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"THE ROLE OF INNOVATION: SPECIFICATION PROBLEMS IN A MODEL FOR THE ROA WITH CROSS-SECTIONAL DATA"

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Dedico questo lavoro, che si pone a conclusione di un cammino caratterizzato da sacrifici e impegno costante, alla mia famiglia. Ringraziandola per avermi donato il regalo più bello: aver creduto in me, sempre e comunque, sostenendomi in ogni modo e avvolgendomi d'amore.

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ABSTRACT IN ITALIANO

Tramite l'utilizzo di un vasto campione d'imprese (2475 aziende Americane, suddivise per settore d'appartenenza), viene analizzato l'effetto dell'investimento in innovazione (approssimato dalla spesa in ricerca e sviluppo) sulla performance aziendale (misurata tramite l'indicatore ROA).

Applicando le conoscenze econometriche, tramite l'apprendimento del software statistico Gretel, si è costruito e discusso un modello OLS di regressione multipla.

Dopo una panoramica della letteratura esistente in materia, finalizzata alla formulazione delle ipotesi econometriche, il paper, tramite un'analisi quantitativa, si focalizza su deduzioni critiche dei problemi di miss-specification presentatisi nella fase d'applicazione del test diagnostico RESET al modello creato e sulla spiegazione delle motivazioni alla base dei valori distorti dei coefficienti delle variabili esplicative utilizzate.

La conclusione cui giunge il seguente lavoro di ricerca è l'impossibilità di ottenere risultati affidabili in uno studio cross-section, quando viene creato un modello di variabili con effetti proiettati nel tempo -prima fra tutte l'investimento in R&D- utilizzando il ROA come misuratore della performance aziendale.

Di fondamentale importanza è stato lo studio autonomo dei principi contabili generalmente accettati negli Stati Uniti d'America (US GAAP) per comprendere i principi di redazione e i criteri di valutazione preposti alla redazione del bilancio d'esercizio, esposti per commentare i risultati ottenuti.

Il fine della prova finale è quello di contribuire - "in negativo" - alla letteratura esistente: vengono formulati ragionamenti atti ad avvalorare la tesi dell'erroneo uso del ROA in un modello "dinamico" analizzato in un istante temporale (anno 2014). Il ROA, in qualità di indicatore misurante la passata redditività aziendale, non è in grado di tenere conto delle prospettive di crescita derivanti da un investimento in innovazione, che si tradurranno in un miglioramento della performance solo superato "un tempo soglia" che permetta ai benefici di prevalere sui costi dell'investimento.

CONTENTS

INTRODUCTION

The aim of satisfying customers' explicit and implicit expectations is key in today's customer-centred era: the main responsible for the creation of a business competitive environment. This mission must be accomplished by companies, no matter the industry they belong to and their size, if they want to achieve a sustainable competitive advantage. The firm, seen as a whole, must develop a quality vision that results not only in products with less and less defects but also (and mainly) in a business model where the crucial concern is a continuous improvement in every respect, to answer customer's needs (see Mele, 2007).

To accomplish this goal, we need the implementation of a system that, meeting quality standards, creates or enhances products and organizational processes.

According to the main business literature the way to manage the process of creating value for customers is innovation and its main tool is investing in Research & Development (noted R&D thereafter).

1.THE ROLE OF INNOVATION

Innovation is at the core of the organizations' competitive advantage, in today's modern world characterized by a "fast-moving business environment open to global competition" (see Teece 2007, p. 1319).

Kanter (2006) terms innovation as the strategic driver of corporate growth covering a wide spectrum not limited to the development of new products and technologies. Indeed, nowadays novel ideas are applied to the creation of "new service offerings, business models, pricing plans and routes to market, as well as new management practices" (see Birkinshaw, 2001, p.1).

Moreover, the modern open economy requires business enterprises to control, protect and manage the innovation process to sustain superior business performance and to achieve long-run, difficult-to-replicate success (see Kamariah et al., 2014 and Teece, 2007).

Another remarkable evidence must be taken into account: economic growth is led by countries engaged in innovation efforts, among all, we find USA: one of the nations with the highest R&D investment intensity, classified as leader of economic development (see Ahmed and Shepherd, 2010).

The theoretical basis of the issue concerning the relevance of innovation, dates back to Schumpeterian (1934, 1942) view of economic change whereby innovation is the "creative destruction" that drives economic dynamics and structure. In this framework the entrepreneur is the "change creator": exploiting his creativity and carrying out unpredictable innovations he enables the firm to improve its position in the market, as regards its efficiency and competitiveness.

The purpose of my study is to investigate the relationship between R&D expense and firm performance with special context to USA and considering year 2014, because as declared by the U.S. department of commerce: "the United States has over a third of the world's total R&D investment, more than any other country" with about $465 billion spending in 2014 alone (see Battelle, 2013 and The executive office of the president & the department of commerce, *Winning business investment in the United States,* 2014, p.2).

To understand why millions of dollars are spent on R&D activity, a panel of publicly listed companies from North America is used to run a cross-sectional regression.

Furthermore, possible differences in the performance are explained taking into consideration the type of industry: classifying firms according to the USA SIC code I distinguished firms according to the sector they belong to: manufacturing, service, sales (I mean retail and wholesale trades) and financial sectors.
My work tries to contribute to the existing literature analysing the topic of innovation with a sample of firms very extended, taking into account not only the classical distinction between manufacturing and non-manufacturing firms, but also expanding the analysis to the sectors with intense investments in R&D. The real degree of novelty characterizing my work, and that-to my knowledge- no (or few) studies have already investigated is the analysis of the distorting effect of ROA on firm performance when we use a cross-sectional sample.

The paper is organized into 7 sections named as follow: introduction, the role of innovation, pros and cons of innovation, theoretical framework, business sectors' features, database, quantitative analysis, conclusion.

2. PROS AND CONS OF INNOVATION

Pros

Today not only the product market but also the market for resources can be depicted as fast-moving business environments characterized by a growing intensity and dynamism of competition. The creation of a sustainable advantage is essential for a company to face the increasing turbulences that everyday show up. In this framework the company must develop a knowledge-based business philosophy where the ability to generate knowledge has a pivotal role in the foundation for firm's competitiveness and strategy formulation. Specialized knowledge itself can't be entirely appropriated by a firm because it resides in individuals and even if it is protected through patents, copyright and trade secrets it fluctuates outside the organization when individuals leave the company. Whereas, the technological capabilities used to give rise, learn and share knowledge, i.e. R&D activities (the ability to create "the new"), are the authentic critical sources that allow firms to face dynamically-competitive conditions (see Grant, 1996)

So, when the company has the instruments to find solutions and develop new ways to exploit the stock of information accumulated and the flow of knowledge of individuals entering the organization, it is enriched by a process that ends up with the creation of an innovative product or service allowing the firm to satisfy market needs even when the changes on the demand side are unforeseen (see Kamariah et al., 2014).

Moreover, according to Schumpeter (1934) innovative firms gain temporary monopoly power when they launch new products in the market, because the higher the degree of novelty they introduce, the lower the direct competition they face. This is a key aspect of investing in R&D because the new products and services, "may work as barriers to entry: intangible capital stocks, or market demand factors, that bring positive values to a firm's performance and future growth opportunities" (see Zhu and Huang, 2012, p.917)

The source of sustained high profits, thus, is continuous innovation that allows hinder competitors' imitation (see Schumpeter, 1934).

Another advantageous feature of R&D is its ability to contribute to a firm's absorptive capacity which is the label given by Cohen and Levinthal (1990, p.128) to "the ability of a firm to

recognize the value of new, external information, assimilate it, and apply it to commercial ends".

In this perspective the exploitation of external findings is a pivotal component of innovation capabilities, so the spillover - caused by the interaction with the firm's endogenous absorptive capacity - is no more considered a complete deterrent to R&D activity because "the negative appropriability incentive associated with spillovers is counterbalanced by a positive absorptive-capacity-building incentive" (see Cohen and Levinthal 1990, p.142). According to the authors, thanks to the ability of R&D to generate in the firm a background knowledge, the firm can itself exploit competitor's spillovers and so the more of them there are out there, the more incentive the firm has to invest in its own R&D.

To conclude the list of the main reasons in favour of R&D investment, I cite Juan V. García-Manjón's (et al., 2012) point of view. According to the authors, firms invest in R&D because it is a mechanism for firm's growth thanks to its positive impact on sales. Moreover, they think that the concern of promoting firm's growth is a central one, because leading to scale economies, being the starting point for technological changings and thus, supporting a better position in the market, it guarantees firm's survival.

Cons

In the literature it is alleged the, so called, managerial risk aversion (see Monks and Minow, 2011) that arises when we analyse the misalignment of interests between managers and shareholders. The former cannot easily diversify away their investment, represented by their time spent at work, because they need a certain period of time to find a replacing job with a high prestige and remuneration. Whereas the latter can quite easily buy and sell stocks, diversifying the investment undertaken. Usually managers are short-sighted, because they are more worried about current earnings rather than favouring investments contributing positively to the performance in the future, thus they "bear none of the long-term risk but can reap the reward of short-term (yet perhaps insubstantial) gains [..] at the expense of the institution, its shareholders [..], the issue known as moral hazard" (see Monks and Minow, 2011, p. 133).

Thus, considering this framework, there are some reasons why managers may prefer avoiding expenses in R&D and Lantz and Sahut (2005) clearly highlight them.

First of all, R&D in quality of intangible asset, is a risky investment because "the decisional choices, resulting from the process of knowledge acquisition and rights, are irreversible and structure firms, sometimes putting them in danger" (see Lantz and Sahut 2005, p. 252).

Moreover, the authors stress the uncertainty and long-term orientation of such immaterial asset, leading benefits to offset costs only after a certain period of time: which is known as "lag time innovation" (see Chao-Hung Wang, 2011).

This intangible enhances the asymmetry between shareholders and managers, contributing to the above-mentioned problem, typical of the principal-agent situation: moral hazard. The principals (the shareholders and, to some extent, the market) lack control (without excessive costs) on the management's behavior. Thus, the latter dealing with an investment whose contents and prospects for current profit are dubious, may prefer to avoid it. From their perspective, firms must bear high expenditures (because of high development and control costs) for an asset with an uncertain future value and so uncertain return.

The probability of failure of R&D projects is high, cause the risk entailed by innovations is both technological – "a technological rupture brutally makes obsolete the discovery" and competitive – "its discovery [may not] become a market standard" (see Lantz and Sahut, 2005, p. 255). The researchers, making as example the case in which a firm stop a R&D project, emphasize the impossibility for the company to recover the full amount invested in the innovative activities: the (most of the time) firm-specific aptitude of intangible expenditure makes R&D an irreversible investment, impossible to be sold at its acquisition cost.

Another disadvantage of investing in innovation is the other side of the spillover phenomenon (see Jaffe, 1986). The public-good-nature of R&D - its non-excludable attribute - force firms to protect the inventions (e.g. with patents) to avoid competitors from copying the knowledge discovered without permission. But this requires a detailed public disclosure of the invention, which in turn, allows competitors to use the discovery as a starting point for further researches, with the aim to improve it, avoiding the significant costs borne by the original inventor in the research phase.

3. THEORETICAL FRAMEWORK

The examination of R&D investment's effects on firm performance has been a popular issue for many years (see Öztürk and Zeren, 2015; Beld, 2014; Ghaffar and Khan, 2014; Zhu and Huang, 2012; Atalaya et al., 2013; Pantagakisa et al., 2010). Using studies focused on OECD countries - because USA is part of this international organization - I identify the hypotheses of my research paper.

3.1 EFFECTS OF R&D INVESTMENT ON FIRM PERFORMANCE

The literature review proves a positive correlation between the expenditures in R&D and the firm's market value (see Ehie and Olibe, 2010). Considering the performance from a market-based view, we take into account market's expectations about future earnings - incorporated in the stocks' price -, focused also on investments with future prospects of profitability as R&D is.

However, mixed or even conflicting results are shown in studies that investigate the influence of R&D on firm performance appreciated in terms of sales growth, income, and return (see Zhu and Huang, 2012).

The earliest evidence that do find some positive effect of R&D activity on sales growth dates back to the 60's, in particular to Mansfield's (1962) work (see Lamperti et al., 2015).

The former author's paper, studying the steel and petroleum U.S. refining industry, highlighted a marked difference between firms that carried out significant innovations during selected periods (from 1916 to 1945) and other comparable ones that were not involved in the innovation process. Successful innovators' rate of growth always exceeded (and many times was twice) that of the others (Mansfiled, 1962).

Conclusion confirmed also by Scherer (1965), who considering data about the Fortune's 500 largest U.S. firms, showed the rewarding effect of R&D investment on firms' profits via sales growth.

Since then many subsequent studies supported the positive impact on sales growth as: Hall, 1987; Geroski 1996; Del Monte and Pagani, 2003; García-Manjón and Romero-Merino, 2012.

Other more recent contributions have shown the critical role of innovation to enhance firm performance.

Van Auker, et al. (2008), analysed 1,091 Spanish manufacturing small and medium enterprises, segmenting them between low and high technology industries. The paper confirmed the positive relationship between innovation (measured, among others, as the degree of R&D expenditures) and firm performance, regardless the sector's technological intensity. Following the authors, the performance's improvement is linked to the impact of three dimensions. Novelty products allow the company's adaptation to market changes and, fulfilling customers' needs, strengthen the relationship with them; the process of innovation contributes to economic efficiency, lowering fixed costs and thus, leading to higher profits and productivity; The managerial and system innovation improves the quality and coordination of tasks.

Bogliacino and Pianta (2010), tested for 38 manufacturing and service sectors, on eight European countries over two time periods from 1994 to 2006, a model based on three perspective of analysis. They considered R&D investment as the main input for the development of successful innovation; they confirmed the innovation-driven high entrepreneurial profits and investigated the extent to which profits, innovative efforts' outcome, are the driver of further technological efforts.

Even though there is a long series of studies about OECD countries supporting the positive nexus with firm performance (see Beld, 2014; Atalay et al., 2013 and Warusawitharana, 2014), some researchers sustain opposite empirical conclusions.

Lantz and Sahut (2005) used data from 2004 annual report of 213 European firms in software, telecommunication, aerospace and biotechnologies sectors. The researchers acknowledged that strong investment in R&D is an essential factor for technological firms' growth and strategic positioning, by means of the exploitation of innovations. But, on the other hand, they shed light on the negative impact of such expenditure on the firms' net income and return. Their working paper found that intensive R&D investing companies' financial performance is significantly strained, with a return two times lower compared to firms with low R&D investments.

Another interesting point of view is such of Lin and Chen (2005) who examining financial data, from 1976 to 1995, of 78 US-based technology companies associated the negative impact of R&D, on firm's profitability and productivity, to a certain investment threshold. The researchers stated a "diseconomy of R&D intensity" (see Lin and Chen, 2005, p. 162): R&D can be a competitive weapon only until a certain extent, because after reaching a certain optimal point R&D emphasis is negatively correlated with R&D efficiency and effectiveness.

The literature highlights reasons for these conflicting results.

First of all, R&D activities are "future-aimed activities": they are a complex construct that needs some time to impact on firm performance, thus there can't be an instantaneous reflection of current R&D investment on current performance (see Zhu and Huang, 2012, p.915).

An interesting point of view that try to balance at the same time positive and negative effects of R&D on performance is that of Chao-Hung Wang (2009) who "explored the issue of performance as the result of both optimal and threshold effects" (see Chao-Hung Wang, p. 61). On the one hand, investing up to (and not beyond) a specific - customized for the firm - amount of R&D is necessary for the establishment of an optimal equilibrium that maximizes the performance. On the other hand, considering the final stage of the innovation process' lifetime, in order for R&D to positively and efficiently affect performance, a minimum threshold of investment is required. If these conditions aren't met the negative effects represented by the expenditures to carry out the investment outweigh the positive ones (see Chao-Hung Wang, 2009).

Thus, it is possible to highlight the presence of a trade-off when investing in R&D: one the one hand in the long run it generates additional profits (see Huang and Liu 2005), but it also increases the firm's total costs, cause according to the US GAAP[1], R&D costs are generally expensed in the income statement as they are incurred, thus decreasing the net income.

Secondly, "most of the studies are based on the manufacture sectors, which include food, textile, wood and furniture, petroleum, electronics, medicine and biological products, information technology industry and so on" (see Zhu and Huang, 2012, p.916). It is important to verify if differences exist between manufacturing and non-manufacturing firms. For this reason, one of the aim of my study is to investigate the effect of R&D investment on the performance of firms distinguishing between companies providing services and those selling tangible goods.

At first glance the effect of R&D on firm performance can't be taken for granted and doesn't allow me to formulate a decisive assumption. A clear-cut trade-off is supposed: on the one hand R&D activities are expensive, but on the other hand they yield benefits to the firm. What I want to do is to investigate what effect prevails analysing only one year of observation and to try to understand the motivation behind the results obtained.

So my hypothesis testing (H1) is: investment in R&D will affect the firm performance. I expect to obtain a significant coefficient (as output of my regression) of the variable expressing the amount of investment in innovation.

But I'm not able to say in advance if this effect will be positive or negative, because of the fragmented available literature. Only at the end of my research I will clearly explain the link between the above-mentioned variables.

[1] The main resources used to report US GAAP are KAISER G. (2013). *IFRS and US GAAP: similarities and differences.* PWC and SHAUN (2010). *Accounting of intangible assets.* Shodhganga.

4. BUSINESS SECTORS' FEATURES

In the following I'll describe the 4 macro-sectors characterizing my sample.

4.1 MANUFACTURING COMPANIES VERSUS NON-MANUFACTURING COMPANIES

"The U.S. economy has been the innovator of virtually all major technologies developed since World War II [..]. American manufacturers have been responsible for more than two-thirds of all private sector R&D that led to these innovative new technologies. More than 90% of new patents derive from the manufacturing sector and the closely integrated engineering and technology-intensive services" (see Nash-Hoff, 2013, p.1)

Manufacturing enterprises are those creating products through processes of fabrication and assembly, converting raw materials or pieces. The finished good is the result of putting together parts that may have a little value in and of themselves, for this reason this sector is considered as a wealth-producing one. This makes manufacturing enterprises, among commercial ones, probably the most complex business, with a complexity increasing accordingly to the size, complexity and aggregate number of products the firm aims to manufacture (see BizFilings, s.d.).

The study of Ho et al. (2005) proposes findings that can be generalized to the description of U.S. industries' market evolution, because of the analysis of one of the most extensive database (15039 firms-years over 1962-2001). According to the authors firms employ different mixes and intensities of R&D investment depending whether they are manufacturing or non-manufacturing. The authors discovered R&D investment is a source of value and return for manufacturing firms, while it doesn't enhance service firms' market performance and return.

According to Mele (2007, p.1) "service organizations are lagging behind their manufacturing counterparts in terms of the effective deployment of [..] a quality-driven strategy, focused on enhancement thanks to R&D". The explanation proposed by the author is that service companies try to reach short cuts to success and aren't interested in spending time and money to implement a sound R&D strategy customized to their core business. The resulting consequence of the not looked after investment in innovation is a poor effect on firm performance.

So, according to this literature innovation influences in an intensive way manufacturing companies' performance and in a non-relevant way service company.

In my work I'll investigate if the firm performance of manufacturing companies is more affected by R&D investment than the firm performance of non-manufacturing companies.
Thus, H2: R&D investment has a higher effect on manufacturing firms' performance than in service one.

4.2. FINANCIAL SECTOR

Notwithstanding the depth sub-prime mortgage crisis of 2007, the US finance industry is one of the most competitive and extensive in the whole world (see Chandler et al., 2010).
The finance industry accounted for 7.2 percent - $1.26 trillion - of US GDP in 2014 (Fontana, 2015) "comprising of a number of sub-industries like insurance industry, mortgage industry, investment services and financial advisory services for example" (see Chandler et al., 2010, p.1)
From the global financial crisis, the need to have an innovative financial architecture has arisen. The main goal to achieve is the creation of a timely efficient and effective landscape to finance in adequate manners businesses, leading to a stable long-term growth for the economy (see Al Maktoum, 2014)
To sustain this aim, a process of financial development must be fostered, and the tool to use is investing in R&D.

4.3. SALES SECTOR

In my analysis I put together the retail sector and the wholesale sector because of the same idea behind their core business: to sale to a consumer. The difference between them is only in the look of the transaction. In the first case the company sales to the final customer, in the second one to another company.

4.3.1 Retail sector

US retail sector's main feature is the race for relevance among retailers.
To survive in nowadays fast-changing competitive environment, differentiation is the key strategy. Diversification both in the in-store offerings - providing an enormous product selection - and in the technologies available to satisfy customers' needs (see Sviokla, 2015).
"In a world where mercurial shoppers are easily bored and yesterday's new invention is already obsolete, retailers are racing to stay relevant with consumers" using customer mainstays such

as brand equity and in-store shopping experience (see Barr, 2015, p.1). Moreover, following Barr et al. (2015), there is the will to buy quality at an affordable price, to be helped sorting through options by trained shop assistants and to share the values of the favourite brand, establishing an emotional connection with it.

The way consumers shop changes continuously because of the proliferation of digital technologies leading to the need for retailers to be present across all platforms available to consumers. Moreover, product pricing, shipping, return options, promotional offerings must be cared according to consumer's up-to date needs, through the collection of as much information as possible about them (see Paul, 2015).

Thus, the retailers supposed to win this race will be only those who, investing in innovation, thanks to R&D expenses, will achieve the above-mentioned goals. This will lead them to stay ahead of the pack.

4.3.2 Wholesale sector

According to the North American Industry Classification System, "the Wholesale Trade sector comprises establishments engaged in the [..] outputs of agriculture, mining, manufacturing, and publishing without transformation, and rendering services incidental to the sale of merchandise".

Companies in this sector distribute merchandise to other businesses, typically specializing by product category and operating from a warehouse or office. In particular, we can highlight 3 main fields characterizing this intermediate step in the merchandise distribution. The sale of goods addressed to other wholesalers or retailers (i.e. resale), the sale of capital or durable non-consumer goods and of raw/intermediate supplies part of the production process (see The North American Industry Classification system, 2016 and First research, W*holesale sector industry profil*e, 2016).

Among the 400,000 establishments composing the US wholesale distribution industry, the top US distributors are Avnet (electronics), McKesson (drugs), and SYSCO (foods). Overall this sector has sales of about $8 trillion (see First research, *Wholesale sector industry profil*e, 2016), given its size and prospects of future growth this sector is supposed to achieve a competitive position alongside of manufacturing- and retail-focused offerings in the market (see Anderson, 2011).

Also in this sector the role of innovation has a major importance, because warehouses usually have no display of merchandise and can't exploit the location where they are, nor the advertising

to the general public. The critical role to attract customers is the quality of the services offered in order to create a long-standing relationship to ensure follow-up orders.

First of all, investments in R&D applied to the wholesale industry consist in creating efficient logistics methods and sophisticated computer systems in order to deal with an increasing international distribution encouraged by low international freight costs.

Moreover, the warehousing industry is no more a passive provider of storage space, investing in R&D it has diversified in the direction of offering add-on services to the customers such as the possibility to keep track of individual items through the supply chain (see First research, *Wholesale sector industry profil*e, 2016).

Then, innovation is of great importance also in the process of creating electronically equipped warehouses. Thanks to computer systems necessary to identify individual items and to track the volume of production it is possible to develop sophisticated functions, such as allowing a computer-guided forklifts to know exactly where a stored item is located (see First research, *Wholesale sector industry profil*e, 2016).

It is evident that for each sector, above described, innovation is a key factor.

Thus the third aim of my study is to understand which of the sectors analysed is more affected by R&D.

5. DATABASE

My sample is made up of 2475 publicly listed companies located in North-America. All the data for the variables in my regression analysis are obtained from the official annual reports available on EDGAR: The Electronic Data Gathering, Analysis, and Retrieval system. In the USA "all companies, foreign and domestic, are required to file registration statements, periodic reports, and other forms electronically through it" (see U.S. Securities and Exchange Commission, F*ilings & Forms*, 2012, p.1).

The current section is focused on the description of my sample and of the variables composing my model.

5.1 SAMPLE

I've used the following procedure in order to have a fair database.
My starting database was formed by 3322 U.S. companies. I cleared it removing from the database firms belonging to sectors with non-relevant intensity of R&D investment, such as firms in the agriculture, forest, mining and fishing sector and firms which were present in a very limited way in my database: construction, transportation, communications, electric, gas sectors. Moreover, to avoid a selection bias, I removed firms with extreme values of the variables (except for the firm size), thus with indexes higher than 100% or lower than -100% because these abnormal values, which if left in my sample could have distorted results, come from transcription errors made by the person who recorded the database. To sustain a strongly balanced database, companies with zero R&D expenditure are part of my sample.
So, after these adjustments, the final number of companies in my sample is 2475.
Moreover, I divided the data into 4 sectors, according to the 3-digit USA SIC codes, that's to say the Standard Industry Classification codes. Companies with a code between 200 till 399 are manufacturing companies, from 500 till 519 we find wholesale trade, from 520 till 599: retail trade, from 600 till 679: financial sector and from 700 till 899: service sector.
The year of observation in my analysis is 2014, the most recent available period for my data and as stated in the introduction a year in which expenditures in R&D were considerable.

5.2 VARIABLES

The purpose of my research is to examine the sign of the causal relationship between R&D investment and firm performance, to understand if manufacturing sector is more affected than service one and to understand which of the 4 sectors composing my database is more influenced by innovation.
To test my hypotheses, I perform a multivariate regression analysis applying OLS regression (Ordinary Least Squares) and using Gretl as statistical software.
The predicted variable, the dependent variable is the firm performance (ROA). The predictor, the independent variable is the R&D investment. I insert in my model also control variables such as firm size, leverage and investments' structure to control if the firm performance is caused by these variables.

5.2.1 Dependent variable

The dependent variable is a variable which is caused by the independent variable. The dependent variable in my study is firm performance analysed from a financial point of view using the Return on Assets as measure (ROA). I calculated this indicator as the ratio of firm's annual net income to firms' total assets. This index, focusing on the firm's past performance, shows if the company uses, in an efficient way, its assets to gain profits.

5.2.2 Independent variable

The independent variable in my model is the expense in R&D. This is my explanatory variable because it is supposed to have an effect on firm performance and it is the main variable of interest in my research.
The R&D intensity (RDI) is used to measure the amount of investment in innovation. I created it as the ratio of the total firm's R&D expenditure to the total assets of the company.

5.2.3 Control variables

Because ROA can be affected by many other factors except R&D, to obtain robust results I consider in the model some control variables reflecting endogenous firm's characteristics.

Firm's size (SIZE)

"Firm size is one of the most acknowledged determinants of a firm's profits in terms of its effect on competitive market power in a given industry" (see Beard and Dess, 1981, p.1)
Among the benefits larger firms employ, we find economies of scale. This cost advantage is responsible, on the one hand, for the reduction of per-unit fixed costs thanks to the existence of an inverse relationship between the volume of output and per-unit fixed cost of production that allows costs to scatter across a larger number of goods. And on the other hand, through the establishment of operational efficiencies and synergies, for the reduction of variable costs per unit of good (see Katz, Rosen et al., 2011 and Investopedia, *What is economies of scale*, 2016). Moreover, large firms benefit from market concentration, market power and favourable access to capital markets (see Baumol 1967 and Lee, 2009).
According to the majority of the studies (see Lee, 2009) that roughly consider the effect of firm's size on the performance without taking into account "market and firm-specific characteristics, such as market concentration, entry barriers ad firm strategies" (see Lee, 2009, p.189), I suppose the existence of a positive association between SIZE and firm performance. Thus, larger firms (exploiting the efficiency gains) are supposed to be more profitable than the smaller ones.
As proxy to measure the size of the firm I consider the natural logarithm of the company's total assets. This shrewdness is useful to normalize the values, because assets are subject to differ a lot, and essential for the regression analysis.

Leverage (LEV)

Any potential solution to the principal-agent problem, i.e. the separation of ownership and control in the firm (see section 2 - *Cons*), involves agency costs. The efforts can be divided into three groups: monitoring costs (manager's activities' control); Bonding costs (to align interests); Residual loss (additional costs that can't be minimized or observed) (see Monks and Minow, 2011)
According to corporate governance theories, leverage affects agency costs and thereby influences firm performance. More precisely, the choice of the capital structure plays a key role in increasing the value of the firm and in limiting managerial miss-conduct (see Berger and Bonnacorsi di Patti, 2002). A higher level of leverage (or a lower equity/asset ratio) reduces the agency cost of outside equity through "the threat of liquidation which causes personal losses to

managers of salaries, reputation, perquisites and through pressure to generate cash flow to pay interest expenses" (see Berger and Bonnacorsi di Patti, 2002, p.1). According to this point of view, choices where the distance between shareholders and managers is reduced are: the type of investments to face, the degree of risk to assume, the firm's liquidation conditions and the dividend policy. All else held equal, this results in reduced outside equity's agency costs and improved firm performance (see Berger and Bonnacorsi di Patti, 2002).

As a consequence, another control variable in my analysis is the leverage. I measure it creating the ratio Liabilities/total assets, i.e. how much of the assets comes from liabilities.

Following the above-mentioned theories, that focus on the benefits of leverage and not on the cost-effect of contracting a loan (interests' expenses that lower profits), I expect a positive effect of LEV on firm performance.

Intangible assets (IA)

As discussed at the OECD Corporate Governance Committee meeting on April 2012 the importance of intangible resources has grown steadily since 1990s. Nowadays it is common to speak about a "conceptual company where the focus is on intangibles such as employee skills, knowledge, trade secrets software, copyrights and patents, customer and supplier relationships" (see Amico et al., 2012, p.4) instead of physical assets.

That's because of the contribution of these corporate assets to the firms' profitability: they allow economic entities to extract a "competitiveness rent" and, thus, to enhance the outcomes of their activity (see Tudor et al., 2014, p.283)

The analysis conducted by Ernst & Young on the 500 Fortune companies is a proof of the growing importance of intangibles: in 1975 the majority of the capitalization (60%) consisted of tangible assets, whereas from 1995 to nowadays a downward trend has dropped to 25 % that percentage in favour of intangibles (see Bloom, 2008).

An interesting point of view is that of Fiordelisi et al. (2012) who demonstrated that investing in intangible assets lower the reputational risk of a company. The risk of a reputational damage is the "risk arising from negative perception on the part of customers, counterparties, shareholders, investors, [..], other relevant parties or regulators that can adversely affect [..] the ability to maintain existing, or establish new, business relationships and continued access to sources of funding" (see Fiordelisi et al., 2011, p.2).

The positive effect of the presence of intangible investments on the firm's reputation is due to the conviction of the market that a considerable amount of investment in non-physical assets is

related to future profitability and thus future availability to cover for any eventual loss (see Tudor et al., 2014).
Thus the expected link between firm performance and IA (that I calculated as the ratio of Intangible assets to total assets) is positive.

Tangible assets (PPE)

My variable PPE (that I created as the ratio of fixed assets to total ones) records the firms' investment in tangible assets, in particular in properties, plant and equipment. These physical assets are long-lived and are used in the core business process to create goods and services, moreover they are not intended for resale (see US GAAP, 2013).
Long-term tangible assets are essential for the company's ability to create value through the generation of cash. This allows to fund business growth and to remunerate through dividends the shareholders (see Rappaport, 2005).
For what explained, I expect a positive link between PPE and ROA[2].

Short term investments (CASH)

Short term investments are very liquid assets because are expected to be sold or converted into cash in the next 3 to 12 months (see Shaun, 2015).
Even if the source of a value-creating growth is long-term investment, managers are attracted by short-term earnings and often abound with the choice of short-term investments leading to simple and quick gain (see the moral hazard problem in section 2 - *Cons*). This Short-termism is not terribly puzzling because "we are speaking about a market dominated by agents responsible for other people's (the shareholders) money but also looking out for their interests" (see Rappaport, 2005, p.65)
Short-term performance is more significant for young companies "where expectations about future growth are much more sensitive to current performance, than for companies with established operating histories" (see Rappaport, 2005, p.65).
But we can correctly say that the obsession for short-term profits is a generalized concern of all CEOs and corporate executives because they know that the stock price of their company's stocks focuses, above all, on current earnings (see Monks and Minow, 2011 and Rappaport, 2005).

[2] In this case I refer to the short-term firm's performance: see *section 6.2 – PPE* for the complete explanation.

Considering that “the professional is incentivized to earn higher, yet ultimately riskier and less-certain paper profits now at the ultimate risk and expense of the shareholders” (see Monks and Minow, 2011, p.133), I expect a negative relationship between firm performance and CASH (that I calculated as the ratio of short term investments to total assets).

6. QUANTITATIVE ANALYSIS

I start my analysis doing the OLS of my simple starting model consisting of my dependent variable, my independent and control ones:

$$ROA = \alpha + ß1*RDI + ß2*SIZE + ß3*LEV + ß4*IA + ß5*PPE + ß6*CASH + \varepsilon$$

Model 1: OLS, using observations 1-2475

Dependent variable: ROA

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
Const	−0.0708788	0.0160493	−4.4163	<0.0001	***
RDI	−0.778446	0.033925	−22.9461	<0.0001	***
SIZE	0.0287261	0.00173112	16.5940	<0.0001	***
LEV	−0.125523	0.0166236	−7.5509	<0.0001	***
IA	−0.0515795	0.01772	−2.9108	0.0036	***
PPE	0.0291586	0.0148518	1.9633	0.0497	**
CASH	−0.142018	0.0180847	−7.8530	<0.0001	***

Mean dependent var	−0.072106	S.D. dependent var	0.236802
Sum squared resid	72.00146	S.E. of regression	0.170804
R-squared	0.480996	Adjusted R-squared	0.479735
F (6, 2468)	381.2109	P-value(F)	0.000000
Log-likelihood	865.5474	Akaike criterion	−1717.095
Schwarz criterion	−1676.397	Hannan-Quinn	−1702.312

We can notice that all the variables are significant as it is shown by the presence of asterisks: one for 90% significance, two for 95% significance and three for 99% significance.

First of all, I check if in my model there is heteroskedasticity. The reason why I care about it is that ignoring the presence of heteroskedasticity will lead to no more efficient OLS estimate: an

alternative estimate still linear and unbiased, but with a lower variance, exists (see Wooldridge, 2014 and Gau, 2002)

Moreover, ignoring the existence of heteroskedasticity will cause inefficient forecasts and biased inconsistent estimated variance and covariance of OLS estimates of the coefficients, causing no longer valid hypothesis testing (see Kmenta, 1986).

The formal tests I carry are the Breusch-pagan and the White tests.

According to Pedace (2016) the Breusch-Pagan test "is usually applied by assuming that heteroskedasticity may be a linear function of all the independent variables in the model, [..] the problem with this test is that it fails to find evidence of a nonlinear relationship between the independent variables and the error variance [leading to wrongly thinking there is homoskedasticity]. To allow the independent variables to have a nonlinear and interactive effect on the error variance [..]" I use also the White test (see Pedace, 2016, p.1).

Breusch-Pagan test for heteroskedasticity -
Null hypothesis: heteroskedasticity not present
Test statistic: LM = 1274.17
with p-value = P (Chi-square (6) > 1274.17) = 4.23741e-272

White's test for heteroskedasticity -
Null hypothesis: heteroskedasticity not present
Test statistic: LM = 566.955
with p-value = P (Chi-square (27) > 566.955) = 2.13874e-102

Since in both tests I have a p-value lower than any level of significance (0.10; 0,05; 0,01) I reject the null hypothesis of homoskedasticity.

Now I want to test whether my regression model is correctly specified in terms of the variables included in the analysis, to do this I use a widely employed (see DeBenedictis and E. A. Giles, 1996) diagnostic test: The Ramsey Regression Equation Specification Error Test (RESET)[3].

RESET test for specification -
Null hypothesis: specification is adequate
Test statistic: F (2, 2466) = 140.175
with p-value = P (F (2, 2466) > 140.175) = 2.19465e-058

[3] Squares and cubes

The result of the test is clear: my model isn't well-specified (the p-value of the test is lower than any level of significance), that means there are errors associated with the specification of the model.

First of all, to solve the problem of heteroskedasticity I choose the Robust option to calculate the p-values of the test statistics, i.e. the standard errors and all inference will be made in the following under the hypothesis of heteroskedasticity.

Model 2: OLS, using observations 1-2475
Dependent variable: ROA
Heteroskedasticity-robust standard errors, variant HC1

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
Const	−0.0708788	0.0191632	−3.6987	0.0002	***
RDI	−0.778446	0.0616432	−12.6282	<0.0001	***
SIZE	0.0287261	0.00238916	12.0235	<0.0001	***
LEV	−0.125523	0.0202205	−6.2077	<0.0001	***
IA	−0.0515795	0.0162793	−3.1684	0.0016	***
PPE	0.0291586	0.0130161	2.2402	0.0252	**
CASH	−0.142018	0.0255413	−5.5603	<0.0001	***

Mean dependent var	−0.072106	S.D. dependent var	0.236802
Sum squared resid	72.00146	S.E. of regression	0.170804
R-squared	0.480996	Adjusted R-squared	0.479735
F (6, 2468)	219.4265	P-value(F)	7.1e-225
Log-likelihood	865.5474	Akaike criterion	−1717.095
Schwarz criterion	−1676.397	Hannan-Quinn	−1702.312

Now, I try to solve the problem of misspecification.
Among the many forms of specification errors, we can find the "exclusion of a relevant variable" causing OLS estimators biasness and inconsistency (see Boyd, 2001).
To verify if the misspecification is caused by this reason, I add to my model other variables. In particular, because I divided my dataset into 4 industrial sectors: manufacturing, service, finance and sales, I created 3 dummy variables considering as a constant the manufacturing

sector (which is the most common among the companies in my database). I also manually created the interaction effects between the 3 dummies and the independent and control variables.

As a whole, I created 18 interaction variables which names are:

Z1=services*RDI; Z2=services*SIZE; Z3=services*LEV; Z4=services*IA; Z5=services*PPE; Z6=services*CASH;

Z7=sales*RDI; Z8=sales*SIZE; Z9=sales*LEV; Z10=sales*IA; Z11=sales*PPE; Z12 =sales*CASH;

Z13=finance*RDI; Z14=finance*SIZE; Z15=finance*LEV; Z16=finance*IA; Z17=finance*PPE; Z18=finance*CASH;

Model 3: OLS, using observations 1-2475

Dependent variable: ROA

Heteroskedasticity-robust standard errors, variant HC1

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
Const	−0.00730057	0.0290571	−0.2512	0.8016	
RDI	−0.78771	0.0701097	−11.2354	<0.0001	***
SIZE	0.0348776	0.002993	11.6530	<0.0001	***
LEV	−0.130962	0.0283659	−4.6169	<0.0001	***
IA	−0.203476	0.0338432	−6.0123	<0.0001	***
PPE	−0.0716005	0.0270506	−2.6469	0.0082	***
CASH	−0.257104	0.039029	−6.5875	<0.0001	***
Services	−0.0282011	0.0754539	−0.3738	0.7086	
Sales	0.00426116	0.0589219	0.0723	0.9424	
Finance	0.012051	0.0479058	0.2516	0.8014	
Z1	0.467011	0.13688	3.4118	0.0007	***
Z2	−0.00131737	0.00649823	−0.2027	0.8394	
Z3	−0.0194545	0.0514789	−0.3779	0.7055	
Z4	0.0807164	0.0709359	1.1379	0.2553	
Z5	0.000223603	0.0557576	0.0040	0.9968	
Z6	0.0645691	0.0843035	0.7659	0.4438	
Z7	−0.0821648	0.619763	−0.1326	0.8945	

Z8	−0.00948671	0.0110121	−0.8615	0.3891	
Z9	−0.0457931	0.0642814	−0.7124	0.4763	
Z10	0.138511	0.0457919	3.0248	0.0025	***
Z11	0.0340134	0.050406	0.6748	0.4999	
Z12	0.105623	0.102899	1.0265	0.3048	
Z13	−0.549291	0.379466	−1.4475	0.1479	
Z14	−0.0277981	0.00463116	−6.0024	<0.0001	***
Z15	0.0594857	0.043894	1.3552	0.1755	
Z16	0.175393	0.0831985	2.1081	0.0351	**
Z17	0.187206	0.078885	2.3732	0.0177	**
Z18	0.410051	0.0668982	6.1295	<0.0001	***

Mean dependent var	−0.072106	S.D. dependent var	0.236802
Sum squared resid	67.51552	S.E. of regression	0.166106
R-squared	0.513332	Adjusted R-squared	0.507962
F (27, 2447)	60.63550	P-value(F)	1.8e-248
Log-likelihood	945.1545	Akaike criterion	−1834.309
Schwarz criterion	−1671.517	Hannan-Quinn	−1775.178

RESET test for specification -
Null hypothesis: specification is adequate
Test statistic: F (2, 2445) = 101.905
with p-value = P (F (2, 2445) > 101.905) = 3.09863e-043

The misspecification in my model is still present.

I proceed the attempt to understand the origin of the specification problems in my model investigating if there is an error in the specification of the functional form. I try to understand if the linear relationship I supposed to exist between the variables is instead a non-linear one. That's because "excluding a relevant quadratic variable will cause my model to be subject to an omitted variable bias and to inconsistency properties" (see Boyd, 2001).

So to check for a possible non-linear effect I deploy in my model the squares of the 6 variables of my initial simple model (see model 1).

Model 4: OLS, using observations 1-2475

Dependent variable: ROA

Heteroskedasticity-robust standard errors, variant HC1

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
Const	−0.18796	0.0445471	−4.2193	<0.0001	***
RDI	−0.905764	0.15629	−5.7954	<0.0001	***
SIZE	0.0856768	0.0109288	7.8395	<0.0001	***
LEV	−0.163319	0.0650668	−2.5100	0.0121	**
IA	−0.163512	0.0551158	−2.9667	0.0030	***
PPE	−0.0425628	0.0647256	−0.6576	0.5109	
CASH	0.0780418	0.0706049	1.1053	0.2691	
Services	0.0331345	0.073746	0.4493	0.6533	
Sales	0.0426968	0.062869	0.6791	0.4971	
Finance	0.00778362	0.0495764	0.1570	0.8753	
Z1	0.443681	0.138196	3.2105	0.0013	***
Z2	−0.00559809	0.00630774	−0.8875	0.3749	
Z3	−0.027502	0.0503947	−0.5457	0.5853	
Z4	0.036048	0.0699471	0.5154	0.6063	
Z5	−0.0151737	0.0545072	−0.2784	0.7807	
Z6	−0.0322875	0.0861702	−0.3747	0.7079	
Z7	−0.0244395	0.69019	−0.0354	0.9718	
Z8	−0.0113215	0.0110664	−1.0230	0.3064	
Z9	−0.0584228	0.0629171	−0.9286	0.3532	
Z10	0.125198	0.0450516	2.7790	0.0055	***
Z11	0.01674	0.0507134	0.3301	0.7414	
Z12	0.0556239	0.106498	0.5223	0.6015	
Z13	−0.561785	0.300216	−1.8713	0.0614	*
Z14	−0.0205112	0.0044029	−4.6586	<0.0001	***
Z15	0.0249603	0.0444368	0.5617	0.5744	
Z16	0.143404	0.080779	1.7753	0.0760	*
Z17	0.184635	0.0742569	2.4864	0.0130	**
Z18	0.300726	0.0671386	4.4792	<0.0001	***

sq_RDI	0.209105	0.294971	0.7089	0.4785	
sq_SIZE	−0.00408881	0.00074613	−5.4800	<0.0001	***
sq_LEV	0.0588418	0.0604433	0.9735	0.3304	
sq_IA	−0.0267558	0.0729936	−0.3666	0.7140	
sq_PPE	−0.0346904	0.0596019	−0.5820	0.5606	
sq_CASH	−0.329138	0.0653341	−5.0378	<0.0001	***

Mean dependent var	−0.072106	S.D. dependent var	0.236802
Sum squared resid	64.35675	S.E. of regression	0.162373
R-squared	0.536101	Adjusted R-squared	0.529830
F (33, 2441)	64.51580	P-value(F)	4.3e-303
Log-likelihood	1004.450	Akaike criterion	−1940.900
Schwarz criterion	−1743.224	Hannan-Quinn	−1869.098

RESET test for specification -
Null hypothesis: specification is adequate
Test statistic: F (2, 2439) = 37.8246
with p-value = P (F (2, 2439) > 37.8246) = 6.64669e-017

The null hypothesis of the RESET test is still rejected. This result is interpreted as the presence of non-linearity in my model. According to Beld (2014) the presence of negative values of the parameters of the squared variables indicates a bend, so a non-linear relationship.
We can see that only the variables SIZE and CASH have a significant non-linear influence on firm performance.
Another reason why my model may be misspecified is the inclusion of an irrelevant variable, according to Boyd (2001).
So I proceed excluding from my model non-significant variables (variables without any asterisk, so variables whose p-value is higher than the level of significance 0.1).

I proceed delating the variables PPE and CASH which are no more significant (compare model 4 with models 1-3).

Model 5: OLS, using observations 1-2475

Dependent variable: ROA

Heteroskedasticity-robust standard errors, variant HC1

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
Const	−0.178779	0.0401495	−4.4528	<0.0001	***
RDI	−0.872116	0.148268	−5.8820	<0.0001	***
SIZE	0.0853639	0.0109436	7.8003	<0.0001	***
LEV	−0.171074	0.0648233	−2.6391	0.0084	***
IA	−0.165692	0.0548881	−3.0187	0.0026	***
Services	0.0271672	0.0726017	0.3742	0.7083	
Sales	0.029898	0.0610162	0.4900	0.6242	
Finance	0.00105577	0.0452579	0.0233	0.9814	
Z1	0.435545	0.138275	3.1498	0.0017	***
Z2	−0.00509975	0.00631842	−0.8071	0.4197	
Z3	−0.0252041	0.0503089	−0.5010	0.6164	
Z4	0.0395053	0.0680046	0.5809	0.5613	
Z5	−0.0177059	0.0512508	−0.3455	0.7298	
Z6	−0.0140891	0.0808563	−0.1742	0.8617	
Z7	0.0127014	0.672763	0.0189	0.9849	
Z8	−0.0113421	0.0110785	−1.0238	0.3060	
Z9	−0.0513348	0.0631074	−0.8135	0.4160	
Z10	0.132843	0.0422732	3.1425	0.0017	***
Z11	0.0206433	0.0481591	0.4286	0.6682	
Z12	0.0849283	0.0996041	0.8527	0.3939	
Z13	−0.577785	0.299748	−1.9276	0.0540	*
Z14	−0.0201909	0.0043908	−4.5985	<0.0001	***
Z15	0.0304202	0.0438592	0.6936	0.4880	
Z16	0.149098	0.0778904	1.9142	0.0557	*
Z17	0.174348	0.0653015	2.6699	0.0076	***
Z18	0.325355	0.0569188	5.7161	<0.0001	***
sq_RDI	0.168215	0.288204	0.5837	0.5595	
sq_SIZE	−0.0040937	0.000748642	−5.4682	<0.0001	***
sq_LEV	0.0605989	0.0604328	1.0027	0.3161	

sq_IA	−0.0309469	0.0697145	−0.4439	0.6571	
sq_PPE	−0.0824916	0.0239472	−3.4447	0.0006	***
sq_CASH	−0.257531	0.0319055	−8.0717	<0.0001	***

Mean dependent var	−0.072106	S.D. dependent var	0.236802
Sum squared resid	64.42405	S.E. of regression	0.162391
R-squared	0.535616	Adjusted R-squared	0.529723
F (31, 2443)	67.26961	P-value(F)	1.0e-299
Log-likelihood	1003.157	Akaike criterion	−1942.313
Schwarz criterion	−1756.265	Hannan-Quinn	−1874.734

RESET test for specification -
Null hypothesis: specification is adequate
Test statistic: F (2, 2441) = 40.7068
with p-value = P (F (2, 2441) > 40.7068) = 4.07091e-018

There is still misspecification.

Then, I remove from my model the variables: services, sales and finance because these 3 dummies aren't significant.

Model 6: OLS, using observations 1-2475
Dependent variable: ROA
Heteroskedasticity-robust standard errors, variant HC1

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
Const	−0.172394	0.0392046	−4.3973	<0.0001	***
RDI	−0.879635	0.143437	−6.1326	<0.0001	***
SIZE	0.0845681	0.0110391	7.6608	<0.0001	***
LEV	−0.171525	0.0647759	−2.6480	0.0081	***
IA	−0.169071	0.0544415	−3.1055	0.0019	***
Z1	0.442049	0.135353	3.2659	0.0011	***
Z2	−0.00401959	0.0051974	−0.7734	0.4394	
Z3	−0.0150984	0.0492155	−0.3068	0.7590	

Z4	0.0575287	0.0486411	1.1827	0.2370	
Z5	−0.00660313	0.0410393	−0.1609	0.8722	
Z6	0.00792993	0.0605901	0.1309	0.8959	
Z7	0.00697889	0.650593	0.0107	0.9914	
Z8	−0.00952301	0.00839666	−1.1341	0.2568	
Z9	−0.0382433	0.0761986	−0.5019	0.6158	
Z10	0.143313	0.0450415	3.1818	0.0015	***
Z11	0.0323875	0.0445946	0.7263	0.4677	
Z12	0.106526	0.122479	0.8697	0.3845	
Z13	−0.578497	0.292717	−1.9763	0.0482	**
Z14	−0.0203063	0.00304721	−6.6639	<0.0001	***
Z15	0.0311049	0.0390869	0.7958	0.4262	
Z16	0.150746	0.0800991	1.8820	0.0600	*
Z17	0.176366	0.0644624	2.7360	0.0063	***
Z18	0.326153	0.0550398	5.9258	<0.0001	***
sq_RDI	0.177314	0.281807	0.6292	0.5293	
sq_SIZE	−0.00405658	0.000753675	−5.3824	<0.0001	***
sq_LEV	0.0591318	0.0602114	0.9821	0.3262	
sq_IA	−0.0304162	0.0694411	−0.4380	0.6614	
sq_PPE	−0.085759	0.022405	−3.8277	0.0001	***
sq_CASH	−0.26091	0.0311222	−8.3834	<0.0001	***

Mean dependent var	−0.072106	S.D. dependent var	0.236802
Sum squared resid	64.43757	S.E. of regression	0.162309
R-squared	0.535519	Adjusted R-squared	0.530202
F (28, 2446)	74.37216	P-value(F)	7.1e-302
Log-likelihood	1002.897	Akaike criterion	−1947.794
Schwarz criterion	−1779.188	Hannan-Quinn	−1886.551

RESET test for specification -

Null hypothesis: specification is adequate

Test statistic: F (2, 2444) = 39.8595

with p-value = P (F (2, 2444) > 39.8595) = 9.23813e-018

The misspecification persists.

I delete the interaction effects of the dummy embodying the service sector and the control variables, so Z2, Z3, Z4, Z5, Z6.

Model 7: OLS, using observations 1-2475

Dependent variable: ROA

Heteroskedasticity-robust standard errors, variant HC1

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
Const	−0.169437	0.0394334	−4.2968	<0.0001	***
RDI	−0.860525	0.144011	−5.9754	<0.0001	***
SIZE	0.0832494	0.0109751	7.5853	<0.0001	***
LEV	−0.175798	0.063179	−2.7825	0.0054	***
IA	−0.164441	0.0524786	−3.1335	0.0017	***
Z1	0.380824	0.0857727	4.4399	<0.0001	***
Z7	−0.0155691	0.650078	−0.0239	0.9809	
Z8	−0.00882049	0.00828821	−1.0642	0.2873	
Z9	−0.0337015	0.074469	−0.4526	0.6509	
Z10	0.130111	0.0420915	3.0912	0.0020	***
Z11	0.0316905	0.0443386	0.7147	0.4748	
Z12	0.106574	0.122361	0.8710	0.3839	
Z13	−0.591981	0.293	−2.0204	0.0434	**
Z14	−0.0197943	0.00271704	−7.2853	<0.0001	***
Z15	0.0362686	0.0356515	1.0173	0.3091	
Z16	0.137601	0.0790336	1.7410	0.0818	*
Z17	0.177307	0.0647348	2.7390	0.0062	***
Z18	0.328263	0.0544763	6.0258	<0.0001	***
sq_RDI	0.163057	0.282357	0.5775	0.5637	
sq_SIZE	−0.00400429	0.000750616	−5.3347	<0.0001	***
sq_LEV	0.0581535	0.0589459	0.9866	0.3240	
sq_IA	−0.019645	0.0681616	−0.2882	0.7732	
sq_PPE	−0.0856051	0.0216215	−3.9593	<0.0001	***
sq_CASH	−0.263935	0.0294656	−8.9574	<0.0001	***

Mean dependent var	−0.072106	S.D. dependent var	0.236802
Sum squared resid	64.55773	S.E. of regression	0.162294
R-squared	0.534653	Adjusted R-squared	0.530286
F (23, 2451)	86.79233	P-value(F)	4.3e-296
Log-likelihood	1000.591	Akaike criterion	−1953.183
Schwarz criterion	−1813.647	Hannan-Quinn	−1902.499

RESET test for specification -

Null hypothesis: specification is adequate

Test statistic: F (2, 2449) = 36.6989

with p-value = P (F (2, 2449) > 36.6989) = 1.97717e-016

Misspecification problem is still present.

I proceed deleting non-significant interactions of sales sector: Z7, Z8, Z9, Z11, Z12

Model 8: OLS, using observations 1-2475

Dependent variable: ROA

Heteroskedasticity-robust standard errors, variant HC1

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
Const	−0.168324	0.0402476	−4.1822	<0.0001	***
RDI	−0.845528	0.14189	−5.9590	<0.0001	***
SIZE	0.0813883	0.0113592	7.1649	<0.0001	***
LEV	−0.177324	0.0639043	−2.7748	0.0056	***
IA	−0.155628	0.0521037	−2.9869	0.0028	***
Z1	0.38347	0.0854959	4.4852	<0.0001	***
Z10	−0.0100343	0.0231904	−0.4327	0.6653	
Z13	−0.591572	0.293464	−2.0158	0.0439	**
Z14	−0.0190242	0.0026056	−7.3013	<0.0001	***
Z15	0.0410467	0.0344162	1.1927	0.2331	
Z16	0.123508	0.0786045	1.5713	0.1163	
Z17	0.174611	0.0654025	2.6698	0.0076	***
Z18	0.325536	0.0543275	5.9921	<0.0001	***

sq_RDI	0.137232	0.280675	0.4889	0.6249	
sq_SIZE	−0.00390518	0.000769502	−5.0749	<0.0001	***
sq_LEV	0.0563045	0.0592566	0.9502	0.3421	
sq_IA	−0.0110006	0.0680536	−0.1616	0.8716	
sq_PPE	−0.0802906	0.0203064	−3.9539	<0.0001	***
sq_CASH	−0.257544	0.0291816	−8.8256	<0.0001	***

Mean dependent var	−0.072106	S.D. dependent var	0.236802
Sum squared resid	64.80053	S.E. of regression	0.162433
R-squared	0.532902	Adjusted R-squared	0.529479
F (18, 2456)	106.4076	P-value(F)	6.1e-291
Log-likelihood	995.9460	Akaike criterion	−1953.892
Schwarz criterion	−1843.426	Hannan-Quinn	−1913.767

RESET test for specification -
Null hypothesis: specification is adequate
Test statistic: F (2, 2454) = 39.6634
with p-value = P (F (2, 2454) > 39.6634) = 1.11417e-017

Miss-specification continues.

I delete the variable Z10, expressing the interaction between the dummy embodying the sales sector and IA, because now it is no more significant.

Model 9: OLS, using observations 1-2475
Dependent variable: ROA
Heteroskedasticity-robust standard errors, variant HC1

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
Const	−0.168152	0.0402584	−4.1768	<0.0001	***
RDI	−0.842961	0.140069	−6.0182	<0.0001	***
SIZE	0.081301	0.0113443	7.1667	<0.0001	***
LEV	−0.177916	0.0639514	−2.7821	0.0054	***
IA	−0.155285	0.0520127	−2.9855	0.0029	***

Z1	0.383808	0.0854183	4.4933	<0.0001	***
Z13	−0.593691	0.292836	−2.0274	0.0427	**
Z14	−0.0190198	0.00260495	−7.3014	<0.0001	***
Z15	0.0413672	0.0343253	1.2051	0.2283	
Z16	0.124593	0.0784959	1.5873	0.1126	
Z17	0.174313	0.0652692	2.6707	0.0076	***
Z18	0.325646	0.0543124	5.9958	<0.0001	***
sq_RDI	0.13378	0.27823	0.4808	0.6307	
sq_SIZE	−0.00389781	0.00076771	−5.0772	<0.0001	***
sq_LEV	0.0566436	0.0593036	0.9551	0.3396	
sq_IA	−0.0128477	0.0673464	−0.1908	0.8487	
sq_PPE	−0.0802278	0.0202822	−3.9556	<0.0001	***
sq_CASH	−0.257745	0.0291733	−8.8350	<0.0001	***

Mean dependent var	−0.072106	S.D. dependent var	0.236802
Sum squared resid	64.80206	S.E. of regression	0.162402
R-squared	0.532891	Adjusted R-squared	0.529659
F (17, 2457)	112.6377	P-value(F)	8.0e-292
Log-likelihood	995.9167	Akaike criterion	−1955.833
Schwarz criterion	−1851.181	Hannan-Quinn	−1917.820

RESET test for specification -
Null hypothesis: specification is adequate
Test statistic: F (2, 2455) = 39.6247
with p-value = P (F (2, 2455) > 39.6247) = 1.15644e-017

There is still presence of misspecification.

I continue eliminating Z15 and Z16 that represent the interactions between the dummy embodying the financial sector and the variables LEV and IA respectively.

Model 10: OLS, using observations 1-2475

Dependent variable: ROA

Heteroskedasticity-robust standard errors, variant HC1

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
Const	−0.170262	0.0402346	−4.2317	<0.0001	***
RDI	−0.845048	0.140044	−6.0342	<0.0001	***
SIZE	0.0816564	0.0113723	7.1803	<0.0001	***
LEV	−0.178304	0.0636871	−2.7997	0.0052	***
IA	−0.15424	0.0515244	−2.9935	0.0028	***
Z1	0.381882	0.0854222	4.4705	<0.0001	***
Z13	−0.537792	0.293557	−1.8320	0.0671	*
Z14	−0.0151553	0.00151126	−10.0282	<0.0001	***
Z17	0.230207	0.0875383	2.6298	0.0086	***
Z18	0.334294	0.0527367	6.3389	<0.0001	***
sq_RDI	0.13438	0.278096	0.4832	0.6290	
sq_SIZE	−0.00396387	0.000770001	−5.1479	<0.0001	***
sq_LEV	0.0613775	0.0582636	1.0534	0.2922	
sq_IA	−0.00076827	0.0686159	−0.0112	0.9911	
sq_PPE	−0.0784104	0.02009	−3.9030	<0.0001	***
sq_CASH	−0.25525	0.0290395	−8.7898	<0.0001	***

Mean dependent var	−0.072106	S.D. dependent var	0.236802
Sum squared resid	64.91652	S.E. of regression	0.162479
R-squared	0.532066	Adjusted R-squared	0.529212
F (15, 2459)	126.5568	P-value(F)	9.8e-292
Log-likelihood	993.7329	Akaike criterion	−1955.466
Schwarz criterion	−1862.442	Hannan-Quinn	−1921.677

RESET test for specification -

Null hypothesis: specification is adequate

Test statistic: F (2, 2457) = 39.5461

with p-value = P (F (2, 2457) > 39.5461) = 1.24735e-017

The misspecification is still unsolved.

I remove form the model the non-significant squares: sq_RDI; sq_LEV; sq_IA

Model 11: OLS, using observations 1-2475

Dependent variable: ROA

Heteroskedasticity-robust standard errors, variant HC1

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
Const	−0.183631	0.0388788	−4.7232	<0.0001	***
RDI	−0.773795	0.0618903	−12.5027	<0.0001	***
SIZE	0.0808674	0.0112334	7.1988	<0.0001	***
LEV	−0.116833	0.019105	−6.1153	<0.0001	***
IA	−0.153769	0.0202206	−7.6046	<0.0001	***
Z1	0.368468	0.0871599	4.2275	<0.0001	***
Z13	−0.57327	0.28761	−1.9932	0.0463	**
Z14	−0.0147728	0.00120312	−12.2787	<0.0001	***
Z17	0.22732	0.0885341	2.5676	0.0103	**
Z18	0.337195	0.053484	6.3046	<0.0001	***
sq_SIZE	−0.00390685	0.000764058	−5.1133	<0.0001	***
sq_PPE	−0.0750799	0.0186287	−4.0303	<0.0001	***
sq_CASH	−0.253244	0.0282762	−8.9561	<0.0001	***

Mean dependent var	−0.072106	S.D. dependent var	0.236802
Sum squared resid	64.98265	S.E. of regression	0.162463
R-squared	0.531590	Adjusted R-squared	0.529307
F (12, 2462)	147.6062	P-value(F)	5.3e-279
Log-likelihood	992.4728	Akaike criterion	−1958.946
Schwarz criterion	−1883.364	Hannan-Quinn	−1931.492

RESET test for specification -

Null hypothesis: specification is adequate

Test statistic: F (2, 2460) = 40.8356

with p-value = P (F (2, 2460) > 40.8356) = 3.57553e-018

Now my model is made up of only significant variables but there is still misspecification.

So after having simplified the model, I try to solve the misspecification problem introducing the square of the remaining significant interaction effects.

Model 12: OLS, using observations 1-2475

Dependent variable: ROA

Heteroskedasticity-robust standard errors, variant HC1

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
Const	−0.182215	0.0389579	−4.6772	<0.0001	***
RDI	−0.78194	0.0631959	−12.3733	<0.0001	***
SIZE	0.0810678	0.0113718	7.1288	<0.0001	***
LEV	−0.117702	0.0192985	−6.0990	<0.0001	***
IA	−0.153999	0.0204289	−7.5383	<0.0001	***
Z1	0.217044	0.137597	1.5774	0.1148	
Z13	0.0414949	0.623136	0.0666	0.9469	
Z14	−0.00906933	0.00536572	−1.6902	0.0911	*
Z17	0.594603	0.175404	3.3899	0.0007	***
Z18	0.0890275	0.119498	0.7450	0.4563	
sq_SIZE	−0.00391136	0.000778953	−5.0213	<0.0001	***
sq_PPE	−0.0779015	0.0189037	−4.1210	<0.0001	***
sq_CASH	−0.251538	0.0287061	−8.7625	<0.0001	***
sq_Z1	0.442232	0.359789	1.2291	0.2191	
sq_Z13	−2.52747	1.51661	−1.6665	0.0957	*
sq_Z14	−0.00062999	0.000573798	−1.0979	0.2723	
sq_Z17	−0.579389	0.204929	−2.8273	0.0047	***
sq_Z18	0.251437	0.172126	1.4608	0.1442	

Mean dependent var	−0.072106	S.D. dependent var	0.236802
Sum squared resid	64.80666	S.E. of regression	0.162408
R-squared	0.532858	Adjusted R-squared	0.529626
F (17, 2457)	139.6664	P-value(F)	0.000000
Log-likelihood	995.8289	Akaike criterion	−1955.658
Schwarz criterion	−1851.006	Hannan-Quinn	−1917.645

RESET test for specification -

Null hypothesis: specification is adequate

Test statistic: F (2, 2455) = 44.5138

with p-value = P (F (2, 2455) > 44.5138) = 1.02376e-019

Misspecification is still present.

I stop here my attempt to find the correct specification of my model, because to continue with the same procedure explained above lead to models that present the same misspecification problems.

6.1 THE CAUSE OF THE MISSPECIFICATION PROBLEMS AND THE EFFECT ON RDI

The reason why my model presents these problems of misspecification is the use of ROA- a measure of the firm performance looking to the past-, for a model about dynamic independent variables, when considering a limited time frame: a selected year- 2014.

ROA is a measure of firm's successfulness that is very difficult to analyse with cross-sectional data, and when doing that we obtain distorted results of the effect of the expense in R&D, but also of other variables (see the following) on firm performance.

The above statement is supported by the evidence of abnormal signs of the coefficients of the variables of my starting model (because it is no possible to identify the correct specification of my model, I'll use as benchmark model 2), explaining the marginal effect of each variable with respect to the ROA.

Rember they are:

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
Const	−0.0708788	0.0191632	−3.6987	0.0002	***
RDI	−0.778446	0.0616432	−12.6282	<0.0001	***
SIZE	0.0287261	0.00238916	12.0235	<0.0001	***
LEV	−0.125523	0.0202205	−6.2077	<0.0001	***
IA	−0.0515795	0.0162793	−3.1684	0.0016	***
PPE	0.0291586	0.0130161	2.2402	0.0252	**
CASH	−0.142018	0.0255413	−5.5603	<0.0001	***

Considering the effect of the expense in R&D on firm performance we can notice a significant relationship, as expected (see H1), with a negative sign.

This is a comprehensive result because we try to analyse the effect of a dynamic variable which positive effects arise over several years, in a particular moment.

To understand this concept, we need a general introduction of how American companies account for innovation, i.e. how they determine how much value they derive from R&D. A clear and robust reporting about the expense addressed in developing innovation is key to help companies' leaders make strategic decisions (see Gittings et al., 2010).

As reported by the US GAAP: "R&D costs are generally expensed as they are incurred"

This means that the company has to report the expense in innovation in the income statement of the year it bears the investment.

So cause in my analysis I investigate the link between the expense of 2014 in R&D and the concurrent effect on firm performance, the cost-effect of spending in research and development prevails over the benefits.

This is why the significant sign of RDI coefficient is negative.

The ROA "is the percentage of profits derived from a company's total assets: how much profit a company generated for each dollar in assets. The higher the percentage of ROA, the better the organization is at using its invested capital, or assets, to turn a profit" (see Denison Consulting, 2012, p.2).

It is an effective financial measure of company performance not vulnerable to financial engineering aimed at distorting the fundamentals of a business and to short-term gaming in the income statement because of the long-term trajectory of decisions concerning tangibles and intangibles.

But this indicator is not the correct dependent variable to use in models concerning "dynamic" variables, if we base the analysis on cross-sectional data. It is true that it can be seen as a measure of companies' ability to find and capture attractive opportunities to execute a long-term strategy. But speaking about performance, it is a "static" item: it expresses "the vision, the ability and the commitment employed to execute a strategy [..]in a given [past] quarter or year" (see Hagel III; Brown; Samoylova; Lui, 2013 p.1).

We can correctly use this indicator to analyse firm's performance affected by dynamic variables when we consider "the long-term trajectory of ROA, rather than a snapshot in any given quarter or year, [that] reveals how effective a company is, over time, at harnessing business opportunities in a highly uncertain environment" (see Hagel III; Brown; Samoylova; Lui, 2013 p.1).

But it is not the correct measure to use in a cross-sectional study that compares different population groups at a single point in time.
If on the one hand, we can compare many different variables at the same time because we can think of this analysis "in terms of taking a snapshot: findings are drawn from whatever fits into the frame [on the other hand we can't really investigate cause-and-effect relationships because] such studies offer a snapshot of a single moment in time. They do not consider what happens before or after the snapshot is taken" (see At work, *What researchers mean by cross-sectional vs longitudinal studies*, 2015, p.*1*).

6.2 CONTROL VARIABLES' DISTORTED SIGNS ANALYSIS

Using ROA as dependent variable distorts the effect of almost all the model's control variables.

Firm's size (SIZE)

The only variable in my study not affected by the distorting effect of a model about dynamic variables analyzed in a single moment is the firm's size, a variable which positive effect on profitability remains also considering a snapshot because of its static nature. The size of a firm can modify over time but on average the dimension of a firm is linked to economy's structural characteristics which have developed among years and can be assumed as consolidated.
To be more precise, the immense literature dealing with the determinants of firm size, has been classified by Kumar et al. (2001) into three main groups: technological, organizational, and institutional.
According to the first theory, focused on the production function, there is a positive connection between market size and firm size (see Adam Smith, 1776), greater capital intensity should be associated with larger firms (see Lucas,1978) and firms in richer countries should be larger (see Kremer 1993).
The second group, focused on the process of control, and the third one, focused on the influences of the economic environment, sustain as main result that a better legal environment (that is a system that offers better protection for critical resources, as the intangible ones) leads to larger firms (see Rajan and Zingales, 2001).
These determinants are intrinsic factors of the context that requires a procedure of changing we can assume not to happen in the recent future. That's why we have no distortions of the SIZE's coefficient.

Whereas, the other control variables have signs that don't correctly embody their effect on firm's performance.

Leverage (LEV)

A company can finance its investments by debt and by equity. The reason why a company may prefer financial leverage "is to magnify the shareholders' return under favourable economic conditions" because [debt coming from financial institutions] "has a lower cost than the firm's rate of return on net assets (ROI) (see Enekwe et al., 2014, p.17).

With the term liability we mean any debt the company incurs as formal loans, financing agreements from vendors, and purchases that have outstanding amounts (see Jhonston, 2016).

But it is not to take for granted that the impact of debt on firm performance shows a negative relationship, for the reasons already mentioned in the first part (see part 5.2.3 – *Leverage*) of my work and for the following ones.

Of course if the indebtedness is analysed in a snapshot it is. If we superficially consider the effect of getting funds from financial institution, the first direct impact on the profitability of a firm is the rate of return to be paid to debtholders. This periodic payment affects corporate performance, impacting profit after tax and thus earnings per share, lowering the earnings eventually addressed to shareholders (Pandey, 2010).

That happens because the financing interest expense incurred for borrowed money (employed for the core business), accounted in the income statement of the period (US GAAP, 2013), affects the net income entering in the numerator of my variable ROA.

So the problem, once again, is considering in a single moment the effect on ROA-a measure of firm's performance that should be considered over time- of an item which benefits arise considering a time span.

With cross-sectional data we investigate the relationship between the amount of liabilities of a firm, without knowing if these ones have been incurred recently or years before, because liabilities are in the statement of financial positions. This is a statement of the assets, liabilities and capital of a business as at a particular date. Within the liabilities we find the non-current ones: debts not payable within the short-run and current liabilities payable within one year.

So, it is comprehensible that the investigated relationship is distorted, the true effect on the performance has to be analysed over time, cause of course companies manage their indebtedness so that the money borrowed contributes to profitability (see Jhonston, 2016), causing the impossibility to have a negative significant sign of the effect of leverage on performance.

Intangible assets (IA)

As explained in the first part of my work (see 5.2.3 - *Intangible assets*), intangible assets, as firm's core resources, are the basis of the competitive advantage (see Hidayati et al., 2012) and thus positively affect company's performance.

By contrast, in my model the relationship is negative. Once again, the problem is the use of ROA in a cross-sectional analysis.

The benefits of investing in intangibles arise over time, and has already explained in the literature frame for the effect of R&D on firm's performance (see section 2 – *Cons*), in the first period the costs linked to the investment prevail. Only after a time lag the benefits compensate and overpass the initial sacrifice.

A brief explanation of what is, under US GAAP, an intangible asset and how it's value is recorded is necessary.

Intangibles are assets without a physical presence. According to the US GAAP definition of asset, they must be "identifiable (being separable and arising from legal rights), non-monetary, controlled by the company and expected to provide future economic benefits to the company".

In understanding the accountability of intangibles we must distinguish between internally generated intangibles, acquired ones and R&D, already explained.

Only when an intangible asset (with a finite life) is purchased from another party a business records its cost in the statement of financial position (see Keythman, 2016) at its amortized cost less impairment.

Whereas" the costs of internally developing, maintaining and restoring intangible assets that are not specifically identifiable, that have indeterminable lives, or that are inherent in a continuing business and related to an entity as a whole, are recognised as an expense when incurred" (US GAAP, 2013).

Intangible assets with indefinite useful lives (there is no foreseeable limit to the period over which the asset is expected to generate net cash inflows for the entity) are not subject to amortisation instead they are subject to impairment testing at least annually and are carried at historical costs less impairment (see Shodhganga, *Accounting of intangibles assets*, 2010 and Kaiser, *IFRS and US GAAP: similarities and differences, 2013*)

The asset impairment loss affects, on the one hand, the income statement lowering profits (even if not immediately the cash balance) and the balance sheet reducing the current carrying value

of the asset to the calculated fair value, every time there is a change in circumstances impacting "the asset's useful life, current market value or salvage value" (see Marz, 2016, p.1)
Also the amortization (which occurs on a systematic basis) has a direct impact on both statements reducing income and company's assets until the end of the intangible asset's useful life. "The reduced net income on the income statement also reduces retained earnings in the stockholders' equity section of the balance sheet" (see Keythman, 2016, p.1).
So focusing my cross-sectional study in a snapshot, the prevailing effect of investing in intangibles is negative on ROA because of the decreasing effect of impairment and amortization on firm's net income (which is at the numerator of my variable ROA).
Whereas considering several years, as period to investigate the effect of investing in intangible assets, the marginal benefit gained during the accounting periods will compensate the marginal periodical cost of impairment and amortisation. This will happen because the competitive advantage gained thanks to innovation is supposed to materialize in an increasing number of customers and commissions of higher amounts. The conclusion will be higher profits for the company.

Property, Plant and equipment (PPE)

Property, Plant and equipment are "tangible assets held for use that are expected to be used for more than one reporting period" (Ernst & Young, 2012).

To properly account fixed assets, you must accomplish some steps. "First of all, you must record the value of the fixed asset at the historic cost and then this value is depreciated to a disposal or residual value. If there are certain indicators that the realizable value of the fixed asset has negatively changed, then the asset is written down and a loss is recorded. This is referred to as impairment" (see Lewis, 2013, p.1).

The depreciation of assets "causes firm's asset amounts, net income and stockholders' equity to decease. This occurs through an accounting adjusting entry in which the account Depreciation Expense is debited and the contra asset account Accumulated Depreciation is credited" (Averkamp, 2016, p.1).

Also the impairment has a double effect: on the one hand it decreases the value of the asset in the balance sheet and on the other hand the recognized loss in the income statement lowers income.

Following the logic of considering a snapshot, in a certain moment, a fixed-asset supposed to have been bought in advance has already contributed positively to the firm's performance in the past allowing the production process. Of course, each year the profits of the firm depend positively on the presence of such investments but adopting the opposite logic used when analyzing intangibles, fixed-assets can't enhance future performance. What I try to say is that when these assets are installed a production threshold is reached and can be taken from granted. To increase the performance, the company must satisfy a larger number of customers and to do that the key role is performed by innovation and not by PPE: R&D is essential to diversify ideas and proposals.

Thus considering a single moment, the link between tangible assets and ROA should be opposite to the existing one between intangibles and ROA. My theory is confirmed by empirical results found. The distorted sign of the coefficient of IA is negative whereas of PPE is positive.

It's only considering a period of time, thus analyzing performance over time, that the true (not distorted) signs of these investments appear: IA leading to innovation process contributes positively to firm's performance whereas PPE having already contributed to profits have a lowering impact on performance because of the decreasing effects of depreciation and impairment on net income.

Short-term investments (CASH)

These assets easily and readily convertible to cash, are reported as current assets on the balance sheet. They can be quickly used by the company first to earn a quick return and then in the case of the need of immediate liquidity (Shaun, 2015). "For the most part, this account contains stocks and bonds that can be liquidated fairly quickly" (see Investopedia, *Short-term investments*, 2016, p.1)

Even considering this variable my cross-sectional analysis of firm's performance is distorted, because of the negative sign of the coefficient. Considering a snapshot, these investments positively contribute to the firm performance analyzed in a single moment: they are undertaken by the company to have the certainty of the availability of cash, to answer business unpredictable needs, and to gain in a fast way.

This reasoning holds only in a cross-sectional analysis that doesn't take into account the damaging effect of short-sighted investments (see section 5.2.3 - *Short term investments*) undertaken by risk-aversion managers, that instead arises considering the effect on performance over time. Thus, it's in the long run that their prevailing influence is negative

6.2.1 THE MODEL WITHOUT RDI

Now I want to validate my conclusion that the use of ROA to measure firm's performance when using cross-sectional data distort the effect of any dynamic investment on firm's performance and thus that it is not just a problem of choosing as independent variable RDI: a dynamic variable with effects impossible to catch in a cross-section analysis.
I consider my original simple model without the independent variable RDI (expense in R&D).

Model 1: OLS, using observations 1-2475
Dependent variable: ROA
Heteroskedasticity-robust standard errors, variant HC1

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
Const	−0.094143	0.0202559	−4.6477	<0.0001	***
SIZE	0.0373778	0.00241087	15.5038	<0.0001	***
LEV	−0.178207	0.0215852	−8.2560	<0.0001	***
IA	−0.0876871	0.0173354	−5.0583	<0.0001	***
PPE	0.00928914	0.0137901	0.6736	0.5006	
CASH	−0.358503	0.0206325	−17.3757	<0.0001	***

Mean dependent var	−0.072106	S.D. dependent var	0.236802
Sum squared resid	87.36224	S.E. of regression	0.188105
R-squared	0.370272	Adjusted R-squared	0.368997
F (5, 2469)	164.0447	P-value(F)	6.7e-151
Log-likelihood	626.2436	Akaike criterion	−1240.487
Schwarz criterion	−1205.603	Hannan-Quinn	−1227.816

RESET test for specification -
Null hypothesis: specification is adequate
Test statistic: F (2, 2467) = 113.797
with p-value = P (F (2, 2467) > 113.797) = 5.33527e-048

We can notice that the misspecification problem is still present and the distortion on the effect of each variable analyzed continues, moreover now PPE is no more significant: a clear example of a distorted result if we think to the relevant role played by tangible assets in determining firm's performance.

6.3 SECTOR-BASED ANALYSIS

After the analysis of all the dataset that emphasized the presence of misspecification in my model, I use the same procedure to verify if the misspecification is persistent in each sector or if there are differences.

Manufacturing sector

I begin making the OLS model with my dependent variable ROA and the 6 explanatory ones for the manufacturing sector, which is composed by 1557 companies.

Model 1: OLS, using observations 1-1557
Dependent variable: ROA

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
Const	−0.00730057	0.023407	−0.3119	0.7552	
RDI	−0.78771	0.0407328	−19.3385	<0.0001	***
SIZE	0.0348776	0.00232308	15.0135	<0.0001	***
LEV	−0.130962	0.0218884	−5.9832	<0.0001	***
IA	−0.203476	0.0307964	−6.6071	<0.0001	***
PPE	−0.0716005	0.0255472	−2.8027	0.0051	***
CASH	−0.257104	0.0268882	−9.5620	<0.0001	***

Mean dependent var	−0.103824	S.D. dependent var	0.266042
Sum squared resid	49.98380	S.E. of regression	0.179576
R-squared	0.546143	Adjusted R-squared	0.544386
F (6, 1550)	310.8618	P-value(F)	1.2e-261
Log-likelihood	467.8320	Akaike criterion	−921.6639
Schwarz criterion	−884.2103	Hannan-Quinn	−907.7372

White's test for heteroskedasticity -

Null hypothesis: heteroskedasticity not present

Test statistic: LM = 315.39

with p-value = P (Chi-square (27) > 315.39) = 6.15236e-051

Breusch-Pagan test for heteroskedasticity -

Null hypothesis: heteroskedasticity not present

Test statistic: LM = 667.423

with p-value = P (Chi-square (6) > 667.423) = 6.59637e-141

RESET test for specification -

Null hypothesis: specification is adequate

Test statistic: F (2, 1548) = 87.1695

with p-value = P (F (2, 1548) > 87.1695) = 1.33933e-036

Heteroskedasticity and misspecification are still present.

Services

I consider the 463 service companies part of my database.

Model 1: OLS, using observations 1-463

Dependent variable: ROA

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
Const	−0.0355016	0.0450407	−0.7882	0.4310	
RDI	−0.3207	0.0898773	−3.5682	0.0004	***
SIZE	0.0335602	0.00404508	8.2966	<0.0001	***
LEV	−0.150416	0.0410636	−3.6630	0.0003	***
IA	−0.122759	0.0496901	−2.4705	0.0139	**
PPE	−0.0713769	0.0413447	−1.7264	0.0850	*
CASH	−0.192535	0.0541611	−3.5548	0.0004	***

Mean dependent var	−0.055831	S.D. dependent var	0.197194

Sum squared resid	13.67786	S.E. of regression	0.173192
R-squared	0.238638	Adjusted R-squared	0.228620
F (6, 456)	23.82116	P-value(F)	1.55e-24
Log-likelihood	158.3625	Akaike criterion	−302.7251
Schwarz criterion	−273.7610	Hannan-Quinn	−291.3227

White's test for heteroskedasticity (squares only) -
Null hypothesis: heteroskedasticity not present
Test statistic: LM = 117.812
with p-value = P (Chi-square (12) > 117.812) = 1.68569e-019

RESET test for specification -
Null hypothesis: specification is adequate
Test statistic: F (2, 454) = 6.33736
with p-value = P (F (2, 454) > 6.33736) = 0.00192947

There is heteroskedasticity and misspecification.

I can confirm my initial assumption H2: considering the absolute value of R&D coefficient, (0.79 for manufacturing companies and 0. 32 for service firms) innovation affects more the performance of manufacturing firms.

Sales sector

In the following I analyse the sales sector which is composed by companies engaged in the wholesale and retail fields, composed by only 167 companies.

Model 1: OLS, using observations 1-167
Dependent variable: ROA

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
Const	−0.00303941	0.045543	−0.0667	0.9469	
RDI	−0.869875	0.56168	−1.5487	0.1234	
SIZE	0.0253909	0.00494203	5.1377	<0.0001	***

LEV	−0.176755	0.0486732	−3.6315	0.0004	***
IA	−0.0649645	0.0478896	−1.3565	0.1768	
PPE	−0.0375871	0.0410526	−0.9156	0.3613	
CASH	−0.151481	0.0631127	−2.4002	0.0175	**

Mean dependent var	0.015378	S.D. dependent var	0.137626
Sum squared resid	2.382388	S.E. of regression	0.122024
R-squared	0.242289	Adjusted R-squared	0.213874
F (6, 160)	8.527029	P-value(F)	4.83e-08
Log-likelihood	117.9031	Akaike criterion	−221.8062
Schwarz criterion	−199.9803	Hannan-Quinn	−212.9475

Because we have a limited number of companies for the White's test I use the variation squares only.

White's test for heteroskedasticity (squares only) -
Null hypothesis: heteroskedasticity not present
Test statistic: LM = 104.629
with p-value = P (Chi-square (12) > 104.629) = 6.86641e-017

Breusch-Pagan test for heteroskedasticity -
Null hypothesis: heteroskedasticity not present
Test statistic: LM = 474.305
with p-value = P (Chi-square (6) > 474.305) = 2.8755e-099

RESET test for specification -
Null hypothesis: specification is adequate
Test statistic: F (2, 158) = 3.4707
with p-value = P (F (2, 158) > 3.4707) = 0.0334861

We can notice that heteroskedasticity is still present, whereas the specification is adequate only comparing the p-value of the RESET test with the level of significance 0.01.

Financial sector

I test the 288 companies composing the financial sector.

Model 1: OLS, using observations 1-288
Dependent variable: ROA

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
Const	0.00475043	0.0230432	0.2062	0.8368	
RDI	−1.337	0.15906	−8.4056	<0.0001	***
SIZE	0.00707952	0.00275149	2.5730	0.0106	**
LEV	−0.071476	0.021753	−3.2858	0.0011	***
IA	−0.0280826	0.0293396	−0.9572	0.3393	
PPE	0.115606	0.05215	2.2168	0.0274	**
CASH	0.152947	0.0307496	4.9739	<0.0001	***

Mean dependent var	0.022478	S.D. dependent var	0.082349
Sum squared resid	1.471470	S.E. of regression	0.072364
R-squared	0.243944	Adjusted R-squared	0.227801
F (6, 281)	15.11095	P-value(F)	5.42e-15
Log-likelihood	351.1903	Akaike criterion	−688.3805
Schwarz criterion	−662.7398	Hannan-Quinn	−678.1053

White's test for heteroskedasticity (squares only) -
Null hypothesis: heteroskedasticity not present
Test statistic: LM = 74.2014
with p-value = P (Chi-square (12) > 74.2014) = 5.20005e-011

RESET test for specification -
Null hypothesis: specification is adequate
Test statistic: F (2, 279) = 12.9971
with p-value = P (F (2, 279) > 12.9971) = 4.00963e-006

There is heteroskedasticity and misspecification.

The “by sector quantitative analysis” proves again the absence of fairness in the results about the specification of my model.
Only the RESET test for the sales sector (and only if compared with a level of significance of 0.01) shows a correct specification of the model.
So it means that there is reason to employ a model, based on a given year, with independent dynamic variables supposed to contribute to the firm’s performance (measured with a variable looking to the past) in the future.
Let’s think about the characteristics of this sector.
Both the retail and wholesale sectors (called sales sector) are focused on intangibles goods. As already explained, sales sector nowadays can gain a competitive positon in the market only thanks to the quality of the add-on services offered to the customers.
So if we take for granted, as starting point, that to offer up-to-date services to customers it is essential to invest in innovation, and if we believe that innovation is a complex process affecting firm performance in the long-run, it is not realistic to obtain that the specification for the model is correct.
Moreover, the sign of the PPE coefficient doesn’t agree with the reasoning made in section 6.2 to justify its positive effect. In some sectors it becomes negative and in others it comes back positive without the possibility to associate a rationale to this behaviour. Moreover, RDI, IA and PPE’s coefficient become no more significant in the sale sector and IA in the financial one. Again, these results are clearly distorted, can’t be considered fair and can’t be rationally justified.
To understand which sector is more affected by R&D (this is the 3rd and last aim of my study), I look to the value (in absolute terms) of RDI’s coefficient in each sector: financial companies have the highest one (1.34). This result reflects the relevance of innovation: investing in R&D is necessary to stay up-to-date in financing the business environment.

7. CONCLUSION

The limit of my study is the use of cross-sectional data in a model for the ROA with dynamic variables. The solution, thus, is to perform a longitudinal study where the subject of my research (the effect of RDI investment on firm's performance) is observed over a period of time lasting many years. Only doing this we will discover the true, not distorted link between my model's variables.

The key point I'd like to stress again is that longitudinal studies go beyond a single moment in time so they can suggest cause-and-effect relationships.

So, the comprehensive question you may ask me is: why did you not set up a panel model?

The main reason is that doing a panel study goes beyond the aim of my study. I see the current research as a starting point to first explore whether there are links between my variables, of what types they are and which are the strongest ones in a single moment. Then, in my future studies, using this groundwork (that has been useful to develop first theories), I will improve the quality of this research paper[4].

[4] Total number of words (from page 1 to page 55): 14193

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