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STOCK MARKET VALUATION OF R&D INVESTMENT: THE CASE OF ITALY

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“Nowadays people know the price of everything and the value of nothing…”

O. Wilde

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1. INTRODUCTION

The question of how research and development (R&D) investment affects the performance of the firm is of considerable interest to economists and other researchers. As noted by Lev (1999), empirical research on the R&D activities and capital markets indicates that markets consider firms' investments in R&D as a significant value-increasing activity. Bublitz and Ettredge (1989), for instance, find that the slope coefficient of regressing stock returns on R&D expenditures is positive, suggesting that stock market values R&D expenditures as an asset rather than a cost. Similar results are reported by Chaucin and Hirschey (1993) and Green, Stark and Thomas (1996), among others.

Even if has been recognized the importance of R&D-related assets for the firm's success in the long run, we are still lacking satisfactory methods to assess its economic value. Indeed, the valuation of technological assets is complicated by several difficulties related to both the very nature of the knowledge generated through the R&D investments and the uncertainty connected to the subsequent technology commercialization (Oriani 2003). This shortcoming affects several important funding decisions inside and outside the firm. However, as noted by Oriani (2003), a stream of empirical literature drawing from the fields of industrial organization and financial economics has extensively coped with the questions concerning the valuation of firms' innovation activities by the financial markets. In this respect, several different estimation methodologies, data sources and variables have been adopted.

Several studies based on US and UK data have used market value as an indicator of the firm's expected R&D performance. A common result of studies investigating the stock market response to R&D expenditures is that the stock market regards R&D expenditure as investment rather than a cost. Consequently, R&D expenditures are positively related to stock returns and other market

valuation measures, such as book-to-market ratio. However, there is little empirical evidence on the issue from other than the US markets. This is most probably due to the absence, in several countries, of comprehensive disclosure requirements concerning research and development activities. Hall & Oriani (2006) tried to fill this gap using a newly constructed panel dataset of firms which are publicly traded in France, Germany, and Italy.

In this paper we take another step investigating the stock reaction to information releases regarding the R&D expenditures in Italy. This investigation is important for several reasons. Italy is one of the largest economy and plays an important role in many international issues. But the Italian economy has several characteristics that makes it unique as the specificity of its capital market, corporate governance regime and law system. Italy, like other Countries in the European Union such as Germany and France, is characterized by a civil law system, where the rights of minority shareholders and creditors are less protected than in the UK and the US, having a common law system (La Porta et al., 1998, 2000). The distinction between civil and common law jurisdictions becomes, in economical terms, a distinction between insider and outsider systems whereas to civil law jurisdictions match up insider financial systems and to common law match up outsider financial systems. In insider financial systems external investors are more exposed to the risk of expropriation by controlling shareholders and ownership structures tend to be more concentrated than in outsider financial system (La Porta et al., 1999). The differences in legal regimes and ownership structures are particularly important for the market valuation of R&D investments, since, as demonstrated by Aboody and Lev (2000), these investments create higher information asymmetries that can favor expropriation by insiders more than other corporate investments. Accordingly, the presence of a controlling shareholder, jointly with a poor protection of minority shareholders, could negatively impact on the market value of R&D investments in Italy. We use an event study methodology to investigate markets response to announcements of increased R&D spending made by Italian firms which are listed in Borsa Italiana Stock Exchange.

2. R&D INVESTMENT AND STOCK MARKET VALUE

As noted by Oriani (2003), literature on innovation is based on the fundamental idea that choices related to the development and use of technology have a critical impact on the firm's performance, so far as to affect his own chances of survival (Suarez e Utterback (1995), Iansiti (1997), Christensen(1997) Christensen et al. (1998), Tegarden et al. (1999)). Innovation acquires a particular strategic and economic importance when it is able to increase and renew the business intangible assets such as knowledge and skills (Abernathy Clark (1985)).

Despite the technological knowledge in this perspective becomes a key variable in explaining the competitive position of the company (Winter 1987, Clark 1987, De Leo 1995, Zack 1999) , there is still a lack of appropriate management tools for its measurement and evaluation (Teece, 1998a; Lev 2001). In particular issues relating to the determination of the real value of knowledge in relation to corporate performance are still open. These limitations create problems for management and outside investors regarding the evaluation and financing of innovative activities.

This situation is largely due to difficulties related to the definition of technological knowledge and uncertainty associated with its potential economic exploitation, which pose challenges from a theoretical and methodological point of view.

The evaluation of R&D activities is seriously impeded by antiquated accounting rules and insufficient disclosure by corporations (Oriani 2003). Despite the obvious benefits of R&D, which generally stretch over extended periods of time, this investment is immediately expensed (written off) in corporate financial reports, leaving no trace of R&D capital on firms' balance sheets and causing material distortions of reported profitability.[1]

[1] The most obvious effect of this accounting practice is to reduce current earnings for companies with high R&D growth. But, a more subtle distortion is the tendency to *inflate* popular return-on-investment measures like ROE and ROA.

The complexity inherent the concept of knowledge is compounded by difficulties due to the low information content on the intangible assets that normally characterizes the company reports which makes measurement effort even more difficult (Lev 1999). It is also difficult to identify clearly the effect of intangibles on the firm's performance, because their power to influence the characteristics of products and services is not always easily observed, especially for outside investors. That fact, of course, creates problems for the definition of performance measures and analytical models on this kind of relationship. The need for a systemic theory of knowledge that goes beyond the usual static and atomistic hypothesis, leading to a more precise determination of its value is therefore perceived by scholars of business issues (Rullani 1994, De Leo 1995 Teece 1998b, Nova 2000). In this perspective, empirical studies that look across different firms and sectors may give strength to new theoretical developments, as well as a more efficient management applications in the field investigated.

In fact there is a large financial and economic literature that has examined the relationship between different measures of technological knowledge and the firm market value, chosen as an indicator of economic performance. The methods used are very different among themselves, and few studies have attempted to systematically review the results (eg. Hall 1999). In general, the empirical approaches used are based on general equilibrium models, but offer a potential contribution, yet poorly investigated, to analysis of issues relating to the evaluation of the technological asset of the company. The results obtained from this analysis in fact pose some questions that are potentially of great interest. First, while showing that the stock market assigns a positive value to the technology assets of the company, this researches show how this value is very variable over time and different environmental contexts (Lustgarten e Thomadakis 1987; Cockburn e Griliches 1988, Hall 1993a 1993b, Lev e Zarowin 1998) , suggesting the existence of factors in terms of economic, sector and enterprise levels which influence the evaluation of technology. Furthermore, the authors analyzing the relationship between R&D investment and subsequent stock returns have

observed that, after checked for firm and industry-specific factors, firms with a higher intensity in R&D have significantly higher yields, advancing the hypothesis of a their previous underestimation (Lev and Sougiannis 1996 1999, Chan et al 1990). An opposite indication is provided by Hall and Hall (1994), according which the market evaluates the R&D investments more than is justifiable on the basis of future performance.

Such studies may provide a valuable reference for the literature on business innovation. We must however consider the risk which it encounters when using techniques from adjacent disciplines. It could happen that the assumptions behind them are not compatible with those based on studies of corporate strategy. The biggest problem may arise from difficulties of financial and econometric methods to capture the complexity of strategic choices that are normally the result of a decision-making process and a series of interrelated actions over time (Lubatkin and Shrieves 1986).

2.1 R&D and Firm's Performance

One of the first problems that must be addressed in order to achieve empirical investigations on the issues under consideration is the definition of variables that measure the technological knowledge. Of course, this question poses many difficulties. First, knowledge is incorporated into different "containers" such as people, processes and systems (Leonard Barton 1992) and is often not codified (Nonaka and Takeuchi 1995, Zander and Kogut 1995, De Leo 1995), so its detection and measurement are particularly complex. Moreover, the technological knowledge is closely linked to other tangible and intangible assets (Adler and Shenhar 1990, Christensen 1996).

This complexity, coupled with the multi-dimensionality that characterizes the concept of knowledge, makes it virtually impossible to define indices that aggregate all aspects. However, even if it is extremely difficult any attempt at measurement, it is possible to investigate the contribution of specific activities on the creation and in the use of technological knowledge capital (Griliches 1995 pp. 76-77). Many studies have adopted this approach, focusing on the R&D activity

on firm technological knowledge. In a formal way, Griliches (1995) defines technological knowledge as a function of R&D investment:

$$K=G\,[W\,(R),\,v] \qquad (2.1.1)$$

where K is the current level of technological knowledge, W (R) is an index of past and current R&D expenses R, or other variables that measure the firm efforts to innovate, and v is a set of non-measurable factors that have an effect on technological knowledge asset.

R&D investments create value for the firm when they generate business intangible capital represented by the new knowledge (Griliches 1981). If we assume that they can be capitalized in accordance with a linear aggregation function[2] and depreciated over time at a constant rate, it is possible to calculate an initial measure of the technological knowledge of the firm (Griliches and Mairesse 1984, Hall 1990) [3]:

$$K_t = (1 - \delta)\, K_{t-1} + R_t \qquad (2.1.2)$$

where K_t is the stock of R&D at year t, R_t is the investment in R&D at year t and δ is the depreciation rate of the R&D stock from year t-1 to year t. Usually the studies observed choose a depreciation rate of $\delta = 0.15$ constant over time (Jaffe 1986, Cockburn and Griliches 1998, Hall 1993a 1993b, Bundell et al. 1999). More analysis instead try to estimate specific depreciation rates for sectors or firms[4].In some cases (for example 1993a Hall, Hall and Vopel, 1996), the annual R&D

[2] The assumption of a linear form of the aggregate function is a simplification, justified by the need to determine an "accounting" measure and not economic of the knowledge. In more complex models can be assumed that the growth rate of knowledge depends on the development stage of technology (eg Nova 2000).

[3] The use of a depreciation rate was due to the decay of knowledge over time (Argote et al. 1990), is the loss of economic value due to the technology progress.

[4] Lev and Sougiannis (1996, 1999), for example, using a procedure that, starting from the accounting profits of the firm, for each sector and each year makes it possible to calculate a different depreciation rate for R&D capital, while Megna and Klock (1993) estimate d introducing a special version of (2.1.2) within the equation of the market value of the firm.

investment is used as an alternative to R&D capital, in view of empirical evidence concerning their persistence over time (Hall et al. 1986).

The use of measures based on R&D investments still does not resolve in a definitive manner the issues relating to the measurement of technological assets for the firm. A first problem arises from scarcity and inadequacy of information on R&D activities in the corporate reports. In effects, the international accounting standards (Generally Accepted Accounting Principles, GAAP) require that R&D investments are not capitalized, but written immediately in the income statement, because of the lack of a clear link with the future economic performance of the firm. So according the accounting perspective, this kind of investment does not contribute to the amount of the capital invested[5]. A further complication arises from the fact that not in all countries companies are required to bear the R&D expenditures separately from other costs of production, so often is particularly difficult to obtain quantitative information on innovative activities at firm level[6]. However, even if there were no problems of reporting, you should address the difficulties concerning the nature of R&D investments. These represent a measure of input, not output, of the innovation processes. They does not have, moreover, a result directly observable or predictable on firm performance, but their value for the firm is linked to the establishment and renewal of the knowledge (Abernathy and Clark 1985). Therefore, their effect on the firm performance is characterized by a high level of uncertainty[7]. The empirical analysis made by Kothari et al

[5] Normally the capitalization of R&D investments is prohibited or permitted only in the presence of specific conditions because of the uncertainty regarding their expected returns. The IAS 38 standard issued by International Accounting Standards Board (IASB) provides that an intangible asset can be capitalized only if it is probable that the economic benefits attributable to it are actually obtained and that its cost can be measured with reliability (www.iasc.org.uk). In Italy, particularly, accounting principals by "Consiglio Nazionale dei Dottori Commercialisti" on "intangible assets" specify that for the capitalization of R&D costs is necessary that these costs relate to a project clearly defined and achievable and are recoverable through the revenue streams that will developed from the project itself (www.cndc.it).

[6] In Europe, for example, the only country where companies are required to report R&D investments separately from other costs is the UK. See Belcher (1996).

[7] Encaoua et al. (2000) distinguish three types of uncertainty relevant to the economic analysis of R&D investments: one linked to the actual capacity of the research projects to generate new knowledge; a second, of strategic nature, linked to the fact that the company is not safe to be the first in launching a new product; third, related to the changing market demand.

(1999) has shown that R&D investments actually increases the uncertainty associated with firm's future earnings.

2.2 Market Value as Performance Indicator

In order to empirically test the relationship between technological knowledge and company results we need to choose a performance measure. One of the possible approaches is to analyze the relationship between innovation measures and profit measures or accounting profitability indices (eg Sougiannis 1994, McEvily and Chakravarthy 1999). In reality these methods have limitations associated with the same kind of indicators used. First the existence of time lags between long and uncertain R&D investments and the effects on firm's performance can prevent an analysis based on accounting indices to consider those effects that go beyond the time considered (Hall 1999). Furthermore, the accounting rate of return is very sensitive to changes in standards or fiscal policies, and even if correctly determined, is not representative of the economic rate of return on investment of a company (Fisher and McGowan 1983). Finally, the use of accounting standards leads to systematically underestimate the value of R&D results, which may depend largely on the creation of strategic options for the future (McGrath 1997).

Alternatively we can use methods that make related R&D investments with the firm market value. According to financial theory, the firm market value should be equal to the sum of the present value of cash flows generated by activities carried out and the present value of cash flows created through the exploitation of future investment opportunities (Myers, 1977, Berk et al. 1999 Jagle 1999). Therefore the use of measures based on market value permits in principle to measure the effect of R&D investment on both existing activities and creating new investment opportunities. The choice of this indicator as a performance measure has the advantage over accounting methods to take a perspective view (Hall 1999, Bharadwaj et al. 1999). It also uses a discount rate of firm cash flows corrected for systematic risk and reduces distortions due to tax and accounting laws (Montgomery and Wernerfelt 1988). In particular, the Tobin's q, which is the ratio between market value and replacement cost of the firm asset, has some interesting

properties. In fact, comparing market data with accounting data, offers the opportunity to examine the difference in the value of input and output (Lindenberg and Ross 1981).

Of course the use of performance measures based on market value requires some assumptions on financial markets. In particular, it presupposes that these are efficient, meaning that stock prices reflect all available information (Fama 1991)[8]. Under this assumption, the market capitalization is a measure that reasonably approximate the present value of all expected cash flows of the firm. Furthermore, the firm value should change when the market receives new information of a general or specific action that changes the expectations about the expected cash flows from current and future activities (Woolridge and Snow 1990)[9].

Under the assumption of efficient markets, shareholders of listed companies agreed with the principle that investment decisions should be evaluated with reference to their impact on the firm market value (Fama and Jensen 1985)[10]. In these circumstances, we can assume that the investment policy of the firm about capital and R&D is aimed at maximizing its market value (Pakes 1985, Hall 1993b). Despite the debate on this issue is still open, there is strong empirical evidence in favor of the efficiency assumption (Fama 1970 1991, Woolridge and Snow 1990).

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[8] Fama (1970) distinguishes three different degrees of market efficiency: weak, where the set of available information is the only historical prices, semi-strong, in which all publicly available information is concerned, strong, in which investors have access to all possible relevant information. Naturally, this definition assumes that the information is publicly available and free. We can still give a definition of efficient markets even in the presence of costly information. In this case, the prices reflect all information available up to that point where the marginal benefits due to action based on new information equal marginal costs to acquire new information (Jensen 1978).

[9] Romer (1993) proposes a model where there is some possibility that price movements are consistent with the assumption of market efficiency, even without the arrival of new information. The idea behind this contribution is that prices of different data sets available are owned by different investors and that the market reveals imperfectly information owned by each investor . Therefore, even in the absence of new information, it is possible that the market reacts to “insider news", ie new information revealed by the behavior of investors.

[10] We need to stress that shareholders in public companies are not involved directly in decision making and that the agency theory has revealed the existence of conflicts of interest with managers (Jensen and Meckling 1976). However, in a logic of second best, the objective of maximizing the market value of the firm is respected, because regulatory mechanisms are activated to the point that their cost equals the market value attributed to the increased ability to control decisions (Fama and Jensen 1983).

The assumption of efficient markets has some important implications for the analysis that follows. First, if R&D investments create an intangible capital that can generate revenue streams in the future, this capital should be reflected in the market value of the firm (Griliches 1981). Secondly, the stock market reactions to firm announcements regarding the R&D activities should represent the assessment of the market for business decisions (Woolridge and Snow 1990). Finally, changes in share price reflect variations in market expectations on the present value of expected cash flows, at least in part due to results obtained from research laboratories of the firm (Pakes 1985).

The use of performance measures based on market value, however, poses some problems that we need to be aware. First, the value of the firm is the sum of the market value of equity and the market value of debt. However, while data on the first are easily obtainable from stock quotes, data on the second are rarely available, especially for European companies, so empirical studies often estimate the market value of the firm by adding up the amount of the accounting value of debt to market capitalization (eg Bundell et al. 1992 1999). Tobin's q also poses some specific problems arising from the fact that its denominator, represented by the value of assets, systematically underestimates the component of intangible assets (Lev 2001). Any comparisons between the performance of different companies based on Tobin's q can be influenced by the different conduct of their activities on the exploitation of intangible assets (Demsetz and Villalonga 2001).

2.3 Empirical Evidence

A common result of studies investigating the stock market response to R&D expenditures is that the stock market regards R&D expenditures as investment rather than a cost. Consequently, R&D expenditures are positively related to stock returns and other market valuation measures, such as book-to-market ratio. However, there is little empirical evidence on the issue from other than the US markets. This is most probably due to the absence, in several countries, of comprehensive disclosure requirements concerning research and development activities. Regarding the US stock market, Bublitz and Ettredge (1989) document

that that the annual R&D expenditures can be used to explain abnormal stock returns. Similar results are reported by Green, Stark and Thomas (1996) in the UK. The above-mentioned studies use only the current R&D expenditures in the valuation models while it can be expected that past R&D expenditures are also value relevant. The use of current R&D expenditures is based on the assumption that current R&D expenditures measure the stock of R&D capital of a firm.

Lev and Sougiannis (1996, 1999) find that the R&D capital is significantly associated with stock returns. This indicates that the stock market regards R&D capital as a valuable asset rather than a cost.

3. EVENT STUDY ANALYSIS

Economists are frequently asked to measure the effect of an economic event on the value of the firm. On the surface this seems like a difficult task, but a measure can be constructed easily using financial market data in an event study. The usefulness of such a study comes from the fact that, given rationality in the marketplace, the effect of an event will be reflected immediately in asset prices. Thus the event's economic impact can be measured using asset prices observed over a relatively short time period. In contrast, direct measures may require many months or even years of observation.

The general applicability of the event-study methodology has lead to its wide use. In the academic accounting and finance field, event-study methodology has been applied to a variety of firm-specific and economy-wide events. Some examples include mergers and acquisitions, earning announcements, issues of new debt or equity, and announcements of macroeconomic variables such as trade deficit. However applications in other fields are also abundant. For example, event studies are used in the field of law and economics to measure the impact on the value of a firm of a change in the regulatory environment, and in legal-liability cases event-studies are used to assess damages [11]. In most applications, the focus is the effect of an event on the price of a particular class of securities of the firm, most often common equity.

Event study have a long history. Perhaps the first published study is Dolley (1933). Dolley examined the price effects of stock splits, studying nominal price changes at the time of the split. Over the decades from the early 1930s until the late 1960s the level of sophistication of event studies increased. Myers and Bakay (1948), Barker (1958), and Ashley (1962) are examples of studies during this period. The improvements include removing general stock market price

[11] See Mitchell and Netter (1994)

movements and separating out confounding events. In the late 1960s seminal studies by Ball and Brown (1968) and Fama, Fisher, Jensen, and Roll (1969) introduced the methodology that is essentially still in use today. Ball and Brown considered the information content of earning, and Fama, Fisher, Jensen, and Roll studied the effects of stock splits after removing the effect of simultaneous dividend increases.

In the years since these pioneering studies, several modifications of the basic methodology have been suggested. These modifications handle complications arising from violations of the statistical assumptions used in the early work, and they can accommodate more specific hypotheses. Brown and Warner (1980, 1985) are useful papers that discuss the practical importance of many of these modifications. The 1980 paper considers implementation issues for data sampled at a monthly interval and the 1985 paper deals with issues for daily data.

3.1 Outline of an Event Study

At the outset is useful to give a brief outline of the structure of an event study. While there is no unique structure, the analysis can be viewed as having seven steps[12]:

1. *Event definition.* The initial task of conducting an event study is to define the event of interest and identify the period over which the security prices of the firms involved in this event will be examined – the *event window.* For example if one is looking at the information content of an earning announcement with daily data, the event will be earning announcement and the event window might be the one day of the announcement. This is done to capture the price effects of the announcements which occur after the stock market closes on the announcement day. The period prior to or after the event may also be of interest and included separately in the analysis. For example in the earnings-announcement case, the market may acquire information about the earning prior to the actual announcement and one can investigate this possibility by examining pre-event returns.

[12] Campbell, Lo, Mackinlay (1997) ch. 4.

2. *Selection criteria.* After identifying the event of interest, it is necessary to determine the selection criteria for the inclusion of a given firm in the study. The criteria may involve restrictions imposed by data availability such as listing on a stock market or may involve restrictions such as membership in a specific industry. At this stage it is useful to summarize some characteristics of the data sample (e.g., firm market capitalization, industry representation, distribution of events through time) and note any potential biases which may have been introduced through the sample selection.
3. *Normal and abnormal returns.* To appraise the event's impact we require a measure of the abnormal return. The abnormal return is the actual *ex post* return of the security over the event window minus the normal return of the firm over the event window. The normal return is defined as the return that would be expected if the event did not take place. For each firm *i* and event date *t* we have

$$\varepsilon^*_{it} = R_{it} - E\,[R_{it} \mid X_t]\,, \qquad (3.1.1)$$

where ε^*_{it} , R_{it} , and $E\,(R_{it})$ are the abnormal, actual, and normal returns, respectively, for time period *t.* X_t is the conditioning information for the normal performance model. There are two common choices for modeling the normal return – the *constant-mean-return model* where X_t is a constant and the *market model* where X_t is the market return. The constant-mean-return model, as the name implies, assumes that the mean return of a given security is constant through the time. The market model assumes a stable linear relation between the market return and the security return.
4. *Estimation procedure.* Once a normal performance model has been selected, the parameters of the model must be estimated using a subset of the data known as the *estimation window*. The most common choice, when feasible, is to use the period prior to the event window for the estimation

window. For example, in an event study using daily data and the market model, the market model parameters could be estimated over the 120 days prior to the event. Generally the event period itself is not included in the estimation period to prevent the event from influencing the normal performance model parameter estimates.

5. *Testing procedure.* With the parameter estimates for the normal performance model, the abnormal return can be calculated. Next, we need to design the testing framework for the abnormal returns. Important considerations are defining the null hypothesis and determining the techniques for aggregating the abnormal returns of individual firms.
6. *Empirical results.* The presentation of the empirical results follows the formulation of the econometric design. In addition to presenting the basic empirical results, the presentation of diagnostics can be fruitful. Occasionally, especially in studies with a limited number of event observations, the empirical results can be heavily influenced by one or two firms. Knowledge of this is important for gauging the importance of the results.
7. *Interpretation and conclusions.* Ideally the empirical results will lead to insights about the mechanisms by which the event affects security prices. Additional analysis may be included to distinguish between competing explanations.

3.2 Models for Measuring Normal Performance

A number of approaches are available to calculate the normal return of given security. The approaches can be loosely grouped into two categories – statistical and economic. Models in the first category follow from statistical assumptions concerning the behavior of asset returns and do not depend on any economic arguments. In contrast, models in the second category rely on assumptions concerning investors' behavior and are not based solely on statistical assumptions. It should, however, be noted that to use economic models in practice it is

necessary to add statistical assumptions. Thus the potential advantage of economic models is not the absence of statistical assumptions, but the opportunity to calculate more precise measures of normal return using economic restrictions.

For the statistical models, it is conventional to assume that asset returns are jointly multivariate normal and independently and identically distributed through time. Formally, we have:

(A1) Let $\mathbf{R_t}$ *be an (N × 1) vector of asset returns for calendar time period t.* $\mathbf{R_t}$ *is independently multivariate normally distributed with mean* $\boldsymbol{\mu}$ *and covariance matrix* $\boldsymbol{\Omega}$ *for all t.*

This distributional assumption is sufficient for the constant-mean-return model and the market model to be correctly specified and permits the development of exact finite-sample distributional results for the estimators and statistics. Inferences using the normal return models are robust to deviations from the assumption.

3.2.1 Constant-Mean-Return Model

Let μ_i the *i*th element of $\boldsymbol{\mu}$, be the mean return for asset *i*. then the constant-mean-return model is

$$Rit = \mu_i + \xi_{it} \qquad (3.2.1)$$

$$E[\xi_{it}] = 0 \qquad Var[\xi_{it}] = \sigma^2_{\xi i}$$

where R_{it} is the *i*th element of $\mathbf{R_t}$, is the period –*t* return on security *i,* ξ_{it} is the disturbance term, and $\sigma^2_{\xi i}$ is the (*i*, *i*) element of $\boldsymbol{\Omega}$.

Although the constant-mean-return model is perhaps the simplest model, Brown and Warner (1980, 1985) find it often yields results similar to those of more sophisticated models. This lack of sensitivity to the model choice can be attributed to the fact that the variance of the abnormal return is frequently not reduced much

by choosing a more sophisticated model. When using daily data the model is typically applied to nominal returns. With monthly data the model can be applied o real returns or excess returns (the return in excess of the nominal riskfree return generally measured using treasury bill) as well as nominal returns.

3.2.2 Market Model

The market model is a statistical model which relates the return of any given security to the return of the market portfolio. The model's linear specification follows from the assumed joint normality of asset returns[13].

For any security *i* we have

$$R_{it} = \alpha_i + \beta_i R_{mt} + \varepsilon_{it} \qquad (3.2.2)$$

$$E[\xi_{it}] = 0 \qquad \text{Var}[\xi_{it}] = \sigma^2_{\xi i}$$

where R_{it} and R_{mt} are the period-*t* returns on security *i* and the market portfolio, respectively, and ε_{it} is the zero mean disturbance term. α_i, β_i, and $\sigma^2_{\xi i}$ are the parameters of the market model. In application a broad-based stock index is used for the market portfolio, the MSCI Italy index and the FTSE Mib index being popular choices. The market model represents a potential improvement over the constant-mean-return model. By removing the portion of the return that is related to variation in the market's return, the variance of the abnormal return is reduced. This can lead to increased ability to detect event effects. The benefit from using the market model will depend upon the R^2, the greater is the variance reduction of the abnormal return, and the larger is the gain.

3.2.3 Other Statistical Models

A number of other statistical models have been proposed for modelling the normal return. A general type of statistical model is the *factor model.* Factor model potentially provide the benefit of reducing the variance of the abnormal return by

[13] The specification actually requires the asset weights in the market portfolio to remain constant. However, changes over time in the market portfolio weights are small enough that they have little effect on empirical work.

explaining more of the variation in the normal return. Typically the factors are portfolios of traded securities. The market model is an example of a one-factor model, but in a multifactor model one might include industry indexes in addition to the market. Sharpe (1970) and Sharpe, Alexander, and Bailey (1995) discuss index models with factors based on industry classification. Another variant of a factor model is a procedure which calculates the abnormal return by taking the difference between the actual return and a portfolio of firms of similar size, where size is measured by market value of equity. In this approach typically ten size groups are considered and the loading on the size portfolios is restricted to unity. This procedure implicitly assumes that expected return is directly related to the market value of equity.

In practice the gains from employing multifactor models for event studies are limited. The reason for this is that the marginal explanatory power of additional factors beyond the market factor is small, and hence there is a little reduction in the variance of the abnormal return. The variance reduction will typically be greatest in cases where the sample firms have a common characteristic, for example they are all members of one industry or they are all firms concentrated in one market capitalization group. In these cases the use of a multifactor model warrants consideration.

Sometimes limited data availability may dictate the use of a restricted model such as the *market-adjusted-return-model*. For some events it is not feasible to have a pre-event estimation period for the abnormal return is used. The market-adjusted-return model can be viewed as a restricted market model with α_i constrained to be 0 and β_i constrained to be 1. Since the model coefficients are prespecified, an estimation period is not required to obtain parameter estimates. This model is often used to study the underpricing of initial public offerings. A general recommendation is to use such restricted models only as a last resort, and to keep in mind that biases may arise if the restrictions are false.

3.2.4 Economic Models

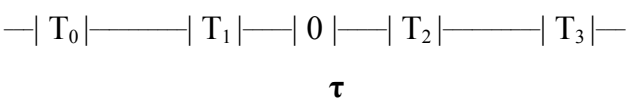
Economic models restrict the parameters of statistical models to provide more constrained normal return models. Two common economic models which provide restrictions are Capital Asset Pricing Model (CAPM) and exact versions of the Arbitrage Pricing Theory (APT). the CAPM, due to Sharpe (1964) and Lintner (1965), is in equilibrium theory where the expected return of a given asset is a linear function of its covariance with the return of the market portfolio. The APT, due to Ross (1976), is an asset pricing theory where the absence of asymptotic arbitrage the expected return of a given asset is determined by its covariances with multiple factors.

The Capital Asset Pricing Model was commonly used in event studies during the 1970s. During the last ten years, however deviations from the CAPM have been discovered, and this casts doubt on the validity of the restrictions imposed by the CAPM on the market model. Since these restrictions can be relaxed at little cost by using the market model, the use of the CAPM in event study has almost ceased.

Some studies have used multifactor normal performance models motivated by the Arbitrage Pricing Theory. The APT can be made to fit the cross-section of mean returns, as shown by Fama and French (1996) and others, so a properly chosen APT model does not impose false restrictions on mean returns. on the other hand the use of the APT complicates the implementation of an event study and has little practical advantage relative to the unrestricted market model. See, for example, Brown and Weinstein (1985). There seems to be no good reason to use an economic model rather than a statistical model in an event study.

3.3 Measuring and analyzing abnormal returns

Figure 3.1 Time line for an Event Study



T_0- T_1= estimation window

T_1- T_2= event window

T_2- T_3= post-event window

First of all we need to define some notation. We index returns in event time using τ . Defining τ as the event date, $\tau = T_1 + 1$ to $\tau = T_2$ is the event window, and $\tau = T_0 + 1$ to $\tau = T_1$ is the estimation window. Let $L_1 = T_1 - T_0$ and $L_2 = T_2 - T_1$ be the length of the estimation window and the event window (figure 3.1). An important assumption throughout the event-study methodology is that the event is exogenous with respect to the change in market value of the security.

3.3.1 Estimation of the Market Model

Recall, that the market model for security *i* and observation is τ in event time is

$$R_{it} = \alpha_i + \beta_i R_{mt} + \varepsilon_{it} \qquad (3.3.1)$$

The estimation-window observations can be expressed can be expressed as a regression system

$$R_i = X_i\theta_i + \varepsilon_i \qquad (3.3.2)$$

where $Ri = [R_{iT_0+1} \cdot \cdot \cdot R_iT_1]'$ is an $(L_1 \times 1)$ vector of the estimation window returns, $X_i = [\iota\ R_m]$ is an $(L_1 \times 2)$ matrix with a vector of ones in the first column and the vector of market return observations $R_m = [R_{mT_0+1} \cdot \cdot \cdot R_{mT_1}]'$ in the second

column, and the $\theta_i = [\alpha_i \quad \beta_i]'$ is the (2 × 1) parameter vector. X has a subscript because the estimation window may have timing that is specific to firm *i*. Under general conditions ordinary least squares (OLS) is a consistent estimation procedure for the market-model parameters. Further, given the assumption 3.2, OLS is efficient.

3.3.2 Statistical Properties of Abnormal Returns

Given the market-model parameter estimates from the estimation window, it is possible to estimate and test the abnormal returns. Let $\hat{\varepsilon}_i^*$ be the (L_2 × 1) sample vector of abnormal returns for firm *i* from the event window $T_1 + 1$ to T_2. Then using the market model to measure the normal return and the OLS estimators, it is possible to generate
the vector of abnormal returns:

$$\begin{aligned}\hat{\varepsilon}_i^* &= R_i^* - \hat{\alpha}_i \iota - \hat{\beta}_i R_m^* \\ &= R_i^* - X_i^* \hat{\theta}_i\end{aligned} \tag{3.3.3}$$

where $R_i^* = \left[R_{iT_i+1} \cdots R_{iT_2} \right]'$ is an (L_2 × 1) vector of the event-window returns, $X_i^* = \left[\iota \, R_m^* \right]$ is an (L_2 × 2) matrix with a vector of ones in the first column and the vector of market return observations in the second, and $\hat{\theta}_i = \left[\alpha_i \beta_i \right]'$ is the (2 × 1) parameter vector estimate.

Conditional on the market return over the event window, the abnormal returns will be jointly with a zero conditional mean and conditional covariance matrix $\mathbf{V}_i$:

$$\begin{aligned}E\left[\hat{\varepsilon}_i^* \mid X_i^* \right] &= E\left[R_i^* - X_i^* \hat{\theta}_i \mid X_i^* \right] \\ &= E\left[\left(R_i^* - X_i^* \theta_i \right) - X_i^* \left(\hat{\theta}_i - \theta_i \right) \mid X_i^* \right] \\ &= 0\end{aligned} \tag{3.3.4}$$

$$
\begin{aligned}
V_i &= E\left[\hat{\varepsilon}_i^{*}\hat{\varepsilon}_i^{*\prime} \mid X_i^{*}\right] \\
&= E\left[\left[\varepsilon_i^{*} - X_i^{*}\left(\hat{\theta}_i - \theta_i\right)\right]\left[\varepsilon_i^{*} - X_i^{*}\left(\hat{\theta}_i - \theta_i\right)\right]' \mid X_i^{*}\right] \\
&= E\left[\varepsilon_i^{*}\varepsilon_i^{*\prime} - \varepsilon_i^{*}\left(\hat{\theta}_i - \theta_i\right)' X_i^{*\prime} - X_i^{*}\left(\hat{\theta}_i - \theta_i\right)\varepsilon_i^{*\prime} + X_i^{*}\left(\hat{\theta}_i - \theta_i\right)\left(\hat{\theta}_i - \theta_i\right)' X_i^{*\prime} \mid X_i^{*}\right] \\
&= I\sigma^2_{\varepsilon_i^{*}} + X_i^{*}\left(X_i' X_i\right)^{-1} X_i^{*\prime}\sigma^2_{\varepsilon_i}
\end{aligned}
\tag{3.3.5}
$$

where I is an identity matrix of size (L2 ×L2) and the first component of the variance is due to future disturbances and the second stems from sampling error in estimating the normal return. As the length of the estimation window L2 increases this drives the size of the second component down. Hence, under the null that the event has no influence on the mean or the variance of returns we can use the above equations, where

$$
E\left(\hat{\varepsilon}_i^{*}\right) \sim \mathrm{N}\left(0, V_i\right) \tag{3.3.6}
$$

3.3.3Aggregation of Abnormal Returns

We have to aggregate the abnormal returns before it is possible to make statistical inferences. Aggregation is across time and across assets (cross section). First, we consider aggregating across time for a single asset and then aggregate both across assets and through time.

Define $CAR_i(\tau_1, \tau_2)$ as the cumulative abnormal return for asset *i* from τ_1 to τ_2 where $T_1 < \tau_1 \leq \tau_2 \leq T_2$. Let γ be an $(L_2 \times 1)$ vector with ones in positions $\tau_1 - T_1$ to $\tau_2 - T_1$ and zeros elsewhere. With this we can define the first two moments of $CAR_i(\tau_1, \tau_2)$ as

$$
\widehat{CAR}_i\left(\tau_1, \tau_2\right) \equiv \gamma' \hat{\varepsilon}_i^{*} \tag{3.3.7}
$$

$$Var\left[\widehat{CAR_i}(\tau_1,\tau_2)\right] = \sigma_i^2(\tau_1,\tau_2) = \gamma' V_i \gamma \tag{3.3.8}$$

Thus from the above two we have:

$$\widehat{CAR_i}(\tau_1,\tau_2) \sim N\left(0,\sigma_i^2(\tau_1,\tau_2)\right) \tag{3.3.9}$$

The constructed test of H_0 for security *i* can be standardized yielding the standardized cumulative abnormal return

$$\widehat{SCAR_i}(\tau_1,\tau_2) = \frac{\hat{CAR}_i(\tau_1,\tau_2)}{\sigma_i(\tau_1,\tau_2)} \tag{3.3.10}$$

where $\sigma_i^2(\tau_1,\tau_2)$ is calculated from the variance of the normal return model; i.e. $\hat{\sigma}_{\varepsilon_i}^2 = \frac{1}{L_1 - 2}\hat{\varepsilon}_i'\hat{\varepsilon}_i$ in the case of the market model.

To aggregate the N securities, let the sample average of the N abnormal return vectors be defined as

$$\bar{\varepsilon}^* = \frac{1}{N}\sum_{i=1}^{N}\hat{\varepsilon}_i^* \tag{3.3.11}$$

$$Var\left[\bar{\varepsilon}^*\right] = V = \frac{1}{N^2}\sum_{i=1}^{N} V_i \tag{3.3.12}$$

As before, it is possible to aggregate the elements of this average abnormal returns vector through time using the same approach as we did for an individual security's vector. Let $\overline{\mathrm{CAR}}(\tau_1,\tau_2)$ be the cumulative average abnormal return from τ_1 to τ_2 where $T_1 < \tau_1 \leq \tau_2 \leq T_2$ and γ again is the $(L_2 \times 1)$ vector with ones in positions $\tau_1 - T_1$ to $\tau_2 - T_1$ and zeros elsewhere.

$$\overline{CAR}_i(\tau_1,\tau_2) \equiv \gamma' \bar{\varepsilon}_i^* \tag{3.3.13}$$

$$Var\left[\overline{CAR}_i(\tau_1,\tau_2)\right] = \bar{\sigma}_i^2(\tau_1,\tau_2) = \gamma' V_i \gamma \tag{3.3.14}$$

Statistical tests on the cumulative abnormal returns are then based on the following distribution:

$$\overline{CAR}_i(\tau_1,\tau_2) \sim N\left(0,\bar{\sigma}_i^2(\tau_1,\tau_2)\right) \tag{3.3.15}$$

Since $\bar{\sigma}_i^2(\tau_1,\tau_2)$ is unknown, use $\hat{\bar{\sigma}}_i^2(\tau_1,\tau_2) = \frac{1}{N^2}\sum_{i=1}^{N} \hat{\sigma}_i^2(\tau_1,\tau_2)$ as a consistent estimator. Next, to test H_0 we can use

$$J_1 = \frac{\overline{CAR}_i(\tau_1,\tau_2)}{\left[\hat{\bar{\sigma}}_i^2(\tau_1,\tau_2)\right]^{\frac{1}{2}}} \sim N(0,1) \tag{3.3.16}$$

For the J_1 test, we assume that there is no overlap of the events for the N assets and that N is large. A second method of aggregation is to give equal weighting to the individual $SCAR_i$'s. This is done by averaging the $SCAR_i$'s

$$\overline{SCAR}(\tau_1,\tau_2) = \frac{1}{N}\sum_{i=1}^{N} \widehat{SCAR}(\tau_1,\tau_2) \tag{3.3.17}$$

Again, under conditions that the events for assets i do not overlap, the null hypothesis can be tested using

$$J_2 = \left(\frac{N(L_1 - 4)}{L_1 - 2}\right)^{\frac{1}{2}} \overline{SCAR}(\tau_1,\tau_2) \sim N(0,1) \tag{3.3.18}$$

When doing an event study one will have to choose between using J_1 or J_2 . If the true abnormal return is constant across the assets, then it is best to give more weight to the securities with the lower abnormal return variance. The J_2 test does this. Instead, if the true abnormal return is larger for securities with higher variance, then it is best to give equal weight to the realized cumulative abnormal return of each security. This is what J_1 does. If the variance is similar across the assets, then there should be no large difference between J_1 and J_2.

It was noted that higher factor models such as the market model versus the constant return model will lead to a reduction in the abnormal return variance. To show this consider the following, where the variance of the abnormal return for the market model is

$$\begin{aligned} \sigma_{\varepsilon_i}^2 &= Var\left[R_{it} - \alpha_i - \beta_i R_{mt}\right] \\ &= Var\left[R_{it}\right] - \beta_i^2 Var\left[R_{mt}\right] \\ &= \left(1 - R_i^2\right) Var\left[R_{it}\right] \end{aligned} \tag{3.3.19}$$

where R_i^2 is the R^2 of the market-model regression for security *i*.

In the constant-mean-return model, the variance of the abnormal return ξ_{it} is the variance of the unconditional return, $Var(R_{it})$ is

$$\sigma_{\xi_i}^2 = Var\left[R_{it} - \mu_i\right] = Var\left[R_{it}\right] \tag{3.3.20}$$

In combining the variance of the market with the mean model we have

$$\sigma_{\varepsilon_i}^2 = \left(1 - R_i^2\right)\sigma_{\xi_i}^2 \tag{3.3.21}$$

The ratio $0 \le \dfrac{\sigma_{\varepsilon_i}^2}{\sigma_{\xi_i}^2} \le 1$ will say something about the strength of the market model over the constant return model.

3.4 Event studies on R&D and innovation

Researchers are increasingly using the event study methodology to assess the effect of strategic decisions on firm performance. Chan, Martin and Kensinger (1990) investigated stock market reaction to information releases regarding the R&D expenditures. They used an event study methodology to investigate U.S. markets response to announcements of increased R&D spending and they find positive responses for high technology firms with increased R&D expenditures and conversely negative responses for low technology firms.

Kelm et al. (1995) examined the impact on the market value of firms' stock of announcements about R&D projects made in the innovation and commercialization stages of the R&D process using this framework.

Sundaram et. Al (1997) used an event study to assess the wealth effects of the shareholders of the U.S. firms announcing R&D expenditure changes, as well as to the wealth effects of their rivals' shareholders.

Stock market valuation of the R&D expenditures is especially interesting in countries where substantial investments are made in R&D. However, empirical evidence from other than the US and the UK markets is lacking.

4. THE CASE OF ITALY : EMPIRICAL EVIDENCE

We use event study methodology to compute the cumulative abnormal returns around the time of the firms' R&D expenditures announcement. Announcement verified using publicly available media reports from Il Sole 24 Ore database. We ran the event study twice for each observation in our sample with event windows of both two and three days. The three day window includes the day of the announcement as well as the day before and after; the two day window includes the day of the announcement and the day before. The day before the official announcement is included in the two different event windows analyzed in order to pick up any leakage of information that may have occurred pre-announcement and in order to better capture market responses occurred the day before their official announcement. The use of a three day window is used in order to better capture market responses for transactions that occurred after the close of trading on the day of the announcement because the full market impact of the transaction announcement would not be realized until the opening of trading on the following day.

4.1 Sample design

From January 1995 to August 2009, Italian firms listed in Borsa Italiana Stock Exchange made over one hundred announcements of plans to increase company-sponsored R&D expenditures from the previous fiscal year. There were no announcements of specific plans to reduce only R&D spending. Announcement dates are obtained from the ***Il Sole 24 ore*** database, which provides news-service articles and selected stories from:

- *Il Sole 24 Ore (newspaper and magazines)*
- *News Radiocor*

We checked that the information was not revealed before to the market. Under this assumption the announcement of an R&D expenditure is new information only if there is a change from the prior year's program. New R&D information should lead to a revision of investor expectations about the firm's future earnings, and hence a change in stock price.[14]

From the sample some announcement were eliminated, for the following reasons:

(a) ***Duplicate announcements.*** These announcements included indications that they were duplicates of earlier statements about R&D expenditure plans.

(b) ***Announcements that lacked specificity.*** These included vague statements such as 'management expects R&D to grow', 'R&D expenditures will be somewhat bigger', or 'company continues plan to increase R & D spending'.

(c)***Announcements made concurrently with news of a capital expenditure decline.***

Of the remaining 93 announcements, only 90 were analyzed because 3 announcements are linked to firms with missing stock market data.

Most announcements simply indicate the amount of planned spending. Few announcement give specific details about the intended research efforts (all of them involved applied research or development). Stated objectives included developing new processes, improving the efficiency of the company's facilities, developing new or improved products with higher profit margins, and improving the overall product mix to boost market share.

Announcement were grouped into different categories defined as follows:

Category I. ***Announcements of plans to increase corporate R&D expenditures or new R&D project.***

For example:

"Fiat will increase its R&D investment to develop eco-friendly cars from Lit. 400 billion to Lit. 500 billion."

(from Il Sole 24 Ore 21/05/1996)"

[14] McConnell and Muscarella (1985) employ a similar model of investor expectations formation in their study of capital expenditure plans.

Category II. ***Announcements of R&D agreement or Joint Venture .***

For example:

"Enel has signed two agreements: one with the Chinese Ministry of Energy and Italian Ministry of Environment for R&D activities on clean energy; the other with Wuhan Group for projects on energy efficiency"

(from News Radiocor 05/05/2008)"

Category III. **A*nnouncements of new innovation or new product introduction.***

For example:

"Fiat auto has presented the new Alfa 166, which has required an R&D investment of €60 million"

(from Il Sole 24 Ore 26/09/2003)"

Table 4.1 gives the frequency of R&D announcements categorized by the type of announcement.

Table 4.1

Distribution of 90 announced increases in company-sponsored R&D expenditures by Borsa Italiana Stock Exchange firms, by type of announcements, in the period l995-2009.

	Type of announcement	Number of observations
I.	Pure R&D announcements	32
II.	Announcements of R&D agreement or Joint Venture	37
III.	Announcements of new innovation or new product introduction	31
Total		90

The announcements were made by relatively large firms in a wide variety of industries, and were relatively evenly distributed over the time period from January 1995 to August 2009.

4.2 Stock-price response to R&D announcements

To measure the stock market's response to R&D announcements, we need an event-study methodology, using the standard market model to measure abnormal performance. We define two different event window to include days -1 through 0 and days -1 through +1 in relation to the announcement. We use the FTSE Mib index as a proxy for market returns, and estimate the parameters of the market model using data for the 201 days before the event window. The estimation period includes days - 250 through -50.

4.2.1 Empirical results: Average abnormal stock performance

Table 4.2

Average abnormal stock return for 90 announcements of new R&D informations by Borsa Italiana Stock Exchange firms, in the period l995-2009

Day relative to R&D announcement	Average abnormal return (in percent)	Percent of positive abnormal returns
-1	-0,10	43,3
0	0,13	46,7
1	-0,19	44,9

We find that on average, announced plans to increase R&D expenditures are not associated with abnormal stock price performance (see table 4.3). The result shows little stock price movements. The average abnormal return (AAR) on day -1, -0,10%, could mean that no information have occurred before the official announcement. On the day of the announcement the AAR is equal to +0,13%, while the day after the announcement the AAR is equal to -0,19.

4.2.2 Empirical results: Cumulative Abnormal Returns

Table 4.3

Distribution of two-day and three-day event window cumulative abnormal returns for 90 announcements of new R&D information by Borsa Italiana Stock Exchange firms, in the period l995-2009

Magnitude of CAR	Number of observation for two-day event window	Number of observation for three-day event window
0,10 < CAR	1	1
0,08 < CAR ≤ 0,10	0	0
0,06 < CAR ≤ 0,08	2	0
0,04 < CAR ≤ 0,06	4	5
0,03 < CAR ≤ 0,04	3	3
0,02 < CAR ≤ 0,03	4	10
0,01 < CAR ≤ 0,02	12	9
0,00 < CAR ≤ 0,01	20	14
-0,01 < CAR ≤ 0,00	16	14
-0,02 < CAR ≤ -0,01	12	12
-0,03 < CAR ≤ -0,02	8	9
-0,04 < CAR ≤ -0,03	3	7
-0,06 < CAR ≤ -0,04	4	5
-0,08 < CAR ≤ -0,06	1	0
-0,10 < CAR ≤ -0,08	0	0
CAR ≤ -0,10	0	1
Total	90	90
Average	0,025%	-0,169%

When we examine the cumulative abnormal returns, we find an average CAR of +0,025% for the two-day event window and an average CAR of -0,169% for the three-day event window. The evidence presented in this section is consistent with the hypothesis that announcements of new R&D information are, on average, not valued by the Italian stock market.

4.3 Factors influencing the share-price responses

Announcements of planned increases in firm-sponsored R&D apparently reveal new information that has no impact on average on share value. The response to

R&D announcements sometimes tends to be positive even for firms that simultaneously experience an earnings decline.

Given the differences among firms and their R&D projects, it is unlikely that all of them experience the same stock-price response to their R&D announcements. The response should be negative if the R&D expenditures are wasteful.

We investigate important factors that may influence the benefits from investing in R&D. First we segment our sample into firms without large shareholders and firms with controlling shareholders[15] to see if there is a different stock price reaction. Then we made the same analysis excluding from our sample the announcement that are related to new product introduction.

4.3.1 CAR and ownership structure

Table 4.4

Average CAR for 90 announcements of new R&D information by Borsa Italiana Stock Exchange firms, by ownership structure, in the period l995-2009

	CAR	
Event window	Firms with controlling shareholders (81 announcements)	Firms without controlling shareholders (9 announcements)
days (-1,0)	-0.099%	1.136%
days (-1,1)	-0.296%	0.977%

When we segment our sample into firms without large shareholders (9 announcement) and firms with controlling shareholders (81 announcements) we find a significant positive stock-price response for the first group and a little negative response for the last group. The stock-price response clearly tends to be positive for firms without controlling shareholders while tends to be negative for firms controlled by a major shareholder (see table 4.4). The average CAR for the first group is +1,136% for the two-day event window and +0,977% for the three day event window, while for the last group the average CAR is respectively -0,099% and -0,296%.

[15] Firms where at least one shareholder holds at least 20% of voting rights (Faccio et al. 2002)

The Italian stock market seems to penalize firms controlled by a major shareholder and this fact could be explained by the expropriation risk suffered by outside investors (La Porta et al. (1998, 2000)). In insider systems characterized by a weak legal protection to financial investors, such as Italy, the controlling shareholders can appropriate minority shareholders' profits exploiting the information asymmetries created by R&D investments.

4.3.2 The impact of new product introduction

Table 4.5

Average CAR for 90 announcements of new R&D information by Borsa Italiana Stock Exchange firms, by ownership structure and category, in the period l995-2009

			Controlling shareholders	No controlling shareholders
			(n. observations)	*(n. observations)*
I	R&D investment & R&D project	CAR (-1, 0)	0,309%	0,778%
			(30)	*(2)*
		CAR (-1, +1)	-0,228%	1,174%
			(30)	*(2)*
II	R&D agreement & Joint Venture	CAR (-1, 0)	-0,034%	1,654%
			(31)	*(6)*
		CAR (-1, +1)	-0,114%	1,295%
			(31)	*(6)*
III	New Product	CAR (-1, 0)	-0,811%	-1,261%
			(20)	*(1)*
		CAR (-1, +1)	-0,681%	-1,329%
			(20)	*(1)*

If we segment our sample into the three different categories of announcements we find some interesting features. The market penalizes firms announcing new product introduction (see table 4.5). Firms announcing a new product introduction reveal the related R&D efforts and the market seems to not appreciate it. This could be probably due to the fact that the R&D investment requested is higher than predicted or maybe that the benefit expected from the new product are worth less than expenses.

Considering our sample without announcements of new product introduction we find that on average the market seems to value more other announcements (see table 4.6). This result supports the conclusion that investors tend to see higher

R&D spending as an indication of better growth opportunity and incorporate this improvement into their valuation of the firm.

The stock-price response tends to be higher for category I (average CAR (-1,0) equal to 0,338%) than for category II (average CAR (-1,0) equal to 0,240%), while the stock-reaction clearly tends to be positive for firms without controlling shareholders (average CAR (-1,0) equal to 1,435%) while tends to be close to 0 for firms controlled by a major shareholder (average CAR (-1,0) equal to 0.135%).

Table 4.6

Average CAR for 69 announcements of new R&D information (excluding new product introduction) by Borsa Italiana Stock Exchange firms, by ownership structure and category, in the period l995-2009

			Controlling shareholders	No controlling shareholders	Total
			(n. observations)	*(n. observations)*	*(n. observations)*
I	R&D investment & R&D project	CAR (-1, 0)	0,309%	0,778%	0,338%
			30	*2*	*32*
		CAR (-1, +1)	-0,228%	1,174%	*-0,140%*
			30	*2*	*32*
II	R&D agreement & Joint Venture	CAR (-1, 0)	-0,034%	1,654%	0,240%
			31	*6*	*37*
		CAR (-1, +1)	-0,114%	1,295%	*0,115%*
			31	*6*	*37*
	Total	CAR (-1, 0)	0,135%	1,435%	0,285%
			61	*8*	*69*
		CAR (-1, +1)	-0,169%	1,264%	-0,004%
			61	*8*	*69*

5. CONCLUSION

This paper investigates the stock market response to firms' R&D expenditures in Italy. This investigation is important for several reasons as the relevance of Italian economy, the specificity of its capital market, corporate governance regime and law system.

In this analysis we dealt with two main difficulties limiting data availability: the fact that R&D disclosure is not compulsory, drastically reducing the number of observations for which R&D is reported; and the small size of the stock market restricting the number of publicly traded firms that could be included in the sample. It is possible that lack of an R&D disclosure obligation in Italy has a negative effect on R&D evaluation, increasing the information asymmetries between firms and investors that critically concern R&D investments. Seaton and Walker (1996) have shown that the introduction of the requirement to disclose corporate R&D investments somewhat reduced the financial constraints faced by British traded firms for innovation.

The results we obtained exhibit several interesting features. For firms without large shareholders the Italian stock market places a higher value on R&D spending while the stock price response tends to be negative or close to zero for firms controlled by a major shareholder. Based on the arguments of La Porta et al. (1998, 2000), this result could be explained by the expropriation risk suffered by outside investors. In other words, when there is a weak legal protection to financial investors, such as Italy, the controlling shareholders can appropriate minority shareholders' profits exploiting the information asymmetries created by R&D investments, consistently with the evidence on R&D and insider gains presented by Aboody and Lev (2000). For this reason, stock market should penalize firms controlled by a major shareholder.

These results support then the idea that legal regimes and ownership structures matter in stock market evaluation of firms' R&D investments. The evidence presented here suggests that legal and corporate governance arrangements can be important as policy measures to reduce the information asymmetries inherent to R&D investments. Stronger investor protection could reduce the reinforcing effect of R&D investments on potential insider expropriation and consequently increase R&D valuation by financial markets. Also corporate governance amendments strengthening or weakening the rights of minority investors at the firm level can be relevant in this respect (Hall and Oriani 2006). For example, Gompers et al. (2003) has shown that governance provisions strengthening shareholder rights are associated with higher firm market value. With specific respect to our research question, these provisions could mitigate the effect of corporate control on the market valuation of R&D investments. This study, which has analyzed the valuation of R&D for Italian firms listed in Borsa Italiana Stock Exchange provided in this respect new evidence, can stimulate the actual debate on R&D financing in the European Union. Even though the evidence concerns a limited number of events analyzed, it represents a first step into a deeper investigation of the interactions between firms, markets and institutions in contexts where the corporate governance regime and the financial markets are significantly different from that of the United States or the United Kingdom.

APPENDIX

List of Announcements

Company	Source	Type	Description	CAR (-1, 0)	CAR (-1, +1)
Brembo	Il Sole 24 ore	Joint venture	Brembo has created a jv with Mercedes Benz for the development and production of ceramic brake systems, with an investment €10 million for the next 2 years	4,339%	2,689%
Caffaro	Il Sole 24 ore	R&D investment	Caffaro scales up the research center of Tor Viscosa and invests €2.5 million for new scientific tools	Data NA	Data NA
Carraro	Il Sole 24 ore	New product	Cararro presents Rondò, a new agricultural machine	-2,515%	1,449%
Danieli	Il Sole 24 ore	R&D investment	New R&D plan for the period 2004-2006 (€140 million)	4,197%	4,833%
Danieli	Il Sole 24 ore	R&D investment	Danieli announces it will invest €140 million for research activity in the next 3 years	-0,218%	-1,090%
Datalogic	Radiocor	R&D project	Datalogic launches the project Handhealth in collaboration with Rizzoli	1,307%	2,891%
Datalogic	Radiocor	New product	Datalogic presents the first bar code reader in a cell phone	-2,633%	-4,686%
Ducati Motor Holding	Il Sole 24 ore	R&D investment	New industrial plan with €40 million of R&D investments and 3 new models	-0,885%	-0,150%
Edison	Il Sole 24 ore	R&D agreement	Agreement among Enel, Pirelli Cavi and Edison to develop a high-temperature superconductor	0,153%	-0,411%
Enel	Il Sole 24 ore	R&D agreement	Agreement among Enel, Pirelli Cavi and Edison to develop a high-temperature superconductor	Data NA	Data NA
Enel	Radiocor	R&D agreement	Agreement between Enel and Saudi Arabia General Investment Authority to develop joint R&D program for clean energy technologies	0,599%	0,657%
Enel	Il Sole 24 ore	R&D agreement	Agreement between Enel and Harvard University with a donation of €5 million to develop joint research programs	0,055%	0,425%
Enel	Radiocor	R&D investment	New research plan of €4 billion in 5 years for renewable energies	0,171%	1,805%
Enel	Radiocor	R&D agreement	Enel and Enea have signed an agreement to develop a new technology to reduce emissions in carbon plants	-0,185%	0,148%

Company	Source	Type	Description	CAR (-1, 0)	CAR (-1, +1)
Enel	Radiocor	R&D agreement	Enel has signed two agreements: one with the Chinese Ministry of Energy and Italian Ministry of Environment for R&D activities on clean energy; the other with Wuhan Group for projects on energy efficiency	-0,517%	-1,803%
Engineering	Radiocor	R&D investment	Engineering has planned for the years 2001-2002 an R&D investment of about €20 million	Data NA	Data NA
Engineering	Radiocor	R&D agreement	Engineering has become the coordinator of a research project of EU to develop an innovative platform for the research of audiovisual contents. The project is worth €14 million	3,002%	2,318%
Eni	Il Sole 24 ore	R&D investment	Eni plan to increase its R&D investment (up to €270 million) in 2005	-0,200%	-0,413%
Eni	Radiocor	R&D investment	In the next 3 years ENI will invest €350 million in the research on biofuels and solar energy	-0,656%	-1,171%
Eni	Radiocor	R&D agreement	Eni and Infineum have signed an agreement for R&D activities in the field of additives for lubricating oils.	1,281%	1,575%
Eni	Il Sole 24 ore	New product	Eni presents the new EST technology to improve refining efficiency	0,093%	-1,154%
Eni	Radiocor	R&D investment	Eni will invest €1 billion in new technologies in the period 2006-2009	0,398%	-0,650%
Eni	Radiocor	R&D agreement	Eni has signed an agreement with Emilia Romagna Region to carry a research project to analyze the seaside. The cost of the project is €4.2 million (3.5 Eni + 0.7 Emilia Romagna)	1,155%	1,284%
Fiat	Il Sole 24 ore	R&D agreement	Alenia Aerospazio and Agusta (finmeccanica Group) will provide Ferrari with know-how on the application of innovative materials to aerodynamics	-0,945%	-2,693%
Fiat	Il Sole 24 ore	R&D investment	Fiat will invest €1.2 billion (of which a part in R&D) receiving public funding of €130 million	-0,611%	-1,051%
Fiat	Il Sole 24 ore	R&D investment	Fiat reveal a plan to invest €19.5 billion to renew the lines of automobiles, trattori(?) and trucks	-3,515%	-3,179%
Fiat	Il Sole 24 ore	New product	Elasis, a company of Fiat Group in Southern Italy, has launched Uniget, a new tool for diesel engines that will be produced by a joint venture between Magneti Marelli and Bosch	2,423%	3,739%
Fiat	Il Sole 24 ore	R&D investment	This year R&D expense shoudl grow to Lit. 2100 billion from Lit. 1928 billion of last year	-1,793%	-2,322%
Fiat	Il Sole 24 ore	R&D project	Fiat will invest Lit 14.4 billion in an applied research project for a 6-places automobile and will receive a contribution on interest payment on a lona granted by IMI	0,270%	-0,430%

Company	Source	Type	Description	CAR (-1, 0)	CAR (-1, +1)
Fiat	Il Sole 24 ore	R&D investment	Fiat will increase its R&D investment to develop eco-friednly cars from Lit. 400 billion to Lit. 500 billion	-3,759%	-2,954%
Fiat	Il Sole 24 ore	R&D investment	Fiat will invest $168 million in new research projects in Brazil	-5,414%	-0,288%
Fiat	Il Sole 24 ore	R&D agreement	Fiat has invested $175 million in an agreement with IBM in the IT field in Latin America	-5,473%	-4,117%
Fiat	Il Sole 24 ore	R&D agreement	Elasis has created a consortium withe The Università di Napoli, which will do research on virtual reality. The immediate investment i Lit. 5 billion, but the total investment will be of Lit. 50 billion by 2001	-0,754%	-2,170%
Fiat	Il Sole 24 ore	R&D investment	Between 2003 and 2006 Fiat will increase its R&D investment by €2 billion per year	1,678%	1,491%
Fiat	Il Sole 24 ore	R&D investment	Fiat Lubrificanti invest Lit. 14 billion to create a new structure to test the base products and the additives	-1,186%	0,279%
Fiat	Il Sole 24 ore	New product	Fiat will launch 15 new car models by 2002 with an investment plan of Lit. 20000 billion	-7,038%	-10,985%
Fiat	Il Sole 24 ore	New product	Fiat presents the Multijet 1.3 developed by Fiat-GM Powertrain	1,919%	1,220%
Fiat	Il Sole 24 ore	New product	Fiat plans to launch 3 new models next year	0,011%	2,155%
Fiat	Il Sole 24 ore	Joint venture	Fiat Avio and Agenzia Spaziale Italiana have crated a new company, Ely, with the objective to develop a family of lanciatori in orbita bassa (?)	-1,673%	-4,898%
Fiat	Il Sole 24 ore	R&D investment	Fiat will increase its R&D investment to the 5% of sales	-2,784%	-2,923%
Fiat	Il Sole 24 ore	New product	Fiat presents the Fiat Panda Aria at the Frankfurt exhibition. The system Multiair is the main novel solution of the research activity at Fiat Group	7,051%	3,353%
Fiat	Il Sole 24 ore	New product	CRF and Fiat Powertrain have elaborated a new technology (Soi)	1,782%	2,865%
Fiat	Il Sole 24 ore	R&D investment	The Minister of Production has signed an agreement with Fiat Powertrain and Elasys for an investment program of €647.6 million, of which €82 million of public funding. The investment program contains new production and research lines	0,345%	0,090%
Fiat	Il Sole 24 ore	New product	Fiat Auto will rpesent Blue&Me, an entertaining system realized in collaboration with Microsoft and Magneti Marelli	-4,935%	-3,960%
Fiat	Radiocor	R&D investment	The CEO Marchionne has announced that in the industrial plan there will €4billion of investments dedicated to R&D activities in the next 4 years. Total investments will be €18 billion	2,712%	5,359%

Company	Source	Type	Description	CAR (-1, 0)	CAR (-1, +1)
Fiat	Il Sole 24 ore	R&D investment	Magneti Marelli will invest €145 million to strenghten the Powertrain line, of which €20 million in research activities. It will hire 25 new researchers	-1,580%	-1,224%
Fiat	Il Sole 24 ore	New product	Fiat auto has presented the new Alfa 166, which has required an R&D investment of €60 million	0,346%	0,134%
Fiat	Il Sole 24 ore	New product	Fiat will present in October the new 600 fueled by idrogen	4,020%	4,181%
Fiat	Il Sole 24 ore	New product	Fiat Auto has presented the new Lancia Y, which has costed €350 million in R&D	0,900%	0,264%
Fiat	Il Sole 24 ore	New product	Fiat has presented the Nuova Punto	-1,415%	0,663%
Fiat	Il Sole 24 ore	R&D investment	Fiat has presented 15 new research project to the Italian Government	1,054%	-0,983%
Fiat	Il Sole 24 ore	R&D agreement	The CEO of Fiat Avio has presented a new system of R&D agreements with Italian Universities	2,409%	1,284%
Fiat	Il Sole 24 ore	R&D agreement	Fiat Avio ahas signed a memorandum of understanding with Rolls royce and GE to enter the US project Jsf foe the development of 4th generation combat airs	0,060%	-1,093%
Fiat	Il Sole 24 ore	New product	Fiat has presented the new Multiple with an electric engine	0,805%	-1,451%
Fiat	Il Sole 24 ore	New product	Maserati has presented the new spyder	-4,736%	-3,283%
Fiat	Il Sole 24 ore	R&D agreement	Magneti Marelli and Fiaam have signed an agreement to develop new lithium batteries	0,552%	-1,223%
Fiat	Radiocor	R&D investment	Fiat has signed with EIB a €400 million loan finalized to sustain group R&D projects	-2,946%	-3,212%
Finemeccanica	Il Sole 24 ore	R&D agreement	Alenia Aerospazio and University of Milano create a new software lab	1,716%	2,844%
Finmatica	Il Sole 24 ore	New product	Finmatica launches Itau, the new software solution for the banking system	-1,159%	-4,185%
Finmeccanica	Il Sole 24 ore	Joint venture	It has been created the joint venture between Alenia Aeronautica and Sukhoi to realize the new Superjet 100. Alenia will invest €250 million	-0,011%	-1,044%
Finmeccanica	Radiocor	R&D agreement	Alenia Aeronautica has announced to have signe a memorandum of udnerstanding with TsAGI, the Russian research institute on aerodynamics, to carry on joint research projects	0,404%	-0,135%
Finmeccanica	Radiocor	R&D agreement	Finmeccanica and Eurotech have signed a partbership agreement for commercial and scientific collaboration. Finmeccanica will have the opportunity to tap into the Eurotech technologies to develop new products to sell on its markets	-2,084%	-0,251%
Finmeccanica	Radiocor	R&D agreement	Finmeccanica and Poste Italiane have signed an agreement to develop collaborations on digital mail, e-government and other innovative services	-0,886%	-0,896%

Company	Source	Type	Description	CAR (-1, 0)	CAR (-1, +1)
Finmeccanica	Il Sole 24 ore	R&D agreement	CNR has signed an agreement with Avio to carry on research in different areas	3,811%	2,471%
Indesit	Il Sole 24 ore	R&D investment	Massimo Rosini, the CTO of th Group, has declared that Indesit will spedn €45-50 million in the next 3 years to provide new products to the market	-3,092%	-0,802%
Italcementi	Radiocor	New product	Italcementi launches TX active, n active principle to reduce polluting emissions	-1,683%	-2,247%
Italcementi	Il Sole 24 ore	R&D investment	Italcementi will invest €10 million an new research center to strenghten the research activities of the group	-2,439%	-5,359%
Merloni (Indesit)	Radiocor	R&D investment	Merloni Elettrodmestici will spend €125 million in 2003 for the development of new products and processes	0,843%	2,852%
Piaggio	Radiocor	R&D investment	Piaggio has signed an agreement with EIB for a €150 million to sustain R&D projects	-1,660%	-2,108%
Pininfarina	Il Sole 24 ore	R&D investment	Pinifarina has made an investment of €4 million for the new simulation system to use in the wind gallery	2,300%	0,359%
Pirelli	Il Sole 24 ore	R&D agreement	Agreement among Enel, Pirelli Cavi and Edison to develop a high-temperature superconductor	-0,503%	-3,632%
Pirelli	Il Sole 24 ore	R&D investment	Pirelli invest Lit. 400 billion for a pilot plant to develop a new fuel ederived from old rubber and plastic.	3,546%	2,998%
Pirelli	Il Sole 24 ore	R&D investment	Pirelli will invest Lit. 2000 billion in optical systems, e-commerce and hi-tech incubators	10,607%	10,417%
Pirelli	Il Sole 24 ore	R&D agreement	Pirelli and e.Biscom will create a joint team of researcher to develop new solutions for Internet services	-1,864%	-3,637%
Pirelli	Il Sole 24 ore	R&D agreement	Pirelli has signed a 5-years R&D agremment with MIT in the field of Photonics. Pirelli Lab will initially invest € 2 million	-2,362%	-2,884%
Pirelli	Il Sole 24 ore	R&D agreement	Pirelli labs has signed 2 new agreements with public research centers for the development of solar cells	-2,561%	-3,915%
Pirelli	Radiocor	R&D agreement	Pirelli and Politecnico di Torino have signed an agreement for research activities in the pneumatics sector for 5 years. Pirelli will invest €15 million	4,465%	4,331%
Pirelli	Radiocor	R&D agreement	Pirelli Ambiente has signed an agreement with LiqTech to develop an innovatoive technology to realize "filtri antiparticolato"	0,327%	3,144%
Pirelli	Radiocor	R&D agreement	Pirelli Labs and Enea have started 3 advanced research projects in the field of renewable energieswithin a general agreement for 5 years	-0,003%	-0,744%

Company	Source	Type	Description	CAR (-1, 0)	CAR (-1, +1)
Pirelli	Radiocor	R&D agreement	Pirelli has signed an agreement with Georgia Tech to develop new broadband technologies. The aggreement will last 5 years	-1,138%	0,808%
Pirelli	Il Sole 24 ore	R&D agreement	Pirelli Labs and Alacatel have signed an agreement for investments in the UMTS mobile network based on optical technologies	1,357%	0,853%
Pirelli	Il Sole 24 ore	New product	Pirelli Tyre launches a new pneumatic for sport motorbikes	0,641%	0,310%
Pirelli	Radiocor	R&D agreement	Fondazione Silvio Tronchetti Provera has signed an ageement with Shandong University to develop an eco-compatible pneumatic. The agreement will be executed by Pirelli Tyre	1,067%	1,444%
Pirelli	Radiocor	R&D investment	Pirelli invests $200 million in Brasil, $100 million for R&D and $100 million to develop production capacity	1,153%	-1,231%
Prysmian	Radiocor	R&D agreement	Prysmian and Fondazione Bruno Kessler have signed an agreement for R&D activities in the cbales and tlc sectors	-0,707%	-2,581%
Recordati	Radiocor	New product	Recordati has received the approcal by the Germany drug agency for Zanitek, a new antideprssive drug	-1,658%	-0,451%
Seat Pg	Radiocor	R&D agreement	Seat Pg has signed an agreement with Telespazio to launch Pagine Gialle Visual	6,136%	4,363%
Snia	Radiocor	R&D project	A project for a new plant for bioethanol	-0,052%	0,178%
Telecom Italia	Il Sole 24 ore	R&D agreement	Ericsson and Telecom have signed an agreement to develop and comemrcialize new cell phones using the Edge system	-0,065%	1,459%
Telecom Italia	Radiocor	R&D agreement	Telecom Italia and Intel have signed an agreement to develop innovative application for home enetertainement and "telemedicina"	0,665%	-0,277%
Telecom Italia	Radiocor	R&D investment	Olivetti will spend €200 million (Of which €100 million in research) to recover in the European ITC market	-1,261%	-1,329%
Telecom Italia	Il Sole 24 ore	New product	Telecom Italia has completed the newtwork development and will launch a new web-based phone service for corporations	1,608%	2,170%
Telecom Italia	Il Sole 24 ore	R&D agreement	Telecom Italia and Philiups have signed an agreement to develop new solutions for domotic appliances	0,033%	0,318%

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