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Labour input productivity: comparative measures and quality issues*

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Summary

Labour remains the most important input in the production process and labour productivity is the most widely used measure of productivity. According to the 1993 System of National Accounts (SNA93), the hours worked represent the preferable measure for quantifying the actual use of labour in the production process. However, the methods for estimating hours actually worked as the concept and definitions leave open many questions at national and international level.
The National Statistical Institute of Italy (Istat) produces current estimates on hours worked that are fully in line with the ESA95 accounts system regulation. The aim of the paper is to underline the differences among all the labour input measures currently produced, that is persons employed according to the domestic concepts, jobs, full-time equivalent units and hours actually worked.
In the paper, the quality-adjusted labour input issue has been faced. Hours worked are incomplete measures of labour input if they don't take in account differences in educational attainment, skills and experience between workers. In order to improve the quality aspects of labour input productivity, we have explored the possibility of using data coming from the Bank of Italy's survey of households' income and wealth on hourly wages by gender, age and educational attainment. Information on changes in hours actually worked for different types of employment have been gathered by the Labour Force Survey. Some first results on the labour productivity growth adjusted and non-adjusted for quality have been presented.

1. Introduction

In the second half of the 1990s, Italy has had a relevant increase of the labour utilisation but the intensity of the growth rates differ in relation to the labour input measure chosen. In particular, the growth rates of the persons employed seem to go faster that those ones of the full-time equivalent units that represents a proxy of the amount of hours worked. At the same time, data shows that not always the production trend follows the employment time profile.

* The views expressed are those of the authors and do not necessarily reflect those of the National Statistical Office of Italy (Istat). Data on hours actually worked are provisional and not officially published yet.

Since 2005, the National Statistical Office of Italy (Istat) has began to produce information on hours actually worked that represent a more appropriate measure to quantify the labour participation to the productive process and to analyse labour productivity growth. The time series of hours actually worked seems to approach well the fluctuations of the production values.
The paper presents all the different measures of labour currently produce by Istat. A detailed description of the method for estimating hours actually worked is presented and a description of the results obtained for the period from 1993 to 2005 too. The results enable, in particular, to understand the impact of the labour factor trend on the productivity, which is firstly calculated without taking into account differentiated types of hours actually worked.
Then, a new method that takes into account variables that correct the traditional method of estimating labour productivity is presented; the new approach introduce factors of differentiation of workforce that measure changes in quality over time.
Section 2 describes all the different measures of labour input produced by Istat. Section 3 describes the methodology used for estimating hours actually worked. Section 4 presents the new approach to taking into account the adjustment for labour quality and the results obtained. Finally, section 5 reports some conclusions and possible future developments of the method proposed.

2. Labour input measures

Labour input can be measured in terms of total hours worked, number of persons employed and/or number of full-time equivalent unit, a unit of analysis obtained transforming part-time jobs in terms of a full-time job. For productivity and GDP growth analysis, it is preferable to measure labour input in terms of hours actually worked.
Total hours actually worked produced by the National Statistical Office of Italy are consistent with National Accounts. Some uncertainty remains regarding the comparability of data with the others European Union countries because the approaches used for annual estimates differ across them.
Total hours worked can be derived by combining estimates of annual hours worked per person employed with average level of employment or per capita hours worked each job multiplied for the number of jobs; according to the Istat approach, jobs represent the basic measure of labour input that is multiplied for per-capita hours data in order to obtain the total amount of hours worked or it is transformed in full-time equivalent unit.
The Italian measures of labour produced by national accountants are currently check by the European Statistical Office, EUROSTAT, with the aim to ensure consistency within the framework of the system of national accounts (ESA 95) and comparability among countries.

2.1 Estimates on hours worked

According to the system of national account, the hours actually worked represent the most adapted measure for quantifying the real use of labour in the income production process. The availability of the information, in particular, would enable to fully consider brief-period fluctuations of the labour factor due to both economic factors and extra-economic factors. The problems associated to this estimate, nevertheless, are different and relate to the difficulties of integrating in a satisfying way the sources from the enterprises side and those from the household's side. Another difficulty lies in measuring the hours worked by self-employed workers and relative remuneration.
In accordance with the Council Regulation 2223/96 on the European system of national and regional economic accounts (ESA95), the total amount includes the hours actually worked, both remunerated and non-remunerated, for all professional statuses (employees and self-employment), as long as they are finalised for the production of an income.

The estimates of the hours worked refer to the jobs according to a domestic concept: in other words, they include all the hours worked in productive units distributed nationally, apart from the residence and nationality of the person carrying out these hours. Moreover, the estimates meet an exhaustive concept of employment that takes into account both the hours worked in a first and multiple job regularly registered as well as those worked unregistered, that is, not declared to the tax office or to social security institutions and insurance companies.
The estimates are drawn by Istat for the period 1980-2005 and divided in 30 economic activity branches of the NACE-Rev 1.2 classification and by occupation (employee and self-employed); the estimates will be regularly produced, together with the other employment measures estimated from the national accounts, that is the number of jobs, persons employed according to the domestic concept and full-time equivalent units.
The total of hours worked represents the total of the hours actually worked, remunerated and/or partially remunerated. The total of hours worked includes the working hours performed in addition to the normal working hours and excludes the hours remunerated but not actually worked (such as holidays, cancelled holidays, sickness, reduction of working hours due to absenteeism, leaves and other), as well as all the hours worked in activities that, according to the national accounts, are not to be considered for the purposes of calculating the GDP (mainly homely work, productive service volunteering, *do-it-yourself* type of activities other than extraordinary house maintenance work).
For estimating the hours worked, the approach Istat has adopted consists in multiplying the number of jobs of specific typologies of employment by an annual per-capita number of hours worked, the latter being directly taken from the statistical surveys that measure this phenomenon.
Jobs are differentiated per type of work, in order to apply homogeneous working hours per capita in relation to the statistical unit of reference (enterprise, institution or household), to the economic activity sector and to the type of employment (registered, unregistered, main and multiple job).
Up until today, the full-time equivalent units have been considered as a *proxy* of the total of hours worked. They are computed by applying to the part-time jobs transformation coefficients obtained from the relation between the hours worked in part-time activities and those worked *full-time* in the same economic activity sector.
In reality, the full-time equivalent units slightly diverge from the total of hours worked not only as level but also as regards the trend, since they are mainly determined by the distribution of the jobs between full-time, part-time and multiple job-holders employment. On the other hand, the total of hours actually worked is identified not only from the composition of the above-indicated jobs but also from other important components, such as overtime and absenteeism from work. If, for example, leaves due to illnesses or for some other motives grow over time and the level and composition between part-time and multiple job-holder employment do not change, the total of hours actually worked will be reduced while the full-time equivalent units will remain unchanged.
In order to interpret correctly the diversity that characterises the full-time equivalent units and the total of hours worked, it is thus necessary to take into account the calculation differences associated to the different aggregates.

2.2 The sources of information used for the estimates

Information regarding the length of time of weekly and/or annual employment is obtained from the workers themselves through statistical surveys addressed to families or from employers through surveys addressed to companies.
The main sources of information on the hours actually worked available are the following:

- The labour force survey[1]

[1] The labour force survey has been completely reviewed since 2004. The new survey is a continuous-type survey and the reference weeks are uniformly distributed over the whole year. The data on the hours worked used for estimating the total of hours actually

- The annual surveys on the private enterprises economic accounts
- The monthly survey on companies with over 500 employees
- The quadrennial survey on the labour cost conducted on a sample of enterprises with 10 employees and over

It is important to highlight that one of the reasons of differentiation between the enterprise surveys and the households surveys is that the first ones analyse the value per capita of the hours actually worked per job and the second ones study the per capita of the hours worked by an employed person in the main job activity and distinctly in the second one.
Another difference is that the enterprise surveys gather information directly from the employers who, theoretically, provide more precise data than those declared by the households. Generally, though, the enterprise surveys do not survey the hours worked by the self-employed workers, they do not cover all economic activity sectors (such as, for example, the agricultural sector, the public administration sector and more generally, all non-market productive activities) and do not survey the employment of who is not regularly registered in the tax-contribution institutions.
Another element to be taken into account when analysing the total of hours worked is that the respondent enterprises could show a certain tendency at declaring more frequently the per capita of hours remunerated rather than that of hours actually worked, even if adequately defined.
The household surveys provide complete information on the hours actually worked, both remunerated and non-remunerated, and on the working hours used unregistered in tax-contribution institutions; moreover, these surveys enable to obtain more detailed information divided per important demographic variables such as gender, age and study degree, all relevant for the purposes of the socio-economic analyses and international comparisons. The coverage of the survey interests the entire economy but, as regards the persons employed deriving from the enterprise surveys, it does not cover the workers present but not resident who work in resident units, as they are not part of the survey sample selected from the population registers.
The data on the hours provided by respondents often result affected by non-systematic response errors. Moreover, the statistical practice pointed out that the information on the hours actually worked tends at approaching that on the usual hours; this is the case of the responses given by persons who are not remunerated per hour worked and who can take into consideration in the response given to the interviewer the overtime worked.
When estimating the total of hours produced by the national accounts, the company surveys produced information on the per-capita of hours actually worked by employees for different industry and service *market* sectors (divisions C-K and M,N,O of the Nace Rev.1.2 classification) and per size of enterprises; the labour force survey provided data for a detailed level of industries (4 digit of the Nace Rev .1.1 classification) per occupation (employees and self-employed).
The total of hours worked has been obtained by applying the per capita of hours actually worked surveyed to the universe of jobs, distinguished into the different types of employment, and estimated coherently with the national accounts.
The estimate of the hours actually worked in the service sectors used also the information available on the per capita of hours actually worked deriving from the following informative sources:

- The General Accounts Department, which enabled to survey the direct and indirect data on the hours worked in the General Government sector (as defined in the national accounts framework);
- The ABI (Italian Bank Association), which provided specific data on the workable hours in the credit sector.

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worked are not those from the continuous survey and the re-alignment to the results of the new survey from the IV quartet of 1992 till the IV quarter of 2003.

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2.3 The estimation procedure of the total of hours worked

The estimation on the total of hours worked was carried out using the so-called *account approach*: data on the per capita of hours worked deriving from the surveys and adequately detailed have been applied to the different types of jobs estimated from the national accounts.
The fact of working on a long time period has entailed the need of harmonising the data of a same survey over time, taking into account the changes that have regarded the statistical units of reference, the survey techniques and the industry coverage.
For the purposes of estimating the total of annual hours worked of employees, it was possible to use all information on the per capita of hours worked deriving from the above-indicated enterprise surveys and available as from 1992. In particular, the annual surveys on the enterprise' economic accounts include, since 1998, all companies with 100 employees and over as well as a sample of companies with a lower number of employees. For the year 2000, it was possible to make use of the detailed data on the number of hours worked obtained from the quadrennial survey on the labour cost structure addressed to companies with 10 employees and over.
The analysis of the enterprises data pointed out to a tendency, which is even more accentuated as regards smaller enterprises, at providing data on the hours remunerated rather than that relatively to the hours actually worked. Thus, a statistical method has been applied, which, based on the information on the number of hours worked and on the remunerated hours, both surveyed by means of the quadrennial labour cost survey, has enabled to reduce the distortion due to this over-estimation.
The data on the per capita of hours actually worked in the industries that are not covered by the enterprise surveys, those relative to the multiple jobs and the per capita of self-employed workers are directly surveyed by means of the labour force survey on a continue base. Starting from the first quarter of 2004, the above survey is conducted each week of the year even if the results are reliable at a quarter level[2].
The *approach per component* method has been only used to calculate the annual per capita of hours worked in the General Government and in the financial industry, and consists in estimating the components that imply a variation of the working time compared to a *norm* considered equal to the working hours established by national agreements. In this case too, the total of hours worked has been obtained multiplying the per capita estimated for the whole of the registered jobs of employees estimated from the national accounts in the competent industries.

2.4 International comparability of the estimates

The use of statistics on labour input is being promoted on an international level in order to improve the comparability of the estimates as regards labour productivity. The definition of labour productivity that is generally accepted is that of Gross Domestic Product per hour worked, even though its is being acknowledged that this measure might not be able to gather the differences of productivity among the various countries because influenced by different factors, such as the composition of labour force (high or low specialisation) among the countries.
Numerous problems need yet to be overcome in order to reach this objective. A factor that affects the quality of international comparisons relatively to the hours worked is represented, as mentioned in previous paragraphs, by the reference measure of the hour per capita indicator that, in some countries, is the person employed and in other countries, such as in Italy, the job.

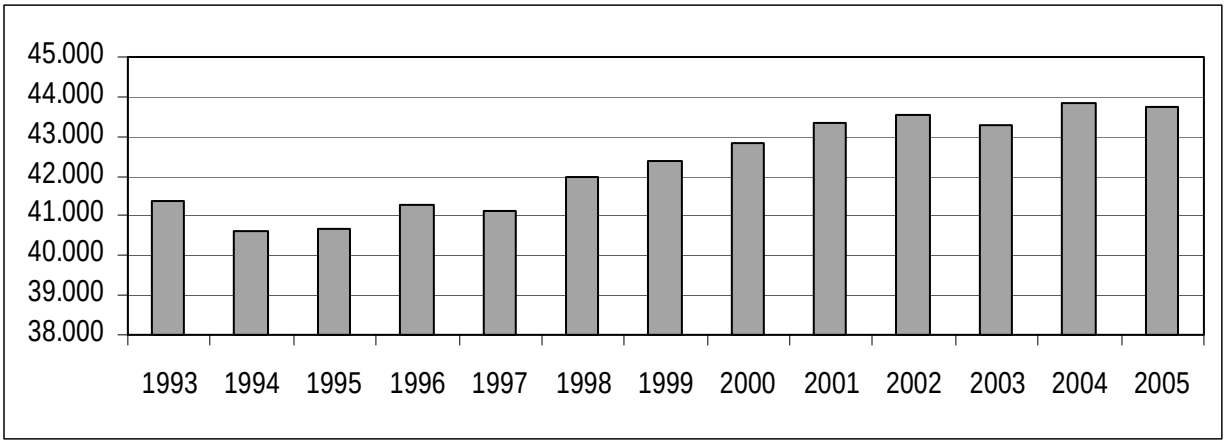
[2] Before of the above date, the survey was done every three month four weeks a year during which there were no holidays, in the months of January, April, July and October. It caused two main problems in terms of hours worked analysis: 1) the possible distortion of the seasonal profile considering the fact that the reference week of the interview is distant from the usual holiday periods; 2) the consequent possible annual over-estimation of the hours actually worked.

Another important aspect is linked to the different concepts and definitions used in the statistical surveys, as well as to the sources of information available and to the different coverage degree of the surveys.
These international comparisons make it necessary to identify an indicator that takes into account some other factors, such as the different weight of the active population and the participation degree of the labour force in order to provide a more accurate framework of the working hours and their effects on the entire economy.
Even in front of evident problems of comparability, the OECD does publish some annual estimates on the hours actually worked on a per capita level for 24 countries. The national institutes of statistics provide these estimates; nevertheless, only for some of them, the results are coherent with the concepts and the coverage degree of the national accounts. To produce these estimates, some countries use the hours actually worked drawn from the enterprises surveys, which generally regard only employees, while other countries use the data from the labour force survey that enables to measure the working hours of self-employed workers.
The series that the OECD has made available up until now represent only the first step towards the harmonization and a greater international comparability of the estimates. The problems linked to the study and the adjusting of the international definitions on the hours worked, as well as the improvement of the quality of information have been object of discussion since a few years within the *Paris Group*, a workgroup that brings together the different national institutes of statistics as well as some important international institutions such as the OECD and the ILO. The objectives the Paris Group has set, include to promote the development of statistical information regarding the hours worked, recognizing their importance for estimating the total of hours to be put in relation to the national accounts economical aggregates, for estimating correctly the productivity of the labour factor and for measuring the impact of the social policies, such as that of reducing the working hours.
Istat has already started since a few years an intense work of developing information on the hours worked and is, on an international level, involved in the activities promoted by the Paris Group and by some other important institutions (Eurostat and OECD); nationally, it aims at promoting mainly the development of concepts, definitions, verification and correction procedures of the information gathered during the various statistical surveys.
The estimates produced by the national accounts will thus evolve in relation to the development of the study and promotion activities of statistical information on the hours worked started by the Institute and which involve various statistical contexts (surveys on enterprises, agricultural farms, households and administrative sources).

2.5 The analysis of the results obtained

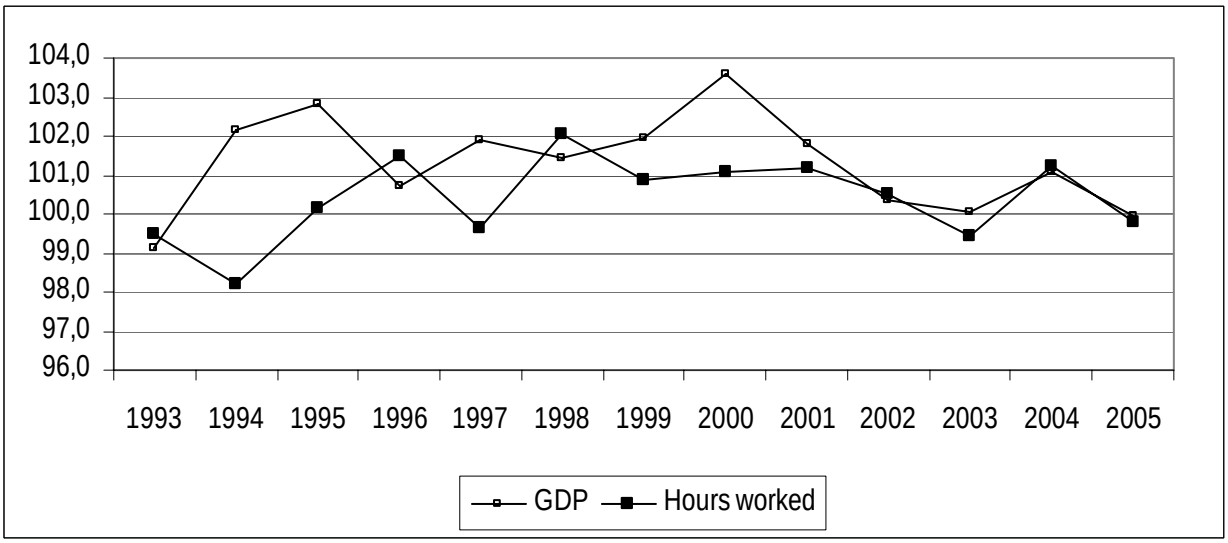
In this paragraph we present some provisional data on hours worked between 1993 and 2005 while the final results will be published in the next month. Provisional data are analysed taking into consideration three different periods (Graph 1). The first period (from 1993 to 1995) is characterised by a reduction of the hours worked; in this phase, the employment registered an unprecedented drop compared to the trend registered during the previous decade. The second period (the two-year period from 1996 to 1997) saw the expansion and subsequent reduction of the hours worked, together with a slow recovery of the employment. Finally, in the third period (from 1998 to 2005), the hours worked grew at a more sustained rhythm, encouraged by the important increase of employment, just interrupted at the end of the period (in 2003 and in 2005).

Graph 1 – The hours actually worked between 1993 and 2005 (*absolute data in millions*)



The availability of the data on the hours worked, together with the estimations of the GDP, enables to analyse better the contribution of the labour factor in the growth of the output (Graph 2). In this case, we can distinguish two distinct phases: one that goes from 1993 to 2001 and the other that goes from 2002 to 2005. The first phase registered a growth of the product almost always superior to that of the hours worked necessary for realising it; the second phase, though, saw a change in the relation between hours worked and product to such an extent that the trend of the total of hours worked appeared to reflect the trend of the GDP due to its intensity and signal with the exception of the 2003 result.

Graph 2 – The total of hours worked and the GDP between 1993 and 2005 (*Chain-based index numbers*)



In 1993, the total of hours worked amounted to about 41,348 millions of hours, while the subsequent years registered a drop following the reduction of jobs; a recovery of the work intensity was registered as from 1998, when the hours worked exceeded, even though to a modest extent, the levels registered at the beginning of the period. In 1998, the hours worked amounted to about 41,994 millions. Since that year, they have registered a quite regular positive trend, even reaching 43,749 millions of hours in 2005.

The whole period, object of observation, enables to study the different growth rhythm of the full-time equivalent units (obtained by transforming the jobs at reduced time and multiple jobs in full-

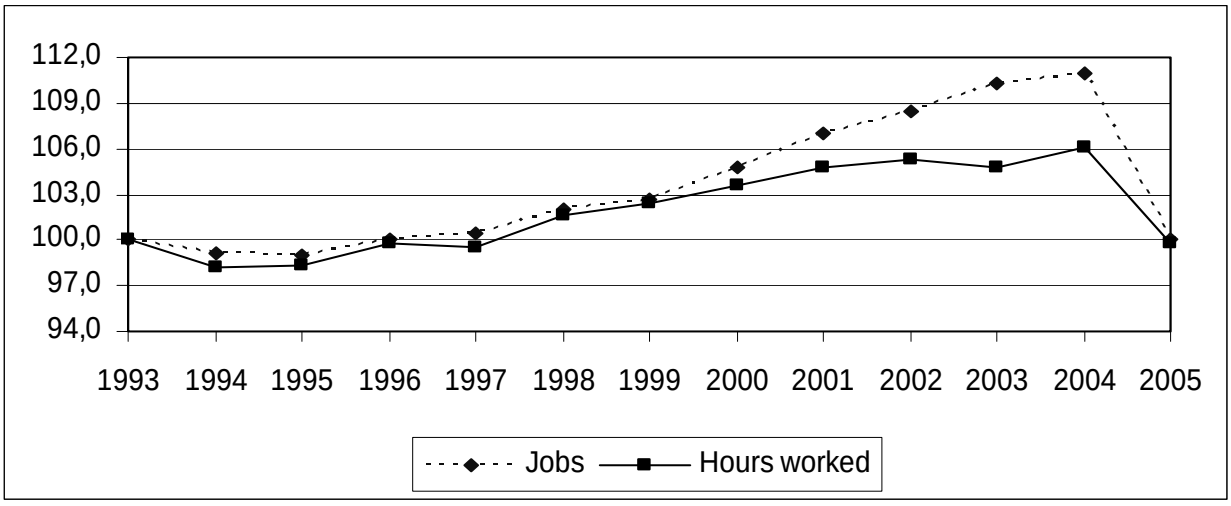
time jobs) compared to the trend of the total of hours worked (Table 1). The comparison between the two employment measures points out to the differences in the intensity of growth rather than to a contraposition in the increase rates; nevertheless, the two measures differ as the full-time equivalent units do not take into account the overtime and absenteeism and do not reflect, as closely as does the total of hours worked, the trend of the jobs and that of the per capita of hours used for the purpose of the estimation.

Table 1 - Growth rates of persons employed, full-time equivalent units, jobs and hours worked (% values)

Years	Persons employed	FTEs	Jobs	Hours worked
1993	-2,7	-3,2	-2,7	-0,5
1994	-1,6	-1,1	-0,8	-1,8
1995	-0,2	0,0	-0,2	0,1
1996	0,6	0,3	1,1	1,5
1997	0,3	0,4	0,5	-0,3
1998	1,0	0,9	1,6	2,1
1999	1,1	0,5	0,6	0,9
2000	1,9	1,8	2,1	1,1
2001	2,0	1,8	2,1	1,2
2002	1,7	1,3	1,4	0,5
2003	1,5	0,6	1,8	-0,5
2004	0,3	0,0	0,5	1,2
2005	0,2	-0,4	0,0	-0,2

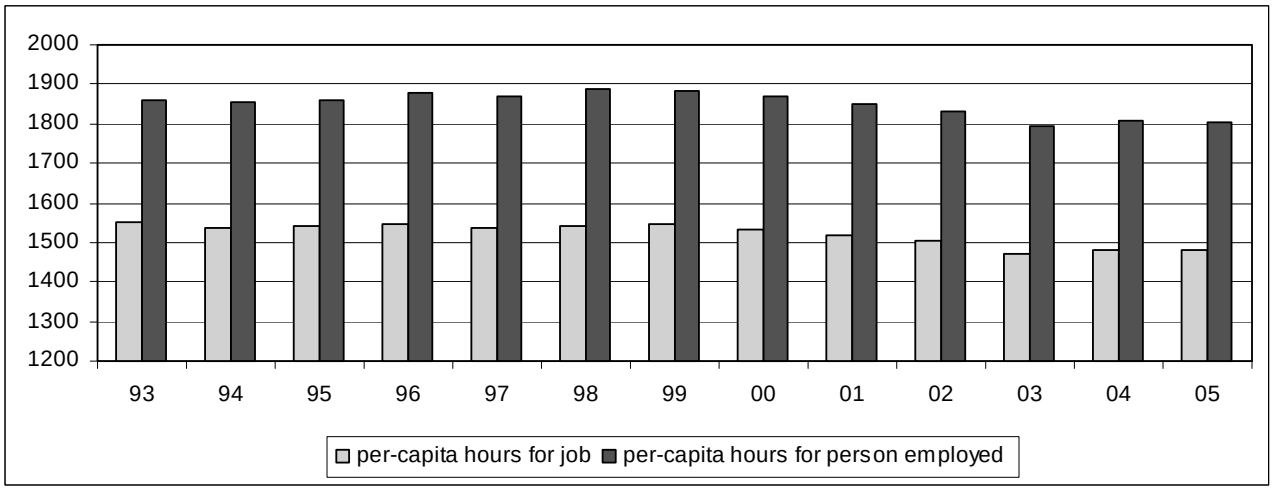
All through the reference period, the trend of the hours worked was influenced by both the trend of the jobs (all employments) and by the changes in the average annual working hours; the years following 1993, the base year=100, registered a drop of the hours worked and jobs up until 1997, a subsequent increase of both employment measures (characterised by a higher dynamism of the hours worked between 1997 and 2002) and, finally, an interruption of this tendency only in 2003 when the increase of the jobs corresponded to a lower increase of the hours (Graph 3).

Graph 3 – The total of hours worked and work positions. Index numbers 1993=100



The years between 1993 and 2005 registered a different trend of the hours worked on an industry level. The index numbers calculated compared to 1993 made equal to 100, registered, in 2005, a reduction of the hours worked in agriculture (index equal to 73,5 in 2005), in the industry (97,9) and a strong increase of the hours worked in the service sector (113,6).
In 2005, the service industry accounts for 67,2% of the total of hours worked, the industry sector 27,4% and agriculture 5,4%; in terms of jobs, these sectors employed around 69%, 27,4% and 6,4% respectively.
These results enable us to see how the productive system (especially in the sector of services) has been using more flexible work contracts and diversified working hours regimes, even as regards full-time workers. Ever since the nineties, companies and public institutions seem not to search anymore, as in the past, regularisation forms of working hours but, on the contrary, tend to accept the changes in the weekly working hours regimes that are reflected in the total estimation of the total of hours worked.
According to the national accounting approach, the total of hours worked is obtained by multiplying the average annual number of hours worked in a job (per capita) per the total of corresponding jobs.
The average annual working hours used for the purposes of the estimation do not refer to the number of physical persons employed but to the total of the jobs that each employed person can carry out, even in different economic activity sectors and different professional statuses (for example, a first job as employee and a second work position as self-employed).
From the national accounting point of view, to calculate the average per capita number of hours worked per job is considered as more correct than to measure the working hours of each person employed. The latter indicator, unlike the previous one, is significant only if measured for the entire economy; it provides no information at an economic activity sector level as there is no certainty as to whether the employed persons surveyed in the same sector are the only ones who have contributed in the total of hours worked, estimated in a given activity sector or in a specific job position.
As highlighted in Graph 4, the average annual per capita of hours worked calculated per employed person appears definitively superior to that estimated per job. In 2005, each employed person worked on average 1,802 hours while the hours corresponding to each job was of 1,479 hours. In 1993, the per capita numbers were of 1,858 hours and 1,511 hours respectively. The results obtained are influenced by the effect of multiple jobs that in 2005 weight for 7,3% on the total amount of hours actually worked (the 5,8% in 1993).
The integrated approach used for the purposes of estimating the labour input of the national accounts enables to measure the work volume in terms of jobs and, consequently, to use better the sources available on the hours worked, in some case, in terms of hours worked per employed person distinguished between first and second job (the surveys addressed to households), and in other cases, in terms of hours worked per job (surveys addressed to enterprises).

Graph 4 – Annual per capita of hours actually worked calculated per employed person and per work position.



3. Labour quality

The methodology applied to measure quality-adjusted labour input is the one of the OECD productivity manual[3]. Data are referred to hours worked by individuals and their hourly income. Hours worked have been disaggregated according to their different characteristics in order to account for quality; in this way, indeed, is possible to consider substitution between the different inputs for identifying properly productivity growth.
The data analysed permits to cross-classify individuals by gender, age and by types of educational attainment.
Several are the approaches proposed by the literature and the practical experience to explicit differentiation of labour input. Differences are related to the measurement used for taking into account individuals skills.
Starting from the application of existing methodologies[4], we have measured labour services in terms of the growth rate of hours worked by each individual labour category weighted with its compensation share in total labour compensation.
We have considered four characteristics (gender, age, education, occupation) to cross-classify labour input for the whole economy. Because the different characteristics are correlated, the corresponding labour compensation measure reflects both the direct contributions of these characteristics to output growth as interaction effects between them. In our approach the interaction effects are reduced because no differentiation by industry is considered and this because of the lack of data by industry.
According to the method applied and the neo-classic theory, each labour category is weighted by its marginal product; the above considerations produce that women and young workers would be less compensated than men or older workers on productivity account.
The approach permits to produce and analyse three different results: 1) the time profile of the simple sum of hours worked, that is the quantity of labour input; 2) the time profile of the quality-adjusted measure of hours worked, that is the quality of labour input; 3) the time profile of the differential effect between the total and the quality of labour input[5].
In conclusion, an increase in the average quality of labour implies that the quality-adjusted measure of hours worked rises faster than the unadjusted measure of labour input.

3.1 Sources of data and the results obtained

The National Statistical Office of Italy doesn't currently produce detailed data on employment, hours worked and labour compensation by category gathered by the same sources of data. In order to reach the goal of measuring labour quality, we have used more that one sources of data.
Data on hours worked detailed by gender, age and education are gathered by the Labour Force Survey, a quarterly survey on a continue base. Totals on hours worked have been then adjusted with the national accounts figures.
Istat compiles a wide range of annual and infra-annual statistics using different sources in the area of wages, earnings, compensation and labour cost. Each of the above statistics represents a part of the phenomenon because based on different definitions and different aims of representing it. In particular, hourly labour compensation by type is available from the Istat Structure of Earning Survey that provides information every four years but, at the moment, it is possible to use only 2002 data.

[3] OECD (2001).
[4] Jorgenson (1987).
[5] Fosgerau and others (2000).

Data on hourly wage compensation by types of labour have been produced using micro data of the Bank of Italy's Survey of Households' income and wealth in the period 1992-2004. This survey is compiled every two year and values for missing years where obtained by interpolation.
In this approach, we take into account only labour compensation of employees. The treatment of income generated by self-employed persons has been not faced. We have assumed that the average compensation per hour of a self-employed person of each type equals that of an employee of the same type.
In the final database of hours actually worked and hourly compensation the information are separated by two gender groups (men, women), four age classes (<25 years old, 25-34, 35-54, >54) and six level of education (elementary school or none, low secondary school, high secondary school and university degree). We have obtained 32 characteristics (2*4*4 cells).
It has been impossible to consider industry because the number of cases in each cell weren't significant.
The value attributed to hours worked is represented by the average compensation per hour; this corresponds to the wage rate from a producer's point of view and it includes all supplements to wages and salaries. In the paper, we take into account only labour compensation of employees. The treatment of income generated by self-employed persons has been not faced. We have assumed that the average compensation per hour of a self-employed person of each type equals that of an employee of the same type.
The labour index proposed in the paper is a weighted average of the growth rate of hours worked according to the above labour characteristics. In particular, three first-order indexes have been computed for each characteristic of the workforce (gender, age and education) combining hours worked with the corresponding compensation; then other three second-order indexes have been obtained through the interaction of each characteristic with the others. The last order represents the total labour services adding the weighted growth rates of each characteristic.
The ratio of labour services obtained using different orders can measure the labour input quality. The labour index in this way is represented by a quantity factor, the volume of hours worked, and a quality factor with the aim of measuring the substitution between the above two factors. The quality index increases when components generating the most labour services grow faster than the other characteristics, or decreases if the least efficient hours worked grew faster than the others.
In order to reach the goal, the growth rate of labour input (indicated in Equation 1) is measured on the base of the following formulation (*Tornqvist index*) [6]:

$$\ln\left(\frac{L_t}{L_{t-1}}\right) = \sum_{i=1}^{n} \frac{1}{2}(v_t^i + v_{t-1}^i) \ln\left(\frac{H_t^i}{H_{t-1}^i}\right) \qquad (1)$$

where H_t^i represents hours worked by each type of employment considered (i = 1,…,n) and where v_t^i is the rate of remuneration associated to it compared to the whole labour cost formulated as:

$$v_t^i = \frac{(w_t^i H_t^i)}{\sum_{i=1}^{n} w_t^i H_t^i} \qquad (2)$$

[6] The Tornqvist index is based on the logarithms differences of the growth rates weighted with the influence of each input cost on the total cost.

where w^i is the price of labour input of type *i*. The above equation expresses the *volume of labour input* as a translog index of the individual components.
To quantify the impact of labour services among different types of labour input, we have adopted the methodology proposed by Jorgenson to assume that labour input for each category L_i is proportional to hours worked H_i. In particular, a measure of the contribution of substitution between components of the labour input respect to the volume of hours worked can be expressed as follows:

$$L_i = Q_i * H_i$$

where L_i represent labour services in cell i, Q_i represent the constants of proportionality of labour input and H_i the non-weighted hours worked. The contribution of substitution among the components of labour input to the volume obtained from a given number of hours is expressed by the following equation:

$$Qi = \frac{Li}{Hi}$$

Where the unweighted sum of hours actually worked is the following:

$$H = \Sigma H_i$$

The quality of labour can be also expressed as follows:

$$\Delta \ln Q = \Sigma \bar{v} \Delta \ln H - \Delta \ln H \qquad (3)$$

In this way, the ratio of labour services measured on the different orders respect to the growth rate of non-weighted hours worked measures the *labour quality index* and it represent the labour-augmentation factor calculated as residual between a constant quality labour input index and an index of the quality of hours worked as a measure of changes in the components of labour input.
Final results will be shown on labour productivity adjusted and non-adjusted for quality for the period 1992-2004. In the two cases, the measure of labour input is represented by hours actually worked.

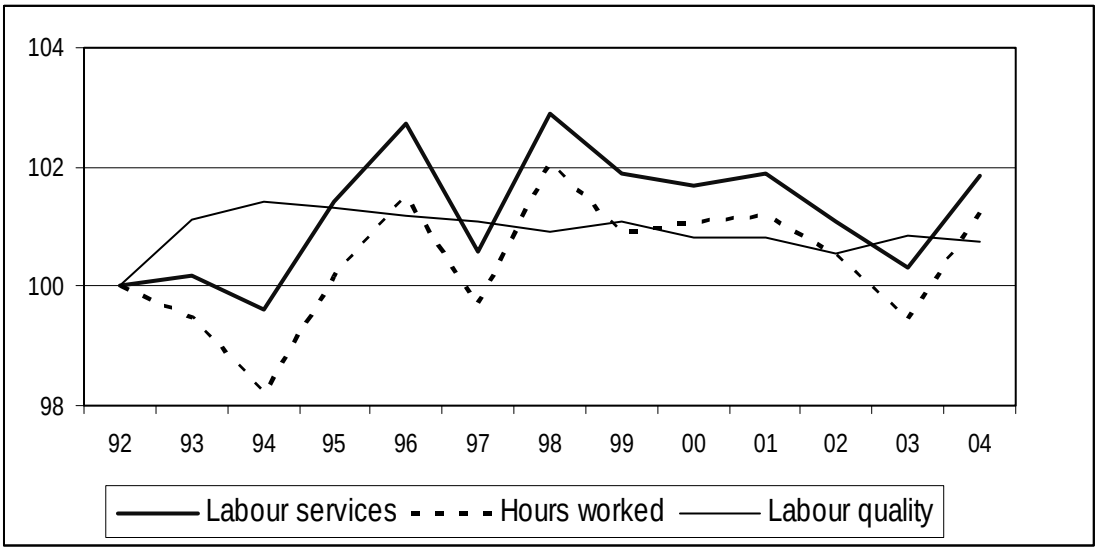
3.2 Quality adjusted labour input results

3.2 Quality adjusted labour input results

The approach here proposed is based on the methodology above described and applied by Melka and Nyman for France[7]. It represents the compositional change in the use of labour by gender, age and education since 1992. The results are shown in Graph 5.

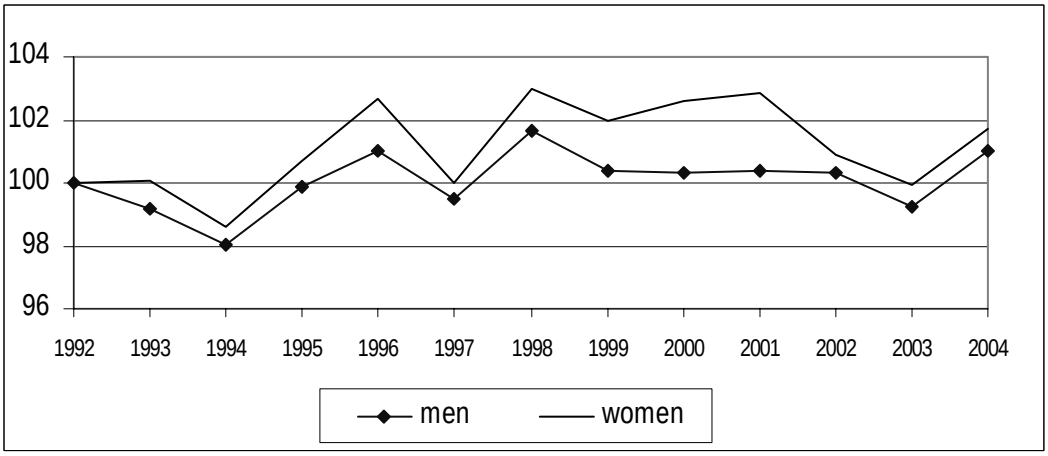
[7] See "Growth acounting and labour qualità in France, 1982-2001" in Growth, Capital and New Technologies by Matilde Mas and Paul Schreyer, Fundation BBVA, 2005.

Graph 5 – Labour services, hours worked and labour quality (1992=100)



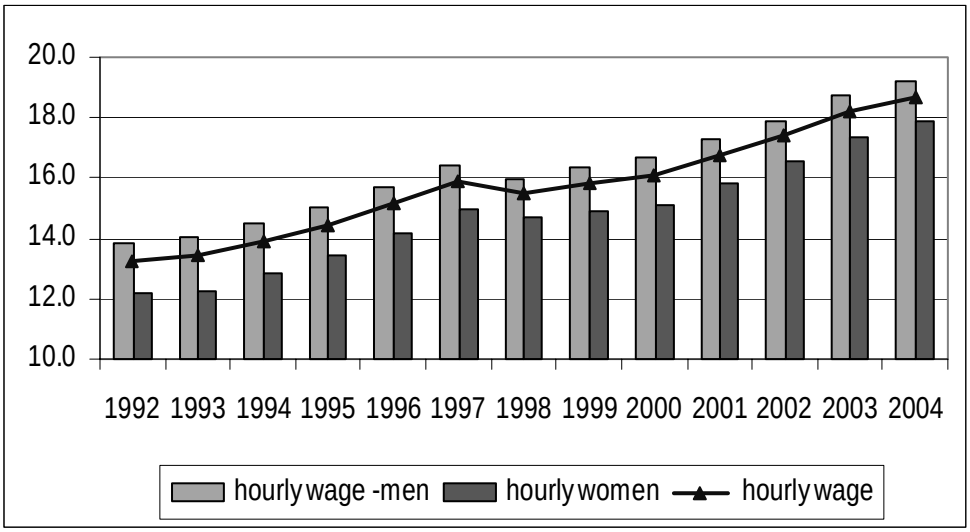
The Graph 5 outlines that hours worked register a positive trend in all the period as quality but with a quite stead intensity. According to our exercise, labour services follows the positive time profile of hours worked.
The difference between labour services and hours worked should measure the compensation weighting scheme and our results seem to show that the quality has received impulse by the categories whose compensation share decrease.
The above results can be well understood analysing some input data that have contributed to determine them. Graph 6 shows the growth rates of hours worked by gender. We see that hours worked by women have increased more that those of men.

Graph 6 – Growth rates of hours worked by gender (1992=100).



In the same period, the differential between hourly wage of men and women has decreased (see Graph 7) but not in a relevant way.

Graph 7 – Hourly wage by gender (absolute value in euro)



In Graph 8 we can see that differential hourly wage of women relative to men is increased in a negative way, especially for women with the university degree whose hours worked are increased significantly over time.

Graph 8 - Hourly wage of women/men by education

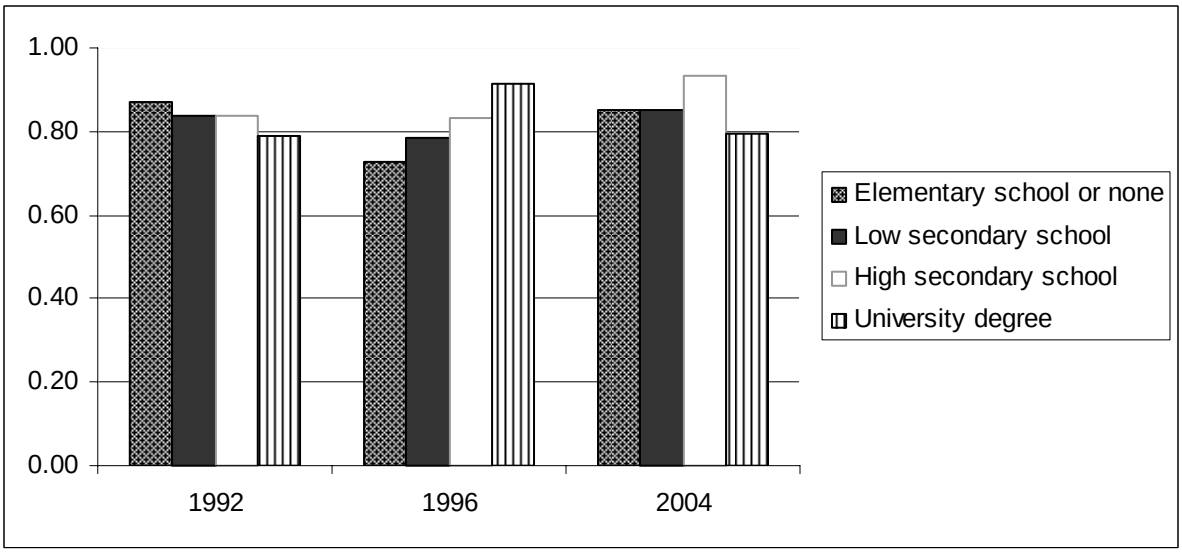


Table 6 presents the contribution of the different characteristics of the labour force to the Italian labour quality. It seems clear that gender doesn't play a role in the labour quality. Education has a relevant role even if its contribution decreases at the end of the period. The major contribution to quality is given by age. In particular, the upper age (35-54 year) has a relevant role in terms of hours worked and, at the same time, their hourly wages increase (see Graph 9).

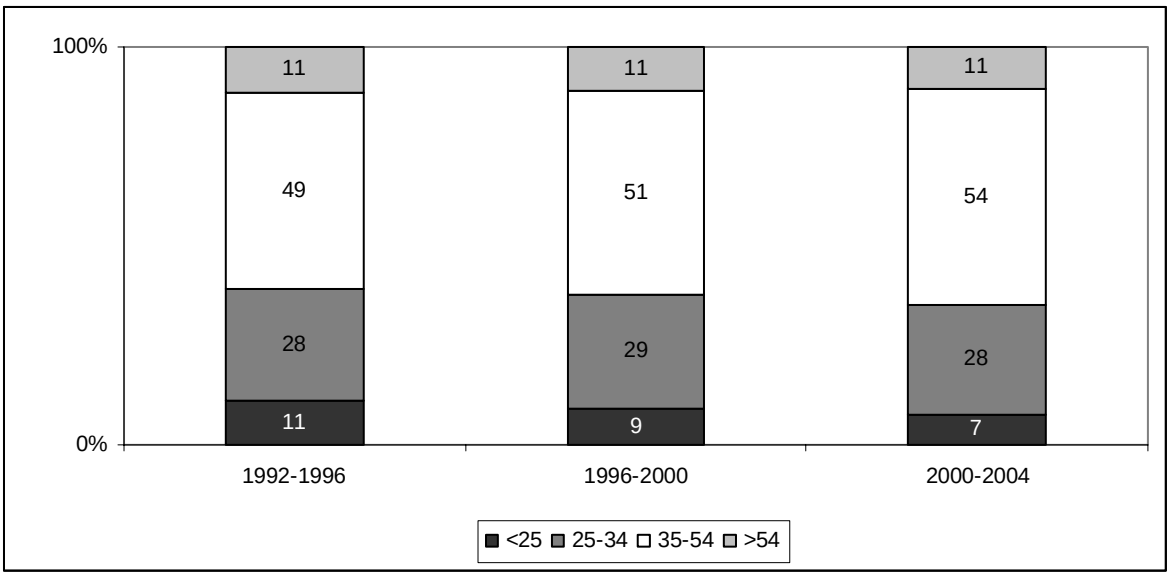
Table 6 -Contribution to Italian labour quality (percentage values)

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Quality	**0,71**	**1,42**	**1,29**	**1,19**	**0,91**	**0,82**	**0,98**	**0,60**	**0,68**	**0,57**	**0,85**	**0,64**
Gender	-0,02	-0,02	-0,02	-0,04	-0,01	-0,02	-0,03	-0,05	-0,05	-0,01	-0,01	-0,01
Age	1,71	0,89	0,86	0,77	0,73	0,77	0,80	0,56	0,51	0,38	0,56	0,39
Education	0,28	0,29	0,23	0,25	0,22	0,12	0,27	0,24	0,29	0,18	0,19	0,24
Sum of interactions	-1,79	-1,56	0,33	1,73	-0,36	2,00	0,86	0,94	1,13	0,54	-0,44	1,24
Non-weighted hours	**-0,53**	**-1,79**	**0,14**	**1,50**	**-0,34**	**2,04**	**0,89**	**1,08**	**1,19**	**0,51**	**-0,54**	**1,22**
Weighted hours (labour services)	**0,18**	**-0,39**	**1,41**	**2,71**	**0,58**	**2,88**	**1,90**	**1,69**	**1,88**	**1,09**	**0,30**	**1,86**

Note: quality is the difference between weighted hours and non weighted hours.

The findings of our exercise need to be better analysed also in relation to the quality of data sources. Firstly, hours worked estimated in the national accounts framework have been split by gender and other characteristics using data of the Quarterly Labour Force Survey and not the new ones of the survey on a continue base only available since 2004. Secondly, the annual Bank of Italy survey on households' balances presents some discontinuities due to the small sample size for guaranteeing reliable estimates and also to the lake of survey in some years.

Graph 9 - Composition of hours worked by age bracket (percentage).



4. Conclusion

This paper describes all the developments done in the last years by the National Statistical Office of Italy on labour input and labour productivity measurement.
In particular, a methodology to currently produce annual estimates on persons employed, jobs and hours actually worked has been adopted. The comparability of the results with the GDP growth rates is assured because of the consistency of the all aggregates produced in the context of national accounts.
Some first attempts to estimate a quality adjusted measure of labour input have been done. However, the quality and the availability of statistical and/or administrative data on hourly wages

detailed by quality aspects of labour force remain uncertain. The results obtained in terms of quality adjusted measure of labour input are fragile, in particular considering the difficulties regarding the measurement of hourly labour cost. Nevertheless, Istat is highly interests to promoting convergence on statistical methodologies on hours actually worked and to provide a better statistical base for labour productivity analysis.

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