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Measuring labour input growth and productivity: a method differentiated per type of employment and labour compensation

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Summary

Employment still represents today the factor that most influences production processes. Traditionally, however, the physical units employed, and not other important factors that influence its quality, are taken into consideration for measuring the labour productivity variations over time. In this article, the results obtained after having applied a new method for estimating labour productivity are presented. The methodological approach used considers variables that enable to correct the classic model of labour productivity estimate, introducing factors that measure quality changes over time. Data are elaborated by industries and in historical series since 1992.

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0. Introduction

Employment still represents today the factor that most influences production processes. Generally, labour productivity is calculated by relating to an output measure, referred to the whole economy or to a specific industry, a measure of the labour factor, represented by the hours worked or by the number of workers employed. In Italy, up until today, the lack of reliable informative sources on the hours worked has led to the use of the ratio between production trends or value added to factor cost and the variation of full-time equivalent units (FTEs), considered as a proxy of hours worked, for measuring labour productivity.

The production trend not always follows that of employment. In order to best understand what contributed to the increase of the product, whether it was a stronger increase of one of the production factor's productivity, a different and more efficient use of productive factors, or even the use of different productive techniques (which use less labour input or make intensive use of capital), it is possible to calculate the measurement of the total factor productivity (TFP). In particular, for measuring the labour productivity, thus, the labour factor contribution is generally calculated by considering only the physical units used and not the other factors that influence its quality.

The paper presents the results of a method for estimating labour input profile for the period from 1992 to 2003 taking into account factors that influence the labour quality. The results enable, in particular, to understand the impact of the labour factor trend on the productivity, which is calculated by taking into consideration the composition of employment. Generally, the new method takes into account variables that correct the traditional method of estimating labour productivity, introducing factors that measure changes in quality over time.

Estimates on hours actually worked are presented even if those are not used for productivity measurement till now.

Section 1 describes the reference theoretic method. Section 2 describes measures of labour input in physical terms. Section 3 describes data sources and estimation method used for calculating labour input and income differentials. Section 4 presents the results obtained. Finally, section 5 reports some conclusions and possible future developments of the method proposed.

1. The theoretic method

The study of labour and total factor productivity in the framework of national accounts schemes enables to analyse the phenomenon coherently with definitions, classifications and estimates both nationally and internationally.

From the practical point of view, two different measurements of productivity can be compared: one based on level estimation and the other based on growth rates. The latter is most often used for international comparisons as it overcomes the problem of monetary conversion.

Nevertheless, numerous difficulties of measurement arise when carrying out international comparisons, such as, in particular, the relevance of methodological aspects in determining the significance and accuracy of the results obtained.

The measurement problems, for example, can have a relevant role in interpreting the productivity growth rates that, even though referring conceptually to the same measurement, can differ in a substantial way. The values obtained, in particular, depend from the definitions

adopted for the relevant variables, from the indexes used in measuring inputs and outputs, from the data and the way in which they are aggregated and finally, from the particular index chosen for measuring the productivity growth rate¹.

The definition of a labour productivity index is rather simple as, generally, it is calculated reporting an output index in a given industry to an index of labour in physical terms in that industry (for example, hours worked).

If it is assumed the invariance of the output over time, the general labour productivity at time t can be obtained by reporting the variation of the output to the prices in a base year to the variations of the labour input in year t .

In this case, the labour productivity change when going from period 0 taken as base to period t will be:

$$PFPL(L) = \frac{Q_t}{Q_o} : \frac{L_t}{L_o} \quad (1)$$

where Q_t is an output index for year t compared to base year 0 and L_t is a labour input index necessary for obtaining that output during the same period. The numerator of the ratio is generally assimilated to a *Laspeyres* production index while the denominator is a labour input index for current year.

In the paper, it has been established a growth rate index for measuring the total factor productivity series based on a homogeneous estimation method for the various factors that participate in the production².

The measurement of TFP can be expressed as the difference between the product's growth rate and the sum of productive factors' growth rates, weighted by the respective weight on the product's total value:

$$\ln(TFP_t/TFP_{t-1}) = \ln(Q_t/Q_{t-1}) - [k\pi_t \ln(K_t/K_{t-1}) + l\pi_t \ln(L_t/L_{t-1}) + ip\pi_t \ln(IP_t/IP_{t-1})] \quad (2)$$

where Q is the output, K , L , IP indicate inputs of capital, labour input and intermediate input respectively, $k\pi$, $l\pi$ and $ip\pi$ represent the output elasticities compared to the single inputs. These elasticities are equal to the average of the cost rate of each factor on the output value at period t and $t-1$ and, for each factor i , are expressed as follows:

$$i\pi_t = (iS_t + iS_{t-1})/2$$

In the case of the labour input, $l\pi$ was calculated as the average of the rates of labour remuneration³ compared to output, (iS), measured at time t and $t-1$, in other words:

$$iS_t = w_t * L_t / P_t * Q_t$$

¹ Colombo L. and Coltro G. (2001).

² Bassanetti A., Iommi M., Jona-Lasinio C., Zollino F. (2004).

³The theory of the firm stipulates that, when the firm is a price-taker on labour market and aims to minimising its total costs, labour of certain type will be hired up to the point where the cost of an additional hour of labour is just equal to the additional revenue that using this labour generates. Then different quality of labour inputs can be weighted with the respective relative wage rate or the share of compensation due to each type of labour.

where w_t is the per-capita compensation and L_t is the labour quantity, both considered at time t .

The growth rate of labour input (indicated in expression 2) is measured on the base of the following formulation (*Tornqvist index*)⁴:

$$\ln\left(\frac{\mathbf{L}_t}{\mathbf{L}_{t-1}}\right) = \sum_{i=1}^n \frac{1}{2} (v_t^i + v_{t-1}^i) \ln\left(\frac{L_t^i}{L_{t-1}^i}\right) \quad (2)$$

where L_t^i represents each type of employment considered ($i = 1, \dots, n$) and where v_t^i is the rate of remuneration associated to it compared to the whole labour cost formulated as:

$$v_t^i = \frac{(w_t L_t^i)}{\sum_{i=1}^n w_t L_t^i} \quad (3)$$

The above measurement requires the availability of various series of data. Quantitative data are necessary as regards the total number of labour input jobs detailed by employment types and industries, as well as price information useful for constructing weights based on which the various types of employment can be aggregated.

The definition of output adopted for estimating total factor productivity, as well as labour productivity, can be referred to different economic aggregates, each of one expressing a different informative content. The definitions adoptable are the following: the gross output, the output net of inter-industry transactions or the value added. In the paper, it has been chosen to apply the method used by the Italian national statistical office (Istat), which is the output net of intrasector transactions (or *net output*)⁵. In this way, each industry is seen as a single vertically integrated enterprise; thus, the production is deducted from all the exchanges that occur among productive units classified in the same industry. The purpose is that of accentuating the role of primary factors compared to the intermediary goods in the computation of productivity.

Using this output measure, numerous problems arise when comparing productivity indexes obtained at various levels of aggregation. The procedure of aggregation by industry entails important complications for measuring productivity: productivity measures for the whole economy can be obtained by aggregating growth rates of productivity on an industry level. In particular, an aggregation procedure is the one based on a weighted average of the growth rates on an industry level where the weights were obtained by relating gross output to the output obtained by excluding inter-industry purchases.

The field of observation is limited to the activities characterised by operators who carry out mainly market activities, excluding a large part of the activities that are not part of the *business sector*: the real estate services, the Public Administration services, education as well as private households with employed persons.

⁴ 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.

⁵ Picozzi L. and Pisani S. (1996).

The measure of productivity by industry is influenced by the choice of the reference statistical unit. The accounts system adopted by European countries (ESA95) identifies in the establishment and the local kind-of-activity unit (LKAU) the most suitable statistical units for analysing productivity⁶. Numerous countries, nevertheless, do not produce national accounts estimates based on the above units of analysis and this contributes at reducing the degree of international comparison as regards the estimates; the Italian national accounts are based on LKA units⁷.

2. Labour input measures and accounting for different types of employment

Labour productivity changes are influenced not only by changes in physical units used, but also by other important factors that have an impact on its quality⁸.

The national account system identifies in the hours actually worked 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 the above 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 of work of self-employed workers and relative remuneration. A cross-classification of work hours based on the main characteristics of the labour force (such as education, professional experience, specialisation, etc) would be preferable.

The European System of National Accounts (ESA95) suggests however, using *full time equivalent units (FTEs)* as an input of labour measure in cases where no adequate statistics on the hours worked are available from various countries. FTEs equal the number of full-time jobs and part-time jobs (main and secondary) transformed into full-time units⁹. One must bear in mind that jobs represent the number of workplaces obtained from the sum of primary jobs and secondary jobs, independently from the number of hours worked. Full-time jobs do not affect from reductions if not due to the effect of the labour performed at reduced time by workers who are currently in redundancy fund. Part-time jobs (main and secondary) are transformed in FTEs by means of coefficients obtained from the ratio between hours actually worked in a job and the hours worked in the same industry in a full-time job.

Even though operating in the context of national accounts, there are numerous difficulties of measurement. Besides the lack of complete information regarding hours actually worked up until today, these difficulties concern the possibility of distinguishing the labour input among the different *skills* (such as qualifications and level of education) due to the lack of detailed and coherent statistical sources even on the corresponding remunerations.

In reality, the total volume of labour in a determinate reference period is the resultant of changes relative to time, efforts and professionalism acquired by the labour force. In this context, FTEs and hours worked do not succeed at capturing the dimension of the different labour specialisation over time.

⁶ Eurostat (1995).

⁷ This is possible because Istat uses the input of labour method for estimating the production aggregates as regards about the 70% of industries. For more details on the input of labour method see the OECD "Handbook on measuring the underground economy", 2001.

⁸ A. Brandolini and P. Cipollone (2001).

⁹ ISTAT (2000).

The method proposed tries to classify the labour input, measured in terms of full-time equivalent units, by different types of employment to which specific remunerations have been attributed. This approach enables to overcome the limit often attributed to statistics relative to labour productivity and to refer only to labour quantity understood as working time, or as number of persons employed and thus, to obtain a measurement of the productivity that takes into account quality of labour offered. In particular, the method tries to gather the effects on production of the qualitative improvements of the labour force, productive organization and sectoral allocation changes of the resources.

The *factors* that according to the method proposed, and based on the available statistical sources, *qualify* the labour input by industry are: the professional qualification of registered employees (distinguished in managers, white collars, blue collars and apprentices), unregistered employees, registered and unregistered self-employed workers¹⁰. Registered and unregistered employees, in particular, are estimated from the national accounts, using an approach that integrates and compares different sources of information on a much-desegregated level compared to the reference statistical unit.

Changes rates of each type of employment by industry are aggregated using a weighting structure represented by the share the specific remuneration belonging to each type on the total labour compensation of that industry. These weights will be higher for the types that receive higher remunerations and the average high wage reflects a usually high specialisation of the labour force. Similarly, for aggregating the labour input over industry, the share of labour compensation for each industry compared to the total labour income distributed represents the weight for aggregating elementary data; these weights will be high for industries that pay higher compensations and lower for industries with lower compensations.

The analytical scheme in Table 1 describes the level of desegregation used for estimating the labour input in quantitative terms.

Table 1 – Classification of full-time equivalent units (FTEs)

Types of employment		Size of enterprise (number of workers)							
		1-5	6-9	10-14	15-19	20-49	50-99	100-249	+250
Registered FTEs employees	<i>Managers</i>	x	x	x	x	x	x	x	x
	<i>white collars</i>	x	x	x	x	x	x	x	x
	<i>blue collars</i>	x	x	x	x	x	x	x	x
	<i>Apprentices</i>	x	x	x	x	x	x	x	x
Unregistered FTEs employees		x	x	x	x				
Registered and unregistered FTEs self-employed		x	x	x	x	x	x	x	x

In conclusion, an approach to measure the *adjusted labour growth rate*, considering a qualitative factor represented by the different remunerations associated to each type of employment, is here described.

¹⁰ To go in depth on the method used by the Italian National Statistical Office (Istat) for measuring unregistered workers and underground value added see Baldassarini A. and Pascarella C. (2003).

Six different types of employment have been identified on the base of the significance of the results obtained by elaborating the basic information with the maximum level of detail available and have contributed to the estimate of the labour input growth rate.

3. Quality - adjusted measure of labour input

Labour input reflects time, effort and skill of work force. The full-time equivalent units, as hours actually worked, capture partially the time dimension but they don't reflect the skill dimension; the simple sum of full-time equivalent units doesn't take in account the heterogeneity of labour.

In the national economic accounts system, aspect of quality is introduced in order to distinguish a volume index by means of a simple sum of the full-time equivalent units. The differentiation of the labour force by *professional skill* can determine either an increase or a reduction of the average quality of labour input. A comparison between adjusted and unadjusted measure of the labour input makes it possible to evaluate quality changes of input of labour over time

In order to analyse labour productivity, the usefulness of the estimate of both measure of labour input (adjusted and unadjusted) has been expressed internationally¹¹. As the TFP represents the component of the output growth that cannot be explained by the single factors (labour, capital and intermediate consumption), a more accurate measure of the labour input, which gathers possible improvements of quality, implies a reduction of TFP. In other words, part of the productivity growth could be interpreted as effects deriving from the investments on human capital.

In literature and statistical practice, there are different approaches to the problem of differentiation of labour input and the choice of the method is strongly limited by availability and frequency of the set of data.

By referring to expression 3 of section 1, different type i of labour input is weighted with the share that labour type i occupies in total labour compensation (v_i) in the economic system at time t . The weights v_i at period t are calculated as the average of the rates during two consecutive years.

In order to measure the adjusted labour input, the method proposed takes into account full-time equivalent units and compensations estimated in national accounts, desegregated by means of some indicators on purpose constructed.

Labour input and compensation are treated differently, making a distinction among six different types of employment, as described in Scheme 1. More details about the estimating method of each component are described forward.

3.1 Labour compensation and labour shares.

The growth rate of total quality-adjusted labour input is measured by an implicit differentiation of full time equivalent units and compensation in the national account system. In the case of registered employees the *factor* that *qualifies* the labour input per industries is the professional qualification distinguished in: managers, white collars, blue collars and apprentices. The professional qualification is considered a *proxy* of the professional

¹¹ OECD (2001).

experience and education of the worker and it is partially related to his skills, innate or acquired over time. The employment structure given by the different professional skills can be associated to different price, which means different compensations.

Scheme 1 – Labour compensation by type of full-time equivalent units

<i>Registered employees</i>	→ compensation of employees by job position (managers, white collars, blue collars, apprentices)
<i>Unregistered employees</i>	→ wages and salaries of unregistered employees
<i>Registered self-employed workers</i>	→ compensation of registered employees
<i>Unregistered self-employed workers</i>	→ compensation of registered employees

The source used is the business register of the Social Security Institute (forward indicated as Social Security register) relative to the form payments of employers' social contributions. This source presents numerous advantages. Moreover, the use for statistical purposes of data from an administrative register requires an onerous treatment in order to make these data conform to the ESA 95 definitions and standards.

The advantages of the above source of information are the following:

- The availability for each enterprise of information on the number of jobs and wages for each type of job position;
- The high level of coverage compared to the exhaustive national account estimate of registered employees jobs (73,5% for the total economy, Table 2);
- The timely availability of data;
- The accuracy of the information relative to wages.

Table 2 – Jobs of registered employees as estimated by national accounts (NA) and as gathered by the Social Security Business Register (SSBR). Year 2000

<i>Industries</i>	NA jobs	SSBR on NA jobs in %
Agriculture	201.100	26,2
Industry, including energy	4.202.800	100,7
Construction	728.100	117,6
Wholesale and retail hotels, transports and communications	2.942.300	95,0
Financial and business activities	1.587.100	99,0
Other service activities	4.722.300	22,5
Total economy	14.382.700	73,5

The use of the Social Security register enables to obtain current estimates of the indicators useful for desegregating input of labour and for differentiating the average compensation of the four job positions: managers, white collars and blue collars and apprentices.

The procedure is composed of three steps. In the first step, the basic data were merged with Istat's statistical register of active enterprises (ASIA) in order to attribute the correct economic activity to each enterprise (expressed on a 5-digit level of the national economic classification) and the enterprise's size class, as it is constructed for the estimate of the aggregates of national accounts.

In the second stage, the data on jobs and remunerations from the Inps archive were elaborated in order to obtain shares of employment and relative differential remunerations distinguished for 101 industries, 8 size classes (the classes were distinguished according to the number of workers: 1-5, 6-9, 10-14, 15-19, 20-49, 50-99, 100-249, over 250) and four professional qualifications (managers, white collars and blue collars and apprentices).

The shares of employment and wage differentials were applied respectively to full time equivalent and to the average compensation per employee estimated in national accounts in the same industry and in the same enterprises size class .

In the third phase the different average compensation for employee distinguished for 101 industries and 8 enterprise size classes were aggregated in 30 industries using as weights the full-time equivalent units estimated in the previous stage. This step has been necessary in order to obtain different average labour cost for each of the four types of employment distinguished for a lower number of industries.

The following tables show the shares and implicit wage differentials by industries.

Table 3 – Full-time equivalent units per job position (% by industry)

<i>Year 1992</i>					
	Managers	White collars	Blue collars	Apprentices	Total
Industry, including energy	1,4	24,8	70,3	3,5	100,0
Construction	1,0	15,8	77,8	5,5	100,0
Wholesale and retail, transp., and commun.	0,8	44,4	51,6	3,2	100,0
Financial and business activities	2,1	78,2	19,0	0,7	100,0
Other services	0,1	79,1	18,4	2,3	100,0
Total economy	1,1	41,1	54,8	3,0	100,0
<i>Year 2002</i>					
	Managers	White collars	Blue collars	Apprentices	Total
Industry, including energy	1,4	26,4	68,1	4,1	100,0
Construction	0,6	14,4	76,6	8,5	100,0
Wholesale and retail, transp., and commun.	0,7	41,9	50,7	6,7	100,0
Financial and business activities	2,2	73,3	20,4	4,1	100,0
Other services	0,2	74,0	21,4	4,5	100,0
Total economy	1,1	43,2	50,6	5,2	100,0

Table 4 – Wage differentials for the years 1992 and 2002 – Total economy average wage =100

<i>Year 1992</i>				
	Managers	White collars	Blue collars	Apprentices
Industry, including energy	95	108	101	100
Construction	89	103	95	106
Wholesale and retail, transp., and commun.	93	88	106	108
Financial and business activities	121	121	109	91
Other services	103	87	106	72
Total economy	100	100	100	100
<i>Year 2000</i>				
	Managers	White collars	Blue collars	Apprentices
Industry, including energy	93	109	101	94
Construction	78	95	93	100
Wholesale and retail, transp., and commun.	85	80	98	107
Financial and business activities	116	115	116	114
Other services	129	94	106	80
Total economy	100	100	100	100

The share of compensation v_i of labour input type i , is the weight used for aggregating the different types of employment. It is represented by the labour's full cost, in other words by the compensation of employees. The latter is composed by the wages and the employer's social contributions; contributions, are distinguished in actual and imputed social contributions¹².

The actual contributions represent in terms of value, almost the totality of the contributions. The imputed contributions, instead, consist in a small part of the compensation (about 2, 5%) and are not directly proportioned to the remuneration

The hypothesis at the basis of this method consists in considering all the social contributions as directly proportional to wage and thus to apply the wage differentials per employee to the compensation per employee estimated in the national accounts system. In this way it became possible to distinguish the average compensation per registered employee in each industry in four types of labour compensations.

In case of unregistered employees the remunerations is derived directly from national account system and include only wages. Indeed, the employee doesn't recognize social contributions to these workers.

Numerous problems arise when estimating the remuneration of the self-employment input. A common way to deal with this point is to assume that the average compensation of a self-employed person equals that of employee in the same industry in the same enterprises size class. In the first step of the study to this type of labour, was assigned the average compensation of a registered worker employed in the same economic activity and enterprises size class.

¹² According to the ESA 95, the actual contributions include the employers' social contributions paid to welfare and assistance institutions and the several . The imputed contributions are the counterpart of social insurance service directly paid by the employer without resorting to insurance companies and without constituting a distinct or special fund for this purpose. An example of service directly paid by the employer is the remuneration assured during the first three days of the employer's illness or even reimbursements for medical expenses.

4. Results and comparisons

The nineties were characterised by a first phase of employment decrease and by a subsequent growth of labour input since 1996. This increase was accompanied by a deep qualitative change of the labour demand; the development of new contract instruments, that have enabled enterprises to make labour more flexible, have led to a significant change towards occupation with a higher professional content.

The productive system, at the same time, has undergone a change that has led to the substitution of the labour factor towards capital input and intermediate inputs. This evidence can be seen in almost all productive sectors, except for the construction sector that registered a substantial stability all throughout the period (see Table 5).

Table 5 – Share of labour input on output at current prices (percentage values)

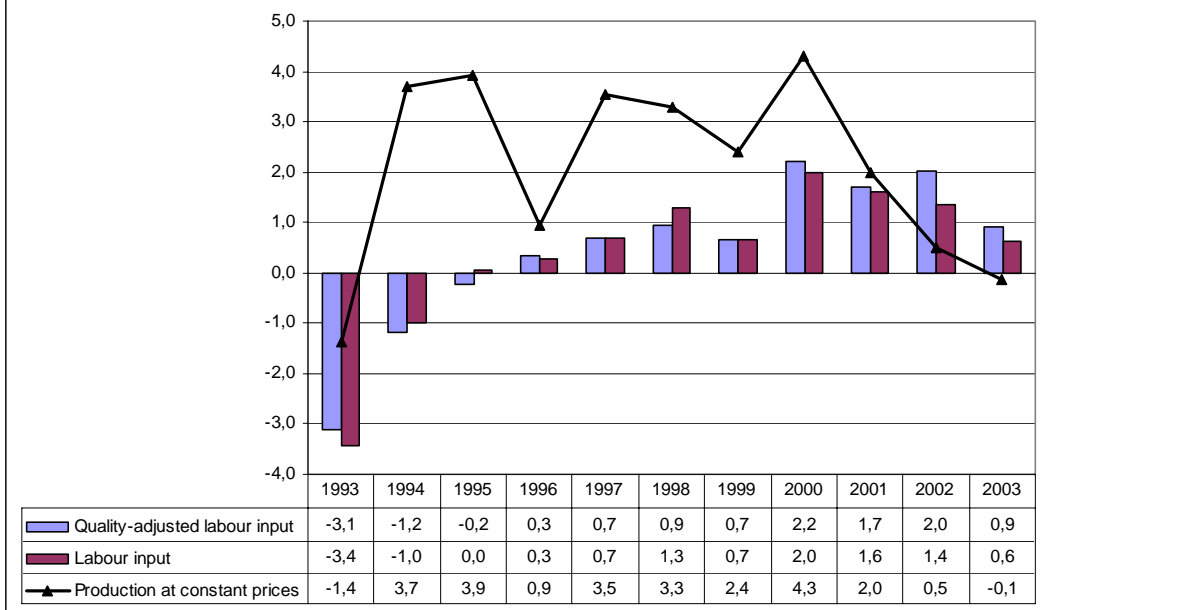
Industries	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Agriculture	61,2	57,8	53,0	49,7	49,5	47,6	44,5	43,5	42,5	42,2	41,9
Industry, including energy	35,2	33,2	30,7	32,0	31,8	31,4	31,2	29,1	29,3	30,1	30,7
Construction	36,4	36,3	35,8	34,9	36,2	35,6	36,3	36,0	36,5	36,2	36,4
Wholesale and retail hotels, transports and communications	45,7	43,3	41,9	41,9	41,1	40,1	40,2	39,7	39,2	39,4	40,0
Financial and business activities	47,9	50,2	46,4	45,7	44,9	44,2	44,4	43,5	43,8	44,5	44,9
Other service activities	52,9	51,9	52,5	53,1	53,5	52,0	51,2	51,0	50,5	49,9	49,3
Total economy	58,3	56,1	53,5	54,0	53,8	53,0	53,0	51,4	51,5	52,3	53,2

In order to examine the relations between the dynamics of the net output and the labour factor, together with the changes in the composition of the labour demand, a comparison was carried out between two different indexes of labour input trends: one calculated with the measurement of the quality-adjusted labour input and the other that considers only the changes of the full-time equivalent units (Graph 1).

Since 1999, it appears evident that the quality-adjusted growth rate results higher of that one represented by the simple trend of the labour input. In 2003, the increase of the adjusted labour input was equal to 0,9% compared to the 0,6% of FTEs increase. The above trends resulted superior to the output trend calculated at constant prices that registered conversely, slight contractions (-0,1%).

For the purpose of a comparative analysis of the output and labour input's growth rates, it is useful to refer to the partial labour productivity measure. Graph 2 indicates two different measurements of productivity that, at the same level of output, use the growth rate of the quality-adjusted and unadjusted labour input. Since 1996, the productivity growth rates calculated with the quality-adjusted labour input result significantly inferior than those of output and higher than those calculated by not considering the changes of the qualitative factors on the labour input. In 2003, the two measurements of productivity resulted as -1,1% and -0,8% respectively.

Graph 1 - Growth rates of labour input, quality-adjusted labour input and production at constant prices



Graph 2 - Growth rates of labour productivity, adjusted and unadjusted of quality labour input, and growth rates of production at constant prices

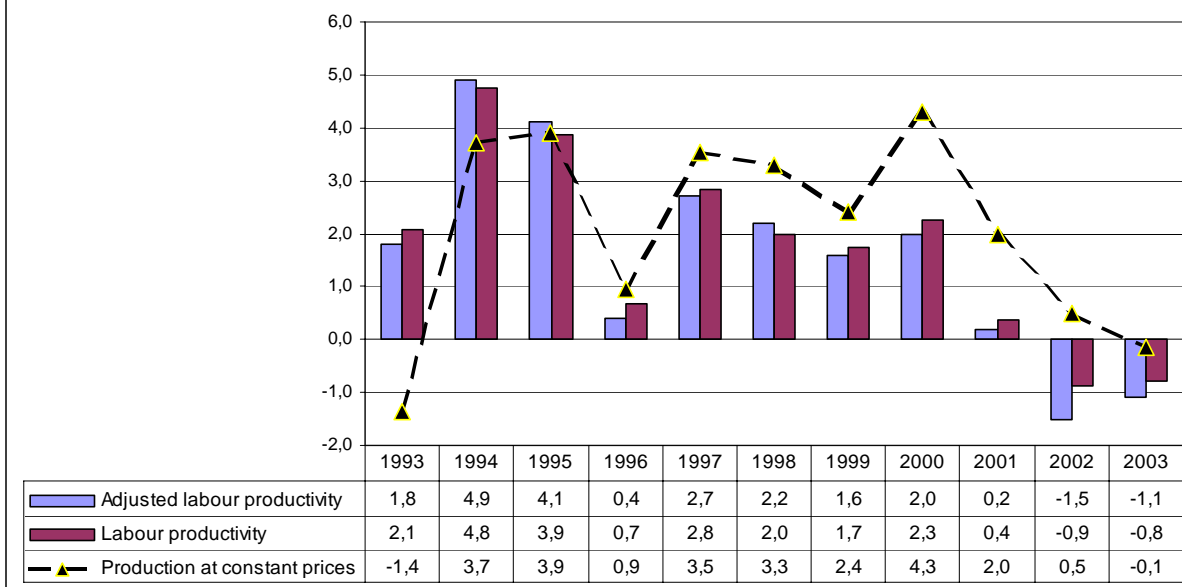


Table 6 indicates the growth rates of the adjusted and unadjusted labour factor desegregated by industry. It highlights how the growth of the adjusted labour input results particularly significant in the financial and the business service activities throughout almost all the period, though to a greater extent as regards year 2000. The growth resulted intense

and superior to the national average even for the sectors of trade, hotels and restaurants, transports. Since 1999, the construction sector underwent a strong decrease.

Data on the growth rates of the quality-unadjusted labour input are indicated in Table 8. They are prevalently less dynamic than those adjusting, for different industries and for various years.

Table 6 – Growth rate of the quality-adjusted labour input

<i>Industries</i>	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Agriculture	-9,0	-5,0	-3,8	-4,3	-2,9	-4,1	-5,6	-2,2	-0,1	-1,9	-3,5
Industry, including energy	-4,0	0,0	0,6	-0,4	0,4	1,8	-0,6	0,0	-0,4	0,9	-0,5
Construction	-3,8	-3,9	-3,1	-1,4	1,3	-2,2	2,0	3,2	4,7	3,6	3,4
Wholesale and retail trade, hotels and restaurants; transport and communications	-2,6	-1,2	-1,3	1,1	0,2	0,9	1,0	2,9	1,9	1,4	1,7
Financial, real-estate, renting and business activities	-1,3	-1,9	2,1	3,0	3,6	3,1	3,5	5,5	3,7	4,8	2,2
Other service activities	-0,7	1,5	1,1	1,2	0,7	1,1	1,5	2,0	2,2	1,7	0,5
<i>Total economy</i>	-3,1	-1,2	-0,2	0,3	0,7	0,9	0,7	2,2	1,7	2,0	0,9

Table 7 – Growth rate of the labour input in terms of full-time equivalent units

<i>Industries</i>	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Agriculture	-9,1	-5,1	-3,6	-4,5	-2,7	-3,9	-5,5	-1,9	-0,1	-1,9	-3,8
Industry, including energy	-4,1	0,0	0,9	-1,1	0,2	2,0	-0,8	0,0	-0,5	0,5	-0,3
Construction	-3,1	-3,2	-1,9	-1,0	1,6	-1,7	2,1	2,9	4,6	2,6	2,8
Wholesale and retail trade, hotels and restaurants; transport and communications	-2,5	-0,6	-1,2	1,0	0,2	1,5	0,9	2,5	2,1	0,5	1,1
Financial, real-estate, renting and business activities	-2,3	-2,1	3,8	4,4	4,7	3,6	4,4	5,7	3,1	5,4	2,3
Other service activities	-0,9	1,8	1,7	1,4	0,4	1,8	1,7	2,2	2,1	1,3	0,1
<i>Total economy</i>	-3,4	-1,0	0,0	0,3	0,7	1,3	0,7	2,0	1,6	1,4	0,6

Results registered for the economy as a whole are determined by a change in the employment composition and by a corresponding differentiation of the remunerations that have favoured employees' growth, in particular the white collars workers, and penalised the self-employed trend (Table 9). It is interesting to observe the growth of the apprentices' component since 1996, year in which, the norm regarding the apprenticeship contract was reviewed (Law No 196).

Table 8 – Income shares by type of full-time equivalent units

<i>Types of employment</i>	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Managers	3,4	3,3	3,2	3,1	3,2	3,2	3,2	3,3	3,3	3,3	3,5
White collars	33,1	33,0	32,9	32,8	33,2	33,4	32,9	33,0	33,8	33,6	34,4
Blue collars	30,0	29,6	29,4	28,9	28,6	28,5	28,1	27,8	27,0	27,2	27,0
Apprentices	0,8	0,8	0,8	0,8	0,8	0,8	1,0	1,3	1,5	1,4	1,6
Unregistered employees	5,9	6,0	6,2	6,5	6,3	6,4	7,0	6,9	6,8	6,8	6,5
Self-employed	26,8	27,2	27,4	27,8	27,9	27,6	27,9	27,6	27,6	27,3	27,0
<i>Total employment</i>	<i>100,0</i>	<i>100,0</i>	<i>100,0</i>	<i>100,0</i>	<i>100,0</i>	<i>100,0</i>	<i>100,0</i>	<i>100,0</i>	<i>100,0</i>	<i>100,0</i>	<i>100,0</i>

Table 9 - Composition of full-time equivalent units by type

<i>Types of employment</i>	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Managers	0,6	0,6	0,6	0,6	0,6	0,6	0,6	0,6	0,6	0,6	0,6
White collars	21,8	22,2	22,2	22,2	22,3	22,4	22,3	22,5	23,0	22,8	23,6
Blue collars	29,0	28,9	28,8	28,2	28,1	28,2	27,7	27,6	27,1	27,6	27,7
Apprentices	1,6	1,6	1,6	1,5	1,5	1,5	1,9	2,4	2,6	2,6	2,8
Unregistered employees	36,7	36,1	36,1	36,2	36,3	35,9	35,8	35,3	35,1	34,7	34,2
Self-employed	10,3	10,6	10,8	11,3	11,1	11,4	11,7	11,6	11,6	11,7	11,1
<i>Total employment</i>	<i>100,0</i>	<i>100,0</i>	<i>100,0</i>	<i>100,0</i>	<i>100,0</i>	<i>100,0</i>	<i>100,0</i>	<i>100,0</i>	<i>100,0</i>	<i>100,0</i>	<i>100,0</i>

Graph 4 indicates the average growth rates of the quality-adjusted labour input calculated for 27 industries and for the whole economy during the period considered. Data are ordered in a decreasing way. Industry that has registered the highest growth rate is that of business activities, leasing and computers (+3,8%), followed by the sector of other public and personal social services (+2,1%) and hotels and restaurants (+1,8%). Industry sector and agriculture have registered the lowest change rates during the whole period.

Istat used the results presented here for estimating the new series of total productivity (TFP) and partial productivity of labour factor¹³.

5. Further developments of the estimation procedure and first results

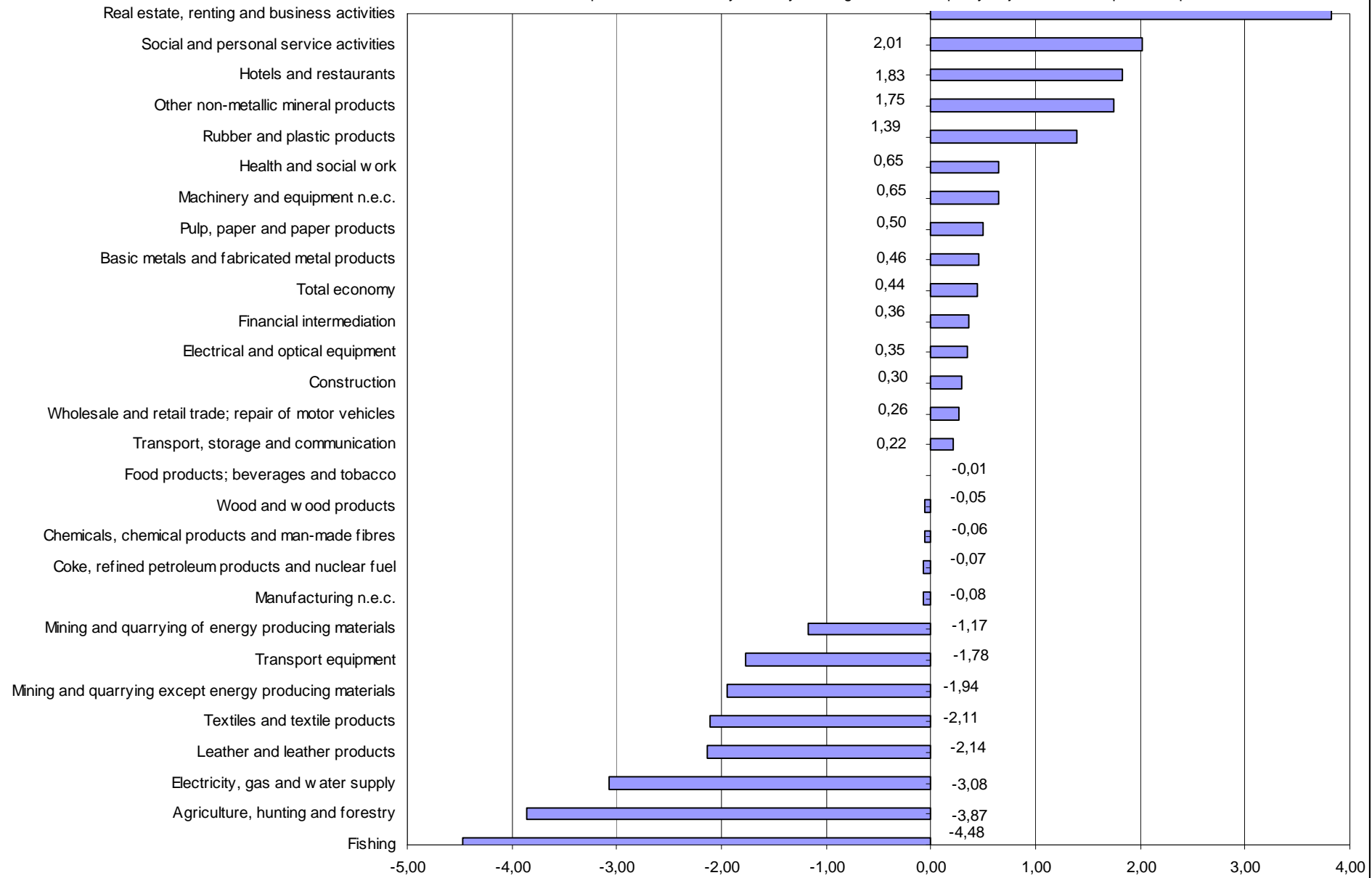
It is possible to improve the estimate of the labour input contribution to the production differentiating further the types of self-employed and remuneration. One possibility for differentiating self-employed persons is to assume that exist some kind of relation between the skill and the type of institutional unit were the self-employee is occupied. The structure of labour input underlying Institutional Sector Account provides a suitable set of information. Therefore this labour input is differentiated by two main type of self-employment: those occupied in the productive units classified in the financial and non-financial corporations sector and those occupied in the household sector.

The *corporation sector* (see ESA95 §2.17) consist of institutional units whose distributive and financial transactions are distinct from those of their owners and which are market producers, whose activity is the production of goods and services¹⁴.

¹³ The new historical series of the total factor productivity are available on the Institute's website: www.istat.it/Economia/Conti-naz/index.html.

¹⁴ According to the Italian institutional accounts, the corporations sector includes all enterprises, co-operative societies and partnerships, ordinary partnerships and one-man companies with over 5 employees.

Graph 4 - Contribution by industry to the growth of the quality-adjusted labour input in the period 1992-2003



The *households sector* includes individuals or group of individuals as consumers and possibly also as entrepreneurs producing market goods and services, provided that, in the latter case, the corresponding activities are not those of separate entities. Therefore the households sector includes the sole proprietorship and partnership without independent legal status that are market producers: household unincorporated enterprises with or without employees¹⁵.

The two types of employment were identified in order to distinguish self-employment carried out in a corporation characterised by complex organization forms (such joint-stock companies) and that carried out in companies where it is difficult to distinguish between company income and household income (the latter contains only the labour remuneration of those who participate in the company's activities).

To measure the growth rate of the two types of employment, it is necessary to attribute to each one of them different remunerations that take into account the different skills and quality of the work carried out. The remuneration assigned to the self-employed of the corporation and quasi-corporation is an average obtained assigning the labour compensation of managers to the self-employed in joint-stock companies and the compensations of blue collars to self-employed in other companies.

The employers of the household sector are remunerated considering the *mixed income* (see ESA95) accruing to them (owners of unincorporated enterprises) from their activity as producers of market goods and services. The mixed-income is balancing item of the generation of income account, in other words, the residual part of the value added, resulting from the production process, after covering compensation of employees and other taxes less subsidies on production. The mixed income contains an unknown element of remuneration for work done by the owner and the property income; in some cases the element of remuneration could be predominant¹⁶. The institutional sector accounts allow property income *proxy* to be computed and therefore labour income *proxy* to be adjusted residually. By subtracting from mixed-income consumption of fixed capital (the part of self-financing necessary to replace capital goods), interest and rent payable and current taxes, is obtained approximately labour income¹⁷ that is taken from the company to be transferred to the household for consumption and savings.

Based on this method, the quality-adjusted labour input growth rate, was measured by taking into account the compensation associated to 7 types of employment and income (in particular, managers, white collars, blue collars, apprentices, unregistered employees, self-employed in corporations sector and household self-employed).

The approach here proposed modifies sensibly the rate of current production that accrues to labour factor at the disadvantage of other productive factors (intermediate and capital input) compared to the first results presented in section 4 (see Table 5 compared to Table 10). In this case, such as in the previous one, the analysis of the data over time highlights a progressive substitution of the labour factor towards the other productive inputs.

¹⁵ According to the Italian institutional accounts, in the households sector are classified ordinary partnership and one-man companies with less than 5 employees

¹⁶ System of National Accounts 1993

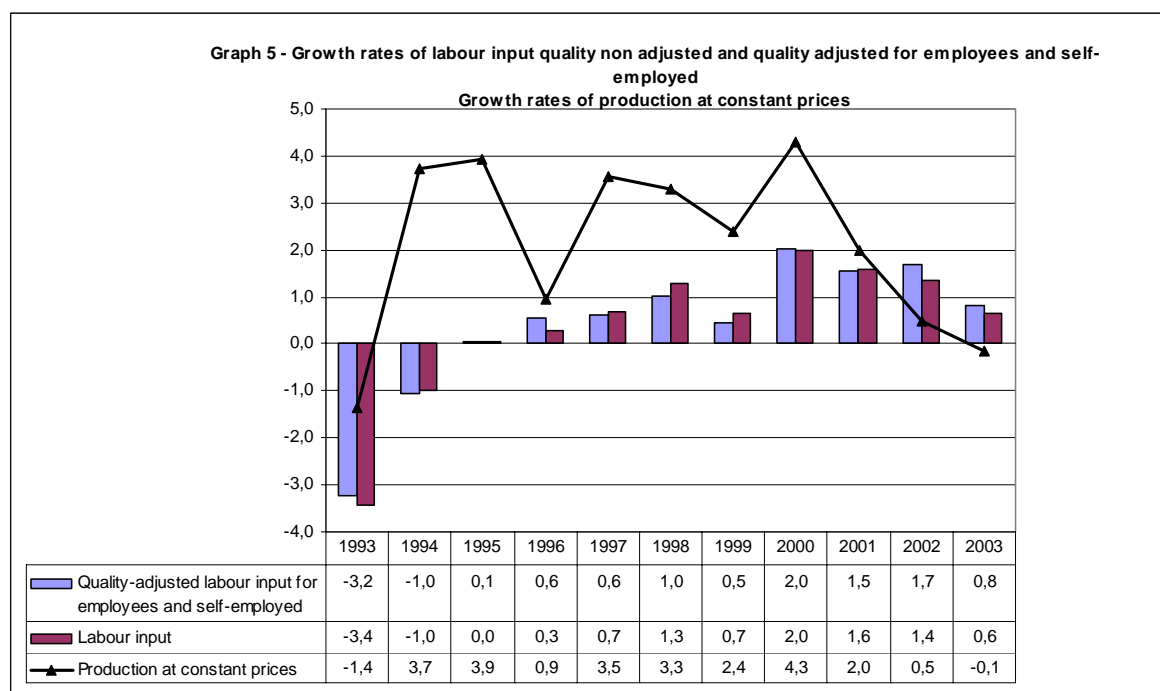
¹⁷ Using of term 'approximately' because this residual flow still contains element of entrepreneur's risk.

Table 10 – Share of labour compensation, obtained differentiating the self-employment remuneration, compared to production at current prices (percentage values)

<i>Industries</i>	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Agriculture	66,0	66,3	65,0	64,9	63,9	63,6	63,0	62,0	61,6	60,9	59,9
Industry, including energy	37,1	35,0	32,5	33,9	33,6	33,5	33,3	31,1	31,4	32,3	33,6
Construction	45,0	45,5	45,1	44,2	45,7	44,9	45,7	45,3	45,7	45,1	45,0
Wholesale and retail trade, hotels and restaurants; transport and communications	50,6	49,1	47,6	48,2	46,7	45,7	45,0	44,5	44,0	44,1	44,3
Financial, real-estate, renting and business activities	55,0	57,4	54,4	54,7	56,2	54,9	54,2	53,1	53,4	54,6	55,6
Other service activities	53,5	52,9	53,7	55,0	55,2	54,3	53,2	52,9	50,4	50,1	50,5
<i>Total economy</i>	<i>63,8</i>	<i>62,1</i>	<i>59,8</i>	<i>61,1</i>	<i>61,0</i>	<i>60,3</i>	<i>60,1</i>	<i>58,2</i>	<i>58,2</i>	<i>59,2</i>	<i>60,5</i>

In the above case, the growth rates of the quality-adjusted labour input are closer to that of the unadjusted labour input compared to the approach whose results were presented in section 4 (Graph 5).

The greater standardisation between adjusted growth rates, obtained with the second approach, compared to the growth rate of the unadjusted labour input seems to be due to the introduction in the estimate of income differentials between different types of self-employed labour.



Actually, if on the one hand, the approach that differentiate the types of self-employment income here presented enables to overcome the approximation at the basis of the estimates presented in section 3 (which uses an informative detail greater than that for the employment incomes), on the other hand, this method, in order to be better interpreted, needs more informative sources suitable for gathering qualitative traits of self-employed persons.

6. Measuring hours actually worked

According to the system of economic accounts (ESA95), the hours worked represent the most adapted measure for quantifying the actual use of labour in the process of wage production.

The availability of labour input in terms of hours enables indeed to fully take into account the short-term fluctuations of labour due to both economic and social factors.

The amount of hours worked represents the total hours actually worked, remunerated and none. 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 annual leaves, 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 own account work, productive service volunteering, *do-it-yourself* type of activities other than extraordinary house maintenance work).

For estimating the hours worked, the approach adopted by Istat consists in multiplying jobs by the average annual number of hours worked per job (also called per-capita of hours worked), the latter being directly taken from the statistical surveys that measure this phenomenon. Jobs are differentiated per typologies in order to apply homogeneous working hours per capita in relation to the statistical unit of reference (enterprise, institution or household), to the industry and to the type of employment (registered, unregistered, main and secondary job). The estimation of the hours worked enables Istat to be fully in line with the ESA 95 accounts system regulation, and to provide users with an important measure of labour input together with that of domestic workers, jobs and full-time equivalent units that are already being currently produced.

Information regarding the length of time of weekly and/or annual employment is obtained from the workers themselves through statistical surveys addressed to households or from employers through surveys addressed to enterprises.

The main sources of information on the hours actually worked available are the following:

- The quarterly labour force survey¹⁸
- The annual surveys on the enterprises economic accounts
- The monthly survey on enterprises 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 business 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 and distinctly in the second one.

Another difference is that the business surveys gather information directly from the employers who, theoretically, provide more precise data than those declared by the households. Generally, though, the business surveys do not collect the hours worked by the self-employed workers, they do not cover all industries (such as, for example, the agriculture, the general government 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 in jobs not registered 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

¹⁸ 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 worked, nevertheless, are not those from the continuous survey. The re-alignment to the results of the new survey will be done at the end of 2005, when the new series of data on the national accounts aggregates will be diffused.

business 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 business 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.1.1 classification) and per size of enterprise; the labour force survey provided data for all 60 economic activity divisions of the Nace classification, distinguished per employees and self-employed workers.

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;
- The ABI (Italian Banks Association), which provided specific data on the workable hours in the financial intermediation services sector.

The estimation on the total of hours worked has 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 estimation procedure used has enabled to measure the total of hours worked for the period 1993-2003. The fact of working on such 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 sectorial 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 business surveys and available as from 1992. In particular, the annual surveys on the business' economic accounts include, since 1998, all enterprises with 100 employees and over as well as a sample of enterprises 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 labour cost survey addressed to enterprises with 10 employees and over.

The analysis of the business source 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.

Data on the per capita of hours actually worked in industries that are not covered by the business surveys, those relative to the second job and the per capita of self-employed workers have been directly surveyed by means of the quarterly labour force survey. Until October 2003, this survey was done every three month four weeks a year during which there were no public holidays, in the months of January, April, July and October.

There are mainly two problems deriving from the use of the non-continuous labour force survey: 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. Consequently, some results deriving from the quarterly *Travels and Holidays* survey have been used, as it is part of the cycle of multi-purpose social surveys that, applied to the data on the per capita surveyed from the survey, have enabled to reduce the effect of the so-called distortion and to improve the quality of information. Once the per capita referring to the various quarters have been defined, it has been possible to estimate the annual total of hours adjusting the data by the possible holidays.

The *approach per component* method has been used to calculate the annual per capita of hours worked in the General Government sector and financial intermediation services sector, and consists in estimating the components that imply a variation of the working time compared to a *norm* considered equal to the contractual working hours.

Labour input measured in terms of hours actually worked as in terms of persons employed, full-time equivalent units and jobs, all according to the domestic concept of employment, are presented in Table 11.

As described above, the total of hours worked is obtained by multiplying the average annual number of hours worked in a work position (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 persons employed but to the total of jobs, or work activities, that each person employed can carry out, even in different industries and with different professional statuses (for example, a first job as employee and a second job 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 whole economy; it provides no information at an industry level as there is no certainty as to whether the employed persons surveyed in the same industry are the only ones who have contributed in the total of hours worked, estimated in a given industry or in a specific job.

As highlighted in Graph 6, the average annual per capita of hours worked calculated per person employed appears definitively superior to that estimated per job. In 2003, each person employed worked on average 1,810 hours while the work intensity corresponding to each job was of 1,426 hours. In 1993, the per capita numbers were of 1,886 hours and 1,433 hours respectively; over time, thus, the per capita per job increased while the one corresponding to each person employed reduced by 76 hours.

Up until today, the full-time equivalent units are considered as a *proxy* of the total of hours worked. They are obtained by applying to the non full-time jobs transformation coefficients measuring the hours worked in part-time industries and those worked full-time in the same industries.

The full-time 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 between full-time, part-time and secondary jobs; as consequence, full-time equivalent units don't take into account important components, such as overtime and absenteeism from work. If, for example, leaves due to illnesses or to some other motives grow over time and the level and composition between part-time and secondary employment do not change, the total of hours actually worked will be reduced while the full-time equivalent units will remain unchanged.

Table 11– Domestic persons employed, jobs and total of hours actually worked (absolute values in thousands and annual variation rates)

Years	Persons employed	Full-time equivalent units	Jobs	Hours actually worked
<i>Absolute values</i>				
1993	22.348,7	22.749,8	29.401,8	42.140.744,1
1994	22.017,1	22.529,2	29.048,5	41.426.723,6
1995	21.992,3	22.528,3	28.835,8	41.254.742,3
1996	22.130,7	22.600,2	28.993,3	41.653.299,8
1997	22.215,3	22.691,5	29.025,6	41.509.376,1
1998	22.448,2	22.915,9	29.270,9	42.261.372,4
1999	22.686,9	23.048,9	29.243,7	42.610.242,0
2000	23.128,4	23.451,6	29.669,4	42.910.844,5
2001	23.581,8	23.836,7	30.137,9	43.641.177,3
2002	24.008,7	24.135,3	30.648,6	43.876.726,6
2003	24.284,1	24.238,5	30.829,4	43.960.224,7
<i>% Variations compared to the previous year</i>				
1993	-	-	-	-
1994	-1,5	-1,0	-1,2	-1,7
1995	-0,1	0,0	-0,7	-0,4
1996	0,6	0,3	0,5	1,0
1997	0,4	0,4	0,1	-0,3
1998	1,0	1,0	0,8	1,8
1999	1,1	0,6	-0,1	0,8
2000	1,9	1,7	1,5	0,7
2001	2,0	1,6	1,6	1,7
2002	1,8	1,3	1,7	0,5
2003	1,1	0,4	0,6	0,2

Graph 6 – Annual per capita of hours actually worked calculated per employed person and job.



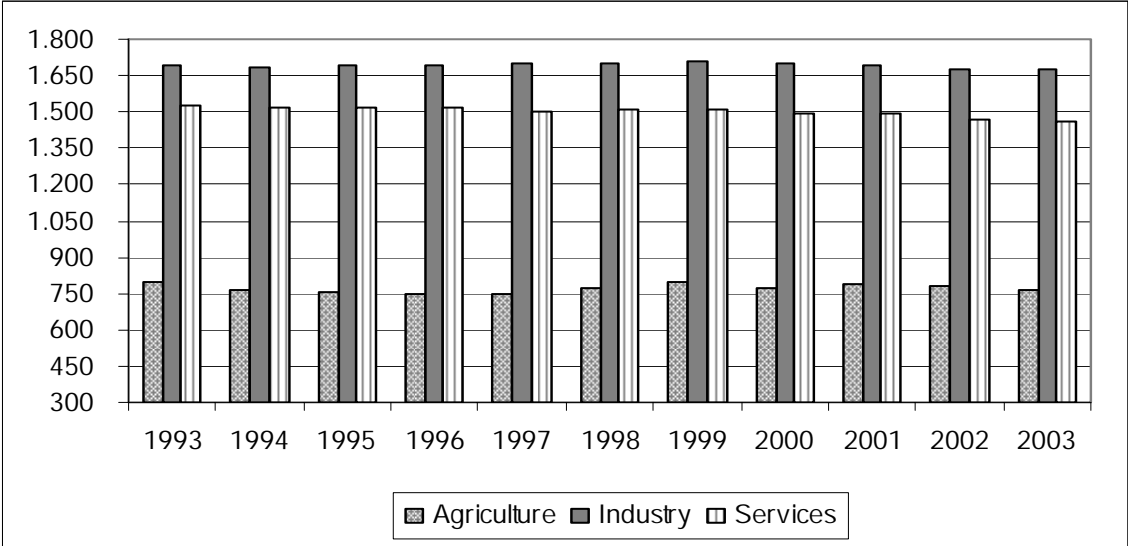
The per capita hours per job and per person employed, if calculated only for the non-agricultural productive activities, are rather different. In particular, in 2003, the per capita per person employed resulted equal to 1,770 hours a year, and therefore lower by about 40 hours compared to that calculated for the whole economy, while the job per capita was higher than the previous one by 92 hours, at about 1,519 hours a year.

The integrated approach used in national accounts enables to measure the labour input 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 person employed distinguished between main and second job (the surveys addressed to households), and in other cases, in terms of hours worked per job (surveys addressed to enterprises).

The per capita of hours actually worked calculated per industry present very different levels, as they suffer mainly from the importance that the multiple jobs take in the different industries (Graph 7). In 2003, for example, in the agricultural sector, about 762 hours were worked on average while industry and service activities registered a higher number of hours (1,673 and 1,460 hours per capita respectively). The decrease in the annual hours worked is a trend common to all three industries: in 1993, the agricultural sector registered 795 hours per capita, the industry sector registered 1,688 hours and the service sector 1,526 hours.

The development of an informative base that enables to associate a specific cost to the different types of employment will allow in the future improving the estimates produced. Therefore, the new labour force survey, conducted on a continue base since January 2004 and which first results have been published in September of the same year, could become a useful instrument for estimating the growth rate of the labour input for two reasons: 1) it will make possible to obtain information that is more complete and detailed on the hours actually worked; 2) it contains specific questions on remunerations that, if validated, would allow to have an informative source able to gather the different qualitative aspects of the labour input (occupation, age, education) to which the corresponding remunerations can be associated

Graph 7 – Annual per capita of hours actually worked per job by industry.



7. Conclusions

The paper describes an approach to improve estimating the input of labour growth rate weighting different types of labour input with the purpose of gathering changes of labour

quality compared to the production growth. The application of the quality-adjusted labour input growth rate to the measure of the total factor productivity enables, moreover, to analyse better the growth of the labour factor also in relation to the changes of other inputs.

In order to improve the quality of labour input measures, Istat has published the first estimates on the hours worked drawn in the context of national economic accounts systems since 1993 till 2003. The new employment measurement enables to overcome the limits generally attributed to full-time equivalent units that can be synthesised as follows: a) they are not able to gather exactly the per-capita number of hours actually worked as they do not consider the variations induced by the economic cycle; b) it ignores labour quality associated to each hour worked.

At present, information on hourly wages is not considered sufficiently reliable to be applied at the above hours worked by types and to construct measures of quality-adjusted labour input. Another difficulty is represented by the lack of information on hourly income of self-employed. The first attempt, conducted to apply hours actually worked to the approach here proposed, has had the following results: a) comparing data on hours actually worked and full-time equivalent units by job position put in light the higher weight of self-employed on the total amount of labour input estimated in terms of hours actually worked; b) as consequence, measuring labour input in terms of hours actually worked produces a growth in the relative weight of self-employed labour income; c) given the above evidences, when the relevance of self-employed in a country is high, it becomes important to identify different hourly income by types of self-employed in order to well measuring the rate of change of the quality-adjusted labour input.

The quality-adjusted labour input method here proposed seems to produce more sensible results using full-time equivalent units as labour input measure; this because the information on hours actually worked are not sufficiently detailed in terms of types of employment.

The research activity on labour productivity in our country should be mainly oriented to examine in-depth the different skills that characterised the labour market and to measure the different forms of remuneration inherent to the above skills. Labour market changes should be well measured verifying the atypical work diffusion acts as well as the industrial enterprises' growing use of professional jobs such as the long-term freelance collaborators or temporary workers.

Moreover, as regards the self-employment, it seems relevant to improve the approaches for measuring self-employed hours worked that affects the quality of international comparisons relatively to the above important measure of labour input.

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