1. Labor Productivity and Total Factor Productivity

One of the most used measures of efficiency of an economy is labor productivity, which is the average output produced by unit of labor. Labor productivity estimates are obtained by dividing the output measure (Gross Domestic Product) by the total labor input used to produce that output.

\[ \text{(1) Labor Productivity } (Y/L) = \frac{\text{Output } (Y)}{\text{Labor Input } (L)} \]

Two measures of labor productivity are included: output per person employed and (for countries for which total hours data are available) output per hour. Later sections describe how the output and labor series are obtained. The database also provides internationally comparable measures of levels of labor productivity by adjusting the output levels for differences in relative price levels by using purchasing power parities (PPPs).

Another type of productivity measure is total factor productivity, which is average output produced by a combination of multiple inputs, including labor and capital input, and with adjustments for changes in the quality of labor and changes in the composition of capital assets. To obtain the total factor productivity measures, a growth accounting framework is used to compute the contribution of these inputs to aggregate gross domestic product (GDP) growth. In the general production function below, output (Y) is produced by an input bundle X, consisting of capital services (K) and labor services (L_Q).

\[ \text{(2) } Y = AX(L_Q, K) \]

Under the assumption of perfect competitive factor markets where the marginal product of each input equals its price and constant returns to scale, the above general production function can be transformed into the following growth accounting framework:

\[ \text{(3) } \Delta lnY = \Delta lnA + v_L \Delta lnL + v_L \Delta lnQ + \sum_{i=1}^{6} v_{K_i} \Delta lnK_i \]

where \( \Delta lnX \) denotes the growth rate of variable X over two studying time periods, v’s stand for the average input shares in total factor income and because of constant returns to scale, \( v_L + \sum_{i=1}^{6} v_{K_i} = 1 \). Equation (3) can be arranged to per hour/worker terms:

\[ \text{(4) } \Delta lny = \Delta lnA + v_L \Delta lnQ + \sum_{i=1}^{6} v_{K_i} \Delta lnk_i \]
where \( y \) is labor productivity, defined as \( y=Y/L \), the ratio of total output to labor quantity, \( k \) is capital deepening, defined as \( k=K/L \), the ratio of capital services to labor quantity. Total hours worked is used as a measure of labor quantity. When this variable is not available in most developing and emerging economies, total employment is used instead under the assumption that the average hours worked per person do not change and the change in total hours worked equals the change in total employment. Equation (3) and (4) illustrate that the output growth is driven by a share weighted input growth and TFP growth, a residual that captures all sources of growth which are left unexplained by labor and capital services in the production function.

The accurate measurement of the variables in the productivity and growth accounting equations is the key to compare and evaluate the sources of output growth. Therefore, we discuss each of the components below.

2. Description of variables and methods

Output, GDP

The output measures in the database represent Gross Domestic Product at market prices, which are obtained from national accounts sources from international organizations and national statistical institutes. The post-1990 measures are obtained from a variety of sources, including the OECD National Accounts. Pre-1990 measures are mostly obtained from historical series, collected by Angus Maddison (2007).

Two gross domestic product (GDP) series are available in the database – GDPEKS and GDPGK. Both are expressed in constant US$ market prices and converted at purchasing power parity covering the period of 1950 - 2010. GDPEKS series are measured in constant 2010 US dollars. \(^1\) It is updated from 2005 EKS PPPs with GDP deflator changes. These 2005 EKS PPPs are unpublished estimates from Penn World Tables (to be used in their upcoming version PWT 7), which are benchmarked on 2005 PPPs from the International Comparisons Project (ICP) at the World Bank (World Bank, 2005). \(^2\) The adjustments made by PWT reflect:

1. an adjustment for global weighting for individual countries using EKS weights over domestic absorption (DA) for all countries rather than over five main regions as was done in the ICP by the World Bank
2. an adjustment for the net foreign balance using the PPP for domestic absorption (DA) rather than the exchange rate as in ICP
3. a downward adjustment in the PPP for China, which originally was based on relatively high prices for 11 cities, in order to better reflect the impact of lower prices in rural areas in China. \(^3\)

\(^1\) “EKS” stands for the originators of this PPP formula, Eltoto, Kovacs and Szulc, which essentially is a multilateral Fisher index.

\(^2\) GDPEKS are available for 111 economies, the following 12 countries are not covered by the PWT PPPs thus do not have GDPEKS series: Algeria, Barbados, Costa Rica, Dominican Republic, Guatemala, Jamaica, Myanmar, St. Lucia, Trinidad & Tobago, Turkmenistan, United Arab Emirates and Uzbekistan.

\(^3\) We thank Alan Heston for providing the PWT rework of the ICP PPP data. For a detailed description on the PWT PPPs, see Angus Deaton and Alan Heston (2008).
The effect of the first two adjustments is an upward adjustment in GDP for the global economy (all countries excluding the USA) of 7.6 percent relative to the U.S. in 2005. The China correction adds another 2 percentage points to this global correction. In the case of the China the first two effects lead to an upward adjustment in GDP of 13 percent relative to the World Bank measure, and together with the adjustment for prices even to an upward adjustment of 28.5 percent of the World Bank GDP level for China.

GDPGK series are expressed in 1990 US dollars and are available for all of the 123 countries in the database. They are converted at “Geary-Khamis” purchasing power parities (PPPs). The 1990 US dollar estimates are in almost all cases derived from Maddison (2007). Maddison used a PPP for China which was constructed back in the 1990s for 1986, and which is much lower than the newly PPP obtained by the ICP/World Bank. As a result Maddison’s GDP level for China in US dollars is roughly 40 percent higher than that of the World Bank. To partially adjust for this we adjusted Maddison’s GDP level for China downwards by 22.6 percent, which brings it relatively close to the adjustments for China in the PWT PPP index, as described above.

Labor quantity

a. Employment

From the perspective of productivity, it is very important that the measure of employment should be consistent with the measure of output. In this regard, the key point is that employment figures should cover all persons engaged in some productivity activity that fall within the production boundary of the system. It needs to include employees, self-employed as well as unpaid family members that are economically engaged, apprentices and the military. The production boundary follows one of two concepts, either the national concept or the domestic concept. The national concept counts all nationals working domestically and abroad, but excludes foreign workers employed domestically. The domestic concept includes all workers employed domestically, but excludes any nationals working abroad. The domestic concept is in line with the production boundary for GDP, thus is the consistent measure of employment as an input.

4 “GK” stand for Geary and Khamis, who were the originators of this PPP formula, which is a multilateral index similar to binary Paasche index, giving relatively large weights to large countries.

5 These data can be obtained from Angus Maddison’s Statistics on World Population, GDP and Per Capita GDP, 1-2006 AD (Last update: February 2010), (see http://www.ggdc.net/maddison/Historical_Statistics/horizontal-file_02-2010.xls).

The United Nations *System of National Accounts 1993* ([United Nation 1993 SNA Chapter 17](#)) prescribes that national accounts statistics must also include compatible measures of employment, as described above. Eurostat, the European Union’s statistical agency, and OECD now both report these National Accounts data on employment submitted by member countries via a joint Eurostat/OECD questionnaire. The employment figures reported under the National Accounts (domestic concept) are therefore the main sources for the employment data in advanced economies in this database. Since the National Accounts data for most countries started from 90’s, employment growth rate from Labor Force Survey (LFS) is used to extrapolate the employment level for earlier years.

A consistent and comparable measure of employment for countries not covered by OECD and Eurostat is scant. For non-OECD East European countries, we made use of data from the Vienna Institute for Comparative Economic Studies (WIIW) and from United Nations Economic Commission for Europe (UNECE). The Eurostat New Cronos Database and the ILO LABORSTA database have also been used frequently for this region. For Asian and Latin American countries we used data from respectively the Asian Development Bank (Manila), GGDC Total Economy Growth Accounting Database and the Economic Commission for Latin America and the Caribbean (ECLAC), extrapolated with series on labor force from World Bank World Development Indicators 2010. Series for Africa and Middle East countries are not for employment but for labor force and were also obtained from World Bank World Development Indicators 2010. Efforts are still under way to find the best available sources for those countries whose employment measure follows the international definition and is consistent with output.

### b. Total Hours worked

Output per worker is a crude measure of productivity and total hours worked is the preferred measure of labor inputs as it measures labor intensity most adequately. The *United Nation 1993 SNA Chapter 17* defines total hours worked as the aggregate number of hours actually worked during the year in employee and self-employment jobs.\(^7\)

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8. US data are from BLS. OECD LFS data are used for United Kingdom because neither OECD nor Eurostat national accounts data are consistent with measure of output. UK data in Eurostat national accounts are in terms of employees from the LFS, while those in OECD national accounts are in terms of jobs based on employer surveys supplemented with LFS data to capture the self-employed.

9. The ILO "Resolution concerning statistics of hours of work", adopted by the tenth International Conference of Labour Statisticians, defines hours worked as follows: Statistics of hours worked should include: (a) Hours actually worked during normal periods of work; (b) Time worked in addition to hours worked during normal periods of work, and generally paid at higher rates than normal rate (overtime); (c) Time spent at the place of work on work such as the preparation of the workplace, repairs and maintenance, preparation and cleaning of tools, and the preparation of receipts, time sheets and reports; (d) Time spent at the place of work waiting or standing-by for such reasons as lack of supply of work, breakdown of machinery, or accidents, or time spent at the place of work during which no work is done but for which payment is made under a guaranteed employment contract; (e) Time corresponding to short periods of rest at the workplace, including tea and coffee breaks. Statistics of hours actually worked should
Series of hours worked are currently available for 51 countries in the database with OECD and Eurostat National Accounts being the major data sources for recent years. Such data sources ensure that the total hours worked is within the production boundary as well as is produced by the employment data used in our database. For a detailed description on data sources, please refer to Detailed Sources of the Total Economy Database™.

Labor Composition

The input in terms of hours worked or total employment as described above, represents a series of labor quantity. In order to measure labor’s contribution to output growth, an adjustment for changes in the composition of labor is needed. The labor composition index can be constructed on the basis of weighted measures of different skill-level groupings in the labor force, using the Törnqvist index:

\[
(5) \Delta \ln Q_t = \sum_i \frac{1}{2} [v_{i,t} + v_{i,t-1}] \Delta \ln h_{i,t}
\]

In which \( v_{i,t} \) is the share in labor compensation by labor type \( i \) and \( \Delta \ln h_{i,t} \) is the log of the change in share of hours worked by labor type \( i \).

The data on share of hours worked by labor skill type is compiled from four databases: Cohen & Soto (2007), Barro & Lee (2000), EUKLEMS and projections by IIASA (2008).\(^{10}\) Cohen & Soto, Barro & Lee and the IIASA projection paper classify the population of 15+ into having received no schooling, only primary schooling, or also secondary or tertiary schooling. Cohen & Soto have data at a 10 year interval while Barro & Lee and IIASA have data at a 5 year interval. The time period for Cohen & Soto is from 1960 to 2010, Barro & Lee from 1960 to 2005 and that for the projection paper is from 2000 to 2050. EUKLEMS categorizes the percentage of total hours worked into low, medium and high skill level, male and female and three different age groups with annual data between 1970 and 2005. Though there are discrepancies between the three datasets in terms of both the coverage (i.e., population vs. hours worked) and the

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\(^{10}\) Cohen & Soto and Barro & Lee construct a data base on educational attainment using the perpetual inventory method. Cohen & Soto divide the total population 15+ in cohorts of 5 years. For every country they have at least one observation of educational attainment and using enrolment ratios they extrapolate backward and forward for 10 year intervals. Barro & Lee do not divide the population into cohorts but instead treat the population as a whole, and they use enrolment ratios to extrapolate backward and forward for 5 year intervals. The EUKLEMS data set is constructed from educational attainment data of the labor force for developed countries, which are assumed comparable with regard to the quality of the education system between countries. The projections by the International Institute for Applied System Analysis (IIASA) are based on a demographic method and uses different scenarios. There are four scenarios in the projection paper, i.e., Constant Enrolment Number (CEN), Constant Enrolment Ratio (CER), Fast Track (FT), and Global Education Trend (GET). CEN and CER are merely benchmark scenarios and are also dismissed as unrealistic by the authors of the paper, FT is a highly optimistic scenario and therefore we use the GET scenario in our estimation as we think it is the most reasonable one among the four.
definition, we lack the information to consolidate the three datasets into a unified one. Instead we have tried to find a statistical relationship among these three datasets. The EUKLEMS dataset is considered to be the most accurate measure among the three and is used as our benchmark for estimation. Among the other three datasets Cohen & Soto is considered most accurate.

Specifically, we use a seemingly unrelated regression (SUR) model to estimate the relationships between:

11 Cohen & Soto and Barro & Lee
12 Cohen & Soto and IIASA
EUKLEMS and Cohen & Soto

We obtain a consolidated combined data set by filling in the missing countries in Cohen & Soto by the projected values of the Barro & Lee data. Then we extrapolate the combined data set into the future using the growth rates of the IIASA, for countries missing Cohen & Soto and Barro & Lee data we use the projected values of the IIASA. Finally we transform the combined data set of Cohen & Soto, Barro & Lee and IIASA using the estimated relationship between Cohen & Soto and EUKLEMS. As we consider EUKLEMS to be the most reliable measure of skill levels, we keep the original EUKLEMS data if available in the transformed combined dataset. This way, we get a dataset with EUKLEMS data together with the projected data of the combined dataset based on EUKLEMS between 1960 and 2050, divided into three skill levels. Thirdly, to smooth out the data for those EUKLEMS countries between the years covered by EUKLEMS and those not covered by EUKLEMS (those years are covered by the projected values of the combined data set), we use the growth rate of the projected non-EUKLEMS years to extend the EUKLEMS year levels. Finally, an exponential interpolation using constant growth rates is applied to get the skill levels in between the available 5 or 10 year intervals.

The compensation data by skill type is constructed using the data set described above and compensation data from EUKLEMS. The shares in total labor compensation by skill type differ widely between countries and years within EUKLEMS. However, wage ratios are fairly stable over time, we can reconstruct wage ratios using:

\[ (6) \; v_{j,i,t} = h_{j,i,t} \frac{w_{j,i,t}}{\bar{w}_{j,t}} \]

In which \( w_{j,i,t} \) is the wage earned by labor type \( i \) at time \( t \) in country \( j \) and \( \bar{w}_{j,t} \) is the average wage at time \( t \) in country \( j \). For each country in EUKLEMS we have \( v_{j,i,t}, h_{j,i,t} \) and \( \bar{w}_{j,t} \). We can therefore calculate \( w_{j,i,t} \) for each country. For each year we then calculate:

\[ \]

11 Data set mentioned first is used as dependent variable
12 Ignoring the separation in gender and age groups for EUKLEMS
For missing years we estimate a trend to extrapolate the wage ratio backward and forward in time. Multiplying the wage ratios by the share in hours worked by skill type gives an estimate of the share in labor compensation for all countries. Again, for EUKLEMS countries the actual share of labor compensation is used and extrapolated backward and forward using the estimated values of labor compensation for missing years. For non-EUKLEMS countries the estimated values of labor compensation are used. Using the data on share in labor compensation and hours worked we can calculate the change in labor composition (equation 5).

**Capital Services**

This section outlines details of the methods employed to estimate capital services. It first provides an overview of the theoretical method based on the analysis developed by Dale Jorgenson and associates (Jorgenson and Griliches, 1967). It then discusses specific implementation issues and issues related to data availability. For more detailed information on the sources of the constant investment data and price indices, please refer to the Detailed Source Notes.

**a. Methodology**

For the calculation of sources of growth, we obtain measures of capital based on two asset groups: non-ICT capital and ICT capital. Non-ICT capital includes three asset types: non-residential construction, transport equipment, and machinery. ICT capital also has three asset types: IT hardware, telecommunication equipment, and software. For each type of asset, capital stock series, $K_{i,t}$, is constructed using the Perpetual Inventory Method (PIM) with a geometric depreciation rate:

$$K_{i,t} = (1 - \delta_i)K_{i,t-1} + I_{i,t}$$

in which $I_{i,t}$ is the constant investment data. The asset type specific depreciation rates, $\delta_i$, is time and country invariant. Initial capital stock, $K_{i,0}$, is calculated using the following formula

$$K_{i,0} = \frac{I_{i,0}}{\delta_i + g}$$

where $I_{i,0}$ is the level of constant investment in the initial period, $g$ is the growth rate of constant GDP (20 year average, starting from the 10 years before the capital data start), and $\delta_i$ is again the depreciation rate.

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13 For years outside the EUKLEMS range we estimate the trend using the Arellano and Bond instrumental variable approach.
Growth in capital services flow is measured by the weighted sum of capital stock growth in different asset types:

\[
\Delta \ln K_t = \ln K_t - \ln K_{t-1} = \sum_i \bar{v}_{i,t} \Delta \ln K_{i,t}
\]

where weights in the above equation are two-period average shares of each asset type in the value of total capital compensation.

\[
\bar{v}_{i,t} = \frac{v_{i,t} + v_{i,t-1}}{2}
\]

\[
v_{i,t} = \frac{p_{K_i,t} K_{i,t}}{\sum_i p_{K_i,t} K_{i,t}}
\]

with \( p_{K_i,t} \) being the rental price of capital services from asset type \( i \) in period \( t \). It is defined as

\[
p_{K_i,t} = p^l_{i,t} i_t + \delta_i p^l_{i,t} - (p^l_{i,t} - p^l_{i,t-1})
\]

This formula shows that the rental fee is determined by the nominal rate of return \( i_t \), the rate of depreciation and the asset-specific capital gains, which is the difference between investment price \( p^l_{i,t} \) and \( p^l_{i,t-1} \). It can also be rewritten as \( p_{K_i,t} = p^l_{i,t} r_{i,t} + \delta_i p^l_{i,t} \) with \( r_{i,t} \) being the real rate of return, defined as the nominal rate of return \( i_t \) adjusted for asset-specific capital gains \( (r_{i,t} = i_t - \frac{p^l_{i,t}}{p^l_{i,t-1}} - 1) \). In equation 13 above, investment price \( p^l_{i,t} \) can be derived by the ratio of current and constant investment price indices. (Note: The rate of depreciation is the same as the rate used in the construction of capital stock in equation 8.

There are two different approaches to estimate the nominal rate of return \( i_t \) in equation 13 above. The first is the \textit{ex-post} or internal rate of return. It is calculated as follows:

\[
i_t = \frac{M_t - \sum_i \delta_i p^l_{i,t} K_{i,t} - (p^l_{i,t} - p^l_{i,t-1}) K_{i,t}}{\sum_i p^l_{i,t} K_{i,t}}
\]

where \( M_t \) is the capital compensation in GDP (which can be derived as value added minus labor compensation using labor share as discussed in the next section). This approach ensures complete consistency between income and production accounts and is thus the preferred method of calculating the nominal rate of return. It is assumed that the total value of capital services equals its compensation for all assets. For each country, this nominal rate of return is invariant across different asset types, but varies across time. When the internal rate of return cannot be calculated using equation 14 due to data deficiency, an \textit{ex-ante} rate of return approach is used. This method is based on the opportunity cost concept using an exogenous value for the rate of return. Specifically, we use the maximum value among a country’s Central Bank Discount Rate, Government Bond Yield, and Lending Rate, all of which are from IMF International Financial Statistics database, as the external rate of return.
b. Implementation

1) Depreciation rates

The following set of depreciation rates is used in this database:

- Construction: 3%
- Transportation: 20%
- Machinery: 13%
- IT Hardware: 30%
- Telecom Equipments: 12%
- Software: 46%

2) Data sources and consistency issues

Major data sources are as follows: (for detailed information on data sources, please refer to the “Detailed Source Notes”)

- Non-ICT investment data and price indices for OECD countries: OECD national accounts data extended with data from Penn World Tables (PWT) data.\(^{14}\)
- Non-ICT investment data and price indices for non-OECD countries: PWT data extended using United Nations national accounts gross fixed capital formation data.\(^{15}\)
- ICT investment data and price indices for countries not covered by EU KLEMS: Jorgenson/Vu dataset extended with WITSA Digital Planet Report 2010.\(^{16}\)

As investment data and price indices are from various sources, two adjustments were made to consolidate the data. Firstly, all price indices, constant investment data and constant GDP (GDPEKS as described in the above section) are benchmarked to 2000;\(^ {17}\) Secondly, as constant investment data from various data sources have different measurement units (for example, OECD data are in PPP adjusted USD, EU KLEMS data are in national currency), we harmonize them with GDPEKS (in 2000 international dollars) by multiplying the ratio of the GDPEKS over constant GDP from the same

\(^{14}\) Price indices from OECD are obtained by diving current investment by constant investment.
\(^{15}\) PWT does not provide price indices. Price indices for PWT countries are from Azeez Erumban (2008).
\(^{16}\) Price indices from Jorgenson/Vu Kuznets data set are obtained by dividing current investment by constant investment.
\(^{17}\) OECD, PWT and Jorgenson/Vu data sets already have 2000 as the benchmark year. EU KLEMS has 1995 as benchmark year. So we re-benchmarked EU KLEMS price indices from 1995 to 2000, then multiply the re-benchmarked price indices with the current investment data to get the constant investment series with 2000 as base year.
source as the investment data, i.e., $constant inv_{eks} = constant inv_i \times GDP_{eks}/GDP_i$

with subscript $i$ indicating data source (e.g., PWT).

- **Negative internal rate of return and rental price of capital**
  The internal rate of return and rental price of capital services cannot be negative. In case of negative values, we use the average of the two adjacent years’ positive internal rates of return/rental price of capital services to replace those years. If the negative value happens in the start or end year, then we use the average of all non-negative value to replace it.

- **Adjustment to machinery investment data and price indices**
  The machinery investment series include hardware and telecommunication data that need to be excluded to avoid double counting. To do so, we firstly deduct the latter two asset types from machinery, all in current price, to obtain an adjusted machinery series. Secondly, we replace the machinery price indices by other machinery (machinery excluding hardware and telecom) price indices reported in EU KLEMS. For countries not covered by EU KLEMS, the original machinery price indices are maintained. Thirdly, we multiply the adjusted machinery investment series in current price with the adjusted machinery price to obtain the adjusted constant machinery investment, i.e., machinery excluding hardware and telecom.

- **Adjustment to ICT price indices**
  The difference in ICT investment price relative to non-ICT investment price will affect the contribution of these two assets. As an example, in early 1990s, Brazil experienced hyper-inflation which made its non-ICT price surge relative to ICT price, leading to a sudden drop in the contribution of non-ICT capital growth to total output growth. To address such volatile relative price changes between ICT and non-ICT capital, we adopt the price harmonization approach pioneered by Schreyer. Specifically, we harmonize the ICT price deflator using the U.S. deflator, adjusted for domestic inflation, and assuming the difference in growth rates between ICT and non-ICT capital in all the countries to be equivalent to that in the U.S.:

$$\Delta \ln \hat{p}_{ICT}^{other} = \Delta \ln p_{non-ICT}^{other} + (\Delta \ln p_{ICT}^{US} - \Delta \ln p_{non-ICT}^{US})$$

$p$ is the investment price in the above equation. ICT and non-ICT price indices are each calculated as weighted averages over three asset types (ICT: hardware, telecom and software; non-ICT: construction, transport and machinery) using their share of current asset investment in total ICT or non-ICT asset investment. We use the reported ICT price deflators from EU KLEMS whenever possible. For

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18 Among our data sources, only EU KLEMS reports price indices for machinery excluding hardware and telecom. We use such adjusted machinery indices whenever possible and extend it to earlier and later years using the growth rates of the original (unadjusted) machinery price indices.

19 See Schreyer (2002) for a discussion of the approach
countries not covered by EU KLEMS, formula 8 is applied to obtain a harmonized ICT price index. After this harmonization procedure, all three asset types of ICT capital will have one price index.

Labor Share

The labor share in total compensation, which is used to assign weights to labor and capital, has been constructed from various sources. The labor shares (ratio of labor compensation to gross value added at basic price) from EUKLEMS are used whenever the data is available. OECD and Eurostat report data on labor compensation for employees and GDP at basic prices (which is GDP at market price minus taxes less subsidies). Under the assumption that the labor compensation for self-employed can be imputed from the average compensation for employees, we adjust the employee labor compensation share by dividing the employee share among total employment to obtain the total labor compensation share among GDP. For a few large non-OECD, non-EU countries, we estimated the labor share using other sources. In the case of China, the labor share is estimated from I/O tables. For Brazil and Russia the labor share is calculated using compensation data from the United Nations and the World Bank.

A few adjustments were made for missing years in the above sources. The latest year in EUKLEMS data (November 2009) is 2007. For years after 2007 we use the growth rate of the computed labor share from OECD and/or Eurostat to extrapolate the EUKLEMS series. We use EUKLEMS country average labor share growth rate to extrapolate missing years before 2007 in various sources.\(^\text{20}\)

For the other emerging and developing economies, we simply use 0.5 as the labor share. In much of the growth accounting literature, a labor share of 0.7 is widely used across time and countries. Gollin (2002) identified and compared several adjustments for calculating labor shares and concluded that factor shares are approximately constant across time and countries within a range of 0.65 to 0.80. However, we use a labor share of 0.5 for emerging and developing economies because in those economies capital is more scarce thus return is high. Further, labor is cheap compared to advanced countries, leading to a lower labor share. Moreover, much depends on the labor share that is allocated to self-employed, especially in emerging and developing economies where this fraction of the workforce is still relatively large.

3. Aggregation of Growth Rates

Growth rates for individual countries are calculated using the log difference. This is necessary in order to facilitate aggregation as well as decomposition of the growth for individual countries and components. With regard to the aggregation to country groups, the following formulas are used for GDP, labor input and labor productivity growth respectively:

\(^{20}\) 2008 data for Australia, Canada, Japan, Korea, New Zealand and US, 2006-08 for Brazil, 2007-08 Russia is extrapolated using the latest 5 year average growth rate of each country.
with $w_i$ as the country share in PPP adjusted nominal GDP of the region for each year and a bar denoting the two-period average. Hence aggregate GDP growth is the weighted sum of the country GDP growth. Growth in labor quantity (employment or hours) is simply the log difference of summed total labor quantity of all the countries in one region. The aggregate labor productivity growth is the weighted sum of country productivity growth plus a reallocation term $R$. The reallocation term is positive if employment shifts from low productivity countries towards high productivity countries.

Aggregate Total Factor Productivity (TFP) growth rates for various country groups are calculated using the following steps.

1. Aggregate labor input growth rates and aggregate capital services growth rates are calculated by taking the weighted average of individual country growth rates. The weights used are two period averages of the country shares in PPP-adjusted nominal GDP of the group for each year.

2. Aggregate labor compensation share for each year is obtained by summing up the labor compensation (PPP adjusted) of individual countries and then dividing this sum by total nominal GDP (PPP adjusted) of the group.

3. TFP growth rates are calculated using

$$
\Delta \ln \Lambda_{\text{region}} = \Delta \ln Y_{\text{region}} - \bar{\alpha}_{\text{region}} \Delta \ln L_{\text{region}} - (1 - \bar{\alpha}_{\text{region}}) \Delta \ln K_{\text{region}}
$$

where $\bar{\alpha}_{\text{Region}}$ is the two period average of the regional labor compensation shares, and $\Delta \ln Y_{\text{region}}$ is defined in equation (16).
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