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**THE OECD SYSTEM OF UNIT LABOUR COST AND RELATED INDICATORS**

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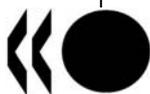
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*March 2008*

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## THE OECD SYSTEM OF UNIT LABOUR COST AND RELATED INDICATORS

### ABSTRACT

This paper outlines in detail the methodology and statistical processes used for compiling the outputs of the *OECD System of Unit Labour Cost and Related Indicators*. This new System has been developed by the OECD in response to concerns from the international community of economic analysts on the limited availability of internationally comparable data concerning labour costs, particularly in activities outside of Manufacturing and on a sub-annual basis. The outputs of this System, which are updated at the end of each quarter, consist of long time series of annual and quarterly unit labour cost and related indicators compiled using a specific methodology to maximise comparability across countries. The related indicators include annual time series for: labour productivity; labour compensation per unit labour input (including PPP adjusted); exchange rate adjusted unit labour costs and; labour income share ratios. Data are available for all OECD Member countries and the Euro area for a wide range of economic activities including Total Economy, Manufacturing & Industry, Market Services and the Business Sector. The release of this new product represents the outcome of four years of development work by the OECD that has benefited from contributions by academia and national consultants, and involved extensive consultation with national statistics offices, national central banks, and the OECD Economics Department.

### RÉSUMÉ

Cet article décrit de façon détaillée la méthodologie et les procédés statistiques utilisés dans le calcul des résultats du *Système OCDE des coûts unitaires de la main d'œuvre et d'indicateurs associés*. L'OCDE a développé ce nouveau système en réponse aux préoccupations de la communauté internationale des analystes économiques sur la disponibilité limitée de coûts de la main d'œuvre comparables à l'échelle internationale, notamment sur une base infra-annuelle et pour des activités autres que manufacturières. Les résultats de ce système, mis à jour à la fin de chaque trimestre, sont des séries chronologiques longues de coûts unitaires de la main d'œuvre trimestriels et annuels et d'indicateurs associés. Ces séries sont calculées selon une méthodologie spécifique maximisant la comparabilité entre les pays. Les indicateurs associés incluent des séries chronologiques annuelles pour : la productivité du travail ; la rémunération du travail par unité de main d'œuvre (y compris un ajustement par les PPA) ; les coûts unitaires de la main d'œuvre ajustés des taux de change et la part des revenus du travail dans la valeur ajoutée (ratios). Les données sont disponibles pour tous les pays membres de l'OCDE et la Zone euro pour un large éventail d'activités économiques : Économie totale, activités de fabrication et industrie, services marchands et secteur marchand. La publication de ce nouveau produit représente le fruit de quatre années de développement par l'OCDE, qui a bénéficié des contributions de consultants académiques et nationaux, et a impliqué une large consultation avec les instituts statistiques nationaux, les banques centrales nationales et le département des affaires économiques de l'OCDE.

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## Overview

1. The *OECD System of Unit Labour Cost and Related Indicators* as described in this working paper was developed in response to concerns from the international community of economic analysts on the limited availability of internationally comparable data concerning labour costs, particularly in activities outside of Manufacturing and on a sub-annual basis. The release of this new product<sup>1</sup> represents the outcome of four years of development work by the OECD which has benefited from contributions by academia and national consultants, and involved extensive consultation with national statistics offices, national central banks, and the OECD Economics Department.

2. Feedback on initially proposed methodology and data sources was also received through the discussion of papers presented at the 2005 meetings of the OECD Short Term Economic Statistics Working Party<sup>2</sup> (STESWP) and the OECD Statistical Working Party<sup>3</sup> (SWIC). This new database also complements the existing OECD Productivity Database<sup>4</sup>.

3. The OECD System of Unit Labour Cost and Related Indicators consists of the following set of quarterly and annual indicators updated at quarterly frequency through the production process summarized in Figure 1 below.

### *Quarterly indicators*

Unit labour cost index: raw, seasonally adjusted and trend-cycle  
Total labour costs: raw temporally disaggregated national currency series  
Real output: raw temporally disaggregate national currency series

### *Annual indicators*

Unit labour cost indexes and levels  
Total labour costs  
Real output  
Exchange rate adjusted unit labour cost indexes and levels  
Labour income share ratio  
Nominal output  
Total employment to employees ratio<sup>5</sup>  
Labour compensation per unit labour input indexes (national currency and \$US PPP adjusted)  
Labour productivity per unit labour input indexes  
Labour productivity per employed person (national currency levels)  
Labour productivity per hour worked (national currency levels)

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<sup>1</sup> The first elements of the OECD System of Unit Labour Cost and Related Indicators were officially released in monthly Main Economic Indicators publication in March 2007. Development work on the system commenced in 2004.

<sup>2</sup> Paper available at: <http://www.oecd.org/dataoecd/45/44/34813443.pdf>

<sup>3</sup> Paper available at: <http://www.oecd.org/dataoecd/33/7/38645314.pdf>

<sup>4</sup> Available at: [www.oecd.org/statistics/productivity](http://www.oecd.org/statistics/productivity)

<sup>5</sup> The Total employment to employees ratio is defined as total hours worked by all persons in employment divided by total hours worked by employees of businesses. If hours worked data is not available then person counts are used. This definition also applies for the 'per unit labour input' definition for Labour compensation and Labour productivity.

Labour compensation per employee (national currency levels)  
 Labour compensation per employee hour worked (national currency levels)  
 Labour compensation per employee (\$US PPP adjusted levels)  
 Labour compensation per hour (\$US PPP adjusted levels)

### ***Country and economic activity coverage***

4. The indicators are available for all OECD Member countries and the Euro area, together with zone aggregate totals (OECD total, Major seven economies, OECD Europe) for the following economic activities based on ISIC rev. 3.

- Total Economy
- Manufacturing (ISIC D)
- Industry (ISIC C\_E)
- Construction (ISIC F)
- Trade, Transport and Communication (ISIC G\_I)
- Finance and Business Services (ISIC J\_K)
- Market services (ISIC activity based proxy G\_K)
- Business Sector excluding Agriculture (ISIC activity based proxy C\_K)

### ***Achieving international comparability for unit labour costs***

5. Unit labour costs (ULC) measure the average cost of labour per unit of output. They are calculated as the ratio of total labour costs to real output, or equivalently, as the ratio of mean labour costs per hour to labour productivity (output per hour). As such, a ULC represents a link between productivity and the cost of labour in producing output. An increase in unit labour costs indicates that growth in average employee compensation exceeds growth in labour productivity, which may create pressure on producer prices.

6. Achieving comparability across countries and economic activities for unit labour costs is a major challenge, particularly for those compiled on a quarterly basis. This stems largely from a lack of uniformity in earnings and labour cost data available on a sub-annual basis across different economic activities within and across countries. In addition, coherence with quarterly indicators of real output may often be poor leading to large volatility in a derived statistic such as the unit labour cost.

7. The OECD has attempted to overcome these problems by developing a stepwise framework for the compilation of the quarterly indicators. A key element of this process is benchmarking to more reliable annual data which are also decomposed and combined with other information to compile the range of related indicators on an annual basis as outlined above. The stepwise process for compiling the quarterly ULC indicators can be summarised as follows:

- Identifying suitable quarterly indicator data. The target variable for total labour costs is compensation of employees, but where this is not available proxy variables are sought, in order of preference: gross wages and salaries; labour cost index multiplied by hours worked; earnings

or wage series multiplied by total employment. The target variable for real output is constant price value added with production indices used as proxies if required and available.

- Benchmarking to more reliable annual data to form a consistent set of temporally disaggregated quarterly time series of total labour costs and real output.
- Taking the quotient of the above input series as the raw ULC series and deriving both seasonally adjusted and trend-cycle series, the latter being a combination of a long-term trend and business cycle series, produced using the TRAMO-SEATS software.

8. Given the inherent volatility in a derived indicator such as the unit labour cost, the OECD presents quarterly growth rates of the trend-cycle series as the headline indicator for the purpose of short-term economic analysis. This series can be regarded as a short-term trend or smoothed seasonally adjusted series, where the degree of smoothing is dependent on the historical volatility of the series and will thus vary from country to country

#### ***Data sources and compiling long time series***

9. Annual benchmark data is sourced from the OECD Annual National Accounts (ANA) database. However, in order to enable the longest possible time series to be compiled, currently published time series available in the ANA database are often linked to historical time series provided to the OECD in the past. This has enabled in most cases the compilation of annual ULC and related indicators back to 1970 for all OECD Member countries for each of the eight economic activities listed in paragraph 4. Similarly, the majority of quarterly time series are sourced from the OECD Quarterly National Accounts (QNA) database, supplemented by a number of other national and international sources where proxy indicators are required. As with the annual data, currently available time series are often linked to historical series provided to the OECD in the past to form the longest possible quarterly time series. The length of time series available for the quarterly ULC indicators differs by country, but a large number of countries have at least 15 years worth of data for each economic activity.

#### ***The quarterly production process***

10. A highly efficient cyclical production process has been developed in order to update both the annual and quarterly indicators on a quarterly basis. Around the end of the last month of the quarter, annual data are downloaded from the ANA database, a range of quality checks applied and all related indicators are derived. Quarterly data are then extracted from the various sources and benchmarked to the annual data using the Fernández method of temporal disaggregation to compile the raw series needed for the quarterly unit labour cost indexes. These raw series are then seasonally adjusted using the TRAMO-SEATS package to produce both seasonally adjusted<sup>6</sup> and trend-cycle series.

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<sup>6</sup> Concurrent seasonal adjustment is used for the quarterly production cycle, and the seasonal models are reviewed annually.

Figure 1:

## QUARTERLY PRODUCTION PROCESS

1. All annual data are updated, data sourced via Annual National Accounts database: Value added constant prices; compensation of employees; total employment and employees.

2. All quarterly data are updated, data sourced via Quarterly National Accounts database: Value added constant prices; compensation of employees.

3. Proxy quarterly indicators sourced via National Statistics Offices, Country Files, Eurostat, and MEI Database: Gross Wages and Salaries, Labour Cost Index, Hours Worked, Earnings, Employment, Production Indexes.

**MEI Database**  
 Series available (OECD.Stat):  
 Quarterly - Total Labour Costs, Real Output, Unit Labour Cost Indicators.  
 Additional Derived Annual Series - Exchange Rate Adjusted ULC, Labour Income Share Ratios, Labour Productivity, Labour Compensation per labour input (national currency and PPP adjusted).

5. Quarterly data for indicators of value added and compensation of employees benchmarked to annual data:

- \* Forces quarterly compensation of employees to adjust for self-employed;
- \* Forces quarterly value added to incorporate ownership of dwellings adjustment;
- \* Produces temporally disaggregated quarterly real output and total labour cost national currency series;
- \* Quarterly series are extended backwards using interpolated annual data;

Production of quarterly quality report and quarterly press release.

6. Seasonal adjustment and trend-cycle series are derived from raw quarterly Unit Labour Cost series using TRAMO-SEATS.

7. Zone aggregates are compiled: OECD Total, Major Seven, and OECD Europe.

### ***Dissemination***

11. All time series together with detailed methodological information and country data sources are freely available through the *OECD System of Unit Labour Cost and Related Indicators* web portal at: <http://stats.oecd.org/mei/default.asp?rev=3>. A quarterly news release containing the latest quarterly updates together with a discussion of main features for the economic activities of Industry and Market Services is released around the middle of January, April, July and October. Quarterly time series for the unit labour cost indexes for all economic activities are also published in the monthly Main Economic Indicators publication.

12. Elements of the *OECD System of Unit Labour Cost and Related indicators* also appear in a number of other OECD publications, such as the OECD Factbook, the OECD Productivity Compendium, and the OECD Economic Outlook.

### ***Future developments***

13. Through cooperation with the European Commission, the OECD has undertaken a project in 2008 to expand the *OECD System of Unit Labour Cost and Related indicators* to the eight European Union countries that are not currently members of the OECD. In addition, research has commenced to investigate the possibility of producing annual indicators for the BRIICS countries (Brazil, China, India, Indonesia, Russian Federation and South Africa).

## 2 Introduction

14. The *OECD System of Unit Labour Cost and Related Indicators* as described in this working paper was developed in response to concerns from the international community of economic analysts on the limited availability of internationally comparable data concerning labour costs, particularly in activities outside of Manufacturing and availability on a sub-annual basis. The release of this new product<sup>7</sup> represents the outcome of four years of development work by the OECD which has benefited from contributions by academia and national consultants, and involved extensive consultation with the OECD Economics Department, several national central banks and national statistics offices. Feedback on initially proposed methodology and data sources was also received through the discussion of papers presented at the 2005 meetings of the OECD Short Term Economic Statistics Working Party (STESWP) and the OECD Statistical Working Party (SWIC).

15. The ultimate goal of this project was to develop an integrated system of unit labour cost (ULC) and related indicators to enable both short term analysis on quarterly time series and structural analysis on annual time series. A highly efficient cyclical production process has been developed in order to update both the annual and quarterly indicators on a quarterly basis. The main internal user of these data are the OECD Economics Department, although the breadth of indicators produced is targeted at a wide range of external users as the database should be regarded as a key source for internationally comparable data on labour costs and related indicators.

## 3 Other international data sources for unit labour costs

16. Whilst other sources of unit labour cost and related indicators existed prior to the development of the new OECD System, many of these sources were lacking in one or more areas such as: comprehensiveness of economic activity coverage; comprehensiveness of country coverage; availability of quarterly time series and; timeliness of updates. Below is brief summary of other international sources of ULC data which were reviewed in detail as part of the project to develop the new OECD System.

### 3.1 International Labour Organisation

17. The Key Indicators of the Labour Market (KILM) database of the International Labour Organisation (Van Ark & Monnikhof, 2000) includes annual time data series for both labour productivity and unit labour costs for 31 countries at the Total Economy level and 23 countries for Manufacturing. The measures mostly cover the period from 1980 although there is a time lag for updating of time series relative to other sources.

### 3.2 United States Bureau of Labour Statistics

18. The United States Bureau of Labour Statistics (BLS) produces annual ULC indexes for the Manufacturing sector for sixteen countries of which fifteen are also covered by the OECD: Australia, Belgium, Canada, Denmark, France, Germany, Italy, Japan, Korea, Netherlands, Norway, Spain, Sweden,

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<sup>7</sup> The first elements of the OECD System of Unit Labour Cost and Related Indicators were officially released in Main Economic Indicators publication in March 2007. Development work on the system commenced in 2004.

the United Kingdom, and the United States. In 2007 a comparison project<sup>8</sup> was undertaken, with close cooperation from the BLS, to compare the OECD's ULC series with those from the BLS<sup>9</sup>.

19. Overall, the comparison projected showed strong correlation (in growth rates) between the two separately produced ULC series for most of the fifteen countries published by both the BLS and OECD. Where differences in a countries' time series between the two sources exists, three main causes were identified:

- The BLS make adjustments to the total labour costs component for subsidies and significant taxes on payrolls and employment. The OECD makes no such adjustments.
- Data vintage: in most cases when compiling long time series, data from older vintages is linked to form the longest possible series. The issue of where the link occurs and the sources of vintage data leads to some differences.
- Data sources: as stated previously, the OECD sources all annual data from the OECD Annual National Accounts database. In some cases the BLS uses data from sources other than national accounts, for various valid reasons (e.g. self-employment contribution), and in rare cases estimates are made based on proxy data.

20. In addition to published ULC data, the BLS also publishes data on labour productivity, hours worked and labour compensation per hour.

### 3.3 OECD Structural Analysis database

21. The OECD Structural Analysis (STAN) database provides a comprehensive set of annual ULC and labour productivity indexes for 26 OECD countries<sup>10</sup> for all ISIC divisions<sup>11</sup> and relevant aggregates of these such as Industry (ISIC divisions C\_E); Business Sector Services (G\_K); Total Services (G\_O); Non Agricultural Business Sector<sup>12</sup> (C\_K) and All Industries. The method used is the division of compensation of employees by constant price value added sourced from a rolling collection of annual national accounts data from OECD countries.

22. The purpose of the STAN database is to provide data at a very fine level for detailed industry analysis purposes. As such, data is not updated with the same frequency as for the *OECD System of Unit Labour Cost and Related Indicators* database and the more simplistic definition of ULC is used without an adjustment for the self-employed. As such, users need to be aware that data from these two OECD sources may not be the same<sup>13</sup>.

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<sup>8</sup> <http://www.oecd.org/dataoecd/32/29/38643335.pdf>

<sup>9</sup> The BLS database also contains series for labour productivity, hours worked and labour compensation per hour. As of yet, these series have not been compared with the equivalent series available in the *OECD System of Unit Labour Cost and Related Indicators*.

<sup>10</sup> STAN ULC indexes exclude Turkey, Iceland, Ireland and Switzerland.

<sup>11</sup> Subject to data availability in the countries covered.

<sup>12</sup> Excluding SIC 70 – Real Estate activities.

<sup>13</sup> More detail on issues affecting the comparability of similarly defined series available in the OECD Productivity Database, OECD STAN database and OECD System of ULC & Related Indicators Database is explained at: <http://www.oecd.org/dataoecd/28/37/40284233.pdf>

### 3.4 European Central Bank

23. The European Central Bank (ECB) publish in their monthly bulletin a quarterly ULC index for the Euro area for the following economic activities based on the NACE industrial classification: Agriculture (A, B); Industry (C\_E); Construction (F); Trade, Transport & Communication Services (G\_J); Finance, Property & Business Services (K, L) and; Government Services (M\_O). The methodology used is:

numerator = compensation of employees / number of employees;  
denominator = constant price value added / total employment.

### 3.5 OECD Economic Outlook

24. The OECD Economic Outlook database, published at six monthly intervals, contains quarterly time series of ULC indexes including two year ahead forecasts for the Manufacturing sector and Total Economy. The Manufacturing sector series are also used as inputs to the real effective exchange rate series published in the Outlook. A key purpose of developing the *OECD System of Unit Labour Cost and Related Indicators* was for the OECD Statistics Directorate to provide the Economics Department with a consistent set of ULC time series which were comparable across countries. As such, the Economics Department now uses the outputs of this new System as its data source for all OECD countries.

## 4 Coverage of economic activities

25. A key development goal of this project was to improve the economic activity coverage of ULC and related indicators, particularly for the services sector and on a quarterly basis. As shown in Section 3 on the review of other existing sources of ULC data, traditionally sub-annual ULC data has only been provided at the Manufacturing and Total Economy levels (with the exception of the Euro area). This most likely reflected a lack of suitable sub-annual time series being available for other economic activities to support the construction of the ULC indicators. In the preliminary stages of this project a major exercise was undertaken to review the availability of sub-annual indicators by economic activity across OECD countries which could be used for compilation of quarterly ULC indexes. Therefore, the selection of economic activities<sup>14</sup> chosen for this project as listed below represented a compromise between user needs and the availability of sufficiently reliable data. Note that both 'Market Services' and the 'Business Sector excluding Agriculture' are activity based proxies of the most prominent market based economic activities.

1. Whole Economy
2. Industry (ISIC C\_E: Mining; Manufacturing; Electricity, Gas & Water)
3. Manufacturing (ISIC D)
4. Construction (ISIC F)
5. Trade, transport and communication (ISIC G\_I: Retail & Wholesale Trade; Accommodation & Restaurants; Transport & Communication)
6. Financial and business services (ISIC J\_K: Financial intermediation; Real estate, renting and business activities)

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<sup>14</sup> Economic activities have been defined according to ISIC rev. 3:  
<http://www.ilo.org/public/english/bureau/stat/class/isic.htm>

7. Market Services (ISIC G\_K)
8. Business Sector excluding Agriculture (ISIC C\_K)

## 5 Conceptual ideals and variables used

### 5.1 Conceptual ideals for the calculation of unit labour costs

26. Unit labour costs (ULC) measure the average cost of labour per unit of output. They are calculated as the ratio of total labour costs to real output, or equivalently, as the ratio of mean labour costs per hour to labour productivity (output per hour). As such, a ULC represents a link between productivity and the cost of labour in producing output. An increase in unit labour costs indicates that growth in average employee compensation exceeds growth in labour productivity, which may create pressure on producer prices.

27. Compensation of employees (COE) compiled according to the System of National Accounts 1993 (SNA 93) is generally recognized as a good proxy to the conceptual ideal of total labour costs. COE covers a significant part of total labour costs such as wages and salaries; bonuses; payments in kind related to labour services (*e.g.* food, fuel, housing); severance and termination pay and; employers' contributions to pension schemes, casualty and life insurance and workers compensation. However, there are two main problems with the use of COE in ULC calculations:

1. COE excludes some relevant items of total labour cost such as the cost of employee training, welfare amenities and recruitment; taxes on employment (*e.g.* payroll tax) and; fringe benefits tax.
2. Labour costs relating to the self-employed are not included in COE.

28. Constant price value added<sup>15</sup> at basic prices (CVA) compiled according to the SNA 93 is generally recognised as the best measure of real output required for the calculation of ULC. However, there are two main concerns in using this variable directly in ULC calculations:

1. Taxes on employment to business (*e.g.* payroll tax), which can be an important labour cost, are included in value added at basic prices but are not included in COE. Conceptually this is a problem because an increase in say the rate of payroll tax, all other things being equal, would cause a fall in the ratio of COE / CVA (as CVA increases whilst COE is unchanged) when in fact it should be shown an increase in ULC.
2. The value added of the national accounts item *Ownership of Dwellings* is recorded as part of ISIC division K, sub-division 70: Real estate activities, and contributes between 5 - 10% of total value added in most OECD countries<sup>16</sup>. The value added associated with *Ownership of Dwellings* is the provision of housing services by a dwelling to its occupants, irrespective of whether the owner is also an occupier. In concept, value added comprises a return to the labour of employees (compensation of employees), a return to capital (gross operating surplus/gross mixed income) and a return to government (other taxes *less* subsidies on production). But in the case of *Ownership of Dwellings* there are no employees, and so this component of value added has nothing to do with the relationship between output and labour costs. Consequently, it should

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<sup>15</sup> Constant price value added is also commonly referred to as value added volume.

<sup>16</sup> Ownership of dwellings accounts for approximately 9% and 7.5% of Australian and United Kingdom GDP respectively based on 2004 data.

ideally be removed from calculations of ULC indexes which cover ISIC division K. If included it has the potential to distort the comparability of ULC indexes across countries, in particular where there are large differences in the level or, more importantly, changes over time across countries in the contribution of *Ownership of Dwellings* to value added.

29. In constructing the OECD System of ULC and Related Indicators the goal has been to achieve a balance between conceptual purity and practicality for maintaining an ongoing production system. With regards to the system of annual indicators, data availability allows close adherence to conceptual ideals, whereas on a quarterly basis more approximations are required. In both cases an effort has been made to build the longest possible time series to support empirical analysis.

## 5.2 Annual indicators: target variables and data availability by country

30. This Section describes in detail the target variables and data sources used to compile the annual indicators available in the *OECD System of Unit Labour Cost and Related Indicators*. A summary list of these indicators is:

- Unit labour cost indexes and levels
- Total labour costs
- Real output
- Exchange rate adjusted unit labour cost indexes and levels
- Labour income share ratio
- Nominal output
- Total employment to employees ratio<sup>17</sup>
- Labour compensation per unit labour input indexes (national currency and \$US PPP adjusted)
- Labour productivity per unit labour input indexes
- Labour productivity per employed person (national currency levels)
- Labour productivity per hour worked (national currency levels)
- Labour compensation per employee (national currency levels)
- Labour compensation per employee hour worked (national currency levels)
- Labour compensation per employee (\$US PPP adjusted levels)
- Labour compensation per hour (\$US PPP adjusted levels)

### 5.2.1 Total labour costs

31. The target variable for total labour costs for annual data sources is COE compiled according to the SNA 93 adjusted for the self-employed by multiplying COE by the ratio of total hours worked by all persons in employment to total hours worked by all employees of businesses. In the case where data on

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<sup>17</sup> The Total employment to employees ratio is defined as total hours worked by all persons in employment divided by total hours worked by employees of businesses. If hours worked data is not available then person counts are used. This definition also applies for the 'per unit labour input' definition for labour compensation and labour productivity.

hours worked is not available, the adjustment ratio is based on total employment in persons divided by total employees of businesses. This adjustment<sup>18</sup> for the self-employed is made for two reasons:

1. As the output of the self-employed contributes to the denominator in the ULC equation (*i.e.* real output) this adjustment is required to ensure consistency between the numerator and denominator when deriving the ULC indicators. If such an adjustment is not made, this has the potential to distort the comparability of ULC indicators (*i.e.* levels and fixed based indexes) across countries if there are large differences in the level or, more importantly, changes over time in the number of self-employed persons across countries. Also, this impact is likely to vary across economic activities within countries, as some economic activities are more likely to have a higher proportion of self-employed (*e.g.* Retail trade) than others.
2. The inclusion of the self-employment adjustment allows the ULC equation to be expressed as:  $(COE / \text{employee hour}) / (CVA / \text{total employment hours})$ , or rather labour compensation per employee hour / labour productivity (output per hour). Thus, the numerator and denominator of the ULC equation expressed in this form become very useful indicators in their own rights, and allow a deeper assessment of the factors driving changes in ULC.

### ***Limitations of the self-employed adjustment***

32. The adjustment for the self-employed assumes that labour compensation per hour or per person is equivalent for the self-employed and employees of businesses. This assumption may be more or less valid across different countries and economic activities, and can therefore affect the reliability of international comparisons. In addition, for many countries the length of time series available to calculate the adjustment is not as long as for COE or CVA. As a result, the adjustment factor is held constant at the last available data point for the historical part of the series. All details on the length of time series available for the adjustment is shown in the country quality notes as outlined in Section 5.2.7.

33. No adjustment is made for the missing items of total labour costs that COE does not cover (*i.e.* the cost of employee training, welfare amenities and recruitment; taxes on employment (*e.g.* payroll tax) and; fringe benefits tax). Whilst some partial data on these items could be obtained from a range of sources, it was not considered practical to make any such adjustments in the regular production system that has been established. Therefore, this is recognized as a methodological limitation of the System.

### **5.2.2 Real output**

34. The target variable for annual real output is constant price value added at basic prices (CVA) compiled according to the SNA 1993. The CVA of activity J\_K is adjusted to remove the component attributed to the services provided by a dwelling to its occupants (*Ownership of Dwellings* – as discussed in point 2 of paragraph 28) as this activity has no associated labour input<sup>19</sup>.

### ***Limitations***

35. The main limitations of the target variable used for real output is that the adjustment to remove dwelling services is only an approximation and employment taxes (or equivalently subsidies) are not

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<sup>18</sup> This type of adjustment for the self employed is commonly made by other institutions compiling measure of ULC, such as the European Central Bank, the United States Bureau of Labour Statistics and the Australian Bureau of Statistics.

<sup>19</sup> A detailed description of the methodology used to make this adjustment is available at: <http://www.oecd.org/dataoecd/37/31/37664867.pdf>

removed from the CVA data source. The latter issue is due to an inability to easily split employment taxes and subsidies from other taxes and subsidies on production which are also included in the basic price measure.

### 5.2.3 Other derived variables

36. In addition to the derived variables of labour compensation per hour (or person) and labour productivity (output per hour or person) three other key derived variables are produced in the OECD System of ULC and Related Indicators, namely:

#### *Labour income share ratio*

This is defined as total labour costs divided by nominal output (current price value added at basic prices, which is stored in the System for weighting purposes). The division of total labour costs by nominal output is sometimes also referred to as a *real unit labour cost* - as it is equivalent to a deflated unit labour cost where the deflator used is the gross value added implicit price deflator for the economic activity concerned.

#### *Exchange rate adjusted ULC*

This variable is obtained by converting total labour costs to a US Dollar basis based on market exchange rates (which are available in the parent database) and dividing this by CVA converted to US Dollars using the prevailing exchange rates in the OECD base year.

#### *Labour compensation per hour / employee adjusted for purchasing power parity*

This variable is obtained by converting compensation of employees in national currency to US Dollars using private consumption purchasing power parities<sup>20</sup>, then dividing by total employee hours (or total employees). This allows direct comparison of labour compensation levels across countries for each economic activity<sup>21</sup>.

### 5.2.4 Data availability and sources used

37. All annual data used for the *OECD System of Unit Labour Cost and Related Indicators* is sourced from the OECD Annual National Accounts (ANA) database. For both COE and CVA data is available for each of the economic activities listed in Section 4 for all OECD countries<sup>22</sup>.

38. The adjustment to COE to account for the contribution of the self employed to total labour costs is based on hours worked data for Australia, Austria, Canada, Denmark, France, Germany, Greece, Hungary, Italy, Korea, Norway, Slovak Republic, Spain, and Sweden. For all other countries data on persons<sup>23</sup> is used, with the exception of Switzerland, Turkey and Iceland where data is not available to

<sup>20</sup> The private consumption PPPs and GDP PPPs used as weights are both obtained from the ANA database.

<sup>21</sup> The comparison of labour compensation levels per employee is available across all OECD countries except Turkey, Switzerland and Iceland, whereas the comparison of labour compensation per hour is only possible for the fifteen countries supplying hours worked for employees.

<sup>22</sup> With the exception of Switzerland, where COE is only available at the Total Economy level.

<sup>23</sup> Note that data on hours worked for the Euro area aggregate is not available and thus persons is used as a proxy. As a consequence, this can lead to an inconsistency between Euro area series included in the System and the constituent countries, as for many of these (Austria, Denmark, France, Germany, Greece, Italy, Spain) the self employment

perform the calculation. For the case of these latter countries, the ULC is derived simply as COE / CVA and published only as an index.

### 5.2.5 Achieving long time series

39. A major strength of the *OECD System of Unit Labour Cost and Related Indicators* database are the long series lengths, with annual time series for most countries beginning in 1970. To achieve such long data series, in some cases linking to historical series has been undertaken. Such linking can involve:

- the use of series sourced from other OECD databases e.g. STAN;
- the use of series sourced from previous classifications or methodologies available in the ANA database;
- imputation based on economic activities with similar growth patterns, e.g. Manufacturing and Industry;
- the use of previous country data, e.g. West Germany;
- the use of series sourced from national institutions that are no longer officially published.

40. In all cases the previous data series were subject to rigorous analysis to ensure their growth patterns were plausible and of adequate quality for compiling the historical segments of the series.

### 5.2.6 Quality evaluation of annual indicators

41. During the formative stages of the project, considerable consultation was undertaken with suppliers of data (e.g. national statistics offices) and users of data (e.g. OECD Economics Department, member country Central Banks and Treasuries). This involved seeking advice on series proposed to be used for compilation (in particular for historical segments) and on the plausibility of outputs for a set of experimental series that were provided for comment.

42. A large focus on quality assurance within the whole System was placed on the annual benchmark data given these are used for benchmarking the quarterly series and as such any errors with the annual series would be transferred to the quarterly series through the benchmarking process.

43. All series of annual indicators produced by the System were evaluated for both internal consistency (e.g. to identify the presence of irregular movements or series breaks), consistency across economic activities (e.g. one would expect the indicators for Manufacturing and Industry to have a close relationship) and consistency across indicators (e.g. observing the relationship between labour productivity and unit labour cost). From this evaluation and subsequent communication with data suppliers a number of amendments were made to the source data, either based on estimations performed by the secretariat to remove breaks in series or through revised data being provided by the source. The most significant of these cases are documented in the information on country data sources as outlined below.

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adjustment (and thus derived series of labour productivity and labour compensation per unit labour input) is based on hours worked data.

### 5.2.7 Detailed information on country data sources

44. The *OECD System of Unit Labour Cost and Related Indicators* provides detailed metadata on country data sources at <http://stats.oecd.org/mei/default.asp?lang=e&subject=19>. This includes information on series lengths, link dates to non currently published times series used to form long time series and the sources used, adjustments made to address breaks in series, sources of proxy data for quarterly indicators variables, and a range of other notes on the expected quality of data.

### 5.3 Quarterly indicators: target variables and data availability by country

45. This Section describes in detail the target variables and data sources used to compile the quarterly indicators available in the *OECD System of Unit Labour Cost and Related Indicators*. A summary list of these indicators is:

Unit labour cost index; raw, seasonally adjusted and trend-cycle

Real output in national currency

Total labour costs in national currency

46. The unit labour cost is only published as an index on a quarterly basis, reflecting the use of proxy variables and the fact that no explicit adjustment is made on a quarterly basis for the self-employed. Due to the process of benchmarking the quarterly indicators of real output and total labour costs to their annual counterparts (as explained in more detail in Section 6.3), the System is able to produce temporally disaggregated quarterly time series of total labour costs and real output in national currency units. These can be a useful by product for users, particularly for those countries which do not compile production or income accounts on a quarterly basis, as these series are essentially estimates of these.

#### 5.3.1 Total labour costs

47. The target variable for the quarterly indicator of total labour costs is COE compiled according to the SNA 93. However, unlike for the annual indicators no explicit adjustment is made for the self-employed for the following three reasons:

1. In many OECD countries there is limited data available for the economic activity breakdown required on a quarterly basis for total employment hours (or persons) and total employees hours (or persons) required to make the self-employment adjustment;
2. The adjustment ratio to account for the self-employed is not expected to change much on a quarterly basis, and indeed making such an adjustment on a quarterly basis where data is available but may be of lower quality may lead to greater volatility of the quarterly ULC index;
3. Quarterly indicator data are benchmarked to the conceptually superior annual data source to form a temporarily disaggregated quarterly time series with the same scope, thus an implicit adjustment for the self-employed is made through this process (see Section 6.3 for a detailed description of this methodology).

#### *Proxy variables for COE*

48. Many OECD countries do not publish quarterly income accounts on a sufficiently detailed basis in comparison to their annual accounts. As a result, quarterly COE by economic activity is not available for several OECD countries and proxy variables need to be sought. The OECD undertook a rigorous exercise to identify available proxy variables across countries with a general order of preference which can be

summarised<sup>24</sup> as: gross wages and salaries; labour cost index multiplied by an appropriate total labour input measure (*i.e.* total hours worked or total employment / employees); average hourly / weekly / monthly earnings multiplied by an appropriate total labour input measure. The quarterly proxy variables used across OECD countries are summarised below in Table 1.

### 5.3.2 Real output

49. The target variable for quarterly real output is constant price value added at basic prices (CVA) compiled according to the SNA93. Where this variable is not available a production index covering the respective economic activities is sought. As most OECD countries produce quarterly production accounts, the requirement for proxy data for quarterly real output is less than for total labour costs as seen in Table 1, although the United States and Japan are two key countries where proxy data is required for several economic activities.

**Table 1 – Use of proxy data sources for quarterly indicators**

Country	Proxy variable for quarterly COE	Proxy for quarterly CVA
Australia	Gross wages and salaries (all activities except total economy).	
Austria	Gross wages and salaries, only manufacturing.	Economic production index, only manufacturing.
Belgium	Gross wages and salaries, only manufacturing.	Economic production index, only manufacturing.
Canada	Gross wages and salaries (all activities except total economy)	
Spain	Multiplication of: labour cost index, weekly hours, and employees. Only manufacturing.	Economic production index, only manufacturing.
Finland	Gross wages and salaries, only manufacturing.	
France	Gross wages and salaries, only manufacturing.	
Hungary	Gross wages and salaries.	Economic production index, only manufacturing.
Ireland	Gross wages and salaries, only manufacturing.	Economic production index, only manufacturing.
Japan	Multiplication of: employees and average monthly cash earnings (all activities except total economy)	Production indexes (all activities except total economy).
Korea	Multiplication of employed persons and average monthly earnings.	
Luxembourg	Gross wages and salaries, only manufacturing.	Economic production index, only manufacturing.
Mexico	Gross wages and salaries, only manufacturing.	
New Zealand	Total gross earnings.	
Poland	Gross wages and salaries, only manufacturing.	
Portugal	Gross wages and salaries: manufacturing, industry, and construction.	Economic production index, only manufacturing.
United States	Multiplication of: employees and average weekly earnings. For manufacturing, industry, construction, and market services.	Economic production index: manufacturing, industry, and construction. Residual calculation for market services

<sup>24</sup> For a more in depth discussion on assessing the relevance of quarterly proxy variables for COE in regards to compiling ULC, see McKenzie and Brackfield (2005).

### 5.3.3 Quality assurance of quarterly proxy variables

50. The quarterly indicator proxy variables used as outlined in Table 1 were assessed in a number of ways to determine their suitability for producing quarterly ULC indexes. The main approach was to assess the relationship between annual growth rates for the proxy variable and that of its benchmark from the ANA. Both graphical inspection and calculation of correlations were used in this process, which enabled a choice to be made if more than one proxy variable was being assessed. The relationship between proxy variables across economic activities was also investigated.

51. The correlation of annual growth rates of quarterly proxy variables against their annual benchmarks can be found at: <http://stats.oecd.org/metadata/publish.asp?ds=1&co=.ULQV.....&lvl=0&format=html&hide=titles> for CVA and: <http://stats.oecd.org/metadata/publish.asp?ds=1&co=.ULQC.....&lvl=0&format=html&hide=nothing> for COE. These correlations give an indication of the reliability of the proxy variables used in the compilation of the quarterly ULC index for the relevant country and economic activity. A low correlation implies that users should take caution when using the resultant quarterly ULC prior to reconciliation with annual benchmark data (which generally occurs with a 12-18 month lag) through the process as described in Section 6.3. However, the process of temporal disaggregation itself and the filtering methods used to produce the final quarterly ULC index trend-cycle series can also help to mitigate some of the quality issues associated with quarterly proxy data. Nonetheless, where quality concerns exist with quarterly proxy data these are flagged in the detailed country metadata as outlined in Section 5.2.7.

### 5.3.4 Data availability and sources used

52. All quarterly data for COE and CVA are sourced from the OECD Quarterly National Accounts (QNA) database. The proxy data as outlined in Table 1 are either collected directly from the country by the OECD or taken from Eurostat's New Cronos database. Due to the unavailability of suitable QNA data nor suitable proxy data for either COE or CVA, no quarterly ULC index is produced in the following countries for the economic activities as listed below in Table 2.

**Table 2: Economic activities for which production of quarterly ULC indexes is not possible**

OECD country	Missing quarterly ULC indexes
Mexico	All economic activities missing except Manufacturing (lack of COE proxy data)
United States	Trade, Transport and Communication; Financial and Business Services (lack of CVA proxy data)
Greece	All economic activities (lack of COE proxy data)
Iceland	All economic activities (lack of COE and CVA proxy data)
Portugal	Total Economy, Trade Transport and Communication; Financial and Business Services (lack of COE proxy data)
Switzerland	All economic activities (lack of COE proxy data)

### 5.3.5 Achieving long time series

53. As with the annual indicators, every effort has been made to compile the longest time series possible for the quarterly indicators to support empirical analysis. In many cases, this has involved linking currently available time series both from the QNA and other sources where proxy data has been used to historical series where these could be found, the main sources being:

- the use of series sourced from previous classifications or methodologies from the QNA database; linking of QNA data to proxy variables with longer time series;
- imputation based on economic activities with similar growth patterns *e.g.* Manufacturing and Industry;
- the use of previous country data *e.g.* West Germany;
- the use of series sourced from national institutions that are no longer officially published.

54. In all cases the previous data series were subject to rigorous analysis to ensure their growth patterns were plausible and of adequate quality for compiling the historical segments of the series. Link dates and specific quality issues are outlined in the detailed metadata on country data sources as explained in Section 5.2.7.

55. Whilst this process has led to some variation in the length of time series available across all OECD countries, more than 60% of countries covered have quarterly ULC indexes which commence on or prior to 1990. Furthermore, ULC index trend-cycle series have been extended to have the same length as their corresponding annual ULC indexes (*i.e.* in most cases back to 1970) through interpolating the annual series as described in Section 6.4.

## **6 Benchmarking and aggregation methods**

### **6.1 Standardisation of reference years**

56. Annual CVA data across countries is provided to the ANA database for a wide range of base years depending on the relevant situation prevailing within the countries national accounts compilation system. All CVA data are therefore re-referenced to the OECD base year, to ensure all outputs produced by the System are directly comparable in terms of reference year.

### **6.2 Aggregation of economic activities**

57. A number of methodological procedures are required to compile the desired economic activities as listed in Section 4, which are somewhat different for the annual and quarterly indicators produced by the System as outlined below.

#### **6.2.1 Annual indicators**

58. In the case of annual indicators, all required data is available from the ANA database for Total Economy, Manufacturing (ISIC D), Industry (ISIC C\_E), Construction (ISIC F), Trade, Transport & Communication (ISIC G\_I) and Finance & Business Services (ISIC J\_K). Therefore, aggregation is only required for compilation of Market Services (ISIC G\_I) and Business Sector excluding Agriculture (ISIC C\_K). As the total labour costs variable is in current prices, the aggregation is just the simple addition of the component economic activities. However, as real output is in constant prices, the component economic activities need to be aggregated through an annual chain linking procedure. The methodology as outlined in Section 6.5.1 for compiling geographical zone aggregates is used, where the component economic activities within a country are the subject of aggregation and their weights are the current price value added from the previous year. Note that in the case of the economic activity J\_K, real output has been adjusted to remove the contribution of the *Ownership of Dwellings* (see paragraph 34) prior to the aggregation.

### 6.2.2 Quarterly indicators

59. Unlike for the annual indicators, it is not a strict requirement for countries to provide QNA data to the OECD using a standardised economic activity breakdown. As a result, aggregation of economic activities provided at a lower level (*e.g.* ISIC division) is often required, in addition to the aggregation required to form the G\_K and C\_K aggregates. The situation is more complex where proxy indicators are used (see Table 1) as these are seldom available for the desired economic activities. Also, in many cases proxy variables are based on national classification systems therefore requiring a complex matching process to estimate the relevant ISIC economic activities. Furthermore, it is often a requirement to aggregate data from two different sources obtained in different units within economic activities or across economic activities. In general, the following approach is used for the aggregation of quarterly indicators.

- Where data is sourced from the QNA database, economic activities are simply added for both COE and CVA to form the required aggregates. As COE is in current prices this is straight forward. The adjustment for the self-employed is then made through the process of benchmarking to annual data as described in Section 6.3. For CVA, the data will be additive for a country after the most recent base year, which therefore includes the end of the time series which is the most relevant part for short-term analysis when the quarterly ULC indexes are compiled. Whilst the remainder of the time series for CVA is not additive, this will be forced through the benchmarking procedure. Similarly, no specific adjustment to remove the impact of *Ownership of Dwellings* from activity J\_K is made because this will also be achieved through the benchmarking process.
- Where proxy data are used, the aggregation method will depend on the unit of the data. Where proxy variables for COE are in current prices (*e.g.* gross wages and salaries, average monthly earnings x employment) the data is added. Where at least one component is expressed as an index (*e.g.* labour cost index x weekly hours x employment) then all inputs are expressed in index form, and multiplied together. Aggregation with indices for other economic activities is performed by weighting the respective component industries using the most recently available ANA data for the economic activity (*i.e.* COE or current price value added at basic prices for CVA proxies). Once all the required economic activities are compiled the data is put through the benchmarking process to generate the temporally disaggregated quarterly series of total labour costs and real output in national currency respectively.

60. To give an indication of the complexity of the above process, only ten of the thirty OECD member countries provide QNA data on the same basis as their ANA data (Czech Republic, Germany, Denmark, United Kingdom, Italy, Netherlands, Norway, Slovak Republic, Sweden, and Turkey) implying the need for individual aggregation processes of quarterly indicators for the other twenty OECD member countries.

### 6.3 Benchmarking (temporal disaggregation)

61. National statistical institutions are frequently faced with the situation of having low frequency data (annual or less frequent) that are comprehensive and not very timely, and high frequency data (quarterly and monthly) of lower accuracy, less detail and less scope, but much more timely. The challenge is then to identify and use appropriate statistical techniques to combine these two sets of data to produce timely, high frequency estimates of the highest degree of accuracy, reliability and detail possible.

62. Benchmarking techniques are those processes optimally combining two or more sources of measurements in order to obtain reliable estimates of the series under investigation. Traditional fields of application of benchmarking techniques are national accounts, censuses and demographic data,

employment, administrative records, and cross-section data. In the case of the compilation of quarterly ULC indexes, the quarterly indicator series of real output and total labour costs as outlined in Section 5.3 are the targets to be benchmarked to their conceptually superior annual series (compiled as outlined in Section 5.2).

63. The *OECD System of Unit Labour Cost and Related Indicators* compilation process uses the Fernández<sup>25</sup> method, within the software tool ECOTRIM<sup>26</sup>. This technique employs a three step process to obtain in the words of Fernández “smooth” estimates that will not show spurious steps or discontinuities...”. The quarterly series now match their annual counterparts as measured in either level or growth terms but the shape of the original quarterly growth pattern is maintained as best as possible through an optimal procedure. For further details on the technical aspects of the methodology readers are referred to Fernández (1981) and DiFonzo (2003).

64. Two quarterly component series are benchmarked to their annual counterparts during the regular quarterly compilation process: COE or the suitable proxy; and CVA or the suitable proxy. These temporally disaggregated (benchmarked) quarterly series in national currency then become useful analytical series in their own right and are made available in the Systems output. The more interesting outputs of this benchmarking process come from the benchmarked proxy series as the System is essentially estimating quarterly production and income accounts for the relevant economic activities for countries that do not currently compile these (e.g. Australia, Canada, Japan, Korea, New Zealand, and the United States especially in the case of income accounts, based on the list of proxy series as shown in Table 1).

65. In the case of proxy indicators the benchmarking process creates what is known as a ‘preliminary benchmarked’ series where the underlying model that has been estimated between the annual and quarterly time series is projected forward using the available quarterly data. Where the quarterly proxy indicator series are volatile, this process of projecting the model tends to eliminate some of this volatility in the quarterly indicator (*i.e.* of COE or CVA), such that extreme negative or positive movements which would otherwise cause an extreme observation for the ULC index are dampened. The OECD performed some case studies to understand better empirically the modelling process of the Fernandez technique and the results of these case studies (for Canada and New Zealand) are available on request.

#### 6.4 Extension of quarterly unit labour cost index series

66. Benchmarking is also used in the System to enable the backwards extension of a number of quarterly time series using their annual counterpart (interpolation of annual data) in the case where the annual ULC index series is longer than the quarterly. The univariate method of Denton<sup>27</sup> available in the ECOTRIM software is used to interpolate the annual unit labour cost index to a quarterly time series which is then linked to the actual quarterly ULC index (trend-cycle measure – see Section 7). This compilation procedure results in the structure of the series changing at the link point, as the trend-cycle series is generated by an underlying ARIMA model whereas the interpolated annual series has no such underlying structure.

<sup>25</sup> A Methodological Note on the Estimation of Time Series, Roque B. Fernández, *The Review of Economics and Statistics*, Vol. 63, No. 3. (Aug., 1981), pp. 471-476.

<sup>26</sup> Barcelan R. and Buono D. (2002). *Temporal Disaggregation Techniques*, ECOTRIM Interface Version 1.01), User Manual – Including Case Studies and Examples, draft version, Eurostat.

<sup>27</sup> Adjustment of monthly or quarterly series to annual totals: An approach based on quadratic minimization, F.T. Denton, *Journal of the American Statistical Association* 66(333) 1971.

67. The main reason why the trend-cycle quarterly ULC indexes are extended by the above method was to enable the longest time series possible where the quarterly ULC indexes are used for modelling purposes in the OECD. It is also useful for completeness to have a set of annual and quarterly time series of the same length, and the process enables quarterly time series to be generated for those countries / economic activities where quarterly indicators are not available as shown in Table 2<sup>28</sup>.

## 6.5 Compilation of geographical zone aggregates

68. Aside from the Euro area which is compiled as a country based on data provided by Eurostat, the OECD calculates geographical zone aggregates for some of the outputs of the OECD System of ULC and Related Indicators. The relevant geographical zone aggregates are:

- OECD – Total (all OECD countries)
- OECD – Europe (the twenty three OECD countries that are part of Europe)
- Major Seven (Canada, France, Germany, Italy, Japan, United Kingdom, United States)
- OECD – Total excluding high inflation countries.

69. The OECD – Total excluding high inflation countries is of interest as an analytical historical reference series as it excludes countries<sup>29</sup> for periods of time where their rate of inflation was significantly higher than other OECD countries and thus their inclusion can distort the OECD – Total aggregate.

70. Zone aggregates are produced for the following quarterly and annual indicators, for all economic activities in the case of the annual indicators, and all but Trade, Transport & Communication (ISIC G\_I) and Financial & Business Services (ISIC J\_K) for the quarterly indicators.

### *Annual indicators*

Unit labour cost index

Labour productivity per unit labour input indexes

Labour compensation per unit labour input indexes (national currency)

Labour compensation per employee<sup>30</sup> (\$US PPP adjusted levels)

### *Quarterly indicators*

Unit labour cost index

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<sup>28</sup> Of course these purely interpolated quarterly series will not be timely as they will only be available up to the latest available annual data. However, these series are also useful inputs to the compilation of geographical zone aggregates as outlined in Section 6.5.

<sup>29</sup> The criterion for a country to be declared as ‘high inflation’ and the list of countries excluded at various points in time is explained in the following article published in the OECD Main Economic Indicators, December 2007: <http://www.oecd.org/dataoecd/1/21/39746430.pdf>

<sup>30</sup> Note that for this indicator, only the OECD – Total is compiled.

### 6.5.1 Methodology for compiling zone aggregates

71. The indicators for geographical zone aggregates are compiled as annually reweighted chained Laspeyres indices. The formula for the quarterly unit labour cost indexes is given below, which represents a quarterly decomposition<sup>31</sup> of the formula for the annually chained Laspeyres index.

$$Z_t = Z_{t-1} \frac{\sum_i w_{i,B} \left( \frac{C_{i,t}}{C_{i,f}} \right)}{\sum_i w_{i,B} \left( \frac{C_{i,t-1}}{C_{i,f}} \right)}$$

- $Z_t$  is the value of the zone in period  $t$ ,
- $w_{i,B}$  is the weight of country  $i$  for current base year  $B$ ,
- $C_{i,t}$  is the indicator from country  $i$  from period  $t$ ,
- $C_{i,f}$  is the value of the indicator from country  $i$  for the first quarter of the year.

72. With the above approach, the weights are updated for the compilation of the zone in the second quarter of each year. The weights used are previous year data on current price gross value added for the relevant economic activity adjusted for purchasing power parity (PPP) by the total economy GDP PPPs (as PPPs for the economic activity breakdown are not available). The OECD employs an automatic rule that a zone will only be compiled if seventy-five percent of countries (assessed by both number and weight) included in the zone have data for the most recent quarter. Therefore, countries with no data for the current quarter are not used in the above calculation and their weight is distributed proportionally to the responding countries.

73. For the compilation of zone aggregates for annual time series, the above formula simplifies to:

$$Z_t = Z_{t-1} * \sum_{i \in R} w_{i,t-1} * \left( \frac{C_{i,t}}{C_{i,t-1}} \right)$$

## 7 Seasonal adjustment and compilation of the trend-cycle series

### 7.1 Overview

74. All quarterly input series are sought in original (*i.e.* unadjusted) form prior to the benchmarking process as outlined in Section 6.3. Raw quarterly unit labour costs are then calculated as the quotient of the temporally disaggregated (benchmarked) quarterly time series of total labour costs and real output, which are then seasonally adjusted using the Tramo-Seats software. In addition to the seasonally adjusted series, Tramo-Seats produces a trend-cycle series which is a combination of the long-term trend and business cycle series also produced by the package. This series is designed to show all cycles of length greater than about two years, as cycles less than this are normally picked up in the seasonal component and taken out of

<sup>31</sup> This decomposition formula is also used at the BLS, see [http://www.bls.gov/opub/hom/homch14\\_e.htm](http://www.bls.gov/opub/hom/homch14_e.htm)

the trend. In simple terms, this series can be regarded as a short-term trend or smoothed seasonally adjusted series, where the degree of smoothing is dependent on the underlying ARIMA model and will thus vary from series to series.

75. The OECD has performed extensive testing of the Tramo-Seats trend-cycle methodology and found that it significantly reduces the volatility of estimated quarterly growth rates of the unit labour cost indexes whilst still effectively extracting the underlying signal in the raw data. Due to the volatility inherent in a derived series such as the ULC, the series of quarterly growth rates based on the trend-cycle series is promoted by the OECD for the purpose of short-term analysis and is thus the focus of the quarterly press release. However, all seasonally adjusted and raw unit labour cost indexes are also published in the database.

## 7.2 Direct vs indirect methods of seasonal adjustment

76. Considerable thought was given as to whether it is preferable to seasonally adjust the inputs to the unit labour cost equation (indirect approach) or to compute the ULC in its raw form and perform the seasonal adjustment at the end of the process (direct approach). There is a long standing debate in the statistical literature as to whether indirect or direct methods of seasonal adjustment are preferable with no clear theoretical conclusions being drawn.<sup>32</sup> Often the debate concerns seasonally adjusted series for aggregates and their sub-components (*e.g.* economic activities or countries) and the importance or not of additivity. For the OECD System of ULC and Related Indicators, the direct approach was used for mostly pragmatic reasons as listed below:

- as quarterly indicator data are often provided at a fine level of industry detail and require a lot of pre-treatment prior to aggregation (see Section 6.2.2), in many cases seasonally adjusted time series are not available from their sources and thus creating and maintaining seasonally adjusted series for all inputs would be a considerable extra burden on the System;
- in addition to the above point, imposing the condition that all partial indicators should be seasonally adjusted would imply that multiple seasonal adjustment methodologies have been used for inputs within the same System;
- in the process of benchmarking, if the input quarterly time series were seasonally adjusted, the seasonal relationship between the input raw series and the temporally disaggregated seasonally adjusted series would be altered;
- it is desirable to have consistency in the quarterly ULC indexes produced by the System, which is best achieved by inputting raw series to the Tramo-Seats software to generate the resultant seasonally adjusted and trend-cycle series.

## 7.3 Review of seasonal models

77. The *OECD System of Unit Labour Cost and Related Indicators* undertakes a comprehensive review of its seasonal adjustment methodology once a year between July and August, and the results are published on the OECD website. This timing was chosen due to the extensive updating carried out by the Annual National Accounts team in the May and June months that impact directly on the ULC input data. The annual seasonal adjustment review involves re-evaluating all series for model and outlier changes (additive outlier, transitory change, and level-shift). For the remainder of the year, seasonal adjustment through Tramo-Seats is performed allowing the coefficients of the model to change but with the

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<sup>32</sup> For example, see Hood & Findley (2001) and Dagum (1979).

underlying ARIMA model locked. However, if major revisions to input quarterly indicator series are observed then model re-identification may be undertaken during the year for some series.

78. It should also be noted that after extensive investigation and testing it was decided that for most series the level-shift outlier operator in Tramo-Seats be switched off. That is, level shifts, which distort the continuity of long time series, are not allowed unless a legitimately observable economic event has occurred. Consequently, approximately 97% of ULC index seasonally adjusted and trend-cycle series are free of level shift outliers.

79. It may occasionally occur that the raw quarterly ULC series is extremely volatile and Tramo-Seats cannot determine a suitable model. In these circumstances, either the airline model is forced if this seems to provide plausible results, otherwise the series is not considered fit for publication.

## **8 Dissemination and quarterly quality evaluation**

### **8.1 Quality evaluation of the quarterly production process**

80. As part of the quarterly production process, which is shown schematically in Figure 1 in Section 1, a detailed quality report is produced to evaluate both inputs to and outputs from the System. This allows queries to be resolved and reasons for large movements to be documented before updating the database which occurs in conjunction with the quarterly press release. The main elements of the quarterly quality report are:

- Review of revisions to all annual data series and of significant movements for any new data points;
- Details of imputation performed<sup>33</sup> for quarterly indicator data that is not available at the end of the time series;
- Review of outputs from the benchmarking process, listing the drivers of large revision to the quarterly benchmarked series;
- Review of outputs of the seasonal adjustment process in Tramo-Seats, in particular for series whose models failed diagnostic tests;
- Detailed revisions analysis of changes to previously published data points (series of quarterly growth rates) for the seasonally adjusted and trend-cycle ULC index series;
- Review of latest movements in the time series and consistency across economic activities.

### **8.2 Dissemination**

81. All time series together with detailed methodological information and country data sources are freely available through the *OECD System of Unit Labour Cost and Related Indicators* web portal at: <http://stats.oecd.org/mei/default.asp?rev=3>. A quarterly news release containing the latest quarterly updates together with a discussion of main features for the economic activities of Industry and Market Services is released around the middle of January, April, July and October. Quarterly time series for the unit labour cost indexes for all economic activities are also published in the monthly Main Economic Indicators publication.

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<sup>33</sup> The methodology used for imputation within the System is available on request.

82. Elements of the *OECD System of Unit Labour Cost and Related Indicators* also appear in a number of other OECD publications, such as the OECD Factbook, the OECD Productivity Compendium, and the OECD Economic Outlook.

## **9 Future work**

### **9.1 Extension to non OECD EU member countries and BRIICS**

83. Through cooperation with the European Commission, the OECD has undertaken a project in 2008 to expand the OECD System of Unit Labour Cost and Related Indicators to the eight European Union member countries that are not currently members of the OECD. In addition, research has commenced to investigate the possibility of producing annual indicators for the BRIICS countries (Brazil, China, India, Indonesia, Russian Federation and South Africa).

### **9.2 Revision analysis for trend-cycle and seasonally adjusted series**

84. As explained in Section 7, the OECD promotes the quarterly growth rates of the ULC index trend-cycle series for the purpose of short-term economic analysis. In the statistical literature there is continual debate about whether trend based indicators are appropriate for the purpose of short-term analysis. Those opposing<sup>34</sup> the use of trend series claim the excessive revision to end points seriously limit the ability to identify turning points, whereas those in favour<sup>35</sup> claim that more simple approaches to filtering perform poorly in identifying turning points and that point estimates of seasonally adjusted series are too volatile on which to base decisions. The research performed by the OECD on quarterly ULC indexes supported the latter view. It has been observed that the most recent quarterly growth rate of the seasonally adjusted series may often be implausible, which can reflect the fact that the seasonally adjusted data themselves are the output of a model subject to end point revisions and the underlying indicators are often substantially revised each quarter. As explained in Section 8, revisions to the end points for both the trend-cycle and seasonally adjusted quarterly growth rate series are evaluated each quarter and anecdotally it does not appear that revisions to the trend-cycle series are more excessive.

85. In the debate concerning the use of seasonally adjusted vs trend based series for the purpose of short-term economic analysis, what appears to be lacking in the literature is detailed empirical research comparing the ongoing revisions in size and direction for seasonally adjusted and trend based series. Consequently, the OECD has been storing a snapshot of each quarterly update of the ULC indexes to enable such an evaluation to be made on the revisions to end points of the published quarterly growth rate seasonally adjusted and trend-cycle series.

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<sup>34</sup> See Eurostat (2008).

<sup>35</sup> See ABS (2003).

## REFERENCES

- ABS (2003). *A Guide to Interpreting Time Series – Monitoring Trends*. Australian Bureau of Statistics Information Paper, Catalogue 1349.0, Canberra, August 2003.
- ABS (2006), *Measuring Changes in Labour Costs*. Feature article: Australian National Accounts, Cat 5206. Canberra, June 2006.
- Barcelan R. and Buono D. (2002). *Temporal Disaggregation Techniques*, ECOTRIM Interface Version 1.01), User Manual – Including Case Studies and Examples, draft version, Eurostat, Luxembourg.
- BLS (2008). Bureau of Labour Statistics *Handbook of Methods, Chapter 14, Producer Prices*. Washington.
- Brackfield D. (2007), *Preliminary Comparison of Unit Labour Cost Indicators*, Compiled by the BLS and OECD. OECD Report, May 2007, Paris.
- Dagum, E.B (1979), *On the Seasonal Adjustment of Economic Time Series Aggregates: A Case Study of the Unemployment Rate*. Counting the Labor Force, National Commission on Employment and Unemployment Statistics, Appendix, 2: 317-344. Washington
- Denton F.T., (1971), *Adjustment of monthly or quarterly series to annual totals: An approach based on quadratic minimization*. Journal of the American Statistical Association 66(333).
- Di Fonzo T. (2003), *Temporal disaggregation using related series: log-transformation and dynamic extensions*, Rivista Internazionale di Scienze Economiche e Commerciali, 50, 3, pp. 371-400.
- Eurostat (2008). *Guidelines on Seasonal Adjustment*. Luxembourg.
- Fernández R.B., (1981), *A methodological note on the Estimation of time series*, The Review of Economics and Statistics 63(3).
- Hood C. & Findley D. (2001), *Comparing Direct and Indirect Seasonal Adjustments of Aggregate Series*. US Census Bureau, Washington, DC 20233
- McKenzie R. (2005), *Development of comparable quarterly unit labour cost indexes for OECD countries*. OECD Short-Term Economic Statistics Expert Group meeting, June 2005, Paris.
- McKenzie R. & Brackfield D. (2005), *Development of comparable quarterly unit labour cost indexes for OECD countries*. OECD Working Party on Statistics meeting, November 2005, Paris.
- McKenzie R. (2007), *Adjusting for Ownership of Dwellings in the OECD System of Unit Labour Cost Indicators*. OECD report, March 2007, Paris.
- McKenzie R. (2007), *Proposed changes to the compilation of zone aggregates for monetary aggregates and other variables in the OECD Main Economic Indicators publication*. Feature article OECD Main Economic Indicators, December 2007, Paris.
- Van Ark, B & Monnikhof, E. *Productivity and Unit Labour Cost Comparisons: a database* Employment Sector, ILO 2000, Geneva.