Detailed Source Notes – *Total Economy Database*™

Output, Labor, and Labor Productivity

I. Total Economy Series - Gross Domestic Product (1990 US$ and 2012 US$)

For each country, specific source descriptions are provided in the ***Total Economy Database*™** - Detailed Source Notes - Output, Labor, and Labor Productivity file, but in general, the following sources were used for the trends in real GDP. From 1990 onwards, series for OECD countries are mostly derived from the most recent editions of OECD National Accounts. For East European countries, we made extensively use of published data from the Vienna Institute for International Economic Studies and from UNECE. As the Eurostat in some cases contains more recent information than the sources mentioned above, we sometimes use this database instead. For Asian countries we used data from the Asian Development Bank Key Indicators 2012. Latin American data stems mostly from the http://www.eclac.cl/. For African and Middle East countries we relied heavily on data from the International Monetary Fund. Series up to 1990 are mostly derived from historical series, collected by Angus Maddison.

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.

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 - 2012. GDPEKS series are measured in constant 2012 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 These 2005 EKS PPPs are unpublished estimates from Penn World Tables (to be used in their upcoming version PWT 7), which are benchmarked on 2005 PPPs from the International Comparisons Project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]

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.[4] They are converted at "Geary-Khamis" purchasing power parities (PPPs). The 1990 US dollar estimates are in almost all cases derived from Maddison (2007).[5] 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

[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).
[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, 1-2008 AD* (Last update: February 2010), (http://www.ggdc.net/maddison/Historical_Statistics/horizontal-file_02-2010.xls).

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.

II. Total Economy Series - Employment (persons) Labor Force (persons)

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.[6] 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.

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 join Eurostat/OECD questionnaire.[7] 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.[8] 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, 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. 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. 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. For certain years still missing adequate employment or labor force data, working age population growth from the U.S. Census Bureau's International Data Base (IDB) may be used for interpolation.

[6] Employment has been defined by the International Labour Organization (ILO) in the "Resolution concerning statistics of the economically active population, employment, unemployment and underemployment", adopted by the thirteenth International Conference of Labour Statisticians. It is defined consistently in the System of National Accounts 1993 (1993 SNA) and European System of Accounts 1995 (1995 ESA). ILO: http://www.ilo.org/public/english/bureau/stat/res/index.htm; 1993 SNA XVII: Population and Labor Inputs: http://unstats.un.org/unsd/sna1993/toctop.asp; 1995 ESA Chapter11 Population and labor Inputs: http://circa.europa.eu/irc/dsis/nfaccount/info/data/esa95/en/esa95en.htm.

[7] Situation of Annual National Accounts in the OECD Database and New Features of the Joint OECD-EUROSTAT Questionnaire: www.oecd.org/dataoecd/9/29/24336184.doc.

[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.

IV. Total Economy Series - Annual hours worked (per person)

Series on hours actually worked per person employed per year are presently available for 52 countries and cover the period 1950-2012. The estimates are intended to include paid overtime and exclude paid hours that are not worked due to sickness, vacation and holidays, etc.

Estimates of working hours involve serious measurement problems and international comparability is troublesome. Even for individual countries very different estimates can circulate, primarily because the numbers are obtained either via labor force surveys or from establishment surveys. An advantage of estimates based on labor force surveys is their comprehensive nature, i.e. all adjustment for overtime, sickness, etc. are included. A disadvantage, however, is that there seems to be a general tendency towards slight overestimation of hours actually worked. Figures based on establishment surveys are usually only for hours paid and may include overtime, and require further adjustments to account for various types of absence. The method for making such adjustments is described in A. Maddison (1980), "Monitoring the Labour Market: A Proposal for a Comprehensive Approach in Official Statistics", Review of Income and Wealth, June, pp. 175-217.

We derived our estimates on a country-by-country basis, basing our judgment on which sources made the most appropriate adjustments at our preferred concepts of "actual hours worked per person employed". In some cases (e.g. France, Germany, United Kingdom and United States) we made use of country specific estimates. For the United States we used a combination of unpublished total working hours from the BLS Productivity Database divided by smoothed employment series from the Current Population Survey. In other cases we relied on estimates from the OECD Growth Project, which are updated by S. Scarpetta, A. Bassanini, D. Pilat and P. Schreyer, "Economic Growth in the OECD Area: Recent Trends at the Aggregate and Sectoral Level", OECD Economic Department Working Papers No. 248, Table A.13. For the European countries the latter data set makes use of the number from the Eurostat Labour Force Survey, but with downward adjustment to account for overstating of hours actually worked. For later years the trend of the OECD Employment Outlook has been used.

For the pre-1980 period the trend in working hours per person employed was derived from the OECD Employment Outlook and subsequent studies by A. Maddison (1982, 1991 and 1995).

IV. Total Economy Series - Population (persons)

For each country individual source descriptions are again given by the ***Total Economy Database™*** - Detailed Source Notes - Output, Labor, and Labor Productivity file, but in general the following sources were used. Historical estimates, pre-1990, are obtained from data underlying Angus Maddison (2007), "Statistics on World Population, GDP, and per capita GDP, 1-2008 AD**,** last updated February 2010." Series from 1990 onwards are mostly derived from the US Census Bureau, International Data Base (IDB).

V. Constant Investment Data and Price Indices

The growth in capital services is estimated by creating the series on capital stock by different asset types. The dataset uses six asset types –

- Non-ICT: Construction, Machinery, Transport Equipment.
- ICT: Software, Hardware, Telecommunications.

Major data sources for constant investment series and price indices are as follows:

- Non-ICT investment data and price indices for OECD countries: OECD national accounts data extended with data from Penn World Tables (PWT).[9]
- Non-ICT investment data and price indices for non-OECD countries: PWT data extended using United Nations national accounts gross fixed capital formation data.[10]

[9] Price indices from OECD are obtained by diving current investment by constant investment.

- ICT investment data and price indices for countries covered by EU KLEMS: EU KLEMS data extended with Jorgenson/Vu Kuznets dataset and WITSA Digital Planet Report 2010.
- ICT investment data and price indices for countries not covered by EU KLEMS: Jorgenson/Vu Kuznets dataset extended with WITSA Digital Planet Report 2010.[11]

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;[12] 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 source as the investment data, i.e.,$constantinv_{eks} = constantinvi \quad \times GDP_{eks}/GDP_i$ with subscript *i* indicating data source (e.g., PWT).

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.[13] 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.

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.[14] 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.:

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

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 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.

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[10] PWT does not provide price indices. Price indices for PWT countries are from Azeez Erumban, "Measurement and analysis of capital, productivity and economic growth," University of Groningen, 2008, (http://dissertations.ub.rug.nl/faculties/feb/2008/a.e.erumban/) for details.

[11] Price indices from Jorgenson/Vu Kuznets data set are obtained by dividing current investment by constant investment.

[12] OECD, PWT and Jorgenson/Vu Kuznets 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.

[13] 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.

[14] See Schreyer (2002) for a discussion of the approach

VI. Labor Share

The labor share in total income, 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 World Input-Output Database (WIOD) and EU-KLEMS 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. Labor shares for the United States are taken from National Income and Product Account from Bureau of Economic Analysis.