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TECHNOLOGICAL BIAS AND REVENUE SHARES: THE ITALIAN EVIDENCE

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Technological bias and revenue shares: the Italian evidence

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Abstract
During last thirty years Italian economy has been characterised by a progressive increase in capital shares. Many economic phenomena can lead to such a result: composition effects, lags in production factors adjustment, market power with an increase in firms' mark up, lowering of unions' bargaining power, technological bias. In this work we try to find out empirical support for any of these explanations. The analysis refers to Italian industry and it is based upon a panel of 12 industrial branches, covering the period 1980-1996. We conclude that a change in the fundamental parameters of the production function cannot be easily rejected as one of the main explanations for the observed increase in capital shares.

JEL CODES: D24, E24, E25

1. INTRODUCTION[♣]

During last thirty years Italian economy has been characterised by a progressive increase in capital share. The expected regularity that shares are driven by forces that, in the medium run, force them towards their constant equilibrium levels does not seem to find much empirical support. Furthermore, this specificity is common to the main European continental economies, while it does not interest the Anglo-Saxon ones.

Blanchard's paper (1997) is an important starting point in the explanation of this evidence. He tries to discriminate among different explanations for the observed increase in capital share. This is done developing international comparisons and jointly modelling capital shares movements with labour market performances: European countries who show increasing capital shares very often observe high unemployment rates, and vice-versa for Anglo-Saxon economies. Bentolilla and Saint-Paul (1999), Blanchard and Giavazzi (2001), Balducci and Staffolani (this book) have addressed the theme also.

In this paper we focus on the Italian case, taking into account sectoral features that very often are neglected in cross-countries analysis. In particular, the analysis refers to Italian industry and it is based upon a panel of industrial branches. In this way we are able to deal with the problem that some results could be related to shifts in sectoral production distribution.

In general the Italian case seems particularly relevant to shed light on this issue because it shows the most spectacular increase in capital share among European countries. Furthermore this increase continued also in the last decade, when a mechanism of incomes policy was in place.

The expectation of constant shares in the medium-long run hinges on two possible sets of theoretical assumptions. The first one is the textbook neoclassical model of economic growth. As it is well known, in this model the steady state equilibrium is characterised by constant factors' shares. This is true independently from every assumption about the aggregate production function. Of course the constancy is expected in the long run. Thus we have to concede that thirty years could not be enough to observe the predicted return to equilibrium.

As a second possibility, one can simply make the hypothesis of an aggregate production function with elasticity of substitution equal to one, at least for new units of capital and labour. In the medium run, where factors use is completely flexible, firms have the possibility to adopt an optimal combination of labour and capital. If the elasticity of relative quantities with respect to relative prices is equal to one, then we should observe constant shares even in the medium run.

Note that this second possibility easily allows modelling non-perfect competitive firms, which charge a mark-up, eventually variable, on their marginal cost. If empirically we can verify that the elasticity of substitution is not too far from one, the observed shift in factors' shares could find an immediate explanation in mark-up movements.

This is the immediate explanation but not the only one. Also a technological bias against labour in the production function could explain the evidence. It follows that an

[♣] This paper is a revised version of the work prepared for "Rapporto Irs per il Cnel sul Costo del Lavoro – 2000". This version has been presented at the 2001 Eale Conference.

important point is in discriminating whether the increase in capital share can be related to a rising mark-up or to changes in fundamental parameters of the production function.

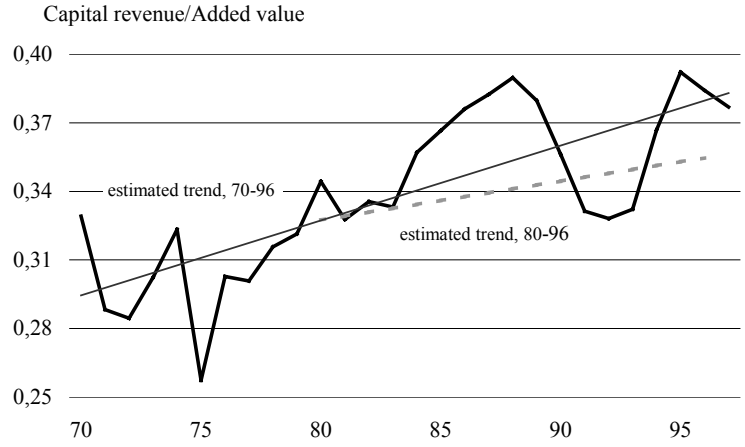
Our focus is on the medium-run. Even if there are some important similarities among analytic tools used to describe medium and long run, we are not interested in investigating the determinants of dynamic steady state. Instead we want to evaluate different possible interpretation for the fact under analysis: composition effects, lags in factors adjustment, shift in the distribution of rents, technological bias. Thus we take a formal econometric approach in the spirit of data description. Tests will be carried on to judge which interpretation is the most convincing. Finding the primitive causes for an eventual mark-up increase or for a technological bias is beyond the scope of this paper.

The paper is organised as follows. Section 2 is devoted to describe the fact of interest across main industrialised countries and across Italian industrial branches. In Section 3 a total productivity measure, based upon Solow residual, is provided. In Section 4 we present a short digression about the relationship between total productivity and labour productivity. Section 5 shows and comments the graphical evidence on the dynamic of the ratios of factors' quantities and prices. In Section 6 we estimate the elasticity of substitution on a panel data set of 12 industrial branches, that covers the period 1980-1996. In Section 7 we present the results for the test proposed by Blanchard to discriminate between the case of technological bias and the case of increase in mark-up. Conclusions in Section 8 end the paper.

2. THE FACT

Since the second half of 70s Italian industry has been characterised by a progressive increase in capital share. The phenomenon is described in figure 1, covering about three decades.

Fig. 1 - Capital share in Italian industry



Source: Authors' elaborations on National Accounts data (share corrected for self-employed).

From an average of .30 in the 70s, capital share has been arising to an average of .36 over the 90s. A positive medium-run trend tends to dominate short run cyclical behaviour. If one fits a linear trend, since 1970 capital share has been increasing of almost 10 percentage points. From the 80s, even if lower in magnitude, the phenomenon is still present.

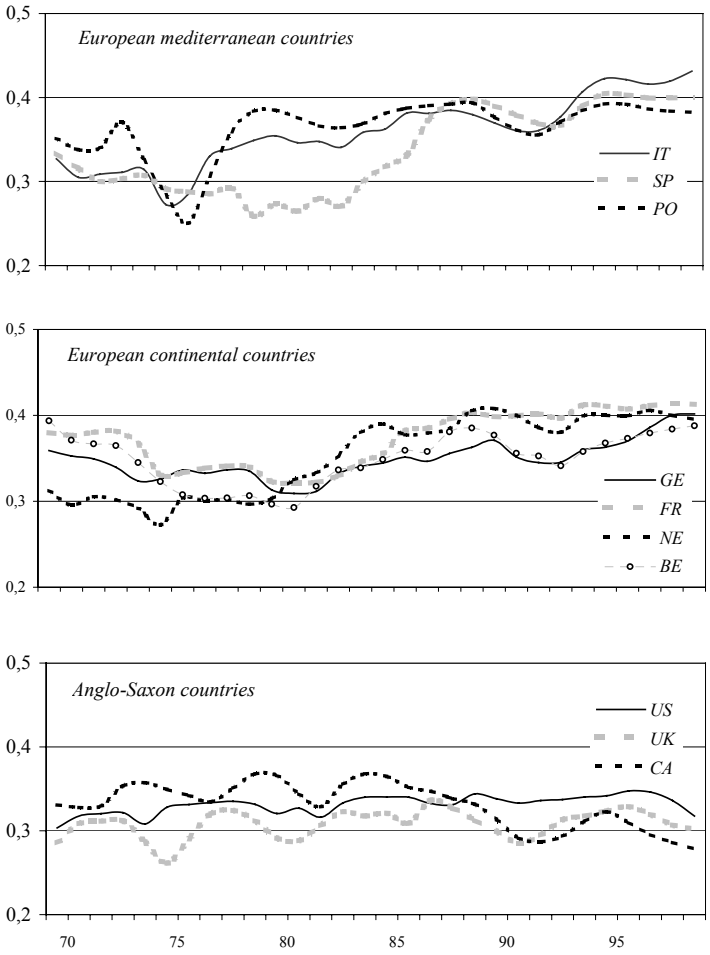
This result is in contrast with the expected regularity that shares are driven by forces that in the medium run, 30 years in our case, force them to return on their constant equilibrium levels.

Figure 2 is devoted to compare national shares' behaviour, grouping countries in Continental Europe, Mediterranean Europe and Anglo-Saxon ones.[1]

The first group, including Italy, Spain and Portugal, shows a capital share that, at the end of the period, is higher than the 1970 level. Continental countries regain during 80s and 90s levels previously reached.[2] Anglo-Saxon countries do not reveal any trend.

Fig. 2 - Capital share by group of countries

Capital revenue/Added value in business sector

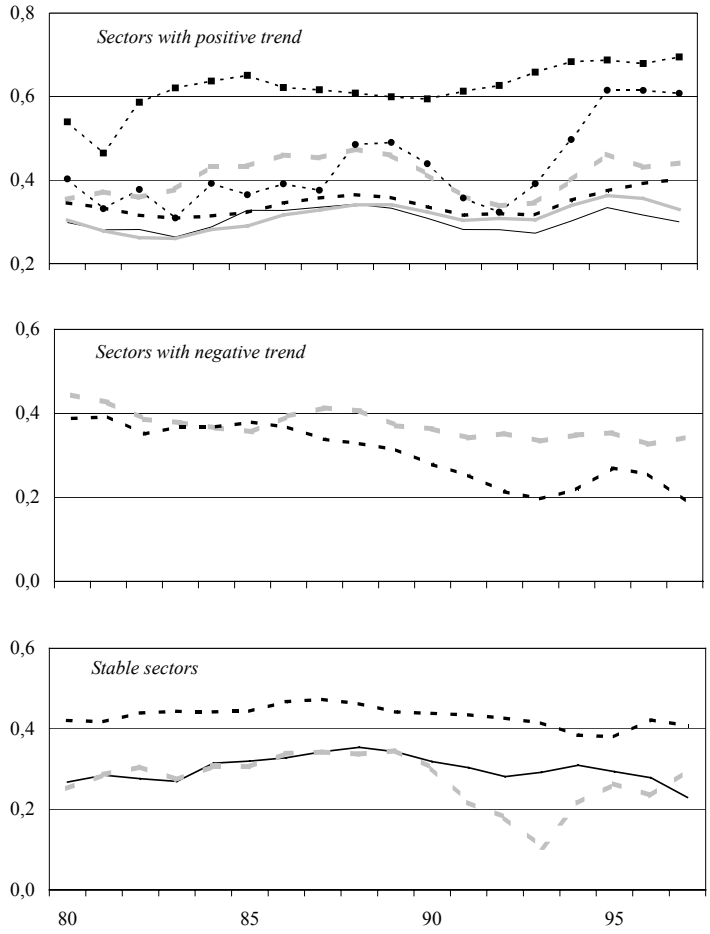


Source: OECD (Shares corrected for self-employed).

A first trivial explanation of what observed could be a change in sector distribution of industrial activity. In the following, to control for such a possibility, econometric analysis will be based on a panel of sector data. National Accounts Statistics allow us to construct a balanced panel of 12 branches that covers the period 1980-1996.[3] Nonetheless, a preliminary graphical overview seems of interest.

Fig. 3 - Sector capital share in Italian industry

Capital revenue/Added value in 12 branches



Source: National Accounts data (Shares corrected for self-employed).

Figure 3 shows that the evolution in capital share across industrial sectors. Capital intensive sectors, such as "energy" and "ferrous and non-ferrous minerals and metals" show an almost constant growth in capital share, which attains respectively an average level of .70 and .61 in 90s. Even labour intensive branches register the phenomenon.

[1] Note that figure 1 refers to industry, while figure 2, for cross-country comparisons, refers to the business sector.

[2] The Netherlands, by the contrary, is similar to Mediterranean countries.

[3] See Appendix for data description.

See for instance the case of "textile and clothing, leather and shoes" as well as a miscellaneous of "wood, furniture, paper, rubber and other industrial products".

Only two sectors show an opposite trend: "non metal minerals and mineral products" and "office machinery, precision instruments, optical and similar". In the second one the reduction in capital share is particularly intense: from .36 during the 80s to .23 in 90s.

Finally, some sectors reveal a positive evolution during the 80s, without any further correction in the average 90s. For simplicity we define these sectors as "stable" and they cover "electrical material and machinery", "transport vehicles" and "food, beverages and tobacco".

The increase in capital share characterises more than half branches of Italian industry. Nonetheless this increase shows a great variability across. This is an aspect to keep in mind in evaluating different explanations. This variability requires an explanation where sectoral specificity can play an important role in the story.

3. TOTAL PRODUCTIVITY AND SOLOW RESIDUAL

This paragraph is devoted to calculate Solow residual because in the following we need a measure of technological progress. Beyond this, total productivity is a useful tool to shed light on further features of Italian industry.[4]

Solow's paper (1957), although followed by a rich debate, remains the basic methodology to measure the increase in total productivity of an economic system. Despite some restrictive hypothesis, Solow residual is still the accepted measure for shifts in production function due to technological progress.

We briefly recall the procedure. Consider an aggregate production function with capital k and labour n as production factors. Assume for the moment that technological progress is Hicks neutral: production function shifts leave unchanged the marginal rate of substitution among factors. Formally one has:

$$y = z_t f\left(k, n\right) \qquad [1]$$

where z_t measures the total cumulative effect of technological shifts during time. Take the total differential with respect to time of *[1]* and assume that factors are paid their marginal productivity. The result is an expression for output growth rate as a combination of technological progress and production factors growth rate:

$$\frac{\Delta y}{y} = a_t \frac{\Delta n}{n} + \left(1 - a_t\right)\frac{\Delta k}{k} + \frac{\Delta z}{z} \qquad [2]$$

with a_t is the labour share in output.

Equation *[2]* is well known as the "fundamental equation of growth accounting". It shows how to insulate shifts of the aggregate production functions. To do so one needs period-to-period changes in few time series such as output, labour and capital as

[4] If the reader is not interested in, this part can be dropped out without losing the line of reasoning.

well as labour and capital shares. Integrating $\Delta z/z$ with respect to time gives the technological evolution. Factor shares in *[2]* change during time. It allows taking into account that growth rate of productivity exhibits more or less random fluctuations about a fixed mean.

Of course behind expression *[2]* there are two crucial hypotheses: i) perfect competition in factors and output markets, from which labour and capital are paid at their marginal productivity, ii) constant returns to scale, from which factor shares sum up to one. These hypotheses allow considering the National Accounts labour share a_t as an unbiased estimator for α_t, the true labour elasticity of the aggregate production function.

In general it is useful to show how *[2]* changes in case of Harrod neutral technological progress, i.e. a progress of labour augmenting type.[5] One gets:

$$\frac{\Delta y}{y} = a_t \frac{\Delta n}{n} + (1 - a_t) \frac{\Delta k}{k} + a_t \frac{\Delta z}{z} \qquad [3]$$

In such a case calculation for the technological progress is simply obtained dividing Solow residual by the labour share. Of course one obtains faster technological progress with respect to Hicks case.

Table 1 - Sectoral summary statistics
Average for the period: 1981-1996

	Annual growth rate			Labour share	Solow residual	
Branches	*Output*	*Labour*	*Capital*		*Hicks*	*Harrod*
Energy	1,0	-0,7	3,0	37,8	-0,6	-1,3
Ferrous and non ferrous mineral and metals	1,5	-3,8	-1,2	57,8	4,4	8,2
Non metal minerals and mineral products	1,3	-1,2	1,2	63,0	1,6	2,6
Chemicals and pharmaceuticals	4,9	-1,4	-0,4	58,9	5,9	10,1
Metal products (no machinery and trasport)	1,8	-1,9	0,9	66,1	2,8	4,2
Industrial and agricolture machinery	0,8	-1,2	1,5	67,5	1,2	1,8
Office machinery, optical and precision instruments	5,0	-1,5	2,6	69,4	5,1	7,7
Electrical pruoducts and machinery	4,1	-1,8	3,0	69,3	4,5	6,5
Transport vehicles	1,0	-2,8	3,4	72,8	2,2	3,5
Food, beverages and tobacco	2,5	-1,4	2,7	56,7	2,2	3,8
Textile, clothing, leather and shoes	1,4	-1,4	0,8	69,5	2,2	3,2
Furniture, paper, rubber and miscellaneous	1,7	-1,6	1,1	68,8	2,5	3,6
Total, industry	**1,8**	**-1,7**	**1,7**	**64,1**	**2,3**	**3,7**

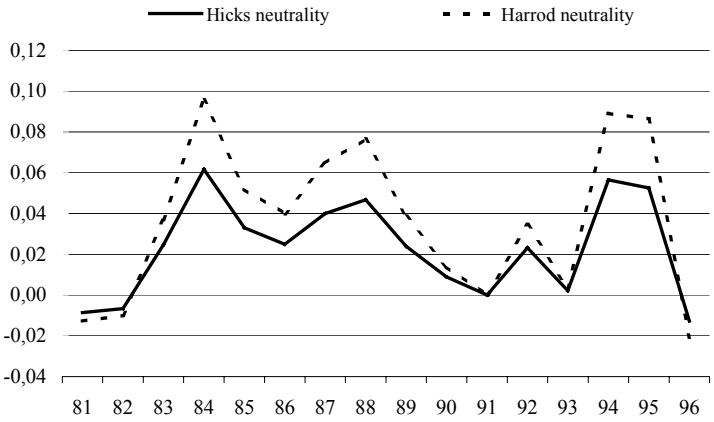
Source: Authors' elaborations on National Accounts Statistics (Sec '79).

[5]This kind of progress leaves the ratio *y/k* unchanged, at a given capital marginal productivity. Typically the production function takes the form *y=f(k,zn)*.

Table 1 reports first of all the average values during the period 1980-1996 for the variables necessary to calculate Solow residual for 12 different branches of the Italian industry. We use added value at constant prices as a proxy for output.[6] Total employment in standardised full time units is our measure for labour input. Net capital stock proxies for capital services. As usual, labour share is corrected for including self-employed. Table 1 reports also Solow residual according Hicks and Harrod versions.

Fig. 4 - Total productivity growth in Italian industry

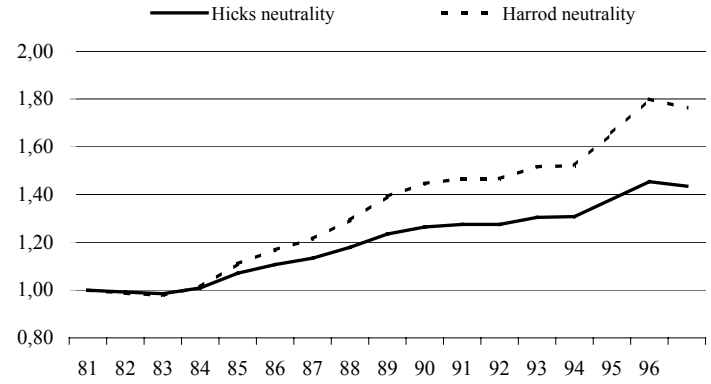
Percentage rates of change



Source: Authors' elaborations on National Accounts data

Fig. 5 - Total productivity level in Italian industry

Index, 1980 = 1



Source: Authors' elaborations on National Accounts data

Figure 4 shows the aggregate Solow residual obtained from *[2]* and Figure 5 its integration over time. Both Hicks neutrality and Harrod neutrality definitions are provided. Figure 4 permits us further considerations. It seems that Solow residual follows a time pattern that resembles a cyclical behaviour. Hall (1988,1990) offers a

[6]Hall (1988, 1990) formally shows that, under hypotheses of perfect markets and constant returns to scale, Solow residual based upon real added value (with shares from nominal added value as elasticity measures) are equivalent to that based on output.

possible explanation for such cyclical movements introducing firm market power and/or increasing returns. It can be useful to summarise briefly Hall's argument.

Imagine a simple case of monopolistic competition. The mark-up, defined as $\mu=p/x$, where p is the price and x is the marginal cost, is usually higher than one. By consequence it can appear a difference between shares calculated starting from a time series based upon prices p and exact elasticity that requires to consider marginal costs x. National Accounts labour share is equivalent to: $a_t = wn/py$, where w is the wage. By straightforward substitutions its relationship with the true elasticity α_t is:

$$\alpha_t \equiv \frac{wn}{xy} = \mu \frac{wn}{py} \equiv \mu a_t \qquad [4]$$

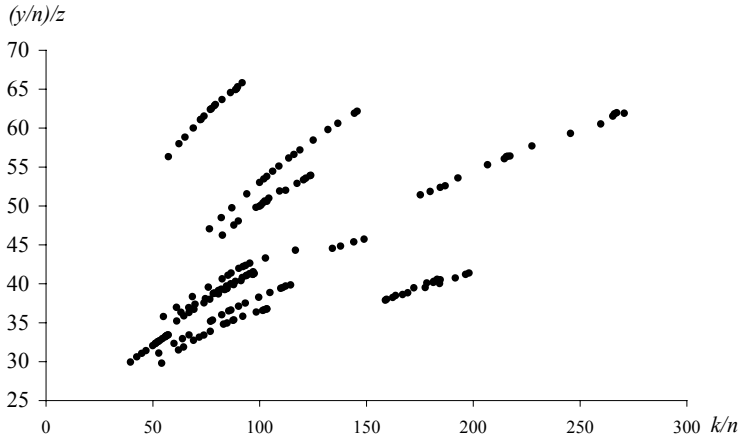
Since μ is usually higher than one it follows an under estimation of the true elasticity, with a consequent pro-cyclical behaviour of Solow residual. Actually imagine to calculate Solow residual from *[2]* where, for sake of simplicity, set the value of $\Delta k/k$ to zero. Since $a_t < \alpha_t$, the measured total productivity, i.e. the Solow residual, will result positively associated with the rate of growth of labour input.

A proposed solution could be to formulate shares considering effective marginal costs instead of factors' revenues. We do not pursue this route, since technological progress calculation is just a pre-requirement to our main focus.

We conclude this section reporting a typical graphical representation of sectoral production function curvature. This recalls Solow (1957). Given a production function as *[1]*, with constant returns to scale, it can be rewritten in terms of y/n and then normalised to: $(y/n)/z_t$. The scatter of $(y/n)/z_t$ against $k/$ traces the production function curvature. Results are shown in figure 6.[7]

Fig. 6 - Production function shape in Italian industry

11 industrial branches



Source: Authors' elaborations on National Accounts data

[7] Energy sector is excluded because of too high capital/ labour ratios that make graph's scale difficult to read for other sectors. In any case, main conclusions still hold also for this branch.

Sectoral profiles easily come into view. A different position on the scatter depends upon specificity in capital intensity or labour productivity. Generally it appears a common slight concavity of sectoral production functions. This signals a decreasing marginal productivity for the relative factor *k/n*. Among possible parametric functional forms for the production function, the Cobb-Douglas could not be so bad. We use this result in the following.

4. A SHORT DIGRESSION

Generally the most common measure of productivity is not the total one but the labour apparent productivity. For instance, in incomes policy experiences as the Italian one (in place from 1993), the rule adopted is to set the wage growth as inflation target plus labour (apparent) productivity. Then an interesting question is the relationship between total productivity, i.e. Solow residual, and this most used labour productivity measure.

Subtracting from both sides of *[3]* the labour growth rate and reordering terms, one gets an expression with a familiar left-hand side term:

$$\left[\frac{\Delta y}{y}-\frac{\Delta n}{n}\right]=\frac{\Delta z}{z}+\left(1-a_t\right)\left[\frac{\Delta k}{k}-\left(\frac{\Delta n}{n}+\frac{\Delta z}{z}\right)\right] \qquad [5]$$

Thus labour productivity can be decomposed into two components. The first one is the Solow residual. The second one is the growth rate of capital per unit of labour in efficiency units, weighted by capital share. This second term becomes zero only in the long run dynamic equilibrium of the textbook growth model, where capital growth per unit of labour is equal to the technological progress growth.

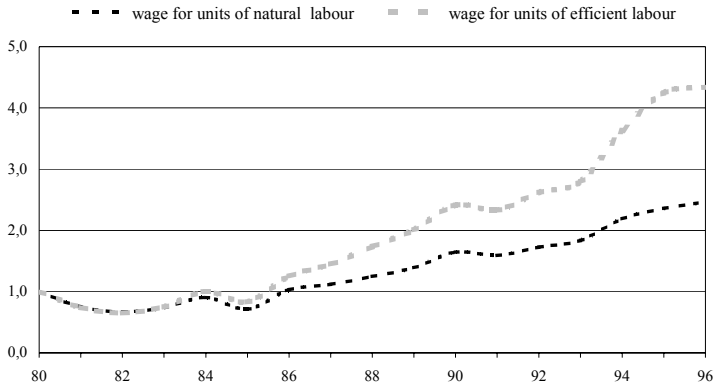
5. RELATIVE QUANTITIES AND PRICES EVIDENCE

The ratio of labour and capital shares can be algebraically decomposed as a product of two ratios. These ratios are factors' relative prices and quantities. It implies that shares do not change whenever a percentage change in relative prices is exactly compensated by an equivalent and opposite in sign change in relative quantities.

Figure 7 and 8 present the evolution of these two ratios to show how the rise in capital share is brought about. These evolutions are presented in terms of natural as well as efficiency units of labour. Leave for a while this second definition, and consider the natural one.

Fig. 7 - Factors relative price

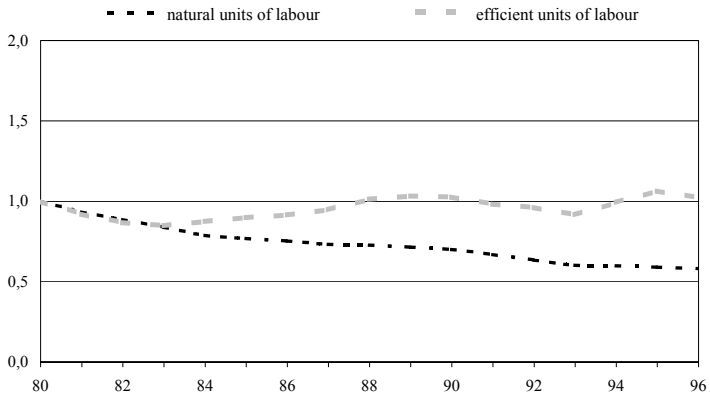
Profit rate / wage rate - Index 1980 = 1



Source: Authors' elaborations on National Accounts data.

Fig. 8 - Factors relative quantities

Labour units/stock of capital - Index, 1980 = 1



Source: Authors' elaborations on National Accounts data

As shown by figure 7, the ratio of gross profit rate to wage rate has been sharply increasing, more than doubling from 1985 to 1996.[8] This is produced by a strong increase of the gross profit rate, from 2% at beginning 80s to 10% at the end of the period under consideration. Simultaneously, relative quantities dynamic, as shown in figure 8, does not compensate prices one. Actually it tends to amplify capital share upsurge.

The two figures track the same story also in terms of wage per efficiency units of labour. Remember that the efficiency units of labour are: $n^* = nz$ and the correspondent wage is $w^* = w/z$. Figure 8 shows that the ratio of labour input in efficiency units to capital input is pretty stable. This recalls the equilibrium condition of the textbook

[8] Profit rate is given by the capital revenue over the stock of capital. By the way, it includes interest paid on the debt as well as income taxes. Wage rate is given by labour revenue to units of full-time standardised labour.

growth model already seen in the previous Section. But the increase of price ratio in figure 7 of course is steeper than in natural units.

At first sight, the aggregate evolution described in figure 7 and 8 seems to be completely irreconcilable with a credible value for the elasticity of substitution. In efficiency units the value of the elasticity seems to be not different from zero.

It is useful to anticipate that, at the contrary, the hypothesis of an average elasticity of substitution close to one can not be easily rejected. Even admitting measurement errors, it does not seem possible that it could take values dramatically lower than one. This is obtained controlling for sector and time effects. Crucially, it is the time effect that permits to reconcile the graphic evidence just presented with an elasticity of substitution close to one.

6. AN ESTIMATION FOR THE ELASTICITY OF SUBSTITUTION

Given a production function with Harrod-neutral technological progress *y=f(zn,k)* and under the hypothesis of factors paid at their marginal productivity, the following relation should be verified:

$$\frac{\pi}{w^*} = g\left(\frac{n^*}{k}\right) \qquad [6]$$

where π is the gross profit rate, $n^* = nz$ is the labour input in efficiency units and $w^* = w/z$, is the wage rate in efficiency units.

With a production function with constant elasticity of substitution (CES) the relation *[6]* becomes:

$$\log\left(\frac{\pi}{w^*}\right) = \frac{1}{\sigma}\log\left(\frac{n^*}{k}\right) \qquad [7]$$

where the parameter σ is clearly the elasticity of substitution.

An econometric exercise based upon this functional form is carried out. Remember that our set is a balanced panel for 12 branches of the Italian industry covering the period 1980-1996. The estimated specification for sector *i* at time *t* has the following form:

$$\log\left(\frac{\pi_{it}}{w^*_{it}}\right) = \frac{1}{\sigma}\log\left(\frac{n^*_{it}}{k_{it}}\right) + x_i + d_t + \varepsilon_{it} \qquad [8]$$

where x_i and d_t correspond respectively to branches and time effects. Thus the specification is a typical two-way fixed-effects model. [9]

[9] Random effects models are not considered. Our panel covers, in fact, the whole population with respect to which we want to make inference (Italian industrial sector). Furthermore, low number of individuals does not imply problems for fixed effects estimations due to lack in degrees of freedom.

Table 2 - Estimates for the elasticity of substitution

Panel 1980-1996, 12 sectors [1]

Dependent variable: Relative price [2]	OLS [3]	TSLS [4]
$1/\sigma$	0,81	0,80
	(0.06)	(0.12)
H_o: $1/\sigma = 1$ [5]	8,95 [1]	
H_o: time dummies jointly null [5]	1238 [16]	

Source: Authors' elaborations on National Accounts data

(1) Estimates are made by DPD per Ox (Arellano, Bond e Doornik, 1999) and SAS/ETS version 6.

(2) Estimates refer to equation *[8]*.

(3) Estimated model includes sector and time fixed effects. Standard errors are shown in parentheses.

(4) Instrumental variables are lags -1 to -5 of the quantities ratio.

(5) Tests refer to OLS estimate. Under the null they have a χ^2 distribution. Degrees of freedom in squared brackets.

First estimation of *[8]* is done by OLS and results are shown in Table 2. The estimated coefficient is significant and as high as .81, not too far from one. It follows an elasticity of substitution slightly higher than one. We test the linear restriction $1/\sigma=1$. The null of an elasticity of substitution equal to one can not be rejected at significance level not much far from the value of 1%.[10]

Second estimation presented in Table 2 is by instrumental variables. It should avoid a possible bias toward 1 depending on the fact that both terms in *[7]* contain the proxy for total productivity, *z*. As we already noted, this proxy is often deemed to be characterised by spurious fluctuations. But the result we get is pretty identical to the OLS one.[11]

To control for this bias we estimated another specification obtained rewriting *[7]* as:

$$\log\left(\frac{\pi}{w}\right)=\frac{1}{\sigma}\log\left(\frac{n}{k}\right)+\left(\frac{1}{\sigma}-1\right)\log z \qquad [9]$$

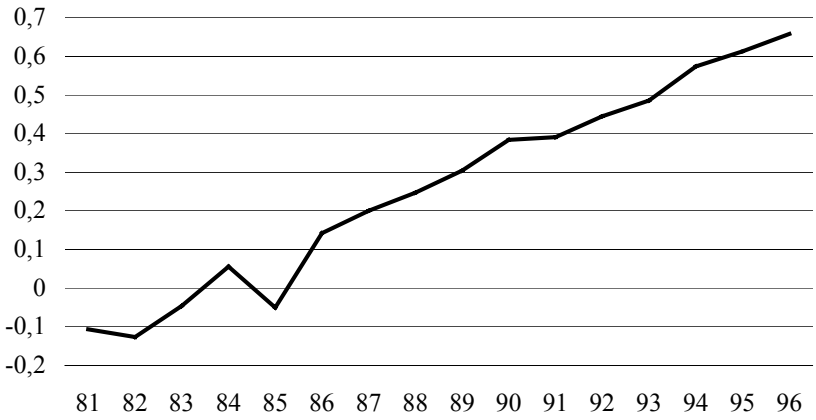
We get two different values for $1/\sigma$ since we estimate *[9]* without restrictions for the two coefficients. From the first coefficient, that one in front of *log(n/k)*, we get .71. From the second one, in front of *log z*, we get .87. Both are not so far from our previous estimations.

[10] The exact significance level is 0.3%. Of course, by conventional significance levels this implies a rejection.

[11] Robustness is checked also by estimating the alternative regression of quantities on prices. It gives a significant coefficient equal to 0.61.

Fig. 9 - Time fixed effect[1]

Estimated coefficents



Source: Authors' elaborations on National Accounts data

[1] Figure shows coefficients of time dummuies in equation [8]. OLS estimate.

Figure 9 sketches the evolution of time dummies coefficients obtained by estimating equation *[8]*. They are increasing as well as statistical significant, as shown in Table 2 by a Wald test, where the null is a joint zero value for time dummies. The meaning is simple: once controlled for quantities dynamic and technological progress, the residual behaviour of factors' rewards ratio still shows an upward slope.

We get two conclusions from these exercises. The first one is that in the dynamic relationship between quantity ratio and price ratio, after controlling for technological progress, there exists a positive significant trend. It is this trend that, bringing about an increase in capital share, waits for an explanation. A CES with constant parameters in not able to accommodate for this increase.

The second conclusion is that, since the elasticity of substitution is not too different from one, drawing on this result it is worthwhile to conduct the test procedure proposed by Blanchard (1997). This will be done in the next section.

7. RENT SHARING AND TECHNOLOGICAL SHIFTS

In finding an explanation for the positive trend depicted by time dummies in Figure 9 the first candidate could be the presence of a dynamic mispecification. After all our estimations are static and can not capture lags in adjusting the optimal factor combination. In other words, the 1980-96 evolution in quantities shown in Figure 8 is at odd if compared with contemporaneous evolution of prices. But it could be the delayed reaction to the opposite price's evolution of 70s.

Actually, it is a broadly accepted opinion that during the 70s Italy as well as European Countries has been subject to an adverse shift in labour supply. Firm's

reaction by less labour intensive factor combination, even starting during 70s, could have become manifest only a decade later.

Economic literature agrees on the ground that factors adjustment delays are usually present. But this sort of explanation for the capital share increase we observe implies a very delayed firm's reaction.

Blanchard (1997) provides estimates for a dynamic labour demand function, finding long adjustment delays. Nevertheless, lags do not appear long enough to completely justify the evolution in labour to capital ratio.

Delays can also be related to adjustment processes of the capital stock to its optimal level in presence of putty-clay technology and vintage effects. A full change in productive processes takes a long time and, even if prices already got their equilibrium level, technology adjustment is far from instantaneous.

But weaknesses are present when we ask how high should be the adjustment costs to ensure that the present capital stock is still reflecting shocks that occurred in 70s. Italian empirical evidence based upon a panel of manufacturing firms evaluate a half life adjustment speed of about three years ad a half (Franzosi, 1999). It means that in this time period a firm can obtain half of the optimal adjustment after a price shock. This value for adjustment costs is obviously too low with respect to long lasting phenomenon of the observed increase in capital share as depicted in Figure 1.

In searching for an explanation we are left with other two possibilities.

The first one is a change in rents distribution against labour. It is important to remark that setting the roots of this story in goods market or in labour market is absolutely not equivalent. If the origin is in the goods market one must concede that in some way competition among firms is decreased, driving an increase in mark-up. The positive aspect of this story is that one gets surely the result in terms of increasing capital share. This can be straightforwardly shown in a WS-PS model.

But if the origin is in labour market things are less clear cut. Not every mechanism on the wage setting side of a WS-PS model is able to produce a decreasing labour share due to a lowering of the unions' bargaining power. Surely a right-to-manage, probably the most employed device in modelling wage determination in Continental European countries does not, because firms stay on their labour demand. At the contrary, efficient bargaining is able to release this result, since the wage plays a purely distributive role. The problem here is that the empirical evidence of efficient bargaining is rather scanty.

In our view the explanation via a lowering of unions' bargaining power faces another difficulty. The remarkable variability in capital share increase across industrial sectors, shown in Section 2, at first sight does not easily match with a pretty generalised decrease in unions' power across these sectors.

The second explanation for the capital share increase relies in a change in fundamental parameters of aggregate production function. At given factors prices, this shift pushes toward a higher use of capital.

Blanchard (1997) proposes a test to discriminate between rents sharing shift or technological shift. The test focuses on some features of the production function. The hypothesis of technological shift implies changes in fundamental parameters, the ones that drive the choice of capital and labour input. In the alternative hypothesis of changing rent sharing these parameters remain constant.

Consider a Cobb-Douglas production function, with labour elasticity α_t, Hicks neutral technological progress z_t and constant returns to scale. Call H' the hypothesis of

technological shift H'' the hypothesis of rents sharing shift. Under H' labour elasticity changes over time. In output per capital form we have:

$$\ln\left(\frac{y_t}{k_t}\right) = \alpha_t \ln\left(\frac{n_t}{k_t}\right) + \ln z_t \qquad [10]$$

Alternatively, under H'', α_t is constant over time, i.e.:

$$\ln\left(\frac{y_t}{k_t}\right) = \alpha \ln\left(\frac{n_t}{k_t}\right) + \ln z_t \qquad [11]$$

Now nest the two possibilities with weight β and (1-β) to get:

$$\ln\left(\frac{y_t}{k_t}\right) = \beta\alpha_t \ln\left(\frac{n_t}{k_t}\right) + (1-\beta)\alpha \ln\left(\frac{n_t}{k_t}\right) + \ln z_t \qquad [12]$$

Reorder terms of *[12]* to obtain an easy functional form to estimate:

$$\ln\left(\frac{y_t}{k_t}\right) - \alpha \ln\left(\frac{n_t}{k_t}\right) = \beta(\alpha_t - \alpha) \ln\left(\frac{n_t}{k_t}\right) + \ln z_t \qquad [13]$$

If β tends to 1 it means that hypothesis H' is more suitable to describe capital share increase. If the coefficient is closed to zero we get evidence in favour of H''.

The exercise is based upon the already described balanced panel for the period 1980-1996, with cross sectional information for 12 branches of the Italian industrial sector. Equation estimated for sector *i* at time *t* is:

$$X_{1it} = x_i + \beta X_{2it} + f_i(t) + \varepsilon_{it} \qquad [14]$$

where $X_1 = \ln(y/k) - \bar{a}\ln(n/k)$ and $X_2 = (a_t - \bar{a})\ln(n/k)$. For α_{it} and α we get the sample values a_{it} and $\bar{a}$ (where the second one is the average value of labour share). Finally, we include $f_i(t)$ as a sector-specific quadratic trend for *ln(z)* and x_i for sectoral fixed effects.

Fixed effects model is estimated by Ordinary Least Squares (OLS). Estimate for β is shown in table 3.

Table 3 - Blanchard test for the increase in capital share

Panel 1980-1996, 12 sectors [1]

	Basic model	Restricted model [3]
β [2]	1,03	1,15
	(0.85)	(0.05)
H_o: $\beta = 1$ [4]	7,703 [1]	
H_o: $\beta = 0$ [4]	449,8 [1]	

Source: Authors' elaborations on National Accounts data

(1) Estimates are made by DPD per Ox (Arellano, Bond e Doornik, 1999) and SAS/ETS version 6.

(2) Estimates refer to ß coefficient in equation [14]. A value close to 1 gives evidence in favour of the technological bias. If close to 0, it gives evidence in favour of the alternative of a mark-up increase.

(3) Restricted model does not admit sector variability for coefficients.

(4) Tests refer to OLS estimates. Under the null they have a χ^2 distribution. Degrees of freedom in squared brackets.

These preliminary results seem to be in favour of a technological bias as a main motivation for the observed increase in capital share. Coefficients are marginally over one and for the restricted model estimates are significant at 1%.[12] To complete the picture we present linear restrictions tests for the value of β. We consider the restricted model for which the Wald tests are more reliable.[13] As expected, we can not reject at approximately 1% the restriction $\beta=1$.[14]

Some caveats are relevant. If we observe the sectoral estimates, conclusions appear to be less clear. The value taken by estimated β, once free to move across sectors shows a great variability. Furthermore, it seems that we are not able to improve estimation robustness if we adopt a limited sample, given by sectors for which we actually observe growth in capital share.

By consequence, it is necessary to be cautions in interpreting results. Looking more carefully at equation *[13]* we can see that dependent variable is, at the end, a measure for the total productivity of the system. Such a productivity is explained by shares (X_2), under H', and by technological progress.

With respect to the first variable, attention has to be paid on the fact that we are using a Cobb-Douglas with all the hypotheses that follows (such as no fixed costs). Labour share α must be assumed as an exact measure for the impact on output/capital ratio of a change in labour/capital ratio under H'.

[12] At the moment we are not able to find useful instrumental variables to take into account a possible endogeneity bias.

[13] Estimate for the basic model β is not highly significant: it follows that linear restriction tests on this coefficient can not be robust.

[14] The exact significance level is 0.6%.

With reference to technological progress, we proxy it by a sector-specific quadratic trend. Undoubtedly this is better than an aggregate estimate. Nevertheless, to quantify the actual dynamic for total factors' productivity remains hard.

Finally, to employ a Cobb-Douglas implies an idea of elasticity of substitution equal to one. Actual lower values could play not in favour of robustness of the test.

Notwithstanding the preceding warnings, it seems that changes in fundamental parameters of the production function play a relevant role – even if not the only one - in explaining the positive trend observed in Italian industry capital share.

8. CONCLUSIONS

This paper starts from a stylised fact: the observed positive trend in capital share during the last thirty years in Italy as well as other European countries. We do not want to look for the causes, as price shocks during 70s and 80s or institutional characteristic of industrial relationships. A wide literature focuses on these topics and a definitive word is still far to be said.

Our goal is to provide a description for the phenomenon in Italian industry. Italy seems to be a particularly case to look at, given the spectacular increase in capital share. Furthermore, we can analyse a 12 sectors panel database for 1980-1996.

We observe that in front of a dramatic increase in gross profit rate to wage rate, the evolution of factors relative quantities does not compensate relative prices effect. Many economic mechanisms can lead to such a result: sectoral composition effects, lags in factors adjustment, technological bias, shift in the distribution of rents. We emphasise that this shift can be traced back to two very different reasons: an increase in firms' mark up or a lowering of unions' power, with efficient bargaining. We describe some of them, for others we provide econometrics evidence.

First of all we argue that lags in adjusting optimal factors' composition for the production after price shocks are likely to occur, but they are not enough to fully explain the observed phenomenon of capital share increase.

Under a CES we estimate the elasticity of substitution between labour and capital. After controlling for technological progress, there exists a positive significant trend. It is this trend that, bringing about an increase in capital share, waits for an explanation. These estimates based upon our 12-sector panel database show that for Italian industry the elasticity of substitution is not too far from one. Anyway, a CES with constant parameters, in not able to accommodate for this increase.

We compare two other possible explanations: a progressive increase in firm's mark-up and a change in fundamental characteristics of the production function. With a test proposed by Blanchard (1997) we try to weight these two hypotheses. We conclude that great part of the explanation for the observed increase in capital shares can be related with a technological bias. At a given level of relative prices the optimal technology adopted has been more and more biased against labour.

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APPENDIX

Data construction and statistics sources

Value added (evaluated at factors costs) and labour units come from National Accounts (Istat). At the beginning of this work, only National Accounts based upon Sec79 were available to cover 80s, but not the more recent Sec95. By consequence, the series and the sector classification belong to Sec79 data.

We consider the sector detail for the industry (transformation and manufacturing, construction is indeed excluded). Net (of depreciation) capital stock for user branch is a series built by Istat that prefers a methodology based upon expenditures. Time series (at prices 1990) distinguish different industrial branches and cover the period 1980-94; years 95 and 96 are opportunely estimated. Sector aggregations have made necessary to match sector from this source with the National Accounts data ones.

Value added, at current prices, is allocated either as labour income or as capital income. Labour share is computed from National Accounts compensation per employee. It includes the imputed income of self-employed individuals, based on the average compensation in the sector of interest. Capital income is obtained by difference.