FEATURE

International comparisons of productivity: the current and constant PPP approach

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SUMMARY

The purpose of this article is to explain the differences between the current and constant purchasing power parity (PPP) approaches to producing estimates of international comparisons of productivity. This aims to outline and explain the context in which the respective approaches should be used. The Office for National Statistics (ONS) recommends that, for assessing differences in productivity levels, the current PPP approach should be used. For comparing differences in productivity growth across countries, the constant PPP approach should be used. This article marks the first time that ONS has produced volume growth rates for these productivity data using the constant PPP approach. These are presented towards the end of this article.

The Office for National Statistics (ONS) produces biannual estimates of international comparisons of productivity (ICP), usually in September and February of every year. The September release extends the ICP time series by one year (as well as including revisions to previously published data) whereas the February release is a revised version of the previous September's data. These revisions occur to the gross domestic product (GDP) and/or purchasing power parity (PPP) component data series. Presently, ICP data are produced using the current PPP approach. The release presents 'snapshots' of the G7 countries' international performances relative to the UK. These ICP data should be interpreted as a series of cross-sections, not as a time series. The technical reasons for this are explained in more depth in this article.

The article also publishes for the first time ONS estimates of ICP using the constant PPP approach that enable international comparisons of productivity growth. The reasons for using the constant PPP approach for time series analyses are discussed. These complementing ICP data are scheduled for incorporation into the September 2007 ICP release and are to become a permanent fixture of this release.

Current PPPs

The role of PPPs in calculating estimates of ICP is to serve as a 'currency converter'. They enable the GDP data of each G7 country, which are expressed in that country's currency, to be converted into a common currency. Without PPPs, it would not be possible to compare the output of these countries which would otherwise be expressed in the different countries' currencies. Current PPPs are used in the ICP estimates produced by ONS because they are the best indication of the most recent and relevant price structure. The role of PPPs is to eliminate the differences in price levels between countries' GDP data to produce a comparable measure of real output that can then be used for international comparisons.

However, the way in which PPPs are constructed for use in the ICP calculations means that they should only be regarded as currency converters for a given point in time. Inter-temporal comparisons of the ICP data produced by ONS should be avoided. This is why previous ICP First Releases have highlighted that users should not infer relative rates of volume growth from the published data. It is also the principal reason why the Organisation for Economic Co-operation and Development

(OECD) focuses on the latest annual data in their productivity levels publication.

Table 1 shows the ICP estimates from the February 2007 ICP First Release, the latest available at the time of writing. In this particular release, the data represented revised data for all years for which ICP data are published (1990 to 2005). However, these data should not be seen as a time series but rather a series of individual 'snapshot' comparisons. Although this difference in interpretation may not seem obvious, it is an important distinction that needs to be made. Users who infer a time series or volume growth from these data are incorrectly interpreting the ICP estimates that are published because of the way in which PPPs are constructed. Analyses of productivity growth require volume measures of output and if current PPPs are used, then changes in output over time are also capturing price changes. This is because PPPs are the best indication of each year's relevant price structure and hence change on an annual basis. Inferring productivity growth rates from these current PPP-based ICP data would also incorporate changes in price structures, and not just volume changes to output.

Whereas the ICP data produced using current PPPs can be used as indicators of how relative productivity levels have evolved over time, provided year-on-year changes are significant, it is advised not to use these data to infer comparisons of productivity growth. Considering the methodological features of the two approaches, the constant PPP approach is recommended for assessing changes over time.

Why current PPPs should not be used for time series analysis

The reason for this caution when interpreting the ICP data is the role of current PPPs as a currency converter. Current PPPs are constructed on an annual basis. The final stage of producing PPPs at the whole economy level involves weighting and averaging the price ratios for individual product groups. This depends on GDP expenditure shares for that particular year. Since new price data are collected on an annual basis, prices and price structures are allowed to vary over time, meaning that international comparisons can be made of labour productivity measures of countries for a given year. This is because for a given year, applying current PPPs to GDP measured at current prices (which are expressed in that country's respective national currency) produces comparable measures of output in volume terms. For a given year, these volume measures are measured with the same price structure (that is, the PPPs for that year).

However, using current PPPs means that inferring productivity growth rates should be avoided. This is because this approach incorporates a combination of the following effects:

- relative volume changes
- changes in relative prices between countries
- changes in methodologies and definitions

Since current PPPs are constructed using current GDP expenditure data, making inter-temporal analyses of ICP data means that volume measures for different years are not measured using the same price structure. As the relative price structures of countries vary from one year to the next, the use of current PPPs explains why growth rates from ONS ICP estimates should not be calculated (see also **Box 1**).

The 'snapshot' approach

If inferences are to be made on whether the productivity gap of the UK relative to its key competitors has narrowed over time using the current PPP approach, the 'snapshot'

Table 1
Current PPP-based ICP estimates

GDP per worker (UK=100)

	Canada	France	Germany	Italy	Japan	UK	US	G7	G7 exc. UK
1990	118	131		133	107	100	137		
1991	116	131	113	132	107	100	136	123	125
1992	115	130	115	131	104	100	136	122	124
1993	113	126	111	132	100	100	133	119	121
1994	112	124	111	132	97	100	131	118	119
1995	111	123	111	134	97	100	130	117	119
1996	109	122	109	132	97	100	129	117	118
1997	107	121	107	129	94	100	128	115	116
1998	106	121	105	129	91	100	128	114	115
1999	109	119	105	127	91	100	131	115	117
2000	106	118	104	125	91	100	128	114	115
2001	104	116	102	121	89	100	125	111	112
2002	98	112	99	115	87	100	122	108	109
2003	97	109	104	111	88	100	123	109	110
2004	95	108	101	106	87	100	123	108	109
2005	96	109	99	104	88	100	125	109	110

GDP per hour worked (UK=100)

	Canada	France	Germany	Italy	Japan	UK	US	G7	G7 exc. UK
1990	117	136		123	93	100	132		
1991	115	136	129	122	94	100	132	119	121
1992	113	133	127	119	92	100	129	117	118
1993	110	129	123	120	91	100	125	115	116
1994	109	128	124	122	89	100	123	114	115
1995	109	130	126	124	90	100	122	114	115
1996	106	128	126	122	89	100	122	113	114
1997	106	128	124	119	88	100	120	112	113
1998	104	128	121	118	85	100	120	111	112
1999	106	126	122	116	86	100	121	112	113
2000	103	126	121	115	85	100	119	110	111
2001	101	126	120	112	84	100	118	109	110
2002	95	123	116	106	82	100	113	105	106
2003	94	119	122	103	81	100	114	106	106
2004	91	117	118	98	81	100	113	104	105
2005	93	119	115	97	83	100	116	106	106

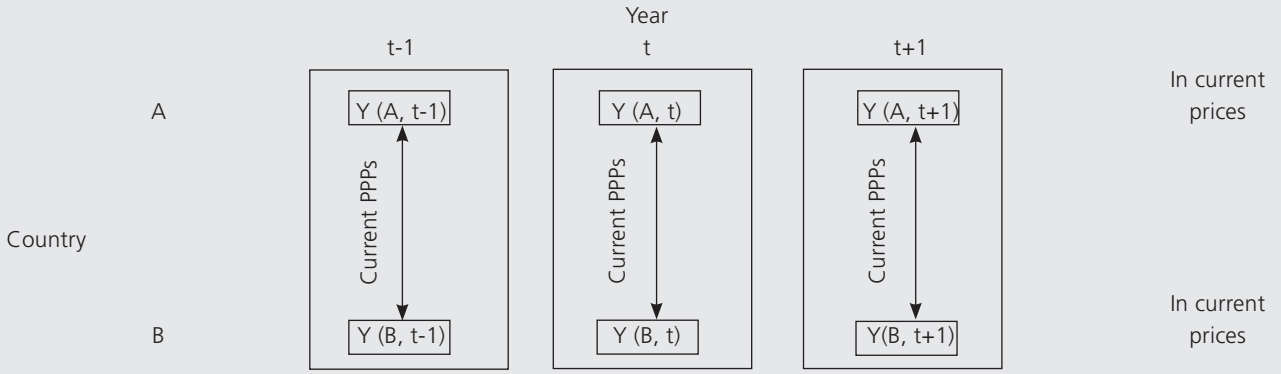
Note:
Data for all years and all countries have been subject to revision in this release.
Source: Office for National Statistics

Box 1

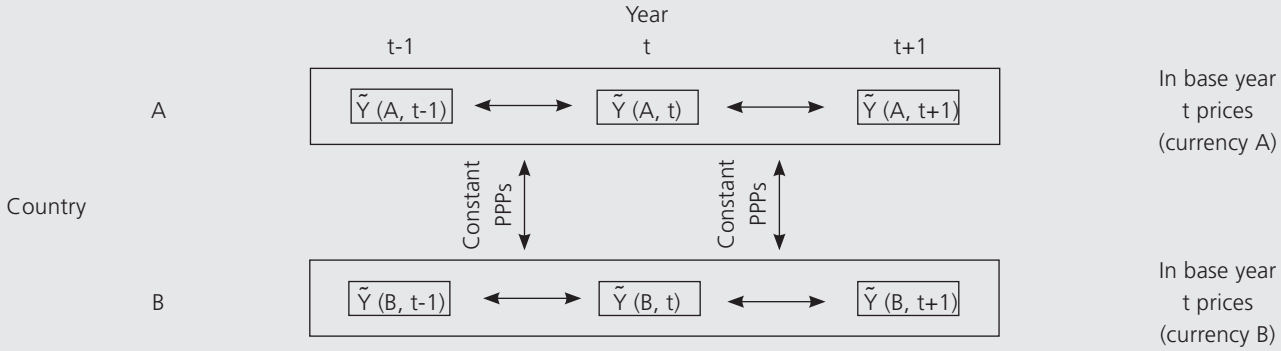
Interpreting current and constant PPP-based ICP data

The diagram below illustrates how the data produced from the two different approaches to producing ICP should be interpreted. When using current PPPs, the data should be seen as a series of snapshots which show the relative levels of productivity for different years. When using the constant PPP approach, the ICP data should be seen as a time series that allows relative rates of productivity growth to be analysed.

Comparing levels of productivity across countries at different points in time



Comparing growth rates of productivity across countries



approach can be used. This compares two snapshots of productivity levels in two different time periods (for example, 1995 and 2005). In this example, the relative performances of countries in 2005 can be compared with what was happening in 1995 in terms of how differences in productivity levels with the UK have changed over time (provided there is a significant change in levels). There is a subtle difference between this approach and inferring comparable measures of growth. The use of current PPPs means that year-on-year growth rates should not be made.

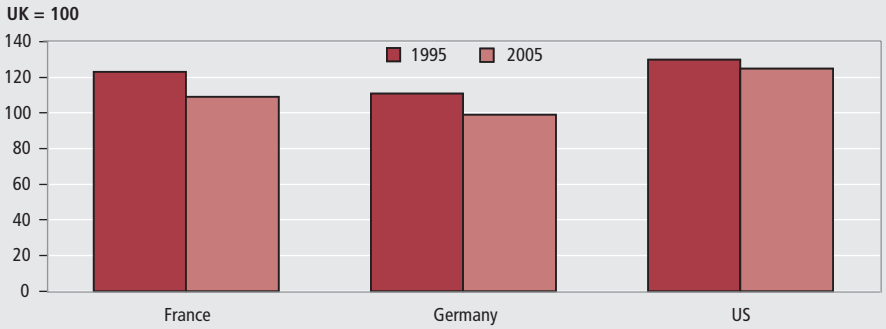
The reason for caution relates to the fact that differences of a few percentage points are not seen as significant when comparing differences in productivity levels for any given year. This is because of the difficulties in calculating PPPs, which means that it is not possible to say that there is significant difference in productivity levels of two countries if their ICP estimates only differ by a few percentage points. A difference of a few percentage points could be caused by this measurement error rather than capturing differences in countries' productivity performance, which is why ONS takes this approach.

This reasoning also holds when using the snapshot approach which compares differences in productivity levels over two time periods. This approach should only be used if there has been a significant change in productivity levels between these two time periods, as defined by the change in percentage points. Analysis of current PPP-based ICP data shows that such differences do not occur on a year-on-year basis, which is why the snapshot approach should be used when using two time periods that are spaced out by several years and not for consecutive years. However, it is not possible to recommend a fixed time period because the change in percentage points in terms of productivity levels varies from country to country. For some countries it may be possible to use the snapshot approach over a three-year period; for other countries it may be much longer.

The snapshot approach, while not allowing a precise quantitative-based analysis to be made as to how much the productivity gap has narrowed (or widened), does allow a qualitative assessment of the direction of change in the productivity gap. However, this cannot be used for comparing real rates of productivity growth.

Figure 1 presents ICP data published in the February 2007 ICP release for France, Germany and the US, the countries that are listed in the joint HMT/BERR Public Service Agreement target. Figure 1 shows that, between 1995 and 2005, the productivity gap between the UK and each of these countries on a GDP per worker measure did narrow, although a precise estimate on how much this gap has narrowed should not be inferred. Instead, this change can only be approximated, although caution should still be used.

Figure 1
The snapshot approach – GDP per worker



Constant PPPs

Constant PPP-based ICP data should be used if comparisons of productivity growth are required. ONS has not yet published ICP estimates with calculated constant PPPs, although these are scheduled for inclusion in the September 2007 ICP First Release. These constant PPP-based ICP data will be suitable for comparing the UK's productivity growth with its key competitors over time.

Comparable measures of output for each G7 country (that is, GDP data adjusted by PPPs) are fixed to a base year. These are then extrapolated backwards and forwards from the base year by applying the annual volume growth rates in GDP in the respective countries, which produces comparable measures of output for the other years in the time series being investigated. This approach allows inter-temporal analyses to be made because the price structure of constant PPPs does not vary over time. Only the PPPs for the base year are used in these calculations. This means that these ICP data are only capturing volume changes.

Box 2 shows in detail the methodology used for calculating ICP estimates based on constant PPPs. It should be apparent from step 2 that the underlying ICP data (that is, before indexing) for the base year should be the same whether the current or constant PPP-based approach is used since the two sets of calculations are identical. The difference occurs for the other years in the time series as the constant PPP approach only uses PPP data for the base year.

When the constant PPP approach is used, the subsequent volume measures of output replicate the relative movements of volume GDP growth. Using constant PPPs instead of current PPPs means that only volume changes to output are captured, and this does not capture changes to relative prices. The only price structure that is taken into account is that in the base year, which is treated as constant, since only PPP data for the base year are used in the calculation.

Another feature of using this constant PPP-based approach is that it avoids difficult interpretations of breaks in the data series as well as avoiding dealing with any methodological changes that may have occurred over this period of time. If current PPPs are to be used when making time series analysis, methodological homogeneity has to be assumed, which is often a strong assumption to make.

Indexing

Current PPP-based ICP data are indexed in such a way that the UK data are equal to 100 for every year. This allows the productivity gap to be measured for any given year, which is in line with the recommended uses of these data. Constant PPP-based ICP data have been indexed in such that a way that the data for every country are equal to 100 in the reference period. The reference period that has been chosen is 1991 because this allows the clearest comparisons of productivity growth for the whole time series for which ICP data are published. It is not possible to use 1990 as there are no German GDP data for that year (due to unification) meaning it is not

Box 2
Producing constant PPPs based ICP estimates

Comparable output measures are calculated by applying the growth rate in GDP volume to the base year GDP estimate that has been adjusted by the PPP, and then extrapolating accordingly. The steps required to calculate the output measure for each country (denoted with the subscript i) is shown below. The remainder of the methodology to produce constant PPP-based ICP estimates is the same as the current approach, namely dividing these output measures by the respective measure of employment.

Step 1: Calculate annual growth rates in constant price GDP

$$g_t = \left(\frac{GDP_i\,(KP)_t}{GDP_i\,(KP)_{t-1}} \right) - 1$$

where KP denotes constant price

Step 2: Calculate the comparable output measure for the base year of PPPs

$$\frac{GDP_{i,\,2002}}{PPP_{i,\,2002}}$$

Step 3: Extrapolate the base year (2002) GDP KP using these growth rates in constant price GDP

(i) Extrapolate forwards for post-2002 time periods:

$$\left(\frac{GDP_i}{PPP_i} \right)_{t+1} = \left(\frac{GDP_i}{PPP_i} \right)_t \times (1+g_{t+1})$$

(ii) Extrapolate backwards for pre-2002 time periods:

$$\left(\frac{GDP_i}{PPP_i} \right)_{t-1} = \frac{\left(\frac{GDP_i}{PPP_i} \right)_t}{(1+g_t)}$$

Note that in step 3 the measure of output is calculated using the constant PPP approach

possible to extrapolate using GDP volume growth.

Issues

Although the use of constant PPPs is more appropriate for producing inter-temporal analyses of ICP data, there is one significant limitation to using constant PPPs. There is the implicit assumption that the price structures do not change over time. The calculation uses the PPP data in the base year, which reflects the price structure of countries in that one year (2002 in this analysis). However, in practice, relative prices do change over time, meaning that any volume measures of output produced using constant PPPs need to be treated with care, especially if a large time series is being looked at. If such changes are ignored over long time periods, it is possible for these ICP data to be biased. This is a feature of all indices that are fixed to a base period.

One other issue to consider is that using a fixed base year approach means that the results are dependent on this year. The choice of the base year is important as it can affect the degree of bias that can be introduced as a result of assuming that price changes do not change over time. The decision has been taken to initially use 2002 as the base year because of the triennial benchmarking exercise undertaken within the Eurostat-OECD PPP Programme. The last benchmark year for this exercise was 2002. Although Eurostat provides annual PPP data for the countries that it co-ordinates, these are not available for OECD countries that are not co-ordinated by OECD. The quality of price data in benchmark years is of a more reliable nature, as in non-benchmark years PPPs are extrapolated between benchmarks, meaning that using a benchmark year minimises the risk that the choice of base year has on the ICP data that are produced. PPP data are due to be benchmarked for 2005 by the end of 2007 so the choice of base year for the February 2008 ICP First Release will reflect this.

Sensitivity analyses

Although not presented here, sensitivity analyses were carried out to assess the effects of using different base years to produce estimates of productivity growth rates. Although in theory this could introduce bias, the results that were produced suggested that this was not the case. The differences that did occur were insignificant, which implies that the choice of base year was not a big issue. This may be because even though the Eurostat-OECD PPP Programme involves a triennial benchmarking exercise, annual benchmark results are available for EU countries reducing the scope for the introduction of bias. ONS produces ICP estimates for the G7 countries, for four of which Eurostat produces annual benchmarked PPP data, which could potentially explain the results that were observed. Despite these results, ONS still recommends that the latest year of this triennial benchmarking exercise is still used as the fixed base year for calculating constant PPP-based ICP data.

Comparisons of productivity growth

Figure 2 and **Figure 3** present a time series from 1990 to 2005 showing each of the G7 countries' relative productivity growth. These are measured by GDP per worker and GDP per hour worked, respectively, and are consistent with the current PPP-based ICP data published in the February 2007 ICP First Release.

These data have been calculated by indexing the constant PPP-based ICP data to 100 for all countries in 1991, which allows a direct comparison of productivity growth rates across these countries. This also deals with the potentially problematic issue of revisions analysis. If the format presently used for current PPP-based ICP estimates were used (always indexing the data to 100 for the UK), revisions would always occur when a new base year were chosen, reflecting the Eurostat-OECD PPP Programme benchmarking process. These revisions would be misleading when comparing new productivity growth rates with previous data.

From these data, it can be seen that the UK has experienced similar levels of productivity growth to the US since 1990, as measured by GDP per worker, and has experienced faster productivity growth than both France and Germany over the same period of time.

However, there are certain differences between these relative productivity growth rates and those measured on a per hour worked basis. The slowdown in productivity growth as measured by GDP per worker for France is not seen when using the per hour worked productivity measure. This reflects that while there has been positive growth in the number of French workers since 1994, there has been predominantly negative growth in the number of hours worked. Figure 3 shows that the negative growth in hours worked has more than offset the positive growth in the number of workers.

Figure 2
Productivity growth – GDP per worker

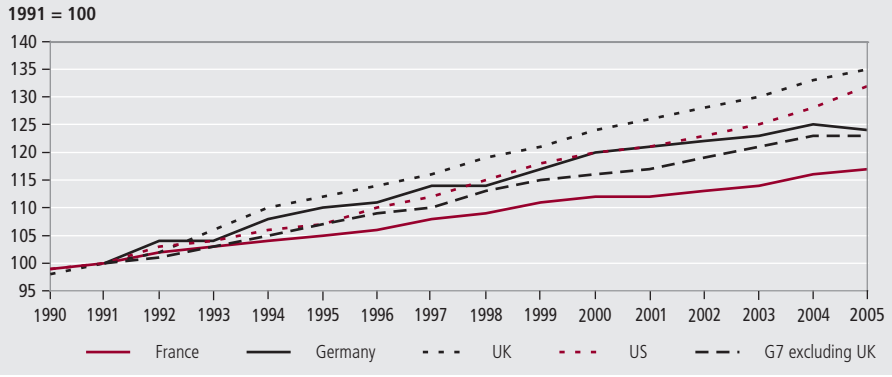
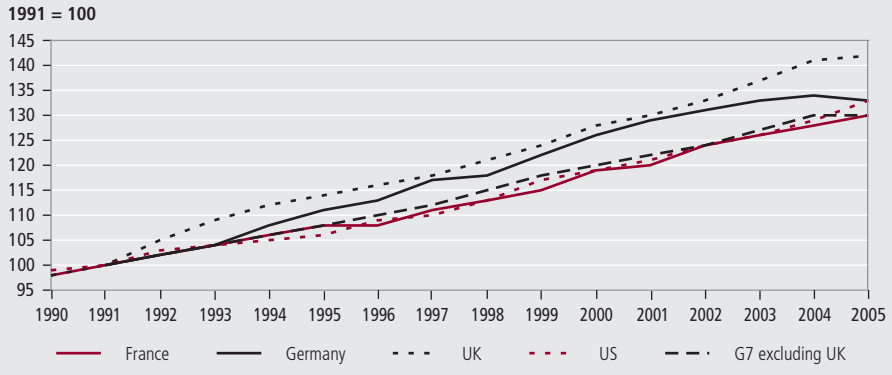


Figure 3
Productivity growth – GDP per hour worked



Another feature is that the productivity growth in the UK and the US have been at similar rates as measured by GDP per worker, but not in terms of GDP per hour worked, where UK productivity has grown at a faster rate.

Proposed structure of the new ICP First Release

The plan is for the September 2007 ICP First Release to include both current and constant PPP-based ICP data. The outline below is a proposal on how these data will be presented in the First Release:

- current PPP-based ICP data will continue to be produced in their current format; the existing series (1990 to latest year) of snapshots for both GDP per worker and GDP per hour worked will continue to be updated and revised in line with the cycle of ICP publications. This will involve the ICP data for the UK being indexed to 100 for each year
- the current graphs that are produced showing the latest snapshot of ICP data will continue to be produced for both measures of productivity: GDP per worker and GDP per hour worked
- the new addition is that the First Release will now contain a chart that illustrates the growth rate in relative productivity using the constant PPP approach. To make the interpretation clearer, it is proposed that the graph will only show comparisons in growth for France, Germany, the UK and the US. The graph will also include figures for the G7 countries excluding the UK to encapsulate the other data used. The reference period will be 1991
- all the ICP data for 1990 to the latest year will be made available on the ONS ICP homepage, using both the current and constant PPP approach, as well as supplementary tables at the back of the First Release. This will include the productivity growth figures for the other G7 countries so users can produce their own graphs if necessary the revisions policy will remain unchanged

Box 3 summarises the advantages and disadvantages of the two approaches to producing ICP estimates. What this table illustrates is when it is appropriate to use the respective approaches, which have formed the basis of the recommendations outlined in this article.

Conclusions

This article has explained in depth why inter-temporal analyses should not be made with the ICP estimates that are presently produced by ONS, which are based on current PPPs. From September 2007, ONS is planning to additionally publish ICP estimates that are based on constant PPPs. These figures are more appropriate for productivity growth analyses for the reasons that have been outlined.

The following summarises the recommended approaches to international comparisons of productivity:

- **productivity levels:** cross-sectional comparisons for any given point in time are best based on current PPPs as they reflect the most recent and most relevant price structure. If users want to assess the difference in productivity levels for any particular year, it is the current PPP-based ICP data that should be used. These have always been published in previous ICP First Releases and will continue to be published
- **productivity growth:** for pure volume comparisons over time, the constant PPP approach to producing ICP data is the recommended option.

Box 3

Advantages and disadvantages of the current and constant PPP approach

	Advantages	Disadvantages
Current PPP approach	Makes use of current price GDP which removes the need for using national GDP deflators, which are often calculated in different ways across the G7 countries. Best method for measuring the productivity gap at a point in time. PPPs are designed specifically to generate comparable volume measures of output between countries.	Relies on the availability of annual PPPs, which can be subject to large revisions. The estimate of the productivity gap (as well as the ranking of countries) is very sensitive to PPP revisions. ICP estimates from the current PPP approach should not be viewed as a time series for the purposes of assessing productivity growth.
Constant PPP approach	Provides timely evidence on UK productivity growth relative to the other G7 countries. Does not rely on a time series of PPPs. Only need PPPs for the base year, which can be taken as one of the benchmark years (the latest available at the time of writing is 2002). The results are generally more comparable and consistent with UK and other countries' national productivity estimates.	The constant PPP approach relies on national deflators to remove the effect of price changes over time. Differences in the way GDP is deflated across national statistical offices may distort some of the identified movements in productivity through their effect on the extrapolated PPPs.

This approach allows inter-temporal analyses to be made because the price structure of constant PPPs does not vary over time as only PPPs for the base year are used in these calculations. This means that these constant-based ICP data should be used for comparing differences in productivity growth rates. This approach minimises the need to interpret data discontinuities arising from methodological changes

Users are advised not to apply growth rates inferred from the constant PPP-based ICP data to productivity levels measured from the current PPP approach as the resultant productivity data will not be correct.

The recommendations that have been outlined in this article are consistent with OECD guidance. The presentation of both these sets of ICP data should be of assistance to users of the ICP First Release.

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