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Purpose of the Eurostat-OECD PPP Programme

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Purpose of the Eurostat-OECD PPP Programme

1

1.1 Introduction

1.1 The Eurostat-OECD PPP Programme was established in the early 1980s to compare on a regular and timely basis the GDPs of the Member States of the European Union and the Member Countries of the OECD. This remains the purpose of the Programme, although its coverage has been broadened to include countries that are not members of either the European Union or the OECD. These are either countries that have applied to join the European Union or the OECD or countries with which Eurostat and the OECD have programmes of technical cooperation in statistics. A brief history of the Programme can be found in Annex I.

1.2 The object of the Programme is to compare the price and volume levels of GDP and its component expenditures across participating countries. Before such comparisons can be made, it is first necessary to express the GDPs – which are in national currencies and valued at national price levels - in a common currency at a uniform price level. Eurostat and the OECD use purchasing power parities (PPPs) to effect this double conversion.

1.3 This chapter sets out the background to the international comparisons of GDP organised by Eurostat and the OECD. It opens with a discussion on GDP as a measure of well-being and then describes the approach to GDP comparisons followed by Eurostat and the OECD. It explains what PPPs are and why they and not exchange rates are employed to make the comparisons. It closes with a review of the uses and users of PPPs and of the points to remember when applying the price and volume measures to which they give rise.

1.2 General approach

1.2.1 Gross domestic product (GDP)

1.4 GDP is a measure of production. It is the sum of the value added generated by producers residing in the economic territory of a country during the accounting period which is usually a calendar year or a quarter.¹ GDP is widely used by academics, policy-makers, politicians, journalists, businessmen, financiers and the general public as an indicator of economic activity. When placed on a per capita basis, it is also used as an indicator of economic welfare or material well-being despite the caveats of its compilers.² Historically there has tended to be a positive correlation between what is measured by the GDP and other measures of economic and social welfare both over time and across socio-economic groups – wealthier has usually meant healthier, better educated and a less inequitable income distribution – and GDP has become to be regarded as a proxy for a society's well-being and development.

1.5 GDP is a summary measure. It does not say anything about the distribution of income within a country. Nor does it show whether growth is the result of increased spending on defence or police or increased spending on education or health. In addition, the coverage of GDP is continually being debated. For instance, should it include housework and other services produced by households for their own consumption and should it be reduced because of environment deterioration and the depletion of subsoil assets. GDP, while a good indicator of economic performance, is not an accurate measure of economic welfare.³ To be so, it either needs to be adapted, thereby possibly reducing its usefulness as a measure of economic activity, or to be complemented with indicators that are better suited to the measurement of well-being. The preferred option of most users, and the focus of international initiatives to bring it about, is the development of complementary measures.⁴

¹ For international price and volume comparisons of GDP the accounting period is generally a calendar year.

² See, for example, paragraphs 1.68 to 1.82 of the SNA 93 or paragraphs 1.75 to 1.84 of the SNA 2008 on the system of national accounts and measures of welfare.

³ For a recent overview of the limitations of GDP see Report by the Commission on the Measurement of Economic Performance and Social Progress, Stiglitz/Sen/Fitoussi, 2008, <http://www.stiglitz-sen-fitoussi.fr/en/index.htm>.

⁴ See the communication of the European Commission GDP and Beyond: Measuring Progress in a Changing World, 2009, <http://www.beyond-gdp.eu/>.

1.6 GDP can be seen as one of a family of indicators that are to be developed to monitor overall social progress as well as the specific elements that constitute well-being. But it is not necessarily the best national accounting aggregate for this purpose. Not only does it cover the goods and services that resident households consume to satisfy their individual needs, it also includes services, such as defence, police and fire protection, that government produces to meet the collective requirements of the community, as well as gross capital formation and net exports neither of which constitute final consumption. A better measure of material well-being is the aggregate actual individual consumption (AIC).⁵ This comprises only the goods and services that households actually consume to satisfy their individual needs. It covers all such goods and services irrespective of whether they are purchased by the households themselves or are provided as social transfers in kind by government and non-profit institutions serving households (NPISHS). Eurostat and OECD comparisons are organised so that both the GDP and the AIC of participating countries can be compared.

1.7 GDP can be estimated using three alternative approaches which yield the same result in theory. These can broadly be described as: the production approach – which sums all the value added generated by the country's resident institutional sectors⁶ during the accounting period; the expenditure approach – which sums all the final expenditures incurred by the country's resident institutional sectors during the accounting period; and the income approach – which sums all the factor incomes paid by the country's resident institutional sectors engaged in domestic production during the accounting period. Price and volume comparisons of GDP are based on the identity: **value = price x volume**. The values of income aggregates, unlike the values of production and expenditure aggregates, cannot be split into meaningful price and volume components. Price and volume comparisons of GDP can only be made from the production side or the expenditure side.

1.2.2 Eurostat-OECD approach

1.8 Eurostat and OECD comparisons are made from the expenditure side which identifies the components of final demand: consumption, investment and net exports. The reasons for this are: the inherent usefulness of making comparisons from the expenditure or demand side; the difficulties of organising comparisons from the production or supply side which require data for both intermediate consumption and gross output in order to effect double deflation; and the generally better comparability among countries of their detailed breakdowns of GDP expenditures. The disadvantage of the expenditure approach is that, although it enables levels and structures of consumption and investment to be compared, it does not identify individual industries. Therefore, productivity comparisons can be made only at the level of the whole economy. To compare productivity at the industry level, international comparisons of GDP have to be made from the production side.⁷

1.9 GDP expenditure values are made up of two components: price and volume. Comparing the expenditure values of countries will not provide a comparison of the volumes of goods and services purchased in countries unless the price level differences that exist between them have been eliminated. This is exactly the same problem faced in making comparisons over time for a single country where changes in values due to price movements are removed by using a *constant* set of prices. Differences in price levels between countries can be removed either by observing the volumes directly or by deriving them indirectly using a measure of relative prices to place the expenditures of all the countries on the same price level. Prices are easier to observe than volumes and direct measures of relative prices usually have a smaller variability than direct measures of relative volumes. In Eurostat and OECD comparisons volumes are mostly estimated indirectly. The exceptions are the volumes for education and, for some countries, housing.

⁵ This concept, or its equivalent, has been used in international comparisons of GDP based on PPPs since the 1950s. It was not until the 1990s that it was adopted by national accountants and included in the international system of national accounts.

⁶ These are non-financial corporations, financial corporations, general government, households and NPISHS.

⁷ Such as those made for the EU KLEMS Project to compare productivity at the industry level in the European Union. The project ran from 2003 to 2008. For methodology and results consult <http://www.euklems.net/>. See also "Purchasing Power Parity Measurement for Industry of Origin Analysis", B. Van Ark, A. Maddison and M. P. Timmer, *The ICP Bulletin*, Volume 5, Number 1, pages 29-34, March 2008 at: http://siteresources.worldbank.org/ICPINT/Resources/270056-1208272795236/ICP_bulletin_03-04_web.pdf

1.10 International volume comparisons of GDP depend on four conditions being met. These are:

- the definition of GDP is the same;
- the measurement of GDP is the same;
- the currency unit in which GDP is expressed is the same; and
- the price level at which GDP is valued is the same.

GDP estimates of countries participating in Eurostat and OECD comparisons generally meet the first condition as they are compiled in line with one of the two complementary international systems of national accounts: the SNA 93⁸ or the ESA 95⁹. Both systems have been updated without affecting their compatibility. Most, if not all, participating countries will have switched to one of the revised versions - either the SNA 2008¹⁰ or the ESA 2010¹¹ - by 2014.

1.11 Whether the second condition is met depends on the degree in which countries are successful in measuring the non-observed economy.¹² Obtaining exhaustive estimates of GDP from all participating countries has to be a long-term endeavour. To this end, Eurostat has worked successfully over the last thirty years with EU Member States to improve the comparability of their GDP estimates. The OECD published a handbook¹³ in 2002 that provides national accountants with guidelines on how to measure the non-observed economy. It draws heavily on the experience of Eurostat among others.

1.12 The third condition of a common currency unit is not met other than by the countries in the euro area. The GDP estimates of the majority of participating countries are expressed in different national currencies. Nor is the fourth condition met as the GDP estimates of participating countries, including those of the countries in the euro area, are valued at national price levels. To meet these last two conditions it is necessary to have conversion rates that both convert to a common currency and equalise the purchasing power of different currencies in the process of conversion. Such conversion rates are called purchasing power parities or PPPs. Eurostat and OECD comparisons are made using PPPs.

⁸ *System of National Accounts 1993*, Commission of the European Communities, International Monetary Fund, Organisation for Economic Co-operation and Development, United Nations, World Bank, 1993.

⁹ *European System of Accounts 1995*, Eurostat, Luxembourg, 1996.

¹⁰ *System of National Accounts 2008*, Commission of the European Communities, International Monetary Fund, Organisation for Economic Co-operation and Development, United Nations, World Bank, New York, 2009.
<http://unstats.un.org/unsd/nationalaccount/sna2008.asp>

¹¹ *European System of Accounts 2010*, Eurostat, Luxembourg, 2011.

¹² The non-observed economy comprises activities that are hidden because they are illegal or because they are legal but carried out clandestinely or because they are undertaken by households for their own use. It also covers activities that are missed because of deficiencies in the statistical system. Such deficiencies include out-of-date survey registers, surveys having too high reporting thresholds or high rates of non-response, poor survey editing procedures, no surveying of informal activities such as street trading, etc.

¹³ *Measuring the Non-Observed Economy – A Handbook*, Organisation for Economic Co-operation and Development, International Labour Organisation, International Monetary Fund, Statistical Committee of the Commonwealth of Independent States, Paris, 2002.

1.3 Exchange rates and PPPs

1.3.1 Exchange rates

1.13 Exchange rates were used to make international comparisons of GDP before PPPs became available. Their use was underpinned by the theory of purchasing power parity in international economics. In its simplest form, the theory suggests that national price levels converted to a common currency using exchange rates should be equal. Arbitrage will ensure that the price of an individual good will be the same in all countries in which it is traded – *the law of one price*. Hence, when the individual goods are taken together, there will be high correlation in general price levels – at least in the medium and long term. The two principle assumptions underlying the theory are that all goods are internationally tradable and that the demand and supply for currency is driven entirely by international trade in goods.

1.14 Exchange rates are determined by the supply and demand for different currencies. But the supply and demand for currencies are influenced by factors such as currency speculation, interest rates, government intervention and capital flows between countries rather than by the currency requirements of international trade. Moreover, many goods and services, such as buildings, all government services and most market services, are not traded internationally. For these reasons, exchange rates do not reflect the relative purchasing powers of currencies in their national markets. Hence, while exchange rates provide GDP estimates that satisfy the third condition of being expressed in the same currency unit, they do not provide GDP estimates that satisfy the fourth condition of being valued at the same price level.

Box 1.1: Exchange rates or PPPs

1. The ratio of the GDPs of two countries when both GDPs are valued at national price levels and expressed in national currencies has three component ratios:

$$GDP \text{ ratio} = \text{price level ratio} \times \text{volume ratio} \times \text{currency ratio (or exchange rate)} \quad (1)$$

2. When converting the GDP ratio in (1) to a common currency using exchange rates – that is, by dividing through by the currency ratio – the resulting GDP_{XR} ratio remains with two component ratios:

$$GDP_{XR} \text{ ratio} = \text{price level ratio} \times \text{volume ratio} \quad (2)$$

The GDP ratio in (2) is expressed in a common currency, but it reflects both the price level differences and the volume differences between the two countries.

3. A PPP is defined as both a currency converter and a spatial price deflator. It comprises two component ratios:

$$PPP = \text{price level ratio} \times \text{currency ratio (or exchange rate)} \quad (3)$$

4. When converting the GDP ratio in (1) to a common currency using a PPP – that is, by dividing through by (3) – the resulting GDP_{PPP} ratio has only one component ratio:

$$GDP_{PPP} \text{ ratio} = \text{volume ratio} \quad (4)$$

The GDP ratio in (4) is expressed in a common currency, is valued at a uniform price level, and reflects only volume differences between the two countries.

5. When the GDPs of two countries are valued at national price levels but expressed in a common currency, as, for example, in the euro area, the GDP ratio still has three component ratios one of which, the currency ratio, equals 1:

$$GDP \text{ ratio} = \text{price level ratio} \times \text{volume ratio} \times \text{currency ratio or 1}$$

Similarly, the PPP still has two component ratios:

$$PPP = \text{price level ratio} \times \text{currency ratio or 1}$$

But, as the currency ratio equals 1, the PPP is, in effect, simply a spatial price deflator.

1.15 Consequently, as explained in Box 1.1, GDPs of countries converted to a common currency with exchange rates reflect not only differences in the volumes produced in the countries, but also differences in the price levels of the countries. In other words, though shown in the same currency, they remain valued at national price levels. As such, they are nominal measures and measures of value. PPPs, on the other hand, are conversion rates that are both currency converters and price deflators. Therefore, as shown in Box 1.1, GDPs of countries converted to a common currency using PPPs are also valued at a uniform price level. They reflect only differences in the volumes of goods and services produced in countries. As such they are real measures and measures of volume.

1.16 Box 1.2 illustrates why PPPs rather than exchange rates should be used for international comparisons of volume. It shows the GDPs of the United States and Japan expressed as a percentage of the GDP for the 27 countries that are members of the European Union – the EU27 – for the reference years 1996, 1999, 2002, 2005 and 2008. There are two sets of percentages: one based on exchange rate converted data, the other based on PPP converted data. It also gives the average annual volume growth rates for five periods: 1996-2008, 1996-1999, 1999-2002, 2002-2005 and 2005-2008.

Box 1.2: GDP levels and growth rates of the United States, Japan and the EU27

Percentage with exchange rate converted GDPs	1996	1999	2002	2005	2008
- EU27	100	100	100	100	100
- United States	83	102	113	91	78
- Japan	50	48	42	33	27
Percentage with PPP converted GDPs	1996	1999	2002	2005	2008
- EU27	100	100	100	100	100
- United States	89	94	91	95	89
- Japan	34	31	29	29	27
Average annual volume growth rates	1996-2008	1996-1999	1999-2002	2002-2005	2005-2008
- EU27	2.3	2.7	2.5	1.8	2.2
- United States	3.0	4.4	3.0	2.7	1.9
- Japan	1.1	0.5	0.8	1.6	1.3

1.17 It appears from the exchange rate converted data that in 1996 the GDP of the EU27 was 17 per cent larger than that of the United States and 50 per cent larger than that of Japan. The PPP converted data show the GDP of the EU27 to have been only 11 per cent larger than the GDP of the United States, but 66 per cent larger than the GDP of Japan. Similar contrary differences between the two sets of percentages exist for 1999, 2002, 2005 and 2008. For example, the exchange rate converted data show the GDP of the United States to have been bigger than that of the EU27 in 1999 and 2002, yet the PPP converted data continue to show it as being smaller, which is in line with the average annual volume growth rates for 1996-1999 and 1999-2002.

1.18 The average annual volume growth rates for 1996-2008 show that the economy of the United States grew faster than that of the EU27, except in the last three years, 2005-2008. Yet from the exchange rate converted data, it seems that the GDP of the United States became smaller relative to the GDP of the EU27: in 1996, the GDP of the United States was 83 per cent of that of the EU27, in 2008 it was 78 per cent. The PPP converted data show the relative sizes of the two economies as remaining unchanged. From 2002 to 2005, the average annual volume growth rates for Japan and the EU27 were much the same being 1.6 and 1.8 per cent respectively. Yet the exchange rate converted data show Japan's GDP relative to that of the EU27 as having fallen from 42 per cent to 33 per cent. The PPP converted data reflect that the GDPs of Japan and the EU27 grew at similar rates. The changes in the relative sizes of the three economies over the five periods as measured by exchange rate converted data are not consistent with their relative growths for the same periods, whereas the changes as measured by PPP converted data generally are.

1.19 Exchange rate converted data are usually misleading on the relative sizes of economies. Price levels are usually higher in high-income countries than they are in low-income countries. If no account is taken of this when converting the GDPs of countries to a common currency, then the size of high-income countries will be overstated and the size of low-income countries will be understated. This is called the Penn effect.¹⁴ It can be explained by the Harrod-Balassa-Samuelson hypothesis¹⁵ and the distinction between tradable products and non-tradable products. The prices of tradable products will basically be determined by the law of one price because if a country prices its tradables too high they will not be sold. Prices for non-tradable products are determined by local circumstances, in particular productivity, which is generally higher in high-income countries. Price level differences between countries are therefore greater for non-tradables than they are for tradables.

1.20 Currency conversions made with exchange rates do not take account of the larger price level differences between countries for non-tradable products. Hence, as demonstrated in Box 1.3, they overstate the size of economies with relatively high price levels and understate the size of economies with relatively low price levels.

1.3.2 Purchasing power parities (PPPs)

1.21 In their simplest form PPPs are nothing more than price relatives that show the ratio of the price in national currencies of the same good or service in different countries.¹⁶ For example, if the price of a hamburger in France is 2.84 euros and in the United States it is 2.20 dollars, the PPP for hamburgers between France and the United States is 2.84 euros to 2.20 dollars or 1.29 euros to the dollar. In other words, for every dollar spent on hamburgers in the United States, 1.29 euros would have to be spent in France to obtain the same quantity and quality – or volume - of hamburgers.¹⁷ To compare the volumes of hamburgers purchased in the two countries, either the expenditure on hamburgers in France can be converted to dollars by dividing it by 1.29 or the expenditure on hamburgers in the United States can be converted to euros by multiplying it by 1.29.

1.22 PPPs are not only calculated for individual goods and services, they are also calculated for product groups and for each of the various levels of aggregation up to and including GDP.¹⁸ The calculation is made in three stages. The first is at the product level, where price relatives are calculated for individual goods and services. The second is at the product group level, where the price relatives calculated for the products in the group are averaged, usually without weights, to obtain PPPs for the group. And the third is at the aggregation levels, where the PPPs for the product groups covered by the aggregation level are weighted and averaged to obtain weighted PPPs for the aggregation level. The weights used to aggregate the PPPs in the third stage are the expenditures on the product groups. In principle, it would be desirable to weight the price relatives within product groups, but the expenditure data required to do this are not available generally.

¹⁴ The economic finding associated with the Penn World Tables. See “The Penn World Table (Mark 5): An expanded set of international comparisons, 1950-1988”, R. Summers and A. Heston, *Quarterly Journal of Economics*, Volume 106, Number 2, pages 327-368, May 1991. The Penn World Tables can be found at: http://pwt.econ.upenn.edu/php_site/pwt_index.php

¹⁵ See *International Economics*, R. Harrod, Cambridge University Press, 1939; “The Purchasing Power Doctrine: A Reappraisal”, B. Balassa, *Journal of Political Economy*, Volume 72, Number 6, pages 584-596, 1964; and “Theoretical Notes on Trade Problems”, P. A. Samuelson, *Review of Economics and Statistics*, Volume 46, Number 2, pages 145-154, 1964.

¹⁶ A well-known example of a one product PPP is that underlying the BigMac currency index of *The Economist*. Presented by the journal as *burgernomics*, the BigMac PPP is defined as “the exchange rate that would mean hamburgers cost the same in America as abroad”. The PPPs calculated by Eurostat and the OECD include hamburgers but also the prices of several hundred other goods and services. As might be expected, *burgernomics* provides a poor guide to overall price levels as measured by the Eurostat-OECD PPP Programme.

¹⁷ The link between quantity, quality and volume is explained in paragraphs 16.11 and 16.12 of the SNA 93.

¹⁸ For example, from *hamburgers to restaurant services*, from *restaurant services to catering services*, from *catering services to catering and accommodation services*, from *catering and accommodation services to individual consumption expenditure by households* and from *individual consumption expenditure by households to GDP*.

Box 1.3: Price levels and indices of nominal and real GDP for the 27 EU countries in 2008

Country (27)	Price levels	Nominal GDP (%)	Real GDP (%)	Nominal GDP per capita	Real GDP per capita
Denmark	138	1.9	1.4	170	123
Ireland	122	1.4	1.2	162	133
Finland	118	1.5	1.3	139	118
Sweden	117	2.7	2.3	144	122
Luxembourg	116	0.3	0.3	324	280
France	114	15.6	13.7	121	107
Belgium	112	2.8	2.5	129	115
Austria	109	2.3	2.1	136	124
Netherlands	108	4.8	4.4	145	134
Germany	104	19.9	19.1	121	116
United Kingdom	103	14.5	14.1	118	115
Italy	101	12.5	12.4	105	104
EU27	100	100	100	100	100
Spain	92	8.7	9.4	95	103
Greece	90	1.9	2.1	84	93
Cyprus	89	0.1	0.2	87	97
Portugal	83	1.4	1.7	65	78
Slovenia	81	0.3	0.4	74	91
Malta	72	0.0	0.1	56	77
Latvia	72	0.2	0.3	41	56
Estonia	71	0.1	0.2	48	68
Czech Republic	70	1.2	1.7	57	81
Poland	68	2.9	4.3	38	56
Slovakia	66	0.5	0.8	48	72
Hungary	66	0.9	1.3	42	64
Lithuania	63	0.3	0.4	38	61
Romania	56	1.1	2.0	26	47
Bulgaria	43	0.3	0.7	19	44

- Price levels are the PPPs divided by exchange rates. The indices of nominal GDP and nominal GDP per capita are based on exchange rate converted data. The indices of real GDP and real GDP per capita are based on PPP converted data.
- When the price level is above 100, the indices of nominal GDP and nominal GDP per capita are higher than the indices of real GDP and real GDP per capita. When the price level is below 100, the indices of nominal GDP and nominal GDP per capita are lower than the indices of real GDP and real GDP per capita.
- The differences between the per capita indices of nominal and real GDP are even more marked. There are changes in ranking. The relative difference between countries also changes. The gap between high income countries and low income countries is much smaller with the per capita indices of real GDP.

1.23 PPPs are still price relatives whether they refer to a product group, an aggregation level or to GDP. It is just that in moving up the hierarchy of aggregation the price relatives refer to increasingly complex assortments of goods and services. Thus, if the PPP for GDP between France and the United States is 0.97 euros to the dollar, it can be inferred that for every dollar spent on the GDP in the United States, 0.97 euros would have to be spent in France to purchase the same volume of goods and services. Purchasing the “same volume of goods and services” does not mean that identical baskets of goods and services will be purchased in both countries. The composition of the baskets will vary between countries and reflect differences in tastes, cultures, climates, price structures, product availability and income levels, but both baskets will, in principle, provide equivalent satisfaction or utility.

1.24 PPPs are defined throughout this manual as being both currency converters and spatial price deflators as this is the definition that applies for the majority of countries participating in Eurostat and OECD comparisons. When countries share a common currency, as do the countries of the euro area, there is no need to convert to a common currency and, as explained in Box 1.1, PPPs can be defined simply as spatial price deflators. This definition also applies to PPPs calculated for regions within a country. It is important to recognise that having the same currency does not necessarily mean having the same price level.¹⁹ PPPs are still required.

1.3.3 Price, volume and value measures

1.25 PPPs are used to convert national expenditures²⁰ on product groups, aggregates and GDP of different countries into real expenditures. The expenditures are real because, as explained earlier, in the process of being converted to a common currency, they are valued at a uniform price level and so reflect only differences in the volumes purchased in countries. They are the spatial equivalent of a time series of GDP for a single country expressed in prices of a fixed reference year or in constant prices. PPPs and real expenditures provide the price and volume measures required for international comparisons. The PPPs and real expenditures for GDP are undoubtedly the most important, but the PPPs and real expenditures below the level of GDP are also useful in their own right. With them international comparisons of price and volume levels can be made for product groups and aggregates as well as for GDP.

1.26 Box 1.4 shows estimates of GDP expenditures at national price levels in national currencies for the EU27²¹, the United States and Japan in 2008. It also shows the estimates after they have been converted to real expenditures and the PPPs used to convert them. Three sets of indices have been derived using these data, the population data and the exchange rates, namely:

- *Indices of real expenditure*: These are measures of volume. They reflect the relative magnitudes of the product groups or aggregates being compared. At the level of GDP they are used to compare the economic size of countries.
- *Indices of real expenditure per capita*: These are standardised measures of volume. They reflect the relative levels of the product groups or aggregates being compared after adjusting for differences in the size of populations between countries. At the level of GDP they are often used to compare the economic well-being of populations.
- *Price level indices (PLIs)*: These are the ratios of PPPs to exchange rates. They provide a measure of the differences in price levels between countries by indicating for a given product group or aggregate the number of units of common currency needed to buy the

¹⁹ See “Does One Currency Mean One Price? An Analysis of the Euro Effect on Price Dispersion and Convergence”, Joanna Wolszczak-Derlacz, *Eastern European Economics*, Volume 28, Issue 2, pages 87-114, 2010.

²⁰ Final expenditures valued at national price levels and expressed in national currencies.

²¹ By convention the euro is the “national” currency for the EU27. As currently only seventeen Member States use the euro as their national currency, the GDPs of the other ten Member States, which are in national currencies, have first to be converted into euros using exchange rates before being added to the GDPs of the other seventeen countries to obtain GDP for the EU27 in euros.

same volume of the product group or aggregate in each country.²² At the level of GDP they provide a measure of the differences in the general price levels of countries.

Box 1.4: Price, volume and value measures for the EU27, the United States and Japan, GDP, 2008

Row	Series	EU27	United States	Japan
1	GDP at national price levels in national currencies (billions)	12493	14297	505112
2	Population (millions)	498.7	304.8	127.5
3	Exchange rate (1 euro = units of national currency)	1.00	1.46	151
4	PPPs for GDP (1 euro = units of national currency)	1.00	1.28	150
5	Real GDP at a uniform price level in euros (billions)	12493	11156	3373
6	Real GDP per capita at a uniform price level in euros	25051	36598	26455
7	Indices of real GDP (EU27 = 100)	100	89	27
8	Indices of real GDP per capita (EU27 = 100)	100	146	106
9	PLIs for GDP (EU27 = 100)	100	87	99
10	Nominal GDP at national price levels in euros (billions)	12493	9760	3336
11	Nominal GDP per capita at national price levels in euros	25051	32018	26164
12	Indices of nominal GDP (EU27 = 100)	100	78	27
13	Indices of nominal GDP per capita (EU27 = 100)	100	128	104

Figures have been rounded.

- Row 5: The GDPs in row 1 divided by the corresponding PPP for GDP in row 4.
- Row 6: The real GDPs in row 5 divided by the corresponding population in row 2.
- Row 7: The real GDPs in row 5 divided by the real GDP for EU27 in row 5.
- Row 8: The real GDPs per capita in row 6 divided by the real GDP per capita for EU27 in row 6.
- Row 9: The PPPs for GDP in row 4 divided by the corresponding exchange rate in row 3.
- Row 10: The GDPs in row 1 divided by the corresponding exchange rate in row 3.
- Row 11: The nominal GDPs in row 10 divided by the corresponding population in row 2.
- Row 12: The nominal GDPs in row 10 divided by the nominal GDP for EU27 in row 10.
- Row 13: The nominal GDPs per capita in row 11 divided by the nominal GDP per capita for EU27 in row 11.

1.27 The indices have the EU27 as base or reference country²³ - that is, the EU27 = 100. But they are not affected by the choice of reference country and can be rebased on the United States or on Japan. The method used by Eurostat and the OECD to calculate and aggregate PPPs provides PPPs that are invariant to the country, or group of countries, chosen as base country. The base country serves as a point of reference only. The PPPs are also transitive. Transitivity is the property where the direct PPP between each pair of countries is equal to the indirect PPP derived via any third country. For example, in the case of the three countries A, B and C, the ratio of the PPP between A and B and the PPP between C and B is equal to the PPP between A and C: in other words, $PPP_{A/B} / PPP_{C/B} = PPP_{A/C}$.

²² From the PPPs in Box 1.4, it can be seen that if a given volume of GDP costs 100 euros in the EU27, it costs 128 US dollars in the United States and 15000 yen in Japan. To compare these prices, it is first necessary to express them in a common currency by converting them to euros using the exchange rates in Box 1.4. The PLIs so derived show that if a given volume of GDP costs 100 euros in the EU27, it costs 87 euros in the United States and 99 euros in Japan. In other words, the general price level of the EU27 is higher than that of the United States and Japan, but only marginally so in the case of Japan.

²³ The term *reference country*, as used in the manual, can refer to a single country such as the United States or to a group of countries such as the EU27 or the OECD.

1.28 If exchange rates are used instead of PPPs, the estimates of GDP expenditures at national price levels in national currencies for the EU27, the United States and Japan in row 1 of Box 1.4 are converted to the nominal expenditures shown in row 10 of the Box. Although these nominal expenditures are expressed in a common currency, the euro, they are still valued at *national price levels* and continue to reflect the differences in price levels between the EU27, the United States and Japan. They are the spatial equivalent of a time series of GDP for a single country expressed in *current prices*. Nominal expenditures give rise to two sets of indices, namely: *indices of nominal expenditure* and *indices of nominal expenditure per capita*. The indices are measures of value. They are not measures of volume and should not be used as such.

1.4 Using PPPs

1.4.1 Uses and users of PPPs

1.29 PPPs are used for research and analysis, for statistical compilation and for administrative purposes. Their users include the European Commission, the International Monetary Fund (IMF), the OECD, the United Nations and the World Bank at the international level and government agencies, universities and research institutes, public and private enterprises, financial institutions, the press and individuals at the national level.

1.30 International organisations, government agencies, universities and research institutes use PPPs as inputs into economic research and policy analysis involving cross-country comparisons of macroeconomic aggregates. In such research and analysis, PPPs are employed either to generate volume measures with which to compare the size of economies and their levels of economic welfare, consumption, investment, government expenditure and overall productivity or to generate price measures with which to compare price levels, price structures, price convergence and competitiveness. Politicians and journalists use PPPs in both these ways in their commentaries on economic and social policy.

1.31 Public enterprises apply PPPs when comparing their prices and operating costs with those of similar public enterprises in other countries. Private firms operating in different countries apply PPPs for the purposes of comparative analysis involving prices, sales, market shares and production costs. Banks employ PPPs in economic analysis and in the monitoring of exchange rates. Individuals often refer to PPPs in salary negotiations when moving from one country to another (as do the personnel managers with whom they are negotiating).

1.32 International organisations use the real expenditures generated by PPPs for statistical purposes. Real GDP and its components are aggregated across countries to provide totals for groups of countries, such as the euro area, the European Union and the OECD. Country shares in these totals are used as weights when economic indicators, such as price indices or growth rates, are combined to obtain averages for groups of countries.

1.33 The European Commission and the IMF employ PPPs for administrative purposes. The European Commission uses the PPPs of Member States when allocating the Structural Funds. The overall aim of the Funds is to gradually reduce economic disparities between Member States. The Funds account for some 30 per cent of the EU budget and the principal indicator determining the allocation is PPP-deflated intra-country regional GDP per capita. The IMF uses PPPs when deciding on the quota subscriptions of member countries.²⁴ A country's quota subscription determines the financial resources it is obliged to provide the IMF, the amount of financing that it can obtain from the IMF, its share in a general allocation of special drawing rights and its voting power in IMF decisions. The weight of GDP in the quota formula is 50 per cent and GDP is an average of GDP converted

²⁴ See Mick Silver, "IMF Applications of Purchasing Power Parity Estimates", IMF Working Paper, 2010, at: <http://www.imf.org/external/pubs/ft/wp/2010/wp10253.pdf>

with exchange rates (with a weight of 60 per cent) and GDP converted with PPPs (with a weight of 40 per cent).²⁵

1.4.2 Points to remember when using PPPs

1.34 PPPs are statistical constructs rather than precise measures. While they provide the best available estimate of the size of a country's economy and of its general price level in relation to the other countries in the comparison, they are, like all statistics, point estimates lying within a range of estimates – the *error margin* – that includes the true value. The error margins surrounding PPPs depend on the reliability of the expenditure weights and the price data as well as to the extent to which the particular goods and services selected for pricing by participating countries actually represent the price levels in each country. As with national accounts data generally, it is not possible to calculate precise error margins for PPPs or for the real expenditure levels and price levels derived from them.

1.35 The indices of real expenditure and real expenditure per capita and the PLIs at the level of GDP are the most reliable with smaller error margins. Experience suggests that differences between countries in these indices of over two percentage points are generally statistically significant. At the level of the main aggregates, error margins are larger and differences in the indices of real expenditure and real expenditure per capita and in the PLIs will also need to be larger to be statistically significant. Below the level of the main aggregates, error margins are compounded by differences in the national classifications used by participating countries in their national accounts. Because the margins of error increase as the level of aggregation gets lower, neither Eurostat nor the OECD publish results of their comparisons below a certain level of detail.

1.36 PLIs at the level of GDP allow the general price levels of countries to be compared with that of a reference country. A value over 100 indicates a higher general price level, a value under 100 indicates a lower general price level. PLIs at the level of GDP also indicate the degree to which a country's exchange rate reflects its general price level in relation to the general price level of the reference country. A value over 100 indicates that the exchange rate understates the general price level, a value under 100 indicates that the exchange rate overstates the general price level. This is not the same as saying a currency is undervalued or overvalued.

1.37 Although PPPs appear in international trade theory in the context of equilibrium exchange rates – that is, the underlying rates of exchange to which actual exchange rates are assumed to converge in the long term²⁶, the PPPs discussed here are not relevant for this purpose as they do not refer solely to domestically-produced tradable goods and services valued at export prices. They have been calculated specifically to enable international price and volume comparisons to be made for GDP and its component expenditures. As such, they refer to the entire range of goods and services which make up GDP as a whole including many items, such as buildings and government services, that are not traded internationally. In addition, except for net foreign trade, they are valued at domestic market prices and are calculated using expenditure weights that reflect domestic demand.

1.38 Indices of real GDP provide a snapshot of the relative volume levels of GDP among participating countries for a given point in time or reference year. When placed side by side, the indices of consecutive reference years appear to provide a moving picture of relative GDP volume levels over the years. This apparent time series of volume measures is actually equivalent to a time series of value indices. This is because the volume indices for each reference year are calculated using the prices and expenditures of that year. Year-to-year changes in the volume indices are thus due to changes in relative price levels as well as changes in relative volume levels. As a result, the rates of relative growth derived from the indices are not consistent with those obtained from GDP volumes estimated by countries.

²⁵ Both the European Commission and the IMF use a three-year average of GDP to limit the impact of single years.

²⁶ “As long as anything like free movement of merchandise and a somewhat comprehensive trade between two countries take place, the actual rate of exchange cannot deviate very much from the purchasing power parity.” Gustav Cassels in “Abnormal deviations in international exchanges”, *Economic Journal* 28, 1918. Equilibrium exchange rates are also referred to as *absolute PPPs*. See *International Economics: Theory and Policy*, Paul Krugman and Maurice Obstfeld, Pearson Higher Education, 2000.

1.39 To trace the evolution of relative GDP volume levels between countries over time, it is necessary to select one of the reference years as a base year and to extrapolate its relative GDP volume levels over the other years. Extrapolation is done by applying the relative rates of GDP volume growth observed in the different countries. This provides a time series of volume indices at a constant uniform price level that replicates exactly the relative movements of GDP volume growth of each country. Underlying this method is the assumption that price structures do not change over time. But it is an economic fact of life that relative prices do change over time and, if such changes are ignored over long periods, a biased picture of the relative economic developments of countries can result. The choice of base year can also influence the picture that emerges.

1.40 Price convergence (or divergence) among countries is of interest in a number of contexts such as competition policy, consumer protection and the determination of real exchange rates²⁷. PLIs provide a means of observing the movement of price levels over time, but they have to be used with caution. First, except within the euro area, they are influenced by exchange rate fluctuations. Second, independently of exchange rates, they are volatile. This is generally so at lower levels of aggregation where sample sizes are small. Usually such volatility diminishes, if not disappears, with aggregation. Volatility particularly arises when the basket of goods and services to be priced changes from one benchmark survey to another in order to accommodate market developments. For example, in this respect, the basket for food and non-alcoholic beverages is relatively stable, while that for electronic products is altered substantially each time it is surveyed. Volatility of this type also diminishes with aggregation. For these reasons, PLIs are better suited to monitoring price convergence at higher levels of aggregation and over long periods of time.

1.41 The PLIs for household final consumption expenditure are sometimes used to measure the differences in the cost of living between countries. This is correct to the extent that they indicate whether the overall price level for consumer goods and services faced by the average household in one country is higher or lower than the overall price level for consumer goods and services faced by the average household in another country. Households or individuals considering moving from one country to another for reasons of employment, retirement or even a holiday should exercise caution when attempting to infer from these measures of overall price levels how the change of country will affect their cost of living. The PLIs for household final consumption expenditure reflect the expenditure pattern of the average household which in all likelihood is different from that of the household or individual contemplating the move. Also, the PLIs are national averages and they do not reflect differences in the cost of living between specific locations such as London and Paris or the Côte d'Azur and the Costa del Sol.

1.42 Box 1.5 outlines the primary and recommended uses of PPPs. These are the uses for which PPPs are designed. It also provides some examples of applications of PPPs for which the results should be interpreted with care. Finally, the Box lists a selection of uses for which PPPs are not intended.

²⁷ See, for example, "What determines European real exchange rates?", M. Berka and M. B. Devereux, National Bureau of Economic Research Working Paper 15753, February 2010, <http://www.nber.org/papers/w15753>

Box 1.5: Examples of the use of Eurostat and OECD PPPs

PPP's are primarily designed for:	<ul style="list-style-type: none"> • Spatial volume comparisons of GDP, GDP per capita and GDP per hour worked • Spatial volume comparisons of the component expenditures of GDP above a certain level of aggregation (called "analytical categories") • Spatial comparisons of price levels at the level of GDP or analytical categories
Provided the results are interpreted with care, PPPs can also be used for:	<ul style="list-style-type: none"> • Spatial comparisons of economic data in national currencies other than analytical categories (in other words, using PPPs as an alternative to exchange rates) • Analysis of price convergence • Analysis of temporal change in volumes or price levels of GDP or analytical categories
PPP's are not designed for:	<ul style="list-style-type: none"> • Strict ranking of countries without taking statistical error margins into account • Calculating national growth rates • Industry-specific output and productivity comparisons • Cost-of-living comparisons for individuals • Assessing potential undervaluation or overvaluation of currencies or use as equilibrium exchange rates

