.12</td>
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<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td></td>
</tr>
</tbody>
</table>

Note: Relative price level is defined as PPPs divided by exchange rate
Source: Author’s calculations on GGDC Productivity Level database

In Tables 2 and 3, we provide labor and multi-factor productivity levels for the year 2005. These results are based on our preferred set of estimates for 1997 (using a mix of PPPs), extrapolated to 2005, which is the latest year for which data is available in the EU KLEMS database (March 2008). To update a volume comparison to 2005, we simply apply the relative volume growth rates between the two countries in the period from 1997 to 2005. Table 2 shows that in most European countries, market economy labor productivity levels compared to the US are lower than levels for the total economy. This is because the relative labor productivity level in non-market services are generally close to one, while in the market economy it is (much) lower. As discussed above, relative productivity levels in non-market services are assumed to be close to one as outputs is typically measured by inputs.10 As such, comparisons of the market economy (that is excluding public administration, health, education and real estate) can be considered to be more meaningful than comparisons for the total economy. Within the EU, large differences can be found. Belgian labor productivity levels are equal to the US but all other countries are lagging behind. Relative levels in France, Germany and the U.K. are around 70-80 percent, while less than 60 percent in Italy and Spain. Levels in Greece and Portugal are even below 40 percent of the US level. In almost all European countries, comparative levels are highest in non-electrical manufacturing, while gaps are typically much bigger for market services.

In Table 3, measures of multi-factor productivity (MFP) are provided. MFP is an indication of relative levels of the efficiency of input use between countries. They are measured as the difference in output between countries when differences in all inputs have been accounted for. Under the set of neo-classical assumptions, differences in MFP levels can be interpreted as differences in the level of disembodied technology. In Table 3, we provide levels for the year 2005 for our set of 20 countries. Estimates are given for nine major sectors and higher aggregates with US=1. It appears that European MFP gaps are smaller than labor productivity gaps due to higher inputs in the US compared to most European countries. Both in terms of capital and skills, inputs in the U.S. are generally higher than in other countries. In most countries, the MFP gap is smallest in manufacturing, while biggest in Market Services. Within market...
services, MFP levels are generally high in Trade and Financial services, but low in Transport and Business Services.

Finally, in Table 4, we provide decompositions of gaps in labor productivity as in equation (6). Differences in labor productivity are decomposed into differences in ICT and non-ICT capital per hour worked, skill intensity and MFP. This is done for 1997, which is the benchmark year for the database. Decompositions are provided for our set of 20 countries for which this is possible. The Table provides figures for the market economy and reads as follows. For example, the first row in Table 4 indicates that in 1997 the (log) labor productivity gap in Australian market economy with the US was 30 percent. Of this, 10 percent was due to lower skill levels. Differences in capital intensity played no significant role. Although ICT intensity was much lower, non-ICT levels were much higher. The remaining gap of 21 percent is explained by differences in MFP. In contrast, Belgium led the US in labor productivity levels by 5 percent. This was completely due to higher levels of non-ICT capital, as Belgium was lagging in terms of skills and MFP. Spain is different again. Although its labor productivity gap with the US is as big as in Australia, this is due to gaps in skills, capital and MFP alike, each accounting for at least 10 percentage points of the overall gap.

Table 4: Breakdown of labor productivity gaps with the U.S., 1997, market economy

<table>
<thead>
<tr>
<th>Country</th>
<th>Labour productivitycomposition</th>
<th>Capital of which ICT</th>
<th>Non-ICT</th>
<th>MFP</th>
</tr>
</thead>
<tbody>
<tr>
<td>AUS</td>
<td>0.30</td>
<td>0.10</td>
<td>0.01</td>
<td>0.04</td>
</tr>
<tr>
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<td>0.10</td>
<td>0.04</td>
<td>0.06</td>
</tr>
<tr>
<td>BEL</td>
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<td>0.04</td>
<td>0.19</td>
<td>0.00</td>
</tr>
<tr>
<td>CAN</td>
<td>1.10</td>
<td>0.05</td>
<td>0.29</td>
<td>0.11</td>
</tr>
<tr>
<td>DNK</td>
<td>-0.16</td>
<td>0.14</td>
<td>0.07</td>
<td>0.02</td>
</tr>
<tr>
<td>ESP</td>
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<td>0.10</td>
<td>0.13</td>
<td>0.06</td>
</tr>
<tr>
<td>FIN</td>
<td>0.24</td>
<td>0.10</td>
<td>0.05</td>
<td>0.05</td>
</tr>
<tr>
<td>FRA</td>
<td>-0.27</td>
<td>0.05</td>
<td>0.03</td>
<td>0.03</td>
</tr>
<tr>
<td>GER</td>
<td>-0.13</td>
<td>0.05</td>
<td>0.02</td>
<td>0.03</td>
</tr>
<tr>
<td>HUN</td>
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<td>0.01</td>
<td>0.27</td>
<td>0.10</td>
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<td>IRL</td>
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<td>0.06</td>
<td>0.01</td>
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<td>0.05</td>
<td>0.10</td>
<td>0.03</td>
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<tr>
<td>NLD</td>
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<td>0.01</td>
<td>0.02</td>
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<td>PRT</td>
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<td>0.31</td>
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<td>SWE</td>
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<td>0.03</td>
<td>0.01</td>
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<tr>
<td>UK</td>
<td>-0.41</td>
<td>0.09</td>
<td>0.09</td>
<td>0.03</td>
</tr>
</tbody>
</table>

Source: Author’s calculations on GGDC Productivity Level database

5. Concluding Remarks

In this article, we’ve presented the GGDC Productivity Level database and its construction. This database provides comparisons of prices and volumes of both output and inputs at a detailed industry level for a set of 30 countries. In addition, it provides estimates of labor and multi-factor productivity. Its results should be seen as experimental, rather than definite. Although the basic methodology is well established, the empirical implementation requires various assumptions, which can have an important impact on the final results. This is buttressed by the results of various sensitivity tests provided in Inklaar and Timmer (2008). In addition, the reliability of the basic data on prices and values declines once one moves into more detail, both in terms of industries, but also in terms of capital and labor types. Compared to growth accounts, level accounts are subject to a wider range of possible measurement errors, and their impact is often larger. For example, the level of output or employment in an industry can be mismeasured while its growth rate is not. The biggest single obstacle to reliable international comparisons of productivity levels is the conversion from simple job (or person) counts to estimates of total hours actually worked. This can only be addressed by further methodological and statistical work to enhance international comparability, preferably within the System of National Accounts.

If one is interested in specific estimates for a country at a detailed industry level, one would do well to consider alternative estimates as well. Inklaar and Timmer (2008) provide alternative measures by providing single deflated value-added based comparisons and comparisons based on expenditure PPP only. Detailed industry estimates should never be interpreted without additional, more qualitative, evidence from careful industry case studies. On the other hand, if one needs a set of level estimates for econometric cross-country analyses, this database provides a unique opportunity to improve estimation models.

In our study we measure GDP from the production side, while ICP measures GDP from the expenditure side. The former explicitly accounts for differences in domestic, import and export prices, while the latter does not adjust for differences in terms-of-trade across countries (see Feenstra et al, 2008). As such, the former measures the production capacity of a country, while the latter measures the consumption possibilities. For example, when a country has to pay relatively high prices for its imports, while receiving low prices for its exports, GDP measured from the production side will be higher than measured from the expenditure side. For productivity comparisons, it is the former we are interested in.

We hope that the analysis shows that new and interesting insights can be generated when one focuses on explaining differences in productivity performances of industries, both for analytical research and business purposes. It allows one to have a more detailed industry perspective on aggregate performance. The industry-of-origin approach used in this paper is not only a complement to comparisons from the expenditure side, as made in the ICP program, but also relies heavily on the information contained in the ICP project, such as detailed expenditure prices.
for consumer goods and investment assets. The former are one of the building blocks in the generation of output PPPs, while the latter are crucial to derive PPPs for capital input. The new 2005 round of ICP offers unique opportunities to extend industry level comparisons of price and productivity to a wider range of countries outside the OECD, such as Brazil, China, India and Russia. This is on the agenda for further research. Having access to reliable and detailed price data from the ICP project is a crucial precondition for the continuation of this line of work.

Footnote
1. See for example the plea made by O’Connor (2008).
2. See for an overview Jorgenson et al. (2005) and van Ark, O’Mahony and Timmer (2008).
4. Note that because of our approach to capital measurement, capital compensation in this formula is based on ex-ante measures of rates of return and will differ from the ex-post measure of capital compensation used as weight in in equation (2), see Inklaar and Timmer (2008, section 4.1).
5. We find that aggregation over quantities leads often to non-plausible results and opt to aggregate over prices as variation in prices across countries is much less than variation in quantities. This is a general finding, see e.g., Allen and Diewert (1981).
6. In practice, this involves applying an EKS procedure to a matrix of all possible binary Törnqvist indices.
7. One is referred to Timmer et al. (2007) for further details about the construction and data sources underlying these PPPs.
8. There is a recent tendency in some countries to come up with genuine output measures. However, by and large, our assumption that output is measured by inputs holds true, in particular for our benchmark year, which is 1997.
9. This identity does not hold when net taxes on intra-industry deliveries are non-zero. We have no information on this type of taxes and subsidies, and assume they are zero.
10. 1997 PPPs for non-market services have been constructed under the assumption that relative MPF levels (sectoral output based) are one. Hence, labor productivity are not necessarily one, depending on the amount of other inputs. Also, the figures in this table refer to 2005 so include any relative changes over the period 1997-2005.

References
Uses of PPP data

Comments on “Business uses of PPPs: Challenges and Opportunities”,
by John O’Connor

John O’Connor’s article in the August 2008 edition of The ICP Bulletin considers how the ICP could be made more useful to the business world, possibly leading to financial support by companies willing to pay for an ICP data base, which is better adapted to their needs. His article is a challenging mixture of good ideas and some that seem less practical. Below I focus on John’s suggestions for making the ICP more attractive to the business community. His article includes a number of other suggestions for improving the ICP, but I won’t touch on those.

UBS Prices and Earnings
John holds up the data base of consumer prices and labor costs maintained by the Swiss banking corporation, UBS, as an example of the kinds of international prices that businesses actually need. The UBS data base Prices and Earnings contains information for 71 cities in 60 countries on the prices of 21 goods and services and on earnings in 14 occupations. Here are its main features:

- Since the price and earnings data are collected by UBS staff, the 71 cities are those where UBS has branches or partners. The cities are predominantly European, American (North and South) and dynamic Asia. Africa is represented by just two cities, Johannesburg and Nairobi and the Middle East by only Dubai and Manama.
- The goods and services range from single items such as a “mid-price car”, “gasoline” and a “taxi fare” to broader categories such as “women’s clothing”, “food” and a “city break”. The selection of goods and services and their weighting to obtain an overall measure of prices in each city reflect the expenditure patterns of a West European in his or her home country and this same consumer basket is priced in all 71 cities.
- The earnings data refer to locally-based employees in 14 occupations. They include some such as “female factory worker”, “product manager”, and “call center agent” that may interest a company that is considering setting up a new foreign subsidiary. Other occupations seem more designed to give a general flavor of the level of local wages such as “cook”, “bus driver” and “primary school teacher”.
- Prices and earnings are all shown in US dollars converted using current exchange rates. The UBS researchers neither calculate their own set of PPPs nor make use of PPPs coming from the ICP. The UBS data base is strictly a data base of price statistics for selected consumer goods and types of labor.

It would be easy to criticize the UBS operation from a statistical point of view, but to be fair, the UBS researchers are open about the weaknesses in their methodology. The key fact, however, is that the UBS Prices and Earnings is a popular website visited by many business people and, in all probability, by at least as many who visit the World Bank’s ICP site.

A main attraction of Prices and Earnings is its presentation. The tables are easy to read and each carries one or two simple messages. The methodological notes are clear and are separated from the main text. The analytic texts have a journalistic rather than an academic feel – short sentences, simple language and with catchy headlines capturing the main messages of each table. The ICP 2005 report contains much the same kind of price information as Prices and Earnings, but in the ICP report it is buried under massive tables with up to 160 rows and 24 columns. The ICP text is certainly well written but it is aimed at professional economists and statisticians as a record of how ICP 2005 was carried out and as a guide to those who will be carrying out future rounds. It is not designed for easy read-
ing, while Prices and Earnings is in many ways a model of how to make statistics interesting to the non-statistician.

Another advantage of the UBS data base is that it refers to prices and earnings in specific cities, while ICP tries to measure prices averaged over all parts of the country. For setting expatriation allowances, city prices are clearly more relevant than national prices. John notes that the ICP software, Toolkit, identifies the location of price observations so that it would be possible to recalculate approximate city PPPs. They would be approximate because they would still have to use national rather than city expenditure weights.

Another apparent selling point of the UBS publication is that it prices an identical basket of goods and services in all 71 cities. This makes the pricing exercise seem very transparent - pricing the same set of items in all cities looks like an objective way of comparing price levels in the different countries. On reflection however, the use of a standard basket turns out to be a major problem for the reasons explained briefly. Simply put, the use of a standard basket implies that expatriates do not change their buying habits to take account of the fact that some things are cheaper in their new foreign posting while some things are more expensive. Expatriate staff whose foreign posting allowances are based on UBS statistics will usually end up with more money than they need to enjoy the living standards they were accustomed to at home. A selling point for employees but not for employers.

Finally, Prices and Earnings is published simultaneously in English, French, Spanish and German. The Global ICP report is currently available only in English, although versions in other languages may be issued later.

What about PPPs?
As noted above, the UBS data base is strictly confined to prices and earnings statistics. What about PPPs? Are they of no interest to the business community? Actually, real (PPP converted) total and per capita GDP are of great interest to corporate strategists and business economists. They do not use nominal (exchange rate converted) GDP for comparing the size of different economies for the same reason that they do not use nominal (current price) GDP for measuring the growth of GDP over time. In both cases, they recognize that differences in prices must be eliminated.

A good example of the use of PPPs in a business setting is provided by the GlobeGro™ model developed by The Leading Edge Strategy Company (TLE). GlobeGro analyzes the global market for consumer goods. Their models mainly use published national accounts, PPPs and household income distribution statistics to identify the size of the markets in 160 countries for different types of consumer goods. These range from basic necessities to luxury and prestige items. Both exchange rates and PPPs are provided but TLE explains why exchange rates are misleading when used to compare the size of markets in different countries. TLE counts some of the largest European companies among its clients so there is clearly a business market for PPPs in their primary use for measuring national accounts aggregates in real (price adjusted) terms. This market is, of course, confined to companies whose activities extend beyond their home markets but in an increasingly globalizing world this market is very large and growing fast.

TLE is, of course, not the only private research company to make use of PPPs. Another example is provided by the IMD’s World Competitive Centre’s publications, which uses about 300 variables to compare “business competitiveness” across countries. PPPs are used to compare both relative incomes and productivity.

An ICP publication aimed at the business community?
What lessons can we learn from UBS’ Prices and Earnings and TLE’s GlobeGro to make the ICP more attractive to business? My suggestion is a, once a year, special edition of The ICP Bulletin directed at the business community – an ICP Business Special. Its timing will depend on the PPP updating schedule but here are some suggestions as to what it might contain.

1. A Box explaining what PPPs are.
No algebra, nothing on the controversies surrounding their calculation and, especially, no mention of transitivity, representativity or Gerschenkron, Here is what it might say.

What are PPPs?
National poverty lines for a reference group of counPurchasing Power Parities (PPPs) are calculated by comparing the prices of identical goods and services in different countries. These price comparisons are made by calculating price relatives, which are the price of a specified good or service in one country divided by the price of the same item in another country. For example, if a 33ce can of Coca Cola Light costs 10 Rupees in one country and 50 Dollars in another, the price relative is 10/50, or 0.20. Price relatives are calculated for several hundred items covering all the final expenditure components of GDP. The

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Purchasing Power Parities are simply the weighted average of these price relatives. The weights used are the shares of expenditures on each item in total GDP. PPPs are currency converters, which equalize the purchasing power of currencies in the different countries. Their primary use is to convert GDP and its expenditure components – household consumption, gross fixed capital formation, etc. – to a common currency so that GDP comparisons can be made in real terms. In real terms means that differences in price levels between countries have been eliminated. (Note that a parallel procedure is used when we compare GDP from year to year in a single country; here differences in price changes over time are eliminated by using constant prices.) A second use of PPPs is to measure differences in price levels between countries, which are done by calculating ratios of PPPs to Exchange rates.

2. Real Expenditures and Price Level Indices. This will make up most of the report. A separate table is shown for total household consumption and gross fixed capital formation and for each of the 12 household expenditure groups identified in the ICP Report – i.e. one table for Food and Non-Alcoholic Beverages, another for Clothing and Footwear right through to Miscellaneous Goods and Services. Each table has just three data columns – the Price Level Index and both total and per capita Real Expenditure. The price levels would be set to New York = 100; real expenditures could be in US dollars.

3. Major cities. The data on price levels will refer to the major city in each country so that the PPPs and price levels will have to be recalculated using Toolkit’s location tags. Real expenditures, on the other hand, will have to remain national since there is no separate information on expenditures in cities. The table stubs might look like this:

4. Only large countries. The number of cities will be restricted to fit legally on a single page. This probably means between 60 and 70. They should be drawn from all regions covered by ICP but will exclude most of the smaller countries.

The problem of weights
The text will need to explain the weighing pattern used to obtain the PPPs. As noted above, UBS uses a standard “European” basket for its price comparisons. This is right for the European cities on which it bases but is wrong for all other cities, particularly those in the developing world. The use of a standard basket assumes that European expatriates posted overseas do not notice the difference in relative prices in their new posting compared with their home country, so that Europeans posted to, say, Bangkok or Sao Paulo are assumed not to hire domestic servants, rent more luxurious accommodation or dine out more often than they did in their home country.

ICP, by contrast, adapts the consumer basket to the actual expenditure patterns of each country, while this is exactly right in an ICP context it is not really what business people want in calculating expatriation allowances. Expatriates posted overseas are unlikely to adopt the average expenditure pattern of their new country (ICP weights), but neither do they stick to their European shopping basket (UBS weights). What business people really need to know is the price of the consumer basket that an expatriate adopts when he or she has settled into their new environment. This will be one that lies somewhere between the UBS and the ICP baskets.

ICP would meet a real and growing need in a globalizing world by providing price level indices based on the expenditure patterns of two or three “expatriate types” who have adapted to living overseas. The expatriate types might include a West European, a North American and an affluent Asian, the last being some composite average of, say, a Japanese, a Korean and a Taiwanese. This would be a quite new venture for ICP which has hitherto focused only on national consumer baskets but it is entirely possible that business partners could be found to collaborate in providing information on the expenditure patterns of their overseas expatriate staff in each city. The price data are, of course already available from ICP so the only additional requirement is for new weights.

All this is for the longer term however and for the immediate future the ICP national weights will have to be used together with city prices - with some of the above text to explain the problem.

What about earnings statistics?
A large part of Prices and Earnings is devoted to the presentation and analysis of its earnings data and John urges ICP to enter the competition by collecting earnings statistics on private sector jobs.

For ICP 2005, earnings in 50 government occupations were measured and those who were involved in this work
came away chastened by the difficulties of collecting internationally comparable earnings statistics. These include defining occupations in a way that can be understood in each country, standardizing for the personal circumstances of employees (qualifications, experience and marital status), measuring hours actually worked as opposed to those officially prescribed, productivity differences and deciding how to treat the many different kinds of social security contributions. The UBS researchers met these same problems but simplified their lives somewhat by confining their observations to a few companies in each capital. They acknowledge that a different selection of companies would have produced a different set of earnings statistics.

Apart from the practical difficulties and costs of expanding data collection to private sector occupations, it is not clear what interest these data hold for the business community. The UBS researchers use their earnings data to calculate “domestic purchasing power”, which they measure by the number of (European-based) baskets of goods and services that can be bought per year by (locally-based) employees. The problem here, recognized by UBS, is that locally-based employees do not purchase European-based basket of consumer items. Even if the weighting problem were solved, “domestic purchasing power” defined in this way is essentially a measure of the relative welfare of employees in different countries. Is this of interest to business people in their professional as opposed to their personal capacity? My answer is no and my conclusion is that ICP should not move in this direction.

**Conclusion**

John O’Connor’s article raised important questions about the future role of ICP in a globalizing world. There is a widespread demand for internationally comparable price statistics and it may be true that ICP has a poor record in publicizing the wide range of price information that it has accumulated since its inception. The UBS Prices and Earnings has some useful lessons for the ICP in this respect.

The great strength of ICP is not just that it collects prices but that it uses them to calculate PPPs. These are just as valuable to business economists as they are to government and academic economists. To some extent, PPPs and their uses are hidden rather than highlighted in the existing ICP reports. Business interest in, and use of, ICP data could be stimulated by an annual ICP Business Special as outlined above. The price level indices will help business looking for an objective basis for compensating staff working outside their home countries and the data on real expenditures will help businesses looking for new markets abroad. These are the bare bones of an ICP Business Special and they should be fleshed out in discussions with, for example, the talented people working for UBS and TLE.

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5. See http://www.imd.ch/research/centers/wcc/index.cfm
6. The suggestion of an annual publication assumes that the benchmark PPPs are updated in sufficient detail each year. Sufficient detail would be separate updating of the main aggregates – private consumption, capital formation and government expenditure. If, instead the PPPs are only updated at the level of GDP, annual publication would not be possible and the “Business Special” would be published only when benchmark estimates become available.

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**Footnote**

1. “Prices and Earnings”, UBS AG, Wealth Management Research, Postfach, CH-8098, Zurich, March 2008. Net: www.ubs.com/research. (At the time of writing “Prices and Earnings” was not available at this web-site, perhaps because it is being updated.)
2. Including prices of seven types of rented accommodation.
4. http://www.tlestrategy.com provides a neat summary of GlobeGro and other data bases available from TLE. The TLE Newsletters available at this site are also recommended reading.
Michael Ward: In Memoriam

Michael Ward died suddenly of a heart attack on 18 October 2008 at his home in Cambridge. He was 69 and leaves behind his wife Rosemary, a son and two daughters and six grandchildren. His death was a great loss to his many friends and colleagues throughout the World. It was also a great shock because right up to the end Michael was his usual busy self. He was Chair of the Programme Committee for the Special IARIW Conference in Kathmandu and was a session organizer for the 2009 ISI meeting in Durban. At the same time, he was involved in finalizing details of a lecture tour in China and was working with the Indian statistical office on a project to improve their price statistics. And those were just the projects he told us about.

Michael went to school at Fetters College in London. In 1958, he went on to Exeter University where he took a BA in Statistics and Economics and later obtained his MA from Cambridge. He started work in 1961 in Salisbury (now Harare) in what was then the Statistical Office of the Federation of the Rhodesias and Nyasaland. He later worked in the statistical office of Lesotho and in the Fiji Islands where he was Head of the Government Statistical Service.

During this time, Michael maintained his link with Cambridge and was a Fellow – later Dean - of Selwyn College and a Senior Researcher in the Department of Applied Economics. From 1972 to 1975, Michael worked for UNESCO as a regional statistical advisor in Southern Africa. In 1975, he returned to academia as Director of the Statistical Programme at the Institute of Development Studies at Sussex University. Both at Cambridge and Sussex, Michael worked with some of the foremost development economists of the time, including Richard Jolly, Graham Pyatt, Dudley Seers and Richard Stone. These were people who, as Michael observed in his book, Quantifying the World, “abhorred any suggestion that facts be fit to theory and spent their lives building theory around observed facts and creating frameworks that more usefully depicted how the real world worked”. Differences between countries in their price levels and real GDP were two “observed facts” that Michael was soon to become aware of.

Michael’s first connection with the ICP came when he joined the OECD in 1982. Without Michael’s determination, ingenuity and sheer hard work, the OECD PPP Program would certainly have been delayed and may never have gotten off the ground. The PPP project that Michael initiated at the OECD later became the Eurostat-OECD PPP Program and now covers all the member countries of the OECD and the European Union as well as eight other countries, including the Russian Federation, with which one or other of the two organizations has arrangements for statistical cooperation.

In 1985, Michael left the OECD to join the World Bank where he stayed until his retirement in 2000. Here he continued to involve himself in ICP issues and, after his retirement, he consulted the ICP Global Office, and the regional implementing agencies for Africa, Asia and Western Asia both in the areas of ICP methodology and program implementation.
One of Micheal’s main concerns was the correct measurement of price relatives for the calculation of PPPs. The standard procedure - used for ICP 2005 – was to calculate price relatives between a pair of countries as the average of all price observations for a specified good or service. Price observations for a specified item such as a kilo of long-grain brown rice may have come from open markets, small grocery shops, and small or large supermarkets and the prices may differ considerably depending on the type of outlet. Michael’s recommendation was the type of outlet should be included as one of the characteristics of the product so that price relatives would be calculated separately for rice sold in open markets and for rice sold in each of the other kind of outlets. He argued that this was particularly important for the calculation of “Poverty PPPs”, since most of the poor live in rural areas or in urban slums and will buy from different kinds of outlets, usually open markets, compared with the rich who may prefer large supermarkets.

While Michael Ward’s intellectual contribution to the ICP and other international statistics was great, his warm and generous personality was equally treasured. He always found time to encourage younger colleagues and was seen as their mentor by many. In a letter of condolence, Peter Hill puts it very simply: “He was a good friend and colleague, courteous, generous, cheerful and kind”. Those are the qualities that so many of us will remember him for and are the reason why he will be so missed throughout the world.

Derek Blades and David Roberts
The ICP Bulletin promotes an active exchange of information on program implementation experiences, and methodological developments. It presents summary reports of case studies and abstracts of research papers and their findings.

Send comments and questions to Virginia Romand vromand@worldbank.org

International Comparison Program
The World Bank
1818 H Street NW, MC2-209
Washington D.C. 20433 USA

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