BEYOND PROFITABILITY: EFFECTS OF ACQUISITIONS ON TECHNICAL EFFICIENCY AND PRODUCTIVITY IN THE ITALIAN PASTA INDUSTRY

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Abstract

Unlike traditional studies on the efficiency-enhancing effect of ownership changes – which use either profitability measures or stock prices – this paper measures the effect of acquisitions directly on acquired firms' technical efficiency. Using a panel of Italian firms in the pasta industry for the 1981-1997 period, I estimate a stochastic production frontier with factors affecting efficiency (i.e. the Battese and Coelli (1995) model), in a translog specification with non-neutral technical progress. The results show that acquired firms' technical efficiency increases within the six years period following the acquisition, regardless of the nationality of the acquirer, and that a more productive use of resources, in particular labour, is the main source of this increase. However, the analysis beyond the six years period casts some doubts about the persistency of this increase.

Keywords: Acquisitions, Technical efficiency, Factor Productivity.

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Contents

1. Introduction

Mergers and acquisition have been widespread in western economies since a very long time. The passing of Antitrust laws in Canada and US at the end of last century witnesses public policy's concerns about the effects of these changes in ownership.

Also the economic literature has been deeply interested in firms' decisions to grow externally, investigating some of the characteristics of these operations, such as their micro- and macro-economic determinants and their effects.

Despite this deep interest, most of these issues have remained unsolved, so that this topic is still very controversial. For instance, a harsh debate exists in literature on whether and how changes in firms' ownership affect firms' performance; in particular, two issues have been theoretically investigated and empirically tested, but without conclusive results: whether mergers and acquisitions generate private benefits and if the *private* benefits are also *social* benefits.

Actually, empirical analysis designed to shed lights on these topics have relied on methodologies that are able to address directly the first issue and only indirectly the second one. The lack of a direct analysis of the real source of the change in performance is unsatisfactory also for policy purposes, as antitrust legislations forbid mergers that increase market power, balancing in some cases the anticompetitive effects with the cost savings that mergers could generate.

Hence, it is not surprising that recent literature has used new kind of data and new methodologies in order to address directly the second issue, focusing on the effect on *specific* components of firm's performance, such as market power on the one hand and productivity or efficiency on the other.

This paper belongs to this recent stream of literature, as it analyses the impact of ownership change on acquired firms' technical efficiency, i.e. their ability to transform resources into output. This paper differs from previous literature in two respects: the data and the time horizon. First, this paper is the first in-depth study of a specific manufacturing industry, the pasta industry in Italy, unlike most previous literature that either analyse many industries or focus on a specific public utility or the service sector. The choice of this specific manufacturing industry, motivated by the large restructuring

process that this industry has experienced in last decades, with a relatively high number of acquisitions, is important in two respects. First, most mergers and acquisitions take place in the manufacturing sector, while changes in ownership in services tend to occur because of particular institutional changes (such as deregulation) and hence are concentrated in specific periods. Second, the use of more homogeneous data allowed by the focus on a specific industry can hopefully lead to more precise results.

The second special feature of this work is time horizon: the vast majority of acquired firms exit the sample only six or more years after the acquisition, so that in this paper it is possible to assess not only the short term effect (3-4 years after the acquisition) as it is usually done in literature, but also the medium long-term impact of ownership change.

The main result of this paper is that acquired firms enjoy, within the six years period following the acquisition, a significant increase in their technical efficiency, and that the increase in labour productivity could be considered the major source of this effect. Moreover, no specific effect is found for multinational acquirers. However, the performance of acquired firms observed in a longer period tend to deteriorate, so that the persistency of the improvement in performance brought in by the change in ownership is doubtful.

These results partially confirm most of the results of previous literature, supporting the view that acquisitions are, at least in the short-medium run, a device for improving acquired firms' performance through a better use of resources. However, no conclusion can be drawn about the social desiderability of these acquisitions, for a double reason: on the one hand, their social desiderability can be evaluated only after analysing also the effect on acquired firms' market power and the effect on acquirers; on the other, the decrease in technical efficiency in the longer run, a result almost new in literature and that needs further investigation, casts some doubts about the persistency of the increase in performance.

The rest of the paper is organised as follows. Next section reviews the classical literature on mergers and acquisitions that uses the old methodologies and the recent one that looks, like this paper, at specific components of firm's performance, in particular at the ownership changes' effect on productivity and efficiency. Description of the pasta industry in Italy and the data used are presented in section 3. Section 4

contains the empirical model, while section 5 comments upon the results. Some final remarks conclude the paper.

2. Effects of ownership changes: old debates and new approaches

2.1. Old debates

An old and harsh debate exists in the economic literature on whether and how changes in firms' ownership affect firms' performance.

In particular, two main themes have been investigated: whether mergers and acquisitions generate private benefits and if the *private* benefits are also *social* benefits, i.e. the ownership changes *create* value or only *transfer* value from some subjects (labour forces, rival firms, consumers, etc.) to new owners.

Regarding both questions, there are two opposite views.

One stream of literature, mainly neo-classical, asserts that mergers and acquisitions lead to an increase in private profitability: in the Structure-Conduct-Performance paradigm, in fact, mergers and acquisitions lead to an increase in market share and hence in profitability. To this view, scholars belonging to the managerial school (Marris (1964), Mueller (1969)) oppose the idea that acquisitions are mostly motivated by the pursuit of growth maximising objectives, and thus have no particular effect on firms involved.

Concerning the source of the gains due to the change in ownership, some scholars argue that acquired firms will benefit, after the acquisition, from minor costs, through synergies with the acquirer, i.e. economies of scale or scope (Williamson (1968)) or correction of managerial failures (Manne (1965)), so that the private gains are generated by a better use of resources and hence are also social gains. On the other hand, there is the idea that merging firms will benefit from larger market power in the product market, through an increase in market share or multimarket contact (Scott (1989)), or will benefit from extra profits transferred from other acquired firm's stakeholders, such as labour forces, so that the increase in profit does not correspond to a social gain (or even correspond to a net loss) for the society as a whole.[1]

[1] Of course, this distinction is so clear only for expository purposes: in reality an acquisition can have

Empirical analysis of the effects of mergers and acquisitions – or more generally of *ownership changes* – have been traditionally performed with two alternative methodologies: one is based on profitability indicators, such as Return on Assets, or Equity or Investment, and – to a lesser extent – on growth and financial indicators, all computed from balance sheet data; the other is based on stock prices movements around the acquisition date.[2]

As far as the first methodology is concerned, the approach used has been that of measuring some performance indexes before and after the change in ownership, using a control group of other firms of same size and industry in order to control for macroeconomic effects, and testing whether these indexes differ significantly. Mueller (1996) contains a review of this traditional methodology; it also summarises the main results obtained by this literature, characterised by a general scepticism towards the effects of mergers and acquisitions.

The methodology based on stock prices uses the so-called "event study methodology", which is a general methodology used to assess the impact of new information (such as the announcement of a takeover) on firm's stock prices. In short, the idea is to construct a "normal" stock return, i.e. a return that could be expected in absence of new information, and then to measure the "abnormal" return around the announcement date as the difference between the actual and the "normal" return.[3]

These two methodologies suffer from some shortcomings, some related to their own nature, others due to their use for assessing the source of the gains generated by mergers and acquisitions.

Concerning the criticisms to the real nature of these methodologies, the use of profitability indicators from balance sheet data has been heavily criticised (Fisher & McGowan (1983)) on the ground that *accounting* rates of return do not correspond to *economic* rates of return, measured as the discount rate that equates the present value of investment's expected net revenue stream to its initial outlay; the "event study methodology" heavily relies on the questionable assumptions of efficient stock markets

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both a market power and a cost reduction effect.

[2] For a clear distinction of the two methodologies see Caves (1989).

[3] The "normal" return is usually measured through the so-called *market model*, where the normal return is the expected return of the stock given the market return. For details about this and alternative methods for measuring "normal" returns see Armitage (1995).

(see Scherer & Ross (1990)) and its results are sensitive to the different time windows used to estimate the expected returns (Magenheim & Mueller (1988)).

On the other hand, these methodologies appreciate only the impact on firm's general performance, such as its market value and its profitability. They do not allow, instead, to assess the impact on specific components of this performance, such as the impact on market power or productivity and/or efficiency, whose evaluation is quite important in policy terms. In fact, antitrust policies are usually designed to prevent mergers that increase market power and sometimes (for instance, the U.S. legislation) they balance the increase in market power with the cost savings generated by the merger. The need to answer the question of the source in private profitability has led scholars to devise *indirect* (but unsatisfactory) methods for assessing the source of firms' alleged increased performance.

In fact, some event studies (Eckbo (1983), Eckbo & Wier (1985)) have tried to assess the effect of acquisitions on market power or efficiency through the analysis of *rival* firms' stock prices reactions to the announcement of the takeover and of the subsequent antitrust intervention. These authors have argued that in a market power-increasing merger the pattern of rival firms' stock prices reactions is necessarily an increase at the announcement of the merger and a decrease at the announcement of the antitrust litigation. However, Schumann (1993) has shown how any pattern of rivals' stock prices movement is compatible with a cost-reducing or a market power-increasing merger.

On the other hand, studies based on balance sheet data, recognising the difficulty in assessing *directly* market power or efficiency, either rely on the joint examination of several indicators (for instance, Hughes, Mueller and Singh (1980, p. 43) suggest to look jointly to profitability, sales and stock prices in order to have an insight of the efficiency or market power effect of mergers) or adjust profit and revenues for changes in input and output prices (Cowling *et al.* (1980)).

It is clear that to address such a delicate question as the effect of acquisition on market power and efficiency more appropriate methods were needed.

2.2. New approaches

All the considerations outlined in the previous section have led economists to address the problem of investigating the source of the gains to merging firms *directly* with new data and new methodologies. This has led to study the effect of ownership changes on market power or prices (as proxy for market power), and to analyse their impact on productivity and efficiency of parties involved in mergers and acquisitions. As this study follows the latter line of research, attempting to go beyond profitability and assessing the effects of acquisitions on acquired firms' technical efficiency and productivity, a brief review of this literature is in order[4].

The pioneering work has been Lichtenberg & Siegel (1987), who find that US plants changing ownership between 1972 and 1981 experienced an increase in the growth rate of total factor productivity (TFP). Their result has been subsequently confirmed by McGuckin & Nguyen (1995) using US plants in the food and beverage industry for the 1977/87 period. Also Baldwin (1995), using Canadian plant level data in the '70s, confirms the general conclusion of a positive effect of acquisitions on labour productivity; however, he also finds that this impact varies with the type of acquisition, being larger for horizontal acquisitions than for unrelated ones, and that foreign acquisitions perform better than domestic ones.

There have also been two other types of analysis of the impact of acquisitions on efficiency and productivity: those focusing on *specific industries* and those focusing on a *specific type of transaction*.

Among the first group, the banking industry is the most intensively studied. The results of these studies are not completely consistent, although there is a certain evidence of an improvement in the efficiency of firms involved. Vander Vennet (1996) analyses some 500 takeovers among European banks and finds an increase in efficiency only for domestic mergers between banks of similar size and for cross-border acquisitions; Akhavein, Berger & Humphrey (1997) report a positive impact on profit efficiency for 57 US "megamergers" in the '80s; Resti (1998) finds a positive impact on technical and cost efficiency for 67 changes in ownership of Italian banks. The only

[4] See Gallet (1996) for a direct measure of mergers' impact on market power. For analyses of the price effect see Prager & Hannan (1998) and the references therein.

contrary finding is that of Peristiani (1997), who finds a negative impact of acquisitions on cost efficiency for mergers occurred in US between 1980 and 1990.

Among the specific types of transactions the most analysed have been privatisations and Management buy-outs (MBO): in both cases the reduction of the agency costs induced by the change in ownership suggests that this change would lead to an increase in efficiency.

As far as privatisations are concerned, Boussofiane, Martin & Parker (1997) find mixed results for 9 UK privatised enterprises; Waddams-Price & Weyman-Jones (1996) report an improvement of technical efficiency in UK gas industry while Fraquelli & Erbetta (1999) find no improvement for Italian privatised firms, except for those acquired by foreign groups.

Regarding MBO, Amess (1997 and 1998) finds higher levels of productivity and technical efficiency for UK firms under management's control than for other firms in the same industry. As the control group includes also the same firms before they underwent a MBO, it can be indirectly inferred that the change in the organisational structure has brought in the improvement in performance.

Summing up, previous literature suggests that the change in ownership generally leads to an increase in productivity and/or efficiency, and that nationality of the acquirer can matter, as targets acquired by foreign firms tend to show the largest increase in efficiency. With this scatter evidence in mind, we now turn to our empirical exercise.

3. The pasta industry in Italy and the data used

3.1. The restructuring of the pasta industry and the acquisition process

Pasta is a typical Italian product: in fact, this country is the world largest producer, consumer and exporter of pasta.

During the period under study in this paper, i.e. the '80s and the '90s, this industry has experienced the end of a massive restructuring process, begun at the end of the second world war.

On the demand side, domestic demand and export have followed different dynamics. In fact, domestic demand is in a maturity phase, with a slow growth rate

(21% in the 1981-1997 period); this is due to a 100% penetration in Italian families and to the slowly substitution of pasta by other goods. On the contrary, export has sharply increased, so that exports in volume have been in 1997 four time larger than in 1981 and now represent more than 40% of total production. The overall effect on production has been an 80% increase in the 1981-1997 period.

On the other hand, there has been a sharp modification of the supply. During the '60s the industry was characterised by a large number of small, one-plant local producers, operating in small geographical markets. Over time, however, the increased competition among producers, the diffusion of big retailers that necessitate of continuous restocking and technological innovation that has decreased the competitiveness of small scale plants have progressively led to the exit of a large number of small, local producers.[5] From 1981 to 1997 the number of operating firms has decreased from 238 to 149.

The combined effect of the increase in the demand and the decrease in the number of producers has led to the increase in the average productive capacity of surviving entities and to the increase in concentration: the former has grown in the 1981/97 period from 42.1 to 88.2 tons/day, while the latter has risen from 27.9% to 36.3%.[6]

Related to this restructuring process, there has been a large number of changes in ownership: from 1983 to 1998 (data for the period before 1983 are not available) there have been 24 acquisitions, listed in table 1.

The main feature of this process has been the entry of some multinationals, motivated by two main reasons: the willingness to enter the rich Italian pasta market pursuing a geographical and product diversification strategy (BSN and Nestlé) and the willingness to have a direct control over acquired firms' products exported into the home market (Borden and C.S.M.). Notice that two of these foreign firms have subsequently resold the acquired firms.

[5] In particular, we refer to the introduction of the high temperature dryer: this innovation reduces drying time, and hence increases productivity, preserving at the same time the quality of the pasta. As the new technology cannot be introduced for small capacities, this innovation has put small plants in a cost disadvantage and hence has increased the mimimum efficient scale.

[6] All these figures underestimate the restructuring phenomenon, as most of the restructuring process had already taken place by 1981. In fact, consider that in 1961 the number of plants was 990, with an average productive capacity of 9.2 tons/day.

Other important aspects of the acquisition process have been the external growth of market leader Barilla, with five acquisitions between 1983 and 1986, and the downstream integration of some firms in the milling industry.

3.2. The sample and the variables used

We use balance sheet data of 34 Italian firms in the pasta industry sampled from 1981 to 1997. These data come from two main sources: the *Centrale dei Bilanci*, a private institution which collects them for a network of Italian banks, and Mediobanca's yearly publication "Le principali società italiane"; in very few cases the necessary data have been collected directly from acquired firms' original balance sheets. Maximum effort has been put to keep consistency in the data.

The criteria for inclusion in the sample have been the following: firms had to be not too diversified (according to the criteria below), acquired firms had to have data for at least 4 years before and 2 years after the acquisition and firms in the control sample had to have at least nine contiguous observations.

First of all, diversified firms have been excluded from the sample. In fact, firms in the pasta industry are often diversified in the animal seed industry or vertically integrated in the milling industry. Moreover, in recent years there has been the diffusion of the "fresh" pasta, whose characteristics[7] make this kind of pasta different from "dry" pasta and hence, in order to have only homogeneous observations in the sample, I have decided to include only firms with at least two thirds of their turnover in the "dry" pasta.[8]

Moreover, I included in the sample firms acquired in one of the 24 operations of acquisition mentioned above if at least four observations before and two after the acquisition were available; at the end, 9 acquired firms were retained. Notice that for 8 out of the 9 firms data are available till 6 years after the acquisition.[9]

[7] The drying process of fresh pasta is much shorter, it is usually stuffed and is much more expensive. In short, it is a luxury good while "dry" pasta is considered an inferior good.

[8] The 34 firms in our sample account for approximately the 40-45% (depending on the year) of the whole Italian production in value. This not very high proportion is due, alongside with the exclusion of diversified firms, also to the lack – because of continuous internal restructuring – of a sufficiently long series of homogeneous data for market leader Barilla, who has a market share of approximately 30%.

[9] From table 1, it can be noticed that three firms have been acquired and subsequently resold. A double

Finally, firms in the control sample have been included only if they had a sufficiently long series of contiguous observations, in order to avoid as much as possible the entry or exit of firms from the sample. For this reason, only firms with at least nine contiguous observations were included (table 2 contains the number of observations for each firms, distinguishing between acquired firms and control sample and their location).

The data form an unbalanced panel for a total of 501 observations. The main reasons of the relative unbalancedness of the panel (77 observations missing out of 578) are two. Inspection of table 3, which presents the structure of the panel, suggests that one reason is the poor number of observations in the first year (1981) and, to a lesser extent, the relatively low number in last three years (51 observations missing). This is due to the sampling process of one of our sources (the *Centrale dei Bilanci*) and is no way linked with a particular process of entry or exit of firms: in fact, I have checked that all firms in the panel in 1994 had not exited the market in 1998. The other reason (that accounts for 19 observations missing) is the exit of some acquired firms that have subsequently been incorporated by the acquirer.

The variables used are *value added*, *turnover*, *net capital stock*, *investments* and the *number of employees*. All of them, except the last one, were expressed in current prices and hence some transformations have been necessary.

Value added and *turnover* have been transformed in 1983 prices by the corresponding three digit production price index (industry 417 in the Nace 81 classification). For *net capital stock* a double operation was necessary. On the one hand, it has been necessary to "sum" different vintages of physical capital: this has been done through the perpetual inventory method, using a depreciation rate of 9%, 1983 as benchmark year and the deflator for investment goods. The choice of 1983 as benchmark year has been motivated by the need to find a year where balance sheet data are as close as possible to the real value of technical assets: as the Visentini Law (L. 72/83) allowed in that year a revaluation of assets' historical cost to market price, it is

acquisition of a firm can hamper the interpretation of the results, as the years between the two acquisitions belong at the same time to the period before and after an acquisition. Even if our data contain two of these firms, we bypass this problem as the period of analysis ends always before the second acquisition. Also notice that there is no acquirer among the 34 firms in our panel; in fact, as mentioned in the preceding footnote, a sufficiently long series was not available for Barilla, while the other Italian acquirer operating in the pasta industry, Tamma, has been excluded because diversified.

likely that 1983 is the year when the difference between historical and actual value is minimised. On the other hand, the capital stock calculated in such a way has then been deflated in real terms at 1983 prices through the deflator for investment goods.[10] *Investments* are investments in technical assets and the *number of employees* is the number of workers at the end of the period.

Table 4 provides descriptive statistics for those variables, dividing between acquired firms and control sample. It can be noticed that acquired firms are larger than the control sample, suggesting to control for size. On the other hand, table 5 contains descriptive statistics for the same variables, dividing observations for acquired firms in four relevant sub-periods, chosen according to the criteria explained in the next section: the main feature is that in the period immediately after the acquisition labour decreases and capital increases with respect to the period immediately before. This suggests that acquisitions could have had an impact on factors utilisation and hence on efficiency; to test this and related hypothesis I turn now to the empirical specification.

4. Empirical specification

Among the different methods used for measuring technical efficiency, I have chosen to adopt a stochastic frontier approach.[11] This approach is based on the specification of a functional form of the production function (e.g. Cobb-Douglas or *translog*) and adding to the usual error term, representing statistical noise, another term representing the departure from the production frontier, i.e. the inefficiency of the firm. The advantage of this method is that it allows to appreciate the statistical significance of the estimated parameters.

More specifically, I used the model recently proposed by Battese & Coelli (1995), which allows for the inclusion of time-variant and firm specific explicative variables in

[10] More precisely, to construct net capital stock at current prices I use the following standard recursive formula of the perpetual inventory method:

$k_{i,t+1} = k_{i,t} * (1\text{-}0.09) * \left(\frac{p_{t+1}}{p_t}\right) + I_{t+1}$ for years after 1983 and $k_{i,t-1} = \left(\frac{k_{i,t} - I_t}{1\text{-}0.09}\right) * \frac{p_{t-1}}{p_t}$ for years before 1983, where k_t is the stock of capital, I_t are investments and p_t are investment goods price index, all referred at time t. For firms entering the panel after 1983, the benchmark year is the first available year.

[11] Literature on efficiency measurement has grown exponentially in recent years. For excellent references see Fried, Knox Lovell & Schmidt (1993) and Coelli, Rao & Battese (1998).

the inefficiency component of the error term, in a two factor *translog* specification of the production function and non-neutral technical change.

In other terms, I have employed the following equation:

$$y_{it} = b_0 + b_K k_{it} + b_L l_{it} + b_T t + b_{KK} k_{it}^2 + b_{LL} l_{it}^2 + b_{TT} t^2 + b_{KL} k_{it} l_{it} + b_{KT} k_{it} t + b_{LT} l_{it} t + (u_{it} - u_{it}) \quad (1)$$

where y_{it}, l_{it} and k_{it} are log of value added, number of employees and capital (deflated according to the criteria discussed above) and t is a time trend starting in 1981 (i.e. t=1 for observations in 1981 and t=17 for observations in 1997).

The error term has a double component typical of stochastic frontiers: a noise component, v_{it}, and an inefficiency component, u_{it}. In this particular model v_{it} is a classical disturbance term (normally identically and independently distributed: $v_{it} \sim$ i.i.d.N(0, σ_v^2)), while u_{it} is independently distributed according to a truncated normal distribution, with truncation at 0, that assures non-negativity: $u_{it} \sim$ i.d.TN(m_{it}, σ_u^2), $u_{it} \geq 0$.

The distinguishing feature of the Battese and Coelli model is that the mean of the truncated normal distribution is a linear function of explicative variables: $m_{it} = z_{it}'\delta$, where δ is a vector of parameters to be estimated and z_{it} represent the time/individual specific variables affecting efficiency: they affect it by shifting the mean of the truncated normal distribution from which u_{it} is drawn. Note that a *negative* coefficient of a *z* variable imply a *negative* effect on the estimated technical *inefficiency* and hence a *positive* effect on estimated technical *efficiency*.[12]

For estimation purposes it is useful to reparametrise the model in terms of: $\sigma^2 = \sigma_v^2 + \sigma_u^2$ and $\gamma = \frac{\sigma_u^2}{\sigma_v^2 + \sigma_u^2}$. The first parameter ($\sigma^2$) is the sum of the variance of the error term and of the inefficiency term. The second parameter is the ratio of the variance of the truncated normal from which the inefficiency term is drawn to the sum of this variance and that of the statistical noise: as its value is bounded between 0

[12] For further details on this topic see Coelli, Rao & Battese (1998), ch. 9.

and 1, this reparametrisation helps the iterative procedure to find the maximum likelihood solutions.[13]

For the purposes of this paper, I have used four groups of variables affecting efficiency: one is the direct object of this study while the others control for time, location and size effects.

One set are dummy variables relating to the acquisition process, and are the direct object of the present study. More precisely, I have used 5 dummy variables, called $\delta_{t-9,t-5}$; $\delta_{t-4,t-1}$; δ_t; $\delta_{t+1,t+6}$; $\delta_{t+7,t+11}$: these variables take a value of 1, only for acquired firms, when the observation year is, respectively, from 9 to 5 and from 4 to 1 years *before* the acquisition year, is the acquisition year, is from 1 to 6 and from 7 to 11 years *after* the acquisition year. The role of such dummies is to isolate acquired firms from the rest of the sample, and to evaluate the effect of the acquisition. The reason why to isolate, both before and after the acquisition, the observations located far from the acquisition year is that only from four years before to six years after the acquisition year I have (almost) balanced data (see table 6). Moreover, as will be clear in next section, the choice of the 6th year after the acquisition as the end of the short- medium run effect, proves to be the best to highlight the difference between the short-medium run impact and the longer run effect. On the other hand, as it is usually done in studies on ownership changes' impact, the acquisition year has been isolated as in that year it is impossible to distinguish the effect of the new ownership from that of the old one.

The second set of variables are dummy variables representing firms' location. As already mentioned, the Italian pasta market is becoming geographically more integrated, so that local markets are disappearing. Nonetheless, firms in the South of Italy still enjoy, because of brand loyalty, some local market power that protects them from outside competition. For this reason, I have used location dummy variables, distinguishing southern, central and northern regions.[14]

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[13] Note that γ is not the proportion of the total variance accounted for by the variance of the inefficiency term, as this variance is smaller than σ_u^2 because of truncation.

[14] See the note in table 1 for the list of regions belonging to the North, the Centre and the South of Italy. The distinction between the North and the Center has been done to check that the only regional difference was between the South and the rest of Italy and not among the three Italian macro regions. Table 2 shows that our control sample is well balanced with respect to location, and that only one acquired firm is located in the South.

The third set of explicative variables are related to calendar years. As macroeconomic conditions can differ from a year to another, a dummy variable for each calendar year has been used, in order to capture the effect specific to each year.[15] The use of time dummies is suggested by the consideration, as Table 7 shows, that acquisitions in our sample are concentrated in the 1985-91 period, so that the four dummy variables above ($\delta_{t-9,t-5}$; $\delta_{t-4,t-1}$; $\delta_{t+1,t+6}$; $\delta_{t+7,t+11}$) take positive value in different periods: for instance, $\delta_{t-9,t-5}$ is positive in correspondence with the years ranging from 1981 to 1986, while $\delta_{t+1,t+6}$ is positive in correspondence with the years ranging from 1986 to 1997.

Finally, last explicative variable is size, proxied by turnover. The need to control for size is jointly motivated by the consideration that size, for organisational reasons, can affect efficiency and that, as already mentioned, acquired firms are larger than firms in the control sample (see table 4).

5. Results

5.1. Technical efficiency

Results of the estimation of equation (1) are presented in table 8, while table 9 contains the statistical tests.[16]

In table 8, estimated parameters of four models are presented. In Model 1 only the location dummy variable and the variables concerning the acquisition are included in the efficiency term, while Model 2 adds to model 1 also the time dummies in the efficiency term. In Model 3 the impact of acquisition in the four years before-six years after period is distinguished according to the nationality of the acquirer. Finally, Model 4 controls that the results of Model 1 are robust to a size effect, adding this variable, proxied by turnover, in the inefficiency term; in particular, I added two dummy variables: one (whose parameter is labelled δ_{small}) takes a value of 1 if the firm, in that

[15] Notice the difference between this and the first set of dummy variables affecting efficiency: in the first set the dummy is referred to the *temporal distance* to the acquisition year and not to the *calendar* year.

[16] We will rely exclusively on Likelihood Ratio tests (LR henceforth) and not on asymptotic t or Wald tests as the former does not require the estimation of the coefficients' variance-covariance matrix that, as the model is non-linear, is only an approximation of the real one.

year, is below the 66th percentile of the distribution, the other (whose parameter is labelled δ_{large}) takes a value of 1 if the firm, in that year, is above the 33rd percentile. [17] [18]

Concerning the production function, there is no significant difference among the parameters of the first three models and the production function seems to be well specified: an LR test rejects the Cobb-Douglas model in favour of the *translog* model and the hypothesis of neutral technical progress is rejected versus that of non-neutral technical progress (see table 9).[19] Moreover, there is some evidence of slight scale economies (the sum of capital and labour elasticity is around 1.07).[20] Technical progress is significantly labour saving and capital augmenting and the yearly growth rate of technical progress is slightly above 3%: although this is a quite high value for a traditional industry as pasta, this is due to some important process innovations in the period under study.[21] The only significant difference in the production function is due to the inclusion of size dummies that, as it could be expected, affects scale economies: in fact, in model 4 the sum of the elasticities of capital and labour is only 1.01.

As far as the variables affecting efficiency are concerned, all models give fairly similar results.[22]

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[17] Notice that instead of choosing, on statistical basis, which model is the "true" model we have preferred to show all estimated models to check the robustness of the estimated impact of acquisitions on efficiency.

[18] It must be stressed that the inclusion of size as an explicative variable of inefficiency is doubtful, as probably the converse relation (from inefficiency to size) is the true one. In any case, size is certainly *endogeneous* with respect to efficiency. With this *caveat* in mind, I include size in order to control for the robustness of the results concerning the effects of acquisition.

[19] Only specification tests performed with respect to model 1 are presented in table 9, as specification tests performed on the other models give very similar results.

[20] Input elasticities are calculated according to the following formula:

$$\varepsilon_{y,i} = \beta_i + 2\,\beta_{ii}\bar{i} + \sum_{\substack{j=K,L,t \\ j\neq i}} \beta_{ji}\bar{j}, \qquad i = K,L \qquad (1)$$

where $\bar{i}$ and $\bar{j}$ are the logarithms of the input sample means. As time is not in logarithms, to obtain the yearly growth rate of technical change is sufficient to apply formula (1) for $i=t$.

[21] The main technological progress has been the introduction of high temperature dryer that has reduced drying time and hence has increased productivity. See also footnote 5.

[22] The estimated value of γ deserves some comments. This value is quite high in all models (above 0.85) indicating that statistical noise plays a minor role and hence this model is similar to a deterministic frontier model with no random error. Moreover, as the value of the parameter is very significantly different from 0, this model performs better, in statistical terms, than a model where z regressors are simply included in the production function.

On one hand, location matters in terms of efficiency. In fact, the parameter for the three Italian macro-regions are jointly very significant; as the parameter for North and Centre were very close, table 8 reports only one parameter, that for the South. As it can be seen, the parameter is positive and significant, implying that firms located in the South are significantly less efficient than the others.

Turning to the variables linked to the acquisition process, models 1 and 2 give very similar results.

The parameter $\delta_{t-4,t-1}$ is positive, implying that before the acquisition acquired firms were less efficient than the control group; on the contrary, the parameter $\delta_{t+1,t+6}$ is in both models negative, showing that after the acquisition acquired firms had become more efficient than the control group. To appreciate the statistical significance of the difference between $\delta_{t-4,t-1}$ and $\delta_{t+1,t+6}$, that gives the impact of acquisition on efficiency, I performed an LR test of the constraint $\delta_{t-4,t-1} = \delta_{t+1,t+6}$, which is presented in table 9. This hypothesis is rejected at a 5% level in both models, even if the p-value (that measures the credibility of the null hypothesis) is higher in the second model, where specific calendar year effects are controlled for.[23]

Notice the value of the parameter $\delta_{t+7,t+11}$, that is positive and significant. This means that firms observed 7 or more years after the acquisition are *less* efficient than the control sample. This casts some doubts about the persistency of the improvement in acquired firms' technical efficiency, even if one must consider that for only five firms I have data 7 years after the acquisition and for only three 8 years after (see table 6).[24]

In model 3 I have split the sample of acquired firms according to the nationality of the acquirer. As mentioned in section 2, in fact, previous empirical literature has shown that in some cases foreign firms' acquisitions have increased acquired firms' efficiency more than domestic acquisitions. The split of $\delta_{t-4,t-1}$ and $\delta_{t+1,t+6}$ in two parameters each, for domestic (labelled $\delta_{t-4,t-1;ita}$ and $\delta_{t+1,t+6;ita}$) and for foreign acquisitions (labelled $\delta_{t-4,t-1;multi}$ and $\delta_{t+1,t+6;multi}$) show that the two groups of acquisitions have similar effects, as both groups improve acquired firms' technical efficiency. A difference is found

[23] Note that the restriction that all time dummies are jointly equal to 0 is not rejected by a LR test.

[24] We have checked that the decrease in efficiency really starts seven years after the acquisition: no firm but one shows a worsening of its performance in the 5th and 6th year after the acquisition. Quite interestingly, this result is very similar to the one reported by Baldwin (1995), ch. 10, who finds that acquired plants experience a sharp decrease in labour productivity in the 7th year after the acquisition.

between the *ex-ante* characteristics of firms acquired by the two types of acquirers: those acquired by foreign firms were *less* efficient than the control sample before the acquisition while those acquired by Italian firms were *more* efficient; however, the distinction between the two types of acquisitions does not add much information, in statistical terms, as an LR test does not reject the simpler model (model 1) against the more general one (model 3).

Finally, the two size class variables included in model 4 as explicative variables of the inefficiency term are statistically very significant; in particular, small firms appear to be the least efficient and large ones appear to be the most efficient. Moreover, the dummy variable for the South is still positive and very significant statistically on the basis of an LR test. Turning to the effect of acquisition on efficiency, an LR test on the constraint $\delta_{t-4,t-1} = \delta_{t+1,t+6}$ has now a p-value of 0.06, higher than before; this increase is due to the fact that 4 out of the 9 acquired firms grow over time changing size class so that part of the increase in efficiency is now attributed to the increased dimensions and not to the change in ownership.

So, even after controlling for size the estimated positive effect of ownership changes still has a statistical significance; however, the parameter $\delta_{t+7,t+11}$ is still positive and significant, confirming the doubts on the persistency of the increase in efficiency.[25]

5.2. Changes in factor productivity

In order to analyse the source of the increase in technical efficiency, table 10 reports for each of the nine acquired firms labour productivity (measured as deflated value added divided by the number of employees), capital productivity (measured as deflated value added divided by capital stock in real terms) and technical efficiency, all normalised with respect to the control sample and averaged in the four relevant

[25] These results rely on the approximation of *output in physical terms* with *output deflated with a market price index*, an approximation that I have employed all over this paper. I do not believe that the use of output in physical terms (or a firm-specific deflator) can affect the result of a positive effect of acquisitions on technical efficiency, as this would require that acquired firms' output price increase after the acquisition and that control firms do not benefit from this increase.

subperiods (t-9,t-5; t-4,t-1; t+1,t+6 and t+7,t+11).[26] Table 10 also contains the rates of growth of capital and labour, averaged in the same four sub-periods.

Notice that for all firms there is at least one factor productivity that increases between the four year before and the six after the acquisition. This reflect new owners' willingness to provide an organisational boost to the acquired firm, as is often declared by acquirers in press statement after the acquisition. Only in six cases out of nine, however, the increase in partial productivities has led to an increase in technical efficiency as well.

For all the six firms, but one, having an increase in technical efficiency there is also the increase in labour productivity, while capital productivity increases only in four cases. More clear is the difference between the two factor productivities if one considers the three firms that experience a decrease in technical efficiency: in all cases, the pattern of change in partial productivity is the same, with an increase in capital productivity and a decrease in labour productivity.

Overall, there is not a very clear distinction between the two factors, but it seems that labour productivity is mostly correlated with technical efficiency, while capital productivity seems to play a minor role.

Turning to the rate of changes of the two factors, in general an inverse relationship between factor productivity and factor quantity is found. However, the reduction in labour is in general small and minor than would be expected if labour reduction would be the only cause of the increase in labour productivity. The same conclusion can be drawn looking at capital productivity. This suggest that it is a more productive use of resources, and not the simple downsizing or elimination of the less productive assets or workers that brings in the increase in efficiency.

Finally, concerning the period from seven to eleven years after the acquisition, it can be noticed that all firms experience a decrease in capital and labour productivity and

[26] Technical efficiency scores presented in table 10 are approximately equal to $1-\hat{u}_{it}$: hence a positive value in the table means that the firm is more efficient than the control sample. The inefficiency components u_{it} are estimated using a model including only a constant term and the dummy variable for firms in southern regions as explicative variables of the inefficiency term. This is because the Battese & Coelli model estimate the inefficiency component given the estimated values of the δ parameters, so that all acquired firms' efficiency scores would be higher in model 1 than in this simpler model. We believe that the latter model highlights more clearly the links beetwen changes in technical efficiency and changes in factor productivity.

in technical efficiency. This worsening of partial productivity indexes confirms the doubts about the persistency of the improvement in technical efficiency.

6. Final comments

In this paper I have adopted an approach different from that used by traditional studies of mergers and acquisitions' impact. Following the most recent literature, I have tried to evaluate ownership changes' effects on acquired firms' technical efficiency, linking this effect to changes in factor productivity.

The following results emerge from the analysis.

There is a clear evidence that acquisitions have increased acquired firms' technical efficiency. This result is robust to changes in model specification and is consistent with most of the literature on ownership changes' effects on acquired units' productivity and efficiency. Moreover, it seems that the reason of the improvement in performance is due to a better use of resources, in particular of the labour factor, while no difference is found between domestic and foreign acquisitions. A less clear evidence concerns acquired firms' performance beyond the six years following the acquisition: in fact, there is some evidence that in a longer period acquired firms' performance worsen, but we do not know how this result is affected by the very small number of observations available in the longer period.

At any rate, no conclusion can be drawn concerning the social desiderability of these operations: this would require also the analysis of the effects on acquiring firms, alongside with the effect on market power of acquired firms. The latter consideration suggests a future, hopefully fruitful, line of research.

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Table 1 - Control acquisitions in the pasta industry over the 1983-98 period

	ACQUIRER (COUNTRY)	ACQUIRER'S INDUSTRY	ACQUIRED FIRM	SELLER	DATE	LOCATION
1	BARILLA (ITA)	PASTA	VOIELLO	Independent firm	1983	South
2	BARILLA (ITA)	PASTA	PASTIFICI MERIDIONALI	Independent firm	1983	South
3	CASILLO	MILLING	PASTIFICIO BRIBANO	Independent firm	1984	North
4	BARILLA (ITA)	PASTA	PASTIFICI VIRGILIO COSTA	Independent firm	1985	South
5	BARILLA (ITA)	PASTA	F.LLI QUINTO E MANFREDI	Independent firm	1985	South
6	BSN-GERVAIS DANONE (FRA)	CONGLOMERATE	PONTE S. GIOVANNI	Independent firm	1985	Centre
7	**CIR-DE BENEDETTI (ITA)**	**CONGLOMERATE**	**BUITONI**	**Independent firm**	**1985**	**Centre**
8	**BARILLA (ITA)**	**PASTA**	**PASTIFICIO BRAIBANTI**	**Independent firm**	**1986**	**Centre**
9	**GAZZOLA (ITA)**	**-----**	**ARRIGHI**	**Independent firm**	**1986**	**North**
10	BSN-GERVAIS DANONE (FRA)	CONGLOMERATE	PASTIFICIO CHIGI	Independent firm	1987	Centre
11	**BSN-GERVAIS DANONE (FRA)**	**CONGLOMERATE**	**PASTIFICIO SPIGA**	**Independent firm**	**1987**	**Centre**
12	BSN-GERVAIS DANONE (FRA)	CONGLOMERATE	PASTIFICIO MANTOVANO	Independent firm	1987	North
13	BSN-GERVAIS DANONE (FRA)	CONGLOMERATE	PASTIFICIO TOMADINI	Independent firm	1987	North
14	**BORDEN (USA)**	**PASTA**	**PASTIFICIO ALBADORO**	**Independent firm**	**1987**	**North**
15	NESTLE' (SWI)	CONGLOMERATE	BUITONI	CIR-DE BENEDETTI	1988	Centre
16	**C.S.M. (NED)**	**CONFECTIONERY**	**AUDISIO**	**Independent firm**	**1988**	**North**
17	**NESTLE' (SVI)**	**CONGLOMERATE**	**PEZZULLO**	**Independent firm**	**1989**	**South**
18	**ALIMCO (ITA)**	**MILLING**	**PASTIFICIO PAGANI**	**Independent firm**	**1990**	**North**
19	PALFIN (ITA)	FINANCIAL	CHIRICO	Independent firm	1990	South
20	BSN-GERVAIS DANONE (FRA)	CONGLOMERATE	AGNESI	Independent firm	1990	North
21	**TAMMA (ITA)**	**PASTA AND RICE**	**PASTIFICIO DEL VERDE**	**Independent firm**	**1991**	**Centre**
22	P.A.I. (FRA)	FINANCIAL	AGNESI	DANONE	1997	North
23	EURICOM (ITA)	RICE	CORTICELLA	Lega delle cooperative	1998	Centre
24	COLUSSI (ITA)	CONFECTIONERY	AUDISIO	C.S.M.	1998	North

Notes:
In bold character the 9 acquisitions for which we have balance sheet data for the acquired firm.
In this table and in the rest of the paper we consider as Northern regions Valle d'Aosta, Piemonte, Liguria, Lombardia, Veneto, Trentino-Alto Adige and Friuli; as Central regions Emilia-Romagna, Toscana, Marche, Umbria, Abruzzi, Molise and Lazio; as Southern regions Puglia, Campania, Basilicata, Calabria, Sicilia and Sardegna.
Gazzola is a former partial owner of a firm in the pasta industry who has sold his stakes in that firm and has subsequently bought Arrighi.

Table 2 - Number of observations by firms, distinguishing between acquired firms and control sample and location

		Number of firms in the control sample				Number of acquired firms			
		North	**Centre**	**South**	**Total**	**North**	**Centre**	**South**	**Total**
Number of observations	17	0	1	1	2	1	0	0	1
	16	3	6	7	16	2	1	0	3
	15	0	0	1	1	1	0	1	2
	14	0	0	1	1	0	0	0	0
	13	1	1	1	3	0	0	0	0
	11	0	0	0	0	0	2	0	2
	10	0	1	0	1	0	0	0	0
	9	0	0	1	1	0	0	0	0
	7	0	0	0	0	0	1	0	1
	TOTAL	**4**	**9**	**12**	**25**	**4**	**4**	**1**	**9**

Table 3 - Number of observations by year

	Year																	
	1981	**1982**	**1983**	**1984**	**1985**	**1986**	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**TOTAL**
Number of observations	4	30	31	32	33	33	33	33	33	33	32	32	31	30	28	28	25	501

Table 4 - Descriptive statistics

	All sample				Control sample				Acquired firms			
	labour	**capital**	**value added**	**turnover**	**labour**	**capital**	**value added**	**turnover**	**labour**	**capital**	**value added**	**turnover**
Mean	131	10417.2	6558.8	32449.3	104	8635.9	5568	26927.7	213.2	15832.9	9571.3	49236.8
St. deviation	180.9	11556.7	7552.7	40658.4	88.4	9353.6	5948.9	28795.6	316.3	15367.9	10619.4	61705.9
Median	84	6500.3	3935.6	19041	69	5164	3212	15864.8	154	9872.2	7364.4	32512.8
Minimum	8	151.6	198	962.8	8	151.6	198	962.8	43	770.3	1628.3	9029.1
Maximum	2172	69406	82189.7	373066.8	406	45037	38003.9	196274.2	2172	69406.1	82189.7	373066.8
Observations	501				377				124			

Note:
Capital, value added and turnover are expressed in millions lire, 1983 prices; labour is the number of workers at the end of the year.

Table 5 - Descriptive statistics for acquired firms, split by subperiods

	From 9 to 5 years before				From 4 to 1 years before				From 1 to 6 years after				From 7 to 9 years after			
	labour	**capital**	**value added**	**turnover**	**labour**	**capital**	**value added**	**turnover**	**labour**	**capital**	**value added**	**turnover**	**labour**	**capital**	**value added**	**turnover**
Mean	180.9	9024.3	7679.7	48590	322.7	16593.7	11313.2	61423.8	162	17071.9	9348.7	43078.8	139.6	15310.1	7586.4	37308
St. deviation	79.2	6321.6	4925.6	58934.2	534.1	16517.1	16731.1	87765.2	131.7	15542.8	7054.8	43636.8	82.1	16537.3	4400.5	13843.6
Median	189.5	7209.7	6040.2	23369.5	179.5	9614.3	6307.6	30096.9	139.5	12216.9	9376.9	37796.5	96	9600.4	5296	31635.1
Minimum	61	770.3	2133.6	16736	48	1287.9	1628.3	9029.1	43	2068.5	2029.5	9055.7	77	7766.3	3190.6	22086
Maximum	277	21396.6	17341.1	232608	2172	59706	82189.7	373066.8	721	64247.4	39201.4	239611	294	69406.1	16803.6	66659.3
Observations	16				36				50				13			

Note:
Capital, value added and turnover are expressed in millions lire, 1983 prices; labour is the number of workers at the end of the year.

Table 6 - Number of observations for acquired firms, with respect to the acquisition year

t-9	t-8	t-7	t-6	t-5	t-4	t-3	t-2	t-1	t	t+1	t+2	t+3	t+4	t+5	t+6	t+7	t+8	t+9	t+10	t+11
1	2	4	4	5	9	9	9	9	9	9	9	8	8	8	8	5	3	3	1	1

Note:
t indicates the acquisition year, t-1 the year before the acquisition year, and so forth.

Table 7 – Number of acquisitions and number of positive observations for each sub-period dummy variable, by year

		Number of acquisitions in the year	Number of positive observations for:				
			$d_{t-9,t-5}$	$d_{t-4,t-1}$	d_t	$d_{t+1,t+6}$	$d_{t+7,t+11}$
Year	1981	0	1	1	0	0	0
	1982	0	5	3	0	0	0
	1983	0	4	5	0	0	0
	1984	0	3	6	0	0	0
	1985	1	2	6	1	0	0
	1986	2	1	5	2	1	0
	1987	2	0	4	2	3	0
	1988	1	0	3	1	4	0
	1989	1	0	2	1	5	0
	1990	1	0	1	1	6	0
	1991	1	0	0	1	7	0
	1992	0	0	0	0	8	0
	1993	0	0	0	0	6	1
	1994	0	0	0	0	4	2
	1995	0	0	0	0	3	3
	1996	0	0	0	0	2	4
	1997	0	0	0	0	1	3
TOTAL		**9**	**16**	**36**	**9**	**50**	**13**

Note:
$\delta_{t-9,t-5}$ (resp. $\delta_{t-4,t-1}$) is a dummy variable that takes value of one, only for acquired firms, if the observation year is from 9 to 5 (resp. from 4 to 1) years before the acquisition year.

δ_t is a dummy variable that takes value of one, only for acquired firms, if the observation year is in the acquisition year.

$\delta_{t+1,t+6}$ (resp. $\delta_{t+7,t+11}$) is a dummy variable that takes value of one, only for acquired firms, if the observation year is from 1 to 6 (resp. from 7 to 11) years after the acquisition year.

Table 8 - ML estimates of equation (1)

	Model 1	Model 2	Model 3	Model 4
b_0	3.909 (6.951)	4.011 (6.166)	3.988 (7.216)	4.184 (5.409)
b_K	-0.506 (-2.468)	-0.504 (-2.292)	-0.548 (-2.681)	-0.452 (-2.087)
b_L	1.655 (7.820)	1.664 (8.531)	1.704 (8.014)	1.570 (6.745)
b_T	0.023 (0.760)	-0.008 (-0.221)	0.026 (0.851)	-0.004 (-0.126)
b_{K2}	0.031 (1.276)	0.027 (1.137)	0.037 (1.493)	0.028 (1.157)
b_{L2}	-0.071 (-2.002)	-0.079 (-2.309)	-0.067 (-1.881)	-0.055 (-1.537)
b_{T2}	0.001 (1.058)	0.002 (2.058)	0.001 (0.945)	0.001 (0.650)
b_{LK}	0.010 (0.186)	0.020 (0.386)	-0.002 (-0.028)	-0.001 (-0.017)
b_{KT}	0.012 (1.863)	0.014 (2.173)	0.010 (1.610)	0.016 (2.494)
b_{LT}	-0.023 (-3.043)	-0.025 (-3.272)	-0.021 (-2.711)	-0.025 (-3.328)
s^2	1.037 (2.420)	0.515 (3.120)	0.778 (2.672)	0.291 (1.255)
g	0.958 (59.193)	0.923 (38.562)	0.944 (43.105)	0.867 (8.869)
d_0	-5.162 (-1.928)	-1.722 (-1.622)	-3.542 (-2.000)	-0.975 (-0.670)
$d_{t-9,t-5}$	-0.022 (-0.054)	0.053 (0.147)	-0.146 (-0.328)	0.247 (0.670)
$d_{t-4,t-1}$	1.501 (2.245)	0.637 (1.915)		0.465 (1.067)
$d_{t-4,t-1;multi}$			1.699 (2.350)	
$d_{t-4,t-1;ita}$			-0.502 (-0.877)	
d_t	-2.777 (-1.668)	-1.180 (-2.015)	-1.827 (-1.503)	-0.668 (-0.722)
$d_{t+1,t+6}$	-3.032 (-1.751)	-1.173 (-2.027)		-0.451 (-0.676)
$d_{t+1,t+6;multi}$			-1.457 (-1.765)	
$d_{t+1,t+6;ita}$			-3.497 (-1.660)	
$d_{t+7,t+11}$	2.599 (2.560)	0.875 (2.207)	1.957 (2.454)	1.164 (1.195)
d_{south}	2.066 (2.237)	0.833 (2.432)	1.405 (2.315)	0.521 (1.066)
d_{small}				0.615 (1.507)
d_{large}				-0.537 (-1.475)
e_K	0.225 (9.494)	0.224 (11.858)	0.225 (8.799)	0.215 (8.662)
e_L	0.846 (29.144)	0.844 (44.083)	0.840 (27.615)	0.792 (22.860)
Technical change (yearly growth rate)	3.3%	3.4%	3.3%	3.2%
Log-likelihood	-86.043	-76.186	-85.108	-76.382
Average Efficiency	82.295%	80.973%	82.010%	79.478%

Notes: t-statistics in brackets.

Model 2 is model 1 estimated with 16 time dummy variables in the inefficiency term. Model 3 is model 1 where $\delta_{t-4,t-1}$ and $\delta_{t+1,t+6}$ are split beetwen italian and foreign acquirers. Model 4 adds to Model 1 size dummy variables in the efficiency term.

Table 9 - LR Tests

Restriction	Degrees of freedom	Statistics	p-value
Translog vs. Cobb-Douglas (Model 1)	6	63.496	0.000
Non neutral vs. neutral technical progress ($\beta_{KT} = \beta_{LT} = 0$) (Model 1)	2	9.288	0.010
$\gamma=\delta_0=\delta_{t-9;\,t-5}=\delta_{t-4;\,t-1}=\delta_t=\delta_{t+1;\,t+6}=\delta_{t+7;\,t+11}=\delta_{south}=0$ (Model 1)	8	75.115	0.000
$\delta_{t-4;\,t-1}=\delta_{t+1;\,t+6}$ (Model 1)	1	5.650	0.017
$\delta_{t-4;\,t-1}=\delta_{t+1;\,t+6}$ (Model 2)	1	4.682	0.030
$\delta_{t-4;\,t-1}=\delta_{t+1;\,t+6}$ (Model 4)	1	3.54	0.060
$\delta_{t+7;\,t+11}=0$ (Model 1)	1	3.272	0.070
$\delta_{t+7;\,t+11}=0$ (Model 2)	1	2.67	0.102
$\delta_{t+7;\,t+11}=0$ (Model 4)	1	6.368	0.012
$\delta_{south}=0$ (Model 1)	1	10.368	0.001
$\delta_{south}=0$ (Model 2)	1	9.248	0.002
$\delta_{south}=0$ (Model 4)	1	11.664	0.001
Time dummies=0 (Model 1 vs. Model 2)	16	19.714	0.233
$\delta_{t-4,t-1;multi} = \delta_{t-4,t-1;ita}$ and $\delta_{t+1,t+6;multi} = \delta_{t+1,t+6;ita}$ (Model 1 vs. Model 3)	2	1.87	0.393
$\delta_{small}=\delta_{large}=0$ (Model 1 vs. Model 4)	2	19.322	0.000

Table 10 - Acquired firms' averages of technical efficiency, labour and capital productivity, yearly growth rates of labour and capital, by sub-period

		sub-period			
		t-9, t-5	**t-4, t-1**	**t+1, t+6**	**t+7, t+11**
FIRM 1	Capital productivity	0.240	-0.489	-0.023	-0.077
	Labour productivity	-0.229	5.320	-2.691	-9.584
	Technical efficiency	0.060	0.062	0.028	0.004
	Capital Rate of growth		83.391%	-0.875%	11.725%
	Labour Rate of growth		5.075%	0.987%	-0.732%
FIRM 2	Capital productivity		-0.095	0.012	-0.208
	Labour productivity		-1.508	-8.795	-16.099
	Technical efficiency		0.055	0.008	-0.058
	Capital Rate of growth		16.398%	24.081%	11.624%
	Labour Rate of growth		-1.911%	11.575%	-2.530%
FIRM 3	Capital productivity	-0.816	0.026	0.441	0.205
	Labour productivity	-13.221	-0.519	-10.025	-17.767
	Technical efficiency	-0.133	0.032	0.038	0.017
	Capital Rate of growth	14.559%	18.768%	5.140%	0.984%
	Labour Rate of growth	0.799%	4.332%	5.477%	-2.943%
FIRM 4	Capital productivity		1.096	-0.033	
	Labour productivity		-2.858	6.268	
	Technical efficiency		0.033	0.050	
	Capital Rate of growth		38.512%	18.983%	
	Labour Rate of growth		-0.546%	-0.429%	
FIRM 5	Capital productivity		0.618	-0.188	
	Labour productivity		-6.445	9.637	
	Technical efficiency		0.010	0.053	
	Capital Rate of growth		35.933%	20.418%	
	Labour Rate of growth		-19.516%	-15.247%	
FIRM 6	Capital productivity	-0.507	-0.403	-0.085	
	Labour productivity	0.797	-1.841	11.556	
	Technical efficiency	-0.002	-0.041	0.063	
	Capital Rate of growth	17.127%	10.790%	-3.884%	
	Labour Rate of growth	14.312%	-4.819%	2.853%	
FIRM 7	Capital productivity	0.910	-0.033	0.032	-0.019
	Labour productivity	9.354	18.977	0.206	-3.238
	Technical efficiency	0.090	0.097	0.053	0.043
	Capital Rate of growth	137.608%	10.550%	6.842%	-2.842%
	Labour Rate of growth	9.935%	9.261%	-0.280%	2.564%
FIRM 8	Capital productivity	0.622	-0.680	-0.471	-0.616
	Labour productivity	27.182	-3.250	25.848	10.804
	Technical efficiency	0.112	-0.264	-0.007	-0.168
	Capital Rate of growth	31.155%	56.904%	2.102%	25.219%
	Labour Rate of growth	-4.674%	-8.444%	-0.173%	0.000%
FIRM 9	Capital productivity		-0.649	-0.304	
	Labour productivity		2.234	2.670	
	Technical efficiency		0.038	0.043	
	Capital Rate of growth		-1.203%	-4.111%	
	Labour Rate of growth		2.443%	-2.947%	

Note: Figures for capital and labour productivity and for technical efficiency are the mean over the sub-period of the difference with the corresponding value of the control sample for each year. Capital productivity and labour productivity are expressed in millions lire, 1983 prices.

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