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Summary

In this paper, we analyze the impact of privatization on the firms' R&D performance. We expect that, in the early period after privatization, path dependencies still negatively affect the efficiency of R&D operations. We test our hypothesis using a Tobin's q measure and estimating a hedonic model, already adopted by several scholars to assess the impact of innovation related assets on the firm's market value (Griliches, 1981). We estimate the regression model on an original panel data of 40 firms, including 20 firms privatized through public share offering in different countries of Western Europe over the period 1982-1997 that were matched at the country and industry level with 20 publicly held firms. Our results show that stock markets evaluate R&D investments of newly privatized companies less than R&D investments of industry-matched companies.

Keywords: Privatization, R&D Performance, market value, corporate restructuring

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1. Introduction

In different countries, State-owned enterprises have historically played a main role in directing and qualifying the evolution of the national innovation systems, both directly, by means of their R&D investments and facilities, and indirectly, by means of their procurement strategies (Nelson, 1993). Over the last two decades, widespread privatization processes have consistently reduced the direct presence of the State as a major player in the economic arena (Siniscalco et al., 1999). Prior research on privatization experiences has generally shown that the change in ownership improves productive efficiency and profitability at the firm level, especially when it coincides with the opening-up of formerly monopolistic markets to competition (see Megginson and Netter, 2001, for a review)

On the contrary, scarce attention has been paid to assessing if and how privatization affects the managerial decision to carry on research and development activities, and hence the innovative performance of the firm. In general, as Parker (1998) points out, the dynamic efficiency gains associated to privatization, regarding investments, research and development and innovation, have been largely ignored, both in theory and in practice.

To this respect, some authors (Shleifer, 1998; Zahra et al. 2000) have argued that private ownership must be preferred to public ownership whenever the incentives to innovate and contain costs are strong and claimed that privatization processes can have a fundamental role

in establishing a new set of organizational dynamics that promote innovation, entrepreneurship and the creation of new ventures. However, more recent studies (Katz, 2001; Munari, 2002; Munari et al., 2002) suggest that the State divestiture can be followed by a consistent restructuring and scaling down of R&D facilities and investments of former public enterprises, especially when the transfer of ownership is accompanied by the contemporaneous liberalization of formerly monopolistic industries, as in the case of public utilities.

In order to shed light on the effects of the State divestiture on the innovative and economic performance of newly privatized firms, in this paper we examine the relationship between privatization, R&D commitment and market value of the firm. In particular we choose the Tobin's q, that is the ratio between the market value and the replacement cost of the firm's assets, as indicator of the firm's economic performance. Consistently, in order to estimate the impact of R&D investments on the performance of privatized firms, we recall the literature that has assessed the relationship between innovation and market value of the firm (see Hall, 1999 and Oriani and Sobrero, 2002, for a review).

Therefore, we first integrate at a theoretical level different fields of study concerning the economic performance of privatized companies, the impact of corporate governance on firms' innovative efforts and the relationship between knowledge assets and market value of the firm, in order to deepen our understanding of the long-run effects of privatizations on firms' innovative performance. To empirically assess the issue, we then adopt a matched-paired research design and use data from a sample of 40 firms - including 20 privatized firms that were coupled at the country and industry level with 20 publicly held firms. The first group refers to a set of companies which were privatized through public share offering in different countries of Western Europe over the period 1982-1997. We examine in a regression framework the relation over time between Tobin's q and R&D investments for privatized and privately owned matched companies, in order to gauge whether significant differences emerge between the two groups relatively to the expected contribution of knowledge capital to firm's economic performance. We adopt panel data techniques in our analysis to address the problem posed by the unobserved firm heterogeneity. Moreover, we deal with the problem of the potential simultaneity between R&D investments and firm's performance by estimating a simultaneous equations regression model.

Our findings are in line with the theoretical expectations about the existence of organizational inertia phenomena which retards the improvements in R&D performance within privatized companies. First, the simple descriptive analysis shows that in the early

years after the public offer privatized firms reduce the level of R&D investments, while their market valuation - expressed by Tobin's q - rises, although on average it remains lower than the one of privately-owned matched companies. Secondly, the results of the regression analyses suggest that R&D investments by newly privatized companies are undervalued by the stock market compared to our control group. In fact, the relationship between Tobin's q and R&D investments is always positive in the case of private companies, whereas for privatized companies the sign of the relation varies in the different estimation models we adopt. Moreover, even when the sign is positive for privatized companies, we do find that R&D investments appear to have a much larger impact on Tobin's q in the case of privately-owned matched firms. We interpret this finding to support the claim of sub-optimal economic private returns from R&D resources within SOEs, and the idea that changes in the firm's innovative and economic performance after privatization do not occur instantaneously, but require more time to be fully accomplished.

The rest of the paper is organized as follows. In Section 2 we first provide theoretical explanations to justify the expectation of relevant changes in R&D behavior and performance after privatization. We then turn to discuss the literature on financial market valuation of the firms' knowledge assets and explain why the market value may result an useful indicator to assess the expected economic performance of the firm's R&D activities after privatization. In Section 3 we describe the sample used in the empirical analysis and the technique adopted to build the industry-matched control group. Section 4 presents the estimation techniques we employ and the results of the different regression analyses. In the final section we draw main conclusions from the empirical analysis and discuss the implications for future research.

2. Theoretical background

2.1 The impact of privatization on firms' R&D behavior

Given that R&D projects are typically risky, unpredictable, long-term oriented and idiosyncratic (Holmstrom, 1989), they inherently involve high agency costs and thus become a potential arena of acute conflicts of interest between executives and shareholders. Therefore, the characteristics of the firm's governance and ownership structure significantly influence the undertaking and performance of innovation activities. Empirically, several studies have assessed the relationship between firms' R&D investment decisions and

different aspects of their corporate governance system - such as the degree of ownership concentration, the presence and role of institutional investors, the composition of the board of directors - although reporting mixed results in many senses (see Munari and Sobrero, 2002a, for a review of this literature).

Along this line of inquiry, we focus on the specificities of having the Government as the sole or dominant shareholder for R&D investments and on the impact of its divestment after privatization on innovation performance at the firm level. Conceptually, it is possible to advance two different but interrelated explanations to justify the expectations of consistent changes in the firm's R&D behaviour following privatization (Munari, 2002; Munari et al., 2002).

The first argument deals with the different set of objectives of public and private entrerprises: at least theoretically, the attitude towards R&D activities within State-owned companies should be more oriented to fulfil general national goals of generating and diffusing the public good of knowledge rather than exclusively addressing business specific objectives, given the wider mission of maximizing social welfare. On the other hand, after the divestiture of the State, the privatized firm has no more implicit or explicit obligation to act in the interest of the public welfare or of the overall industry. This should push the management to reconsider the scope of R&D projects undertaken, by focusing on those most closely linked to the needs of the core business.

Secondly, if we relax the rather "heroic" assumption that SOEs seek to maximize public interest and recall the arguments of public choice theory (Niskanen, 1971; Buchanan, 1972), and property rights theory (De Alessi, 1987; Vickers and Yarrow, 1988) a possible reduction of resources devoted to R&D after privatization may be rather ascribed to efficiency gains and to the elimination of wastes and duplication of resources characterizing the company under State ownership. Privatization produces an increased alignment of managerial incentives with firm financial performance, ultimately promoting a more efficient use of resources, which is likely to characterize the management of innovation activities as well. Indeed, most of the studies on the economic consequences of privatization generally show consistent efficiency gains and improvements in productivity after the divestiture of the State (La Porta and Lopez de Silanes, 1997; Megginson et al., 1994; D'Souza and Megginson, 1999; Dewenter and Malatesta, 2001).

Ultimately, these two different explanations converge in theoretically supporting the expectations of a reduction in R&D investments level after the State divestiture. Recent empirical evidence seems to reinforce this view. Using data from privatization experiences

undertaken in the United Kingdom, Japan, Italy and France, Munari et al. (2002) and Munari (2002) document that privatization represents a significant break in the way R&D activities are considered and managed. The most striking effect highlighted regards a substantial restructuring and scaling-down of R&D facilities after privatization, which follows the change in their mission towards a more direct contribution to the creation of value for the company and the new private shareholders. In an analysis of the national innovation systems of Brasil, Argentina and Chile, Katz (2001) reports that the widespread privatization and liberalization programs undertaken during the 90s in those countries dramatically reduced the size of R&D facilities of privatized companies, and in some cases lead to their dismissal.

An econometric analysis based on a sample of 37 companies privatized through public share offering in Western European countries in the period 1980-1997 shows that, after controlling for inter-industry differences, privatization processes negatively affect different measures of R&D commitment (Munari and Sobrero, 2002b). Moreover, the same study documents a significant increase in the number of patents assigned to the companies of the sample following privatization. However, this increase in the propensity to patent does not impact negatively on the average patent quality, as measured by the number of citations received by following patents[2].

2.2. The impact of privatization on firms' innovative performance

Indeed, R&D expenditures, and somehow patents as well, are essentially "input" rather than "output" measures of innovative activity. Therefore, previous evidences on the dynamics of R&D investments and patenting activity do not fully address the question of whether privatization effectively impacts on the innovative and long-term economic performance of the company.

Building on the above mentioned considerations, we should expect privatization to be associated with higher private economic gains stemming from R&D activities. Following the State divestiture, the firm not only could focus on those R&D activities more important and useful for its own business needs (for instance by abandoning or outsourcing those activities more directly linked to the interest of public welfare), but it should also be able to manage its R&D resources in a more efficient way. These two different lines of reasoning lead to opposite conclusions about the possible consequences of privatization for social welfare in

[2] The degree to which this measure assesses the quality and the technological importance of a patent is broadly discussed in Hall et al. (2000).

the long run, but converge in suggesting that the private economic returns stemming from innovative activities are likely to increase after the divestment of the State.

Moreover, the change in ownership fosters a greater entrepreneurial orientation in the recognition and exploitation of business opportunities (Frydman et al., 1998; Zahra et al., 2000). Consequently, the issues of the valorization and exploitation of the technological capital become major concerns after privatization, and several organizational solutions targeted to improve their effectiveness are typically undertaken as suggested by the observed increase in patent productivity (Munari, 2002). In summary, we should expect that, *ceteris paribus*, any currency unit invested in R&D by the privatized company should generate higher expected economic results in comparison to what happened under the State ownership.

Indeed, a major drawback of the economic literature on the consequences of the State divestment resides in the fact that privatization is usually interpreted as a discrete event, and in the underlying assumption that it should immediately lead to better economic performance. On the contrary, the organizational change processes induced by the transfer of ownership from the State to the market, which are far from being immediate and smooth, have been largely unexplored in the literature (Cuervo and Villalonga, 2000).

A first important contribution of looking at the microprocesses of organizational change in the study of privatization derives from the observation that organizations do not adapt instantaneously to a different institutional and competitive context, but are characterized by substantial inertia and are slow to change (Nelson and Winter, 1982; Hannan and Freeman, 1984). Firms develop through an incremental process of recombination of their existing resources and capabilities that is highly dependent on initial conditions (Kogut and Zander, 1992). Early stages of privatization are thus typically still characterized by residual conformity to public sectors norms and routines, even though they increasingly prove to be obsolete and unfit as a source of competitive advantage in the new environment. In such circumstances, both from an institutional and individual point of view, there is a search for a new identity and new rules, and two different templates, the old public sector one and the new private sector one, still coexist. The adoption of a private sector template thus does not take place at a point in time, but through an incremental and progressive process of experimentation (Johnson et al., 2000).

With specific regard to the case of R&D activities, the above mentioned considerations suggest that in the early period following privatization path dependencies may still negatively affect the efficiency of R&D operations. Thus, if we assume that the private returns to R&D investments of SOEs are sub-optimal and that changes in their productivity tend to be

difficult and gradual, the expected positive effect of privatization on innovation performance might not fully materialize at least in the short term. However, the returns to R&D activities are likely to gradually increase over time, as the efficiency pressures brought by private ownership diffuse and establish through the organization

2.3. Tobin's q and the assessment of R&D performance in newly privatized firms

The market value of the firm can be an useful indicator to assess the expected economic performance of the firm's R&D activities after privatization for at least two reasons. First, market value is a forward-looking measure expressing the stock market expectations about firms' future performance. Second, previous empirical literature has already shown that it is possible to assess the specific effect of different technology-related assets on the market value of the firm (Hall, 1999).

The Tobin's q, in particular, has the advantage to be a ratio between financial price data and accounting data. Thus, it allows comparisons between outputs, measured by the market valuation of the firm, and inputs, measured by the replacement cost of the firm's assets (Lindenberg and Ross, 1981). Tobin's q has then some particularly attractive theoretical properties for empirical analysis: it implicitly uses the correct cash flow risk-adjusted discounted rate, imputes equilibrium returns and minimizes distortions due to tax laws and accounting standards (Montgomery and Wernerfelt, 1988).

Tobin's q increases, *ceteris paribus*, with the expected streams of extra profits stemming from firm-specific Ricardian rents (Lindenberg and Ross, 1981), because its denominator is the market value of the firm, that in efficient stock markets is equal to the discounted value of firm's present and future cash flows. However, even in absence of market power, Tobin's q can exceed the unity because of measurement problems affecting the book value of firm's assets. In particular, as corporate reports provide very poor information on the intangible assets, in practice Tobin's q is often calculated as the ratio of the market value of the firm to the book value of its tangible assets, even though the growing importance of intangible assets in the firm's value is broadly recognized. For example, R&D investments are not normally capitalized, but are expensed to P&L accounts when incurred, so that they do not concur to the book value of the firm's assets (Lev and Sougiannis, 1996). This implies that, *ceteris paribus*, Tobin's q is higher when R&D-related intangibles become a larger fraction of the firm's total assets.

These considerations can be fruitfully applied to the analysis of innovation performance of newly privatized firms. In fact, as already discussed, newly privatized firms tend to reduce their efforts in R&D activity after the public offer, so that, *ceteris paribus*, we could expect a decrease in their Tobin's q. However, according to previous arguments, after privatization both a rise in productivity and a new focus on business opportunities could increase the expected rents from the R&D activities, so that the net effect on Tobin's q is uncertain.

Tobin's q can then be used as a measure of expected performance to assess the private returns to innovation of newly privatized firms. Unfortunately, data on market value are not available before the privatization, and hence pre- and post-privatization comparisons are not feasible. However, it is possible to analyze the impact of R&D investments on Tobin's q of privatized firms in comparison to a sample of publicly-held firms. This is the strategy we will follow in this paper. In line with previous reasoning, because of considerable lags between the changes in corporate governance structure and changes in R&D effectiveness and profitability, we expect to observe an initial difference in the market valuation of R&D investments of privatized and comparable publicly-held firms that should progressively disappear over time.

2.4 Endogeneity issues

In the analysis of the relationship between R&D investments and Tobin's q of privatized firms, R&D investments can not be treated as an exogenous variable for two main reasons. First, since R&D is chosen on the basis of economic incentives, it is unlikely that it is independent from firm's market valuation (Griliches, 1995). In fact, previous empirical literature has shown that R&D investments depend on firm's economic and financial performance (Blundell et al. 1992; Hall et al., 1999; Bond and Cummins, 2001). This issue creates confusion on the causality direction between R&D investments and Tobin's q. Previous empirical work has already recognized this potential issue and has treated R&D investments as an endogeneous variable (i.e., Jaffe, 1986).

Second, both Tobin's q and R&D investments are likely to be endogenously determined by the exogenous changes in corporate governance led by the firm's privatization process. Empirical literature has shown that privatization positively affects different measures of firm's performance, such as profits (D'Souza and Megginson, 1999; Bortolotti et al., 2002), stock returns (Megginson, 2000; Dewenter and Malatesta, 2001) and Tobin's q (Claessens et

al., 1997). At the same time, it has been shown that R&D investments decrease over time after privatization (Munari and Sobrero, 2002b; Munari et al., 2002). To the extent that this endogeneity issue exists, a problem of simultaneity between R&D investments and Tobin's q arises. In this case, a pooled OLS estimator would lead to inconsistent coefficients.

In this paper, we will address these questions treating R&D investments as endogeneous within a simultaneous equations model.

3. Data

3.1 Sample

We created an original dataset including R&D expenditures and accounting and stock market information for a matched-paired sample of privatized and publicly held companies. We started our data collection with a sample taken from two articles by Megginson et al. (1994) and D'Souza and Megginson (1999), including 174 companies, operating in 35 different industries, that were fully or partially privatized worldwide through public share offering in 32 countries between 1980 and 1997. Following Megginson et al. (1994), our definition of privatization includes any measure that transfers some or all of the ownership and/or control over SOE to the private sector. We decided to consider only companies privatized through public sale, in order to control for information asymmetries, which might be generated by private solicitation processes and could not be controlled effectively.

We further integrated this initial sample with information on privatization processes derived from: (1) the complete list of companies privatized worldwide in the 80s compiled by the World Bank (Candoy-Seske, 1988); (2) the description of privatization programs adopted by the countries of the European Union provided by Parker (1998); (3) additional information taken from business journals and publications reported in the archive Lexis-Nexis. The final sample we were able to draw up after this initial phase included 182 firms from 32 countries.

We then decided to limit our analysis only to firms which were privatized in Western European countries for several reasons. First, the vast majority of privatization programs that occurred worldwide in the period 1977-1997 took place in Western European countries (Siniscalco et al., 1999). Second, obtaining information on the key-variables for non Western European firms is extremely difficult, especially with regards to data on research and development expenditures. Moreover, by considering firms from Western European

countries, we were able to collect data at country and industry level as well, using the OECD official statistics, as we describe later on.

We then identified all the R&D performing firms in Western European countries from the initial sample, and kept only those reporting R&D expenditures in their financial statements in the period. We then decided to drop the public utilities (telecommunications, energy and water services) from this intermediate sample, because, as these firms typically operated under a monopolistic regime, it was not possible to accurately match them at country and industry level. After cleaning the initial sample by following these criteria, we were left with a final sample of 20 privatized companies operating in 6 Western European countries (Finland, France, Germany, Holland, Italy and United Kingdom) and 10 different manufacturing industries.

As a second step, we gathered data for a set of firms that were publicly-traded throughout the same time period, in order to constitute a control group. We followed two fundamental criteria in our matching process. First, each privatized firm had to be matched with a company operating in the same country, in order to take into account possible country-specific effects in the treatment of R&D expenditures (i.e. the existence of fiscal incentives or legal differences in the capitalization and disclosure of R&D expenditures) and market valuation. Second, we operated an industry-level matching, given that the amount of technological opportunities and the incentives to invest in R&D activities consistently vary across different sectors (Jaffe, 1986; Cohen and Levin, 1989).

More precisely, for each privatized firm in our sample we formed a list of all the publicly-traded R&D-doing firms in the same country and the same industry, classified using the 2-digit SIC code. From this list, we then chose the company that was more similar to the privatized firm with respect to total sales at the year after the public offer and retained it if complete data were available for the following years. In the end, we were able to match the 20 privatized firms of the first group with 20 firms which were privately held throughout the same period. The constituents of the two samples are reported in Table 1.

--- Insert Table 1 about here ---

3.2 Variables

For each firm in both samples we collected data on the main accounting figures and the market capitalization for the five years following the public offer. The source of accounting

figures, except Italy, is Datastream International, which provides a full coverage of British firms and a coverage superior to 75% of the publicly traded companies from other European countries. All the accounting data of Italian firms have been gathered from "Centrale dei Bilanci", a broad database including financial statements of about 40.000 Italian companies, available at the Research Department of the Bank of Italy.

Data on R&D expenditures for all the countries have been firstly obtained from Datastream International. However, as the disclosure of annual R&D expenditures is compulsory only for British firms, this information is not always available for other European companies. For firms in these countries we gathered data on R&D expenditures from two more databases: Worldscope and Global Vantage.

We finally gathered the following accounting data: annual R&D investments (*RD*), other intangible assets (*I*), mainly consisting of trademarks and goodwill, total financial debt (*D*) obtaining by summing up short- and long-term borrowing, net tangible assets (*A*) and total sales (*S*). The R&D capital (*RDC*) has been computed as a perpetual inventory of the past R&D expenditures with a constant depreciation rate, as described in detail by Griliches and Mairesse (1984) and Hall (1990a).

The total market value (*V*) should be calculated as the sum of the market capitalization of the firm and the market value of its debt. However, the data on the market value of debt are often not available. Some of the studies on US samples try to define proxies for the market value of debt using data on corporate bond market (see for example Hall, 1990a). This solution is not feasible for European samples because of the very limited development of corporate bond markets. Therefore, according to previous similar analyses on UK data (Blundell et al., 1992, 1999), we calculate the market value of the firm adding the value of outstanding debt to market capitalization.

At industry level, we calculated the R&D intensity for each year and country. This measure was computed as the ratio between the R&D investments at 2.digit ISIC code reported in the ANBERD database and the 2-digit ISIC code value added reported in the STAN database. Both the databases are maintained by OECD and are compatible.

Variables description and computation is illustrated in detail in Table 2.

--- Insert Table 2 about here ---

4. Model specification

According to the theoretical background, in order to compare the R&D performance of privatized and publicly held firms, the empirical analysis intends to estimate the impact of the R&D investments on the market value of the firm for both samples. To this purpose we recall the empirical literature on innovation and market value (Hall, 1999). Some specific adjustments will be adopted to deal with the questions related to firm-specific effects and endogeneity issues.

4.1 Basic model

Some studies following the seminal contribution of Griliches (1981) have used the Tobin's q to infer the value of the firm's stock of knowledge (among others Jaffe, 1986; Cockburn and Griliches, 1988; Hall, 1993a, 1993b; Blundell et al., 1999; Hall et al., 2000). In these analyses, the firm is assumed to be a bundle of independent tangible and intangible assets (Hall, 1999). The impact of each specific asset on the market value is the result of the interaction between the firms' demand of funds to finance the investment in that asset and the investors' supply of the funds for that assets (Hall, 1993b). Accordingly, the market value of the firm (V) is normally expressed as follows (Hall, 1999):

[1] $V_{it} = b\,(A_{it} + \gamma_K K_{it})$

where i denotes firms, t years, A is the book value of net tangible assets, K is firm's knowledge capital. Since the firm's stock of knowledge is not directly observable and is hard to measure, it has been often computed as an R&D-based measure. The main assumption made in this perspective is that R&D investments contribute to the generation of an intangible capital that is evaluated by the stock market (Griliches, 1981). Consistently with previous literature (Cockburn and Griliches, 1988; Hall, 1993a, 1993b), we use two alternative measures of K: annual R&D investments (*RD*) and R&D capital (*RDC*), that are calculated as explained in the previous section. The coefficient b is the market valuation of firm's assets and reflects its differential risk and monopoly position (Griliches, 1981), whereas the coefficient γ_K measures the market valuation of K relative to the tangible capital A. Under the

theoretical assumptions of the model, γ_K depends on the expected impact of knowledge capital on the firm's expected economic performance.

Scaling both the members of equation [1] by *A* and taking the natural logs, we obtain the following expression:

[2] $\ln(V_{it}/A_{it}) = \ln b + \ln(1 + \gamma_K K_{it}/A_{it})$

where *V*/*A* is a form of Tobin's q. In most of previous work on this subject, the term $\ln(1 + \gamma_K K_{it}/A_{it})$ has been approximated by $\gamma_K K_{it}/A_{it}$ (Griliches, 1981; Cockburn e Griliches, 1988; Hall, 1993a, 1993b; Blundell et al., 1999), so that the following linear regression model where the dependent variable is the natural log of Tobin's q has been derived:

[3] $\ln q_{it} = \ln(V_{it}/A_{it}) = \ln b + \gamma_K K_{it}/A_{it} + e_{it}$

The following set of control variables has been added:

- *I*/*A*
- *D*/*A*
- *ln S*
- year dummies
- country dummies

The ratio *I*/*A* appears as explanatory variable to account for eventual differential impacts of non R&D-related intangible assets on the firm's market value. Consistently with the previous work of Demsetz and Villalonga (2001), the inclusion of the ratio *D*/*A*, representing the share of firm's assets financed through debt, serves to capture eventual value enhancing or value destroying effects related to the exposure of the firm to interest rate variations in the observed period. The natural log of *S* is included to control eventual size effects on the market value. Full sets of year and country dummies are added to account for time and country effects. We have initially estimated equation [3] through plain OLS.

4.2 Fixed- and random-effects

The estimation of equation [1] through OLS does not account for the eventual unobserved firm-specific heterogeneity ν_i. Assuming that this component is constant over time, this

problem can be eliminated recurring to the fixed-effects estimator, that subtracts the individual mean from each variable. The estimator can be expressed in the following way:

$$[4] \quad (y_{it} - \bar{y}_i) = \beta(x_{it} - \bar{x}_i) + (\varepsilon_{it} - \bar{\varepsilon}_i)$$

where $\bar{y}_i$ is the individual mean of the dependent variable, $\bar{x}_i$ is the individual mean of the independent variable and $\bar{\varepsilon}_i$ is the individual mean of the error term. However, even though the fixed-effects estimation accounts for unobserved firm-specific heterogeneity, it drastically reduces the degrees of freedom. For this reason along with the fixed-effects model, we run a random-effects regression, as done by previous studies on similar topics (Bortolotti et al., 2001, 2002). In this case, the latent variable v_i is treated as a random variable with mean $\bar{v}$ and variance σ_v^2. The random-effects estimator is then obtained by computing a ratio θ of the relative importance of within and between variation of the total disturbance (v_i + ε_{it}) and using this ratio to combine fixed-effects estimator and between estimator optimally. In particular, the expression $(1-\sqrt{\theta})$ times the individual mean is subtracted from each variable:

$$[5] \quad (y_{it} - \sqrt{\theta}\,\bar{y}_i) = (1-\sqrt{\theta})\alpha + (x_{it} - \sqrt{\theta}\,\bar{x}_i)\beta + [(1-\sqrt{\theta})v_i + (\varepsilon_{it} - \sqrt{\theta}\,\bar{\varepsilon}_i)]$$

where θ is a function of the variance of the basic error term σ_ε^2 and the variance of the individual component σ_v^2.[3]

The random-effects is more efficient than fixed-effects estimator because it uses both within and between information. However, in order to have consistent results more conditions are required for the random-effects than for the fixed-effects estimator. In particular, the terms v_i and x_{it} must be uncorrelated. In fact, if they were correlated, the estimator could not determine how much of a variation of the dependent variable has to be assigned to β or to v_i. In order to check the assumption of no correlation, we use the Hausman (1978) specification test of the null hypothesis that there are no systematic differences between fixed-effects and random-effects coefficients. The logic underpinning the test is that fixed-effects estimator is consistent under both null and alternative hypothesis, whereas random-effects estimator is

[3] To compute θ we refer to the procedure used by TSP for small samples. See Hall and Cummins (1999) for details.

consistent only under the null hypothesis. Therefore, only in case the null hypothesis can not be rejected, a random-effects specification can be adopted.

4.3 Simultaneous equations

To address the potential problem of the eventual simultaneity of R&D investments and Tobin's q, we estimate also a model of simultaneous equations through the two-stage least squares (2SLS) method, similarly to previous empirical analyses on corporate governance and market value (Loderer and Martin, 1997; Cho, 1998; Demsetz and Villalonga, 2001). The first equation is the corporate value equation described by [3] and the second is a linear equation of *RD* or *RDC* on the following regressors:

- ln q
- ln S
- D/A
- RDIND

The natural log of Tobin's q is included to take into account the effect of economic incentives to invest in R&D, consistently with previous analyses on the relationship between market value and innovation (i.e., Blundell et al., 1992). To control for scale effects in R&D investments, we consider the firm's size in any give year as measured by the log transformation of *S*. Following the evidence provided by Hall (1990b), which shows a negative association between firm's debt level and R&D investments, we include in the model a leverage variable (*D*/*A*). The underlying notion views debt financing as inappropriate for funding R&D investments, given that servicing a debt typically requires a stable stream of cash flows which can be deviated from innovative projects. Finally, we take into account the fact that the level of technological opportunities in an industry is an important determinant of the managerial decision to invest in R&D (Cohen and Levin, 1989). For these reasons, similarly to Lev and Sougiannis (1996), we include the variable *RDIND* to control for industry-, country- and time-specific factors influencing firms' R&D investments.

5. R&D and market value of privatized vs. matched firms: Empirical evidence

5.1 Descriptive statistics and correlation

Descriptive statistics of the variables are reported in Table 2. They show that privatized firms present slightly lower mean values of *RD*/*A*, *RDC*/*A* and Tobin's q (respectively .051 vs. .063, .219 vs. .253 and 1.017 vs. 1.540) and a higher mean value of *D*/*A* (.411 vs. 336). Furthermore, they are larger than matched firms in terms of average total sales (14,100 vs. 6,630 millions of Euros) and total tangible assets (10,500 vs. 3,837 millions of Euros).

--- Insert Table 2 about here ---

However, it results more interesting and informative to explore the patterns of *RD*/*A* and Tobin's q over time for privatized firms, as reported in Figure 1. To this respect, we first focus on the case of privatized companies, and notice that the average *RD*/*A* ratio initially declines after the public offer, whereas Tobin's q increases. The valuation of privatized firms by the market thus incorporates the positive effects brought by the new ownership and governance structure on expected profitability. Moreover, the pattern of Tobin's q during the first two years clearly diverges from the one of *RD*/*A*. Thus, the market valuation of privatized companies does not seem to respond negatively to the decreasing level of R&D activities. On the contrary, the higher value attributed by the market reflects positive expectations that the management may be more able to generate profits from the firm's tangible and intangible assets.

--- Insert Figure 1 about here ---

In table 4 we report the correlations among all the variables for the samples of privatized and matched firms. No serious problems of multicollineraity seem to emerge. For privatized firms there is a high negative and significant correlation between *ln S* and *ln q* (-.50), a result that may require a more detailed inquiry with respect to the R&D investments equation in the simultaneous equations model. In the case of matched firms, *I*/*A* is positively correlated *RD*/*A* and *RDC*/*A* (.38 for both variables), suggesting that the two variables might be jointly influenced by some exogenous factors.

--- Insert Table 4 About here ---

5.2 Results

We first estimate equation [3] using pooled OLS. In model (1) we include the ratio *RD*/*A*, whereas in model (2) we substitute the annual R&D expenditures (*RD*) with the R&D capital (*RDC*). Table 5 reports the results of the regression on the two different samples. Consistently with previous research (Hall, 1999), the regression analysis shows a significant positive effect of R&D investments on Tobin's q, even though the R&D coefficient in model (1) is not statistically significant for privatized firms. It is interesting to notice that in the case of privatized companies the magnitude of the relation is consistently lower then in the case of publicly held matched companies. This result holds for both the estimated models. In model (1), the R&D investments coefficient takes the value of 1.286 for privatized companies and 7.504, almost six times bigger, for publicly held companies. When we substitute *RD* with *RDC* in model (2), we have that the coefficient of the R&D capital for publicly held firms (1.917) is almost five times bigger than the same coefficient for privatized firms (.386). The significantly higher value of the constant for privatized firms (1.985 in model (1) and 1.902 in model (2)) can be justified by the economic meaning of *ln b* that, as seen in previous section, represents the market valuation of all firm's assets and is linked to market power. Therefore, it is likely that in the early years after the State divestment, privatized firms still benefit from a high market power, especially in those industries not immediately opened up to competition. The ratios *I*/*A* and *D*/*A* have a positive impact on Tobin's q for both the samples, but their coefficients are statistically significant only for privatized firms. Finally, it has to be remarked that *ln S* has a negative and significant effect on Tobin's q, indicating that smaller privatized firms have a higher market valuation.

--- Insert Table 5 about here ---

In Table 6 we report the fixed-effects (FE) and random-effects (RE) estimations of models (1) and (2). As we could expect, FE estimation shows that the stock market places a higher valuation on R&D assets of publicly-held firms vs. privatized firms (the coefficients are 2.524 vs. –1.088 for RD/A and .544 vs. .313 for RDC/A), but never produces statistically

significant results with respect to both *RD*/*A* and *RDC*/*A*. RE estimation also shows a difference between market valuation of R&D investments, but in this case the coefficients of both *RD*/*A* and *RDC*/*A* for publicly-held firms are statistically significant, respectively at 5% and 10% level. Moreover, in all the models using the RE estimator, the Hausman test does not allow to reject the null hypothesis (the *p*-value is always bigger than .1) suggesting that the estimator is admissible.

--- Insert Table 6 about here ---

In Table 7 we report the results of the 2SLS estimation of the simultaneous equations model where *ln q* and *RD*/*A* in model (1) and *RDC*/*A* in model (2) are the endogeneous variables. The corporate value equation substantially confirms the results shown in Table 5 and Table 6. The coefficients of R&D investments are strongly positive and statistically significant at 5% level for publicly-held firms (8.795 in model (1) and 2.027 in model (2)), whereas they are negative and not significant for privatized firms. The joint estimation of the R&D investments equation provides some additional useful insights. With particular respect to the leverage *D*/*A*, it shows that while it has a negative and significant impact on R&D spending for publicly-held firms (the coefficient is -.065 in model (1) and -.270 in model (2)), consistently with the traditional argument discussed in the previous section, it has the opposite effect for privatized firms, presenting a positive coefficient that is even statistically significant in model (2). This finding is coherent with the evidence reported by Dewenter and Malatesta (2001) showing that privatized firms are more leveraged than publicly held firms for two main reasons: the reluctance to issue new equity when they were under the State ownership and the existence of implicit or explicit loan guarantees allowing them to borrow at favourable rates. Therefore, while in publicly held firms a higher ratio *D*/*A* increases the external control and consequently reduces the propensity to invest in risky activities such as R&D, in privatized firms the debt is more likely to be an important source for R&D financing.

--- Insert Table 7 about here ---

In summary, the results emerging from the different models strongly support the existence of a gap between the stock market valuation of R&D investments of privatized and

comparable private firms. In fact, in all the models involving the privately-owned matched companies, the coefficients of R&D investments are positive and often significant, in line with the general findings of the literature on market value and innovation (Hall, 1999; Oriani and Sobrero, 2002). On the contrary, in the case of privatized firms the evidence is less clear, since the sign of the relationship is often negative. Moreover, even when the sign is positive, the R&D coefficient is never significant (except for model (2) in the pooled OLS estimation) and always consistently lower than the correspondent value for privately-owned firms.

The existence of a low market valuation of R&D investments in the case of privatized companies can be explained by the existence of path dependencies which negatively affect the R&D performance in the early period after the State divestment. This suggests that the private returns generated from R&D activities of formerly publicly-owned enterprises are sub-optimal in terms of private returns, and that the improvement brought by private-ownership might not be immediate as implicitly assumed by the economic literature studying the impact of privatization. On the contrary, it is likely that the returns to R&D activities gradually increase over time, as the efficiency pressures brought by private ownership diffuse through the organization. This would mean that the relation between R&D and Tobin's q should strengthen over time.

6. Conclusions

In this paper we have discussed the impact of privatization on the economic returns stemming from the firm's R&D operations. Even though there exists a broad theoretical and empirical literature on the effects of privatization on the firm's economic performance in the short term, to our knowledge there are no contributions studying in depth the specific implications for the effectiveness of R&D activities. Research into the economics of innovation and technological change has shown that the economic growth of firms, industries and countries in the long-run is heavily dependent on today's innovation strategies (Griliches, 1979; Romer, 1990). For this reason, understanding the impact of privatization processes on R&D investments and outcomes should be considered as a relevant issue for both researchers and policy-makers, given that in different countries SOEs have played a central role in directing and enhancing the development of national innovation system (Nelson, 1993; Katz, 2001). This paper represents a first step in this direction.

We have advanced that the literature on innovation and market value, inspired by the seminal contribution of Griliches (1981), can be an useful reference to address the issue of R&D performance after privatization. In particular, we have shown how Tobin's q can allow to gauge eventual changes in the expected economic results of R&D investments. Given the problems of simultaneity between R&D investments and Tobin's q, we have estimated a simultaneous equations model where also the R&D variable was treated as endogeneous.

The findings of the regression analyses suggest that R&D investments by newly privatized companies seem to be undervalued by the stock market compared to our benchmark of publicly held companies. In fact, the relation between Tobin's q and R&D capital, always positive and significant for the privately owned firms used as a control group, is rarely significant and sometimes even negative in the case of privatized firms, depending on the estimation model adopted.

Under the assumption of efficient capital markets, our results support the view of low private economic returns stemming from R&D activities of formerly publicly-owned enterprises, which can be theoretically explained in terms of excess of diversification and low productivity level. Our findings show that the beneficial effects brought by privatization on innovation activities do not take place overnight, but through a gradual process that can last several years, because of the inertia that typically characterizes the organizations and delay the adaptation to the new institutional and competitive context. This evidence is consistent with qualitative studies that document relevant restructuring processes within the R&D units of recently privatized firms and result in a period of high uncertainty and instability at the individual and organizational level (Munari, 2002; Munari et al., 2002).

Finally, it is important to acknowledge this paper's limitations. A first weakness is related to the small number of companies constituting our sample, which is strictly dependent on the limited number of privatization programs of relevant size that have occurred worldwide over the last twenty years. The possibility of considering larger samples in future research, for example by including firms privatized in developing economies, will largely depend on the objective difficulties of collecting reliable, publicly-available financial and innovation data on international companies.

A major difficulty in the assessment of firm-level changes in performance after privatization is related to the multiplicity of variables that intervene at different levels (firm, industry and country) and generate substantial noise around the ownership effect (Cuervo and Villalonga, 2000; Ramamurti, 2000). This was our main concern and we tried to control for it by adopting a matched-paired research design, as indicated by other works in the literature on

the consequences of privatization (Cragg and Dyck, 1999; La Porta and Loperz-de-Silanes, 1999).

Then, in our analysis we measured the firm's commitment to innovative activities by means of R&D investments. Further research could adopt alternative innovation measures in the market value model, for instance the number of patents assigned, which have been demonstrated to correlate more strongly to market valuation when their relative quality is considered (Hall et al., 2000). Moreover, we explicitly focused on the impact of privatization on the private economic returns to innovation activities, but ignored the issue of the effects in terms of social returns. Since the seminal works of Arrow (1962) and Nelson (1959), the economic literature has highlighted the existence of a relevant gap between the social and the private returns to R&D investments, the former being significantly higher expecially in the case of fundamental research activities. Assessing the impact of privatization on the long-term effects of innovation activities for social welfare appears an important and promising avenue for future studies, given the role played by SOEs in the technological and economic evolution of several industries of both industrialized and developing countries.

Despite these limitations, we believe that the evidence emerging from this study could stimulate new research and help shed light on a topic of great importance for researchers, managers and policy makers.

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Table 1 - Sample firms (privatized vs. matched firms)

	Privatized firm			Matched firm		
IPO year	*Name*	*Nat*	*Industry*	*Name*	*Nat*	*Industry*
1985	British Aerospace	UK	Aerospace & defence	BBA Group	UK	Motor Vehicles
1982	British Amersham	UK	Pharma	Glaxo	UK	Pharma
1986	British Gas	UK	Gas distribution	Burmah Castrol	UK	Oil&Gas
1982	British Petroleum	UK	Oil&gas	Shell	UK	Oil&gas
1988	British Steel	UK	Primary metal	Cookson Group	UK	Primary metal
1987	Rolls Royce	UK	Aerospace & defence	Westland Group	UK	Aerospace & defence
1986	Elf Aquitaine	FR	Oil&gas	Air Liquide	FR	Chemical
1986	Saint Gobain	FR	Stone, clay & glass	Valeo	FR	Motor Vehicles
1987	Alcatel-Alsthom	FR	Electronics & Tlc	Schneider	FR	Electrical
1993	Rhone-Poulenc	FR	Pharma	L'Oreal	FR	Soap & toiletries
1995	Pechiney	FR	Metal products	Fives Lille	FR	Machinery
1995	Usinor Sarcinor	FR	Metal Products	Legrand	FR	Electrical
1994	Renault	FR	Motor Vehicles	Peugeot	FR	Motor Vehicles
1997	Bull	FR	Computers	Compagnie des signaux	FR	Electronics & Tlc
1989	DSM	NE	Chemical	Akzo Nobel	NE	Chemical
1994	Kemira	FI	Chemical	Orion	FI	Pharma
1994	Outokompu	FI	Primary metal	Partek	FI	Machinery
1995	ENI	IT	Oil&gas	Montedison	IT	Chemical
1986	Nuovo Pignone	IT	Machinery	Magneti Marelli	IT	Electrical
1988	Volkswagen	DE	Motor Vehicles	Ford-Werke	DE	Motor Vehicles

Table 2. Variables description

Variable	Definition	Calculation (Datastream Code in Parentheses)
V	Total market value of the firm	Market capitalization at 12/31 (MV) + Loan capital (321) + Short-term borrowing (309)
RD	Annual R&D investments	Annual R&D investments (119)
RDC	R&D capital	Perpetual inventory of annual R&D expenditures (119)
A	Book value of net tangible assets	Total assets (392) – [Current liabilities (389) – Short-term borrowing (309)] – Total intangible assets (344)
I	Book value of other intangible assets	Total intangible assets (344)
D	Total financial debt	Loan capital (321) + Short-term borrowing (389)
S	Total sales	Total sales (104)
RDIND	Industry-level R&D intensity	2-digit ISIC annual R&D expenditures/ 2-digit ISIC output

Table 3 - Descriptive statistics for privatized and matched firms

	Obs	Mean	Std Deviation	Median
Privatized firms				
S (millions	103	14,100	13,800	9,836
A (millions	103	10,500	10,200	6,150
RD / A	103	.051	.045	.027
RDC / A	103	.219	.189	.125
I / A	103	.078	.129	.018
D / A	103	.411	.254	.378
Tobin's q	103	1.017	.492	.339
Publicly held firms				
S (millions	103	6,630	8,937	2,256
A (millions	103	3,837	5,555	1,310
RD / A	103	.063	.049	.049
RDC / A	103	.253	.195	.181
I / A	103	.112	.195	.028
D / A	103	.336	.221	.332
Tobin's q	103	1.540	1.274	.483

Table 4 – Correlations for privatized and matched firms

				Privatized firms			
	ln q	RD/A	RDC/A	I/A	D/A	ln S	RDIND
ln q	1.00						
RD/A	.23**	1.00					
RDC/A	.24**	.95***	1.00				
I/A	.15	.07	.10	1.00			
D/A	.11	-.05	.00	.08	1.00		
ln S	-.50***	-.31***	-.28***	.22**	.27***	1.00	
RDIND	.07	.75***	.72***	.07	-.16	-.27***	1.00
				Publicly held firms			
	ln q	RD/A	RDC/A	I/A	D/A	ln S	RDIND
ln q	1.00						
RD/A	.36***	1.00					
RDC/A	.32***	.98***	1.00				
I/A	.29***	.38***	.38***	1.00			
D/A	-.03	-.33	-.36***	.15	1.00		
ln S	-.01	.10	.10	.12	.23*	1.00	
RDIND	.18*	.31***	.34***	-.09	-.44***	-.40***	1.00

* significant at the ten percent level.
** significant at the five percent level.
*** significant at the one percent level.

Table 5 – Results of pooled OLS regression (dependent variable: ln q)

Variable	(1) Privatized firms	(1) Publicly held firms	(2) Privatized firms	(2) Publicly held firms
Intercept	1.985***	-.025	1.902***	-.117
	(.484)	(1.163)	(.479)	(1.183)
RD / A	1.286	7.504***		
	(.855)	(2.451)		
RDC / A			.386**	1.917***
			(.197)	(.639)
I / A	1.113***	.695	1.097***	.718
	(.288)	(.494)	(.286)	(.494)
D / A	.497***	.496	.489***	.596
	(.180)	(.360)	(.178)	(.367)
ln S	-.133***	-.010	-.127***	-.010
	(.030)	(.064)	(.030)	(.064)
Year dummies	YES	YES	YES	YES
Country dummies	YES	YES	YES	YES
R^2	.604	.378	.611	.375
N. of firms	20	20	20	20
N. obs.	103	103	103	103

* significant at the ten percent level.
** significant at the five percent level.
*** significant at the one percent level.

Table 6 – Results of fixed- and random-effects regression (dependent variable: ln q)

Variable	(1) Privatized firms **FE**	(1) Privatized firms **RE**	(1) Publicly held firms **FE**	(1) Publicly held firms **RE**	(2) Privatized firms **FE**	(2) Privatized firms **RE**	(2) Publicly held firms **FE**	(2) Publicly held firms **RE**
Intercept		2.454***		-.176		2.280***		-.303
		(.725)		(1.341)		(.746)		(1.358)
RD / A	-1.088	-.397	2.524	4.401**				
	(1.419)	(1.017)	(3.484)	(2.217)				
RDC / A					.313	.190	.544	1.103*
					(.494)	(.300)	(1.038)	(.597)
I / A	1.179***	1.037***	.245	.612	1.104***	.986***	.229	.591
	(.396)	(.322)	(.582)	(.422)	(.399)	(.325)	(.592)	(.431)
D / A	.211	.270	.413	.304	.206	.252	.393	.310
	(.263)	(.201)	(.441)	(.364)	(.264)	(.202)	(.441)	(.369)
ln S	-.203	-.189***	-.291	.041	-.250*	-.180***	-.256	-.034
	(.145)	(.048)	(.290)	(.091)	(.136)	(.049)	(.294)	(.091)
Year dummies	YES	YES	YES	YES	YES	YES	YES	YES
R^2	.898	.330	.825	.253	.897	.342	.824	.236
σ^2_ε		.315E-1		.133		.316E-1		.134
σ^2_ν		.894E-1		.251		.888E-1		.256
θ		.555E-1		.814E-1		.560E-1		.803E-1
Hausman test (p-value)		.149		.446		.160		.457
N. of firms	20	20	20	20	20	20	20	20
N. obs.	103	103	103	103	103	103	103	103

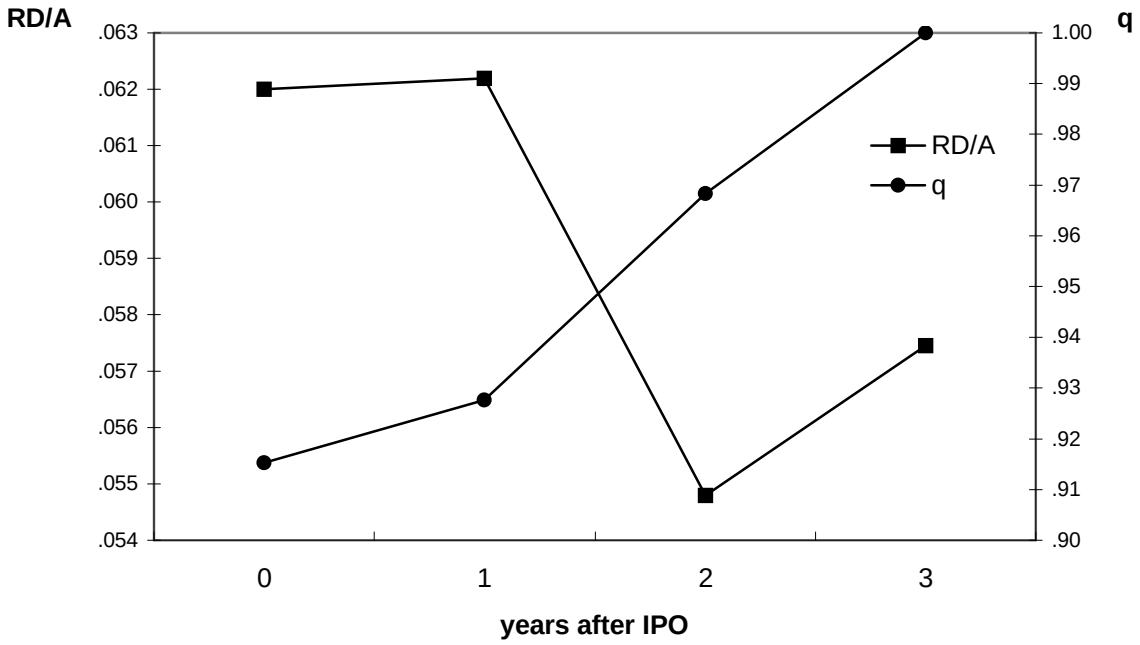
* significant at the ten percent level.
** significant at the five percent level.
*** significant at the one percent level.

Table 7 – Results of 2SLS regression

	(1) Privatized firms		(1) Publicly held firms		(2) Privatized firms		(2) Publicly held firms	
Dep. Variable	ln q	RD / A	ln q	RD / A	ln q	RDC / A	ln q	RDC / A
Ind. Variables								
Constant	2.361***	.081*	-.282	-.062	2.361***	.367*	-.207	-.303
	(.534)	(.043)	(1.319)	(.063)	(.536)	(.209)	(1.300)	(.245)
RD / A	-.404		8.795**					
	(1.251)		(3.965)					
RDC / A					.-.094		2.027**	
					(.292)		(.914)	
I / A	1.151***		.543		1.153***		.669	
	(.296)		(.616)		(.298)		(.575)	
D / A	.534***	.019	.523	-.065***	.534***	.125**	.611	-.270***
	(.185)	(.013)	(.366)	(.023)	(.186)	(.060)	(377)	(.090)
ln S	-.159***	-.005	-.002	.009**	-.159***	-.022	-.007	.038**
	(.034)	(.003)	(.067)	(.004)	(.034)	(0.014)	(.067)	(.015)
ln q		.001		.051***		-.030		.179***
		(.013)		(.012)		(.058)		(.048)
RDIND		.316***		.079		1.284***		.446*
		(.029)		(.069)		(.132)		(.268)
Year dummies	YES	NO	YES	NO	YES	NO	YES	NO
Country dummies	YES	NO	YES	NO	YES	NO	YES	NO
R^2	.583	.590	.376	.133	.581	.530	.375	.182
N. of firms	20	20	20	20	20	20	20	20
N. obs.	103	103	103	103	103	103	103	103

* significant at the ten percent level.
** significant at the five percent level.
*** significant at the one percent level.

Figure 1 - RD/A ratio (left axis) and Tobin's q (right axis) for privatized firms (only 13 firms for which observations are available for all the years from year 0 to year 3 after privatization)



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(xlii) This paper was presented at the International Workshop on "Climate Change and Mediterranean Coastal Systems: Regional Scenarios and Vulnerability Assessment" organised by the Fondazione Eni Enrico Mattei in co-operation with the Istituto Veneto di Scienze, Lettere ed Arti, Venice, December 9-10, 1999.

(xliii)This paper was presented at the International Workshop on "Voluntary Approaches, Competition and Competitiveness" organised by the Fondazione Eni Enrico Mattei within the research activities of the CAVA Network, Milan, May 25-26,2000.

(xliv) This paper was presented at the International Workshop on "Green National Accounting in Europe: Comparison of Methods and Experiences" organised by the Fondazione Eni Enrico Mattei within the Concerted Action of Environmental Valuation in Europe (EVE), Milan, March 4-7, 2000

(xlv) This paper was presented at the International Workshop on "New Ports and Urban and Regional Development. The Dynamics of Sustainability" organised by the Fondazione Eni Enrico Mattei, Venice, May 5-6, 2000.

(xlvi) This paper was presented at the Sixth Meeting of the Coalition Theory Network organised by the Fondazione Eni Enrico Mattei and the CORE, Université Catholique de Louvain, Louvain-la-Neuve, Belgium, January 26-27, 2001

(xlvii) This paper was presented at the RICAMARE Workshop "Socioeconomic Assessments of Climate Change in the Mediterranean: Impact, Adaptation and Mitigation Co-benefits", organised by the Fondazione Eni Enrico Mattei, Milan, February 9-10, 2001

(xlviii) This paper was presented at the International Workshop "Trade and the Environment in the Perspective of the EU Enlargement ", organised by the Fondazione Eni Enrico Mattei, Milan, May 17-18, 2001

(xlix) This paper was presented at the International Conference "Knowledge as an Economic Good", organised by Fondazione Eni Enrico Mattei and The Beijer International Institute of Environmental Economics, Palermo, April 20-21, 2001

(l) This paper was presented at the Workshop "Growth, Environmental Policies and Sustainability" organised by the Fondazione Eni Enrico Mattei, Venice, June 1, 2001

(li) This paper was presented at the Fourth Toulouse Conference on Environment and Resource Economics on "Property Rights, Institutions and Management of Environmental and Natural Resources", organised by Fondazione Eni Enrico Mattei, IDEI and INRA and sponsored by MATE, Toulouse, May 3-4, 2001

(lii) This paper was presented at the International Conference on "Economic Valuation of Environmental Goods", organised by Fondazione Eni Enrico Mattei in cooperation with CORILA, Venice, May 11, 2001

(liii) This paper was circulated at the International Conference on "Climate Policy – Do We Need a New Approach?", jointly organised by Fondazione Eni Enrico Mattei, Stanford University and Venice International University, Isola di San Servolo, Venice, September 6-8, 2001

(liv) This paper was presented at the Seventh Meeting of the Coalition Theory Network organised by the Fondazione Eni Enrico Mattei and the CORE, Université Catholique de Louvain, Venice, Italy, January 11-12, 2002

(lv) This paper was presented at the First Workshop of the Concerted Action on Tradable Emission Permits (CATEP) organised by the Fondazione Eni Enrico Mattei, Venice, Italy, December 3-4, 2001

(lvi) This paper was presented at the ESF EURESCO Conference on Environmental Policy in a Global Economy "The International Dimension of Environmental Policy", organised with the collaboration of the Fondazione Eni Enrico Mattei , Acquafredda di Maratea, October 6-11, 2001

(lvii) This paper was presented at the First Workshop of "CFEWE – Carbon Flows between Eastern and Western Europe", organised by the Fondazione Eni Enrico Mattei and Zentrum fur Europaische Integrationsforschung (ZEI), Milan, July 5-6, 2001

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