Technological Change and the Wage Differential between Skilled and Unskilled Workers: Evidence from Italy 1977-2004

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Abstract

We study the evolution of the wage differentials between skilled and unskilled workers in Italy from 1977 to 2004. In this period, the differentials do not show a clear trend (save for a feeble increasing trend in the very last years), but they fluctuate widely around a fairly stable mean.

There are four possible factors that influence the evolution of those differentials. The first is the relative supply of skilled workers, as an increase in their supply reduces their relative wage. The second is technological change, which could be skill-biased and could increase the gap. The third is international commerce, which increases the competition from less developed country, possibly reducing the wage of the less skilled. The last is related to the institutions in the labour market, which could affect the distribution of earnings and the way in which wages respond to changes in the relative labour supply.

After discussing these theoretical aspects, we perform an econometrical analysis for the Italian case with the SUR estimation technique, and we test which of these factors are important in explaining the evolution of the differentials.

1 Introduction

The wage differentials between skilled and unskilled workers (which is usually identified with the so called college-premium) has received, in recent times, much attention from several economics scholars. Its evolution through time, and the reason of such evolution, has been studied both theoretically and empirically and has often been related to the effect of technological change. The main idea behind this is that progress may be biased towards certain categories of workers (usually the skilled), granting them better salaries as new technologies are adopted. The analysis of the American data on this subject is at the centre of several studies. Katz and Murphy (1992) is probably the most influential work, but several other articles followed: for example, Acemoglu (1998) and

Card and DiNardo (2002) developed better theoretical models and Baudry and Greene (2005) updated the analysis up to recent years.

On the contrary, fewer works have appeared covering the European case. A recent paper, Koeniger, Leonardi and Nunziata (2007) build a very good theoretical and empirical analysis of the relation between institutions and wage differentials in Europe, but their empirical analysis is based on the differential between the workers whose earnings are in the top and bottom 20 percent of income distribution and, moreover, they only present results for the European case as whole, with no clear insights on the single countries.

There are even less works for the Italian case: some of them, like Erikson and Ichino (1994) argue and suggest the presence of a skill-biased technological progress while Daini et alii (1998) shows that a clear relations between the wage of the skilled and the international commerce seems to be missing. In any case, their papers do not focus on the skill-bias nor they conduct an empirical analysis on the skilled-unskilled differentials. In effects, there is no paper, to our knowledge, that has examined extensively the Italian data. An analysis of the wage differentials in this country is particularly interesting because they show a different time pattern with respect to their American counterpart. While in the USA those differentials have kept growing from the seventies (though at a much higher rate until the mid eighties than in later years), there is no clear trend for the data in Italy. If we consider the years from 1977 to 2004, the Italian college premium seems to be quite volatile, but it keeps fluctuating around a constant mean, with only the very last years showing a slightly increasing trend. As a matter of fact, the ratio between the average monthly salary of skilled worker and unskilled in Italy fluctuates from a minimum of 1.2 to a maximum of 1.52 (with a mean of 1.348) whereas the American steadily grows from slightly above 1 to 1.29.

It is worth to note that when referring to skilled workers, the above articles (and our paper as well) refers to workers with at least an undergraduate degree. In this sense the differentials between wages of the skilled and the unskilled are strictly related to the college premium.

The approach we follow in this paper is to explain some possible factors that influence the skilled-unskilled differential and to discuss some of the theoretical models on which they are grounded. Then, we test which factors (and theories) are able to interpret the Italian data.

When examining these wage differentials there are roughly four main factors that could be able to explain them: the supply of skilled workers, the technological change, the international commerce and several other elements that we could gather in a broad category that is usually called the "institutional factors".

The first is also the most simple and widely accepted (see Katz and Murphy (1992)): in a competitive market, when skilled workers become relatively more available their relative salary should decrease. This however may lead to a less intuitive puzzle: since the skilled worker relative supply keeps increasing through time, why we do not observe a fall in the wage differentials?

This consideration open the field to the possibility that the relative demand

for skilled workers may be increasing as well (possibly because of technological progress) or that other factors are at works.

The role of technological change is usually considered the main reason why we do not observe such a fall in the differentials and the work by Acemoglu (1998) and Card and DiNardo (2002) suggests that the adoption of new technologies favour the more skilled, increasing the demand for their services. This is somehow confirmed in the empirical analysis for the USA.

On parallel lines there is the consideration that an increase in the international commerce (brought on through the so called globalization of the world economy) could reduce the relative demand for unskilled workers. In fact there is a widespread belief, at least at the theoretical level (see Krugman and Lawrence (1994) and Borjas and Ramey (1995), to name only a few), that globalization increases the competition from the less developed country so that those sectors with less technological contents (and that employ more unskilled workers) are forced to reduce their prices or their employment. Symmetrically, the wage of the unskilled is reduced and the college gap widen.

The final elements are related to the institutional factors and in particular to the institutions in the labour markets. The considerations we have brought forth this far are tied to the idea that the labour markets operate in perfect competition, but things may work out differently when this is not the case. Indeed, the presence of labour regulations and unions may greatly influence the wage differentials. There are two basic reason for this: first, unionization is usually more present among the unskilled worker so that the wage pressure is higher for them (see Card (1998)); second, a more regulated labour market seems to promote more wage compression (see DiNardo and Lamieux (1997)). In accordance with them, Koeniger, Leonardi and Nunziata (2007) builds a model that specifically relate the wage bargaining system to the wage differentials. All these findings suggest that stronger institutions in the labour markets induce wage compression and reduce the college premium.

For our analysis, we cannot rely on any official data that directly measure this differential. All the series of the differentials, and on the supply of skilled workers, must be constructed starting from surveys on the labour force. In this paper, we derive the data for the Italian case from the Bank of Italy Survey of Household Income and Wealth (BSHW) and from Consortium of Household Panels for European Socio-economic Research (CHER). With these datasets we have information for individual workers from the years 1977 to 2004 (but a few years are missing) and we can derive the average monthly salary for the skilled and unskilled. We adjust those data to take into account compositional effects. In practice, we impose that the composition of workers with respect to gender and experience stays constant through time: this is a standard procedure that was also performed in the other works on the subject.

In a similar way, we derive the relative supply of skilled workers. To do this, we follow Katz and Murphy (1992) and we suppose that the supply exactly equals employments. As for the international commerce, we use data on openness (export plus imports over GDP), imports over GDP and imports from non industrial country over GDP as possible measure for it.

Finally we try to take into account the institutions in the labour market through the adoption of dummy variables that split the sample in two periods: the first until 1980 and the second after it. We choose this year because traditionally, in Italy, the autumn of 1980 put an end to a season of strong union activism.

To perform the econometric analysis we also derive the wages differential inside some sub-groups: male workers employed as clerks or teachers, female workers employed and clerks and teachers and the rest of male workers. Then we estimate the three series adopting SUR technique.

The results show that the supply of relative skilled worker and the skill-biased technological change are the main force in determining the wage differential. However, the skill bias is feeble and has a smaller magnitude than in the United States. Our estimation suggests that the skill bias trend is nearly negligible for the clerks/teachers jobs and has a coefficient of 0.0116 for the rest of the workers. The same coefficient for the United States was estimated by Katz and Murphy to be (without distinction for the jobs) to be around 0.033. It should be stressed however that this analysis for the US used data up to the end of the eighties and that the work by Baudry and Greene suggests that this trend is not so important and that is the ratio between skilled supply over computer based capital stock to be the driving force: a variable that it is not available for Italy.

The institutional factors seems to matter as well as the wage differentials show a (statistically significant) different responsiveness to the relative supply since 1981.

The paper is organized as follows: after this introduction we present the data in section 2, we describe some of the theories behind this issue in section 3 and we perform the empirical analysis in section 4.

2 Data

The BSHW and the CHER are the main data sources for this study. The former provides individual informations on Italian workers collected through 18 surveys carried out yearly over the period 1977-2004. Beginning from 1987 the survey has become biennial and in 1985 and 1997 data were not collected. The CHER provides information on Italian workers from 1994 to 2001. In total we have data on 23 years spanning from 1977 and 2004.

The above data allowed us to obtain information about:

- demographic aspects: age, education, gender;
- professional status: business sector, employment position and number of months worked per year;
- net income from subordinate work;
- sample weights.

In the analysis we use real monthly wages of paid workers, expressed in euros: their values are obtained by dividing the annual earnings by months worked. These nominal values are then transformed into real terms using a

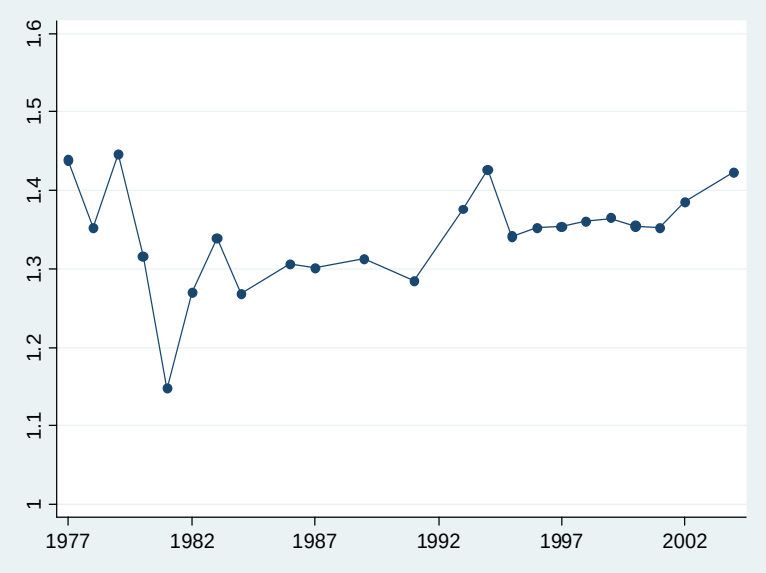

Figure 1: College premium over the period 1977-2004

GDP deflator. Data before 2002, expressed in Italian liras, are converted to euros in accordance with the official exchange rate 1936.27.

We chose to consider only the paid workers to make our study more reliable because of the incompleteness of the dataset for self employed workers.

Once collected, we use this pool of data to construct some aggregate series. Basically these series describe the wages and the labour supply of workers with different educational degrees. We identify two types of workers, which we call "skilled" and "unskilled". Their cut-off point is the attainment of the university degree. Skilled workers include people with a graduate or post-graduate degree; unskilled workers include those with a lower educational levels as well as workers with no degree.

We begin comparing earnings of graduate and undergraduate by analysing movements in the relative (average) wages of these two kinds of workers. In this analysis we construct two series for the skill-premium: a baseline series and an alternative one that controls the compositional effects due to changes in the population over the time.

The baseline series is simply the ratio in the average wages between skilled and unskilled and is presented in figure 1.

The series shows a feeble rising trend of the relative wage beginning from 1981. This increase follows a dramatic fall of the curve observed at the turn of the decade.

The basic movements may look similar to what is observed in US (Beaudry and Green, 2005), yet the timing and the size of the phenomenon do not match:

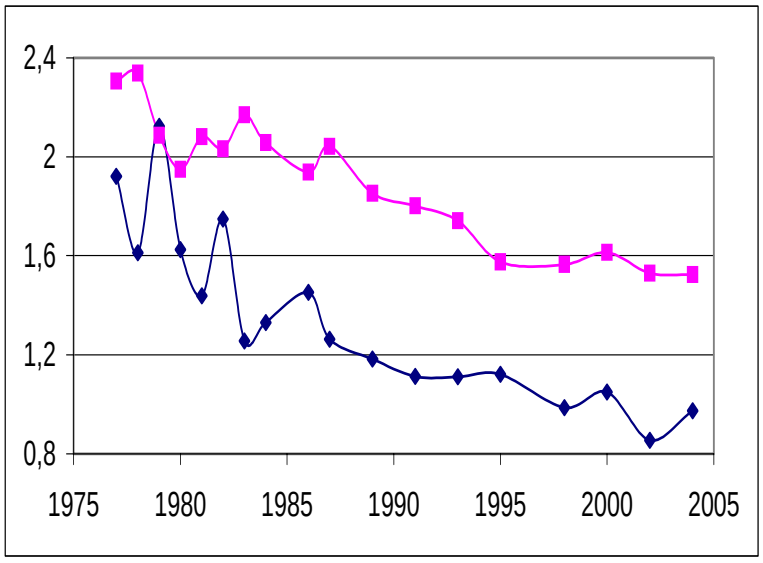

Figure 2: Male labour supply over female labour supply for skilled (blue line) and unskilled (pink line) from 1977 to 2004

US relative wages have a smoother trend in the first period. Their decrease is less rapid and it continues for a 7 year period up to the minimum in 1979. On the contrary, the American rise is very sharp in the first ten years and progressively grows milder.

The ratio between skilled and unskilled wages so obtained is directly derived from the data so that can be considered "pure data" and therefore it can be influenced by exogenous factors not concerning this study but able to interfere with it. An example of this is the gender composition of our sample. Figure 2 illustrates that the ratios between males and females supply is not constant through time both for skilled and unskilled workers. It is easy to understand that changes in this ratio will be able to produce changes in the average wage which are not related to any educational parameter.

Similar conclusions can be drawn if we take into account the experience (which in Italy is extremely important in determining earnings) and the clerks share.[1]

We proceed then to build a series of skill premium cleaned-up from noises, a series that will be freed from the effects of changes in the composition of the sample through time. To do that we adopt the procedure presented in Katz and

[1]We refer to the clerks share because, in the Bank of Italy survey, teachers are included in this category. Since teachers are skilled workers that, at least in Italy, are not particularly well paid, it is particularly important to take into account how large is their presence in the skilled labour supply.

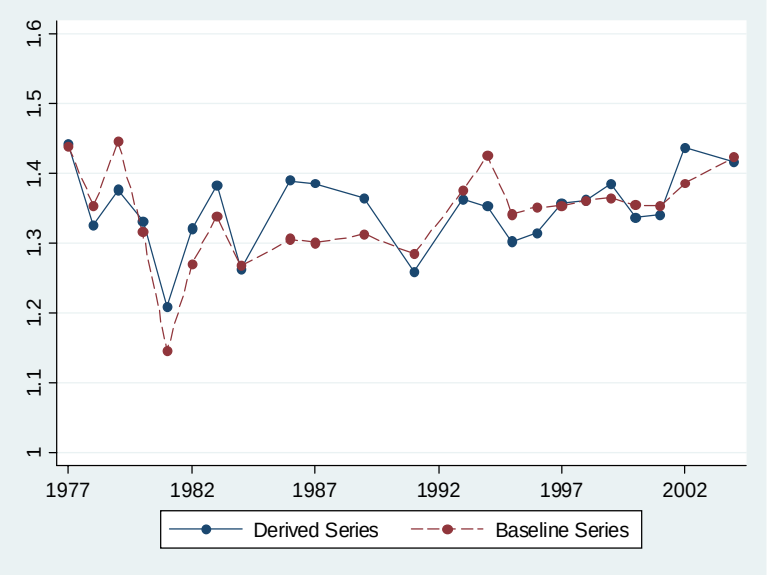

Figure 3: The skill premium derived series compared to the baseline series from 1977 to 2004

Murphy (1992), wich we describe in what follows.

The basic idea is to group and weight data so that a homogeneous composition of labour supply is guaranteed: in this way, the influences on wages of experience, gender and kind of job are avoided. To obtain this, we divide the sample into two educational groups. For each group (skilled and unskilled) we pick out 8 classes of experience (0-2 years, 3-9, 10-16, 17-23, 24-30, 31-38, 39-45 and 46 and more), in turn divided by gender and kind of job (clerks and non clerks). So we obtain two matrices of 32 cells every year. For each cell, and for each year studied, we calculate the average monthly wage of skilled and unskilled workers. The average monthly wages per cell are assembled in two yearly values: one for skilled and one for unskilled.

We obtain the aggregate average wages as the weighted average of all the cells in a matrix. The weights are the same for all the years (allowing us to take away the compositional effects) and are computed as the average through time (from 1977 to 2004) of the occupational rate in each cell. Once we obtained the average wages for both kinds of workers we compute their ratio[2]. Figure 3 highlights our results.

The figure shows that fluctuations in the skill premium are quite similar for

[2]There is alternative method presented in Beaudry and Green (2004). According to it, the compositional effects can be removed through a preliminary regression. We choose not to adopt this method because it may present some problems when some of the cells contain very few observations, something which we could not exclude for the first years of our analysis.

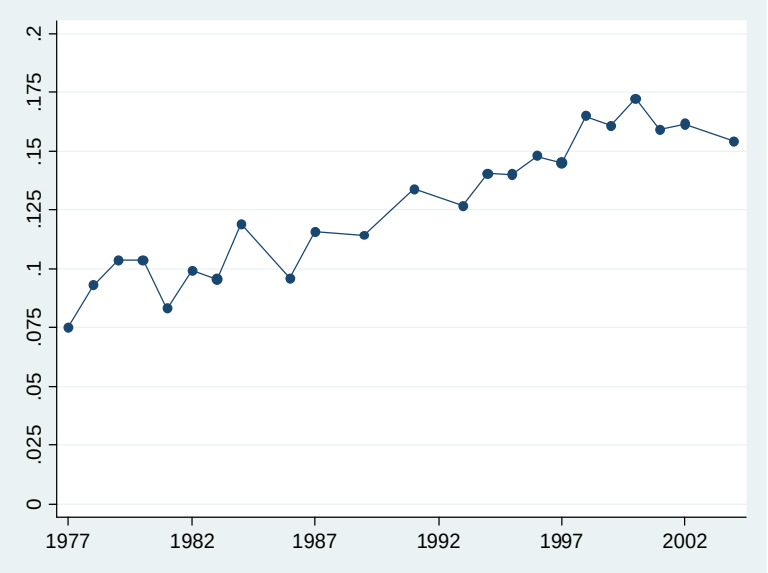

Figure 4: Relative supply of skilled measured efficiency units from 1977 to 2004

the two series. However, after the influence of the composition in experience, gender and kind of job has been removed, the increasing trend is even more feeble and the initial fall seems to be more moderate. In all our empirical analysis we will use this "derived" series.

The second key variable of the study aims to compare labour supply of graduate and undergraduate workers.

In principle we could simply use the ratio of weighted months worked by skilled on weighted months worked by unskilled. However, we desire to aggregate quantities of work that should be homogeneous in terms of efficiency units. Then, following the previous literature on this subject we suppose that real wage measures the efficiency of each unit.

To do that we divide workers into two matrices of 32 cells every year, as seen before. For each cell, and for each year studied, we calculate the sum of months worked and the average monthly wages using weights constant through time. These weights are given by the ratio of average relative wage of each cell through the period, over the average relative wage of a particular cell chosen as reference.

Finally, we generate our time series of relative supply as the ratio of annual supply of skilled on unskilled workers. Figure 4 represents the series.

As shown in figure 4, we observe an increasing trend in the supply of skilled workers through the time.

3 The Determination of the Wage Differential

There are four basic elements that influence the ratio between the earning of the skilled and the unskilled. The first is related to the supply and demand of each of those workers: in a competitive environment, higher relative supply of skilled reduces their relative wage and vice-versa. Moreover, if the demand of a given kind of workers rises, it improves their relative wage as well. If we have in mind the time pattern of the relative supply of workers for Italy, we see that the skilled workers became more present and this should have reduced their relative wages. Since this is the case some other factors must be present.

A second element in explaining the earning gap is the role played by technology. In truth this is related to the above supply and demand scheme: the technological change may advantage a category of worker more than the other and, as a consequence, it may rise their relative wage. In practice technology may be biased toward a category of workers and through the supply and demand mechanism it may affect the earning gap. The third element is the role of international commerce and how it may affect the demand for unskilled and skilled labour: the general idea in this field is that the so called "globalization" should reduce the demand for unskilled labour in developed countries. Finally the institutional factors in the labour markets, and the presence of union bargaining in particular may play an important role in the process, possibly introducing less inequality in wages and reducing the extent of the supply and demand mechanism. In what follows we will try to formalize the first two effects while we will simply discuss the latter two.

3.1 A Simple Competitive Model for the College Premium

A base model to explain the evolution of the relative wages takes into consideration the role of the demand and supply of labour. What we present here is inspired by the model proposed by Katz and Murphy (1992).

We imagine that there exist two kinds of factors: skilled labour (S), which is supplied by workers holding at least an undergraduate degree, and unskilled labour (U), which is supplied by the rest of workers. The total production in a given period t is given by a production function with Constant Elasticity of Substitution:

$$Y_t = (S_t^\rho + U_t^\rho)^{\frac{1}{\rho}} \tag{1}$$

where ρ determines the degree of substitution. We imagine that the above function display decreasing return to scale so that $0 < \rho < 1$.

The supply of skilled and unskilled at time t is exogenously fixed (as it reflects past choice of education) and we imagine that this supply is fully hired by firms. This process determines the wages as in a competitive labour market, so the workers are paid at their marginal productivity:

$$W_t^S = \frac{1}{\rho}\left(S_t^\rho + U_t^\rho\right)^{\frac{1}{\rho}-1} \rho S_t^{\rho-1} \tag{2}$$

$$W_t^U = \frac{1}{\rho}\left(S_t^\rho + U_t^\rho\right)^{\frac{1}{\rho}-1} \rho U_t^{\rho-1} \tag{2a}$$

where W_t^S and W_t^U are the wages paid to skilled and unskilled workers. The relative wage W_t^{REL} is given by

$$W_t^{REL} = \frac{W_t^S}{W_t^U} = \left(\frac{S_t}{U_t}\right)^{\rho-1} \tag{3}$$

so that the relative wage is a decreasing function of the relative supply of labour. In this base version of the model the relative wage depends only on the supply of demand of each kind of labour: the workers that are less present, receive also the highest wage. In this sense, a wage gap for the skilled is not grounded much on their better skills but rather on their scarcity.

3.1.1 The role of technology

To better explain how technology may enter in the wage gap we start by formalizing in more detail the production function. Let us suppose that production in a period t is now given by

$$Y_t = \left[\alpha\left(aS_t\right)^\rho + \left(1-\alpha\right)\left(bU_t\right)^\rho\right]^{\frac{1}{\rho}} \tag{4}$$

where parameters α , a and b are related to the technology adopted. In particular α shows the share of activities of each kind of workers, while a and b are related to the productivity of each factors. We have chosen a particular function (a CES function), but this only to facilitate this illustrative example.

Even in this case it is the mechanism of supply and demand that determines the wages: in fact, if each workers is paid at his marginal productivity we have

$$W_t^S = \frac{1}{\rho}\left[\alpha\left(aS_t\right)^\rho + \left(1-\alpha\right)\left(bU_t\right)^\rho\right]^{\frac{1}{\rho}-1} \rho\alpha a\left(aS_t\right)^{\rho-1} \tag{5}$$

$$W_t^U = \frac{1}{\rho}\left[\alpha\left(aS_t\right)^\rho + \left(1-\alpha\right)\left(bU_t\right)^\rho\right]^{\frac{1}{\rho}-1} \rho\left(1-\alpha\right) b\left(bU_t\right)^{\rho-1} \tag{5a}$$

and the relative wage is given by

$$W_t^{REL} = \frac{W_t^S}{W_t^U} = \frac{\alpha}{1-\alpha}\left(\frac{a}{b}\right)^\rho \left(\frac{S_t}{U_t}\right)^{\rho-1} \tag{6}$$

Equation (6) tells that relative wages depends both on the relative supply and the productivity that the technological parameters imply. This far we have imagined that the technological parameters are fixed but we can easily suppose that they change through time as a consequence of technological innovation. Relative wages are then given by

$$W_t^{REL} = \frac{\alpha_t}{1-\alpha_t}\left(\frac{a_t}{b_t}\right)^{\rho}\left(\frac{S_t}{U_t}\right)^{\rho-1} \tag{7}$$

or in logarithmic terms

$$w_t = \log\frac{\alpha_t}{1-\alpha_t} + \rho\log\frac{a_t}{b_t} + (\rho-1)\log\frac{S_t}{U_t} \tag{8}$$

Where $w_t = \log W_t^{REL}$.The above tells us that the evolution through time is explained by the evolution of the relative supply and the change in technology. In effect it is quite obvious that innovation affect the above parameters: historically workers productivity have clearly risen and, with respect of our model, this happens through a change in a_t and b_t (or, in some cases in α_t). However this is not enough to explain a change in the relative wage: as long as a_t and b_t grow at the same rate (and α_t stay constant) we should not observe a change in the relative wage. On the contrary if technological innovation produce a rise in α_t or in the ratio $\frac{a_t}{b_t}$ it necessarily implies a rise in the wage gap. In the latter case we observe Skill-Biased Technological Change[3].

In any case we can write the above equation as

$$w_t = \alpha + \rho G_t + \phi R_t \tag{9}$$

where $\alpha = \log\frac{\alpha_t}{1-\alpha_t}$, $G_t = \log\frac{a_t}{b_t}$ and $R_t = \log\frac{S_t}{U_t}$, so that the college premium is identified by the sum of two distinct effect: one from technology (ρG_t) and one from supply (ϕR_t).

In this kind of model, the standard assumption which is that the effect of (biased) technological change is approximate by a linear trade: the equation we are going to estimate is then:

$$w_t = \alpha + \rho t + \phi R_t. \tag{10}$$

In our empirical analysis we will at first adopt this assumption but the will later switch to another proxy which is related to the aggregate expenditure in research and development.

[3]If we observe a rise in $\frac{a_t}{b_t}$ we say that the SBTC is intensive and the marginal productivity increase of the skilled workers does not necessarily implies a decrease of that of the unskilled. On the contrary when α_t rises, the SBTC is extensive and it implies a reduction in the unskilled workers marginal productivity. See Johnson and Stafford (1998).

3.2 International Commerce and Globalization

The third factor which may have an effect on the college premium is related to international commerce and how the recent trend of globalization may have increased the competition brought forth by the developing countries. The general idea is that the presence in the markets of goods produced in less developed country may lead to a reduction of the wage of the less skilled relatively to the skilled (see Borjas and Ramey (1995) and Wood (1995)).

The basic assumption that leads to this conclusion comes from the Heckscher-Ohlin theory and asserts that a country produces and exports goods that are obtained through the factors that are relatively more available in that country: unskilled labour in less developed countries and skilled labour in the others. This assumption leads the way to the Stolper-Samuelson theorem which tell us that a fall in the relative price of a good should reduce the rate of return of the factor that is used intensively to produce that good.

According to this view, there are two ways in which international commerce should reduces the return of skilled workers in industrial countries. The first has its origins in the product market and it propagates in the labour market. In fact, trading with less developed country increases the competition in the markets with less technological advanced goods. Any firm (even in the developed countries) belonging to such industries is forced to lower the prices to face the new degree of competition or to shift toward more technological products (or, obviously to exit the market). Whatever is the reaction of the firms, the wages in that sector should decline either as a direct effect (in the case of a reduction in price) either as an indirect effect through a fall in the labor demand. Since we started from the assumption that these sectors usually employ relatively more unskilled than skilled workers the eventual consequence of this process is a widening of the college gap.

The second one is even more simple and is related to the globalization of the labour market. If even these markets are increasingly internationally interconnected, then unskilled workers face a fiercer competition from the large amounts of unskilled workers that are present in developing countries. Somehow then, the effective supply of unskilled workers increases in the presence of a globalization trend.

The above reasoning should imply a positive correlation between a variable measuring the international commerce and the wage gap between the skilled and unskilled workers. Then, to control for this, we introduce T_t, a variable that measure the degree of international commerce. The equation we want to estimate should take the form:

$$w_t = \alpha + \rho t + \phi R_t + \gamma T_t. \tag{11}$$

However the choice of which is a suitable variable to measure international commerce is particularly tricky and we will discuss different possibilities in the next section.

3.3 Institutional Factors

At last, we discuss how institutional factors may affect the determination of wages and through this, the inequality in the earning of skilled and unskilled. A recent article by Koeniger, Leonardi, Nunziata (2007) contains a very good model that tries to demonstrate how some particular institutions are relevant in this context: they focus their attention, among others, on the bargaining power, on the unemployment benefits (and replacement rate) and employment protection. In effect, in a bargaining context, the level of wage depends directly on the outside option, and the latter is heavily influenced by the above institutions[4]. As a direct consequences, however, those institutions should have an effect on the wage differentials only if they are somehow different across the skilled and unskilled. For example, the replacement rate should influence the wage gap only if it assumes different values for the skilled and the unskilled. In addition, as far as the bargaining power is concerned, the above authors suggest that usually the unions have objectives where the wage of unskilled has a greater weight, so that higher bargaining should push the wages of unskilled more than those of the skilled, effectively reducing the gap. This latter effect has the same consequences (but not exactly the same causes) to what Card (1998) suggests. According to him, unionization is stronger among the unskilled, so that a high union power usually increase their wage pressure.

More in general differences in labour market institutions and mechanics could imply differences in the importance of the relative supply: in different context wages may react differently to change in the relative supply.

How the above reasoning can be gathered in exact variables to be used in an estimation is not an easy question. First of all, there are no data measuring values of replacement rates and employment protection that distinguish between different education levels. Nor there is a particular reason why we should expect that they should differ among the different levels. Things are a bit simpler as the way the should union power enter the picture: according to the above theories, it simply promotes wage compression. Then, all we have to do to control for this, it is to find a reasonable proxy for union power. Alternatively, if we have enough information to suppose that the period we analysis can be divided in different phases identified by different union power or labour market dynamics, we could adopt dummy variables.

The adoption of dummy variables can be useful also to control for the last aspect we wish to treat. In fact, we could take into account the fact that the wage bargaining reduces the responsiveness of the relative wage to the relative supply allowing the coefficient of relative supply to takes different values in different periods. This obviously necessitate that we have some historical information that allows us to split the sample in some subperiods.

This said, a reasonable specification that controls for the institutional factor is:

[4]This is a common results in the literature and Koeniger, Leonardi and Nunziata (2007) is no exceptions. See however Layard at alli (1991) for a more "classical" discussion of this.

$$w_t = \alpha + \rho t + \gamma T_t + \beta B_t + \sum_{i=1}^{K} \phi_i \delta_{i,t} R_t \tag{12}$$

where B_t is either a proxy for union power (which could take the form of a dummy variable) and $\delta_{i,t}$ are dummies that identifies one of the K periods inside which is reasonable to believe that the degree of union power has not changed. The following section will deal on how to effectively measure those variables

4 Empirical Analysis

We have seen that various factors play a role in the determination of the Italian college premium from 1977 to 2004 and, following the discussion of the previous, we focus on the relative supply of skilled workers, technological change, international trade and institutional factors.

Given the lack of observations, we decide to better exploit the initial survey and to do that we compute the wage differentials among different categories of workers. We select four different categories: males working as clerks/teachers (MC), females working as clerks/teachers (FC), other male workers (OM) and other female workers (OF). Then we derive the wage differentials inside these groups. However, the data on the last group is not reliable: in fact our starting survey contains very few observations on female skilled workers that are not working as clerks/teachers (for some years as little as 5) so that their wage differential cannot be accurate. Therefore we choose not to use this category and we end up then with 3 distinct series for the college premium, each one for a different category (figure 5 depicts them).

In principle, we could simply pool the data from the 3 series (obtaining 69 observations) and run regressions on the pooled data. This, however, could still be problematic, in fact it is quite probable that the errors related to different categories should be correlated during the same year: for example, an exogenous shock that push the wage differential up for male clerks in a given year, is very likely to have a similar effects on the wage differentials of the other categories: this would lead us to biased estimates. This consideration inspires somehow its own solution: in fact we can specify equations for the three different series, put them together in a single system and allow for correlation in the errors of the different equations

$$\begin{cases} w_{t,MC} = \beta_{MC} X_{t,MC} + \varepsilon_{t,MC} \\ w_{t,FC} = \beta_{FC} X_{t,FC} + \varepsilon_{t,FC} \\ w_{t,OM} = \beta_{OM} X_{t,OM} + \varepsilon_{t,OM} \end{cases} \tag{13}$$

where β_i are the vectors of the coefficients for the category i and $X_{t,i}$ is a matrix with the regressors. The vectors $\varepsilon_{t,i}$ are the stochastic errors for which we allow that $E(\varepsilon_{t,i}\varepsilon_{t,k}) \neq 0$.

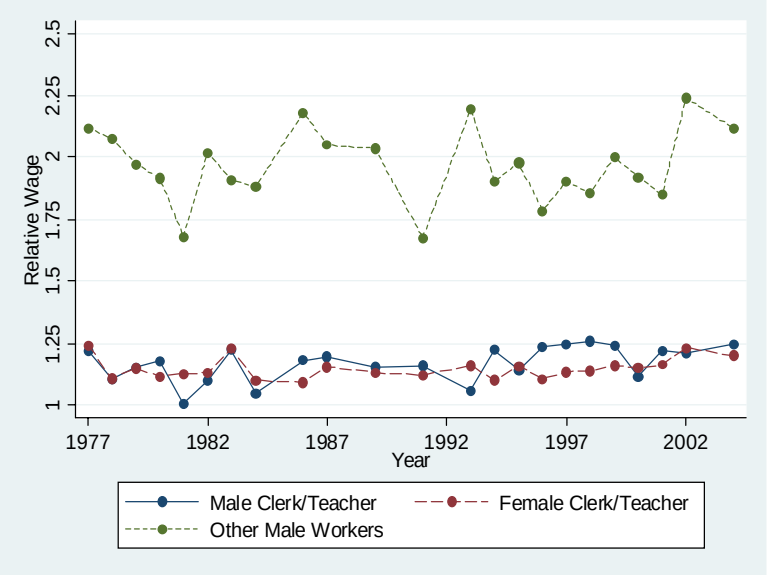

Figure 5: College premium for the different categories

We can estimate the above adopting the Seemingly Unrelated Regression (SUR) of Zellner. This technique, exploiting the correlations between the errors, improve the efficiency of the estimates, which was our initial concern. Note that $X_{t,i}$ may be the same for all the different equations or we could also use different regressors.[5] In our particular case we assume that the relevant variable when the relative supply is concerned is the one computed inside a given category of jobs, with no distinction between the male and the female. This is a bit like assuming that labour in clerks sector and the non clerks is not an exact substitute, while male and the female labour it is perfectly substitutable. We end up using two series for supply, one that gathers all workers in the clerks/teachers sector (which we indicate simply with C) and one that gathers all (male) workers in the others sectors[6].

In any case, estimating the whole system allows us to test whether the values of the β_i are different among the equations, effectively investigating on whether the various factors have different effects among the different categories.

In all the regressions we performed a solid results was the fact that the constant term was not significantly different from zero. This has two possible interpretations: the first one is that the α parameter has a value of 0.5 so that both skilled and unskilled account for the same share in the production. The second one is that the technological linear trend captures both the change in

[5] A consequence of using the same set of regressors is that we obtain the same estimation of the coefficient as if we would estimate the equations separately.

[6] We also tried to use three different series, but we obtained quite similar results.

the relative productivity and the change in share of labour.

4.1 Relative skilled supply and technological change

We start our analysis with the simplest case and we consider only the role of skilled supply and of technological progress. Adopting equation (2) we proceed to estimate the following system through the SUR technique:

$$\begin{cases} w_{t,MC} = \alpha_{MC} + \rho_{MC} t + \phi_{MC} R_{t,C} + \varepsilon_{t,MC} \\ w_{t,FC} = \alpha_{C} + \rho_{FC} t + \phi_{FC} R_{t,C} + \varepsilon_{t,FC} \\ w_{t,MO} = \alpha_{OM} + \rho_{OM} t + \phi_{OM} R_{t,OM} + \varepsilon_{t,OC} \end{cases} \tag{14}$$

where t is a time trend which act as a proxy for technological change and $R_{t,i}$ is the relative skilled supply in the i sector. The results are shown in table 1.

	Coefficient	(Std. Err.)	t value
Clerks/Teachers Male			
Technological Progress	.00327	(.00109)	2.99 ***
Relative Skilled Supply	-.06676	(.0105018)	-6.36 ***
Clerks/Teachers Female			
Technological Progress	.00104	(.0009235)	1.13
Relative Skilled Supply	-.07365	(.0088697)	-8.30 ***
Other Male			
Technological Progress	.008147	(.0016331)	4.99 ***
Relative Skilled Supply	-.19263	(.0092642)	-20.79 ***

Significance levels: * 10%, ** 5%, *** 1%

Table 1: SUR Estimation with Technological Change and Relative Supply only

The estimates are interesting and they hint to the existence of a trend but the role of relative supply is not clean-cut. Possibly something is missing in the picture, so we proceed in adopting a richer specification.

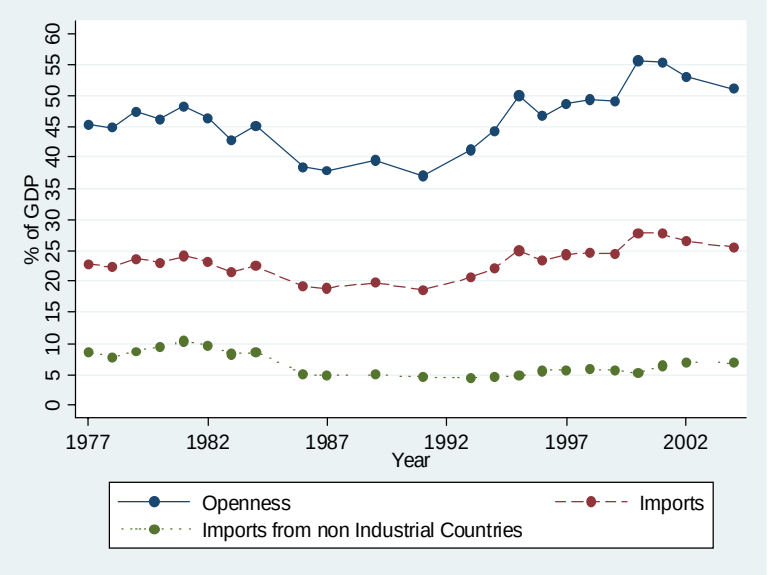

Figure 6: Italian opening to the international trade from 1977 to 2004, expressed as percentage of the GDP

4.2 Openness to trade and imports

We now want to add to our starting specification a variable which could measure the international commerce. This, as we discussed before, could produce a rise in the wage differentials, as a consequence of the stronger competition from the less developed countries.

The system we are to estimate with SUR regressions becomes

$$\begin{cases} w_{t,MC} = \alpha_{MC} + \rho_{MC} t + \phi_{MC} R_{t,C} + \gamma_{MC} T_t + \varepsilon_{t,MC} \\ w_{t,FC} = \alpha_{C} + \rho_{FC} t + \phi_{FC} R_{t,C} + \gamma_{FC} T_t + \varepsilon_{t,FC} \\ w_{t,OM} = \alpha_{OM} + \rho_{OM} t + \phi_{OM} R_{t,OM} + \gamma_{OM} T_t + \varepsilon_{t,OM} \end{cases} \tag{15}$$

where T_t is a variable that somehow measure the international commerce. We perform our estimations trying three different variables for that: openness (export plus imports over GDP), imports over GDP and imports from non industrial countries over GDP. The figure 6 shows the evolution of these three variables

In table 2 we reports the results of the estimation: they strongly point to the fact that international commerce, at least in the way we measured it, has no influence on the college premium.

It is possible that our variables do not fully capture the dimension of international commerce and other measures may deliver different results. In any case it should be stressed that these results seem to be in line with the findings of

	International Commerce is Total Trade			*International Commerce is Imports*			*International Commerce is Imports from non Industrial Conutry*		
	Coefficient	(Std. Err.)	t value	Coefficient	(Std. Err.)	t value	Coefficient	(Std. Err.)	t value
Clerks/Teachers Male									
Technological Progress	-.04897	(.0432645)	-1.13 *	-.0490	(.0432629)	-1.13 *	-.0446	(.031251)	-1.43 ***
Relative Skilled Supply	.0028	(.001563)	1.80	.0028	(.0015627)	1.80	.0037	(.00119)	3.07
International Commerce	.0008	(.001914)	0.42	.0016	(.003828)	0.42	.0049	(.006551)	0.75
Clerks/Teachers Female									
Technological Progress	-.0043	(.033929)	-0.13	-.0043	(.0339205)	-0.13	-.0274	(.02501)	-1.10 *
Relative Skilled Supply	-.0008	(.001235)	-0.66	-.0008	(.0012348)	-0.66	.0019	(.00095)	1.94 ***
International Commerce	.0032	(.004502)	0.70	.00632	(.009002)	0.71	.0102	(.01555)	0.65
Other Male									
Technological Progress	-.1742	(.036098)	-4.83 ***	-.1741	(.0361047)	-4.82 ***	-.2040	(.028052)	-7.27 ***
Relative Skilled Supply	.0068	(.002908)	2.36 *	.0068	(.0029082)	2.36 **	.0080	(.001664)	4.80 ***
International Commerce	.0016	(.002944)	0.53	.0031	(.00589)	0.53	-.0046	(.010848)	-0.42

Significance levels: * 10%, ** 5%, *** 1%

Table 2: SUR Estimation with Technological Change, Relative Supply and International Commerce

another paper on a similar subject by Faini et alli (1998): their results hint at the lack of a clear correlation between the degree of openness and the return to capital, something they motivate with the fact that Italy goods are not exactly with capital-intensive technology. Similarly, Italian production may not use intensively skilled labour so that the categories of labour are equally effected by in increase in international commerce.

4.3 Assessing the Role of Institutional Factors

Finally we proceed in the attempt of including the role of institutional factors in our estimation. Given the fact that the trade variable seemed not to be relevant, we omit it[7] in what follows.

We have discussed before that there exist several possibilities to include these factors, however here we choose to use dummy variables to split the sample in two periods which we believe were different in terms of union power and activism. We choose 1981 as the watershed for these periods: the choice was motivated on historical grounds as the date of October 14th 1980, with the so called "Marcia dei Quadri", is usually considered the end of a season of great union power. Therefore we adopt a specification that allow for different coefficients for R_t before and after 1981 and we add a dummy variable B_t which is one until 1981 and zero after that.

$$\begin{cases} w_{t,MC} = \alpha_{MC} + \rho_{MC}t + \lambda_{MC}B_t + \phi_{MC1}B_tR_{t,C} + \phi_{MC2}B_tR_{t,C} + \varepsilon_{t,MC} \\ w_{t,FC} = \alpha_{FC} + \rho_{FC}t + \lambda_{FC}B_t + \phi_{FC1}B_tR_{t,C} + \phi_{FC2}B_tR_{t,C} + \varepsilon_{t,FC} \\ w_{t,OM} = \alpha_{OM} + \rho_{OM}t + \lambda_{OM}B_t + \phi_{OM1}B_tR_{t,OM} + \phi_{OM2}B_tR_{t,OM} + \varepsilon_{t,OM} \end{cases} \tag{16}$$

It must be stressed that different possibilities where tried as well: we tried to use Unionization Rate as a proxy for union power and to split the sample adopting the year 1993 (when the Ciampi government strongly encourage agreements between unions and firms) as the watershed; none of these attempts however produced satisfactory results. We present in table 3 the estimation of the system (16)

Most of the results are coherent on what we had expected, and interestingly, the coefficients for the category MC and FC seems to be very similar, hinting that these two groups may share a common set of coefficients. We can further investigate this aspect through tests on the hypothesis that the coefficients related to FC are equal to those related to MC. Table 4 shows the results of these tests and it clearly indicates that we cannot refuse the hypothesis of equality for any of the coefficients.

We incorporate these information and estimate a system including those restriction, further improving the efficiency. The results of this are presented in table 5.

[7] Even if we do not present the results her, we tried to run regressions with both international commerce and institutional factors. The former however was still not significant.

	With the Dummy for Union Power			*Without the Dummy for Union Power*		
	Coefficient	(Std. Err.)	t value	Coefficient	(Std.Err.)	t value
Clerks/Teachers Male						
Technological Progress	.0044	(.00132)	3.32 ***	.0043	(.001318)	3.31 ***
Relative Skilled Supply – 1st Period	-.1944	(.35990)	-0.54	-.0773	(.012961)	-5.96 ***
Relative Skilled Supply – 2nd Period	-.0531	(.0140859)	-3.77 ***	-.0533	(.014067)	-3.79 ***
Dummy for Union Power	-.2132	(.6545159)	-0.33			
Clerks/Teachers Female						
Technological Progress	.0023	(.0010565)	2.17 **	.0023	(.001065)	2.19 **
Relative Skilled Supply – 1st Period	.1452	(.2994928)	0.48	-.0876	(.010448)	-8.38 ***
Relative Skilled Supply – 2nd Period	-.0581	(.0112748)	-5.16 ***	-.0577	(.011369)	-5.07 ***
Dummy for Union Power	.4234	(.5446181)	0.78			
Other Male						
Technological Progress	.0105	(.001723)	6.12 ***	.0105	(.001726)	6.11 ***
Relative Skilled Supply – 1st Period	-.1890	(.150237)	-1.26	-.2115	(.010869)	-19.46 ***
Relative Skilled Supply – 2nd Period	-.1742	(.0109692)	-15.88 ***	-.1741	(.010991)	-15.84 ***
Dummy for Union Power	.0722	(.4815959)	0.15			

Significance levels: * 10%, ** 5%, *** 1%

Table 3: SUR Estimation with Technological Change, Relative Supply and Institutional Factors

The results are again relevant, all the coefficients have the expected sign: technological change push the differentials up (so we observe a skill-bias) while the relative skilled supply push them down. In any case the magnitude of the skill bias is very small and hardly comparable with the american one: in effect, it is large enough to compensate the increasing relative supply but not to produce a clear increase in the wage differentials. The magnitude of the coefficients of relative supplies are interesting as well: if we look af the elasticity of the wage gap with respect to the relative supply, we observe that, for all the workers, it assumes lower values in the period before 1981. Indeed we can test the hypothesis that the elasticity assumes the same value in the two periods and the results of these tests (table 6) tell us that we can strongly reject this hypothesis for both the categories.

This seems to indicate that in the period before 1981 the labour market was problably undergoing important changes and that relative wages were quick to adjust to the increasing skilled supply. Instead, in the second period, the increase in the skilled supply was having less effects in the labour market and wages responded to it with less vigour. This may also indicate that the difference

Tests for the Equality of the coefficients between the Male and Female Clerks/Teachers		
	chi2	Prob > chi2
Technological Progress	1.78	0.1826
Relative Skilled Supply – 1st Period	0.47	0.4912
Relative Skilled Supply – 2nd Period	0.07	0.7881
All the coefficients simultaneously	5.31	0.1502

Table 4

	Coefficient	(Std.Err.)	t value
Clerks/Teachers for both Male/Female			
Technological Progress	.0031	(.0009088)	3.46 ***
Relative Skilled Supply – 1st Period	-.0835	(.0089139)	-9.37 ***
Relative Skilled Supply – 2nd Period	-.0560	(.0097021)	-5.77 ***
Other Male			
Technological Progress	.0116	(.0015397)	7.53 ***
Relative Skilled Supply – 1st Period	-.2085	(.0096675)	-21.57 ***
Relative Skilled Supply – 2nd Period	-.1728	(.0098154)	-17.60 ***

Significance levels: * 10%, ** 5%, *** 1%

Table 5: SUR Estimation of the Restricted Model

Tests for the Equality of the coefficients between Clerks/Teachers and the rest of the Workers		
	chi2	Prob > chi2
Technological Progress	19.88	0.0000
Relative Skilled Supply – 1st Period	78.99	0.0000
Relative Skilled Supply – 2nd Period	62.68	0.0000

Table 6

Tests for the Equality of the coefficients of the relative skilled supply between the different periods		
	chi2	Prob > chi2
Clerks/Teachers	4.98	0.0253
Other Workers	7.51	0.0061

Table 7

in skills between a graduate and a non graduate was tightening.

The other dimension which is worth to explore is related to whether the values of the coefficients are the same for the teacher/clerks and for the other workers, and table 7 reports the tests of their equality.

Those tests clearly show that technological change has a different impact on the different categories and it is far less relevant for workers that are employed as teacher/clerks. Even the elasticities to supply assume values that are quite different.

4.4 Time Trend or Technological Trend?

The existence of a trend in the evolution of the wage differential may not necessarily be due to the technological change. While it is legitimate to assume that the technology level keeps improving through time, we do not know if it does so in a linear way. The adoption of a linear trend imply, by definition, that the improvement in technology is the same in every year. To relax this hypothesis we need a proxy whose growth year after year is not constant. A possible solution is to build a variable starting from data on the aggregate expenditure on research and development. In particular we adopt the hypothesis that the improvement in the technological level in a given year is given by the aggregate expenditure on research and development over the GDP (ERD). Then, if we sum up all the ERD through the years, we obtain what we call a technological trend (TTRD), which we use as a proxy for technological progress in our regression. We perform then the same specification as (16) using the variable TTRD

	Coefficient	(Std. Err.)	t value
Clerks/Teachers for both Male/Female			
Technological Progress (TTRD)	.00283	(.0007519)	3.76 ***
Relative Skilled Supply	-.0631	(.00685)	-9.21 ***
Other Male			
Technological Progress (TTRD)	.0114	(.0016239)	7.01 ***
Relative Skilled Supply	-.1873	(.00883)	-21.20 ***

Significance levels: * 10%, ** 5%, *** 1%

Table 8: SUR Estimation of the Restricted Model whit ERD as a proxy for technological progress

in it. However since data on R&D are available only from 1981, we do not adopt different coefficients for the labour supply in differents subperiods. Moreover to save space, we directly apply the equality restriction on the coefficients of labour supply and technological change of male and female clerks.[8] Table 8 presents the results.

Last regression further confirms the impression that the positive but feeble trend in the evolution of the wage differentials of skilled and unskilled workers is effectively due to the skill-biased technological change.

5 Conclusions

We analysed the evolution in the wage differentials between skilled and unskilled in Italy in the last 30 years and we tried to assess which where the main driving force behind it. We found that relative supply and skill-biased technological change are relevant but the effect of the latter is feeble. Interesting results are obtained when we distinguish on the base of the workers' jobs. In the case of clerks and teachers the effect of the skill-bias is nearly negligible and the wage differentials seems to be less responsive to change in the relative supply. In effect we found out two different sectors of the economy, one where skill bias is feeble but clearly present and another where it is hardly present. We also find out that the elasticity to supply decrease after 1980: hinting probably to an increase of the substitutability between the work of a graduate and that of a non-graduate.

[8] Obviously we tested those restrictions and we did not reject them.

References

[1] Acemoglu, Daron (1998), Why Do New Technologies Complement Skills? Directed Technical Change and Wage Inequality; *Quarterly Journal of Economics*, November 1998, v. 113, iss. 4, pp. 1055-89.

[2] Beaudry, Paul; Green, David (2005), Changes in U.S. Wages, 1976-2000: Ongoing Skill Bias or Major Technological Change?.; *Journal of Labor Economics*, July 2005, v. 23, iss. 3, pp. 609-48 .

[3] Berman, Eli; Bound, John; Machin, Stephen (1998), Implications of Skill-Biased Technological Change: International Evidence; *Quarterly Journal of Economics*, November 1998, v. 113, iss. 4, pp. 1245-79.

[4] Borjas, George J.; Ramey, Valerie A. (1995), Foreign Competition, Market Power, and Wage Inequality; *Quarterly Journal of Economics*, November 1995, v. 110, iss. 4, pp. 1075-1110.

[5] Card, David (1998), Falling Union Membership and Rising Wage Inequality: What's the Connection?; *NBER Working Papers*: 6520.

[6] Card, David; DiNardo, John E. (2002),Skill-Biased Technological Change and Rising Wage Inequality: Some Problems and Puzzles; *Journal of Labor Economics*, October 2002, v. 20, iss. 4, pp. 733-83.

[7] DiNardo, John; Lemieux, Thomas (1997), Diverging Male Wage Inequality in the United States and Canada, 1981-1988: *Do Institutions Explain the Difference?*; Industrial and Labor Relations Review, July 1997, v. 50, iss. 4, pp. 629-51.

[8] Erickson, Christopher L. and Ichino, Andrea (1995), Wage Differentials in Italy: Market Forces, Institutions, and Inflation, in Freeman, Richard B. and Lawrence F. Katz, *Differences and Changes in Wage Structures.*

[9] Faini, Falzoni, Galeotti, Helg, Turrini (1998), *Importing Jobs and Exporting Firms?*, CEPR Discussion Paper 2033.

[10] Katz, Lawrence F.; Murphy, Kevin M. (1992), Changes in Relative Wages, 1963-1987: Supply and Demand Factors; *Quarterly Journal of Economics*, February 1992, v. 107, iss. 1, pp. 35-78.

[11] Koeniger, Leonardi, Nunziata, Labour Market Institutions and Wage Inequality, *IZA Discussion Paper 1291.*

[12] Krugman, Paul; Lawrence, Robert (1993), Trade, Jobs, and Wages; *NBER Working Papers:* 4478.