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Abstract

This paper presents an alternative way of studying the relationship among factors' inequality, growth and technological progress, heavily based on industrial production data. With a better dataset than those normally used in the literature, a set of econometric predictions derived from our theory have been tested. We find strong support of our two predictions. First, industries experiencing high technological progress demand more skilled labor. Second, there is a negative relationship between the rate of technological progress in an industry and the elasticity of substitution between production and non-production workers. This elasticity seems to be a function of the rate of technological progress actually used in the industry.

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1 Introduction

This paper deals with growth, technological progress, human capital and inequality. These four topics have received great attention in economic literature, and in particular, in empirical studies. Typically such studies perform cross-country cross-section analyses. Nevertheless, there is no irrefutable result about how the causal relationship between inequality and growth works. In this paper, we attempt to throw some light on the topic by studying, with a different database, a new explanation for the relationship.

Empirical studies which try to analyze this relationship are not conclusive. The outcome seems to be highly dependent on the number of countries considered in the analysis as well as on the period covered and the different regressors considered. The difficulty in disentangling the channels through which growth and education are related is partly due to the poor data sets available.

Here we propose a new causal relation between growth, education and inequality whose econometric implications can be easily tested with larger data sets than those normally used in this literature. In order to clarify the exposition, we will first explain what we understand by education, technological progress and inequality in this paper.

Education (or broadly speaking human capital related to some sort of educational process) has been treated in the literature in three different ways: as another input of production within a one sector exogenous growth model (e.g. the Augmented Solow model), as the source of growth in endogenous growth models such as Lucas (1988 or as an input in designing new goods or intermediate goods in the R&D sector, the engine of the growth process (Romer (1990) or Grossman and Helpman (1991)). Here we treat it both as an input in the production of goods[1], and as an input in adopting new technologies. We abstract here from the source of these new technologies, we simply assume their existence. From this perspective we are closer to an exogenous growth framework. But in principle, our analysis adds some new interactions among the processes of technological progress, the relationship between inputs in the production process and factor income inequality, which would also be compatible with an endogenous growth framework; in particular, with any model where human capital plays a paramount role in explaining long term patterns of economic growth. Although with a different internal logic, all these models would predict some connection between the level of education and the rate of growth, as observed in applied work by Barro (1991) and Barro and Lee (1993) among others.

Technological progress (both exogenous and endogenous) has a different nature in each of these models. In endogenous growth models, it is normally attached to the idea of knowledge as a non-rival but potentially excludable good (Romer 1990). In exogenous models, technological progress is assumed to take place over time but cannot be easily attached to any economic concept. Here, by technological progress, we mean the machines

[1] This is so because we will distinguish two types of labour, each one with a different level of skill, that can also be related to different levels of education.

and technologies *actually used* in the production process. We do not refer to the amount of knowledge in an economy, not even to the level of knowledge embodied in capital goods, but to the amount of knowledge *actually used* in the production process, which will probably be a high proportion of existing knowledge, (but not necessarily all).

Finally, we should also explain what we mean here by inequality. In the context of this paper, inequality is related to factor inequality and not to income inequality. We look at the evolution of two different kinds of labour that can be assumed to be associated with specific levels of skills and education. Since different individuals receive different wages depending on the type of labour they supply, some linkage exists between factor inequality and income inequality; but this linkage is far from being the focus of the analysis. Furthermore, the way we measure this factor inequality is through the share of one type of labour over total value added. Thus, it is a very production-based way of dealing with the issue of inequality. The evolution of the share informs us on the joint behaviour of relative labour demand and relative wages. It is an indicator of inequality between two types of labour. The relationship between growth and inequality will be based on the different role of these inputs in the production process and on their different ability to help firms adopt new technologies.

Authors like Alesina and Rodrick (1994) and Persson and Tabellini (1991) argue that inequality is bad for growth to the extent resources are re-distributed to a non accumulated factor of production. In public education models, education is the engine of growth as suggested by Barro (1991). These models (e.g. Rehme 1997) are based on the stylized fact that high growth economies have more expensive education systems and show low income inequality (as in Persson and Tabellini (1991) or Alesina and Rodrick (1994)). Both sets of models are consistent with the empirical fact that countries with unequal income distributions have achieved lower per capita GDP growth. Indeed, initial inequality seems to be detrimental for long-run growth[2]. Though the link between income distribution and growth may arise through a variety of channels apart from investment in human capital[3], this is the linkage we are interested in. Our theory on factor inequality is closely related to this argument based on public education and human capital. The causality runs from inequality to growth, but identifying inequality as an insufficient level of education in the workforce, which implies a high level of factor inequality.

Our argument will be basically as follows: We believe extensive education may cause not only growth but also equality. As the proportion of educated people increases in a country, the returns to education diminishes. With lower returns to education, the cost of adopting new technology goes down (since a certain amount of skilled-educated people are needed in order to properly deal with new technologies or new production processes and make the best of them). As a consequence, the process of adopting new technology spreads up as does the rate of improvement of technology in use. At the end of the process,

[2]See Beénabou (1996)

[3]There are the demand side explanations or the explanation derived from the talent allocation model among others. See Perotti (1995) for a brief review of theories on groth and inequality.

the substitutability between educated and not so educated labour has changed. caused by this spread of technology. The rate of technological progress affects the possibilities of substitution between inputs that embody different levels of education and skills. There is a continuous tension between the spread of technology and the elasticity of substitution. Rapid spread of technological progress implies a low elasticity of substitution between high skilled and low skilled labour.

The remainder of the paper is organized as follows. Section 2 briefly describes the database used in the empirical analysis. Section 3 presents and explains the empirical implications of our theory while in Section 4 we analyze the econometric results and we perform some sensitivity analysis to see to what extent the results of the previous section can be relied upon. Finally Section 5 draws the main conclusions.

2 Data description

Most of the data used in this paper were obtained from a large data set developed by Wayne Gray at the NBER, which covers 449 U.S. 4-digit SIC (Standard Industry Classification of 1972) level manufacturing industries, during the period 1958-1986[4]. The main source of this data set is the Annual Survey of Manufacturers (ASM), conducted by the U.S. Census Bureau. Other sources include several US government agencies.

A list of sectors included in the data set at 2-digit level can be found in Table 1. Although we include them in the analysis, we do not present those sectors in food products: the 2-digit manufacturing industry 20. This group includes diverse sectors which behave with different patterns. By excluding them we can have a better flavour of the data set as a whole. We give information about the number of 4-digit level industries within each 2-digit group, the total value added of each 2-digit sector averaged over the sample period and the relative size of each sector with respect to the whole manufacturing sector (excluding food products).

[4]We cannot include the last two years in our sample because data on labour compensation had to be adjusted with NIPA features which only go up to 1984. The adjustment is described below.

Table 1: SUM OF VALUE ADDED, AVERAGE OF TOTAL VALUE ADDED FOR EACH 2-DIGIT SECTOR

Sector	Num. of sub-sector	Value Added	Relative Value Added
21. Tobacco	4	5867	1%
22. Textile Mill	30	24289	4%
23. Apparel	33	26527	4%
24. Lumber-Wood	17	19962	3%
25. Furniture	13	9992	2%
26. Paper	17	27153	4%
27. Printing	16	302332	5%
28. Chemicals	28	53289	8%
29. Petroleum-Coal	5	27355	4%
30. Rubber-Plastic	6	18339	3%
31. Leather	11	5680	1%
32. Stone-Glass	27	19701	3%
33. Primary Metals	26	54364	8%
34. Fabr. Metals	36	47965	7%
35. Machinery	44	102521	16%
36. Electric Machinery	39	56363	9%
37. Trans. Equipment	17	92725	14%
38. Instruments	13	16791	3%
39. Miscellaneous	20	10525	2%

[a]Value added is million dollars and it is the average over the sample period (1958-1984) of the summation over 4- digit sectors. The percentage is on total value added for the 19 manufacturing industries considered (excluding food products).

[b]Source: Jimenez (1996)

From the 18 variables included in the data set, we will be working with the following:

- **Nominal gross output:** Computed as the value of shipments plus inventory change, in millions of dollars.

- **Total labour:** Number of employees in 1.000s. It includes workers in production plans (both production and non-production workers), but it does not include employees in auxiliary (administrative) units.

- **Compensation of total labour:** Total payroll in millions of dollars without social security payments and employer payments for some fringe benefits.

- **Production workers:** Number of production workers in thousands. They are defined as "workers engaged in fabricating, processing, assembling, inspecting and other manufacturing".

- **Non-production workers:** They are defined as "personnel, including those engaged in supervision, installation and servicing of own product, sales, delivery, professional, technological, administrative. etc".

- **Compensation of total labour:** Total payroll in millions of dollars without social security payments and employer payments for some fringe benefits.

- **Compensation of production workers:** Wages expressed in millions of dollars.

- **Material Costs:** They include both materials and energy although excluding purchased services. Thus the cost of total intermediate inputs is slightly underestimated.

- **Price of materials:** Price deflator for materials (base 1972). It was constructed by averaging together price deflators for 529 inputs (corresponding to 369 manufacturing industries and 160 non-manufacturing industries), and weighing them by the relative size of each industry's purchases of that input in the Bureau of Census' Input-Output tables. The tables were computed for 1972, 1977 and 1980-82.

- **Capital**: Real capital stock in millions of 1972. They refer to both structures and equipment measured at the beginning of the year. These data are based on estimates from a joint project by the University of Pennsylvania, the Census Bureau, the SRI Inc., and from the Bureau of Industrial Economics of the Commerce Department.

- **Output price:** Price deflator for the value of shipments (base 1972). It is used as a proxy for the gross output deflator, since no inventory deflator is available. It comes from the Bureau of Economic Analysis in the Commerce Department and it is based on product price indices from the Bureau of Labour Statistics, supplemented by a few specialized deflators for military goods from the government division of BEA.

We will also be using the share and quantities of non-production workers. These are derived by substracting the figures for production workers from those of total labour. Data on wages are computed by dividing the corresponding labour compensation figures by the quantity if this labour.

This data set permits the computation of Solow residuals distinguishing two different labour inputs: production workers' hours and the number of non production workers. However, Gray's data on labour compensation are underestimated because they do not include Social Security benefits and the pay of employees in auxiliary units, which account for as much as 10% of total employees. Likeliest, data on materials' share are also undervalued[5]. Therefore if we compute the Solow residuals from Gray's data, we would be underestimating these two shares and overestimating the Solow residuals, thus introducing a potential bias in the results.

Fortunately, this problem has been partially overcome by Jimenez (1996) and Jimenez and Marchetti (1995) by using 2-digit figures on labour compensation from the National Income and Production Accounts (NIPA)[6]. They correct the measures of labour shares by "multiplying the labour compensation of each 4- digit industry by an adjustment factor, which is different from each 2-digit sector and each time period. This adjustment factor is equal to the correct NIPA labour compensation divided by the undervalued equivalent in our database".

Any time we compute the Solow residual in this paper, we will be using the adjusted figures drawn from Jimenez (1996). In what follows, we describe how he adjusted the labour compensation data. He applies the same adjusting coefficient C_t to both types of shares (production and non-production workers):

$$C_t = \frac{COMP_{NIPA,t}}{COMP_{CENSUS,t}}$$

where $COMP_{NIPA,t}$ stands for the compensation of labour in period t correctly calculated by the NIPA figures at the 2-digit level. $COMP_{CENSUS,t}$ is the sum over 4-digit industries within each 2-digit sector of the variable "Compensation of total labour" in the panel, also at period t. By multiplying C_t by the compensation on total labour for each 4-digit industry we are assuming that, within each 2-digit sector, all industries pay the same proportion of wages to those working in the administrative units, and that Social Security payments are also the same proportion for each sector.

When we compute the Solow Residual with the adjusted data on labour compensation, we will apply the same coefficient to both the compensation of production workers and of non-production workers. Thus, as Jimenez (1996) explains "this implies firstly, that we are also assuming that the proportion across 4-digit industries in maintained for

[5]These critiques were firstly risen by Norrbin (1993)

[6]Unfortunately, data on materials cost are not available

both production and non-production workers: and secondly, that we are overadjusting the share of production workers, since the adjusting factor C_t takes into account the under-measurement of the wages of workers on auxiliary units in our panel, and these workers should be considered as only non- production workers. This overadjustment has a parallel in an underadjustment of non-production workers."

3 Empirical predictions

Our argument has interesting empirical implications, some of which have been already supported by the literature. The story will be better understood if we start by describing the way we conceive the dynamics of the industrial sectors in a country. This is heavily based on the idea of capital skill complementarity and technological progress biased towards skilled labor[7], but we introduce some dynamic perspective.

The main idea is that **the degree of substitutability between skilled and unskilled labor changes both across industries and over time** in the production process and that the value of the elasticity of substitution is determined by the pace of technological progress. With the spread of technological progress over the whole economy. we should observe a shift from medium-low technology capital towards high technology capital. As a technology matures, we can obtain the same (or better) product as before by combining not highly skilled labor with more user-friendly capital. This phenomenon can be observed over relatively long periods of time[8]. Thus, accumulation of physical capital will play an important role. The rate of technological progress will affect the possibilities for substitution between inputs in the production process. In industries in which the technological level is rapidly progressing (e.g. aerospace, telecommunication, pharmaceutical..), which normally also correspond to highly capitalized industries, skilled workers and unskilled workers are not very close substitutes in production. They are closer to be complements because the kind of tasks performed by the two groups are very much differentiated and, especially at the early stages of an innovation, they both are essential in the production process. Here high capital-skill complementarity as well as technological progress biased towards skilled labor will be observed.

On the contrary, in those industries in which the technology is "matured or exhausted", in the sense that improvements in the production process as well as the creation of new goods or innovative activities are improbable (e.g. calculators, cars, television).

[7]Technological progress is said to be biased towards a production factor if, along the steady state, the share of the factor presents an upward trend. Capital-skill complementarity refers to the fact that physical capital seems to be more complementary in production (or less substitute) with skilled labor than with unskilled labor

[8]A very extreme example would be the copy-making process: Centuries ago a skilled worker (able to understand how the Gutemmberg printing press worked) combined with a new technology (the Gutemberg press) was needed in order to get a printed copy. Nowadays press machines (now relatively old technology) are able to give the same outcome if properly used by (in comparative terms) less skilled labor.

the situation is the opposite. Here skilled and unskilled labor are much more substitutes in production and the adoption of more user-friendly capital as a result of the process of technological progress, shift away skilled workers from these industries. Thus, the proportion of skilled labor needed in the production process decreases. When the replacement of skilled by unskilled workers has taken place, we should also find a shift towards a mature user-friendly technology embodied in new vintages of capital that, handled by semi-skilled or unskilled labor, produces an equivalent or very similar output. Accumulated capital will now be (in comparative terms) more a complement for unskilled than for skilled labour. Machines and unskilled labour will now account for the main part of the production process.

The same phenomenon would also take place over time. In periods in which the pace of technological progress is high, the increasing relative demand of skilled to unskilled workers would overcome any substitutability between both categories. In fact, during these periods of high technological growth, new capital and more skills are needed in order to introduce newly discovered techniques into both new and existing production processes. Then technological progress, physical capital and skilled labour will present the closest linkages. As the new techniques spread over the whole economy, and as the specific techniques become well-known and increasingly embodied in new generations of capital, substitutability will increase. In the limit, during periods of very low rates of change in the rate of technological progress, new generations of physical capital will allow even unskilled workers to perform tasks which did not exist at the beginning of the innovation.

This argument has clear empirical implications regarding the relationship among growth, equality and education across countries. First we should observe that, regarding growth, it is not key whether the country under study is comparatively rich or poor but whether it possesses the appropriate level of education in the work force in order to perform the "take off". Machinery can be easily bought abroad and, with machinery its embodied technological progress. Even when most countries in the world have access to this kind of applied technology, not all of them seem to profit from it and grow. This might be due to the lack of an educated work force needed to properly use and take advantage of the new production processes. Skilled labour is needed (as an initial condition) for this "take off" to take place. The higher the level of average education of the work force in a country, the easier it will be for its labour to exploit both the complementarity with physical capital and the nature of a technological progress which seems to required skilled labour. Furthermore, there will be no constraint regarding what kind of technology to implement because of an insufficiently prepared labour force. The potential knowledge spillovers will not be limited *a priori* making it easier for the country to appropriate them. It is not only that a high level of average education implies that the work force knows better how to e.g, deal with machines, but also that now it is more probable that they perform a minor improvement in the machine or in the production process, leading to future within industry spill overs. This idea of a "threshold" in the level of education or skills in a country has been implemented by authors who set up growth models with a research sector as the engine of growth. They argue that, in order to be able to research, a minimum number of skilled workers must be employed by the sector (Azaridis and Drazen 1990). García-Peñalosa (1995) shows how, with the proper set up, any economy whose initial level of human capital is below a certain threshold value can never converge to the rate of growth or to the level of human capital of richer economies.

Our point is that **imported machines do more for growth when they are placed in a country with a higher level of average education**. We should then observe how poor and educated countries grow faster than rich and not so educated ones. Reviewing some literature on the empirics of economic growth may be of help[9]. Within the exogenous growth literature, the Augmented Solow model (which includes accumulation of human capital as well as physical capital and labour in explaining the growth of output) is the proper bench mark. Mankiw, Romer and Weil (1992) found that, when including human capital, the rate of convergence in the Solow model increases, stressing therefore the role of human capital in determining the speed of convergence[10]. Barro and Sala-i-Martín (1995) review a vast amount of work on the empirics of economic growth to conclude that there is evidence that countries with higher initial human capital converge faster to their steady-state positions. Higher initial human capital speeding up convergence is not an exclusive prediction of the Augmented Solow model. Models of technological diffusion which stress the role of innovations in the growth process (like Young 1993, Grossman and Helpman 1990 or Aghion and Howitt 1992 among others), would also predict it. Our theory could also be inserted within literature on multiple equilibrium models (Azariadis and Drazen 1990), or convergence clubs (Quah 1995).

The idea of a higher growth potential attached to a good education record in a country has been also documented by economic historians. Sandberg (1982), talks in these terms about the growth performance of countries up to 1913: "The poor, high literacy countries ... grew the fastest... As for the low literacy countries, this group's growth rate was clearly slower than that of the others". O'Rourke and Williamson (1996), when analyzing the contribution of schooling to GDP per worker growth during the late 19th century, found that "Poor countries well endowed with schooling catch up faster than those poorly endowed". Other examples can be easily found, among which the comment of Cipolla (1969) that "more literate countries were the first to import the Industrial Revolution".

[9]In this literature, school enrollment rates are normally used as a proxy for average education. Educational attainments in secondary and higher schooling have proved to be determinant in the catch-up process, in comparison to primary education which does not seem to be significatively related to the growth rates.

[10]It should be stressed that we do not need the hypothesis of convergence in order to support our argument. We do not need to assume the existence of a steady-state level of income. Differences among countries in the level of income per capita could persist indefinitely over time if e.g. we move to an endogenous growth model ala Lucas (1988). In this case, the size of domestic human capital stocks determine the ability to adopt innovation and the ability to catch-up. Different endowments of human capital would account for persistent long-run growth differentials across countries.

The role of human capital in explaining the growth phenomenon has recently received much attention. We do not attempt to make a point which has been already largely documented and analyzed. Our approach here is more related to the level of education and skills which are actually applied in the production structure of an economy. We are aware of the fact that human capital (however measured), skills and formal education are not strictly speaking equivalent concepts. Still, we believe they can be understood as good proxies for the amount of knowledge of the active labor force in a country.

The two implications derived from our theory can be tested with a different (much larger) data set from the one usually used in the literature[11]. First, over a relatively long period of time, we should observe how industries with a high speed of technological progress also present a high demand for skilled labor[12]. This will be tested by proxying technological progress via Solow Residuals and demand for skilled labor through the share of non production workers divided by total wage bill. If our theory is correct, we should observe a positive and significant relationship between these two variables: share of non-production labour and Solow Residual (SR hereafter).

An interesting exercise consists of studying how the same relationship behaves at business cycles frequencies. In this case we would be dealing with the phenomenon not of growth[13] but of cycles. The relevance of such an analysis is based on the idea that if we find a significant (but of opposite sign) linkage between the SR and our dependent variable, applied work should be very careful with the way data are *cleaned* from the cyclical fluctuations. If not properly purged from demand shocks, empirical studies on growth and inequality might yield to the wrong conclusions.

The second implication concerns the elasticity of substitution between skilled and unskilled workers (in our case, non-production and production workers). Our theory predicts that such an elasticity is a function of the rate of technological progress in the industry. In particular, if the theory is correct, this elasticity should decrease with the rate of technological progress applied in the production process. The higher the rate of technological progress, the more difficult is it to substitute skilled for unskilled labor. Thus, we predict that high SR industries should present a high share of non-production workers because the effect of relative wages on relative employment will be low.

4 Empirical Analysis

Here we will test the econometric implications of our theory, by using relatively simple panel data techniques. All regressions have been performed both with group dummies and with group and time dummies. When only group effects have been estimated, we

[11]Some comment about cross-section data points and countries

[12]This derives from the previous discussion about the industrial dynamics in a country.

[13]Only Real Business Cycle models claim that the nature of the forces causing long-run growth and business cycle fluctuations are essentially the same: i.e. productivity shocks.

allow the intercept to vary *only* across industries and not over time. There follows a brief summary of the two predictions and their respective econometric performance.

Prediction I: The first of our predictions is that industries with a high average Solow residual should also present a high relative proportion of skilled to unskilled workers. This can be tested by running the following regression:

$$s_{np_{it}} = \beta_{npt} SR_{it} + \alpha_i + \lambda_t + \epsilon_{np_{it}} \qquad (1)$$

where s_{np} stands for the share of non-production workers across industries and over time and SR_{it} for the different values taken by the Solow Residual across industries and over time. The terms α_i and λ_t represent group and time dummy effects respectively while $\epsilon_{np_{it}}$ represents the effects of those unobserved variables that vary over i (industry) and t (time). All the regressions will be performed by using OLS. Tables 3 and 4 present the results of performing such regressions both with group dummies (the so called fixed effects estimator) and with group and time dummies. In both cases the coefficient on the SR present a positive sign and is significant. This is consistent with our first prediction. The R^2 values are also very high. When time dummies are included, the values of the estimated coefficients decrease, with the highest decrease occurring during the oil crisis subperiod. Time specific effects seem to capture much of the impact of the oil crisis on the dependent variable.

A similar regression has been run with the rate of change of these same variables. In this case we are not capturing the long-run relationship between the share of non-production workers and the SR, but rather their relationship at business cycle frequencies. Here, the procyclical nature of the SR might be dominating the linkage in which case we would capture the effect across industries and over time of demand shocks. The equation to be estimated will now be:

$$\Delta s_{np_{it}} = \beta_{npt} \Delta SR_{it} + \alpha_i + \lambda_t + \epsilon_{np_{it}} \qquad (2)$$

Again, both group dummies (within-industry estimators) and group and time dummies effects have been estimated. Results are presented in Tables 5 and 6 The relationship between the rate of change of the share and the rate of change of the SR is still positive and significant. In principle, the nature of the relationship does not seem to be different in the short than in the long run. It is worthwhile to point out that now we are not studying how technological progress affects the demand for skilled labour. Rather we are now capturing the relationship between the rate of change of the rate of change of technological progress and the rate of change in the demand for skilled labour. Although with the same result as before, R^2 values are noticeably lower, suggesting that the capacity of the change in the rate of change of technology in explaining movements in the share of non-production workers at business cycle frequencies, is very limited.

Sensitivity analysis of Prediction I The evidence presented up to now is fully consistent with our theory. Nevertheless, it is possible to go further in the analysis and explore how sensitive our prediction is with respect to the rate of technological progress in an industry. We know, according to our results, that demand for skilled labor depends on the level of the SR (rate of technological progress). Now we are interested in testing whether this effect is homogenous across industries of different rates of technological progress. We need therefore to partition industries according to the level of their SR. We will distinguish two groups of industries (which will be called high SR and low SR industries) depending on whether their SR takes values above or below a bench mark. We have chosen two different bench marks to see how robust the results are: the mean and the median of the SR. Both statistics are computed for each period; that is we allow industries to shift from e.g. the group of low SR to the group of high SR from the period 1958-1973 to the period 1974-1985. Thus the category industries belong to is not fixed over time[14].

A summary of the SR statistics calculated from the sample data used is presented in Table C.1. Information about the mean, the median, the standard deviation, kurtosis and skewness can be useful in understanding their performance in future regressions. The last two statistics are only presented for the whole sample since the subgroups (low and high SR industries) are not normal by construction. Instead, for these samples we present the maximum and the minimum value taken by the SR. The number of industries, the number of observations and the period covered are given for reasons of clarity. For the whole sample, the median is lower than or equal to the mean. This happens also for both groups of high SR industries. Only with the low SR industries, the median tends to be bigger than the mean. Dispersion is relatively higher during the second subperiod 1973-1984 (during both oil crises). There are negative values in all subsamples, as we can see from the information on minimum values. The lowest maximum and the highest minimum tend to cluster during the period 1958-1973, while the highest maximum and the lowest minimum appear from 1973 to 1984. This makes one think of a higher concentration of the SR values during the first subperiod (1958-1973), confirmed by the value of the standard deviation. Likewise, accompanied by the lower standard deviation, there is the minimum distance between the mean and the median. Statistics from 1973 to 1984 present the highest dispersion and a considerable distance between mean and median. Concerning the whole sample, the distribution seems leptokurtotic and slightly skewed. We would expect a test on normality to be rejected. But as we have a good amount of observations, we can always consider the assumption that parameter estimates are normally distributed by resorting to the central limit theorem to be sensible. From now on, we will replicate equation (1) distinguishing between high and low SR industries, and specifying whether the bench mark is the mean or the median of the SR. We first perform regression (1)

[14]In order to get the bench marks of the SR we do the following: first we get the mean over time of the SR for each industry and then we get the mean or the median of these values. We do the same three times, for the whole period and for the two subperiods.

for those industries with a SR above the mean, second for those industries with a SR below the mean, third for those industries with a SR above the median and finally, for those industries with a SR below the median. Results can be found in Tables 7 to 14. As before, we estimate the equation both with group and group and time dummies. When the median of the SR is used as the bench mark, coefficients on the SR are always higher for high SR industries than for low SR industries, the difference reaching its maximum during the second subperiod. On the contrary, when the mean is used as the bench mark, the difference in the SR coefficient is lower for high than low SR industries for this subperiod (1973-1984). In general, we can say that the econometric evidence supports our prediction as the estimated coefficient on the SR is always positive for all subsets of industries and all subperiods.

Equation (2) has also been run differentiating between high and low SR industries. These results are presented in Tables 15 to 22. They are almost identical when partitioning with respect to the mean compared to when partitioning with respect to the median. In this case, the difference between the coefficient on ΔSR for high and low SR industries is negative. This can be interpreted in two different ways, depending on the meaning we give to ΔSR. The SR seems to be made up of two components: a short-run cyclical component and a long-run component close to the idea of technological progress. If we think that the last component is dominating the result in the regression, then this is a puzzling result. If we believe it is the cyclical component which is present, then it only means that low SR industries are more exposed to the business cycle. Besides, since we are taking first differences, it seems more sensible to interpret ΔSR as the business cycle than as something linked with the rate of technological progress.

Although our theory is supported by our data, empirical evidence has been based on a very simple model. In order to discover to what extent the results are a consequence of a too simplistic specification (a possible oversimplification), or whether they respond to the authentic sources moving the dependent variable, we are going to enlarge the model. This will be done by restoring to an econometric specification derived from a translog cost function[15]. The next equation to be estimated is the following:

$$s_{np} = \beta_{np} ln(K/Y) + \beta_{npt} SR + \beta_{npnp} ln(W_{np}/W_p) + \alpha_i + \lambda_t + \epsilon_{np_{it}} \quad (3)$$

where $ln(K/Y)$ stands for the log of the capital to output ratio and $\ln(W_{np}/W_p)$ represents the wage ratio of non-production workers with respect to production workers. Concerning the new parameters to be estimated β_{np} tells us whether physical capital and skilled labor are complements or substitutes in the production process; β_{npnp} gives information on whether the elasticity of substitution between production and non-production labor is above or below one (see Appendix A to understand the interpretation of the coefficients).

[15]See Appendix A for a brief explanation of how this expression has been derived.

Results are presented in Tables 23 and 24 (for all industries). Both tables support capital-skill complementarity and an elasticity of substitution between production and non-production workers below unity (since β_{npnp} is positive). The inclusion of time dummies seems to have most effect on the impact of the capital/output ratio on the share for the whole period and the first subperiod. The coefficient we are interested in, the sign of the SR coefficient, is positive and significant, supporting the prediction that demand for skilled labor is a positive function of the rate of adopting new technology. The value of this estimated coefficient is again very sensitive to the inclusion of time dummies during the oil crisis period: its impact goes from 0.022 down to 0.011 when time dummies are included. R^2 values remain as high (around 0.99) as in previous regressions.

The next step consists of replicating the regression distinguishing between high and low SR industries and studying whether the relationship is sensitive to the rate of technological progress. If the rate of technological progress is causing the demand for skilled labor then we should observe how the impact of the SR on demand for skilled labor is not homogeneous across industries with different levels of SR's. One problem lies on the way we partition industries and on whether the partition enhances properly such differences in technology. That is why we replicate all regressions for the two bench marks: the mean and the median.

Tables 25 to 32 present the results of running equation (3) differentiating between high and low SR industries. In those industries with a high SR, the impact of capital on the share seems to be dictated by the oil crisis subperiod where the estimated value of the coefficient is either negative or close to zero and non significant. This is the same both in the mean and in the median case. A similar phenomenon happens with the effect of the SR on the share for those industries with a low SR: Again the coefficient on the SR is negative for the whole period and caused by its behaviour during the subperiod of both oil crises. Nevertheless, the estimated value of the SR coefficient is always positive and significant for the high SR industries. It is systematically higher in those industries with a high SR. These values are also higher than those obtained when all industries are considered (see Tables 23 and 24). For example, in the case of group estimates during the fist subperiod 1958-1973, the impact of the SR on the share was 0.056 for those industries with a SR above the mean, 0.037 for all industries as a whole and only 0.011 for those industries with a SR below the mean. Similar figures would be obtained if we repeat this exercise differentiating among industries with respect to the median. This is always the case either when we focus on the group dummies estimator or on the group and time dummies estimator. Furthermore, in the case of the second subperiod this effect is negative for industries with a low SR, making it clear that the relationship between the demand for skilled labor and the rate of technological progress in an industry is not independent of the existing rate of technological progress in that industry. In general, by subsamples and subperiods the estimated coefficients on the SR are positive both when the dependent variable is the share of the non-production workers share or the level of the share. The only exceptions are small borderline significant estimated coefficients for low SR indutries in the period of the oil crises.

Prediction II: There is still another prediction to be tested. Namely, whether the elasticity of substitution between skilled and unskilled labor depends on the rate of technological progress. In order to test this prediction, we reconsider the results of running equation (3) distinguishing between high and low SR industries as we did before in Tables 25 to 32. By now we know that, for all industries, the elasticity between production and non-production workers is below unity since β_{npnp} has a positive sign in equation (3). In both cases, the estimated value of β_{npnp} is higher for the high SR industries than for the low SR industries. Therefore the elasticity of substitution is lower for those industries with higher rates of technological progress. The difference between high and low SR industries is bigger when the cuttoff point is the mean. This is so because SR values are highly volatile and dispersed and thus, there are less industries in the group of a SR above the mean than in the group of a SR above the median. This difference is always bigger when group and time dummies are estimated than when only group dummies are estimated (other things equal). As an example of this unequal elasticity of substitution, consider the group effects estimator. Difference in the estimated values of β_{npnp} between high and low SR industries is 0.07 for the whole period when the mean is the bench mark and of 0.04 when the median is the bench mark. This exercise can be repeated changing the sample period, the estimation method (from group dummies to group and time dummies) or the bench mark value of the SR (mean or median), with the same outcome: the possibilities for substitution of unskilled for skilled labor decreases with the rate of technological progress in the industry.

Sensitivity Analysis of Prediction II: The first exercise will be to run equation (3) omitting the SR, which is the most volatile variable, and see whether the results are sensitive to this omission. That is, we estimate the following expression:

$$s_{np} = \beta_{np} ln(K/Y) + \beta_{npnp} ln(W_{np}/W_p) + \alpha_i + \lambda_t + \epsilon_{np_{it}} \quad (4)$$

As before, we first present the results when differentiating between high and low SR industries with respect to the mean and then with respect to the median. Results can be found in Tables 33 to 40. As before, estimated values of β_{npnp} are always higher for high SR industries than for low SR industries. Again, the same happens both when the mean is used as the cutoff point and when the median is used, and for both group and group and time dummy estimators. The omission of the SR does not seem to have any relevant impact, since estimated values are almost identical to the ones we had before.

It seems the only way of studying the impact of the rate of technological change on the elasticity of substitution is by differentiating between high and low SR industries. Including all the industries in the same regression would force us to control for three phenomena at the same time. First, we know that the rate of technological change (the SR) has a positive impact on the share, then we also know that the elasticity of substitution is below one (because β_{npnp} is always positive). Now it turns out that we should construct some composite of the SR and $ln(W_{np}/W_p)$ and include it in the regression jointly with SR and $ln(W_{np}/W_p)$ to control for the impact of SR on the elasticity. But collinearity problems would make the whole exercise fruitless mainly because of the high volatility of the SR[16]. Thus, we have tried to disentangle among these three forces by differentiating between high and low SR industries.

A relatively straightforward way of seeing whether the elasticity of substitution between production and non-production labour depends on the rate of technological progress in an industry, consists of computing such elasticities. We can derive an expression for the elasticity as a function of one of the parameters estimated, namely β_{npnp}[17]. Thus, the elasticity will take different values depending on from which equation we take the estimated value of the parameter. Besides, we have performed all estimations with group and with group and time dummies and for different sample periods. Tables 49 and 50 present all this information making precise whether the sample corresponds to all industries, to high SR industries (above the mean or the median) or to low SR industries (below the mean or the median). In practically all cases, the elasticity is lower in industries with a high SR than in industries with a low SR. There are no significant differences between choosing the mean or the median as the bench mark. Differences in elasticities between high and low SR industries are higher when group and time dummies are estimated than when only group dummies are estimated. The estimated values of β_{npnp} in equations (3) and (4) yield similar results. The conclusion is clear: the theory seems to be strongly supported.

The next exercise is an alternative way of testing the same phenomenon. To do so we run the following regression:

$$s_{np} = \beta_{np} ln(K/Y) + \beta_{npnp} ln(W_{np}/W_p) + \gamma d_\gamma [ln(K/Y)]_{hsr} + \\ + \nu d_\nu [ln(W_{np}/W p_p)]_{hsr} + \alpha_i + \lambda_t + \epsilon_{np_{it}} \qquad (6)$$

where d_γ and d_ν are dummy variables which take a value 1 or 0 depending on whether the industry belongs to the high SR group or to the low SR group, respectively. The

[16] We did try to run a regression of the type described above:

$$s_{np} = \beta_{np} ln(K/Y) + \phi SR \; ln(W_{np}/W p_p) + \beta_{npnp} ln(W_{np}/W_p) \\ + \beta_{npt} SR + \alpha_i + \lambda_t + \epsilon_{np_{it}} \qquad (5)$$

and study whether the estimated value of ϕ was positive (meaning the SR affects the elasticity) and significant. The problem, as we say, was the high correlation between the new regressor and the SR which was always above 0.8 in absolute value. Dropping the SR solves this problem and give us sensible t- statistics; but a positive value of ϕ could arise both because the rate of technology has a negative impact on the elasticity or because the SR itself affects the share.

[17] Appendix D develops the derivation of the elasticity

new regressors $[ln(K/Y)]_{hsr}$ and $[ln(W_{np}/W_p)]_{hsr}$ are simply the values of $ln(K/Y)$ and $ln(W_{np}/W_p)$ for those industries with a high SR. The new coefficients γ and ν give us the difference between high and low SR industries in the impact of $ln(K/Y)$ and $ln(W_{np}/W_p)$ respectively on the demand for skilled labour. Thus, if these new coefficients turn out to be significant, this would mean there is a significant difference in the response of industries depending on their level of technology.

Results are presented in Tables 41 to 44. Again, we first identify high SR industries as those with a SR above the mean and then as those with a SR above the median. The effect of the capital-output ratio on the share, although positive for all industries, is of different sign during the second subperiod for industries with a high SR than for industries with a low SR. This is so for both bench marks, mean and median, of the SR. During the first subperiod, this difference is positive, meaning a higher level of capital skill complementarity occurring in those industries with higher SR. Regarding the elasticity of substitution, as ν is always positive. This is evidence of a lower degree of substitutability between production and non-production workers in industries with a higher SR, as prediction II maintains. This is so in all cases, except the second subperiod being the case in which the median of the SR is taken as the bench mark.

A last exercise would consist of running this same regression but including the SR for all industries and the SR in high SR industries with another dummy. This is:

$$s_{np} = \beta_{np} ln(K/Y) + \beta_{npnp} ln(W_{np}/W_p) + \beta_{npt} SR + \phi d_\phi [SR]_{hsr} + \\ + \gamma d_\gamma [ln(K/Y)]_{hsr} + \nu d_\nu [ln(W_{np}/W_p)]_{hsr} + \alpha_i + \lambda_t + \epsilon_{np_{it}} \quad (7)$$

where d_ϕ is a dummy variable taking values 1 or 0 depending on whether the industry belongs to the high SR or to the low SR group. Likewise, $[SR]_{hsr}$ represents the value of the SR for the high SR industries. Running this regression is useful in two ways. On one hand, we can see whether the results alter because of the inclusion of another variable. On the other, we can extend the **sensitivity analysis of Prediction I** and deepen the study of whether the impact of the rate of technological progress on the demand for skilled labor is significantly different depending on the rate of technological progress enjoyed in the industry. Again, if we find d_ϕ to be significantly different from zero, this would reinforce our empirical evidence supporting Prediction I.

As before, we first present the results using the mean of the SR as the bench mark (Tables 45 and 46) and then the median of the SR (Tables 47 and 48). The results are virtually identical concerning the values of the estimated coefficients. The new variable $d_\phi[SR]_{hsr}$ is always positive (almost always significant), meaning that there is a difference in the way technological progress affects the share of non-production labour depending on the rate of technological progress in the industry. Once again, results support Prediction II.

5 Concluding remarks

This paper presents a new view of the effects of education and technological progress in the growth process. We have argued that a country with a highly educated workforce will grow faster and will enjoy a lower level of inequality. As the level of education grows, the returns to education diminishes, making it cheaper to adopt new technologies. If firms exploit this fact, the economy will end up with a different production structure which continuously conditions the growth process and the spread of technology. Because of the nature of technological progress (in particular, because firms need educated labour in order to deal with high-technology capital), specific relationships among factors of production (especially skilled and unskilled labour) are imposed. Our point is that the possibilities of substitution between skilled and unskilled labour are not independent of the rate of technological progress. Talking about the rate of aggregate technological progress in a country in this context is not appropriate, because technology involves different coexisting technologies which in practice, work at the industry level. Thus, if we move towards a more dissaggregated approach, we can easily control for this process. This allows us to test our theory (or at least its econometric implications) with industrial data. To be able to perform applied work on the relationship between growth and inequality with more than 11.000 data points is in itself a step forward. The first econometric implication: that there is a higher share of non-production labour in those industries with a higher rate of technological progress, is strongly supported by the data. The second implication: that the elasticity of substitution between production and non-production workers is a negative function of the rate of technological progress enjoyed by the industry, is also strongly supported by the data. Both results are robust to different specifications and ways of estimation. This result lets us conclude that the theory behaves very successfully when confronted with the data.

Appendix A: A model

We present the model for two inputs into production: production and non production labour, and derive the final expression we estimate in the paper.

We will assume that, over the time horizons we are working with, capital can be treated as a fixed factor while the other inputs should be treated as variable. The econometric specification estimated in the paper can easily be derived from a translog cost function which expresses the expenditures on variable inputs as a function of the variable input prices, the level of output (Y_t), and the quantities of the fixed factor (K_t). We will also introduce a technological progress indicator θ_t. The translog cost function can be interpreted as a second-order Taylor's approximation in logarithms to an arbitrary cost function. The dual cost function approach is particularly accurate if industries are reasonably competitive and if data are diseggregated, since in such a case it is more likely that prices are exogenous. The variable inputs in our variable cost function are the number of non-production workers N_{np} and the number of production workers N_p. Materials will be ignored for simplicity. Their respective prices are denoted by W_{np} and W_p. Thus, the total variable cost or total wage bill will be $TVC = TWB = N_{np}W_{np} + N_pW_p$.

We can obtain an equation for the variable input we are interested in based on the translog variable cost function, by using Shephard's Lemma and obtaining the corresponding FOC's for the cost minimization problem[18]. The corresponding FOC's for the two variable inputs will turn out to be:

$$\frac{\delta ln(TVC)}{\delta ln(W_{np})} = \frac{N_{np}W_{np}}{TVC} = s_{np} = \alpha_{np} + \beta_{npnp}ln(W_{np}) + \beta_{npp}ln(W_p) + \\ +\beta_{npK}ln(K) + \beta_{npY}ln(Y) + \beta_{npt}ln(\theta_{npt}) \tag{8}$$

$$\frac{\delta ln(TVC)}{\delta ln(W_p)} = \frac{N_pW_p}{TVC} = s_p = \alpha_p + \beta_{pnp}ln(W_{np}) + \beta_{pp}ln(W_p) + \\ +\beta_{pK}ln(K) + \beta_{pY}ln(Y) + \beta_{pt}ln(\theta_{pt}) \tag{9}$$

We will call s_{np} and s_p the share of non-production workers wage bill and share of production workers wage bill in total variable cost. The analysis can be simplified by focusing on one out of these two equations in order to study the behaviour of the input shares. In our case, we are interested in studying equation (A.3). For a cost function to be well behaved, it has to be homogeneous of degree one in prices, given Y and enjoy other regularity conditions (symmetry and adding-up). Assuming a well behaved cost function plus constant returns to scale implies the following set of restrictions

[18] As capital is treated as a fixed (and exogenous) factor, there is no FOC attached to it

$$\beta_{npnp} + \beta_{npp} = 0, \quad \beta_{npk} = -\beta_{npy} = \beta_{np}$$
$$\beta_{pnp} + \beta_{pp} = 0, \quad \beta_{pk} = -\beta_{py} = \beta_p$$
$$\alpha_{np} + \alpha_p = 1$$

Introducing such restrictions into equation (8) and appending an error term ϵ yields the following expresion:

$$s_{np} = \alpha_{np} + \beta_{npnp} ln(W_{np}/W_p) + \beta_{np} ln(K/Y) + \beta_{npt} ln(\theta) + \epsilon_{np_{it}} \quad (10)$$

It should be noted that we are not fully following the standard cost function approach in which technological progress is treated as a factor of production. We never estimate eq (8), because in order to test our predictions we need to relate the *share* to *technological progress*, and not to *the level of technology.* Within this approach, we could ONLY include the Solow Residual if we first differentiate the equation. Then $\Delta ln(\theta)$ could be proxied with the Solow Residual. But what our prediction says is that there is a relationship between the share and the Solow Residuals. In other words, we use this approach as a guideline of what kind of variables might be affecting the share.

The remaining considerations about the interpretation of the coefficients also apply here. Changes in the wage bill share will reflect changes in relative skill levels. The relative utilization of production and non production labor will not be affected by the absence of materials as far as the elasticity of substitution between production labor and materials and the elasticity of substitution between non-production labor and materials are similar enough. This way we can assure that changes in material prices will not cause substitution away from or towards either type of labour. The direction of the bias will depend on whether the elasticity of substitution between materials and non-production labour is above or below the elasticity of substitution between materials and production labour. A brief summary of the interpretation of the coefficients is presented in Table 2.

Finally it should be noted that by estimating an equation like the one above, we are exploring the factors that drive our dependent variable at a within-industry level. Between-industry forces (that traditionally account for much less movement in the dependent variable) are therefore ignored.

Table 2: INTERPRETATION OF THE COEFFICIENTS

Parameters	positive sign	negative sign
β_{npnp}	Elasticity of substitution between production and non-production workers below one	Elasticity of substitution between production and non-production workers above one
β_{np}	Capital skill complementarity	Capital skill substitutability
β_{npt}	High rate of technical progress benefits non-production workers	High rate of technical progress damages non-production workers

Appendix B: Tables

In what follows * denotes significnat at 5% level.

Dependent variable-Share of non-production labor for all industries

$$s_{np_{it}} = \beta_{npt} SR_{it} + \alpha_i + \lambda_t + \epsilon_{np_{it}} \tag{1}$$

Table 3: ESTIMATION OF EQUATION 1 FOR ALL INDUSTRIES

Regressor	1958-1984	1958-1973	1974-1984
SR	0.059	0.052	0.057
t-ratio	11.61*	9.28*	11.92*
R^2	0.98	0.99	0.99

Least squares with group dummy variables

Table 4: ESTIMATION OF EQUATION 1 FOR ALL INDUSTRIES

Regressor	1958-1984	1958-1973	1974-1984
SR	0.053	0.046	0.033
t-ratio	10.84*	8.02*	7.23*
Constant	0.062	0.060	0.065
t-ratio	1031*	1022*	981*
R^2	0.98	0.99	0.99

Least squares with group and time dummies

Dependent variable-First difference of the non-production labor share

$$\Delta s_{np_{it}} = \beta_{npt} \Delta SR_{it} + \alpha_i + \lambda_t + \epsilon_{np_{it}} \tag{2}$$

Table 5: ESTIMATION OF EQUATION 2 FOR ALL INDUSTRIES

Regressor	1958-1984	1958-1973	1974-1984
ΔSR	0.040	0.043	0.03
t-ratio	19.33*	13.26*	12.54*
R^2	0.05	0.06	0.12

Least squares with group dummies

Table 6: ESTIMATION OF EQUATION 2 FOR ALL INDUSTRIES

Regressor	1958-1984	1958-1973	1974-1984
ΔSR	0.0297	0.0332	0.024
t-ratio	14.05*	9.95*	8.38*
R^2	0.12	0.11	0.20

Least squares with group dummies and period effects

Dependent variable-Share of non-production labor for those industries with a Solow residual above the mean

$$s_{np_{it}} = \beta_{npt} SR_{it} + \alpha_i + \lambda_t + \epsilon_{np_{it}} \tag{1}$$

Table 7: ESTIMATION OF EQ 1 FOR HIGH SR INDUSTRIES

Regressor	1958-1984	1958-1973	1974-1984
SR	0.0817	0.0716	0.0348
t-ratio	8.45*	7.66*	4.66*
R^2	0.97	0.99	0.99

Least squares with group dummy variables

Table 8: ESTIMATION OF EQ 1 FOR HIGH SR INDUSTRIES

Regressor	1958-1984	1958-1973	1974-1984
SR	0.070	0.061	0.015
t-ratio	7.49*	6.42*	2.12*
Constant	0.0835	0.0828	0.068
t-ratio	533*	626*	554*
R^2	0.98	0.99	0.99

Least squares with group and time dummies

Dependent variable-Share of non-production labor for those industries with a Solow residual below the mean

$$s_{np_{it}} = \beta_{npt} SR_{it} + \alpha_i + \lambda_t + \epsilon_{np_{it}} \qquad (1)$$

Table 9: ESTIMATION OF EQ 1 FOR LOW SR INDUSTRIES

Regressor	1958-1984	1958-1973	1974-1984
SR	0.0133	0.024	0.075
t-ratio	1.66*	3.55*	12.00*
R^2	0.98	0.99	0.99

Least squares with group dummy variables

Table 10: ESTIMATION OF EQ 1 FOR LOW SR INDUSTRIES

Regressor	1958-1984	1958-1973	1974-1984
SR	0.0056	0.0225	0.048
t-ratio	0.76*	3.20*	7.96*
Constant	0.043	0.047	0.063
t-ratio	666*	827*	790*
R^2	0.98	0.98	0.99

Least squares with group and time dummies

Dependent variable-Share of non-production labor for those industries with a Solow residual above the median

$$s_{np_{it}} = \beta_{npt} SR_{it} + \alpha_i + \lambda_t + \epsilon_{np_{it}} \quad (1)$$

Table 11: ESTIMATION OF EQ 1 FOR HIGH SR INDUSTRIES

Regressor	1958-1984	1958-1973	1974-1984
SR	0.073	0.068	0.035
t-ratio	9.78*	8.44*	5.42*
R^2	0.98	0.99	0.99

Least squares with group dummy variables

Table 12: ESTIMATION OF EQ 1 FOR HIGH SR INDUSTRIES

Regressor	1958-1984	1958-1973	1974-1984
SR	0.064	0.058	0.017
t-ratio	8.80*	6.96*	2.77*
Constant	0.073	0.076	0.062
t-ratio	695*	725*	640*
R^2	0.98	0.99	0.99

Least squares with group and time dummies

Dependent variable-Share of non-production labor for those industries with a Solow residual below the median

$$s_{np_{it}} = \beta_{npt} SR_{it} + \alpha_i + \lambda_t + \epsilon_{np_{it}} \tag{1}$$

Table 13: ESTIMATION OF EQ 1 FOR LOW SR INDUSTRIES

Regressor	1958-1984	1958-1973	1974-1984
SR	0.033	0.0196	0.077
t-ratio	5.03*	2.65*	11.17*
R^2	0.97	0.98	0.99

Least squares with group dummy variables

Table 14: ESTIMATION OF EQ 1 FOR LOW SR INDUSTRIES

Regressor	1958-1984	1958-1973	1974-1984
SR	0.030	0.0197	0.046
t-ratio	4.94*	2.62*	6.94*
Constant	0.051	0.044	0.068
t-ratio	814*	732*	724*
R^2	0.98	0.98	0.99

Least squares with group and time dummies

Dependent variable-First difference of the non-production labor share for those industries with an SR above the mean

$$\Delta s_{np_{it}} = \beta_{npt} \Delta SR_{it} + \alpha_i + \lambda_t + \epsilon_{np_{it}} \tag{2}$$

Table 15: ESTIMATION OF EQ 2 FOR HIGH SR INDUSTRIES

Regressor	1958-1984	1958-1973	1974-1984
ΔSR	0.035	0.051	0.029
t-ratio	9.25*	9.52*	5.99*
R^2	0.05	0.07	0.09

Least squares with group dummies

Table 16: ESTIMATION OF EQ 2 FOR HIGH SR INDUSTRIES

Regressor	1958-1984	1958-1973	1974-1984
ΔSR	0.022	0.038	0.017
t-ratio	5.91*	7.09*	3.70*
Constant	0.0004	0.0001	0.0052
t-ratio	5.63*	1.20	4.84*
R^2	0.13	0.15	0.20

Least squares with group dummies and period effects

Dependent variable-First difference of the non-production labor share for those industries with an SR below the mean

$$\Delta s_{np_{it}} = \beta_{npt} \Delta SR_{it} + \alpha_i + \lambda_t + \epsilon_{np_{it}} \tag{2}$$

Table 17: ESTIMATION OF EQ 2 FOR LOW SR INDUSTRIES

Regressor	1958-1984	1958-1973	1974-1984
ΔSR	0.046	0.032	0.059
t-ratio	18.70*	7.95*	13.59*
R^2	0.05	0.04	0.17

Least squares with group dummies

Table 18: ESTIMATION OF EQ 2 FOR LOW SR INDUSTRIES

Regressor	1958-1984	1958-1973	1974-1984
ΔSR	0.036	0.024	0.047
t-ratio	14.43*	5.76*	10.63*
Constant	0.0002	0.0001	0.00061
t-ratio	8.13*	2.52*	8.40*
R^2	0.12	0.08	0.23

Least squares with group dummies and period effects

Dependent variable-First difference of the non-production labor share for those industries with an SR above the median

$$\Delta s_{np_{it}} = \beta_{npt} \Delta SR_{it} + \alpha_i + \lambda_t + \epsilon_{np_{it}} \tag{2}$$

Table 19: ESTIMATION OF EQ 2 FOR HIGH SR INDUSTRIES

Regressor	1958-1984	1958-1973	1974-1984
ΔSR	035	0.048	0.029
t-ratio	11.67*	10.31*	6.79*
R^2	0.05	0.06	0.09

Least squares with group dummies

Table 20: ESTIMATION OF EQ 2 FOR HIGH SR INDUSTRIES

Regressor	1958-1984	1958-1973	1974-1984
ΔSR	0.022	0.035	0.0180
t-ratio	7.53*	7.30*	4.30*
Constant	0.00038	0.00010	0.00046
t-ratio	6.65*	1.27*	5.28*
R^2	0.13	0.14	0.17

Least squares with group dummies and period effects

Dependent variable-First difference of the non-production labor share for those industries with an SR below the median

$$\Delta s_{np_{it}} = \beta_{npt} \Delta SR_{it} + \alpha_i + \lambda_t + \epsilon_{np_{it}} \quad (2)$$

Table 21: ESTIMATION OF EQ 2 FOR LOW SR INDUSTRIES

Regressor	1958-1984	1958-1973	1974-1984
ΔSR	0.050	0.040	0.044
t-ratio	17.26*	10.97*	11.07*
R^2	0.06	0.07	0.14

Least squares with group dummies

Table 22: ESTIMATION OF EQ 2 FOR LOW SR INDUSTRIES

Regressor	1958-1984	1958-1973	1974-1984
ΔSR	0.040	0.040	0.030
t-ratio	13.82*	10.99*	7.68*
Constant	0.0003	0.0002	0.0008
t-ratio	7.24*	3.75*	9.99*
R^2	0.12	0.09	0.24

Least squares with group dummies and period effects

Dependent variable-Share of non-production labor for all industries

$$s_{np} = \beta_{np} ln(K/Y) + \beta_{npt} SR + \beta_{npnp} ln(W_{np}/W_p) + \alpha_i + \lambda_t + \epsilon_{np_{it}} \quad (3)$$

Table 23: ESTIMATION OF EQ 3 FOR ALL INDUSTRIES

Regressor	1958-1984	1958-1973	1974-1984
ln(K/Y)	0.020	0.0199	0.039
t-ratio	18.21*	14.25*	22.65*
$ln(W_{np}/W_p)$	0.072	0.061	0.060
t-ratio	22.37*	19.96*	12.99*
SR	0.045	0.037	0.022
t-ratio	9.21*	6.75*	4.81*
R^2	0.98	0.99	0.99

Least squares with group dummies

Table 24: ESTIMATION OF EQ 3 FOR ALL INDUSTRIES

Regressor	1958-1984	1958-1973	1974-1984
ln(K/Y)	0.0067	0.0153	0.030
t-ratio	6.30*	10.99*	18.43*
$ln(W_{np}/W_p)$	0.0836	0.061	0.078
t-ratio	27.68*	20.45*	18.14*
SR	0.048	0.035	0.0112
t-ratio	10.04*	6.19*	2.51*
Constant	0.056	0.058	0.063
t-ratio	173.10*	150.49*	140.48*
R^2	0.98	0.99	0.99

Least squares with group and time dummies

Dependent variable-Share of non-production labor for industries above the mean

$$s_{np} = \beta_{np} ln(K/Y) + \beta_{npt} SR + \beta_{npnp} ln(W_{np}/W_p) + \alpha_i + \lambda_t + \epsilon_{np_{it}} \quad (3)$$

Table 25: ESTIMATION OF EQ 3 FOR HIGH SR INDUSTRIES

Regressor	1958-1984	1958-1973	1974-1984
ln(K/Y)	-0.005	0.0203	-0.00037
t-ratio	-2.37*	9.00*	-0.138*
$ln(W_{np}/W_p)$	0.111	0.073	0.080
t-ratio	15.60*	12.90*	10.84*
SR	0.086	0.0566	0.041
t-ratio	9.12*	6.11*	5.53*
R^2	0.98	0.99	0.99

Least squares with group dummies

Table 26: ESTIMATION OF EQ 3 FOR HIGH SR INDUSTRIES

Regressor	1958-1984	1958-1973	1974-1984
ln(K/Y)	-0.007	0.020	0.001
t-ratio	-3.92*	9.01*	0.43*
$ln(W_{np}/W_p)$	0.128	0.074	0.093
t-ratio	19.23*	13.57*	13.57*
SR	0.073	0.047	0.021
t-ratio	8.17*	5.09*	3.05*
Constant	0.068	0.079	0.060
t-ratio	78.43*	98.95*	68.28*
R^2	0.98	0.99	0.99

Least squares with group and time dummies

Dependent variable-Share of non-production labor for industries below the mean

$$s_{np} = \beta_{np} ln(K/Y) + \beta_{npt} SR + \beta_{npnp} ln(W_{np}/W_p) + \alpha_i + \lambda_t + \epsilon_{np_{it}} \quad (3)$$

Table 27: ESTIMATION OF EQ 3 FOR LOW SR INDUSTRIES

Regressor	1958-1984	1958-1973	1974-1984
ln(K/Y)	0.033	0.0182	0.073
t-ratio	20.20*	10.29*	36.18*
$ln(W_{np}/W_p)$	0.043	0.0507	0.057
t-ratio	13.08*	15.21*	10.45*
SR	-0.0097	0.0119	-0.015
t-ratio	-1.29	1.75	-2.07*
R^2	0.98	0.98	0.99

Least squares with group dummies

Table 28: ESTIMATION OF EQ 3 FOR LOW SR INDUSTRIES

Regressor	1958-1984	1958-1973	1974-1984
ln(K/Y)	0.020	0.00984	0.0597
t-ratio	11.40*	5.30*	28.01*
$ln(W_{np}/W_p)$	0.0468	0.050	0.069
t-ratio	14.73*	15.22*	13.13*
SR	-0.008	0.014	-0.011
t-ratio	-1.14	2.09*	-2.03*
Constant	0.043	0.045	0.066
t-ratio	119.44*	108.39*	135.97*
R^2	0.98	0.99	0.99

Least squares with group and time dummies

Dependent variable-Share of non-production labor for those industries with a Solow residual above the median

$$s_{np} = \beta_{np} ln(K/Y) + \beta_{npt} SR + \beta_{npnp} ln(W_{np}/W_p) + \alpha_i + \lambda_t + \epsilon_{np_{it}} \quad (3)$$

Table 29: ESTIMATION OF EQ 3 FOR HIGH SR INDUSTRIES

Regressor	1958-1984	1958-1973	1974-1984
ln(K/Y)	-0.005	0.020	-0.0003
t-ratio	-2.37*	9.00*	-0.138*
$ln(W_{np}/W_p)$	0.111	0.073	0.080
t-ratio	15.60*	12.90*	10.84*
SR	0.086	0.056	0.0413
t-ratio	9.12*	6.11*	5.53*
R^2	0.98	0.99	0.99

Least squares with group dummies

Table 30: ESTIMATION OF EQ 3 FOR HIGH SR INDUSTRIES

Regressor	1958-1984	1958-1973	1974-1984
ln(K/Y)	-0.0078	0.020	0.0011
t-ratio	-3.92*	9.01*	0.43
$ln(W_{np}/W_p)$	0.128	0.074	0.093
t-ratio	19.23*	13.57*	13.57*
SR	0.068	0.079	0.060
t-ratio	8.17*	5.09*	3.05*
Constant	0.068	0.079	0.060
t-ratio	78.43*	98.95*	68.28*
R^2	0.98	0.99	0.99

Least squares with group and time dummies

Dependent variable-Share of non-production labor for those industries with a Solow residual below the median

$$s_{np} = \beta_{np} ln(K/Y) + \beta_{npt} SR + \beta_{npnp} ln(W_{np}/W_p) + \alpha_i + \lambda_t + \epsilon_{np_{it}} \quad (3)$$

Table 31: ESTIMATION OF EQ 3 FOR LOW SR INDUSTRIES

Regressor	1958-1984	1958-1973	1974-1984
ln(K/Y)	0.033	0.018	0.073
t-ratio	20.20*	10.29*	36.18*
$ln(W_{np}/W_p)$	0.043	0.050	0.057
t-ratio	13.08*	15.21*	10.45*
SR	-0.009	0.011	-0.011
t-ratio	-1.29	1.75	-2.07*
R^2	0.98	0.99	0.99

Least squares with group dummies

Table 32: ESTIMATION OF EQ 3 FOR LOW SR INDUSTRIES

Regressor	1958-1984	1958-1973	1974-1984
ln(K/Y)	0.020	0.009	0.059
t-ratio	11.40*	5.30*	28.01*
$ln(W_{np}/W_p)$	0.046	0.050	0.069
t-ratio	14.73*	15.22*	13.13*
SR	-0.008	-0.008	-0.011
t-ratio	-1.14*	2.09*	-2.03*
Constant	0.043	0.045	0.066
t-ratio	119.44*	108.39*	135.97*
R^2	0.98	0.98	0.99

Least squares with group and time dummies

Dependent variable-Share of non-production labor for those industries with a Solow residual above the mean

$$s_{np} = \beta_{np} ln(K/Y) + \beta_{npnp} ln(W_{np}/W_p) + \alpha_i + \lambda_t + \epsilon_{np_{i,t}} \quad (4)$$

Table 33: ESTIMATION OF EQ 4 FOR HIGH SR INDUSTRIES

Regressor	1958-1984	1958-1973	1974-1984
ln(K/Y)	-0.002	0.024	0.003
t-ratio	-1.18	10.99*	1.25
$ln(W_{np}/W_p)$	0.110	0.070	0.076
t-ratio	15.30*	12.36*	10.25*
R^2	0.98	0.99	0.99

Least squares with group dummies

Table 34: ESTIMATION OF EQ 4 FOR HIGH SR INDUSTRIES

Regressor	1958-1984	1958-1973	1974-1984
ln(K/Y)	-0.006	0.023	0.002
t-ratio	-3.06*	10.31*	1.17
$ln(W_{np}/W_p)$	0.128	0.073	0.091
t-ratio	19.07*	13.28*	13.38*
Constant	0.068	0.080	0.060
t-ratio	79.12*	102.56*	71.11*
R^2	0.98	0.99	0.99

Least squares with group and time dummies

Dependent variable-Share of non-production labor for those industries with a Solow residual below the mean

$$s_{np} = \beta_{np} ln(K/Y) + \beta_{npnp} ln(W_{np}/W_p) + \alpha_i + \lambda_t + \epsilon_{np_{it}} \tag{4}$$

Table 35: ESTIMATION OF EQ 4 FOR LOW SR INDUSTRIES

Regressor	1958-1984	1958-1973	1974-1984
ln(K/Y)	0.033	0.018	0.071
t-ratio	20.26*	10.98*	39.13*
$ln(W_{np}/W_p)$	0.043	0.050	0.057
t-ratio	13.12*	15.15*	10.43*
R^2	0.98	0.98	0.99

Least squares with group dummies

Table 36: ESTIMATION OF EQ 4 FOR LOW SR INDUSTRIES

Regressor	1958-1984	1958-1973	1974-1984
ln(K/Y)	0.019	0.010	0.058
t-ratio	11.38*	6.00*	29.47*
$ln(W_{np}/W_p)$	0.046	0.050	0.069
t-ratio	14.76*	15.18*	13.13*
Constant	0.043	0.046	0.066
t-ratio	120.74*	111.44*	138.97*
R^2	0.98	0.98	0.99

Least squares with group and time dummies

Dependent variable-Share of non-production labor for those industries with a Solow residual above the median

$$s_{np} = \beta_{np} ln(K/Y) + \beta_{npnp} ln(W_{np}/W_p) + \alpha_i + \lambda_t + \epsilon_{np_{it}} \quad (4)$$

Table 37: ESTIMATION OF EQ 4 FOR HIGH SR INDUSTRIES

Regressor	1958-1984	1958-1973	1974-1984
ln(K/Y)	0.004	0.024	0.005
t-ratio	2.59*	12.39*	2.42*
$ln(W_{np}/W_p)$	0.093	0.072	0.065
t-ratio	17.58*	14.47*	10.79*
R^2	0.98	0.99	0.99

Least squares with group dummies

Table 38: ESTIMATION OF EQ 4 FOR HIGH SR INDUSTRIES

Regressor	1958-1984	1958-1973	1974-1984
ln(K/Y)	-0.001	0.021	0.004
t-ratio	-0.92	10.83*	1.84
$ln(W_{np}/W_p)$	0.113	0.076	0.081
t-ratio	22.81*	15.63*	14.18*
Constant	0.062	0.074	0.055
t-ratio	104.77*	112.55*	81.85*
R^2	0.98	0.99	0.99

Least squares with group and time dummies

Dependent variable-Share of non-production labor for those industries with a Solow residual below the median

$$s_{np} = \beta_{np} ln(K/Y) + \beta_{npnp} ln(W_{np}/W_p) + \alpha_i + \lambda_t + \epsilon_{np_{it}} \quad (4)$$

Table 39: ESTIMATION OF EQ 4 FOR LOW SR INDUSTRIES

Regressor	1958-1984	1958-1973	1974-1984
ln(K/Y)	0.047	0.020	0.073
t-ratio	39.49*	10.91*	37.42*
$ln(W_{np}/W_p)$	0.047	0.041	0.064
t-ratio	14.46*	12.48*	9.94*
R^2	0.98	0.98	0.99

Least squares with group dummies

Table 40: ESTIMATION OF EQ 4 FOR LOW SR INDUSTRIES

Regressor	1958-1984	1958-1973	1974-1984
ln(K/Y)	0.031	0.021	0.057
t-ratio	23.53	6.39*	26.90*
$ln(W_{np}/W_p)$	0.051	0.041	0.076
t-ratio	16.20*	12.35*	12.36*
Constant	0.053	0.043	0.070
t-ratio	167.02*	101.25*	128.86*
R^2	0.98	0.98	0.99

Least squares with group and time dummies

Dependent variable-Share of non-production labor for all industries, high Solow residual above the mean

$$s_{np} = \beta_{np} ln(K/Y) + \beta_{npnp} ln(W_{np}/W_p) + \gamma d_\gamma [ln(K/Y)]_{hsr} + + \nu d_\nu [ln(W_{np}/W p_p)]_{hsr} + \alpha_i + \lambda_t + \epsilon_{np_{it}} \quad (6)$$

Table 41: ESTIMATION OF EQ 6 FOR ALL INDUSTRIES

Regressor	1958-1984	1958-1973	1974-1984
ln(K/Y)	0.046	0.018	0.071
t-ratio	30.64*	8.66*	35.02*
$ln(W_{np}/W_p)$	0.047	0.050	0.057
t-ratio	11.73*	11.95*	9.34*
$d_\gamma * ln(K/Y)_{hsr}$	-0.048	0.005	-0.068
t-ratio	-22.98*	1.85	-22.12*
$d_\nu * ln(W_{np}/W_p)_{hsr}$	0.062	0.019	0.019
t-ratio	9.68*	3.24*	2.15*
R^2	0.98	0.99	0.99

Least squares with group dummies

Dependent variable-Share of non-production labor for all industries. high Solow residual above the mean

$$s_{np} = \beta_{np} ln(K/Y) + \beta_{npnp} ln(W_{np}/W_p) + \gamma d_\gamma [ln(K/Y)]_{hsr} + \qquad (6)$$
$$+ \nu d_\nu [ln(W_{np}/Wp_p)]_{hsr} + \alpha_i + \lambda_t + \epsilon_{np_{it}}$$

Table 42: ESTIMATION OF EQ 6 FOR ALL INDUSTRIES

Regressor	1958-1984	1958-1973	1974-1984
ln(K/Y)	0.0234	0.007	0.054
t-ratio	15.31*	3.24*	26.46*
$ln(W_{np}/W_p)$	0.057	0.049	0.071
t-ratio	15.00*	12.05*	12.42*
$d_\gamma * ln(K/Y)_{hsr}$	-0.028	0.016	-0.050
t-ratio	-13.67*	5.77*	-16.65*
$d_\nu * ln(W_{np}/W_p)_{hsr}$	0.064	0.023	0.018
t-ratio	10.65*	3.87*	2.17*
Constant	0.057	0.058	0.063
t-ratio	176.15*	148.48*	149.61*
R^2	0.98	0.99	0.99

Least squares with group dummies and period effects.

Dependent variable-Share of non-production labor for all industries. high Solow residual above the median

$$s_{np} = \beta_{np} ln(K/Y) + \beta_{npnp} ln(W_{np}/W_p) + \gamma d_\gamma [ln(K/Y)]_{hsr} + \\ + \nu d_\nu [ln(W_{np}/W p_p)]_{hsr} + \alpha_i + \lambda_t + \epsilon_{np_{it}} \quad (6)$$

Table 43: ESTIMATION OF EQ 6 FOR ALL INDUSTRIES

Regressor	1958-1984	1958-1973	1974-1984
ln(K/Y)	0.047	0.0178	0.073
t-ratio	28.11*	7.24*	34.85*
$ln(W_{np}/W_p)$	0.048	0.045	0.064
t-ratio	10.29*	10.08*	9.26*
$d_\gamma * ln(K/Y)_{hsr}$	-0.043	0.062	-0.067
t-ratio	-19.81*	2.10*	-21.86*
$d_\nu * ln(W_{np}/W_p)_{hsr}$	0.045	0.027	0.011
t-ratio	7.10*	4.43*	0.13*
R^2	0.98	0.99	0.99

Least squares with group dummies.

Dependent variable-Share of non-production labor for all industries, high Solow residual above the median

$$s_{np} = \beta_{np} ln(K/Y) + \beta_{npnp} ln(W_{np}/W_p) + \gamma d_\gamma [ln(K/Y)]_{hsr} + \\ + \nu d_\nu [ln(W_{np}/W p_p)]_{hsr} + \alpha_i + \lambda_t + \epsilon_{np_{it}} \quad (6)$$

Table 44: ESTIMATION OF EQ 6 FOR ALL INDSUTRIES

Regressor	1958-1984	1958-1973	1974-1984
ln(K/Y)	0.022	0.005	0.055
t-ratio	13.19*	2.14*	26.51*
$ln(W_{np}/W_p)$	0.053	0.043	0.078
t-ratio	12.23*	9.96*	11.90*
$d_\gamma * ln(K/Y)_{hsr}$	-0.022	0.016	-0.050
t-ratio	-10.72*	5.75*	-16.70*
$d_\nu * ln(W_{np}/W_p)_{hsr}$	0.055	0.031	0.002
t-ratio	9.33*	5.24*	0.33
Constant	0.057	0.058	0.063
t-ratio	147.87*	149.78*	146.68*
R^2	0.98	0.99	0.99

Least squares with group dummies and period effects

Dependent variable-Share of non-production labor for all industries, high Solow residual above the mean

$$s_{np} = \beta_{np} ln(K/Y) + \beta_{npnp} ln(W_{np}/W_p) + \beta_{npt} SR + \phi d_\phi [SR]_{hsr} + + \gamma d_\gamma [ln(K/Y)]_{hsr} + \nu d_\nu [ln(W_{np}/W_p)]_{hsr} + \alpha_i + \lambda_t + \epsilon_{np_{it}} \quad (7)$$

Table 45: ESTIMATION OF EQ 7 FOR ALL INDUSTRIES

Regressor	1958-1984	1958-1973	1974-1984
ln(K/Y)	0.046	0.018	0.073
t-ratio	30.46*	8.15*	32.53*
$ln(W_{np}/W_p)$	0.047	0.050	0.057
t-ratio	11.81*	12.05*	9.40*
$d_\gamma * ln(K/Y)_{hsr}$	-0.051	0.002	-0.074
t-ratio	-42.13*	0.73	-22.54*
$d_\nu * ln(W_{np}/W_p)_{hsr}$	0.063	0.022	0.023
t-ratio	9.90*	3.66*	2.60*
SR	-0.004	0.011	-0.011
t-ratio	-0.69	1.38	-1.86
$d_\phi * SR_{hsr}$	0.091	0.044	0.052
t-ratio	9.43*	3.95*	5.90*
R^2	0.98	0.99	0.99

Least squares with group dummies.

Dependent variable-Share of non-production labor for all industries. high Solow residual above the mean

$$s_{np} = \beta_{np} ln(K/Y) + \beta_{npnp} ln(W_{np}/W_p) + \beta_{npt} SR + \phi d_\phi [SR]_{hsr} + \qquad (7)$$
$$+ \gamma d_\gamma [ln(K/Y)]_{hsr} + \nu d_\nu [ln(W_{np}/W_p)]_{hsr} + \alpha_i + \lambda_t + \epsilon_{np_{it}}$$

Table 46: ESTIMATION OF EQ 7 FOR ALL INDUSTRIES

Regressor	1958-1984	1958-1973	1974-1984
ln(K/Y)	0.0233	0.0063	0.056
t-ratio	15.02*	2.78*	25.19*
$ln(W_{np}/W_p)$	0.057	0.049	0.071
t-ratio	15.01*	12.07*	12.41*
$d_\gamma * ln(K/Y)_{hsr}$	-0.010	0.017	-0.011
t-ratio	-1.53	2.03*	-1.91
$d_\nu * ln(W_{np}/W_p)_{hsr}$	0.063	0.022	0.023
t-ratio	-14.45*	4.88*	-17.02*
SR	-0.065	0.025	0.020
t-ratio	10.86*	4.21*	-2.46*
$d_\phi * SR_{hsr}$	0.065	0.030	0.037
t-ratio	7.19*	2.79*	4.35*
Constant	0.057	0.058	0.063
t-ratio	175.04*	144.17*	145.73*
R^2	0.98	0.99	0.99

Least squares with group dummies and period effects.

Dependent variable-Share of non-production labor for all industries, high Solow residual above the median

$$s_{np} = \beta_{np} ln(K/Y) + \beta_{npnp} ln(W_{np}/W_p) + \beta_{npt} SR + \phi d_\phi [SR]_{hsr} + \\ + \gamma d_\gamma [ln(K/Y)]_{hsr} + \nu d_\nu [ln(W_{np}/W_p)]_{hsr} + \alpha_i + \lambda_t + \epsilon_{np_{it}} \quad (7)$$

Table 47: ESTIMATION OF EQ 7 FOR ALL INDUSTRIES

Regressor	1958-1984	1958-1973	1974-1984
ln(K/Y)	0.047	0.017	0.075
t-ratio	28.01*	6.97*	32.44*
$ln(W_{np}/W_p)$	0.048	0.045	0.064
t-ratio	10.36*	10.07*	9.35*
$d_\gamma * ln(K/Y)_{hsr}$	-0.064	0.0060	-0.014
t-ratio	-0.79*	0.61	-2.27*
$d_\nu * ln(W_{np}/W_p)_{hsr}$	-0.046	0.0029	0.0042
t-ratio	-20.42*	0.98	-22.36*
SR	0.0462	0.0293	-22.36
t-ratio	7.28*	4.77*	0.47
$d_\phi * SR_{hsr}$	0.080	0.046	0.054
t-ratio	7.92*	3.92*	6.07*
R^2	0.98	0.99	0.99

Least squares with group dummies.

Dependent variable-Share of non-production labor for all industries. high Solow residual above the median

$$s_{np} = \beta_{np} ln(K/Y) + \beta_{npnp} ln(W_{np}/W_p) + \beta_{npt} SR + \phi d_\phi [SR]_{hsr} + \\ + \gamma d_\gamma [ln(K/Y)]_{hsr} + \nu d_\nu [ln(W_{np}/W_p)]_{hsr} + \alpha_i + \lambda_t + \epsilon_{np_{it}} \quad (7)$$

Table 48: ESTIMATION OF EQ 7 FOR ALL INDUSTRIES

Regressor	1958-1984	1958-1973	1974-1984
ln(K/Y)	0.022	0.0047	0.058
t-ratio	12.87*	1.88	25.21*
$ln(W_{np}/W_p)$	0.053	0.043	0.078
t-ratio	12.19*	9.96*	11.92*
$d_\gamma * ln(K/Y)_{hsr}$	0.012	0.012	-0.013
t-ratio	1.58	1.31	-2.16*
$d_\nu * ln(W_{np}/W_p)_{hsr}$	-0.024	0.014	0.054
t-ratio	-11.41*	4.86*	-17.07*
SR	9.54	5.52	0.53
t-ratio	5.63*	2.84*	-4.37*
$d_\phi * SR_{hsr}$	0.053	0.033	0.0372
t-ratio	5.63*	2.84*	4.37*
Constant	0.057	0.058	0.062
t-ratio	173.58*	145.44*	143.04*
R^2	0.98	0.99	0.99

Least squares with group dummies and period effects.

Appendix C: Summary Statistics

Table C.1: SUMMARY STATISTICS OF THE SOLOW RESIDUAL

Period	Sample	# ind.	# obs.	mean	median	stan.dev.	kurtosis	skewness
1958-1984	whole sample	449	11674	0.021	0.009	0.013	19.02	0.78
1958-1973	whole sample	449	7184	0.026	0.022	0.011	11.59	0.76
1974-1984	whole sample	449	4490	0.001	0.001	0.016	22.57	1.11
							Maximum	Minimum
1958-1984	high SR above mean	146	3796	0.057	0.046	0.017	0.161	-0.108
1958-1973	high SR above mean	169	2704	0.005	0.0052	0.013	0.127	-0.016
1974-1984	high SR above mean	166	1660	0.006	0.0041	0.019	0.172	-0.107
1958-1984	low SR below mean	303	7878	0.0004	0.00009	0.0107	0.153	-0.143
1958-1973	low SR below mean	280	4480	0.0005	0.0009	0.0087	0.057	-0.091
1974-1984	low SR below mean	283	2830	-0.001	-0.00018	0.0144	0.153	-0.166
1958-1984	high SR above median	225	5850	0.0043	0.0036	0.0154	0.161	-0.107
1958-1973	high SR above median	225	3600	0.0050	0.0044	0.013	0.127	-0.061
1974-1984	high SR above median	225	2250	0.0048	0.0034	0.017	0.172	-0.108
1958-1984	low SR below median	224	5824	0.0000	0.00078	0.0108	0.111	-0.145
1958-1973	low SR below median	224	3584	0.0001	0.00078	0.008	0.042	-0.091
1974-1984	low SR below median	224	2240	-0.002	-0.00068	0.0155	0.153	-0.166

[a] # ind. stands for number of industries and # obs. stands for number of observations. This is constructed by multipying the number of industries by the number of observations by industry.

Appendix D: Elasticities of substitution

D.1: Derivation of the elasticities of substitution

Let us assume we have a regression of the form:

$$\Delta s_{np} = \Delta\beta_{npnp} ln(W_{np}/W_p) + \gamma \Delta ln Z + \epsilon \tag{11}$$

where s_{np} stands for the share of non production workers divided by total wage bill and Z is a set of exogenous variables. As before, $ln(W_{np}/W_p)$ represents the relative wages of non production to production workers. The elasticity of substitution between production and non production workers ϕ can be expressed as:

$$N_{np}/N_p = (W_{np}/W_p)^{\phi} A(Z) \tag{12}$$

Where N_{np}/N_p is the ratio of non production to production workers labour. Thus, for other things equal (for any fixed Z) we will have:

$$\frac{dln(N_{np}/N_p)}{dln(W_{np}/W_p)} = \phi \tag{13}$$

Multiplying equation 11 by $1/N_{np}W_{np}$ and substitutiting equation 12 into the new 11 yields:

$$\Delta \frac{(W_{np}/W_p)^{1-\phi} A(Z)}{(W_{np}/W_p)^{1-\phi} A(Z) + 1} = \beta_{npnp} \Delta ln(W_{np}/W_p) + \gamma \Delta Z + \phi \tag{14}$$

Considering A(Z) a constant ($\Delta A(Z) = 0$) and dividing the equation by $\Delta ln(W_{np}/W_p)$, in the limit we will have:

$$\frac{d}{d(W_{np}/W_p)} \left[\frac{(W_{np}/W_p)^{1-\phi} A(Z)}{(W_{np}/W_p)^{1-\phi} A(Z) + 1} \right] = \beta_{npnp} \frac{d}{d(W_{np}/W_p)} [dln(W_{np}/W_p)] \tag{15}$$

Taking derivatives and using equation 12:

$$(1 - \phi) = \frac{\frac{NnpW_{np}}{N_pW_p}}{(\frac{NnpW_{np}}{N_pW_p} + 1)^2} = \beta_{npnp} \tag{16}$$

The computed value of ϕ will therefore depend on the estimated value of β_{npnp}. This is:

$$\varphi = 1 - \beta_{npnp} \left[\frac{N_{np} W_{np}}{N_p W_p} + 1 \right]^2 \frac{N_p W_p}{N_{np} W_{np}} \qquad (17)$$

In the next section we present the computed values of the elasticites specifying the sample used, the periods covered and from which equation we took the estimated value of β_{npnp}.

D.2: Elasticities of substitution

Table 49: ELASTICITIES OF SUBSTITUTION FOR EQ. (3)

Group dummies estimator					
Period	all ind.	high SR > mean	low SR < mean	high SR > med	low SR < med
1958-1984	0.690	0.541	0.801	0.537	0.798
1958-1973	0.730	0.680	0.767	0.682	0.761
1974-1984	0.746	0.667	0.754	0.664	0.756
Group and time dummies estimator					
Period	all ind.	high SR > mean	low SR < mean	high SR > med	low SR < med
1958-1984	0.643	0.471	0.787	0.466	0.784
1958-1973	0.730	0.778	0.767	0.678	0.761
1974-1984	0.670	0.613	0.703	0.609	0.756

Table 50: ELASTICITIES OF SUBSTITUTION FOR EQ. (4)

Group dummies estimator				
Period	high SR > mean	low SR < mean	high SR > median	low SR < median
1958-1984	0.545	0.801	0.612	0.779
1958-1973	0.695	0.767	0.686	0.804
1974-1984	0.684	0.754	0.727	0.726
Group and time dummies estimator				
Period	high SR > mean	low SR < mean	high SR > median	low SR < median
1958-1984	0.471	0.787	0.529	0.761
1958-1973	0.682	0.767	0.686	0.804
1974-1984	0.621	0.703	0.660	0.675

References

[1] P. Aghion and Howitt P. A model of growth through creative destruction. *Econometrica*, 60(2):323 – 351, 1996.

[2] Alberto Alesina and D. Rodrick. Distributive politics and economic growth. Working Paper 3668, NBER, 1991.

[3] Alberto Alesina and D. Rodrick. Distributive politics and economic growth. *Quarterly Journal of Economics*, 109:465 – 490, 1994.

[4] S. G. Allen. Technology and the wage structure. Working Paper 5534, NBER, 1996.

[5] Keneth J. Arrow. The economic implication of learning by doing. *Review of Economic Studies*, 29:155 – 173, 1962.

[6] Costas Azaridis. *Intertemporal Macroeconomics*. Oxford: Blackwell, 1993.

[7] R. J. Barro and Xavier Sala-i Martin. *Economic Growth*. New York McGraw Hill, 1995.

[8] Robert Barro. Economic growth in a cross-section of countries. *Quarterly Journal of Economics*, 106(2):407 – 443, 1991.

[9] Robert J. Barro and Jong-Wha Lee. International comparison of educational attainment. Working Papers in Economics 4349, NBER, 1993.

[10] A. Bartel and F. Lichtenberg. The comparative advantage of educated workers in implementing new technology. *Review of Economic Studies*, pages 1 – 11, 1987.

[11] R. Beńabouu. Inequality and growth. Working Paper 5658, NBER, 1996.

[12] J. Berman, E. Bound and Z. Griliches. Changes in the demand for skilled labour within us manufacturing industries: evidence from the annual survey of manufactures. *Quarterly Journal of Economics*, 109:367 – 397, 1994.

[13] J. Berman, E. Bound and S. Machin. Implications of skill biased technological change: International evidence. Paper presented at the EUI, 1994.

[14] G. Bertola. Flexibility, investment and gorwth. Discussion Paper 422, CEPR, 1990.

[15] G. Bertola. Wages, profits and theories of growth. Nota di lavoro 48.93, Fundazione Enrico Mattei, 1993.

[16] G. Bertola and A. Ichino. Wage inequality and unemployment: Us versus europe. Discussion Papers series 1186, CEPR, 1995.

[17] D. Blackburn, M. Bloom and R. Freeman. The declining economic position of less-skilled american males. Working Paper 3186, NBER, 1989.

[18] O. Blanchard and S. Fischer. *Lectures on Macroeconomics*. The MIT Press, 1989.

[19] A. C. Chiang. *Elements of Dynamic Optimization*. New York McGraw Hill, 1992.

[20] Wan J. Chung. *Utility and Production functions. Theory and Applications*. Blackwell, 1995.

[21] J. M. Constantine and D. Newmark. Training and growth of wage inequality. Working Paper 4729, NBER, 1994.

[22] C. L. Evans. Productivity shocks and real business cycles. *Journal of Monetary Economics*, 29:191 – 208, 1992.

[23] R. B. Freeman. The decline in the economic rewards to college education. *Review of Economics and Statistics*, 59:18 – 29, 1977.

[24] S. García-Cerveró. Skill differentials in the short and in the long run: a 4-digit sic level us manufacturing study. Working Papers in Economics 96/37, European University Institute, 1996.

[25] C. García-Peñalosa. Absolute povery and relative inequality: A theory of growth and wage differentials. Discussion Paper 97, Nuffield College, Oxford, UK, 1995.

[26] W. Gray. Productive database. Manuscript, Clark University, 1989.

[27] Z. Griliches. *Technology, innovation and productivity*. Basil Blackwell, 1988.

[28] G. M. Grossman and E. Helpman. *Innovation and Growth in the global economy*. Cambridge, Mass., MIT Press, 1991.

[29] G. M. Grossman and E. Helpman. Quality ladders in the theory of growth. *Review of Economic Studies*, 58(1):43 – 61, 1991.

[30] R. E. Hall. The relationship between price and marginal cost. *Journal of Political Economy*, 96:921 – 945, 1988.

[31] D. S. Hamermesh. Labour demand and the structure of adjustement costs. *American Economic Review*, 79(4):674 – 689, 1989.

[32] Miguel Jimenez. The solow residual, the dual solow residual and the sources of business cycles. Ph.D, 1996.

[33] Miguel Jimenez and Domenico Marcheti. Thick-market externalities in us manufacturing: a dymanic study with panel data. Working Papers in Economics 95/14, European University Institute, 1995.

[34] R. Lukepohl H. Judge, G. Griffiths and L. Tsoung-Chao. *The theory and practise of econometrics.* John Wiley and sons, 1985.

[35] N. Kaldor. Alternative theories of income distribution. *Review of Economic Studies*, 48/5:83 – 100, 1956.

[36] L. F. Katz and K. M. Murphy. Changes in relative wages, 1963-1987: supply and demand factors. Working Papers in Economics 3927, NBER, 1991.

[37] Ida Kearney. Sectoral shifs in the demand for skilled and unskilled labour in irish manufacturing sector 1979-1990: A panel data study. EUI, Mimeo, 1996.

[38] S. Kuznets. Economic growth and income inequality. *American Economic Review*, 45:1 – 28, 1955.

[39] F. Levy and R. Murname. Us earning levels and earning inequality: a review of recent trends and proposed explanations. *Journal of Economic Literature*, 30:1333 – 1381, 1992.

[40] Robert E. Lucas. On the mechanics of economic development. *Journal of Monetary Economics*, 22:3 – 41, 1988.

[41] S. Machin. Changes in the relative demand for skills in the uk labour market. Discussion Paper 952, CEPR, 1994.

[42] D. Mankiew, N. Romer and D. Weil. A contribution to the empirics of economic growth. *Quarterly Journal of Economics*, 107(2):407 – 437, 1992.

[43] J. Mincer. Human capital responses to technological change in the labour market. Working Papers in Economics 3207, NBER, 1989.

[44] J. Mincer. Human capital, technology and the wage structure: what do time series show ? Working Papers in Economics 3581, NBER, 1991.

[45] William D. Nordhaus. The economic theory of technological change. *American Economic Review*, 2:18 – 28, 1969.

[46] Federal Reserve Bank of New York. Economic policy review. Working Papers in Economics 94/40, Federal Reserve Bank of New York, 1994.

[47] Kevin H. O'Rourke and G. Williamson. Jeffrey. Around the euroepan periphery 1870-1913: Globalization, schooling and growth. Discussion Paper 1343, CEPR, 1996.

[48] T. Persson and Guido Tabellini. Is inequality harmful for growth ? Discussion Paper 581, CEPR, 1991.

[49] Danny T. Quah. Empirics for economic growth and convergence. Discussion Papers 1140, CEPR, 1995.

[50] Gunter Rehme. Essays on distributive policies and economic growth. Ph.D. EUI. 1997.

[51] David Romer. *Advanced Macroeconomics*. New York McGraw Hill. 1996.

[52] Paul Romer. Increasing returns and long run growth. *Journal of Political Economy*. 94:1002 – 1037, 1986.

[53] Paul Romer. Endogenous tehcnological change. *Journal of Political Economy*. 98:S71 – S103, 1990.

[54] Robert Solow. A contribution to the theory of economic growth. *Quarterly Journal of Economics*, 70/1:65 – 94, 1956.

[55] Robert M. Solow. Tehnical change and the aggregate production function. *Review of Economics and Statistics*, 39(3):312 – 320, 1957.

[56] Nancy Stokey. Learning by doing and the introduction of new goods. *Journal of Political Economy*, 4:701 – 717, 1996.

[57] Robert J. Waldmann. Inequality, economic growth and the debt crisis. Working Papers in Economics 94/40, European University Institute, 1994.

[58] Alwyn Young. Substitution and complementarity in endogenous innovation. *Quarterly Journal of Economics*, 108(3):775 – 807, 1993.

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