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A. Ciammola, F. Ceccato, M.C. Congia, S. Pacini, F.M. Rapiti e D. Tuzi

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Abstract: The EC Regulation N.450/03 requires the Member States the quarterly production and timely transmission to Eurostat of a comparable hourly Labour Cost Index, to be used as a key indicator in the analysis of short and medium-term economic development in the European context. The compilation of the Italian LCI is based on a very complex process combining different information contributing to the separate estimation of the numerator and the denominator. The use of administrative data as main source to estimate the labour cost components, at the numerator, implies some peculiar statistical issues to be faced taking into account also the binding timeliness in the release of the indicator. Referring to the denominator, the lack of a direct short-term business survey collecting the hours worked leads to the adoption of a temporal disaggregation technique to derive the quarterly estimates from annual business benchmarks. In the paper the main characteristics of the index and the compiling methods are described and the trends of LCI time series are analysed also in comparison to other short term statistics on labour cost. Since 2003, many efforts have been done to improve the overall quality of the Italian LCI in terms of accuracy, reliability, punctuality, coherence and comparability achieving very appreciable results and suggesting the possibility to release this indicator, in the near future, also at national level. However, some quality issues remain still open: the improvement in the estimation of the hours worked and the elimination of the incoherencies in the directly seasonally adjusted series. Moreover, attention has to be addressed also to the extension of the Italian LCI coverage to the economic activity sections L, M, N and O of Nace Rev.1.1.

Parole chiave: Hourly Labour Cost, Chain Laspeyres Index, Principal European Economic Indicators, Integration of Sources, Temporal Disaggregation, Working Day and Seasonal Adjustment.

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1. Introduction[1]

The labour cost is an important factor in the analysis of short- and medium-term economic development at national and European level. The timely production of a labour cost index for every EU member state as well as the Euro zone and the EU aggregates has been considered by the Commission and the European Central Bank to be extremely important for assessing the inflationary pressure that may arise from developments in the labour market. A labour cost index is also important for the social partners in wage negotiations and for the different directorates of the Commission in monitoring short-term developments in labour costs.

For these reasons in February 2003 the regulation (N. 450 of the European Parliament and of the Council of 27/02/2003) concerning the labour cost index (LCI) has been approved to establish a common framework for the production and transmission of comparable hourly labour cost indices in the Community for C to K Nace Rev.1.1 sections[2]. In July 2003 the Commission adopted an implementing regulation (N. 1216/2003), setting out in more detail the procedures for transmitting the index, the specific (seasonal) adjustments to be made and the content of the national quality reports. Recently a new Commission Regulation N. 224/2007 of 1 March 2007 has been adopted which amends the implementing regulation of 2003 and extends the scope of the labour cost index to cover the economic activities defined by Nace Rev.1.1, sections L, M, N and O, mainly non-market services.

Since 2004 the majority of the EU member states has delivered regularly their national LCI to Eurostat that has compiled and published a quarterly news release to show the development of hourly labour costs for EU aggregates and the Member States[3]. The Labour Cost Index is also included in the list of the Principal European Economic Indicators (PEEIs).

As opposed to other EU official statistics, the LCI Regulations allows all NSIs greater flexibility in terms of combination of sources, data collection and processing. In this case the old preference for harmonisation of input has shifted somewhat in favour of harmonised output. This is clear in the article 7 of the Council regulations which reads:

"*Member States may produce the necessary estimates by using a combination of different sources specified below by applying the principle of administrative simplification: (a) surveys, where statistical units, as defined in Regulation (EEC) No 696/93, are asked to give timely, accurate and complete information; (b) other appropriate sources, including administrative data if these are appropriate in terms of timeliness and relevance; (c) appropriate statistical estimation procedures*".

The rational behind this choice is explained in the Whereas (4) of the regulation which reads:

"*The benefits of collecting, at Community level, complete data on all segments of the economy should be balanced against the reporting possibilities and the response burden on small and medium-sized enterprises (SMEs)*".

Furthermore, article 8 of the Council regulation and article 2 of the Commission regulation specify a number of requisites regarding the quality the statistics produced by member countries must have in order to ensure reliability, completeness and international comparability[4].

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[1] Although the document is the result of a joint work of the authors, the paragraphs may be attributed as follow: § 1. Fabio Rapiti; § 2. Francesca Ceccato and M. Carla Congia; § 3.1 Silvia Pacini and Fabio Rapiti; § 3.2.1 Francesca Ceccato, Fabio Rapiti; § 3.2.2 Anna Ciammola; § 3.2.3 Francesca Ceccato and Anna Ciammola; § 4.1 Silvia Pacini and Donatella Tuzi; § 4.2 and 4.3 Francesca Ceccato and M. Carla Congia; § 5.1 and 5.2 Anna Ciammola; § 5.3 Donatella Tuzi; § 6.1. Francesca Ceccato and M. Carla Congia; § 6.2. M. Carla Congia and Donatella Tuzi; § 7 is the result of a collective work of the authors.

[2] Nace Rev.1.1 sections are: C=Mining and quarrying; D=Manufacturing; E=Electricity, gas and water supply; F=Construction; G=Wholesale and retail trade; repair of motor vehicles, motorcycles and personal and household goods; H=Hotels and restaurants; I=Transport, storage and communication; J=Financial intermediation; K=Real estate, renting and business activities; L=Public administration and defence; compulsory social security; M=Education; N=Health and social work; O=Other community, social and personal service activities.

[3] The quarterly news release is published on the basis of a release calendar; both can be found on Eurostat's website http://epp.eurostat.ec.europa.eu/.

[4] The provision of annual national quality reports is required under Article 8(2) of this Regulation. In Annex I of the implementing regulation (Regulation No 1216/2003), the quality of the labour cost index has been set out to cover the

In Italy, as in many other member states, the hourly LCI is compiled combining different pre-existent statistical sources and estimating separately numerator and denominator: the labour cost (the numerator) is estimated using the Oros survey based mainly on administrative data, while the hours worked (the denominator) are obtained through a mix of different sources.
Since 2002 the Oros survey has been used primarily to produce and release national quarterly Fte (Full time equivalent) indicators on gross wages, other labour costs and total labour cost in the private sector[5]. Those became the most used Italian indicators to monitor and analyse the short-term evolution of wages and labour cost. Up to March 2005 Italy had a derogation which allowed to deliver the latter indicators per Fte to Eurostat to satisfy the LCI regulations in the place of the actual hourly indices. From June 2005 Istat started to deliver to Eurostat the Italian hourly LCI at first with a confidentiality status. At that time the LCI was considered as the product of an experimental compilation method, which needed some further improvements. This was exclusively due to the hours worked component that was estimated indirectly through a complex methodology which had needed a long time to reach accuracy and stability. Thus for the first years the Italian LCI overall data quality was considered sufficient only to use the indices to compile the EU aggregates. More recently the LCI has reached an higher accuracy[6] which allows the removal of the confidentiality status in the Eurostat releases and even to plan a national diffusion policy.
At the moment, Italy and other Member States deliver to Eurostat LCI data series for sections C to K but from first quarter of 2009 onwards, as derogations expire, they will have to include NACE Rev 1. sections L to O. Moreover, Regulation N. 1893/2006 of 20 December 2006 concerning the change of nomenclature from Nace Rev 1.1 to Nace Rev.2 will start to affect the LCI. Data delivered for the first quarter 2009 will have to be already coded according to Nace Rev.2.
This paper is divided in seven parts. In the next paragraph the main characteristics of the index and the compiling methods are described. The third paragraph deals with the main sources used with a detailed description of the procedure used to estimate the hours worked. In the fourth section the trend of LCI time series is analysed also in comparison to other short term statistics on labour cost. The fifth paragraph shows the working days and seasonally adjusted indices, describing the methodology used to remove these components. The sixth paragraph describes the way the index is disseminated by Eurostat. Finally some conclusions and open issues are discussed in the seventh paragraph.

2. The labour cost index

The Italian quarterly labour cost index provides a timely indicator of the growth in labour costs per hour worked that reflects changes in wages and salaries, other labour costs and the quantity of hours worked. It satisfies the requirements of the EU Regulations, mentioned in the previous section, which establish a common framework for the production of comparable short-term labour cost statistics in the European Community. Each Member State has been required to produce quarterly labour cost indices broken down by economic sectors included in the industrial and services activities (C to K sections of the classification NACE Rev.1) for the three labour cost variables: (a) gross wages and salaries including direct remunerations, bonuses and allowances paid by an employer in cash or in kind to an employee in return for work done, payments to employees saving schemes, payments for days not worked and remunerations in kind such as food, drink, fuel, company cars, etc.; (b) other labour costs including employers' social contributions plus employment taxes less subsidies received by employers; (c) total labour cost as the sum of the previous two components.
These three indicators have as their denominator the hours actually worked by employees. The hours not worked because of holidays, leaves or sickness, even if paid, are excluded.

---

following dimensions: relevance, accuracy, timeliness and punctuality, accessibility and clarity, comparability, coherence and completeness.

[5] For the Oros Fte indicators see http://www.istat.it/salastampa/comunicati/in_calendario/oros/

[6] Although a number of quality issues still require further efforts (see § 3.2).

The information on hours worked provides the most accurate measure of labour input by measuring short-term fluctuation (i.e. overtime) or changes in working patterns (more part-time workers). The use of the hours worked as denominator controls for shifts in working patterns within industries and minimises the impact on the labour cost of the volume changes in the number of hours worked.
The Italian LCI hourly indices have been produced for each section of the economic activities' classification, as well as for the overall economy, from the first quarter 1996 onwards in unadjusted, working-day and seasonally adjusted form.
The current practice for the estimation of the Italian LCI indicators implies that the quarterly elementary indices have been produced at section level for each labour cost category (total labour cost, wages and salaries, other labour costs). Considering the indicator on total labour cost as an example, the indices compiling methods are illustrated below.
The elementary index has been calculated for each section *i* as the ratio of the labour cost per hour worked in quarter *t* and year *j* to the average of the labour cost per hour in the base year *k*.
In formula:

$$I_{i,tj(k)} = \frac{w_i^{tj}}{\omega_i^k} \tag{1}$$

where
w_i^{tj} = total labour cost per hour worked of employees in economic activity *i*, quarter *t* and year *j*
ω_i^k = total labour cost per hour worked of employees in economic activity *i*, in base year *k*

According to the European Commission implementing Regulation, the labour cost index for the aggregate C to K of Nace Rev.1.1 classification is defined as an annually chain-linked Laspeyres index based upon a weighting structure at section level. Three separate indices, one for each target variable, are compiled and then chained with annual links to the reference year 2000.

In the first step, the Laspeyres index is calculated as a weighted arithmetic average of the elementary indices $I_{i,tj(k)}$ using weights derived from aggregate labour cost in the base year.
The Laspeyres index of the total labour cost with reference to the quarter *t*, year *j* with base year *k*, is defined as follows:

$$LCI_{tj(k)} = \frac{\sum_i w_i^{tj} h_i^k}{\sum_i \omega_i^k h_i^k} = \frac{\sum_i \left(w_i^{tj} / \omega_i^k\right) \omega_i^k h_i^k}{\sum_i W_i^k} = \frac{\sum_i \left(w_i^{tj} / \omega_i^k\right) W_i^k}{\sum_i W_i^k} \tag{2}$$

where
h_i^k = hours worked by employees in section *i*, base year *k*
$W_i^k = \omega_i^k h_i^k$ = total labour cost of employees in section *i*, base year *k*.

The annual weights are defined as the share of the total labour cost in section *i* and base year *k*:

$$\frac{W_i^k}{\sum_i W_i^k} \tag{3}$$

In order to have indices whose weighting structures are as up-to-date and relevant as possible, the quarterly LCI is not related to a fixed base but to a variable one. According to EU rules, the weights to be used for the calculation of the index have to refer to a maximum of two years before the period which they relate to. In the Italian practice these weights are referred to the previous year.

In the second step, as the base period changes from year to year, annual links are used to make the indices calculated in different base year coherent and for joining them to the same reference period that remains fixed (k=0).
The annual links for year l to year $l + 1$ are calculated and defined as:

$$L_{l,l+1} = \frac{\sum_i \omega_i^{l+1} h_i^l}{\sum_i \omega_i^l h_i^l} \tag{4}$$

where $0 \leq l < l + 1 < j$.

These links represent, essentially, the Laspeyres indices of the total labour cost for a year l+1 to the previous year l.

Finally, the chain-linked Laspeyres index for quarter t of year j with reference year $k = 0$ and m as the interval required to process and apply the necessary annual weights, is given by the following expression:

$$LCI_{tj(0)} = 100(L_{0,1})(L_{1,2})\ldots(L_{j-m-1,j-m})LCI_{tj(j-m)} \tag{5}$$

where the interval m is equal 1 for the Italian index. The first reference year is 2000, when the annual labour cost index equals 100.
The LCI compilation as an annually chain-linked Laspeyres index reduces the potential effect of changes in the composition of the workforce within economic activities. However, the LCI remains subject to compositional effects due to changes in quality aspects of occupation (i.e. skilled/unskilled employment, improvements in employee productivity) and human capital shifts.

3. Sources of data and variables estimation

3.1. The numerator: labour costs

The Italian LCI has a lot of peculiarities mainly due to its hybrid nature depending on the high number of input sources used. This indicator is produced combining very different information contributing to the estimation of both the numerator and the denominator. The labour cost estimates, representing the numerator of the index, are drawn from the Istat quarterly Oros survey, mainly based on administrative data collected by the National Social Security Institute (INPS). Since 2003 this survey has been used to produce national full time equivalent (Fte) indicators[7] on gross wages, other labour cost and total labour costs for Italian firms with at least one employee in the private sector (sections C to K of the Nace Rev.1.1 classification). It is also used to satisfy the Short-Term Statistics (STS) Regulations (employment and wages variables).
Each quarter two new estimates of the numerator are produced: the preliminary estimate of the current quarter t based on a "non-random" sample of the monthly social security contribution declarations (DM10 forms), and a revised (final) estimate of quarter t-5 based on the total population of INPS data. These two datasets are provided by INPS to Istat every three months together with the Administrative Business Register. The latter collects individual information on administrative units and allows the estimation of the current population. This Administrative Register is integrated with the Istat official Business Register (called ASIA) to acquire the economic activity code whose quality is higher than the administrative one, even if it is available with a delay of 18 months.

[7] For a deep description of the Oros Survey see Baldi et al. (2004, 2008), Congia, Pacini, Tuzi (2008).

In spring 2004 an important change affected data used for the preliminary estimation, causing a methodological modification in the Oros survey. In fact, before that time the current quarter had been estimated using a sample with a large coverage, growing over time (as electronic way to send DM10 declarations to INPS had been spreading among firms). Since the second quarter 2004, when the use of internet became compulsory as delivering mode for all firms, the number of sample units has nearly covered the total population and data exploited to produce the preliminary estimate have been no longer considered as a sample. As a consequence, the calibration method[8] implemented until the first quarter 2004 has been replaced by summing up available data. It is worth highlighting that the two datasets used for the preliminary and the final estimates are still different because of their size and their quality. On the one hand the final population contains more units than the preliminary one although the difference is small and quickly declining; on the other hand, only the final dataset is checked by INPS.
With regard to the target variables, a complex retrieval and translation procedure is necessary to get the statistical information from the administrative source. Furthermore in order to obtain a complete estimate of the labour cost some components of the other labour cost not provided by INPS have to be estimated. In particular the employers' injuries insurance premiums paid to the National Work Accident Insurance Institute (INAIL) and the termination of employment relationship allowance (TFR) have to be added.
Moreover the INPS administrative data are also integrated with a statistical source. Concerning firms with more than 500 employees, the census data are drawn from the Istat Monthly Survey on Labour Input Variables in Large Firms (hereinafter Large Enterprises Survey - LES). This statistical information, related to about 1000 firms employing more than the 20% of the target population, is preferred to the administrative ones because directly checked by Istat experts and more exhaustive. Besides, until 2004 large firms were not well represented in the INPS non-random sample while some of them have coverage problems in the INPS data because of the existence of different institutes for the payment of social contribution. The integration of LES data to produce Oros estimates has been realized since 2000 while for the previous years estimations were based only on the INPS source because LES data were not available with the details required by Oros. To conclude the archive of the monthly contribution declarations is used as labour input variables concerning all firms not included in the LES, mainly small and medium size enterprises (SME), besides the large firms not included in the monthly survey because they are persistent non-respondents and the temporary employment agencies. Unfortunately this administrative archive does not provide data concerning hours worked. In fact, in the INPS monthly declaration this information is neither complete nor suitable for statistical purposes. For this reason the Italian hourly LCI is compiled estimating separately total labour cost (numerator) and hours worked (denominator) and therefore using different sources. The latter variable is obtained multiplying the per capita hours worked, estimated combining different sources as shown in the next paragraph, by the number of the employees of the Oros survey at section level in order to guarantee the maximum coherence between numerator and denominator.

3.2. The denominator: hours worked

3.2.1. Sources: opportunities and constraints

The lack of a direct and exhaustive short-term survey to collect the hours worked data from business units led to reach the best estimate using a combination of available sources.
Data on hours worked from business surveys are generally preferable than those collected through households surveys. In Italy, at the moment Istat LES survey collects very detailed information on hours worked and paid at short-term frequency but this is limited to a specific portion of firms. Because of the small population coverage in some NACE sectors, the hours worked drawn from LES could either underestimate/overestimate the level of hours worked or show seasonal pattern non

[8] The calibration methodology used to obtain the preliminary estimate was built to cope with the non-random sample and to produce coherent estimates of the target variables.

representative of the whole firm population. This situation will change as soon as the new quarterly hours worked data on SME are available through the survey on job vacancies and hours actually worked (VELA) .

On the other hand the use of LFS (Labour Force Survey), which collects regularly quarterly hours worked data, has some well known drawbacks related to household surveys. First, as the economic activity in LFS is based on self-classification, the reliability of the indicators also at section level of the NACE classification is poorer than that of business statistics classified using register information. Second, in the past (up to 2003) LFS data were collected by interviewing households in a fixed and unique week of the reference quarter; this prevented a reliable identification of seasonality in the corresponding time series. The continuous LFS, started in 2004, has overcome this latter problem but it has produced a structural break in the time series (Istat, 2006a). In order to remove this break, data referring to the period from the first quarter 1996 to the fourth quarter 2003 have been back-casted, even though, to ensure a sufficient quality, the back-casting has been limited to an aggregated activity breakdown, unsuitable to the LCI aims.

The lack of a direct source led to use the annual hours worked drawn from structural sources (Istat, 2006b) and to implement an indirect estimation of quarterly per capita hours worked through temporal disaggregation techniques with reference indicators.

Only in September 2008, Istat National Account Department has started to release a new quarterly estimation on total hours worked for nine economical aggregations according to the European System of National Account (ESA 95) concepts and definitions[9], thus in paragraph 4.3 those data has taken into consideration just for some comparisons.

The indirect estimation has been carried out through the following three steps:

1. choice of the annual benchmarks; they are a combination of Istat's two structural surveys on enterprises: SCI (Survey on the accounts system, on the enterprises with more than 100 persons employed) and PMI (Survey on small and medium-sized enterprises, with 1 to 99 employees).
2. identification of the best quarterly indicators suited as reference indicators for the disaggregation procedure. After extensive testing, a single indicator for each section was chosen.
3. quarterly disaggregation of the annual benchmarks mentioned above.

The choice to estimate per capita hours worked data through a sound benchmark drawn from annual Structural Business Statistics (SBS) data, instead of using LFS[10], has the advantage to ensure that the denominator is more consistent with the numerator, in terms of quality of the classifications of the employees in the private sectors and of the hours worked variable estimation itself. On the other hand the main disadvantages are: first, long time series are required for both quarterly indicators and benchmarks; second, for the annual data, being usually available with a long delay, the estimation of the latest two years are forecast observing the evolution of the quarterly related indicators; finally, preliminary hours worked (and LCI indices) suffer significant revisions when new annual data become available.

As regard to the first step, SCI and PMI data are chosen to apply the indirect procedure. They are the output of the annual business surveys which are carried out using a method that is harmonized at European level according to SBS Regulation (N. 58/97) and supply the best annual estimates for the total amount of hours worked and the related number of jobs. The first one is a census survey on firms with more than 100 employees, while PMI is a sample survey, that consists of more than 100 thousand units, stratified by three firm-size classes (1-9, 10-19 and 20-99) and four digits economic activities classification. The reference population is based on the annual ASIA register. Both the surveys cover the firms referring to sections C to O of the Nace Rev. 1.1 excluding sections J (financial intermediation) and L (public administration and defence; compulsory social security).

The surveys collect the main economic variables referring to the balance sheet and economic account of the firms. Concerning the hours worked variable, it refers to employees only and includes all hours actually worked in the year (ordinary, over-time, etc.), excluding the hours paid but not worked (holidays, sick leave, etc.).

[9] At first, the data was released at 80 days from the reference period, only from March 2009 the data has been available at 70 days.

[10] Some EU Member states used or still use LFS data to estimate hours worked as denominator of the LCI.

According to the SBS regulation, SCI and PMI data are released 18 months after the end of the reference year l and, consequently, up to two years (namely l+1 and l+2) are estimated (forecast) applying the annual growth computed on the quarterly reference indicator, (l'+1)/l' and (l'+2)/(l'+1), to the previous year, respectively l and l+1. According to the above notation, l represents the per capita annual (SCI and PMI) hours worked and l' represents the per capita annual hours worked calculated summing up the quarterly per capita hours worked.
Usually small firms have some difficulties in reporting hours actually worked preferring the calculation of hours paid. Since the latter is greater than hours actually worked, Istat applies a correcting coefficient to reduce the original data collected with the PMI survey. This coefficient is compiled for the three size classes and the Nace divisions considered[11].
Data on hours worked and on employees are then aggregated at section level to calculate the annual per capita hours worked for each section from C to K of the Nace Rev.1.1, excluded the Financial Intermediation sector (section J of Nace Rev.1.1). The latter is the only section in which the temporal disaggregation procedure is not applied preferring the direct use of the per capita hours worked drawn from the monthly LES survey whose coverage in term of employees guarantees a representative and good quality quarterly indicator.

3.2.2. The quarterly disaggregation technique

Starting from the annual benchmarks, to obtain the quarterly hours worked, a temporal disaggregation procedure has to be used. It says, as a rule, that given an observed low-frequency (yearly) time series, the objective of any temporal disaggregation technique is to derive an estimate of the underlying high-frequency (quarterly) observations. This problem is known as interpolation for stock time series or distribution for flow time series (Chow and Lin, 1971). Here only the distribution of flow time series is considered, as the annual per capita hours worked are achieved as sum of the quarterly figures.
The econometric literature offers many methods to disaggregate low frequency time series and the most used ones exploit external variables observed at a higher frequency (see Di Fonzo, 1987). Though complex models and sophisticated estimation methods have been recently proposed, the shortness of the available time series allows the use of simple disaggregation techniques, namely the Chow-Lin proposal (Chow and Lin, 1971) and the Fernandez approach (Fernandez, 1981). In both cases, the following regression model is assumed at the high frequency:

$$\mathbf{y}_h = \mathbf{X}_h\beta + \mathbf{u}_h \qquad (6)$$

where $\mathbf{y}_h$ is the (unknown) series of interest, $\mathbf{X}_h$ is the matrix containing the related indicator(s), the constant and possible dummies, β is the vector of regression coefficients and $\mathbf{u}_h$ is the disturbance series.
Pre-multiplying both members of (9) by an aggregation matrix $\mathbf{C}$, the annual (observable) counterpart is derived:

$$\mathbf{C}\mathbf{y}_h = \mathbf{C}\mathbf{X}_h\beta + \mathbf{C}\mathbf{u}_h \quad \rightarrow \quad \mathbf{y}_l = \mathbf{X}_l\beta + \mathbf{u}_l. \qquad (7)$$

The difference between the Chow Lin and the Fernandez proposal lies on the structure for the disturbance term $\mathbf{u}_h$ in (9): the former suggests the Markov process $\mathbf{u}_h = \varrho\mathbf{u}_{h-1} + \boldsymbol{\varepsilon}_h$, with the autoregressive coefficient $|\varrho|<1$, and the latter a random walk model $\mathbf{u}_h = \mathbf{u}_{h-1} + \boldsymbol{\varepsilon}_h$ ($u_0 = 0$), where $\boldsymbol{\varepsilon}_h$ is a white noise process. In the real situations ϱ is unknown and its estimate can be derived either minimizing the estimated generalized least squares or maximizing the likelihood function. The former often yields a unit autoregressive parameter, so the Markov process and the random walk process become indistinguishable; the latter may estimate a negative autoregressive parameter that yields an unreliable disaggregation. On the contrary the Fernandez procedure does not need the estimation of any parameter, the residual covariance matrix being completely known, and this represents an important aspect to be considered when few observations are available. Results based on a simulation

[11] This correction is also applied for the estimation of hours actually worked in the National Account.

exercise (Ciammola *et al.*, 2005) show that the Fernandez procedure assures good results in solving the distribution problem, gives slightly less satisfactory estimates in extrapolation (namely in estimating quarterly values outside the sample period) and, consequently, produces larger revisions for the extrapolated quarters when a new annual data becomes available.
In order to choose between these two procedures, several elements are considered: the autoregressive coefficient, its stability over the last two available years[12] and its closeness to the unit root; the revision size of the extrapolated quarters when a new annual data becomes available; the closeness of the disaggregated series to the quarterly indicators through the correlation coefficients in levels, quarter-to-quarter variations and year-to-year variations. At the end of this testing exercise, the Fernandez procedure is selected since negligible differences are detected between the two procedures, the autoregressive parameters are often close to the unit root and nearly identical revisions of the extrapolated quarters are produced (due to the use of *forecast* annual data).

3.2.3. The choice of the quarterly indicators

When temporal disaggregation techniques are used, the selection of quarterly reference indicators is particularly important and usually a strong correlation is expected between the low frequency and the high frequency data, in terms of levels, year-on-year and quarter-on-quarter changes.
As far as per capita hours worked is concerned, three different sources have been used as quarterly indicators. Besides LFS and LES surveys, a further administrative source, that is drawn from the Building Workers' Welfare Funds (BWWF), is available to estimate the ordinary hours worked in the construction sector (section F of Nace Rev.1.1). The sources chosen to derive the quarterly indicators on hours worked at section Nace Rev.1.1 level are the following: sections C, D, E, G, I, J, K are covered by LES; section F by BWWF; section H by LFS.
The derivation of the quarterly indicators has been a long and not easy task based on the analysis of the relationship between SCI-PMI annual data and short term indicators. At first, the results did not definitely support one particular source and therefore a further and in deep analysis has been carried on. In particular, for sections D and F the LFS source seems to be preferable; for sections E, G and K the LES source produces good results; for section J, being dominated by large firms, LES data can be directly utilized without disaggregating the SCI-PMI data; for sections H and I results are poor.
A more detailed study concerning the industrial sector (C to E) reveals some important results:
1. the hours worked disaggregated using the LFS indicators show a volatile profile that does not represent the typical seasonal pattern of the hours worked, whose main feature is the fall occurring at the third quarter;
2. as table 1 shows, the hours worked disaggregated using the LES indicators are more coherent with other important short-term indicators, namely the industrial production index (the coherence is evaluated through the correlation coefficients on year-on-year growth rates and quarter-on-quarter growth rates[13] between the disaggregated hours worked and the reference indicators).

The main disadvantage in the use of LES indicators is that for some NACE sectors (F, G, H and K) the LES coverage is very low with the consequence that the hours worked, though having a regular well defined seasonality, reflect behaviours and choices of large firms (e.g. redundancy fund is more frequently paid by large firms than by small ones). This is definitely true in section F and H.

Table 1: *Correlation coefficients between short-term economic indicators for the industrial sector*

	Year-on-year growth rates			Quarter-on-quarter growth rates		
	LES HW	**LFS HW**	**IIP**	**LES HW**	**LFS HW**	**IIP**
LES HW	1	0.64	0.74	1	0.91	0.99
LFS HW		1	0.33		1	0.88
IIP			1			1

Legend: HW = Disaggregated hours worked - IIP = Index of industrial production.

[12] The shortness of the low frequency time series prevents us carrying out the stability analysis over a longer span.
[13] Quarter-on-quarter growth rates are calculated on raw data in order to better evaluate the similarity of the seasonal patterns.

In particular, for the construction sector the BWWF data are available from January 1995. However, they only refer to regular hours worked by blue-collars and apprentices. In order to derive the total hours worked, the overtime hours have to be estimated. Such estimation is performed using a short-term indicator released by LES survey, that is the percentage share of overtime on regular hours of blue collars and apprentices. As the construction sector has been covered only since January 2000, the share applied for the years 1995-1999 was computed as average of the monthly percentage share observed over the years 2000-2004. Then, the per capita hours worked are finally derived using the BWWF number of blue collars and apprentices. The disaggregation of SCI-PMI annual data using BWWF does not overcome clearly the disaggregation with the LFS indicator as the results are almost equivalent. However, the BWWF indicator was eventually selected as it assured more coherent results with the production index in the construction sector.

As far as section H is concerned, a detailed analysis has been performed over the span from the third quarter 2003 up to the third quarter 2005 using the preliminary data drawn from VELA survey that collects hours worked in small and medium enterprises with more than 9 employees, whose hours worked final estimates will be available by 2010. This study shows the unsuitability of the LES indicator as related indicator to disaggregate SBS data (ISTAT, 2006b). In fact, the seasonal pattern transmitted to the disaggregated data is typical of the large enterprises, with deep drops at the third quarters. Then LFS data were analysed. Although their seasonality is less regular, they do not exhibit deep falls at the third quarters. Provisional data drawn from VELA survey, covering about 85% of firms and a very short span, have peaks at the same quarters. Therefore LFS data were chosen as related indicator to disaggregate SBS data. As mentioned in paragraph 3.2.1, LFS time series have a structural break occurring in the first quarter 2004 and the back-data are available at a narrow activity breakdown not directly utilizable (the aggregation of sections G and H). In order to derive the per-capita hours worked only for section H, the following steps are performed:

1) derivation of the quarterly time series concerning both per-capita hours worked (regarding only the reference week) and employees for the aggregate G-H;
2) computation of the quarterly total hours worked multiplying the per-capita hours worked by the number of weeks of every quarter and the number of employees (for the aggregate G-H again);
3) splitting of hours worked and employees between sections G and H through:
   i. the computation, for each variable, of the quarterly shares (based on the years 2004-2005 from the new continuous LFS) of each sector out of the total amounts;
   ii. the application of the previous shares on the quarterly aggregates G-H from 1996 up to 2003, deriving the quarterly figures for G and H, separately;
4) computation of per-capita hours worked for section H and linking with the data drawn from the new continuous LFS;
5) removal of outliers (treated as additive outliers) with TRAMO-SEATS tool (Gomez and Maravall, 1996).

The output of the latter step represents the related indicator used to disaggregate the SBS annual data for NACE section H.

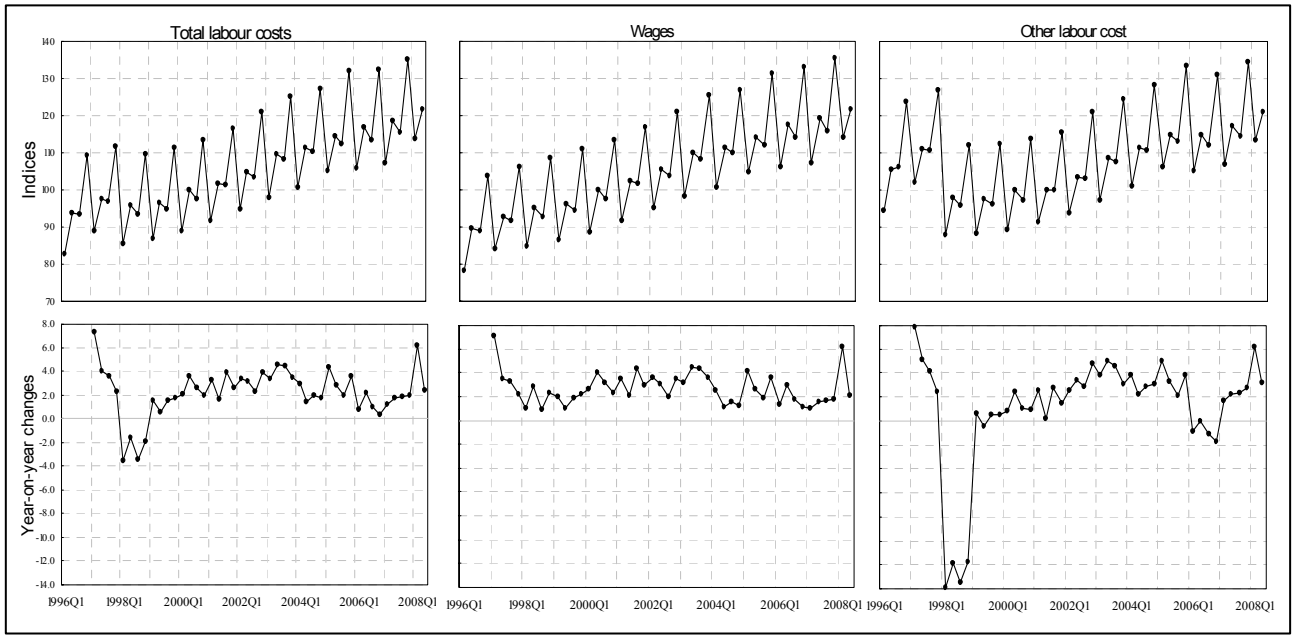
For the sake of completeness, it is worth stressing some further issues. Firstly, in the equation used to disaggregate annual hours worked only one related indicator is considered; however, when the relationship between annual data and the related indicator is poor one dummy variable (at most two dummy variables) is included in the model. Secondly, apart from the construction sector, whose BWWF hours worked are available since January 1995, both LES and LFS worked hours time series start in 1996. Thirdly, an *ad-hoc* intervention is carried out on LES indicator referring to I section on the first quarter 2002: through TRAMO-SEATS tool, the original figure is replaced after having removed an additive outlier. Finally, since the collection process of the BWWF archive is rather slow and ends after about one and a half year, the last observations of the related indicator used to disaggregate SBS data of the construction sector are provisional and are revised several times.

4. The LCI time series

4.1. The dynamic of the quarterly LCI

As introduced in the previous paragraphs the Labour Cost Index shows the short term development of the hourly labour cost in charge of the employers for engaging labour work force, namely wages and salaries and labour costs other than wages. A short analysis on the Italian LCI time series between the first quarter 1996 and the second quarter 2008 shows a growing trend of the indicator characterized by a strong periodicity as clearly highlighted by regularly spaced peaks (Figure 1).

Figure 1: *Total hourly labour cost series for the aggregate C to K NACE Rev.1.1. Index (year 2000=100) and Y-on-Y quarterly growth rates (%) - Q1:1996-Q2:2008*



The main component of the total labour cost are wages and salaries covering roughly two-thirds of the aggregated cost. This variable is responsible for the typical periodic profile detected for the aggregate, with the highest peaks laying in the fourth and second quarters (Figure 1). The yearly maximum values referred to the fourth quarters are explained by the annual payment of an additional sum equivalent to one month's pay, regularly distributed in December (13th month pay). Besides, a supplementary payment commonly distributed in June, fixed or linked to productivity or profitability parameters, causes the peaks detected in the second quarters.

More in general, the dynamic of the Italian gross wages is largely determined by the national collective agreements that should firstly reflect the prices evolution. Actually, the adjustment of wages to inflation is not regularly applied because of delays in the collective agreement renewals with respect to the scheduled times. In addition, gross wages are established through a second level firm or territorial wage bargaining, that should be linked to some specific economic indicators. However, this second component is mainly concentrated in large enterprises.

Looking at the year-on-year changes, that neutralize the most regular periodic behaviours of the analyzed indicator (Figure 1), the gross wages time series starts with the highest value in the examined period. This anomalous occurrence is motivated by an exceptional concentration of collective agreement renewals, interesting about the 70% of the private employees and incorporating the high levels of inflation occurred in the previous years. These effects are gradually absorbed in the following quarters characterized by decreasing growth rates. Starting from 2000 and for about 4 years, higher values of the year-on-year changes can be observed again. This dynamic is driven by two main effects: a new wages bargaining wave occurred in the first two years, supported by the payment of some bonuses,

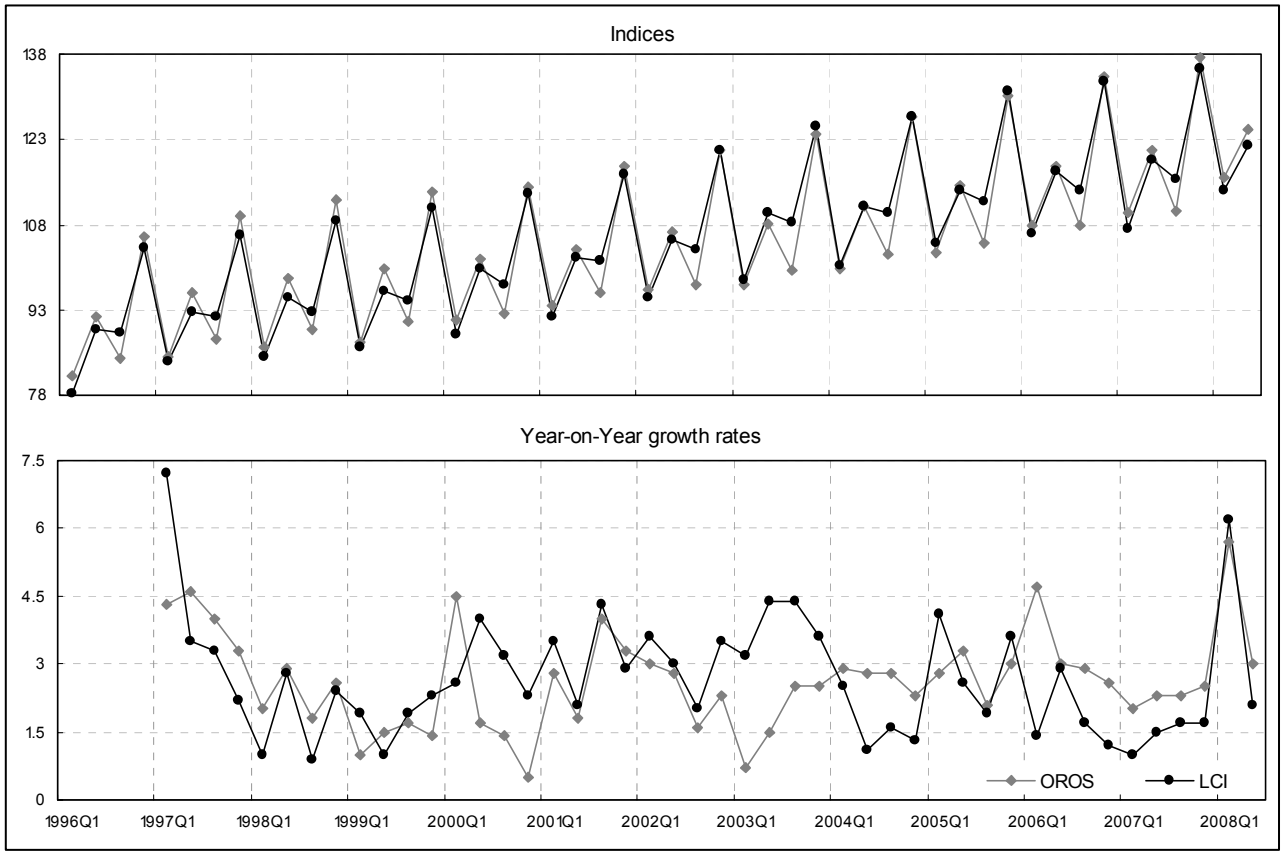
and a phase of economic slowdown affecting also the hours worked. In the last years of the analyzed period, from 2004 to 2008, a weak economic acceleration leads to an increase in the hours worked. In the meanwhile a wage moderation phase is observed, mainly due to a complex bargaining period causing a vacancy in the collective agreements renewal. The accelerating inflation and the lack of an automatic adjustment of wages to the prices growth protracted the wage negotiations. This complex bargaining period brings to a generalized collective agreements renewal whose effects are evident on the first quarter 2008 changes, when a strong wage increase is observed.
The second component of the LCI, the other labour costs, is strictly correlated to wages resulting as the application of contribution rates on the remuneration. Nevertheless, it is also influenced by the legislative changes in the contribution system that explain the differences in the dynamic between wage and non-wage costs. The most evident change concerning the social contribution system occurs in 1998[14], implying a level shift of the whole time series (Figure 1). Further slight reductions of some contribution rates occurs in 1999 and 2006 explaining the slower other labour cost growth rates compared to wages.

4.2 The Italian LCI in comparison to the other national quarterly labour cost indicators

The main short-term indicators on the evolution of labour cost for Italian businesses published at national level are, at the moment, the quarterly Oros indices. These indicators measure the quarterly changes on gross wages, other labour costs and total labour cost per full time equivalent (Fte) jobs for the private non-agricultural firms with at least one employee. As above mentioned (see § 1), they are produced using the data drawn from the quarterly Oros survey and released by the Italian National Institute of Statistics at about 70-74 days from the end of the reference quarter.
For better understanding the meaning of the LCI hourly indicators, a comparison with the Oros time series may be greatly useful.
The Oros indices are produced at section level and for the three aggregates of industry, services and total economy (C to K of the Nace Rev.1.1 classification). The indices are compiled as the ratio of aggregate values in the quarter *t* of year *j* to the average of the aggregate values in the base year *k*. In practice, as regards the numerator, the price per unit of quantity (gross wages, other labour costs and total labour cost per Fte), is multiplied by the number of quantity units (Fte jobs). At the denominator, the annual values are calculated as the arithmetic average of the quarterly values referred to the base year.
The figure 2 shows the comparison between the Oros and LCI indices referred to the period from the first quarter 1996 to the second quarter 2008, both in base year 2000.
The indices on gross wages show a similar trend characterized by an increasing and seasonal profile. Some differences in the seasonal pattern emerge due to the peculiarities of the different denominator of the two indicators. In particular, the main discrepancies are referred to the third quarters when the LCI hourly gross wages indices have higher values than the Oros gross wages per Fte ones. In fact, while the numerator of the two indicators is defined (see § 2) and measured in the same way and includes also payments for days not worked, the denominator of the hourly indicator is made up of hours actually worked (see §3.2), therefore excluding holidays. That explains the higher values of LCI in the third quarters when employees take much of their leave.
Moreover, the year-on-year growth rates highlight some discrepancies between the two sources which seem not to be systematic along the entire period analysed. The higher differences emerge in the period from the second quarter 2000 to the fourth quarter 2003, when the dynamic of the LCI hourly gross wages is faster than that of the Oros indicator, reaching 2.9 percentage points in the second quarter 2003. On the contrary, over the span from the first quarter 2004 up to the second quarter 2008 the LCI indicator is mainly characterised by a lower increasing, especially in the first quarter 2006 (spread of -3.3 percentage point).

[14] From 1998 the National Health Service contribution paid as percentage of wages by the firms have been cancelled and in the meantime all business with or without empoyees have to pay a new regional tax on production base on added value. This caused a sharp decline of other labour costs between 1997 and 1998.

Figure 2: *Gross wages per fte (OROS) and per hours worked (LCI) for the aggregate C to K Nace Rev.1.1 (year 2000=100).*



A more in deep analysis has stressed that the reasons of these differences are to be found largely in the different labour input unit used as the indices denominator, but also in the different formulation of the indices. The first factor influences the different dynamics above analysed, in particular the period of LCI higher growth is related to a lower increasing of the hours worked in comparison with the Fte employment dynamic, while from the first quarter 2004 onwards the Fte units growth was higher than those of the hours worked causing an opposite performance.

In addition, the second reason is not negligible as well. The calculation method of the index gives a contribution to the discrepancies analysed. To asses that contribution, the Oros indicator has been compiled, using the same formula of the LCI, as a chain Laspeyres index. Such an index has shown a faster dynamic in the entire period. The differences between the year-on-year growth rates of a simulated Oros chain Laspeyres index and the current Oros indices are equal to 0.2 percentage points on average, reaching the highest value in the second quarter 2003 (0.6 percentage points). This implies that the different index formula of the LCI and Oros indicators lead to wider positive discrepancies and narrow negative ones on the quarterly changes.

The figures 3 and 4 show the comparison between the LCI and Oros indicators on the other labour costs and total labour cost. The results of the analysis on indices and year-on-year changes concerning these two variables are similar to those emerged on gross wages. Then, the seasonal pattern of these variables indices show the same discrepancies in the third quarter due to the denominator, as above illustrated. The comparison between quarterly year-on-year changes confirms similar spreads to those observed for the gross wages. It means that the differences and their causes do not change when the variables considered at the numerator are other labour costs, total labour cost or wages and salaries.

Figure 3: *Other labour costs per fte (OROS) and per hours worked (LCI) for the aggregate C to K Nace Rev.1.1 (year 2000=100).*

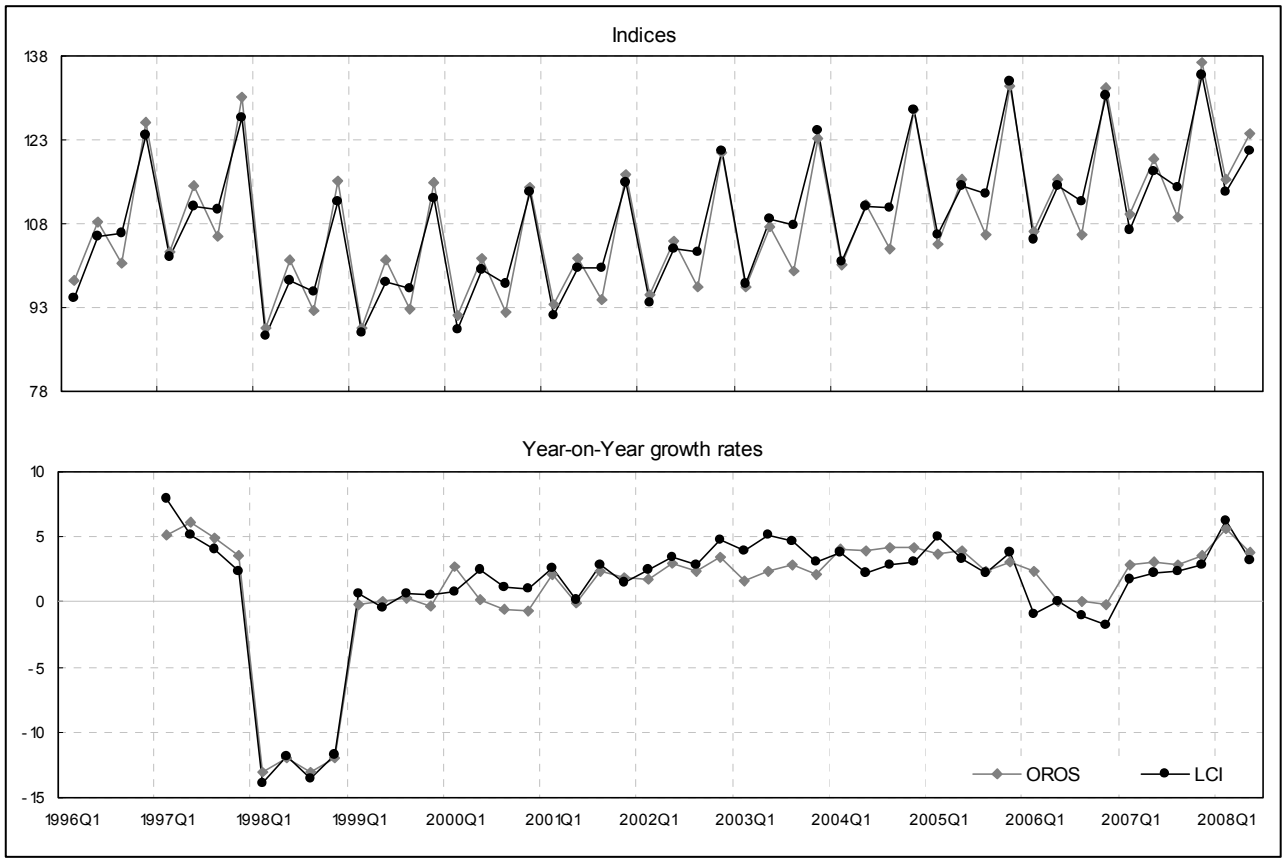
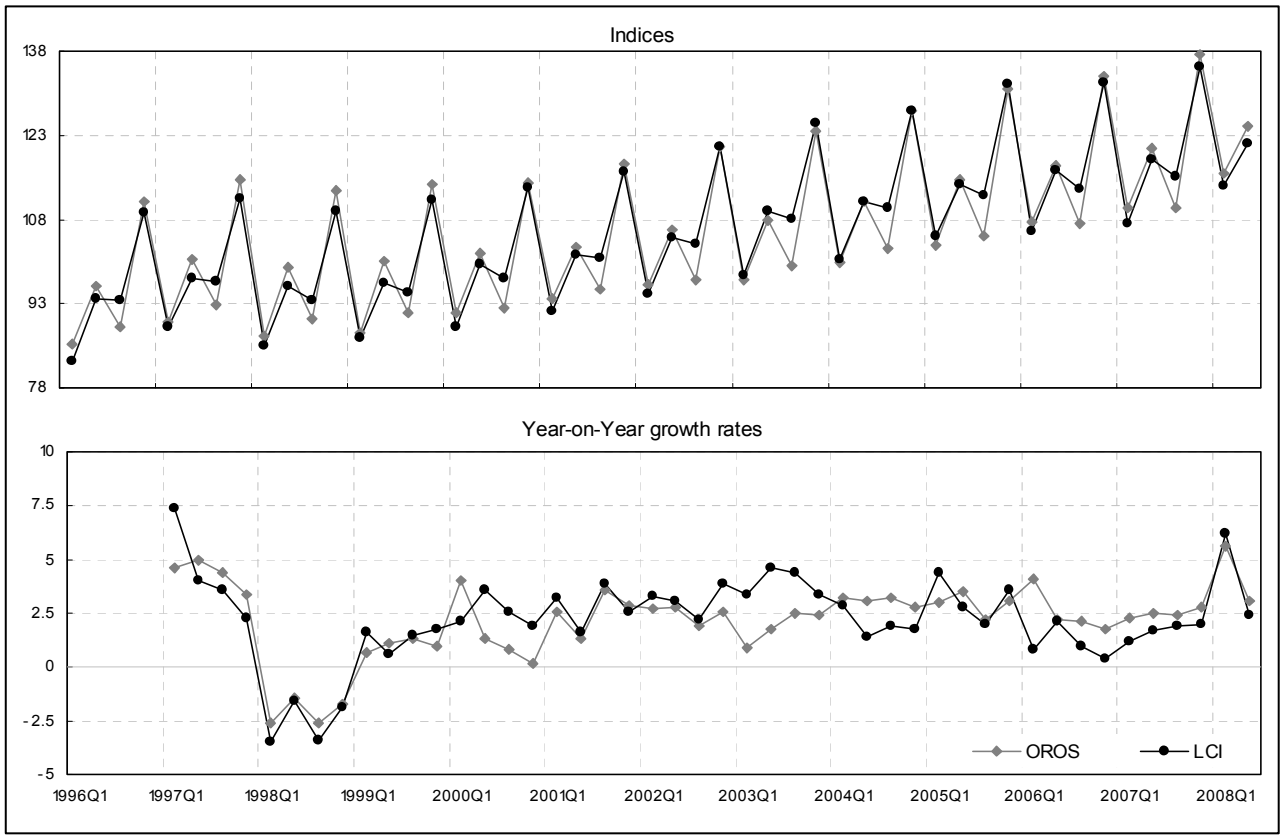


Figure 4: *Total labour cost per fte (OROS) and per hours worked (LCI) for the aggregate C to K Nace Rev.1.1 (year 2000=100).*



4.3 Coherence of the Italian LCI with comparable National Accounts data

The coherence with the National Accounts data is an important aspect to assess the quality of the Italian LCI. In fact, Eurostat has required (see the annex 1 of the Commission Regulation N.1216/2003) that the LCI annual quality report (Istat, 2008) includes a comparison with the Quarterly National Accounts (QNA) figures on compensation of employees per hours worked. However, only after the first regular national release of the Italian QNA data on hours worked in August 2008, it has been possible to compare the Italian LCI with the QNA compensation of employees per hours worked according to the ESA 95 definition.

When comparing LCI indices and QNA data it is worthwhile not forgetting the large differences in coverage, concepts, definitions and sources:

- the QNA data coverage in terms of employment includes regular and irregular workers (those latter workers active in the underground economy have a share of about 16% on the total work); irregular workers are absent in the LCI.
- the QNA data include managers which are excluded from the OROS survey that represents the main source of the LCI numerator.
- the QNA data are estimated on accrual basis, following the ESA 95; as opposite, the LCI (Oros) data refer to cash.
- the variables have some differences in definitions: in QNA the gross wages include the wage in kind and tips. The Oros survey does not cover tips and includes only very partially wages in kind.
- The QNA hours worked estimates are mainly based on Labour force survey data because of their longer time series and coherence with the QNA employees and self-employed estimates. Instead, the hours worked used as the LCI denominator have been estimated using mainly data drawn from business survey to assure the coherence with the LCI numerator (see § 3.2).

The QNA employees' compensation and wage amounts have been divided by the QNA hours worked to obtain hourly indicators comparable with the LCI. Also, the other labour costs, obtained as difference between the two previous variables, are divided by the hours worked. Before analysing the QNA and LCI series, it is necessary to highlight that the LCI is compiled as a chain Laspeyres index (see § 2), while the QNA is calculated as the ratio of the aggregate values in the quarter *t* of year *j* to the average of the aggregate values in the base year *k*[15].

The following figures show the year-on-year quarterly growth rates of QNA and LCI indices and their differences in terms of percentage points over the period from the first quarter 1997 to the second quarter 2008. The analysis is referred to the time series on wages (Figure 5), other labour costs (Figure 6) and total labour cost (Figure 7) per hours worked, and limited to the non-agricultural private sector, excluding government and private non-profit institutions (C to K in Nace Rev.1.1).

On the whole, the QNA and LCI series are highly correlated and their patterns are very similar. Analysing the QNA and LCI quarterly year-on-year growth rates, it is relevant to note that the discrepancies in the series do not have always the same sign but show a non-regular alternation during the observed period. This randomness in the discrepancies excludes a systematic gap between the two sources.

Focusing on gross wages series, the growth rates spreads in absolute values are on average, calculated in the entire period, equal to 0.9 percentage points and they reach the maximum size of 2.3 in the second quarter 2005.

Looking at the wider differences, it emerges that the QNA gross wages growth is faster than that of the LCI mainly in two periods: from the second quarter 1998 to the third quarter 1999 and from the second quarter 2005 to the second quarter 2006. On the opposite, the dynamic of the QNA series is

[15] The numerator is the price per unit of quantity (employees compensation, wages and other labour costs per hours worked) multiplied by the number of hours worked; the denominator is the arithmetic average of the quarterly values referred to the base year 2000.

lower than that of the LCI from the third quarter 2002 to the fourth quarter 2003. The several reasons are to be found in the differences in the coverage, definitions and sources affecting both the numerator and the denominator; in the hours worked estimation methods and in the formula used to compile the indices.
Analysing the same differences on non-wage costs and total labour cost, they are on average similar to those of the gross wages (respectively 1 and 0.9 percentage points); the other labour costs presents the maximum value of 2.6 in the first quarter 2000. The comparison between the discrepancies on wages and other labour costs (Figures 5 and 6) shows that their sign is the same until the fourth quarter 2003, while their magnitude, regarding to the other labour costs, is larger over a span from the four quarter 1999 to the third quarter 2000. The sign of these discrepancies is random reversed from the first quarter 2004 onwards.
In the comparison of LCI and QNA data on other labour costs and total labour cost, the same reasons above pointed up for the wages series discrepancies are valid.

Figure 5 : *QNA and LCI wage series for C to K Nace Rev. 1.1 aggregate: quarterly Y-on-Y growth rates (%) and differences in percentage points – Q1:1997-Q2:2008*

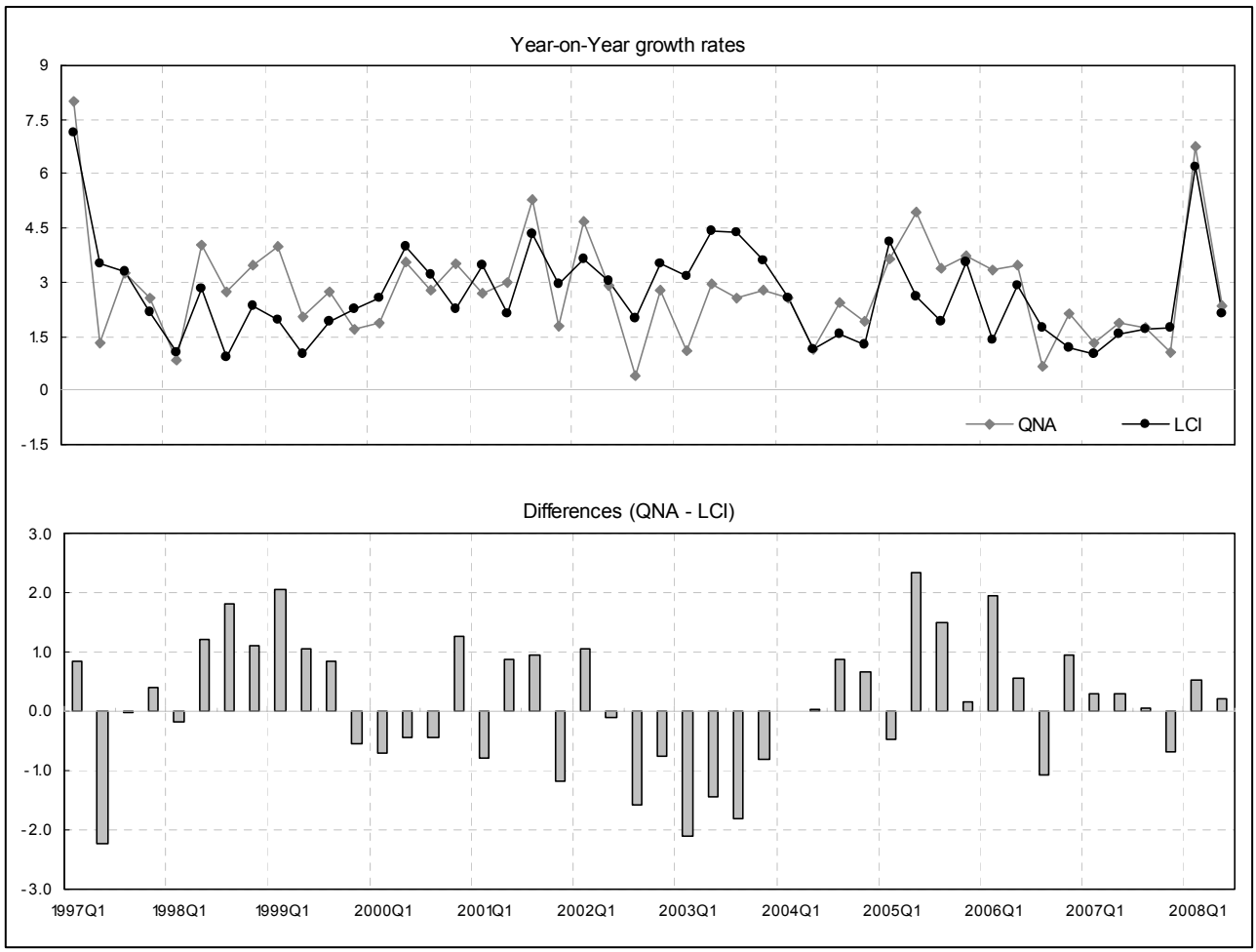


Figure 6: *QNA and LCI other labour costs series for C to K Nace Rev. 1.1 aggregate: quarterly Y-on-Y growth rates (%) and differences in percentage points – Q1:1997-Q2:2008*

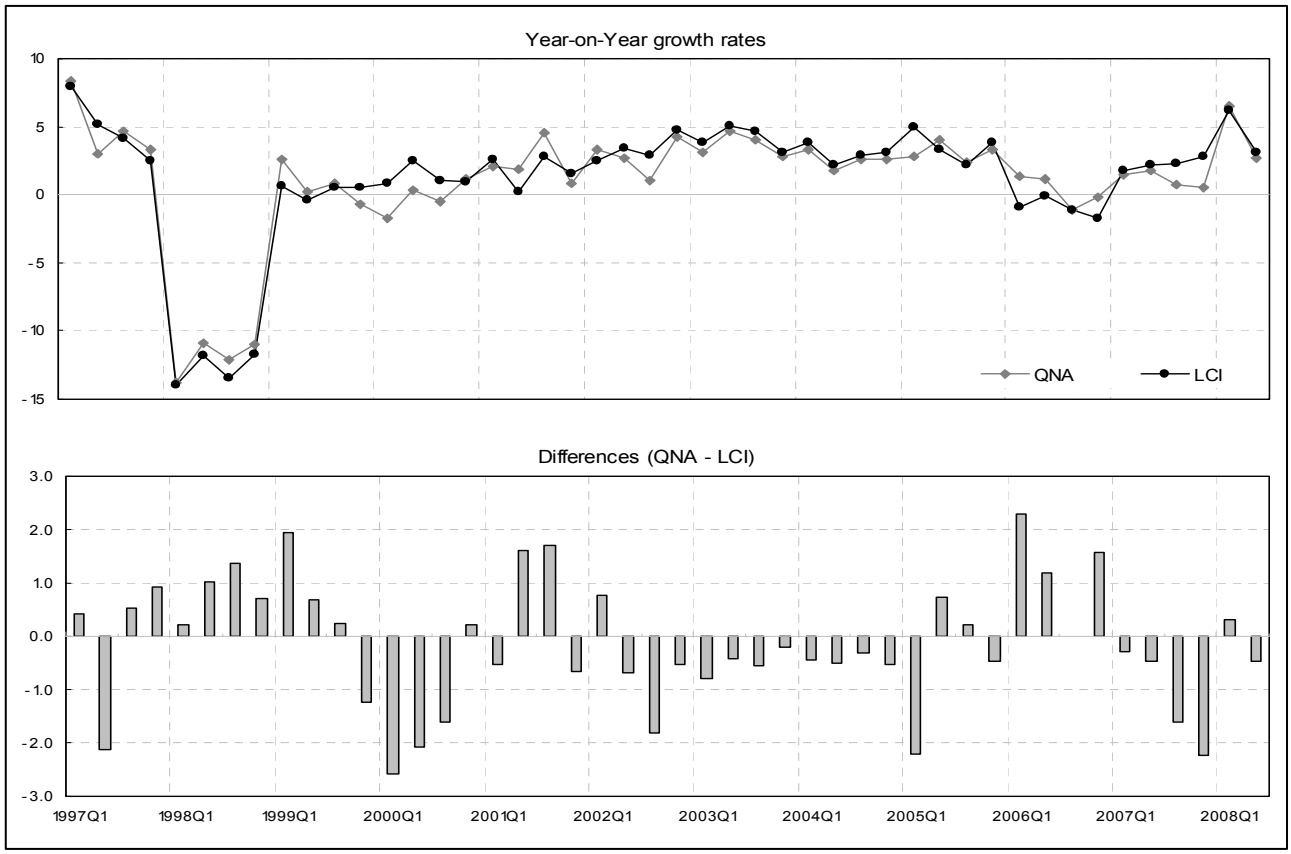
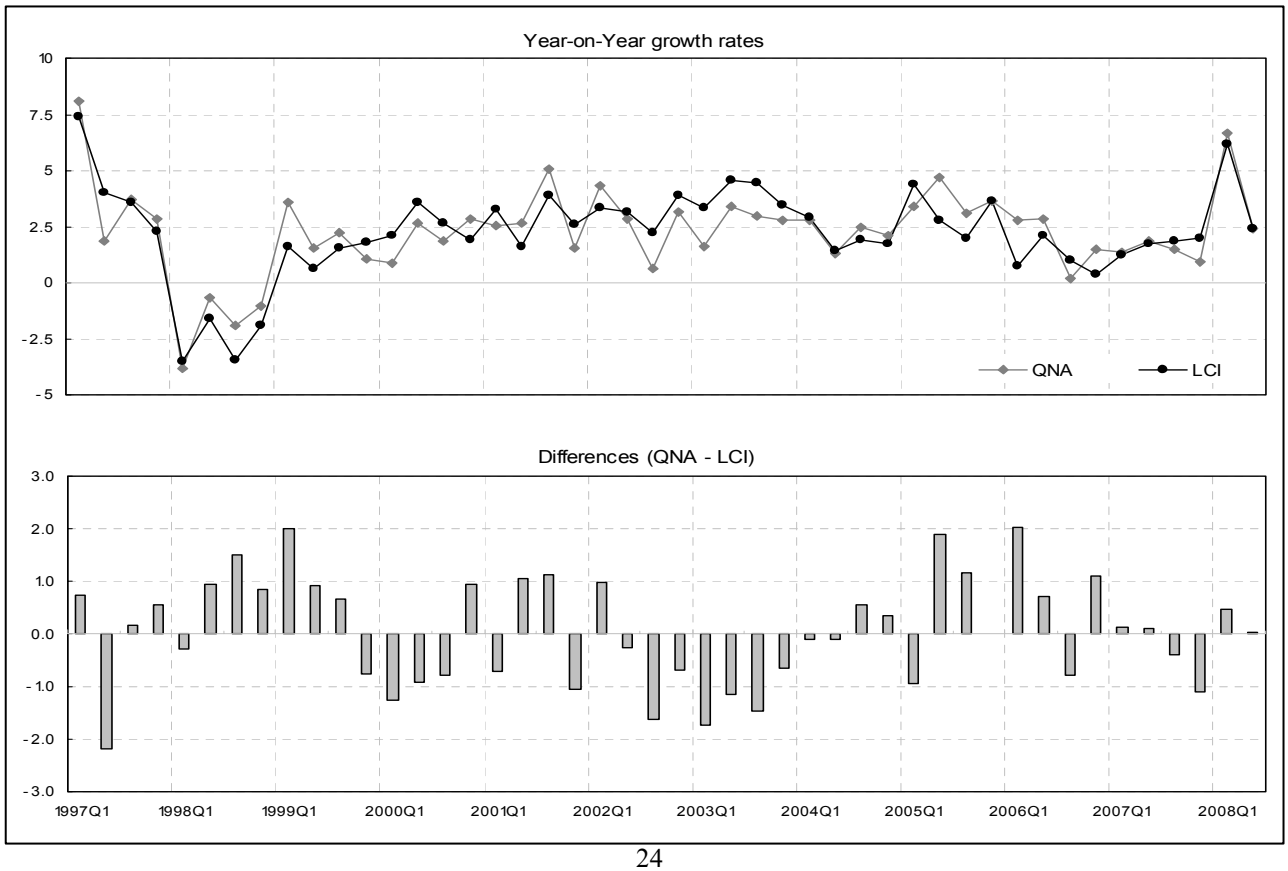


Figure 7 : *QNA and LCI total labour cost series for C to K Nace Rev. 1.1 aggregate: quarterly Y-on-Y growth rates (%) and differences in percentage points – Q1:1997-Q2:2008*



5. The LCI calendar and seasonal adjustment

As revealed in the previous section, the LCI indicators show an important seasonal pattern and are affected by calendar effects. Such factors, representing respectively the stochastic and the deterministic parts of the seasonal component, affect both the numerator and the denominator of the labour cost per hour worked altering the analysis of both the quarter-on-quarter and the year-on-year growth rates. In particular, the seasonal pattern of the wages and consequently, of the other costs and of the total labour cost, is featured by a medium peak at the second quarter and a larger peak at the fourth quarter, while the seasonal pattern of hours worked is more instable and almost always displays a drop at the third quarter. On the other hand, the calendar component, due to the structure and composition of calendar, affects the wages and the other labour costs in a marginal way because it mainly reflects the payment of overtime work, while it is more significant for the hours worked because of the statistical method adopted for their estimation.
In accordance with the Commission Regulation (EC) No 1216/2003 implementing the Regulation (EC) No 450/2003, seasonal and working-day adjustment of the labour cost indices is an essential part of their compilation, since adjusted series make it possible to compare results and to interpret subsequent values of indices. Consequently, LCI indices are transmitted in the following forms: unadjusted, working-day adjusted and seasonally adjusted (i.e. adjusted for both stochastic seasonality and calendar effects).
The following subsections focus on some methodological and practical issues concerning the seasonal adjustment. It is worth stressing that in the treatment of the LCI time series the direct approach is performed, i.e. each series is analysed and treated independently, neglecting the relationship between the total labour cost and its components and between the NACE sections and the overall indices.
The programs TRAMO "Time Series Regression with ARIMA Noise, Missing Observations and Outliers" and SEATS "Signal Extraction in ARIMA Time Series" (Gomez and Maravall, 1996) are used. In particular, the former is used to correct, among other effects, calendar effects and to produce forecasts and backcasts through reg-ARIMA models; the latter is used to estimate the seasonally adjusted series through the ARIMA-model based (AMB) approach. More often than not, they are used together.

5.1. The calendar adjustment

The structure and composition of the calendar can affect economic activities in different ways. Calendar effects typically include:
- the different number of working days on a specific quarter;
- National holidays falling on working days;
- the leap year effect;
- moving holidays such as Easter, that can fall in the first quarter or in the second quarter.

As stated in the ESS guidelines on seasonal adjustment, recently released by Eurostat (Eurostat, 2009), it is important to note that part of the calendar effects is seasonal so that it is removed by the standard seasonal adjustment filters. As a consequence, calendar adjustments, as pre-treatment of seasonal adjustment, have to deal only with the non-seasonal part of the effects mentioned above.
The calendar adjustment in Italian LCI indices is carried out using the regression approach through TRAMO-SEATS. Given a time series $y(t)$, the regression approach estimates a regression model with ARIMA (AutoRegressive Integrated Moving Average) residuals (reg-ARIMA model):

$$y(t) = \mathbf{x}'(t)\boldsymbol{\beta} + z(t) \tag{8}$$

where $\mathbf{x}'(t) = (x_1(t), x_2(t), ..., x_n(t))$ contains the regressors related to the calendar effects[16], $\boldsymbol{\beta} = (\beta_1, \beta_2, ..., \beta_n)'$ contains the coefficients to be estimated and $z(t)$ follows an ARIMA process:

$$\phi(B)\,\delta(B)z(t) = \theta(B)a(t) \tag{9}$$

where B is the backshift operator such that $B\,z(t) = z(t-1)$, $\phi(B), \delta(B)$ and $\theta(B)$ are finite polynomials of order p, d and q and $a(t)$ is a white noise i.i.d WN(0, σ_a^2).
After the estimation, $\mathbf{x}'(t)\hat{\boldsymbol{\beta}}$ represents the deterministic calendar component. The calendar adjusted series $\hat{z}(t)$ is then derived removing it from the original raw series:

$$\hat{z}(t) = y(t) - \mathbf{x}'(t)\hat{\boldsymbol{\beta}}\,.^{17} \tag{10}$$

When the calendar component is multiplicative, the calendar adjusted series is computed through:

$$\hat{z}(t) = y(t) / \exp\{\mathbf{x}'(t)\hat{\boldsymbol{\beta}}\}\,.^{18} \tag{11}$$

Since neither the Easter effect nor the leap-year effect are statistically significant, in the adjustment of LCI indices, only one regressor is considered. For each quarter *t*, it takes into account the effects due to both the number of working-days (Monday, Tuesday, …, Friday) and the National holidays not falling on week-ends:

$$x(t)^* = td - h(t) = (\#Mon(t) + \#Tue(t) + ... \#Fri(t) - \#Hol(t)) - 5/2(\#Sat(t) + \#Sun(t) + \#Hol(t)). \tag{12}$$

Since the regressor $td - h(t)$ has a significant mean, in order to avoid that the calendar adjustment could modify the original level, it is used in a slightly different version, namely:

$$x(t) = (td - h(t)) - Mean(td - h(t))\,, \tag{13}$$

where $Mean(td - h(t))$ is computed over the 1996-2020 span. This long period, up to 2020, avoids future changes in the regressor when new observations become available.
The criteria used to assess the significance of the calendar effects are: statistical criteria, namely *t*-value and BIC (Bayesian Information Criterion) value, and the sign of the estimated coefficient, which is expected to be negative. If the statistical criteria are fulfilled then the sign is considered. Actually, working-day effects may affect both components of the LCI indices, wages/other labour costs and hours worked, but the latter is affected in a much stronger way. In fact, wages and consequently other labour costs may be either fixed (independent of the number of working-days and the hours worked) or linked to the hours worked for a negligible share concerning especially the overtime work. As a consequence the calendar effects of hours worked should dominate those of labour costs.
The operating procedure carried out to adjust LCI indices for calendar effects consists of three steps:
1. estimation of the REG-ARIMA models with TRAMO;
2. calculation of the calendar adjusted series;

[16] Actually, other deterministic components could be included, for example outliers (usually additive outliers, temporary changes, level shifts and seasonal level shifts), intervention variables, etc.
[17] When the regressors include only calendar effects (excluding outliers and other effects) the series $\hat{z}(t)$ adjusted for calendar effects corresponds to the *linearized* series.
[18] The multiplicative model, unlike the additive one, adjust the original series for a calendar component proportional to the its level. This proves to be an important property when the figure to be adjusted is particularly small (for further details http://www.istat.it/strumenti/metodi/destag/produzione_industriale/effetti_calendario/) .

3. re-scaling such adjusted series so that the arithmetic average is equal to 100 for the base year.
In particular, the indices adjusted for calendar effects refer to wages, other costs and total labour cost for NACE sections D, E, H, J and K and for the overall aggregate C-K (see table 2). As stated above, the direct approach is used, therefore each series is treated independently. In order to ensure coherency among the three variables, the adjustment of wages and total labour costs is sometimes imposed on the other costs indices.[19] Results are displayed in section 5.3.

5.2. The seasonal adjustment

When time series show seasonal features, due to seasons and climate, habits and practices (school holidays, summer closing, Christmas shopping, …), administrative rules and deadlines, the seasonal adjustment provides more understandable series, whose subsequent data can be compared to read the recent economic dynamics. However, as seasonality is not precisely defined, seasonal adjustment often depends on the models and the tool used. The program SEATS, performing the decomposition, decomposes $z(t)$ as:

$$z(t) = p(t) + s(t) + u(t) \tag{14}$$

where $p(t), s(t)$ and $u(t)$ are, respectively, the trend-cycle, the seasonal and the irregular components. Sometimes a further component, the so-called transitory component $c(t)$, can be estimated. Seasonal adjustment denotes the particular case in which:

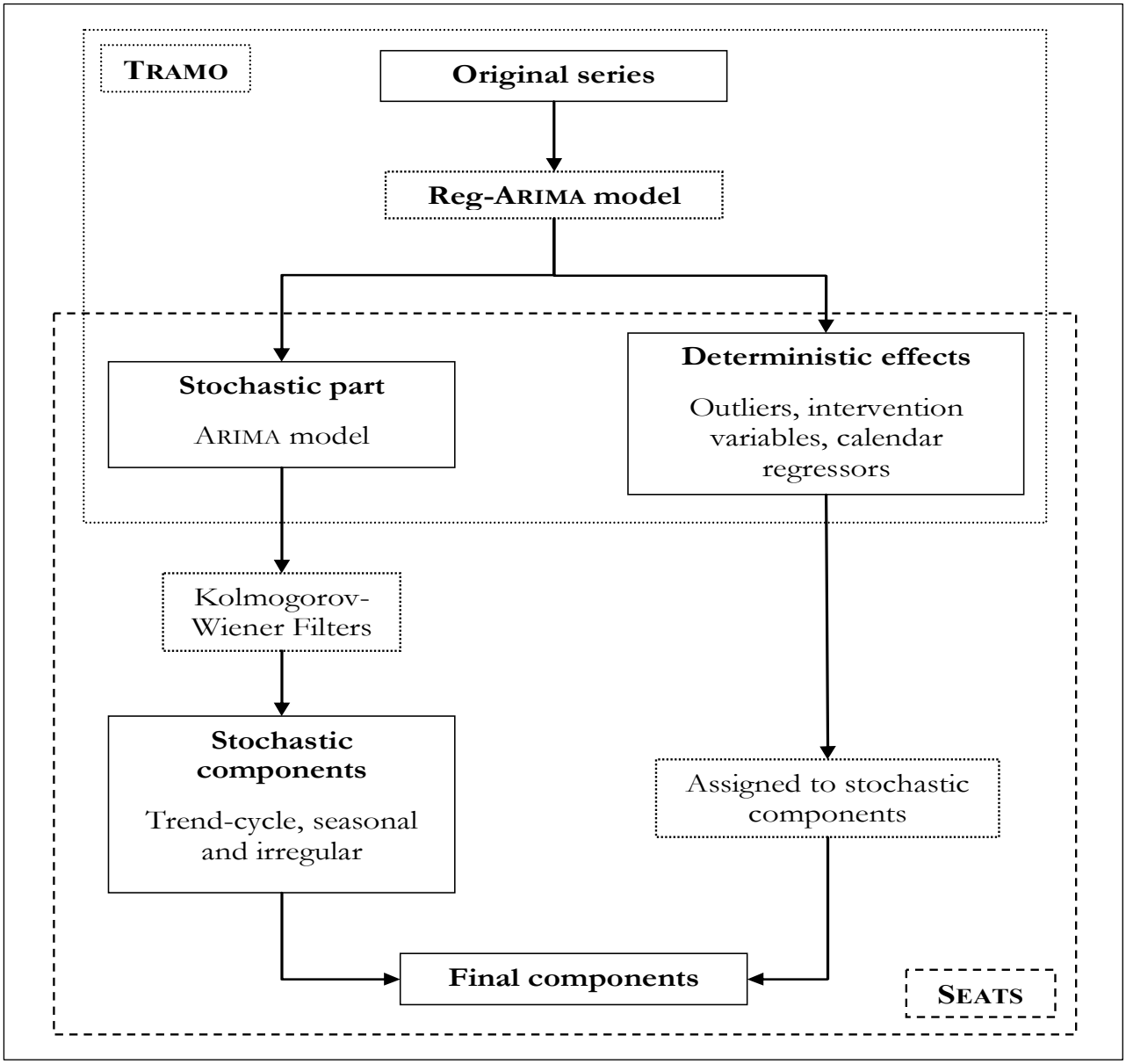
$$z(t) = n(t) + s(t) \tag{15}$$

where $n(t) = p(t) + u(t)$ represents the seasonally adjusted series.

Figure 8 represents the procedure TRAMO-SEATS when they are used together to decompose a time series.
Firstly the original series is processed by TRAMO, that identifies and estimates a REG-ARIMA model, produces forecasts and passes both the *linearized* series and the determistic effects to SEATS. Secondly the latter decomposes the *linearized* series through the Kolmogorov-Wiener filters, computes both standard errors and forecasts for the components and returns the final components together with their standard errors and forecasts assigning the deterministic effects in accordance with their nature. The stochastic components coincide with the final ones whenever the deterministic effects are null.
The design of this procedure is very similar to X-12-ARIMA (US Census Bureau, 2007), based on a REG-ARIMA modelling subprogram and on the X-11 module performing the decomposition through moving average filters. The main difference between the two procedures lies in the nature of the filters. In fact, while Seats derives symmetric, centred and convergent filters of infinite length from ARIMA models for the components (in turn derived from the ARIMA model estimated for the series to be decomposed), X-11 derives components through an iterative process utilizing suitable moving averages.

[19] The indirect approach is computationally more expensive. In fact the calendar adjustment should be firstly performed on the related indicators of hours worked using reg-ARIMA models, then on the SBS annual data using a proportional approach and finally on the labour cost variables.

Figure 8: *Seasonal adjustment with TRAMO-SEATS*



The seasonal adjustment of the LCI indices is performed together with the calendar adjustment according to the direct approach. In fact, with a single run of TRAMO-SEATS for each series, both the calendar effects and the seasonality are estimated, and consequently, after minor interventions, both calendar adjusted series and seasonally adjusted series are produced. Moreover each series is treated independently of the others, according to the direct approach. This allows to take into account the particular features of each series in the signal extraction, but it does not ensure coherent results (particularly coherent quarter-on-quarter growth rates) either between components (wages/other costs) and aggregates (total labour cost), or between NACE sections and overall indices. In order to avoid this lack of coherence the indirect approach is being studied, since it derives the seasonally adjusted aggregated indicators as aggregation of seasonally adjusted components through a complex weighting system.

Table 2 summarizes the REG-ARIMA models used to seasonally adjust LCI indicators over the period Q1:1996-Q2:2008, for a total of 50 observations. The model airline is always estimated except for sections E and J, outliers are mostly detected at the first quarters and they are generally due to permanent changes in regulations in force. The related seasonally adjusted series are described in next section.

Table 2: *Reg-Arima models used to seasonally adjust the LCI indicators.*

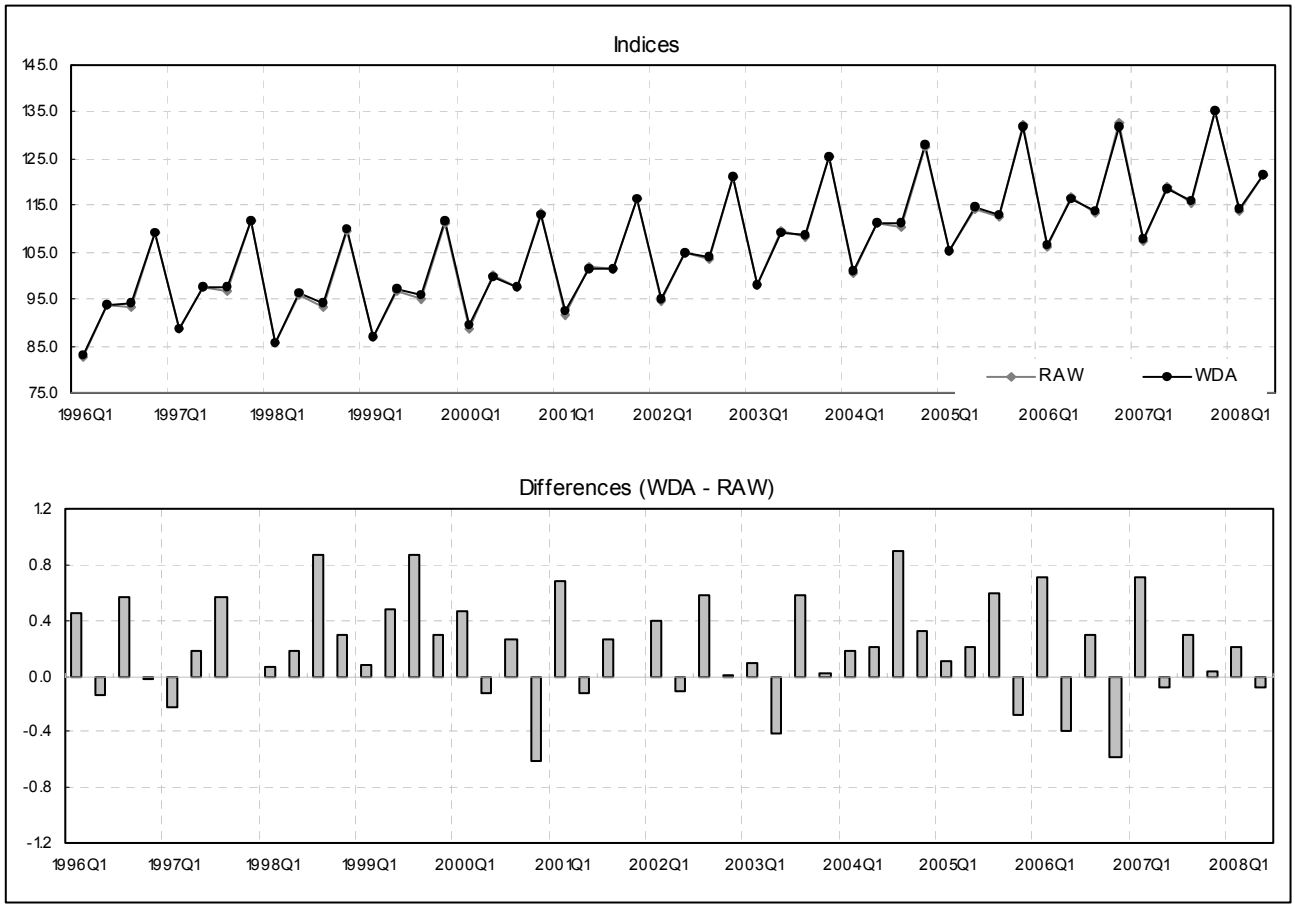
NACE Sections	**C**			**D**			**E**			**F**			**G**		
Variables	**W**	**O**	**T**	**W**	**O**	**T**	**W**	**O**	**T**	**W**	**O**	**T**	**W**	**O**	**T**
Additive decomposition	Y	Y	Y										Y	Y	Y
Constant							Y		Y						
Calendar effects				Y	Y	Y	Y	Y	Y						
Additive outliers				I-08	I-08	I-08									
Level shifts					I-98	I-98		I-98	I-98	I-06	I-98 I-06	I-98 I-06		I-98	I-98
Temporary changes										I-97	I-97	I-97	III-04	III-04	III-04
Airline model	Y	Y	Y	Y	Y	Y		Y		Y	Y	Y	Y	Y	Y
MAPR after 1 quarter	0.23	0.09	0.21	0.10	0.16	0.10	0.75	0.33	0.65	0.08	0.22	0.11	0.20	0.31	0.18
MAPR after 1 year	0.59	0.21	0.58	0.15	0.25	0.16	0.95	0.27	0.79	0.12	0.27	0.17	0.36	0.46	0.33
NACE Sections	**H**			**I**			**J**			**K**			**C-K**		
Variables	**W**	**O**	**T**	**W**	**O**	**T**	**W**	**O**	**T**	**W**	**O**	**T**	**W**	**O**	**T**
Additive decomposition	Y	Y	Y							Y	Y	Y	Y	Y	Y
Constant															
Calendar effects	Y	Y	Y				Y	Y	Y	Y	Y	Y	Y	Y	Y
Additive outliers	II-02	II-02	II-02				II-05 I-08	II-05 I-08	II-05 I-08				I-08	I-08	I-08
Level shifts		I-98	I-98		I-98	I-98		I-98	I-98	I-06	I-98 I-06	I-98 I-06		I-98	I-98
Temporary changes				II-03	II-03	II-03									
Airline model	Y	Y	Y	Y	Y	Y				Y	Y	Y	Y	Y	Y
MAPR after 1 quarter	0.32	0.50	0.39	0.31	0.47	0.42	0.38	0.75	0.43	0.12	0.06	0.11	0.10	0.36	0.14
MAPR after 1 year	0.45	0.54	0.58	0.67	0.69	0.58	0.30	1.05	0.43	0.20	0.09	0.16	0.18	0.58	0.24

Legend: W = Wages – O = Other costs – T = Total costs – Y = Yes – MAPR = Mean of Absolute Percentage Revisions (computed over the last three years comparing the concurrent estimates of the seasonally adjusted data with the estimates derived when one (four) more quarter(s) is available).

5.3. The effect of the working days and seasonal adjustment on the LCI

The removal of the calendar effects from the LCI time series implies (WDA), on the whole, an up shift of the original time series (Figure **9**), confirming the hypothesis that this "disturbing" factor has a stronger effect on the hours worked, at the denominator of the indices. The magnitude of the correction varies along the quarters, depending on the varying number of working days.

Figure 9: *Total hourly labour cost series for C to K NACE Rev.1.1 aggregate, non-working day and working day adjusted. Index (year 2000=100) and differences (points in percentage) – Q1:1996-Q2:2008*

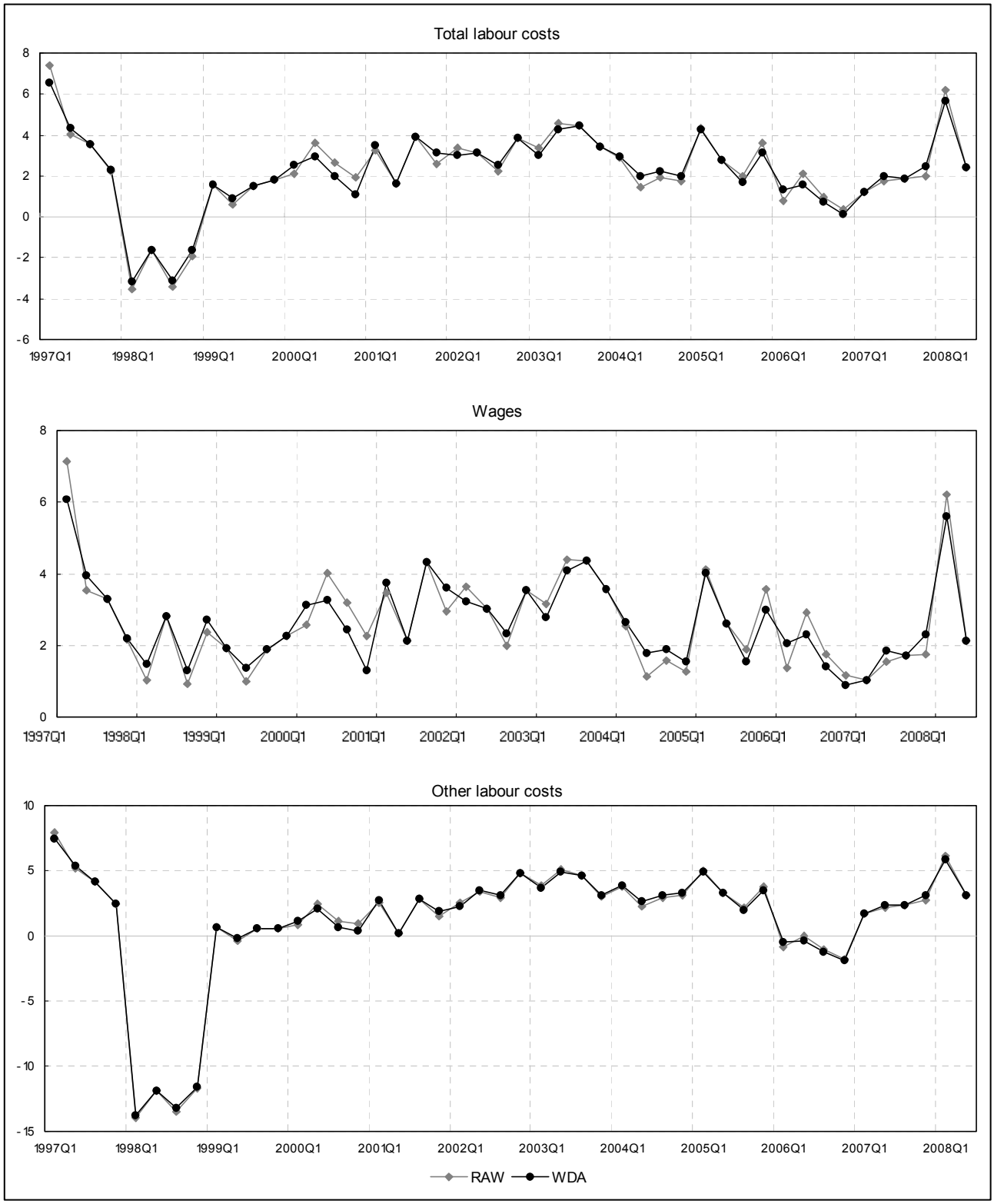


The most significant corrections regularly characterize the third quarters of the index time series, due to the particular low levels of the hours worked concentrated in this period of the year (summer holidays). In general, corrections fluctuate from a level of 1 (observed in third quarter 1998, 1999 and 2004 where the highest number of quarterly working days is registered) to -0.6 percentage points (fourth quarters 2000 and 2006 characterized by the smallest number of working days) (Figure **9**). In the overall period the average correction is of about 0.2 percentage points.

The working-day correction of the LCI appears to be mainly the effect of the adjustment of the wages index. Actually, the other labour costs are not strictly linked to the calendar composition excluding their wage component.

By eliminating possible deviations from the quarter specific average values, the working-day correction should allow a more appropriate comparison between equivalent quarters in two consecutive years. The effect of the correction by the calendar effects on the year-on-year change values is not predictable a priori, depending both on the adjustment of *t* and of *t*-4. In fact, as Figure **10** shows positive shifts alternate negative translations. The most relevant quarter-on-quarter changes correction affects first quarter 1997 reduced by about 1 percentage point (first quarter 1996 was characterized by a larger number of working days and by a particular high level of the hours worked).

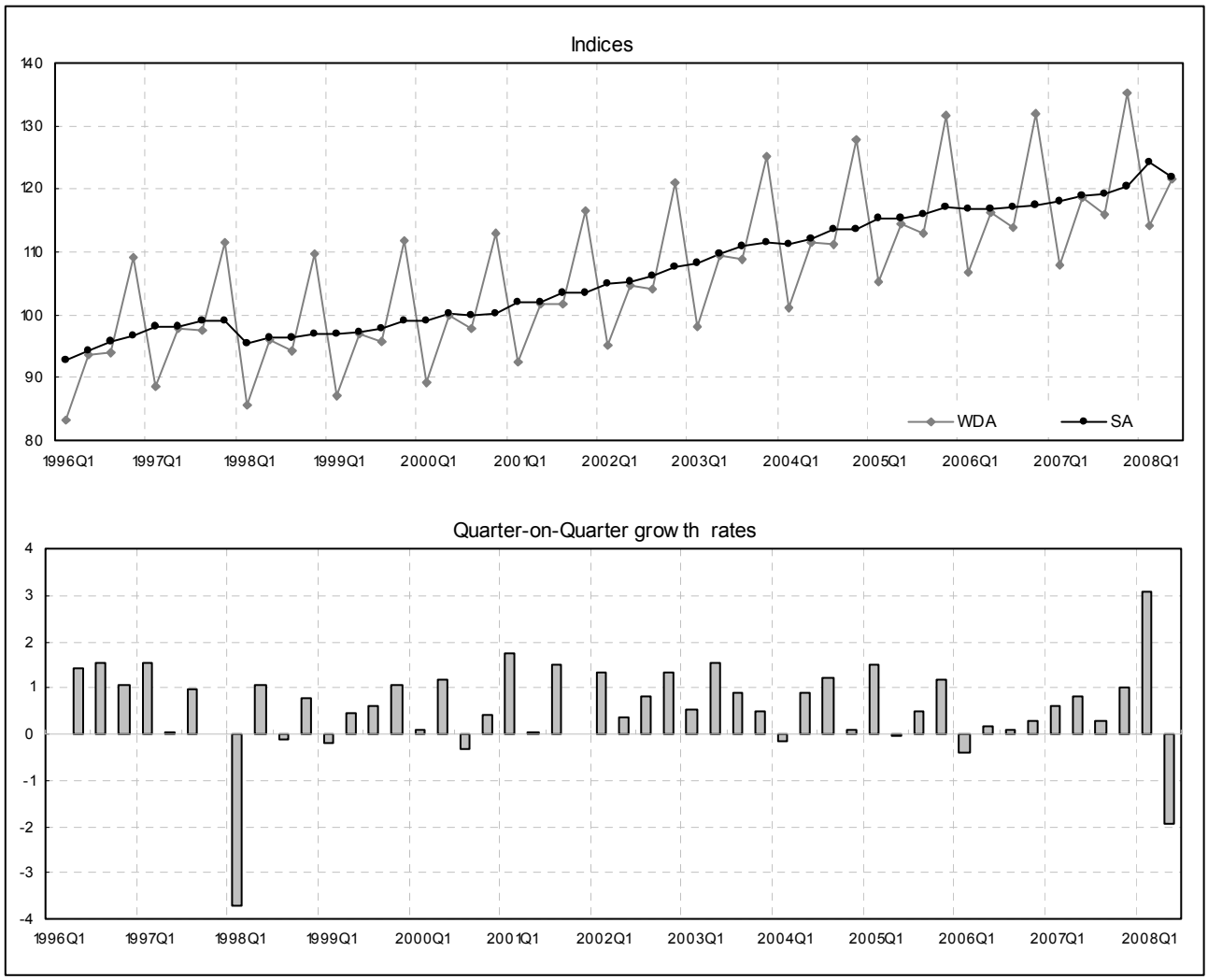
Figure 10: *Total hourly labour cost, wages and other labour cost series for C to K NACE Rev.1.1 aggregate, raw and working day adjusted. Year-on-year percentage changes – Q1:1997-Q2:2008*



Further significant interventions affect the periods ranging from the second to the fourth quarter 2000, due to the combination of a high positive correction in the corresponding quarter of 1999 and a high negative correction in 2000 (the result is a reduction of about -0.7 of the year-on-year LCI variations). High and positive corrections affect fourth quarter 2001, second quarter 2004 and first 2006 (about 0.6 points in percentage) due to the high translations on the relative previous quarters implied by the lower number of working days in these periods.

The characterizing periodic profile emerged in the Italian non-seasonally adjusted LCI series is neutralized through the correction for seasonality (SA) (Figure 11). As far as it concerns the total labour costs, the resulting seasonally adjusted time series highlights a steady rise starting from first quarter 1998 after a sudden fall.

Figure 11: *Total hourly labour cost series for C to K NACE Rev.1.1 aggregate, working day (year 2000=100) and seasonally adjusted. Index - Q1:1996-Q2:2008*



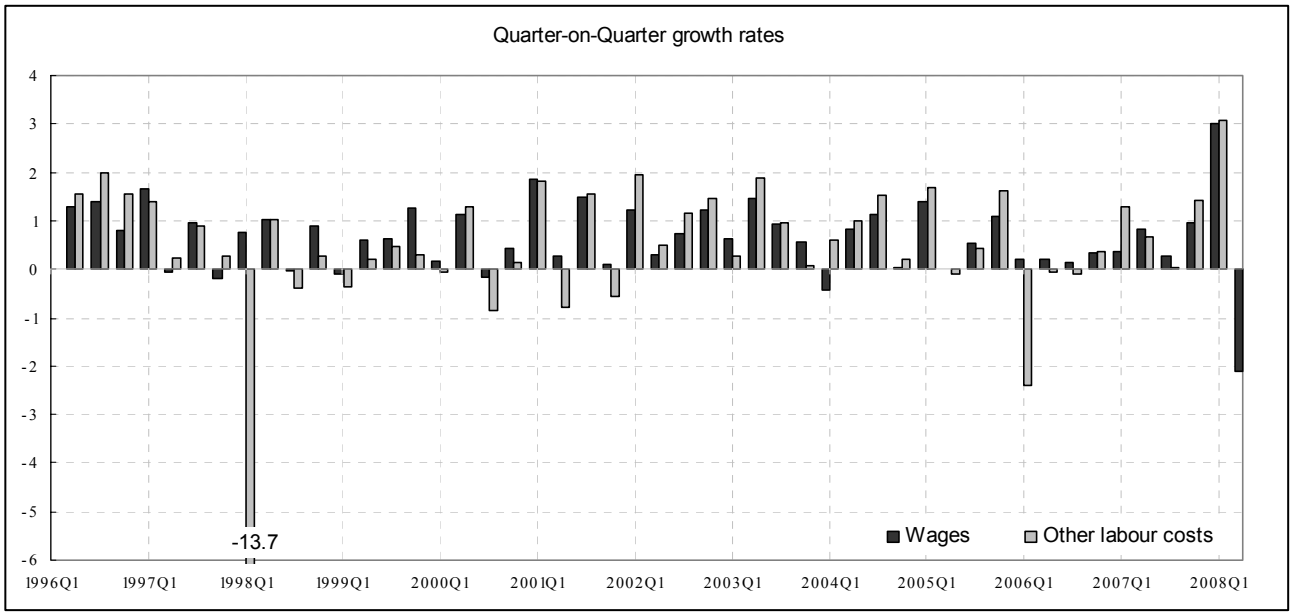
This shift of the time series is caused by the significant change introduced in the Italian social contribution system, as already explained in a previous section (see § 4.1). This exceptional event, causing the highest reduction of the SA total labour costs index in the examined period (about -4%), corresponds to a 14% reduction of the other labour cost SA index with respect to the previous quarter (Figure 11). In the model used for the seasonal adjustment of the LCI series, this event has been treated as a "level shift" (table 27). Given its magnitude, it is significant in all the labour costs series and appears clearly in the final seasonally adjusted series since level shifts are assigned to the trend-cycle component.

The following quarters show a more regular profile in the SA total labour costs series, characterized by less variable quarter-on-quarter changes.

This quite regular fluctuation is broken off by an outlier affecting first quarter 2008, implying an increase of about 3% of the SA index that involves a following reduction of 2% in the second quarter 2008 (figure 12).

As the corresponding short term variations of the two labour cost components show, the effects of this event due to an exceptional increase in wages, are completely reflected by the labour costs other than wages: both the variables show a quarter-on-quarter change passing from +3% to -2% (Figure 12). This anomalous increase, motivated by an atypical concentration of collective agreement renewals (see § 4.1), has been included in the models for the seasonal adjustment as an "additive outlier" (table 27), that is a shock in the time series affecting just one occurrence. It is significant in all the labour cost time series of sectors D and J, where the renewals are mostly concentrated, affecting also the total economy time series. This kind of outlier re-emerges in the final SA series as the seasonal adjustment procedure assigns it to the final irregular component. It's worth observing as the magnitude of the change occurred in first quarter 2008 does not find a correspondent reduction in the following quarter, although the event motivating this exceptional increase, should have completely been absorbed by the subsequent levels of the labour cost indices: a further renewal, even if less significant, affects the second quarter 2008, restraining the expected reduction in the quarter-on-quarter variation.

Figure 12: *Hourly wages and other labour costs series for C to K NACE Rev.1.1 aggregate, seasonally adjusted. Quarter-on quarter percentage changes – Q2:1996-Q2:2008*



6. The official release

6.1. The data transmission to Eurostat

The national LCI data on hourly wages and salaries, other labour costs and total labour cost have to be supplied to Eurostat in index form, for each section as well as for the overall economy, not later than 70 days after the reference period. The weights used to calculate the indices of the total economy aggregate for the three variables have to be transmitted in euro values at the same time. Each index series is delivered in unadjusted, seasonally and working-day adjusted form (90 series overall), covering the span from the first quarter 1996 up to the last quarter released.
Eurostat requires data supplied according to the standard specification shown in the Table 3. As regard to the indices, the following information is needed: the country, the variable which the series are referred to, the economic activity code of Nace Rev.1.1, the presentation form of the series (NSA, WDA, SA), the flag to specify if data are provisional, the indices reference year and quarter, the base year and the indices values. Similar information on weights has to be sent.

Table 3: *The contents for the Italian LCI data transmission: an example*

INDICES								
Country	**Series**	**NACE**	**Presentation**	**Flag**	**Year**	**Quarter**	**Reference year**	**Value**
IT	lci_tot	D	NSA	P	2008	2	2000	113.093
IT	lci_wag	D	WDA	P	2008	2	2000	112.678
IT	lci_oth	D	SA	P	2008	2	2000	108.782

WEIGHTS				
Country	**Series**	**NACE**	**Year**	**Value**
IT	wgt_tot	D	1996	7.94E+09
IT	wgt_wag	D	1996	5.49E+09
IT	wgt_oth	D	1996	2.45E+09

The appropriate technical format for the data transmission has been defined by Eurostat in compliance with the interchange standards approved by the Statistical Programme Committee (SPC). For the Labour Cost Index data transmission, the use of GEneric Statistical MESsage for Time Series data exchange (GESMES/TS) has been adopted. That standard format can be created by means of a number of applications, but Eurostat recommends the use of the GENEDI tool[20]. The GENEDI toolbox is able to do all conversion, encoding and transmission tasks related to GESMES and data transmission to Eurostat.
In the Italian LCI transmission practice, the GENEDI procedure is exploited using as input two files in CSV format containing the indices and the weights. The mapping module generates two new CSV files compliant with the GESMES structure referred to the LCI. Then, they are submitted to an automatic process that verifies if data are in compliance with some validation rules and translates them into GESMES messages. At the end, all GESMES messages are stored into an output folder and, if required, automatically sent to Eurostat using an electronic mail. That sending option is not used for the Italian LCI data as the transmission via eDAMIS Web Application (eWA) is preferred.
eDAMIS[21] is a complete environment that offers data transmission and management services in the European Statistical System. It includes advanced data transmission facilities for all Eurostat data providers, mainly based on the eWA. The eWA is a local HTTP server, that is used through a Web browser to send the GESMES messages containing the Italian LCI data to the Eurostat eDAMIS server.
Moreover, the article 6.2 of the Regulation 450/2003 requires the Member States deliver also the explanations needed to interpret the changes in the data either arising from methodological or technical changes, or due to changes in the labour market (so called Metadata). In order to ensure regular transmission of LCI metadata, Eurostat has defined a template. For example, changes to collective agreements or rules for non-wage costs that may have an impact on the evolution of the LCI series for the latest periods have to be pointed out. The template has one section to report changes to methodology that lead to revisions of past data or breaks in the series, affecting NSA as well as WDA and SA series. Detailed information about the reasons of the possible revisions and the data quality control is required. All metadata referred to the Italian LCI series are sent every quarter via e-mail at the same time of the data transmission via eWA.

6.2. The Eurostat dissemination policy

Before publishing the national and aggregate figures for the European Union (EU27) and the Euro Area (EA15), Eurostat carries out some preliminary checks on the data sent by the MSs as well as few computing steps to assure the consistency of the European aggregate indices.

[20] The GENEDI (GENeric Electronic Data Interchange) tool is available for free download from the group "EDI and Statistics" (Information on standards and tools for the exchange of statistical data) on the Eurostat CIRCA side: http://forum.europa.eu.int/Public/irc/dsis/Home/main.
[21] It stands for "electronic Data files Administration and Management Information System".

After their acknowledgment, the national LCI series are inspected in order to check their completeness, the presence of possible outliers or unusual developments, the consistency of the totals. If national data have been subjected to any revisions, their reasons and magnitude are analysed using the information in the metadata template (see § 6.1).
Once data have passed these checks, all the NSA, WDA and SA single series at section level and for all countries are automatically rebased to the year 2000. Their aggregates for industry, services and total economy are subsequently recalculated using "harmonised" weights.
The harmonisation of weights is needed in order to calculate the EU and EA aggregates. So far, Eurostat has set up a "translation" procedure of the country weights into the same unit (euro) because most MSs send them in different formats (shares or national currency other than euro). While this information is crucial to compile the EU and EA aggregates of the three variables, Eurostat uses the same harmonised weights also to recalculate the aggregated country figures to be published in order to assure consistency and comparability.
The procedure applied by Eurostat is strongly based on the use of auxiliary variables, following the steps explained below:

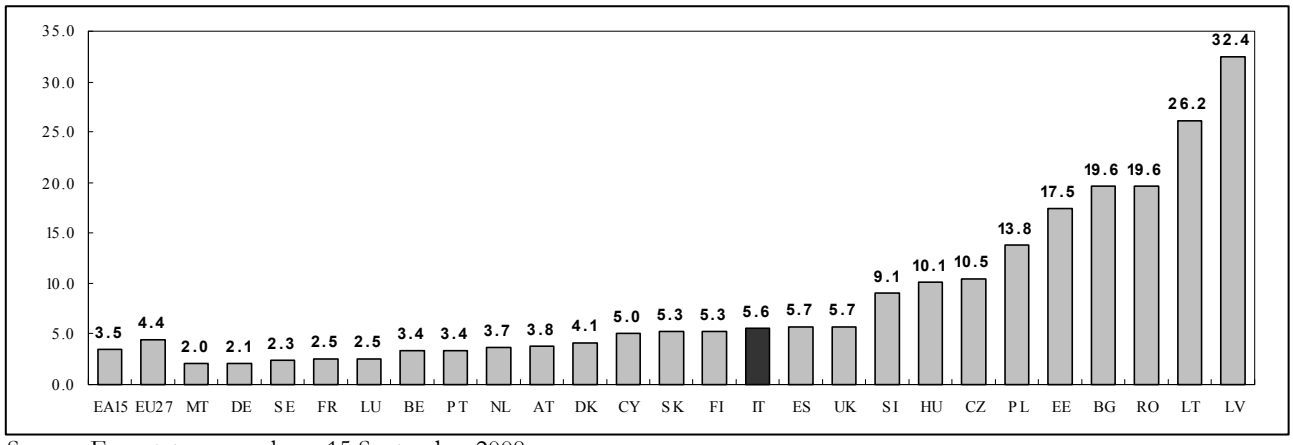
1. from National Accounts are drawn data for compensation of employees and wages and salaries at the breakdown level of Nace rev.1 C to E, F, G to I, J to K, L to P and P;
2. due to the lack of specific information on taxes paid and subsidies received by the employer in the National Accounts, these auxiliary variables are taken from the Labour Cost Survey (LCS), as well as a coherent information on compensation of employees with the same breakdown;
3. the information from the LCS is used to calculate the share of taxes minus subsidies from total employment cost;
4. this share is then multiplied by the compensation of employees from National Accounts to get consistent figures and to calculate the Total Labour Cost in current euros;
5. Other Labour Costs are obtained adding the share multiplied by wages and salaries from National Accounts to the difference between the compensation of employees and the wages and salaries from National Accounts; Wages and salaries information is taken directly from the National Accounts so the two components, evidently, have to add up to Total Labour Cost;
6. then, the euro weights of each Nace section for each country are derived by using the weights sent by each MS in combination with the National Accounts information. Shares for single Nace section are applied to disaggregate each breakdown level of Nace rev.1.

These weights are finally used to compile the EU and EA aggregate indices NSA, WDA and SA both at section level and for the industry, services and total economy aggregates.
The current weighting scheme used by Eurostat leads to some discrepancies between the aggregate figures produced and eventually nationally published, and those released by Eurostat and may concern also those countries, as Italy, that already send the weights in euro values. In fact, for reasons of internal coherence the above illustrated procedure is applied to all the aggregated series (NSA, WDA and SA) of all the MSs[22].
The harmonization of the aggregates together with the automatic rebasing of the series performed by Eurostat, imply also some differences between the SA figures. In particular, the rebasing of the SA series (2000=100) that does not affect the quarter-on-quarter changes, produces a shift of the entire original time series. The magnitude of this shift depends on the significance of the deterministic effects in the base year that, in the Italian case, consist only on the calendar component characterized by a lower number of working days in year 2000[23] than the other years. This practice, that is not common in the compilation of other seasonally adjusted European indicators, will create discrepancies when these indicators are published at national level.

[22] In the case of the Italian Total Labour Costs index for the C to K aggregate, the harmonization procedure implies mostly positive slight differences between the indicator recalculated by Eurostat and the index originally sent, reaching a maximum of about 0.3 percentage points.
[23] In sections E, H and J, where the working day effect appears to be more significant, the released SA indices are higher of about 1% with respect to those produced by Istat.

The LCI is one of the most important Euro-Indicators, the European and national short term indicators that provide a comprehensive and detailed portrait of the short-term economic situation in the euro area, the European Union and the Member States. Eurostat releases the LCI through various dissemination formats.
The LCI data are firstly published through the Eurostat news release, a press release issued approximately 74 days after the end of the reference quarter, in accordance with a release calendar for Euro indicators set up annually. The LCI press release contains a concise comment on the aggregate EA and EU working day adjusted year-on-year growth rates for the target variables as well as some comparisons among the MSs figures (see http://epp.eurostat.ec.europa.eu/cache/ITY_PUBLIC/3-15092009-AP/EN/3-15092009-AP-EN.PDF). The news release is also sent to the Commissioner's Cabinet and to the Eurostat and Commission Press Offices prior to data release, while the European Central Bank receives the Labour Cost Index data, under embargo and for internal use only, prior to their release to the public.
Simultaneously, the Eurostat online database is updated with the last LCI data[24]. This database contains key indicators of mostly harmonized and uniformly structured and documented national and European series. The LCI data can be extracted from the Population and social conditions section, Labour Market item, with the help of a user-friendly browser. Methodological summary pages in SDDS format are also available.
The Eurostat web site includes also a page dedicated to the Principal European Economic Indicators (PEEIs), that is timely updated with the LCI data and the related news release[25].
The LCI data are reported in various other Eurostat Official statistical publications, available on the web as the monthly Eurostat review "Eurostatistics".
A picture of the current evolution of the Italian Labour Cost Index in the European context, is shown in figure 13, where the annual increase of the working-day adjusted total hourly labour costs for the first quarter 2008 is represented. Reaching a value of 5.6%, the growth of the Italian LCI exceeds both the EA15 (3.5%) and the EA27 (4.4%) changes. The high growth observed in this quarter brings the Italian LCI near to the Spanish and English values (5.7%). Among the Member States, the smallest annual increase is observed for Malta (2%) and Germany (2.1%). The highest annual rises are registered in Latvia (32.4%) and Lithuania (26.2%).

Figure 13: *Total hourly labour costs for C to K Nace Rev. 1.1 aggregate, working day adjusted, in the European MSs (*). Percentage change compared with same quarter of previous year - Q1:2008*



Source: Eurostat, news release 15 September 2008.
(*) The Euro area (EA15) consists of Belgium (BE), Germany (DE), Ireland (IE), Greece (EL), Spain (ES), France (FR), Italy (IT), Cyprus (CY), Luxembourg (LU), Malta (MT), the Netherlands (NL), Austria (AT), Portugal (PT), Slovenia (SI) and Finland (FI). The EU27 includes the Euro15 and Bulgaria (BG), the Czech Republic (CZ), Denmark (DK), Latvia (LV), Lithuania (LT), Hungary (HU), Poland (PL), Romania (RO), Slovakia (SK), Sweden (SE) and the United Kingdom (UK).

[24] See the internet address http://epp.eurostat.ec.europa.eu/portal/page/portal/labour_market/labour_costs/database.
[25] See the internet address http://epp.eurostat.ec.europa.eu/portal/page/portal/euroindicators/peeis.

7. Final remarks and open issues

Before and after the adoption of the LCI regulation a lot of work has been done to compile the Italian LCI which is based on a very complex process combining different information contributing to the separate estimation of the numerator and the denominator. Since the first delivery to Eurostat in 2003 when "per full time equivalent" indices have been supplied, important improvements have been made. The main progress was introduced in June 2005 with the production and delivery of a "hourly" LCI replacing the previous indices. The overall quality of the LCI and the timeliness of the delivery have gradually improved: accuracy, reliability, punctuality, coherence and comparability have been going slowly better and better although the costs for the NSI and the burden on firms have been kept very low.

Nevertheless there are quality issues which still require further efforts. Moreover, very soon new challenges have to be faced: the developments of the Regulation require a change of nomenclature from Nace Rev1.1 to Nace Rev.2 starting from first quarter of 2009 and, from the same quarter onwards, the indices have to include also Nace Rev.1.1 sections L to O (P, Q, R, S in Nace Rev.2) that are not yet covered in the Italian LCI.

The main quality issues which have to be addressed regard hours worked as denominator of the index and the seasonal adjustment of the series. As already explained in paragraph 3.2, the indirect approach used at the moment to derive hours worked has some disadvantages which cannot be overcome/solved in the short and medium run. Therefore, soon, the quarterly hours worked time series obtained with the indirect approach will be substituted with a new direct estimation which should improve the accuracy and reliability of the denominator and reduce the size of revisions. In spring 2010 the new hours worked per capita estimate covering all firms with more than 10 employee, based on the integration of the LES and VELA surveys, will be used as denominator of the LCI.

As far as the seasonal adjustment is concerned, the direct approach currently used often produces incoherent results in indices and quarter-on-quarter growth rates either between components (wages and other costs) and aggregate (total labour cost), or between Nace sections and overall indices. In order to avoid this drawback, for each section the model estimated for the dominant component (wages) is imposed to seasonally adjust the other series (other costs and total labour cost).

Therefore a transition to a better methodological treatment has already been planned. Very soon an indirect approach will be implemented implying the direct seasonal adjustment of only raw wages and other labour cost series at section level. The aggregated series will be then obtained indirectly through the aggregation of the seasonally adjusted components using suitable weights.

The new classification and the coverage of new sections are rather challenging topics. While the transition to the Nace Rev.2 is already in progress and the new series will be released from June 2009 starting from the first quarter 2000 (reference year 2008), the extension of the LCI to L, M, N and O, mainly non-market services economic activity sections, is an issue which deserves more attention. The feasibility studies carried out in the last years rejected any option which would imply a direct collection of new survey data and evaluated the possibility to use some administrative data, partly already used as indicators in the context of the quarterly national accounts. The final recommendation of the study is the following: instead of producing a quarterly separate estimation just for LCI it is better to use a statistical estimation procedure based on "improved" quarterly National Accounts data on gross wages, contributions, compensation of employees, hours worked. Therefore Istat is planning to produce an LCI in L, M, N and O sections using estimates deriving from Istat National Account Department and supporting the National Account Department itself to improve those estimates exploiting better some short term administrative sources.

All the improvements already in progress or to be implemented in the near future will allow not only to deliver a better quality LCI to Eurostat but also the release of the indices at national level in the Istat website.

References

Baldi C., Ceccato F., Cimino E., Congia M.C., Pacini S., Rapiti F., Tuzi D. (2004), "Use of Administrative Data to produce Short Term Statistics on Employment, Wages and Labour Cost", *Essays*, n.15, Istat.

Baldi C., Ceccato F., Cimino E., CongiaM.C., Pacini S., Rapiti F., Tuzi D. (2008), "Il controllo e la correzione in una indagine congiunturale su dati amministrativi. Il caso della rilevazione Oros". *Contributi*, n.13 pp. 29-61, Istat.

Chow, G.C. and Lin, A.L. (1971) "Best Linear Unbiased Interpolation, Distribution, and Extrapolation of Time Series by Related Series", *Review of Economics and Statistics*, Vol 53, No 4, pp. 372-375.

Ciammola, A., Di Palma, F., Marini, M. (2005), "Temporal Disaggregation Techniques of Time Series by Related Series: a Comparison by a Monte Carlo Experiment", *Eurostat working papers and studies*, Luxembourg, ISSN 1725-4825.

Congia, M.C., Pacini S., Tuzi D. (2008), "Quality Challenges in Processing Administrative Data to Produce Short-Term Labour Cost Statistics", paper presented at the European Conference on Quality in Official Statistics (Q2008), 8-11 July 2008, Rome, Italy.

Di Fonzo, T. (1987), 1987, "La stima indiretta di serie economiche trimestrali", Cleup, Padova.

Eurostat (2009) "ESS Guidelines on Seasonal Adjustment". *Eurostat Methodologies and Working papers*. Luxembourg, ISSN 1977-0375.

Fernandez, R. (1981): "A methodological note on the estimation of time series" *The Review of Economics and Statistics*, 63(3), 471–478.

Gómez V., Maravall A. (1996), "Programs TRAMO (Time series Regression with Arima noise, Missing observations and Outliers) and SEATS (Signal Extraction in Arima Time Series). Instructions for the User", *Working Paper* 9628, Servicio de Estudios, Banco de España.

Istat (2006a), "La rilevazione sulle forze di lavoro: contenuti, metodologie, organizzazione". *Metodi e norme*, N.32.

Istat (2006b), "Rapporto finale del gruppo interdipartimentale Istat sulle ore lavorate". *Documento interno.*

Istat (2008), "Labour Cost Index Quality Report. 2008", delivered to Eurostat on October 2008.

US Census Bureau (2007), "X-12-ARIMA Reference Manual, Version 0.3", Time Series Staff Statistical Research Division, U.S. Bureau of the Census, Washington D.C.

Contributi ISTAT(*)

1/2005 – Fabrizio M. Arosio – *La stampa periodica e l'informazione on-line: risultati dell'indagine pilota sui quotidiani on-line*

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