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A STUDY OF FIRM'S COMPETITIVENESS: R&D AND PROFITABILITY IN THE GREEK PHARMACEUTICAL INDUSTRY

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Η συγγραφή της παρούσας διδακτορικής διατριβής είναι αποτέλεσμα πολυετούς και εργώδους προσπάθειας, συνεχής αναζήτησης, μελέτης, αφοσίωσης αλλά και θυσιών. Με την ολοκλήρωση της θα ήθελα να ευχαριστήσω θερμά τον επιβλέποντα καθηγητή μου, Δημήτριο Κυρκιλή που με εμπιστεύτηκε και μου έδωσε την ευκαιρία να αποκτήσω την εμπειρία αυτή. Η συμβολή του, η καθοδήγηση του αλλά και η πολύτιμη εμπειρία του ήταν καθοριστικοί παράγοντες για την περάτωση της διατριβής αυτής.

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ABSTRACT

The aim of this dissertation is to determine the factors that affect the firm competitiveness of Greek pharmaceutical Industry which produce branded generics and include in-house R&D sections for the period 1998-2016. Greek pharmaceutical industry is one of the most dynamic in the Greek manufacturing sector and its contribution affects considerably the Greek economy as a whole.

The concept of firm competitiveness provided the theoretical framework of the study. It has been presented a plethora of definitions about firm competitiveness and techniques for its measuring addressing an overall analysis. The major variable under investigation is the innovation or otherwise R&D expenditures and its impact on firm competitiveness. In order to conclude in accurate results, more variables have been included. In addition, profitability has been used as a proxy of firm competitiveness.

Two profitability equations have been constructed and three econometric techniques have been used for the econometric analysis. Data sample consist of 246 total observations. Results reveal the crucial role of R&D intensity ratio and the effect of the other determinants on the profitability and by extension in firm competitiveness. The study closes with the policy implication and suggestions for further research.

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ABBREVIATIONS

RBV	Resource-Based View
OECD	Organization for Economic Co-operation and Development
R&D	Research and Development activity
EU	European Union
EFPIA	European Federation of Pharmaceutical Industries and Associations
IOBE	Foundation for Economic and Industrial Research
ELSTAT	Hellenic Statistical Authority
OTC	Over the counter
GDP	Gross Domestic Product
V.A.T	Value-Added-Tax
GVA	Gross-Value-Added
EOF	National Organization for Medicines
GMM	Generalized Method of Moments
FE	Fixed Effect
ROE	Return on equity
OLS	Ordinary Least Square
GLS	Generalized Least Square
PEF	Hellenic Pharmaceutical Association
GPM	Gross Profit Margin
FGLS	Feasible Generalized Least Square

CHAPTER 1. INTRODUCTION

1.1 The aim of this study

Greek pharmaceutical industry has an active presence since 1970 in the Greek economy. The industry's course of action for over fifty years gave prominence to the importance of the sector for the whole of the Greek economy. Up to date, the Greek pharmaceutical industry has more than forty four domestic industries with twenty eight factories characterized by "state of the art" technology and equipment. The Greek pharmaceutical industry mainly produces branded-generics of high quality in line with the standards of quality assurance

The domestic pharmaceutical industry is considered as one of the most dominant sectors of the Greek manufacturing industry contributing to the employment, the gross value added and the export activity. The severe financial crisis though changed the working conditions against the domestic industry through the austerity, fiscal adjustment, claw back and rebate mechanism. Despite those negative factors, the domestic industry managed to maintain its competitive position, moderating the negative impacts of the fiscal crisis in Greece.

The manufacturing base of generics drugs is considered strong in Greece and upon which, the Greek pharmaceutical industry can be further developed. More specifically, the domestic pharmaceutical industry contributes to the Greek economy almost €3 billion per year (IOBE, 2019). Furthermore, more than 12.000 employees are working in the industry directly and it is estimated that 13.000 work positions are indirectly affected by the sector. Consequently, the total impact of the industry on the employment sector arises to more than 53.000 work positions.

The role of Research and Development (R&D) in the industry is rather deterministic and is considered as the main driver for its success and development. R&D expenditures of the industry amount for over 350 €million during the last decade and employees highly educated personnel increasing the added-value of the industry. This significant amount leads to the equally significant investigations of the R&D impact on the sector. According to the industry delegators, there are strong opportunities for the Greek pharmaceutical industry to become an important research hub within the European context. Investments in R&D have a unique multiplicative value for the Greek economy, creating new and highly-paid work positions and contributing to sustainable and stable growth rate.

The Greek pharmaceutical industry is extremely competitive. It exports in more than eighty five countries worldwide and the Greek branded generics have received approval from eighty five international organizations. Pharmaceutical products are ranked at second place of Greek exporters giving to the industry an export-oriented feature. During the period 2010 up to today, the industry increased considerably its exports reaching in 2019 more than €1 billion. The international competitiveness of the industry became the definitive factor for its survival and growth.

The pharmaceutical industry operates in a regulated environment and prices are subject to state valorization while the state intervenes in a arranging profit margins and imposing the mechanisms of rebate[1] and claw back[2].

[1] Rebate: A rebate is a form of a scaled percentage discount in which part of the purchase price of a medication is returned to the purchaser.

[2] Claw back: It is a mechanism of automatic returns. This measure provides that in case the monthly public pharmaceutical spending of Organizations of Social security exceeds the budgeted spending, the excess amount would be paid by the pharmaceutical firms.

Within this institutional setting, it seems challenging and at the same time very interesting to investigate the factors that affect the competitiveness and by extension the profitability of the domestic pharmaceutical companies.

The concept of competitiveness despite of the increased economic and political importance is difficult to be defined explicitly and therefore it is rather complicated for scholars to estimate its determinants (Porter, 1998; LaureandViviani, 2010). The pharmaceutical industry operates in oligopoly market structure and in some cases in monopoly structure; the study of competitiveness becomes even more challenging.

Taking into account the economic conditions both international and domestic shaping a volatile environment, the study of financial and other factors that affect the competitiveness of Greek pharmaceutical companies with in-house R&D department, gain a special interest.

The aim of this dissertation is to determine the factors that affect the firm competitiveness of Greek pharmaceutical Industry that produce branded generics and include in-house R&D sections in their production line for the period 1998-2016. The major variable under investigation is the innovation or otherwise R&D expenditures and its impact on firm competitiveness. In order to conclude in accurate results, more variables have been included.

This dissertation is divided in ten chapters. The first chapter is the introduction where is presented briefly the aim of this dissertation , the structure and its contribution.

The second chapter starts with the analysis of the meaning of competitiveness and definitions about it. In addition this chapter is referred to the theoretical framework of

competitiveness which has been used in this dissertation in order to support the econometric part of this thesis. Firm competitiveness is one of the main variables under investigation in this thesis.

The third chapter includes an analysis of pharmaceutical innovation. It is presenting clearly the prominent and inspiring theory of Schumpeter about innovation. Additionally, it is analyzing the driving factors, the classification and the indicators of innovation. An extended reference about innovation and its relationship with competitiveness is included also in this chapter.

In the fourth chapter there is a brief reference to the pharmaceutical industry both in Europe and globally. The features of the pharmaceutical industry are cited and the importance of innovation on the development of new drugs is also pointed out. Statistical data are presented in this chapter according to the literature about the expenditures in R&D.

The fifth chapter elaborates the basic characteristics of the Greek pharmaceutical industry and some important economic features both by demand and supply side. The chapter is closing with a reference to the strong and weak points of the industry, opportunities, threats and development prospects for the future.

The sixth chapter starts with a comprehensive literature review about the determinants of profitability since the latter is used as a proxy of competitiveness. Research and Development is considered as the main determinant but other variables are examined as well. Based on the literature review, the hypotheses of the dissertation are constructed.

Chapter seven includes the description of data collection and the description of how competitiveness, the independent variable of the thesis, has been measured. In addition, it is described how the independent variables have been constructed based on the literature.

In the eighth chapter, the methodological framework of the econometric estimates of the model is mentioned.

The ninth chapter is referred to the specification of the profitability equation, the estimation of the models and the presentation of the results. Then, the test of possible and frequently shown problems as autocorrelation and heteroskedasticity is applied to the model. Finally the FGLS estimation is applied after the appropriate test. Lastly, chapter ten presents the conclusions of the study and suggestions for further research.

1.2 Contribution of the Dissertation

The Greek Pharmaceutical sector presents a huge heterogeneity which makes more complicated its investigation yet it is one of the most dynamic and developing industries in the Greek economy. There is a constant increase in industry exports in the international markets implying that trust of the latter towards the Greek pharmaceutical industry while there is a certain prospect for its development. Thus, the need for further investigation of this sector is needed.

To the best of the author's knowledge, there is no other study which investigates the domestic pharmaceutical industry based on recording R&D expenditures in order to examine the effect of R&D on firm competitiveness. All of the selected firms are

members of the Hellenic Pharmaceutical Association and have been selected under the strict condition that they are manufactures and invest in R&D.

The contribution of this thesis lies in the fact that the role and the effect of a vital determinant, that of innovation, is examined in a sample that has never been selected in this specific way. In addition, an interaction term has been constructed for the first time in order to test the effect of R&D expenditures on firm competitiveness and by extension in firm profitability through the impact of financial crisis in the domestic industry.

Therefore, this thesis provides more empirical evidence at the firm level and investigates an issue which has been remained almost unexplored in Greece.

CHAPTER 2 Concepts and Theory

2.1 The Concept of Competitiveness

In the late 1970s the concept of competitiveness attracted the attention of scholars and politicians in an effort to secure economic growth and stability within a flattering situation in the global environment (Krugman, 1996). However, the cornerstone in the theory of competitiveness came in 1990 when the economist Michael Porter published his influential book, Competitive Advantage of Nations that spread the term worldwide.

Globalization and structural changes in world economy over the last decades brought to the surface new challenges for firms, industries and countries. The concept of competitiveness mainly focused on the issue of competitiveness at the country level. There are policies via which governments can boost and increase national industrial competitiveness.

There is a plethora of definitions about the concept of competitiveness at all levels which vary considerably among studies. Even if these definitions seem to be direct, such term is often used in a very diverse and ambiguous way. The vague dimension of the term leads to a substantial limited consensus on the actual definition of the term, and the way it can be measured (Lee &Karpova2018).

Generally speaking, competitiveness can be defined as the ability of a nation or a firm directly connected to prosperity or to continued superior performance (Powell, 2011).World Economic Forum, more recently, used the Global Competitiveness Index in order to rank countries and defined competitiveness as a “set of institutions, policies and factors that determine the level of productivity of a country” (World

Economic Forum, 2015). Moreover, the term competitiveness is used to indicate current financial performance of various entities and additionally national capabilities in relation to global economy. (Krugman 1996).

According to Porter,1990 in his exceptional work about the Competitive Advantages of Countries, competitiveness is defined as: "The only meaningful concept of competitiveness at the national level is productivity. The Principle Goal of a nation is to produce a high standard of living for its citizen. Productivity is the prime determinant of a nation's long-run standard of living. More concretely, a nation's standard of living depends on the capacity of its companies to achieve high levels of productivity and to increase it over time. They must develop necessary capabilities to compete in more specialized industry segments, where productivity is generally high" (Porter, 1990)

From the above definitions becomes clear that factors as productivity, standard of living, national per capita income, firm productivity and competition compose Porter's competitiveness. Porter assumes standards of living are the principal goal and the firm and industry productivity is the main tool for achieving this aim.

Fagerberg (1988) in his paper about international competitiveness developed a model to test differing trends in international competitiveness approximated by economic growth rates across countries rejecting at the same time relative unit labor cost as the main factor for competitiveness across countries. He defines competitiveness as the ability of a nation to achieve mainly income and employment growth without worsening balance-of-payments. His work emphasizes that the major component explaining differences in international competitiveness across countries is the technological competitiveness. He, additionally, pointed out that investments and

consequently the factors affecting investments play a vital role for national technological competitiveness.

According to Aiginger (2006) and his paper about competitiveness and welfare creation, the possibilities of a nation to create welfare are measured by a function of income per capita, group of social and distributional indicators and a set of ecological indexes. In his definition, he added that competitiveness can be emerged by a process which includes physical and human capital, technical progress, production capabilities and trust.

The concept of competitiveness highlights the capability of an economy at national level to achieve both social well-being and better standard of living for its citizens (Chikan 2008). Chikan (2008) argues that competitiveness can be ensured within a business environment which can produce and utilize goods and services meeting the global standards.

The definition of European Commission of competitiveness focuses on the ability of a country to produce and create goods and services for international markets, to secure high and sustainable levels of employment and income while being able to successfully meet external competition. (European Commission, 1999)

Hatsopoulos et al (1998) in their work about US competitiveness define competitiveness as not only the ability of a country to maintain a balanced trade account but additionally to ensure a growing standard of living of its citizens. According to Kohler (2006) the main determinants of competitiveness are national welfare, a stable economic growth, an equal distribution of income and sustainable productivity.

Oughton and Whittam (1996) are referring to the long-run growth in productivity and the rising living standards as the main component of their definition about competitiveness. In addition, increasing employment and the sustaining full employment are important competitiveness's factors.

Scott & Lodge (1985) in their study define national competitiveness as the productive abilities of a country and its capacity to export products or services to international markets. According to the World Economic Forum's Global Competitiveness Report, competitiveness is defined "as the set of institutions, policies and factors that determine the level of productivity of a country".

In addition, national competitiveness is described by Tyson D.Andrea (1992) as the ability of a country to produce goods and services aiming at meeting the level of international competition in order to enhance its productivity and improving the existing standards of living. Porter (1990) in his study about Competitive Advantage of Nations points out that competitiveness at the country level is national productivity and defines competitiveness as the ability of the nation to provide a high standard of living and a high employment to its citizens. In the same line with others authors, Krugman (1990,1994) in his work links competitiveness with productivity. He mentions that the ability of a country to improve standards of living for its residents depends strongly on its ability to enhance its productivity.

There is a strongly interconnection between the different dimensions of competitiveness. A country's competitiveness specific factors influence its firm's international competitiveness and on the other hand a country's international competitiveness is depicted on its firms' competitiveness which is in contrast to other countries' firms (Depperu&Cerrato, 2011)

Definitions of competitiveness extent in three levels of analysis- nation, industry and firm. Lately, firm level competitiveness has been considered as an essential element for building the industry and nation level competitiveness (Porter, 1990; Ambastha and Momaya,2004) and it has attracted the attention of researchers more than the others two dimension. Buckley et al (1988) indicates that firm's competitiveness applies to the firm's potential to generate and sell products and services in improving quality and lowering cost in comparison to its domestic and global competitors.

Chao-Hung and Li-Chang (2010) define firm competitiveness as the economic strength of the company against its competitors in the international marketplace. Ajitabh and Momaya (2004) focus their competitiveness definition on the firm's market share in the competitive market. The importance of firm competitiveness is considerably prominent. Porter (1998) points out that the firms are competing in the international environment and not the nations. Firm competitiveness analysis focuses on behaviors and performance of firms (Depperu&Cerrato, 2011)

Douglas and Ryman (2003) characterized competitiveness as multidimensional index with a long-term orientation, controllability and dynamism and it is regarded as the ability of a business to combine its sources and capabilities in order to create value-adding elements.

Clark J.M (1961) suggests in his work that innovation introduced by the firm is the driver of firm's competitive advantage. Innovation boosts technological progress, enhance the competitive advantage of the firm leading to economic growth and improvement of competitiveness at macro-level.

According to the theory of Austrian School and its general approach for market competition is an automatic dynamic process. A firm could survive or not in competition based on its capabilities and the degree that it is corresponding efficiently to the market needs (Zhang, Ebbers, Mulder, 2013) .

Evolutionary Economics suggest that a crucial factor for an enterprise to survive in the long- run–and increases its competitiveness, is its ability to constantly adjust to environment changes (Schumpeter, 1950).

2.2 Porter's Theory of Competitive Advantage.

Michael Porter's theory concerning the competitive advantage of nations was one of the most prominent about competitiveness and provided all the appropriate tools for analyzing all competitiveness dimensions.

Porter suggests that the term competitiveness is used in academic research in a confusing way, and the concept is misunderstood. In Porter's report (Porter, 2004) about the microeconomic foundations of prosperity, he focuses on the microeconomic drivers of competitiveness rather than in macroeconomic conditions as a source for economic growth. He developed a framework where countries and firms are able to analyze their competitive advantage and measure their competitiveness. Productivity, as an explanatory power of competitiveness, exploits human capital, capital and natural resources. The appropriate platform where a successful competitive strategy can be built on is rooted in a country's microeconomic framework.

In his book about the competitive advantage of nations, Porter tries to shed light on the reasons why some nations are performing better than others. He relates directly productivity and competitiveness at national level in his definition. Porter argues that

a nation is comprised of the aggregation of industries so the analysis should be on those industries (Porter, 1990). Since industries are made up by domestic firms, then firm competitiveness is strongly connected with the theory of competitive advantage and national productivity. The ability of domestic firms to succeed in particular industries is affected by their national environment (Porter, 1990). His theory suggests that the major role of a country is to create the appropriate context within which domestic firms can grow and expand internationally. The nation plays a vital role in forming the structure of the firm and its identity and affects the availability and access to the resources available to the firms. Special attention is given on individual industries where the competitive advantage theory can be applied and how the domestic environment of a nation forms the identity of an enterprise and its managerial structure and strategy (Grant, 1991).

Based on the interdependence among national context and firm's ability to perform internationally, Porter developed his prestigious theory of competitive diamond where he regards the competitiveness of a country as a function of four main set of interlinked factors which influence firm's ability to gain competitive advantage:

1. Factor conditions
2. Demand conditions
3. Related and supporting industries
4. Firm strategy, structure and rivalry

In accordance to factor conditions, an industry needs an adequate supply of factors in its home base in order to be successful (Davies & Ellis 2000). Factor conditions comprise a number of five categories: human resources, physical resources, knowledge resources, capital resources and infrastructure. Factor conditions are the

inputs which affect competition and they are regarding as the prerequisite for gaining competitive advantage. What determines though their impact on competitiveness is the extent of efficiency and effectiveness of those particular factors within the industry (Porter, 1990a).

Trying to isolate the factors which have a greater impact on the creation of competitive advantage in the framework of competitive diamond, segregation among factors has been applied. (Porter, 1990a). Factors of production are divided into two groups based on the investment required for their possession. So those factors are categorized into basic and advanced. Basic factors are considered those which are passively inherited and their creation does not demand any advanced private or social investment. Basic factors include unskilled labor, natural resources, climate and debt capital. On the other side, advanced factors are factors which require advanced and large investments for their existence. Advanced factors can be improved under continuous investment both in human and physical capital.

In addition, Porter (1990b, p.79) proposes that a nation creates the most significant determinants of production. Concerning the significance of demand conditions , it is stated that competitiveness within an industry can be achieved on condition that demand conditions permit the successful realization of firm's products (Vlados, 2019)With demand conditions, Porter points out that home demand forms the rate and the characteristics of development and innovation by a country's companies (Porter, 1990b). In this framework, he classifies three essential broad factors of home demand: (a)*Home demand Composition, (b)Demand Size and Pattern of Growth and (c) Internalization of Domestic Demand.*

Regarding Home Demand Composition, Porter, states that the structure of internal demand affects directly the perception, interpretation and response of companies to buyer needs. As an important feature of demand composition is considered the degree of buyers' sophistication since sophisticated buyers ask for high quality products leading companies to innovate continuously (Kharub et al, 2017).

Demand size and Pattern of Growth is related with the maintenance of competitive advantage. The size of the internal demand plays a vital role since in Porter's theory the magnitude of the home market can enhance and boost domestic firms to exploit economies of scale and engage in large- scale investments. The rate of domestic demand growth could lead domestic firms to generate and advance their competitive advantage. The growth rate results in a faster adoption of new technology by home firms and in making changes for increasing their efficiency (Wonglimpiyarat, 2017).

Concerning the Internalization of Domestic Demand, Porter suggests that is the third aspect in which domestic demand condition contributes to national competitive advantage throughout a process where a country's domestic demand internalizes and boosts domestic products and services abroad.

According to Related and Supporting Industries, Porter (Porter, 1990a) claims that existence of related industries is the third factor of competitive advantage since their existence provide downstream industries with a more effective and direct access to cost-effective resources. He supports the statement that the existence of related industries results in the generation of new competitive industries. All those supporting industries coordinate and share activities with domestic firms. Related and supporting industries boost the maintenance and establishment of competitive advantage giving opportunities for information exchange and technical interchange (Vlados, 2019).

Firm strategy, structure and rivalry (Porter, 1990a) affect considerably the process of innovation and the international success of domestic firms. Regarding the strategy and structure of domestic firms, the author states that national conditions plays a vital role on how companies are managed and how they decide to compete. Within this framework, it may be argued that there are considerable differences within and among nations in the goals that firms set to achieve.

Besides the four main determinants for the generation of competitive advantage, Porter adds two other determinants which are important in affecting complementarily the creation of competitive advantage. These are chances and government. Chance events are considered events non controllable by firms like as pure inventions and breakthroughs in technology. It is regarded that they can shift competitive advantage in specific industries. Government and its policies can change considerably the system of competitive advantage determinants either reinforcing or undermining those (Stonehouse & Snowdon 2007).

2.3 The Concept of Competitiveness at a firm level.

Firm level competitiveness has attracted considerable attention among scholars, managers, and policy makers. Countries can compete on the basis that national firms are competitive. Literature focuses on individual firms, global strategies and resources positions in order to reveal the real sources of their competitiveness.

As Krugman and Obstfeld (1994) claim, competitiveness at firm level leads to the ability to create profits and increase firm's market share. Firms have to use internal resources and capabilities to produce appropriate products and services at right price and qualities (Wysokinska, 2003) in order to commercialize efficiently its products

and meet customers' needs (Porter ME, 1990).In the long run period, in a free trade environment, competitiveness is measured by the capability of the firm to continue its business cycle boosting investments and generating profits (Rojas, Cerda, Garcia &Barcenas, 2013).

Siudek and Zawojska (2014) claim that firm competitiveness is consisted of both tangible and intangible assets. Trying to better understand firm competitiveness, it is vital to recognize its endogenous and dynamic features, that lead to increasing productivity and profitability which in turn implies improvement of competitiveness (Elion S, 1985). Although profitability and productivity are key indicators of company competitiveness, other factors affect the former within a firm as, internalization of a firm, inter-company relations and regional infrastructure (Buckley, Pass, and Prescott, 1988). Additionally, business environment dynamics, rapid adaptation, flexibility, and speed are becoming vital resources of competitiveness (Barney et al.,2001).

Porter's explanation of competitiveness focuses on industrial economics. Porter affirms that the competitive advantage comes from the competitive strategy a firm chooses to diminish threats or to take advantage of opportunities within the industry (Porter , 1980,1985).

The RBV theory changed the attention from industry structure towards the resources generated by a company. Firm strategy can be defined as the match between firm's internal sources and capabilities with the potential opportunities and threats of its external environment (Grant, 1991; Barney, 1986). Firm strategy is directly connected with firm competitiveness. At the firm strategy level, the attention is

focused on the importance and role of firm resources in shaping the industrial and geographical limits of firm's activities (Teece, 1980).

Additionally, RBV, emerged around 1991, claims that at firm strategy level, investigations in the relationships between resources, competition and profitability incorporate the analysis of competitive imitations (Rumelt,1984), the returns to innovation (Teece,1988), the importance of imperfect information in generating profitability and the tools by which resource growth process can hold competitive advantage of the firm (Dierickx and Cool, 1989).

RBV theory suggests that resources and capabilities of the business consist of the foundation context for its long-lasting strategy for competitiveness because of two main factors: the internal sources and abilities of a firm offer the primary guidelines for a business's strategy and sources and capabilities are the basic framework for profit generation.

The RBV can be associated with at least two economic theories, the neo-classical microeconomics and the evolutionary economics (Barney et al.2001). Neo-classical microeconomics examines the way market power determine the quantity and the price of goods and services which are sold in a market. Neo-classical theory and RBV accept the same assumptions: the economic actors (firms or individuals) rationally act in order to maximize their utility; markets show a variation in competitiveness and asymmetry of information (Barney et al.2001). The main difference between those two theories is that according to the neo-classical theory, in general, factors of production such as resources and capabilities have an elastic behavior in supply (Barney, 2002; Hansen and Wernerfelt, 1989). So, when a demand for a specific factor of production increases, then the price for buying those factors as well and the

total quantity of this recourse will also increase in the market. On the contrary RBV theory argues that under certain circumstances, factors of production (resources and capabilities) maybe inelastic in supply.

According to some scholars, the RBV may be regarded as the rational extension of neo-classical theory, therefore equilibrium analysis could be adopted by RBV. Moreover, when a firm acquires the needed resources to boost its competitiveness and generate profit then an imperfect competition would be appear.

Firm competitiveness can be explained by a different perspective combing resource-based view and evolutionary economics. Nelson and Winter (1982) provided the most influential work at this field. In their theoretical framework, firms have differences in "routines" they develop for running their businesses. In this context, routines is the major issue of analysis since can lead to some selection mechanisms where some of these routines seems to be more efficient and effective comparing to others. The most efficient and effective routines lead to competitive advantages for firms(Nelson and Winter, 1982). On the contrary, firms with the least efficient routines may not survive in the long-run period.

According to evolutionary economics, these routines create a performance which secures firms survival. There are some analogies between RBV and evolutionary economics. Those routines that a firm adopts to ensure its survival can be an example of resources and capabilities; either resources and capabilities or routines may be the ability of a company to strengthen its competitive advantage and to extent its competitiveness (Nelson and Winter, 1982).

In empirical literature, numerous papers attempted to describe firm's resources and capabilities features and establish a potential relationship between those features and

firm's performance. The RBV theories mainly concentrate on how the firms exploit their valuable sources and abilities to create profits.

RBV approach regards firm competitiveness as a driver force of a firm's performance and profitability. RBV of competitiveness is regarded as a static approach and includes both the internal and external sources and assets of a firm (Depperu & Cerrato, 2005). Internal sources incorporate all the intangible and tangible assets and sources of a firm such as fixed assets, and financial assets. Intangible assets,-include all firm's strategies, human resources strategies and managerial abilities of a firm. Intangible assets are mainly employee-oriented sources while tangible assets are mainly firm-related assets ((Depperu, Cerrato, 2005).

On the other hand, external resources are industry-related resources and contain all the factors linked to the industry structure and competition such as bargaining power of industry agents, competition forces between existing firms and threats of substation by other competitors and new entrants within the industry (Porter, 1980). As it is already mentioned above, source-based view approach falls within the framework of a static view due to the fact that the focus of interest is both resources and key assets as the basis of firm's competitiveness. In contrast with this static view the dynamic view focuses on the dynamic capabilities of firms. The dynamic view implies that capabilities and resources are transformed into new ones enabling companies to exploit the new resources and create new and innovative competitive advantages (Teece, Pisano, Shuen , 1997).

2.4 Measurement of Firm Competitiveness

The present dissertation focuses on the microeconomic level of competitiveness while firms operate in relatively competitive markets. Firm competitiveness is considered as the main determinant of the firm's survival in the long-run. Based on this, firm competitiveness can be approximated by firm performance. Firms increase their production and sales through profitable opportunities. Therefore, the presence of a strong firm performance set the appropriate framework for a competitive industry.

A significant effort has been made by both theoretical and empirical research regarding the factors which affect the financial performance of firms. There are many different ways to measure firm competitiveness. Empirical studies relate competitive advantage with the economic performance of firms. Financial ratios are being used for measuring firm performance and more specific through profitability ratios. Moreover, productivity is an important indicator of firm's competitiveness, especially when the industry supplies homogenous products (Depperu, Cerrato, 2005).

Jacobson and Aeker (1985) using as measurement of firm competitiveness both the profit margin and market share concluded that only advertisement has a positive and statistical impact on profitability and by extension on firm competitiveness. Collins and Preston (1969) also use profitability ratios as a measurement of firm competitiveness. They studied 243 manufacturing firms for the time period 1968-1973 and they found out that concentration and capital intensity positively affect firm competitiveness.

Profit margins have been used extensively in empirical research as an indicator of firm's competitiveness. Martin et al (1991) compared the competitiveness of five food industries in Canada and the USA using both profitability and market share as indicators of competitiveness. In addition Haskel and Scaramozzino (1997) used

profitability as a proxy for firm competitiveness. They studied the factors which play a vital role for firm competitiveness through a panel data analysis for manufacturing firms in the UK. Their results indicated that profitability of companies, and so competitiveness, are affected by market share and some other factors such as capital structure and leverage.

Most recent studies place emphasis on profitability as an indicator of firm's competitiveness.More precisely, Asimakopoulos et al (2009) and Goddard et al (2005) used the return of assets as the dependent variable for profitability, an indicator of how profitable a company is relative to its total assets.

Lalinsky (2013) used a dynamic panel data model to explore the components of firm's competitiveness selecting profitability as an estimator of firm competitiveness. Annual data of firms in Slovakia has been analyzed between the years 2001-2009 and the results indicated that profitability of firms, estimated by return on assets, is affected by market share and other specific factors.

Chapter 3 Innovation

3.1 Schumpeter's Theory on Innovation.

Innovation has been characterized as a significant driver of competitiveness and its role for economic growth is catalytic (Porter, 1985; Hanusch and Pyka, 2007). Despite innovation has been the main area of interest for institutional economists, the major contribution came from Joseph Schumpeter in 1934 who recognized and gave prominence to the impact of technological innovation on economic progress (Foster, 1991) and his contribution in the field of innovation remains remarkable over the course of the following years. In a series of scientific research, Schumpeter developed an original framework about economic and social change in the long run through the impact of innovation.

In his book of Capitalism, Socialism and Democracy, Schumpeter implied that innovation is the major cause of economic change because of the gales of "creative destruction" caused by innovation (Schumpeter, 1942).This process describes the forces of innovative activity that affect economic systems in different time periods, leading to the destruction of the old economic structure and the generation of a new one. (Schumpeter, 1942). He suggested the classification of innovation process into four stages: invention, innovation, diffusion and imitation (Burton-Jones, 1999).

Schumpeter, (1942) defined various types of innovation including new methods of production process, new resources of raw material and the supply of semi-finished inputs in the production process defining them as process innovation Another type of innovation is the product innovation regarding the creation of new products or the improvement of existing ones. In the Schumpeterian framework analysis, the phases of diffusion and imitation process of innovation influence in a greater extent the

economic activity than the initial phase of invention. Schumpeter linked the innovation process with the activities of entrepreneurs which generate incentives for investments and accelerate employment and growth. According to Schumpeter, economic change is explained by innovation and firms' activities are the major innovators (Courvisanos and Verspagen, 2004).

3.2 Definitions, indicators and classification of innovation.

Schumpeter (1934) defined innovation as "the introduction of a product which is new to consumers or with higher quality than existing products, new methods of production, the opening of new markets, the use of new sources of supply and new forms of competition, that lead to the restructuring of an industry." Forsman (2011) defines innovation as the creation and application of new or advanced procedures, the generation of new products and services, novel production process in order to increase the competitiveness of a firm. The Organization for Economic Co-operation and Development (OECD) defines innovation as "the implementation of a new or significantly improved product (goog or service, or process, a new marketing method, or a new organizational method in business practices, workplace organization or external relations (OECD, 2005)." Therefore, the essence of innovation refers to novelty and commercialization of products, methods and processes applied to the market and to practical use (Kiveu and Muathe, 2019).

Different types of innovation have been proposed by scholars throughout the years based on two categories of innovation: the target of change and the novelty or the degree of change. According to the first group, there is a categorization into five sub-groups based on Schumpeter: new products, new processes, new resources of raw materials, creation of new markets and new methods of organization (Schumpeter,

1934). On the other hand, OECD innovation manual recognizes four type of innovation divided into product innovation, process innovation, marketing innovation and organizational innovation (OECD, 2005).

Another classification of innovation is radical or incremental founded on the level or nature of novelty. Radical innovation is defined as a unique, new and influential innovation which results in a considerably improvement and changes leading to new products and processes and the destruction or substitution of the existing product or services and procedures (Varis and Littunen, 2010). Radical innovations present a considerably performance leading to the generation of new markets or the inevitable transformation of the existing. Radical innovation demands exclusively new and advanced knowledge and technology and requires a high degree of research and development (Varis and Littunen, 2010).

Incremental innovation improves the existing products and processes regarding their functionality, efficiency and performance. It is regarded as the most common type of innovation carried out by organization and firms. Incremental innovation is based on the existing knowledge and technology within the firm. However, radical innovation is the driving force for high economic performance of firms and the secure of competitive advantage. Firm characteristics and its network determine the nature of innovation (Ahuja and Lambert, 2001) .

There is no consensus regarding the measures of innovation. Literature review reveals that there are various indicators for estimating innovation, including both innovation outputs and inputs (Ahuja and Katila, 2001). Innovation input indicators include the ratio of research and development (R&D) intensity divided by sales or by the number of employees. It is the most common indicator measurement found in the

empirical literature. As innovation output indicators they are considered the registered patents or the new products and services (Kiveu and Muathe, 2019). Both innovation groups of estimators present advantages and disadvantages, so the selection of the appropriate indicator depends on the firm, industry or country specific characteristics.

3.3 Competition and Innovation.

The investigation of the relationship between competition and innovation consists of one of the most important research issues in the field of economics although the existing literature offers contradictory evidence. The potential effects of both competition and the firms' innovation intensity and Research and Development (R&D) activity attracted the interest of researchers (Castellaci et al., 2009). One major assumption in several research papers pointed out that industry-level competition may reduce the monopoly power generated by innovative activity diminishing that way any incentives for further engagement in R&D activities (Geroski,1990).This assumption, known as Schumpeterian effect implies that there is a negative link between the extent of competition and the R&D intensity of companies (Nicoletti and Scarpetta, 2003)

Although, industrial organization theory generally expresses the concern that innovation activity may decrease as competition increases, empirical work proves the opposite. Recent research indicated that competition may enhance R&D activities and investment because there is a marginal increase in profits for firms investing in R&D activity in neck- to-neck industries where the competition is considerably intense. This argument known as escape-competition effect (Aghion et al, 2005; Aghion, Harris and Vickers, 1997) showed that the level of market competition and innovation maybe be positively related. Combining these two contradictory arguments, Ahion et

al, (2005) suggested the existence of an inverted U-shape linkage between innovation and market competition where the highest levels of innovation is between the lowest and highest level of competition.

The negative linear relationship of perfect competition and innovation is built on the Schumpeterian effect where perfect competition diminishes the incentives for innovation. The mechanism around this process implies that firm profits decrease when competition increases because the incentives for innovation depend on the returns a firm can earn upon its innovation activities (Moen et al., 2019). Perfect competition, therefore, diminishes the incentives for innovation investments and vice versa (Ahion et al, (2005). In line with the above statement, Kraft (1989), and Hamberg (1964) examined the relationship between perfect competition and innovation and found out a negative impact.

Dasgupta and Stiglitz (1980) extensively examined the concurrent link between R&D and competition. More particular, in the light of the impact of market structure on R&D, they came to a conclusion that when the level of concentration in an industry is small then R&D expenditures are positively related with the degree of concentration. In addition, they pointed out that in industries with no barriers to entry and a small level of concentration, an R&D effort per firm will increase concentration within the industry. On the other side, when there are industries with barriers to entry, an increase in the number of enterprises will lead to the decrease of R&D expenditures and decrease in the degree of monopoly. (Dasgupta and Stiglitz, 1980).

Aghion and Howitt (1990) created an endogenous growth framework based on the Schumpeterian theory about creative destruction and pointed out a negative correlation between degree of competition and R&D. Their argument supports the

notion that whether the incentive of innovation is boosted by the prospect of higher returns and profits, the expectation of rising competition will lead to decreased profits and thus to abandoning of any prospect for innovation.

On the contrary, economists shared the view that innovation is strengthened with competition, and the benefits for firms are stronger in competitive markets rather than in imperfect competition or monopoly (Arrow, 1962). Porter (1990) supported that firms are forced to innovate within a high competition context in order toensure their survival. Incremental profits by innovation may be secured with competition and firms intend to increase R&D expenditures in order to outpace competition and overtake their rivals (Moen et al., 2019).

Geroski (1990) conducted a cross-section study using data on innovation introduced in UK during the decade of the 70s. His empirical work was applied in an inter-industry comparison among manufacturing firms and explored the research question of whether an increase in competition decreases innovation. He focused more on market structure elements than concentration ratios and he tried to separate the impact that competition forces have on innovation via effects on post-innovation rents. He concluded that there is no evidence for a negative relationship between competitive rivalry and innovation.

Blundell et al. (1999), constructed a dynamic model for firm innovation taking into account firm-specific effects. Their model included two equations, an innovation equation and a value equation in panel data analysis. They contributed to the literature the suggestion that more competitive industries aggregate more innovations and market shares play a vital role for firms which attempt to commercialize innovation.

In addition, they found out that as competition increases in the industry the innovative activity increases too.

3.4 Driving Factors of Innovation

3.4.1 Firm size and innovation.

The Schumpeterian theory connects firm size and innovation effort mainly for three reasons: **first**, large firms are able to bear the high cost of R&D investment programs, **second**, only a large and diversified firm can afford and absorb potential failures during the innovation process. **Third**, large firms can dominate the market than smaller ones and so they can reap the returns of innovation (Hay and Morris, 1979). Thus, the dominance of large firms fueled by the large scale production, capacity and infrastructure, finances opportunities of marketing and R&D in order to create new technology (Bhattacharya and Bloch, 2004).

On the other hand, small firms show flexibility in exploiting human capital in innovation related projects and confront a less complex management procedures in commencing new projects. In addition, they may be faster in recognizing the opportunities for the implementation of innovation.

The majority of empirical studies examine the Schumpeterian argument concerning the impact of firm size on the innovative activity either at firm or industry level. Empirical research signaled that in western economies innovation is conducted by large firms and is concentrated in few industries (Bhattacharya and Bloch, 2004).Large firms possess the advantage of internal knowledge, disposability of financial sources for innovation and market power over small firms (Cohen,1996).

Generally, the link of firm size and innovation per se seems to be unclear because the determinants that influence innovation in large and small firms differ considerably in market concentration, knowledge environment and specific technological advancement.

3.4.2 Market Structure and Innovation.

Market concentration is regarded as an important determinant for expenditure in R&D. According to Industrial Organization theory, average expenditure on R&D depends not only on the level of concentration in the sector but it is affected by the firm's market share as well. It has been suggested that firms gaining a large market share may present less incentives for innovation than firms with the small one. Grabowski and Baxter, (1973)tested this hypothesis and found a clear evidence that firms with high markets share corresponded to their rivals innovation initiatives with one year time lag.

Both monopoly and oligopoly market structures provide the appropriate environment for securing profits to firms in order to engage in R&D activities, given that R&D is per se uncertain and costly in terms of both money and time. Imperfect competition creates the appropriate environment for firms to internalize the benefits of R&D activity. An interesting finding in empirical literature is that innovation performance and R&D intensity increase with competition initially, and then they decrease at later stages(Bhattacharya and Bloch, 2004). Only firms which achieve at least in the short-run some monopoly power and thus they manage to at prevent at least temporarily imitation by other rivals, engage in innovation activities (Morton, Kamien and Schartz, 1975).

3.4.3 Growth of markets and Innovation

The precise understanding of market needs by suppliers may be regarded as the most important driving forces of innovation activity. Positive growth prospects of demand attract investments in innovation since firms are more willing to develop innovation that serves larger markets and increases profitability.

The implementation of new innovation is likely to take place when there is enough market growth to absorb the new products. The expansion of demand is an important determinant for firms to innovate in order to take advantage over their competitors and exploit the benefits of market expansion (Geroski and Walters, 1995).

According to literature, demand influences innovation choices through the incentive effect and the uncertainty effect (Fontana and Guerzoni, 2008). Inventive effect implies that when an innovation is introduced to the market,demand performs as a multiplier of the increased firm mark-up (Fontana and Guerzoni, 2008).Early literature highlighted the effect of demand upon innovation arguing that there is no possibility for innovation about products and technology without a prior demand trigger (Schmookler, 1966; Myers and Marquis, 1969).

Increasing demand offers economic incentives for innovation and the latter can be regarded as the evolution of the economic activity and will be determined by the expected profitability. More particularly, in case that the optimization in the production process and improvements of the product quality lead to an increase of mark-up of firms per unit sold, then a rise of the number of units sold will boost future profits of firms(Fontana and Guerzoni, 2008). In empirical studies, market size is used as the most appropriate proxy for the demand effect.

3.4.4 Diversification of Firms and Innovation.

Innovation activity acts as a major catalyst for firm growth through diversification into new markets. An increasing number of patents or expenditures in R&D may depict the intensity of firm diversification. An explanation is that firms which differentiate its technology may accept more spillovers from related technological sectors. Besides, diversification of firms eliminates the risk from technological investments and motivates firms to increase expenditures on R&D. Diversification of firms brings economic benefits from the new technological capabilities (Garcia-Vega, 2006).

A modern firm needs to invest into new scientific base for being able to correspond successfully in a diversified demand. Technological and product diversification of a firm acts as an important driver for innovation. The linkage between firm diversification and innovation has gained an increasing attention in research since the middle of the 20th century. Regardless of that, a different standpoint shows an ambiguous sign of the correlation between diversification of a firm and innovation. (Jarrar and Smith, 2011).

Diversification is a well-established strategy of firm growth which continuously prompts a contextual change in the firm structure. Diversification includes advanced skills, technological inventions and new products and signifies a distinct separation from the past firm practices (Jarrar and Smith, 2011).

Economic and strategic management approaches proposes that diversification enhances more innovation because of more chances of the innovation results can be exchanged and exploited (Nelson, 1959). Moreover, agency theory approach explains

that diversification decreases organizational investment risk and at the same time boosts firms to absorb more risk from innovation (Garcia-Vega, 2006).

There is a vast empirical literature indicating the positive relationship between diversification and innovation. Early studies of Grabowski, (1968) and Teece, (1980) reported that diversification was positively related to R&D intensity as a proxy of innovation in chemicals and the drug pharmaceutical industry for Grabowski and the petroleum industry for Teece. A more recent study of Garcia-Vegra (2006) in a sample of 544 European firms provided distinct evidence that an increase in diversification of technology results in increasing R&D intensity and number of patents.

On the other hand, the negative impact of firm diversification on innovation is explained because of high uncertainty and risk of the change. Baysinger and Hoskisson (1989) reported a negative relationship between diversification and innovation. They attributed their results to the standpoint that diversification approaches are applied mainly in projects with short-term financial control whereas innovation projects are regarded as more long term, thus this explains the reason innovation projects are less demanded in highly diversified firms.

In addition, Miller (2004) stated a negative relationship between diversification and innovation. He interpreted his results in the fact that non all firms can absorb innovation and so they are not innovative leaders. In that case, those firms experience a decrease in profits and limited market share.

Chapter 4 Features of the Pharmaceutical Industry

4.1 Pharmaceutical Innovation

The pharmaceutical industry is regarded traditionally as a highly R&D-intensive industry which has brought about radical technological changes over the last seventy years. In general, the evolution of the pharmaceutical industry has been based upon institutional changes and technological advances. The industry's evolution may be divided in three main periods. The **first** period is started around 1850 and lasted until1945, and it is characterized by new drug development and the conducted research was realized by relatively undeveloped methods(Malebra and Orsenigo, 2002).

The **second** period of the industry's evolution started after the end of the 2nd World War until the end of the 60' and includes the development of penicillin which shifted considerably the industry. In this period the main feature is the rapid rate of drug production and the development of more structured in-house R&D programs. The **third** period which is fitted after 1970 but the flourishing of this period came the last two decades, is characterized by dramatic technological progress and an extended use of generic engineering methods in the production and development of new molecular entities (Malebra and Orsenigo, 2002).

The profits of effective innovation are huge in pharmaceutical industry. There is clearly a relationship between innovation and firm growth (PWC, 2013). A significant percentage of Pharma executives admit that innovation is essential to Pharma business. Pharmaceutical companies spend an important amount of their revenues on innovation and R&D. (PricewaterhouseCoopers ,2013)

The R&D process is characterized by large financial risks and many research projects fail to turn into a marketed product. In addition, pharmaceutical R&D process is marked by a long-lasting period about a decade or more(DiMasi et., 2003)since the clinical testing in humans is going through three successive phases.

DiMasi et al., (2016) in their compound-based study of the cost of new drug development, pointed out those total out-of-pocket and capitalized R&D expenditures for the development of a new drug amounts to $1395 billion and $2558 billion respectively. Corporate expenditures in R&D and innovation by extension in pharmaceuticals presents a series of features that make it rather difficult to finance it than others investments (Hall et al.,2016). The role of patents is of substantial importance for that industry playing an important role for confronting the financial constraints. The patent impact is greater for small companies since they face larger financial obstacles in order to finance their R&D process (Hall et al.,2016).

An interesting question to address is whether regulation affects innovation in the pharmaceutical industry. Existing evidences show no definite indication about both the strength that the sign of this effect. Although it is rather certain that the regulatory framework of the industry is an important determinant of innovation activities of firms in the industry, the impact of regulation depends on the different types of innovation and the way innovation is implemented (Blind, 2012). In the USA the pharmaceutical industry is characterized by a demanding regulative framework, and empirical evidence indicate that this led to more innovation and more competitive structures in the pharmaceutical industry in comparison with both Europe and Japan. A possible explanation is the fact that demanding regulatory framework makes pharmaceutical companies more selective and more productive about the compound which are planning to launch in the global market (Blind, 2012).

Pharmaceutical innovation targeting to the development of new drugs is substantially risky, complex and costly. R&D expenditures have been growing over time. In 1975 the cost for developing a new medicine has been estimated at the amount of €149 million (in 2000 prices) while in 2000 it increased at about €870 million (European Commission, 2014).In 2010 the cost of R&D reached the amount of approximately €1 billion for each new pharmaceutical product launched to the market (European Commission, 2014). The strict regulatory framework of this industry leads the marketing authorization organizations to raise both the standards concerning the quality and their demand for the volume of data submitted by firms in order to evaluate the safety and effectiveness of drugs resulting to increasing costs.

4.2 Pharmaceutical Industry: A strategic sector of the European Economy

The European pharmaceutical sector has been a substantial contributor to both scientific progress and breakthrough achievements in medicines. In addition, it is considered as one of the driving forces of the European industry's growth. A strong and robust European pharmaceutical industry is vital for European public health, economic development and science (European Commission, 2014).

The pharmaceutical industry is of major economic importance in the EU since the pharmaceutical sector produces one of the larger outputs in value terms, employs a considerably large number of labors and it is considered as one of the industries with the relatively higher labor productivity (European Competitiveness Report 2012).

Demand for pharmaceutical products is price inelastic and expected to increase over time, in spite of the recent economic downturn, thus showing the real power of the sector. The pharmaceutical industry is a leader in the knowledge-based economy

showing a substantial high ratio of R&D investment to net sales in comparison to other industries. It is essential then for the European Union (EU) pharmaceutical industry to maintain its competitive advantage. On the other hand, there are some shortcomings in the industry such as lack of confidence, financing constraints and market uncertainty. (European Competitiveness Report 2).

According to the latest report of the European Federation of Pharmaceutical Industries and Associations (EFPIA 2018), R&D expenditures in Europe were estimated at €35.200 billion in 2017 almost twice as much as the amount of €17.849 billion in 2000 while the R&D expenditures in US were estimated in $54.418 billion. The exports were estimated in €385 billion in 2017. In addition, world pharmaceutical sales accounted for 22.2% for Europe while in North America the percentage was about 48.1% (EFPIA, 2018). Between the period 2013 and 2017 the number of new chemical and biological entities were about 100 entities for US while in Europe were about 77. In European pharmaceutical industry were employing about 750.000 people in 2017.

The pharmaceutical industry is a high technology-intensive sector having a higher-than-average R&D intensity ratio. More specifically, according to the *EU R&D Investment Scoreboard, 2016* the pharmaceutical industry's R&D intensity ratio was about 15% while the same ratio in the software & computer services and the technology hardware and equipment sectors were 10.6% and 8.4% respectively.

4.3 Market Characteristics and structure of the pharmaceutical sector

4.3.1 The supply side

The Suppliers of pharmaceutical products may be classified in two main categories. The **first** one consists of companies which invest in research and development and produce new pharmaceutical products protected by patent. These companies are called originators. The **second** category consists of companies which produce generics. Generics are medicines with the same active pharmaceutical ingredients with the original medicines and can be used against the same diseases as the original medicines. The benefit of using generics is the lower production cost that in turn lowers the expenditure on drugs for national health care systems.

The category, of originators, can be further distinguished into two other subgroups. The first one consists of large multinational companies which are involved in every stage of creating new medicines starting from the early stage of research through the final stage of marketing the new medicine. The second one consists of companies which focus on a single stage of the complete cycle of creating and distributing a medicine. The reason of this specialization is that these companies do not have the necessary resources to get involved in all or multiple stages of the process on their own

4.3.2 The largest originators

Prescription medicines are the main source of revenues for companies which produce patented medicines. The percentage of revenues from this category of medicines can reach 80% on average

The cost of producing and distributing a medicine into the market can split in 5 basic cost factors but three of them are the most important accounting for a percentage of almost 60% of the revenues earned by selling prescribed medicines. The cost of manufacturing and the cost of promoting the medicine are the two main cost factors followed at a small distance by R&D. Administration costs are in the fourth place and distribution costs complete the list of cost factors.

4.3.3 Generic Companies

Generic companies are in general smaller than the ones producing original medicines and they reproduce prototype medicines whose their patents have expired.

The most obvious advantage of generic medicines is the lower price they have compared with the price of the original ones. The direct effect of lower prices is the reduced costs for the Health Care Systems of countries which promote the replacement, in a high percentage, of original medicines by generics. Another positive impact of generics is the pressure they set on originators for constant research and development on new medicines in order to maintain high profits. After the expiration of the patent of an original medicine, a large share of its users will turn to the cheaper generic, reducing profits of the prototype producer. This fact forces originators to invest in research for new prototype medicines. Besides, generic companies offer employment to a large number of highly skilled personnel. Legislation is very strict for both originators and generics producing companies especially for pricing and taking marketing authorization. One major difference is that generic companies do not need to prove the safety and efficiency of their products through undertaking clinical trials and making public announcements of the whole process of clinical tests when genetics products have the same effects on the same diseases as the prototypes do.

Generic companies face the same with originators five basic cost factors but the weighting of the cost factors is considerably different .The most important cost factor of generic companies is the manufacturing cost which accounts for almost half of their annual revenues and followed by marketing and promotion costs.

Pharmaceutical Sector Inquiry report of EU (2009) refers to the global share of cost factors of both originator and generic companies as a share of annual turnover. The following table (Table 1) provides information about global shares of cost factors for both the originator and generic companies.

R&D cost, although low for generic companies runs third in importance but still, this factor comes in third position of cost factors. Based on the table 1 it is worth to mention that R&D cost is very high for originators, trailing only by few percentage units from the two first cost factors. General administration cost and distribution cost covers the last two positions of cost factors with the percentages of these factors to be very close to the percentages these factors have in the case of originators.

Table 1: Global share of cost factors of originator and generic companies as a percentage of annual turnover

	Marketing and promotion costs	Manufacturing Costs	R&D costs	General administration and overhead costs	Distribution costs	Other annual costs
Originator Companies	21%	21%	18%	7%	1%	2%
Generic Companies	13%	51%	7%	6%	3%	1%

Source: Pharmaceutical Sector Inquiry[3]

[3] Based on an available sample size of 32 originator companies

The distribution channel of medicines consists of producers, wholesalers, pharmacies and traders. Wholesalers connect producers with pharmacies and all other entities which have the authorization to sell medicines. However, distribution of pharmaceutical products through wholesalers is not mandatory in the EU and as a result producers may provide directly pharmacies and hospitals with medicines. Traders buy products from countries where prices are low and then they sell these products in countries where prices are higher. Pharmacies in the EU operate under strict regulation laws pertained to the required geographical distance between pharmacies, the ownership structure of pharmacies, the opportunity or obligation to provide a cheaper generic medicine instead of the respective prototype and the option of the pharmacist to provide the patient the cheapest generic when the prescription states active substance and not a specific product.

4.3.4 Product life sciences

R&D is the first face of the process of making and marketing a prototype medicine. R&D along with the stage of licensing by the authorities constitute the pre-launch phase. After this phase the product is manufactured and distributed to the market while being protected by a patent. The third, and last phase of the product's life cycle, begins with the expiration of the patent which gives to generics the opportunity to enter the market and reduce the market share of the originator.

R&D supports the production of a new medicine but also the effort of an existing medicine to cure a different disease from the one which originally was made for. The pre-launch phase can be further divided into three phases. At the beginning, scientists try to find elements, such as enzymes, which are connected with the disease under consideration and after contacting a number of tests to create the new medicine. After

the promising medicine has been produced, in the second phase pre-clinical trials are conducted for testing the efficiency of the medicine in the laboratory environment and against animals.

The second phase continues with the clinical trials where the medicine is being tested in humans in three stages. At the first stage only healthy people receive the medicine and in this way the safety of the new product is being verified. When safety is secured, efficiency must be proved. In the second stage people who suffer from the disease receive the medicine.

Clinical testing ends at the third stage when the medicine is given in a large number of patients. If the clinical trials are successful the company submits an application for marketing authorization to the European Medicines Agency and/or other national authorities. As soon as the marketing authorization is awarded the new medicine is supplied to the market initializing the second phase of the medicine's life cycle during which it is protected by a patent.

The patent is very crucial for the profitability of the originator because during the patented period the company owns and markets the medicine exclusively, no imitation is allowed, and the company has the opportunity to recover the Research and Development expenses, makes special effort to extend the time in which a generic will not be allowed to enter the market, to increase the market share of the patent protected product against the products of competitors.

The last phase of an originator life cycle starts when the product loses the protection of the patent. At this point of time generic companies are allowed to market their products. As generics are less expensive than prototypes they will push prices

downwards. This fact combined with the growing market share earned by the generics will reduce the profitability of originator companies

4.3.5 Patents

One of the most important features of the pharmaceutical sector is the existence of patents. Patents support innovation in a direct way. They give the incentive to the pharmaceutical companies to invest a large amount of money in research and development. By knowing that if they succeed to create a new medicine, companies will have a secured time period of exclusivity and high profits they are willing to take the investment risk. Although patents provide protection to originators from generic companies copying their medicines, however they do not restrict competition from other originator companies which produce their own patented medicines for the same disease.

In addition, the patent holder is mandatory to make public all the available information about the patent application. After the publication, other companies may use the information in order to improve their own products, create new products or even improve the product for which the patent was originally granted conducting research leading this way to further innovation.

Pharmaceutical industry has a dramatic impact on people health and wellbeing. It is a sector characterized as cornerstone of an economy. Furthermore, it is a sector which represents an increasing interest for investigation. This chapter sheds light on some basic aspects of this industry as pharmaceutical innovation and provides the reader with some important data from the global pharmaceutical industry. The chapter closes with the presentation of the market structure and characteristics of the industry.

Chapter 5 The Greek Pharmaceutical Industry

5.1 Demand Side: Health and Pharmaceutical expenditure

One of the main determinants of the demand in the pharmaceutical market is the age structure of the population.(IOBE, 2019; ICAP, 2018). The aging of population increases the demand for health care services and the demand for pharmaceuticals products, i.e., drugs and over the counter (OTC). The long-term prediction of the Hellenic Statistical Authority (ELSTAT) shows a sizeable increase of the percentage of old ages in total population until 2050, as it is reported in Table 2 below.

Table 2: Age groups % shares of the total Greek population.

YEAR	POPULATION ABOVE 65 YEARS OLD	POPULATION ABOVE 75 YEARS OLD
2011	19.00%	9.30%
2012	19.30%	9.60%
2013	19.60%	9.70%
2014	20.50%	10.50%
2015	20.90%	10.80%
2016	21.30%	11.00%
2017	21.50%	11.10%
2020	20.90%*	10.20%*
2030	24.00%*	11.80%*
2040	28.50%*	14.30%*
2050	32.10%*	17.80%*
Source: ICAP 2018; Author's table		

Notes: * values show predictions.

The share of the population aged 65and above in Greece is predicted to rise from 20.9% in 2020 to32.10% in 2050.The share of population aged 75 and above is expected to increase from 10.20% in 2020 to17.80% in 2050.These age groups have high demand for medical services including demand for drugs and OTC products, and their estimated increased share of total population in the future is expected to raise demand accordingly.

According to the OECD, 2019 statistics, total health care expenditure (private and public) recorded an upward trend in the 2001-2009 period followed by a significant decrease in the after 2009 period because of the financial crisis, and the austerity measures, and the rationalization of the public procurement system for medical services and drugs provision implemented for balancing both public and current account deficits. Table 3 reports the total health expenditures as a share of GDP from 2000 until 2018 adopted from OECD, 2019 Statistics. Total health spending is defined as, "the final consumption of health care goods and services (i.e. current health expenditure) including personal health care (curative care, rehabilitative care, long-term care, ancillary services and medical goods) and collective services (prevention and public health services as well as health administration), but excluding spending on investments" (OECD Data, 2019).

Table 3: Total health spending as a share to GDP

YEAR	Total, % of GDP
2000	7.24
2001	7.99
2002	8.23
2003	8.45
2004	8.09
2005	8.56
2006	8.26
2007	8.40
2008	8.83
2009	9.41
2010	9.52
2011	9.03
2012	8.79
2013	8.32
2014	7.85
2015	8.02
2016	8.21
2017	7.96
2018	7.71
Source: OECD statistics, 2019; Author's table.	

In 2017, total health spending in Greece was amounted to €14.9 billion of which €9.1 was public health expenditure and €5.8 was private health expenditure (ELSTAT

2019; OECD Statistics,2019). The following table (table 4) presents the total and public health expenditure, in billion € for the 2009 – 2017 period.

Table 4: Total and public health expenditure in Greece (billion €)

YEAR	2009	2010	2011	2012	2013	2014	2015	2016	2017
PUBLIC HEALTH EXPENDITURE (billion€)	15.4	14.9	12.4	11.3	9.4	8.3	8.4	9.0	9.1
TOTAL HEALTH EXPENDITURE (billion€)	22.5	21.6	18.8	17.0	15.2	14.2	14.4	14.7	14.4
Source: EL.STAT 2019; OECD Health Statistics, 2019. Data are in current prices.									

In 2016, total health spending amounted to €14.7 billion significantly below by 32.4% its 2009-year value of €22.5 billion. In the same period public health spending declined by approximately 42% (EL.STAT 2019; OECD Health Statistics, 2019).

In the following table (table 5), it is presenting the difference in the total per capita health expenditure between Greece, EU23 and Southern countries (Italy, Spain, Portugal).

Table 5: Public health expenditure per capita (euro)Greece-EU23-Southern countries.

YEAR	PUBLICHEALTH EXPENDITURE PER CAPITA		
	GREECE	**EU23***	**EU SOUTH** COUNTRIES**
2009	€1389	€2307	€1.691
2016	€789	€2767	€1.650
YEAR	**PRIVATE HEALTH EXPENDITURE PER CAPITA**		
	GREECE	**EU23***	**EU SOUTH** COUNTRIES**
2009	638	584	516
2016	564	745	616
Source: OECD Health Statistics, 2019, Author's table			

Notes: *****EU23 group of EU member states does not include Bulgaria, Cyprus, Croatia, Romania, and Malta.**EU South Countries include Italy, Spain, Portugal.

The per capita public health expenditure shows also a decline by 43.2% during the same period going down from €1389 in 2009 to €789 in 2016. The per capita private health expenditure also declined from€638 in 2009 to €564 in 2016 due to the reduction of the purchasing power in Greece. By comparison in the same period, the per capita public health expenditure in the EU23 group rose by 19.9% while EU South countries recorded a minor decline by-2.4%.

Total pharmaceutical expenditure as a share to GDP recorded an almost continuous upward trend between 2000 and2009reaching 2.5% in 2009 compared with 1.4% in 2000 (OECD, 2019). According to OECD's definition total pharmaceutical expenditure includes the spending on pharmaceutical products such as medicinal preparations, branded and generic medicines, drugs, patent medicines and over-the-counter products like vitamins, minerals and other oral contraceptives.(OECD, 2019)

Pharmaceutical expenditure includes the spending for drugs (prescribed and non-prescribed drugs) and other medical products which are dispensed to outpatients. Total pharmaceutical spending is analyzed in public and private. Public pharmaceutical expenditure includes social health insurance expenditures and expenditures of the national health system for drugs (reimbursement of pharmaceutical spending of assured) whereas private includes out-of-pocket payments, co-payments and the reimbursement of part of expenditure by private insurance companies (Kousoulakou and Vitsou, 2008).

Total expenditure for pharmaceuticals and other medical-non durable goods in billion € from 2009 until 2018 is presented in the following table (table 6).

Table 6: Total expenditure for pharmaceuticals and other non-durable goods (billion.€)-Greece.

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
TOTAL	6.1	6.2	5.8	4.9	4.2	3.8	3.8	3.9	4.0	3.7
PRIVATE	1.3	1.4	1.4	1.4	1.7	1.8	1.8	1.8	1.8	1.9
PUBLIC	4.8	4.8	4.4	3.4	2.5	2.0	2.0	2.0	2.1	1.9
Source: Foundation of Economic and Industrial Research(IOBE, 2019); ELSTAT, 2019										

Total spending for pharmaceuticals and other medical non-durable goods mounted up to €3.7 billion in 2018 down from €6.1 billion in 2009 recording a heavy decrease by 38.8%. Similarly, public expenditure amounted to €4.8 billion in 2009 compared with €1.9 million in 2018 recording a significant decrease by -59.4%. On the contrary, private expenditure increased from €1.3 billion in 2009 to €1.8 billion in 2018.

It has to be noted that the public pharmaceutical expenditure per capita (€198)in Greece was lower than the EU-22 (data not available for Bulgaria, Croatia, Cyprus,

Romania, Malta, UK) average public pharmaceutical expenditure (€310)in 2017 according to IOBE, 2019.

The next two tables, i.e. Tables 7 and 8 show the outpatient pharmaceutical spending (excluding patient's contribution), total, public and private between 2000 and 2017. Total outpatient pharmaceutical spending refers to the drugs' sales of pharmaceutical companies towards wholesales and pharmacies.

Table 7: Outpatient Pharmaceutical expenditures (€billion.) (2000-2008)

	2000	2001	2002	2003	2004	2005	2006	2007	2008
Total Pharmaceutical expenditure	2.04	2.32	2.68	3.13	3.55	4.02	4.6	5.4	5.8
Public pharmaceutical expenditure(€)	1.27	1.50	1.80	2.16	2.42	2.86	3.51	4.04	4.53
Public pharmaceutical expenditure per capita(€)	117	137	104	196	219	258	315	362	404
Private pharmaceutical expenditure(€)	764	822	879	972	1.129	1.157	1.090	1.374	1.304
Private pharmaceutical expenditure per capita(€)	70	75	80	88	102	104	98	123	116
Source: IOBE, 2012, Note: Total pharmaceutical Expenditure refers to drug sales o pharmaceutical companies to wholesalers and pharmacies according to publication of National Drug Association (EOF)subtracting the value of parallel exports.									

There is an increasing trend in pharmaceutical expenditure during the period 2000-2008. Total pharmaceutical expenditure increased from €2.04 billion to €5.8 billion Correspondingly, private and public health expenditure increased considerably the same period.

Table 8: Outpatient Pharmaceutical expenditures (€billion.) (2009-2017)

	2009	2010	2011	2012	2013	2014	2015	2016	2017
Total Pharmaceutical expenditure(€)	6.34	7.3	6.7	5.9	5.69	5.63	5.60	5.82	5.78
Public pharmaceutical expenditure(€)	5.09	4.50	3.92	2.88	2.37	2.00	2.00	1.94	1.94
Public pharmaceutical expenditure per capita(€)	452	402	352	260	215	183	184	180	181
Private pharmaceutical expenditure(€)	1.25	2.84	2.83	3.08	3.32	3.63	3.60	3.87	3.83
Private pharmaceutical expenditure per capita(€)	111	254	255	279	302	333	332	359	356
Source: ICAP , 2018									

The increasing trend in the pharmaceutical expenditures has been inverted during the years between 2010 and 2017 recording a continuous decline as a result of the austerity policy measures implemented in Greece for combating the debt crisis. Public outpatient pharmaceutical expenditure presents similar trend for the years 2010 to 2017. The austere fiscal policy led to a series of price cuts for drugs in that period that in conjunction with considerably increases of V.A.T rates induced a large fall in the public pharmaceutical expenditure which in the same period decreased with an average annual rate of 11.2%. At the same time, private pharmaceutical spending shows a constant increase.

5.3 Supply Side: Domestic Production

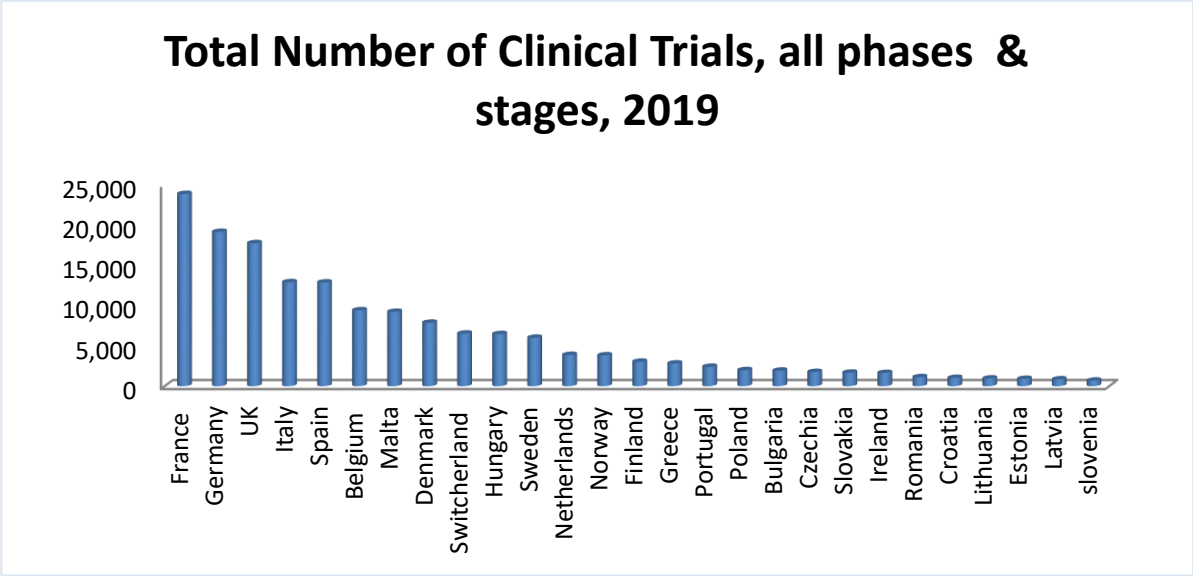
The pharmaceutical industry is considered as one of the most dynamic sectors in Greek manufacturing. The Greek pharmaceutical industry is comprised of 106 companies including multinational and national pharma firms. The supply of the pharmaceutical products in Greece is served by domestic producers and importing/commercial companies. Out of the 106 companies in the sector, approximately 55 are subsidiaries of multinational companies with main activity the import and distribution of pharmaceutical products (including cosmetics and other OTC products) of the parent company. The remaining 50 companies produce generics drugs and at the same time promote patented drugs of multinational companies.

The contribution of the sector to the GDP of the country is estimated to €2.8 billion in the 2000 decade (IOBE, 2013) .In the same period, the industry recorded the highest annual average increase in terms of GVA among all manufacturing industries within the EU members-state (IOBE, 2013).

Producers companies holding a dominant position in the domestic pharmaceutical industry conduct a considerable amount of investment into new research programs regarding development of new generic drugs while there are important potentials of further improvement. (ICAP, 2018).

Concerning the R&D, 2. 811 clinical trials were conducted in 2019 in Greece (IOBE,2019). The country ranks 15thin clinical trials among the EU28 in the same period as it can seen in diagram 1.

Diagram 1: Total Number of Clinical Trials, all phases & stages, 2019 Source: IOBE,2019



The pharmaceutical industry has invested about €51 million in R&D in 2017 and this amount accounts for 5% of total R&D expenditure in Greece for the same year, lower than the 8% share it accounted for the year 2015. Although the Greek pharmaceutical industry values R&D investments as a driving force for the industry, Greece still holds a low position among EU state-members in R&D investments in pharmaceuticals. More specific, R&D in domestic pharmaceutical industry corresponds to 5% of total Research and Development expenditure in Greece in 2017 showing a decreasing trend comparing to 2015 where the same percentage accounted for 8%. (IOBE, 2019). The countries with the highest percentage of R&D expenditures in pharmaceuticals as a share of total R&D expenditure were Slovakia, Slovenia and Belgium in 2017 accounting for 32%, 30% and 27% respectively (IOBE, 2019).

According to IOBE, 2019 in terms of ex-factory prices (value) the pharmaceutical production in Greece amounted to almost €1.0 billion in 2018 slightly higher than 2017. The following diagram 2 presents the evolution of the Greek pharmaceutical industry production in million € for the 2002 – 2018 period and table 9 presents the annual change of the production of pharmaceutical products for the same period.

The diagram 2 shows the production of pharmaceutical productions between 2002 and 2018. There is a remarkable increase from 2002 until 2010 where the production from €431 million reached the €918 million respectively. In the consecutive years, it is depicted a fluctuation in the production where the years 2012 and 2014 observed the highest decrease of -9% and -4.90% (see table 9) respectively. Production of pharmaceuticals reached the amount of 996 million euro in 2018(IOBE, 2019).

Diagram 2: Production of Pharmaceutical Products (million. €). Source: IOBE 2019

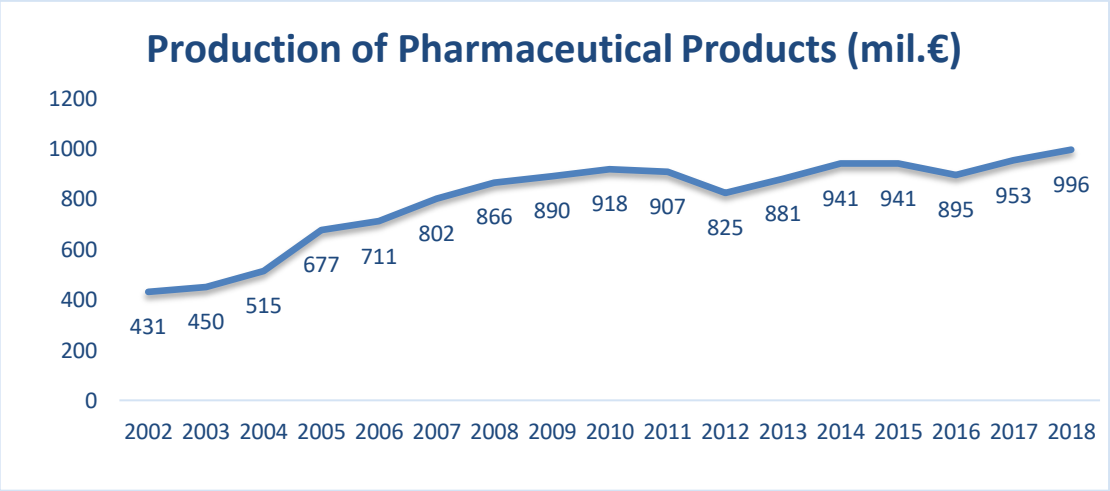


Table 9: % Annual change of production of pharmaceutical products, 2002-2018

YEAR	%ANNUAL CHANGE
2002	16.1
2003	4.4
2004	14.40%
2005	31.40%
2006	5%
2007	12.90%
2008	7.90%
2009	2.80%
2010	3.10%
2011	-1.20%
2012	-9%
2013	6.70%
2014	6.80%
2015	0.00%
2016	-4.90%
2017	6.50%
2018	4.50%
Source: IOBE, 2019; Author's Table	

Table 10 shows the evolution of sales of pharmaceutical products in Greece during the period 2002-2018. As it can be seen in the table sales of pharmaceutical products in Greece initially recorded an upward trend starting in 2002 and up to 2009 when sales amounted to €8.4 billion. In the consecutive years, pharmaceutical sales reduced significantly due to the financial crisis and the fiscal adjustment in Greece. The downward trend stabilized in 2015 and afterward it is observed an increase until 2018 (€6.2 billion) (EOF), 2019).

Table 10: Sales in Pharmaceuticals products in values (billion.€)

YEAR	SALES IN PHARMACEUTICALS PRODUCTS IN VALUES (BIL. €)
2002	3.7
2003	4.3
2004	4.9
2005	6.1
2006	6.9
2007	6.9
2008	8
2009	8.4
2010	7
2011	6.8
2012	6
2013	5.7
2014	5.6
2015	5.6
2016	5.8
2017	5.8
2018	6.2
Source: EOF, 2019; IOBE, 2019	

The GVA of the pharmaceutical industry fell in both absolute terms (see Table 11) and as a percentage share of total manufacturing from €463 million and 4.6% respectively in 2005to €422 million and 2.8% respectively in 2008. Since 2009 the GVA of the pharmaceutical industry has followed an increasing trend up to 2013, it decreased the next two years, and then it rose up to €553 million in 2017, while its percentage share to total manufacturing GVA was rather stable at around 3.4% in the period of 2009 to 2017. (IOBE, 2019).

Table 11: Gross Value-Added in pharmaceutical and total manufacturing sector in €million

YEAR	GVA Pharmaceutical	% Share in manufacturing
2005	673	4.6%
2006	624	4.0%
2007	562	3.4%
2008	422	3.8%
2009	434	3.2%
2010	521	3.2%
2011	515	3.2%
2012	424	3.0%
2013	563	3.9%
2014	523	3.4%
2015	494	3.2%
2016	509	3.1%
2017	559	3.0%
Source: IOBE, 2019; Author's Table		

Labor personnel in the pharmaceutical industry are highly skilled. According to the International Standard Classification of Education the employees in the pharmaceutical industry are University graduates at 60.6% of total when the respective percentage for the total economy is 36.6% and in manufacturing only 22.8 (see Table 12) for the year 2018 in Greece (IOBE, 2019). The level of education in this sector includes employers holding a bachelor, master and PhD degree (IOBE, 2019).

Table 12: Number of employees with university education in pharmaceutical production industry. (2011-2018)

YEAR	Pharmaceutical Production	Manufacturing	Total Economy
2011	49.3%	16.2%	30.2%
2012	48.6%	17.8%	32.1%
2013	50.3%	18.2%	33.4%
2014	66.4%	18.2%	33.5%
2015	71.6%	20.1%	33.8%
2016	64.0%	22.7%	35.0%
2017	60.5%	22.0%	35.7%
2018	60.6%	22.8%	36.6%
Source: IOBE, 2019; Author's Table			

At the beginning of the Greek financial crisis (2010) the total number of employees in the pharmaceutical industry was 16.2 thousand people. In the year 2011 employment in the sector reduced to 13.7 thousand people and it remained rather stable for the next four years. In 2016 the industry recorded an impressive increase of employment by 28.2%. In the consecutive years up to 2019 there is a considerably large variance in the employment in pharmaceutical production. (see Table 13) (IOBE, 2019). Greek pharmaceutical production has a considerably important contribution in the employment sector. It has been estimated that every job position in the pharmaceutical sector create three more positions in the total economy. Therefore, it is highlighted the significance of this sector against brain drain.

Table 13: Employment in Pharmaceutical Production during the period 2011 to 2018 (thousands persons)

YEAR	Employees in Pharmaceutical Production	% annual change
2011	13.7	-
2012	14.0	2.2%
2013	13.2	-5.7%
2014	13.3	0.8%
2015	13.1	-1.5%
2016	16.8	28.2%
2017	14.4	-14.3%
2018	17.1	18.4%
2019	21.2	24.5%
Source: IOBE, 2019, Author's Table		

Tables 14 show exports and imports of pharmaceutical products for 2007-2018. Imports report a slightly increasing trend between 2007 and 2010 (from €3.38 billion to €3.57 billion respectively) followed by a decreasing trend up to 2014 (from €3.27 billion in 2011 to €2.69 billion in 2014). In the consecutive 2015-2018 period pharmaceutical imports remain rather stable. Exports fluctuated slightly before they stabilize in 2013-2016. Some minor increase is reported in the next two years. The pharmaceutical industry trade balance although it is negative shows a significantly decreasing trend in the long term. The trade deficit was €2.41 billion in 2007 and only €554 million in 2019.

Table 14: Evolution of pharmaceutical trade balance in current prices (million.€) (2007 – 2019).

Year	Imports	Exports	Trade Balance
2007	3.38	974	-2.41
2008	3.68	880	-2.80
2009	3.94	949	-3.00
2010	3.57	1.04	-2.53
2011	3.27	921	-2.35
2012	2.94	968	-1.70
2013	2.76	1.05	-1.70
2014	2.69	1.04	-1.64
2015	2.80	1.02	-1.77
2016	2.86	1.06	-1.80
2017	2.73	1.15	-1.58
2018	2.76	1.88	-1.3
2019	2.44	1.88	-554
Source: IOBE, 2019; Author's table			

5.4 The Size Market of Generics in the Greek Pharmaceutical Industry

The production of domestic generic drugs in Greece has attracted the interest of domestic pharmaceutical industry in recent years, especially after the decision of the state to implement policies of boosting their consumption in order to manage the cost of national pharmaceutical care.

According to the ICAP GROUP sector analysis, 2018 the value of the domestically produced medicines amounts to €937 million in 2017 Despite the decrease in value by 9.2% in 2012 Domestic pharmaceutical industry managed to be adapted briefly during the crisis period and since the following of 2013 there were observed a steady increase up to 2017 (see table 15) (ICAP, 2018).

Table 15: Evolution of sales of domestically produced medicines (2002-2017)

YEAR	Value (mil.€)	%annual Change
2002	398	-
2003	419	5,2%
2004	512	22,2%
2005	673	31,4%
2006	693	3,0%
2007	793	14,3%
2008	858	8,2%
2009	883	3,0%
2010	884	0,1%
2011	908	2,7%
2012	825	-9,2%
2013	880	6,8%
2014	941	6,9%
2015	951	1,0%
2016	948	-0,3%
2017	937	-1,2%
Source:ICAP, 2018; Author's table		

Market sources are reporting that domestically produced generics drugs reach a rate of 45%-50% of the total domestic production of medicines in Greece (ICAP, 2018) and their value were estimated in €425 million in 2017 (ICAP, 2018). In Table 14, it is presented the Greek market size for generics both for hospital and outpatient consumption in value and volume in the 2011-2018 period (ICAP, 2018). According to table 14 there is a steady decrease in the value of the market size of the domestically produced generics medicines from 398 million to €468 million between the year 2011 and 2018 while the volume of the market increased from 85 million packages to 132 million in the same period. The consecutive decreases on the prices of on-patent drugs which affects those of generics also resulted in this downward trend in value in spite of the augmented consumption at volume level (ICAP,2018).

Table 16: Domestic Market of Generics Drugs in value (million.€) and in volume 2011-2018

YEAR	MARKET SIZE IN VALUE	MARKET SIZE IN VOLUME
2011	665.000.000	85.000.000
2012	580.000.000	90.000.000
2013	536.000.000	95.000.000
2014	530.000.000	102.000.000
2015	513.000.000	105.000.000
2016	502.000.000	123.000.000
2017	480.000.000	129.000.000
2018	468.000.000	132.000.000
Source: ICAP,2018; Author's Table		

It is reminded that the memorandum goal for the generic drugs market penetration is expected to rise to 60% in the next years up to next years. Therefore, many of pharmaceutical companies (both importers and producers) have focused in the strengthening of their pharmaceutical portfolio and their placement in the generic drug market.

In table 17 is showcased the evolution of the allocation of generics and patented drugs the last four years (2015-2018) in terms of value. It is noted that the patented category includes all of the rest drug categories (on patent, off patent, etc.).

Table 17: The evolution of drugs' market distribution in Greece (2016-2018)

YEAR	On-patent	Generics
2015	81.5%	18.5%
2016	81.7%	18.3%
2017	81.9%	17.8%
2018	82.2%	17.8%
Source: ICAP, 2018, Author's table		

Based on market sources, the highest market share in the production of domestic generic drugs are hold by the Greek pharmaceutical firms as Vianex, Gap, Elpen, Demo, Rafarm, Bennett, Uni-pharm. Representatives of domestic pharmaceutical production point out the lack of specific political policy for boosting generic drugs penetration in the domestic market and the continuing changes in the institutional framework as two major problems in the sector, leading domestic pharmaceutical businesses to a constantly effort for adaption to an ever-changing environment.

5.4 Competitive environment Analysis and Developing Opportunities of the Greek Pharmaceutical Industry.

The generic drugs category is gaining ground recently, especially after the decision for fiscal adjustment and rationalization of expenditure in the pharmaceutical department. As a result, the majority of pharmaceuticals enterprising in the Greek market include in their portfolio generic drugs (produced/developed as well as imported).

In the same line with the introduction of diminished pricing, it was decided the implementation of prescription by active ingredient and thus leading many pharmaceutical companies to gravitate towards the development/distribution of generic drugs. Even if the results were not the expected, multinational groups are backing up the presence of their subsidiary companies and widen their portfolio with the specific category, while the local groups invest significantly in generic drugs development.

In the pharmaceutical industry there are some legal complications for a new company to overcome. On the one hand the protection of 'patented' pharmaceuticals against their generics and on the other in the level of approval, testing and price determination from the State.

In the pharmaceutical industry, the providers are mostly chemical industries and industries providing the active ingredients for the production of the drugs in question. In general, their negotiation power is considered strong.

Drug pricing is object of strict state regulations and as such is controlled by government authorities setting their market price. The negotiation power of consumers is limited to payment options.

The institutional framework which surrounds the pharmaceutical sector (existence in patent protection for on-patent drugs) creates a specific competitive environment. The decision of Greek State to enhance and boost the consumption of generic drugs urged domestic pharmaceutical companies to boost the production of generics, forcing further the existing high competition within the sector.

It has to be referred that domestic pharmaceutical companies dispose significant assets on R&D and make investments in order to renew and modernize their equipment and production process while show an increased interest for a continuing expansion of their production with new generics.

The Greek pharmaceutical industry had an outstanding growth between the period 2000-2010. Based on this development, the domestic industry set the appropriate framework which has been accelerated its further enlargement and growth over the next years. The tremendous financial crisis in Greece and the fiscal measures for

purging of the Greek economy and decrease of health care spending affected considerably the industry. However, the domestic pharmaceutical sector was one of the most important sectors which contribute in the total economy in terms of employment, gross value added and trade balance.

There are some specific strong points in this industry which can lead to a further development. The inelastic and stable demand of the drugs is a strong element for the domestic pharmaceutical industry which can be exploited further. In addition, it has to be enhanced the co-operation between the domestic pharmaceutical companies with developed and established distribution networks (wholesalers) with a wide geographical cover for minimize costs and increasing profits. It is vital the co-operation between the domestic and international pharmaceutical industry generic and the creation of strong business networks.

The opportunities in the Greek pharmaceutical sector include the development of new generic drugs and the further penetration of them in the domestic market. During the financial crisis indicated that the export activities of Greek pharmaceutical industry remain stable. Thus, the export activity and the reinforcement of extroversion of the industry is a strong opportunity for the industry. The expiration of the patent of the on-patent in the recent years provides a further motive for exploitation by the sector.

Despite the opportunities and the strong points of the Greek industry, there are significant obstacles that threat the Greek pharmaceutical industry. The continuing fall of prices of generic drugs decrease the profits within the sector. The delay of approval of the generics drugs in conjunction with the lasting changes in legislation

set difficulties to the sector. The lack of trust from a share of patients and health care providers constitutes another weak point for the domestic industry.

A significant threat can be regarded the increased load of the implementation of rebate and claw back mechanisms which deter pharmaceutical companies to invest in R&D programs and clinical trials. It is necessary for re-evolution of the rebate and clawback mechanism by the government and an effort for offsetting part of claw back with investments either in production or in R&D.

The number of clinical trials and research activity in the domestic pharmaceutical industry is regarded as considerably low. The co-operation between pharmaceutical firms and research centers and universities presents an important lag comparing the situation in other EU countries. The removal of those bureaucratic issues which worsened the effort for more R&D and clinical trials is decisive.

CHAPTER 6 DETERMINANTS OF FIRM PROFITABILITY& HYPOTHESES DEVELOPMENT.

6.1 Introduction

Extensive research has been conducted about the factors affecting the profitability of firms and by extension firm's competitiveness. Competition is the main driving force of market dynamics. Firms under competitive pressure feel the need to survive and to answer to market changes designing and implementing appropriate strategies.

Various definitions about firm's competitiveness indicate a clear connection between competitiveness and profitability that has led to the use of profitability as a proxy of competitiveness. Profitability is regarded as a key factor for estimating firm competitiveness (Buckley et al., 1988; Fischer and Schornberg, 2006; Numerous studies have selected profitability as a way to measure firm competitiveness (Liargovas and Skandalis, 2004; Selcuk, 2016; Anastasopoulos, 2004; McDonald,1999; Lalinsky, 2013; Lazar, 2016; Notta et al., 2010). Profitability is a financial index and the advantage of employing them for measuring profitability is the easiness of calculations and the way of their construction is accepted worldwide in the theoretical literature (Liargovas and Skandalis, 2004; Selcuk, 2016).

Competitiveness though is a function of several firm determinants including not only profitability but productivity, efficiency and market share (Rosli, Sidek, 2013). Those non-financial indicators are also important, although financial ones are most widely used. Generally, market share may also be an alternative proxy for competitiveness (Lalinsky, 2013; Liargovas and Skandalis, 2004; Selcuk, 2016; Kiveu, Muathe, 2019) but for the purposes of this empirical work has been selected profitability. Profitability has been selected because of the easiness of calculation of

the one part and the avoidance of measurement errors using market share of the other part given the significant heterogeneity of the Greek pharmaceutical industry.

6.2 Profitability & Innovation

Innovation applies to all scientific, technological, financial, managerial activities which results in or are planned to result in the implementation of new advanced technologies or improved products and services. Innovative activity is boosted by the results of new technological achievements, new technology combinations, or the application of up-to-date knowledge acquired by the enterprise. (Eurostat, 2012)

Therefore, innovation includes new ideas which affect the behavior of firms and economic agents in an unknown way (Iraj and Nebojsa, 2010). Innovation enables companies to differentiate themselves from their competitors as regards new products, processes, organization achievements and costs. The introduction of a new technology, the efficient use of human capital and improvements in organizational processes lead to a more advanced production process and consequently innovation increases firm's efficiency(OECD, 1997)

Firm behavior models imply that innovation has no long-term effect on firm performance since the new knowledge will be diffused and imitated by competitors (Iraj and Nebojsa, 2010).Therefore, in the long run period companies would converge to the steady-state equilibrium. Nonetheless, there is extensive empirical evidence that firms in specific industries perform in a superior way with respect their rivals (Kemp, et al.2003)

Based on the evolutionary model of the firm, innovations which accelerate the generation of new products and improvements of existing processes, lead to the continuous change of the economic system (Nelson and Winter, 1982).

Klette et al., (2000) have developed a firm behavior model based on the endogenous firm growth theory and they found out that the growth of the firm is affected by the quality of its own products and of its competitors' products, and additionally innovation improves the quality of its own products. In their work, R&D and innovation were the driving factors of growth but they ignored the significant aspect of imitation. Their model concludes also that firms which operate in industries with increasing demand for high quality products and high innovative opportunities, then it is more possible to have higher R&D intensity needs. This work uses R&D as a proxy for innovation.

Studies on the relationship between firm performance and innovation typically indicate a positive relationship. Griliches (1986) pointed out that higher R&D investment led to higher productivity growth. In his work he collected and analyzed 1,000 data for US firm for the period between 1972 and 1977. The framework used for the analysis was the standard production function of Cobb-Douglas. In addition, his work showed that both privately and publicly financed R&D expenditures affected positive firm productivity but the former had a greater impact on it. .

In the majority of studies, innovation is measured as R&D expenditures In some cases, the R&D intensity ratio is used as a proxy for innovation. R&D intensity ratio is quantified as R&D expenditure divided by total sales (Klomp and Van Leeuwen 2001, Stoevsky 2005, Chudnovsky, Lopez and Pupato2006). Nevertheless, R&D expenditures do not incorporate all the innovation effort (Kemp et al., 2003) and this

approximation present some limitations such as learning by doing or the knowledge incorporated in the human capital and the new investments on technical equipment. Generally, innovation efforts measured by R&D expenditure do not lead to always to an innovation output since firms spending on R&D for a long period may not benefit from those investments (Bessler and Bittelmyer, 2008).

Crepon et al., 1998, have developed a four-stage model for capturing the innovation process as a whole. The decision to innovate and the decision on how much would be spending on innovation refer to the first and second stage respectively. The relation between expenditures on innovation and innovation output, and the relation between innovation output and firm performance refer to the third and fourth stage respectively. The results of this stage show the causality between the decision to innovate and the firm performance. In this particular study the firm's performance correlates positively with higher innovation expenditures.

Adamou and Sasidsharan , 2007 examined the relationship between R&D and the growth of firms using a panel data of Indian manufacturing firms. They underlined that R&D is an essential determinant of firm's performance. They used as an explanatory variable, the R&D intensity ratio and as an approximation of the firm's performance, the dependent variable they used the growth of sales. A GMM econometric model method for FE panel data was applied for testing for endogeneity of R&D . Results indicated that R&D intensity affects positively firm's performance.

Shin, et al. (2009), concluded that there is a positive and statistically significant relationship between R&D expenditure and the performance of firms. In their model R&D spending was defined as the independent variable, and gross profit measured profitability which approximated the firm's efficiency and it was the dependent

variable. Multiple regression analysis was used on a sample of 200 global electronic industries in the period 2000-2005.

A comparative study conducted by Rao et al., 2013in a sample of technology-intensive firms in China and Japan examined the impact of R&D expenditures measured as R&D investment spending on firm performance. They investigate a potential lag effect of R&D spending on firm's performance. They used both the logarithmic value of R&D expenditure and the R&D intensity ratio as explanatory variables, while for firm performance was approximated by ROE. Results revealed a positive relationship between the one lag value of R&D with firm's profitability.

Nunes and Serrasqueiro, 2015 studied the determinants of firm profitability in a sample of information-intensive companies in Portugal. A dynamic panel analysis was used and they concluded that there is a positive and statistically significant impact of R&D spending on profitability.

The importance of the R&D effect on profitability in the sector of information-technology was also pointed out by Doh and Prince, 2015. They conducted an empirical study on 40 USA based information technology firms, assessing the impact of innovation on revenue generation. R&D used as a proxy for innovation. They came to the conclusion that information technology firms which invest more on R&D expenditures generate more profits. They also found that investors evaluate higher companies that invest larger shares of their profits on R&D.

Gunday, Ulusoy, Kilic and Alpkan (2008) conducted a study covering 184 firms in the manufacturing sector in Turkey aiming at exploring the impact of innovation approximated by R&D expenditures on financial and production performance. Data was collected through a questionnaire mailed to those firms and a factor statistical

analysis shed light on the main determinants of innovation. Furthermore, they applied regression analysis on the model with results pointing out the positive relationship between innovative activity and profitability.

Contrary though with literature showing a positive relationship between innovation and profitability, Selcuk, 2016 indicated a negative relationship between R&D expenditures used as a proxy for innovation and profitability. The negative relationship implied that the positive spillovers of R&D investment spending cannot offset increasing costs reducing both net and gross profits.

Although, there is an extensive consensus on the positive impact of R&D expenditure on firm's profitability there is a debate on the exact nature of this relationship .Geroski and Machin (1992) and Geroskiet al. (1993) demonstrated the positive effect of innovation on firm-level profitability but they commented that this effect is relatively small and temporary. They claimed that indirect effects are greater and rather permanent. The innovation process instead may establish a rather long-lasting positive effect on firm profitability.

Cefis and Ciccarelli (2005), conducted a survey of 267 UK manufacturing firms for thd 1988-1992 period based on the idea that innovation activities strengthen the internal capabilities of firms. They reached three important results: there is a positive effect of innovation on profits that is slightly diminishing over time. There is a difference in profitability levels between innovators and non –innovators mainly when the comparison is between firms persistent in innovation activity and non innovator firms and lastly there is an established differentiation in profits meaning that innovators and non innovators are not converge to the same level of profitability indicating that innovators create specific capabilities and competencies due to

innovation activity. Overall, innovators show on average higher profits in the long-term. They have run a dynamic econometric model using four estimation methods i.e., Fixed and Random effect, OLS, and Bayesian methods.

Hajiheydari, et al.(2011) investigated the potential effects of R&D investment on the firm profitability of the world's top pharmaceutical companies for the year 2010. A regression analysis was applied and the results revealed a positive impact of R&D expenditure on operating sales and profitability. In addition, Roberts (1999) examining the main argument for the potential impact of R&D costs on firm profitability in the US pharmaceutical industry, he concluded that new products brought by US pharmaceutical firms provide a long-lasting high profitability at firm-level.

Nord (2011) examined the influence of R&D investment costs on firm's profitability in the US pharmaceutical industry. He selected the top 16 pharmaceutical companies and conducted a regression analysis. The main variables used in the model were the ratio of market value divided to firm revenues as a proxy to profitability and R&D intensity ratio. The argument developed in his study is that as R&D investment increases firm profitability increases too. Results confirmed this hypothesis made and a statistically significant relationship between those two variables was revealed.

The international financial crisis of 2008 affected severely economies across countries. Business performance is highly unstable under crisis and recession condition and so survival of firms cannot easily be secured (Lome, Heggeseth, Moen, 2016). R&D investments are regarded as expenditures for firms in the short-run and may be affected since firm survival is the primal goal for managers (Lome, Heggeseth, Moen, 2016; Wang, Ahmet, 2007). Although it is well known that R&D

plays a particular role for firm growth (Delmar and Wikland,2008) , existing literature is limited concerning the effect of R&D expenditure on firm performance during recession. Lome, Heggeseth, Moen, 2016 investigate the impact of R&D on firm performance in the light of financial crisis. They used a binary logistic regression for a sample of 247 manufacturing firms in Norway and found out that firms which invest in R&D activities perform better than other firms during the financial crisis of 2008.

Zuaghi, Sanchez and Martinez, 2018 conducted a study examining the impact of internal R&D activities on the innovation performance of high-tech and low-tech manufacturing firms in Spain during the period 2006-2013. In their analysis, they tried to figure out whether financial crisis moderate negatively the impact of R&D intensity ratio on innovation performance using interaction terms for R&D intensity ratio and financial crisis. They collected a sample of more than 28.000 observations categorizing them into high-tech and low-tech firms and they conducted a random-effects panel Tobit model for testing the hypotheses. Among their results, they concluded that positive effect of R&D intensity ratio on innovation performance is stronger during the years of financial crisis for high-tech firms (Zuaghi, Sanchez and Martinez, 2018).

Overall, the literature review shows a consensus over the positive relationship between R&D expenditures and firm profitability with the causality running from the former to the latter. Based on this consensus, the following research hypothesis may be stated:

H_1: Research and Development (R&D) intensity ratio have a positive effect on profitability in Greek pharmaceutical firms.

H_2: Research and Development (R&D) intensity ratio via the impact of financial crisis have a negative effect on profitability in the Greek pharmaceutical firms.

6.3Profitability and Firm Size

The size of the firm plays a principal role in firm level competitiveness and subsequently affects profitability in many ways. Key characteristics of a large firm are its potential to exploit economies of scale and scope, the standardization and formalization of the procedures, and the acquisition of a pool of resources, skills, and capabilities (Majumdar, 1997). These features accelerate large firms to operate more effectively and generate superior performance in comparison with smaller firms (Penrose 1959). There is an opposite–view in literature suggesting that larger firms face relatively inferior performances because of inefficiencies generated in the market. In addition, bigger firms are regarded more capital intensity (Hay and Morris, 1979) which means that bigger firms tend to have higher levels of operating leverage and are more vulnerable to economic slowdowns.

Theory and empirical research, therefore, is ambiguous on the precise connection of firm size and profitability. Specific approaches have been designed by scholars to classify the theories of firm size in order to shed light on this controversial relationship (Bauman and Kaen, 2003). Technological theories link firm size with the production process and focus on physical capital and economies of scale and scope as the determinants of firm size and by extension of profitability. Organizational theories relate firm size and profitability with organizational transactions costs and agency

costs. Institutional theories connect firm size to factors as legal systems, patent protection policies, market size and anti-trust regulation (Bauman and Kaen, 2003).

Despite these theories provide a wide range of insights on the linkage between firm size and profitability, there is no clear evidence whether this relationship is positive, negative or neutral. Contradictory empirical results could be explained as a result of different sample sizes, industries, time horizons, methods of measurement and indicators, and finally of different business environments.

Amato and Wilder (1985) studied the nature of the relationship between firm size and profitability in the US manufacturing sector. Because of the lack of high quality sample at firm level measuring the firm size, authors worked at an aggregate level in order to test the relative importance of firm size on profits. For measuring firm size, they divided their sample into groups according to the class of assets size. Firm size was measured as total assets in each size group divided by the number of firms in each group. Their results indicated that there is no statistical significant relationship between firm size and profitability. Majumdar (1997) concluded a positive relationship between firm size and profitability. He used a sample of 1020 Indian firms exploring the impact of firm size on firm level performance.

In line with the argument that firm size affects positively firm-level profitability, it is the work of Papadogonas (1999) who conducted a study in a sample of 3035 Greek manufacturing firms over a period between 1995 and 1999. His paper attempts to specify possible factors which affect the profitability of Greek manufacturing firms. The econometric results indicated that firm size affects profitability positively.

A potential relationship between firm size and profitability was tested by Lee (2009). His econometric technique is based on a FE dynamic panel data model to test

the above relationship in a sample of more than 7000 firms. He indicated that firm size played a vital role and affected profitability positively but there is no linear relationship between them.

Vijayakumar and Tamizhselvan (2010) explored the role of firm size on firm performance. A positive association between size and firm profitability was found out. In their model, they used different measures of firm size such as total sales and total assets and different measures for profitability such as profit margin and profit on total assets. The model was applied in a sample of 15 firms in India.

Maja and Josipa (2012) conducted a survey of Croatian firms about the effect of firm size on profitability with annual evidence from 2050 manufacturing firms during the period of 2002 to 2010 .For measuring profitability, authors used various ratios such as return on assets, ROE , profit margin while the natural logarithm of firm's total assets and the natural logarithms of numbers of employees were used as a measure for firm size. Their results revealed a positive but weak relationship between firm size and profitability

Liargovas and Scandalis, (2004) carried out a study in order to develop an adequate framework of firm competitiveness. Their analysis was based on a set of data of 102 Green firms operating in the manufacturing sector. A profitability measure was used to approximate firm competitiveness. Their results demonstrated that a variety of factors affect firm profitability and by extension firm competitiveness. Firm size is among of those variables which have a positive and statistically significant impact on firm profitability.

Firm size is a major determinant of competitiveness. On this basis the following hypothesis may be stated:

H_3: Firm size has a positive effect on profitability in the Greek pharmaceutical industry.

6.4 Profitability and Liquidity

Liquidity management is vital for every organization and firm in order to pay current obligations including operating and financial costs. Companies which may be unwilling or unable to borrow appropriate funds for financing R&D for generating new products and processes, they should secure substantial cash flows for maintaining an adequate R&D effort (Kamien and Schwartz, 1975). Liquidity and profitability are two major factors of the "corporate business cycle" (Kamien and Schwartz, 1975). Liquidity management refers to the ability of a company to meet its short term obligations such as operating and financial costs. The measurement of profitability and liquidity highlights the financial sustainability of a firm.

The investigation of the relationship between liquidity and profitability plays a vital role for firm' life since there is no possibility for firms to survive without securing the adequate levels of liquidity. According to Bardia (2004), liquidity management has turned into a substantial aspect of judging the firm performance and by extension firm profitability. Empirical evidence points out that there is need for efficient liquidity since both excessive and inadequate liquidity should be avoided. In the case of inadequate liquidity, liquidity risk implies that firms face increased probability to be unable to meet their obligations to creditors. On the other hand, excessive liquidity demonstrates cumulated unused assets which not bring profits to the firms.

The empirical literature has explored a potential connection between profitability and liquidity. Duan and Niu (2020), examine the effect of liquidity on bank profitability. Panel data of US banks were used in the study. Quartely data for a period from 2001 up to 2016 was used. The statistical analysis found out a positive impact of liquidity on bank profitability. This result holds for the period of financial crisis and normal periods alike.

Ehiedu (2014) conducted a study in order to test the hypothesis that there is a positive effect of liquidity on profitability. The survey conducted on domestic firms in Nigeria and secondary data was collected by the financial statements. The overall results of the study showed a positive correlation among those two variables.

Abuzar (2014) empirically tested the relation between profitability and liquidity in a sample of stock listed companies in Saudi Arabia. Liquidity was measured as current ratio and cash gap, and regression analysis was applied. The paper indicated a negative and statistically significant relationship between company's profitability and liquidity ratio. The explanation for the results referred to the fact that this relationship is more prone to firms with high current ratio and longer cash gap.

Tailab (2014) conducted a study aiming at giving insight to the factors that affect profitability of non- financial U.S firms. A variety of variables were used such as leverage, liquidity, firm age, firm size, sales growth and inventory. The sample of the firms consists of 100 American companies for a period of five years from 2009 until 2003. Secondary data was collected by annual financial balance sheet. Regression analysis shows a positive impact of liquidity on profitability.

According to Almajali and Alamro (2012), liquidity has a positive impact on the profitability of Jordan insurance companies. In their study, a sample of 25 Insurance

companies listed at Amman stock Exchange during the 2002 -2007period. A panel data analysis was used in the study. In line with a positive association between liquidity and profitability was the study of Pathirawasam (2003) who conducted a study examining the effect of firm-specific factors on firm performance within a sample of 102 listed at Colombo Stock Exchange during the period between 2008 until 2009. His results pointed out the positive association between quick ratio as liquidity approximation and firm performance.

On the other hand, there is strong evidence that liquidity negatively affects the level of profitability due to rather inefficient use of the cash conversion cycle by managers and because different components of liquidity such as accounts receivables, account payables etc. are not at in an optimum level (Lazaridis, Tryfonidis, 2006). Thus, a very high level of liquidity can affect negatively the profitability of the firm.

Based on the above-mentioned empirical literature, the relationship between liquidity ratio and profitability may be characterized as ambiguous, since there is evidence for both positive and negative relationship and also for both statistically and non statistically significant. Nevertheless, based on the majority of studies the following hypothesis may be based on:

H_4: Liquidity ratio has a positive effect on the profitability in the Greek pharmaceutical firms.

6.5 Financial Leverage and Profitability

Financial leverage indicates the firm's ability to meet its financial obligations. Financial leverage depicts the financial health of a firm and it is characterized as

booster of the firm performance. (Tahu and Susilo, 2017). Leverage shed some light upon the capital structure of the firm and it is considered as the key decision area for financial management. Every company asks for financial capital to operate its business. The level of debt and equity that refers to enterprise's capital structure has risk and return implications as well. Leverage or capital structure implies the way that a firm finances its operations and growth by utilizing different alternatives sources of funds. (Modigliani & Miller, 1958)

The mode of financial leverage presents a great variety by industry and by the business sector. There are many business and industry sectors which choose to operate with a high degree of financial leverage. Nevertheless, excessive level of leverage may lead to negative consequences for the company's performance.

Kumar et al.(2014)conducted a study on Bate India Limited company the largest foot wear retailer and industry leader company in India exploring the relationship between leverage, profitability and return of investments. Leverage was measured as the ratio of total debt to shareholders equity, and profitability was measured by the index of ROE. An OLS econometric analysis was applied and the results indicated a positive relation of leverage to profitability of a firm.

Tahu and Susiko(2017) examined the effect of leverage and liquidity to the firm performance in 30 manufacturing firms listed in the Indonesian stock exchange. Their results indicated a negative but not statistically significant relationship between leverage and firm performance.

Ibhagui and Olokoyo(2018), examined the empirical relation between leverage and firm performance by using firm size variable as threshold upon a certain size leverage is not negatively related to firm's profitability. For measuring firm performance,

certain indexes of profitability have been used. A panel data set of 101 listed companies in Nigeria during the period 2003 and 2007 was used. The main research question was whether the impact of leverage on firm performance depends on firm size. According to their results, there is a negative and statistically significant effect of leverage on firm performance for small-size firms but this negative effect tend to decrease as firm size grows and when firm size exceeds a certain level, this negative effect disappears.

An additional study has been conducted by Yoon and Jang, 2005 for exploring the relationship between leverage and profitability using ROE as proxy of profitability, in the American market between the period 1998 and 2003 using the econometric methodology of a panel OLS regression analysis. The found a positive link between leverage and profitability (Yoon and Jang 2005).

The way leverage is measures seems that differentiate the relationship between profitability and leverage. Abor (2005) conducted a study testing the link between leverage and firm profitability in a group of enterprises in West Africa and more precisely at Ghana's Stock Exchange for a five year period. He measured leverage using three different indexes and he ended to inconclusive results. More specific, his results revealed a negative relationship between the ratio of short-term debt to total assets and the profitability while there is a negative relationship between the ratio of long-term debt to total assets and profitability. Measuring leverage as total debt to total assets, results indicated a positive relationship between profitability and financial leverage.

In addition, Robb and Robinson (2009) and Ruland and Zhou (2005) confirm the positive relationship between leverage and profitability in line with the influential

paper of Modiglianni and Miller (1958) where it was argued that profitable firms indicated their quality by leveraging up, leading to a positive relation between leverage and profitability. More specifically, Robb and Robinson (2009) claimed that earnings from leverage are sizeable resulting to improving the firm's performance.

Empirical literature review demonstrates a negative relationship between leverage and profitability yet. Such studies are Fama and French (1998), Negash (2001) and Phillips and Sipahioglou (2004). In fact, Fama and French (1998) found a negative relationship between leverage and of profitability at firm level giving as a possible explanation that the level of leverage caused agency problems to a firm.

Notta et al. (2010) explored the factors affecting profitability of the food and beverages manufacturing firms in the Greek market and they found out a negative and statistically significant relationship between leverage and profitability. In line with Notta et (2010) study, Voulgaris and Lemonakis (2014) and . Liargovas and Skandalis (2004) resulted to a negative but statistically significant relationship between leverage and firm performance for the Greek manufacturing sector as well.

It is obvious from the above listed literature that there is not an empirical consensus on the nature of the relationship between leverage and profits at the firm level. Therefore, a twofold hypothesis may be stated:

H_5: Leverage ratio has a positive effect on the profitability in the Greek pharmaceutical firms.

H_6: Leverage ratio has a negative effect on the profitability in the Greek pharmaceutical firms.

6.6 Firm age and Profitability

Theoretical literature claims that older firms perform financially better than younger ones due to the fact that they are more experienced and exploit benefits stemming from "learning by doing"(Vassilakis, 2008) and they are not vulnerable to liabilities of newness meaning the higher risk of failure of younger companies at the starting point of their function. (Stinchcombe, 1965). A stream of though, suggests that older firms cannot deal with negative impacts on their financial performance because of "inertia effects" leading companies to be inflexible to new changes and adaption of the rapidly changing business environment (Barron et al, 1994).

However there is an extended empirical literature indicating that a negative relationship between age and profitability rate. Akben –Seluck (2016), examined the effect of age on profitability on 302 non-financial companies listed in Istanbul Stock Exchange between 2005 and 2014. A FE model with robust standard errors has been estimated. Results indicated a negative relationship between firm age and profitability measured as return on assets, return on equity and gross profit margin.

Majumdar (1997) using a large data set of 1020 Indian firms, explored the potential relationship between firm age and size with profitability. His results provided evidence for a negative relationship between firm age and the profit level.

On the contrary, Coad et al. (2013) documented in his study that older firms enjoy a positive relationship between firms' age and profitability. They analyzed a panel of Spanish manufacturing firms between 1998 and 2006 concerning the relation of profitability and age. They revealed that older firms enjoy higher profits and

productivity level. In addition, older firms have a greater capacity to turn sales growth into profit and productivity.

Agiomirakis et al., (2006) examine the effect of economic crisis on factors of profitability for the Greek tourism sector. The sample included 134 hotels for a time period covering the years 2006 until 2010. A panel GLS econometric method was used. Their results regarding age and profitability found a positive and statistically significant sign. Ghafoorifard et al. (2014) provided evidence that older firms have higher profitability listed in the in Tehran Stock exchange.

Empirical evidence is also. Therefore the following twofold hypothesis may develop:

H_7: Firm age has a positive effect on the profitability of Greek pharmaceutical firms.

H_8: Firm age has a negative effect on the profitability of pharmaceutical firms.

6.7 Capital intensity and Profitability

Capital intensity ratio often represents the operating leverage of a firm (Lee, 2010) and capital intensive firms tend to have high levels of operating leverage. A high volume of production is needed by capital-intensive industries for providing a sufficient return on investment. As a result, a change in sales in those industries may affect significantly profits and returns on investments (Reitenga, 2000).

Acknowledging that levels of capital intensity ratio vary across industries, pharmaceutical industry is considered as high capital-intensive. The capital intensity ratio is an important determinant of the industry's performance. In general, literature and empirical evidence in financial economics examine the linkage between the

capital intensity ratio and various other factors as firm performance, profitability, financial risk but there is no clear and conclusive result for this relation (Lee, 2010).

Capital intensive firms combining both financial and operating leverage face increasing risk in the case of an unexpectedly sales fall of. Capital intensity tends to increase risk because of a considerable part of total fixed cost and in cases of demand and sales fluctuations losses are expected to be much greater than in industries of relatively low capital-intensity.

Reitenga (2000) examined the effects of capital intensity ratio on market returns to chemical industry enterprises and she concluded in a positive relationship between them. The efficient use of already existed fixed assets may contribute to decreasing capital costs and therefore increasing returns. In conjunction with these findings, it is the study of Blacconiere and Pattern (1994) that showed a positive relationship between capital intensity and firm's value.

Lee (2010) examined the relation between capital intensity and firm performance in the U.S restaurant industry founding out a negative relationship between the two. Feeny (2010) analyzed the determinants of profitability in Australian firms. He found out a negative relationship between capital intensity and profitability in the majority of the examined enterprises but he pointed out that for some industries this relation turns into a positive one. Earlier studies concluded a negative relationship as well (Martin, 1983; Harris 1986).

Based on the discussion above, the following may develop:

H_9: Capital intensity has a positive effect on the profitability of Greek pharmaceutical firms.

CHAPTER 7 DATA THE MODEL AND VARIABLES

7.1 Data Selection

The Greek Pharmaceutical Industry is officially represented by the Hellenic Pharmaceutical Association. The member firms of the PEF were used as the main source for data collection for this dissertation. According to PEF, there are 46 pharmaceutical firms registered as official members. Statistical Classification of economic activities (NACE rev.2) of European Commission was used to represent domestic pharmaceutical industry in this dissertation. According to NACE rev2, in Greece, domestic pharmaceutical production is taking the code 21.1 *Production of Basic Pharmaceutical Products in Gree*ce (Eurostat, 2008) and all the collected firms of the sample are classified as 21.10. In this category, the following activities are included:

i. Drug production
ii. Production of chemical contraceptives for external use and hormonal contraceptives
iii. Production of medical diagnostic preparations, including pregnancy tests
iv. Production of radioactive in-vivo diagnostic agent
v. Biotechnology drug production.

For the purposes of this dissertation not all PEF member firms were included in the sample. More specifically, the following categories were excluded: domestic pharmaceutical firms producing medicines on behalf of third companies, companies operating as sales agents of foreign multinationals, and companies' operating simultaneously under the 20.2 and other classification codes were excluded. In addition, companies with no recorded data on R&D expenditure on their financial

statement were excluded from the sample even though some of these are considered as production units.

Annual financial and income statements from the ICAP-Hellas DATA PRISM database have been used for data collection for the 1998-2016 period. In order to complement the required data set and to fill possible year and other gabs of the initial data set, additional sources have been used as individual firm financial statements published in their official websites. In Greece, publication of financial statements is mandatory for all SA companies. Besides accounting-based and market-based variables have been constructed on collected data for the purpose of econometric analysis and hypothesis testing.

Overall, the sample consists of 13 firms for a time period from 1998 up to 2016 and it includes 247 observations in total. Although the PEF has 46 companies as official members, only 13 out of report a complete data set adequate for constructing the variables of the model. The selected firms mainly produce branded-generics medicines. The exact specification of the time period has been defined due to data availability. A main consideration for the sample collection was the data availability for R&D expenditures for the full period, i.d. 1998-2016 financial years.

7.2 The Model and Variables

In this subsection, it is analyzed the process of measuring variables of the econometric model. The theory of Accounting and Finance and Industrial Economics provide the appropriate scientific background for the construction and estimation of financial ratios other firm-specific variables respectively.

7.2.1 Financial Ratios: the use and utility

Following the Financial economics theory, the use of financial ratios is considered as the main technique for the analysis of financial and income statements. Financial ratios accelerate the diffusion of information and provide explicit and precise results concerning the business activity of a company (Alexander et al., 2005). Based on the system of financial ratios, the degree of efficiency of the various economic activities of the company is determined. Financial ratios assist scholars and managers to gain a wider insight about the future performance of the firm.

The specific nature of financial ratios is due to the fact that the ratio expressed either in absolute terms or as a percentage, provides new, different and independent information from the informative context of the initial accounting measures combined generating the financial ratio (Apostolou &Dimitras, 2010). The reasons for using financial ratios are rooted in the fact they are both objective measures and they are based on publicly available information (Balcaen and Ooghe, 2006; Dirickx, Van Landeghem, 1994)

For constructing the ratios in this dissertation, balance sheet, and income statements have been used. Specific rules were taken into account in order to increase the validity of the results. According to the financial ratios literature, a high financial ratio corresponds to a favorable situations while a low one to a more negative (Balcaen and Ooghe, 2006). Moreover, financial ratios cover all the activity sectors of the business unit , thus they allow for a broader analysis of each activity.

Nevertheless financial ratios have some limitation and they are open to criticism because they are limited to annual account information and they suffer from certain

drawbacks. Financial Ratio analysis provides past information while users need more current and future information while the calculation process of different ratios is not standardize (Balcaen and Ooghe, 2006). In addition, companies may select different financial reporting context which lead to different accounting results for identical transactions (Balcaen and Ooghe, 2006).

Despite the criticism, the importance of financial ratios and their meaning should not be questioned (Laitinen, 1994) in using them in time-series, cross-section and panel data analysis.

For the purpose of the present dissertation, firm competitiveness is approached through the following ratios: liquidity, solvency and profitability. All values are sourced in the financial balance sheets and income statements of the sample firms and they were initially in current monetary values. In order to remove the inflation effect nominal values have been transformed to constant values taking the year 2009 as the base year.

7.2.2 Dependent Variables

- **Measuring Profitability**

Based on the existing literature, profitability has been used as an indicator competitiveness at firm level (Collins and Preston, 1969; Gale, 1972;Haskel & Scaramozzino,1997; Anastasopoulos, 2004; Fischer and Schornber, 2007; Laureti and Viviani , 2010; Tailab, 2014; Lalinsky, 2013). For the purpose of this dissertation two financial ratios are constructed to measure profitability and, therefore, the competitiveness of a firm (Liargovas and Skandalis, 2004).

Gross profit margin (GPM): this financial ratio expresses the relation between gross profits and sales of a company. More specifically, it depicts the percentage size of the GPM in which the company sells its output and the way that the price of the output is determined by the latter (Balcaen and Ooghe, 2006). Therefore, a high gross profit ratio indicates the ability of a firm maintain its profits when a potential rise of production costs takes place. The formula for calculating gross profit margin is the following:

$$\textit{Gross Profit Margin} = \frac{\textit{Gross Profit}(\textit{Sales} - \textit{Costs of Goods})}{\textit{Sales}}$$

Return of Equity : It is a financial measure indicating the potential of a firm to generate profits. ROE links the profitability of a corporation with stockholders' equity.Generally, it is considered as one of the most valuable financial ratios for measuring profitability and efficient. Relatively high or low ROE vary significantly from one industry group or sector to another. (Moussou, Romec, 2014). A high ROE implies that a firm increases its profit creation without using more capital. A higher ROE is a better index showing an efficient use of equity capital comparing to a low ROE. Although a high ROE is a positive sign for the company, it is not always a good thing. When a company has higher ROE comparing the average ROE of similar companies in the sector then it may indicate a high debt. When it is used to compare one company to another similar company, the evaluation will be more meaningful (Alexander, D. et al 2005).Concerning the main goal of a firm to maximize its profit, this ratio indicates the degree in which this initial target may be succeed. The final

formula for computing ROE in which has been used in the econometric model of the thesis is the following:

$$\textbf{\textit{Return on Equity}} = \frac{\textbf{\textit{Net Profit}}}{\textbf{\textit{Average Total Equity}}}\textbf{\textit{(\%)}}$$

Those two financial ratios (GPM &ROE) have been selected as dependent variables in this model. Following much of the recent empirical literature, GPM and ROE are two of the most common indicators for profitability (Notta et al., 2010; Liargovas & Scandalis, 2010; Selcuk, 2016). Gross profit margin does not exhibits inflation bias (Selcuk, 2016) and ROEdoes not only estimates profitability but explores the capabilities of generating income with each assets.

7.3 Independent variables

- **Research and Development**

This dissertation uses Research and Development intensity as one of the main explanatory variables of the model and attracts the interest of the author to investigate its impact on the pharmaceutical firms of the sample. R&D intensity can be regarded as a one of the main indicators of innovation activity.(Nord, 2011). R&D intensity is measured by the ratio of an annual firm's expenditure on research and development divided by the annual firm's sales.

$$\textbf{\textit{R\&D Intensity}} = \frac{\textbf{\textit{annual R\&D expenditure}}}{\textbf{\textit{annual Sales}}}$$

This variable avoid the problem of measurement bias because it is not affecting by research perception. (Balcaen and Ooghe, 2006). Based on empirical results it is

expected that R&D intensity has a positive and statistically significant effect on profitability.

- **Liquidity ratio.**

This financial ratio refers to a debtor's ability to finance and pay off current debt obligations without increasing external capital (Liargovas& Skandalis, 2004). The main target of liquidity is to convert assets into cash quickly and with low cost and it shows the potential of the firm to manage working capital when kept at normal levels. Liquidity is also an important evaluator of the credit worthiness and investment worthiness. There are three types of common liquidity ratio: current ratio, quick ratio and cash ratio. In this dissertation the current ratio is used to measuring liquidity since current ratio takes into consideration all current assets (Goswami and Sarkar, 2011). The mathematical formula is as it follows:

$$\textbf{\textit{Current Ratio}}=\frac{\textbf{\textit{current assets}}}{\textbf{\textit{current liabilites}}}$$

According to Financial Accounting, current assets is considered the source of a company for running and growing its business(Lyroudi, Lazaridis Y, 2000). Current liabilities are defined as short-term financial obligations of a firm usually within one year or within a normal operating cycle. Literature,in general points out that liquidity has a positive effect on profitability (Gurbuz, Aybars and Kutlu, 2010). However, when liquidity is excessive the effect is negative (reference). In this dissertation a positive prospective is expected due to the fact that firms with a high liquidity ratio are characterized more profitable.

- **Capital Intensity**

The capital intensity ratio, indicates the operating leverage of an entity. Essentially, this metric informs researchers of how much capital is needed for producing one extra

unit of revenue. There are different ways of measuring the capital intensity ratio. In the existing literature (Blacconiere and Pattern 1994; Lee, 2010 ;Feeny2010; Reitenga (2000), this metric is measured by the ratio of total assets or fixed assets divided by total sales. In addition, an alternative way of measuring capital intensity, it is to construct a ratio putting the unit in the numerator and asset turnover ratio in the denominator. However, for the needs of this thesis the capital intensity metric is constructed as it follows:

$$\textbf{Capital intensity ratio (CAI)} = \frac{\boldsymbol{Average\ Total\ Asstes}}{\boldsymbol{Total\ Sales}}$$

- **Leverage Ratio**

The leverage ratio indicates the ability of a firm to accomplish its financial obligations and shows the financial health of the firm. It is a crucial financial measurement which expresses the debt accumulated by a firm (Makris, 2016). Stigliz (1969), claimed that if the level of debt increases, the value of the firm decreases because there is the risk of bankruptcy. A considerably high leverage ratio is associated with a greater risk of failure while a lower leverage ratio is associated with financial stability (Notta et all.2010). The existing empirical work shows a negative relationship between profitability and the leverage ratio(Assimakopoulos et al, 2009; Nunes et al.). However, it has also been argued that the leverage ratio can positively affect profitability (Lazar, 2016) In this dissertation, it is expected a negative relationship between the leverage ratio and profitability in line with the majority of empirical evidence which claims that leverage has a negative relation with profitability. The mathematical formula is the following :

$$\textbf{Leverage Ratio} = \frac{\boldsymbol{Total\ liabilities}}{\boldsymbol{Average\ total\ Equity}}$$

- **Size of the firm**

The size of the firm is a crucial element for investment decisions and affects considerably the financial performance and health of the company since it may have an impact on the competitive power of a firm (Sign et al, 2007). In this dissertation size of a firm has been calculated as the logarithmic transformation of total assets .Industrial economics theory suggests that large firms have more power and are ,more secure than small ones since the latter faces a more volatile and risky environment for investment decisions (Hay & Morris,1979). Theory shows that a potential increase in firm size may increase profits and competitive power since large firms may have competitive advantages comparing small ones (Sign et al, 2007). For the present analysis, it is expected a positive relationship between size of the firm and profitability.

- **Age of the firm**

Firm performance changes along the firm's life cycle (Coad, Segarra, Tereul, 2013). According to literature, older firms may take advantage of reputation effect which enable them to increase their margin on sales (Agiomirakis et al, 2006). At the same time though, older firms may suffer from a more rigid managerial structure and bureaucratic processes while younger companies are more flexible earning higher profits (Notta et al). Given that research evidence is inconclusive there is no definite expectation for the sing of this variable which may be either negative or positive. The age of the firm is measured as the logarithmic transformation of the number of years between the year of the firm's initial establishment until 2016.

- **Financial Crisis**

The period of the analysis, i.e., 1998-2016 includes the years when a tremendous financial crisis hit the Greek economy. It has been considered necessary to take into account the potential financial crisis effect in the econometric analysis. A dummy variable has been used in order to capture the effect of the crisis. The dummy variable takes the value of 1 for the years during crisis from 2010 until 2015 and 0 otherwise.

- **Lagged profitability**

The econometric model includes one year lagged profitability in order to examine the impact of the previous period profitability in the profitability of the current period. Generally, empirical research found out a positive relationship between the two. It is expected that positive profitability of the previous year may boost firm's growth in the current period. In this model this variable has been calculated as a one year lag of GPM ($GPM_{i,t-1}$) for model (1) and one year lag of ROE ($ROE_{i,t-1}$) for model (2).

CHAPTER 8 METHODOLOGY

8.1 Panel Data Analysis

The econometric technique chosen for conducting the empirical research is that of panel data analysis. Panel Data analysis or Longitudinal Data analysis observes a given sample of subjects, such as persons, households, firms, countries etc. over time (Frees, 2004). Panel Data analysis allows for the observation of a large number of subjects, unlike time series analysis which observes a single variable over time. Studying a wide cross-section panel of "agents" over time allow researchers to recognize dynamic aspects of a problem. This analysis combines features from time series and cross-sectional analysis together and has earned a vital role in the empirical literature and has evolved as a major subfield of econometrics.

Panel Data analysis presents strong advantages in comparison with pure time series or cross-sectional analysis alone.

- Using Panel Data analysis, estimation efficiency is increasing. This analysis contains more degrees of freedom and sample variability is larger than in cross-sectional or time-series analysis alone (Hsia, 2003)
- Panel Data analysis eliminates potential issues of multicollinearity since more observations are available (Hsia, 2003).
- Panel Data Analysis presents large capacity of analyzing and isolating the complexity of human behavior. More precisely, Panel Data analysis constructs and testes more complicated hypotheses, control the omitted variables and reveal dynamic relationships. In addition, it offers more precise and accurate predictions outcomes by pooling the data than other techniques.

- Panel Data analysis solves the problem of unobserved heterogeneity by certain transformations to the data.
- Panel Data analysis provides easier computations and inference.

There are some limitations in Panel Data analysis which are referring to specific issues as:

- There are difficulties in sample selection.
- It is regarded as a poor technique analysis when the main variables of interest do not vary over time.
- There is a possibility of measurement errors in the case of micro-data.

8.2 Unit Root Tests in Panel Data

The studies of Quah (1994), Breitung and Meyer (1994), and Levin , et all. (2002) accelerated the establishment of unit root test in a non-stationary panel, as a useful tool for econometric analysis. Dickey-Fuller and the Augmented Dickey-Fuller (ADF) classical unit root tests have been criticized because of their weak power on small samples and additionally because they lack power of distinguishing the unit root null hypotheses from stationary alternatives (Maddala & Wu, 1999). Consequently, Unit Root tests for panel data have been attracted the interest of scholars and they have been extensively applied for data where the number of time series observations were limited while the number of cross- sectional data was large. It should be referred that cross-sectional subjects could be households, firms, countries, regions and they are being shaped whether the analysis is conducting in microeconomic level or macroeconomic one. Panel data analysis allows for a large number of observations

where N →infinite for a given time T, in contrast to time series analysis where T→infinite for a given number of N.

According to Baltagi and Kao (2000) panel data analysis combines the strong elements of both cross sectional and time series analysis. Their claim enhances the standard unit root tests in samples with limited data. The reason that standard unit root tests show a low performance in panel data framework is the different null hypothesis which is appropriate in this context. For instance, it is assumed the basic model

$$\Delta y_{i,t} = \beta i y_{i,t} + u_{i,t} \qquad (8.1)$$

Where i= 1,2,…..,N and t= 1,2,…..,T. In the framework of time series analysis and in the case of one unit i, where i=1, the hypotheses which will be tested are the following:

$$H_o: \beta_1 = 0$$

$$H_1: \beta_1 < 0$$

On the contrary, when the framework of the analysis is based on panel data the combination of the tested hypotheses changes:

$$H_o: \beta_i = 0$$

$$H_1: \beta_1 < 0$$

where i= 1,2,…..N.

In recent years, econometric literature has developed a number of tests for unit root tests in panel data. Those tests have been classified into the two generations unit root tests. Unit root tests of first generation built on cross-sectional independence hypothesis.

After the influential work of Levin and Lin (1992,1993) and Levin, et al (2002) about the first generation Unit Root Test, numerous tests have been proposed concerning this independence of cross sectional units by Maddala and Wu (1999), Hardi (2000), Choi (2001), Levin, et al (2002) and Im, et al (2003).

Second Generation Unit Root Tests include tests which are characterized by the rejection of the independence hypothesis of cross sectional units. According to Chang (2002, 2004) who adopted the second generation tests, he proposed the use of non linear instrumental variables and the use of bootstrap approaches in order to solve the issue of cross-sectional dependency. The second generation includes two important categories. The first one is referring to factor structure approach. In this approach of tests are included those of Phillip and Sul (2003), Bai and Ng (2004,2005), Choi (2004), Moon and Peron (2004) and Pesaran (2007). The second one includes others approaches.

8.2.1 Levin, Lin and Chu Unit Root Test

Levin, Lin and Chu test has been formulated upon the total results of Levin and Lin studies in the decade of 1990. They generalized their test procedure taking into account the issues of autocorrelation and heteroskedacity. The procedure they followed was including the generalization of Quah model (1994) allowing the heterogeneity of the individual deterministic effects as the individual specific intercepts and the time trend. In addition, it is allowed the structure heterogeneity of error term auto-correlation supposing that the autoregressive parameters of first order are homogeneity. (Levin & Lin, 1992, 1993).

Initially, there is a stochastic process $\{y_{it}\}$ of panel with both cross sectional units i=1,2….N and each cross sectional unit contains t=1,…..T time series observations. It is of major importance to investigate whether $\{y_{it}\}$ is integrated for each cross sectional unit of the panel. As it has already mentioned in the case of a single time series, each individual regression may contain a deterministic like as an intercept term and a time trend. The stochastic process {yit} may consists of three possible models:

Model 1: $\Delta y_{it} = \beta y_{it-1} + v_{it}$

Model 2: $\Delta y_{it} = \delta\iota + \beta\, y_{it-1} + v_{it}$

Model 3: $\Delta yit = \delta i + \beta\, y_{it-1} + \gamma it + v_{i,t,}$ where $-2<\beta \leq 0$ for I = 1,….,N.

When the panel unit root test procedure uses the Model 1, it evaluates the following null hypothesis against its alternative:

$$H_0: \beta = 0$$

$$H_1: \beta< 0$$

When the panel unit root process uses Model 2, the series {yit} contains an individual-specific mean and the pair of hypothesis which is tested is the following:

$$H_o: \beta=0,\ \delta_i=0, \text{ for all cross sectional units i}$$

$$H_1: \beta< 0,\ \delta 1 \in R$$

Finally, in the Model 3 the series {yit} includes an individual- specific mean and a time trend. The panel unit root test process evaluates the following combination of hypothesis:

$H_0 : \beta = 0, \gamma_i = 0$, for all the cross sectional units, i

$H_1 : \beta < 0, \gamma i \in R$

Similar as in the case of a single time-series, if a deterministic element such as an intercept term or a time trend exists but it is not included in the regression then unit root test is considered as inconsistent. On the other side, If there is a deterministic element in the regression analysis but it is not observed in the data, then the statistical power of the unit root test will be eliminated. Campbell and Perron (1991) describe a method of assessing which deterministic elements could be included in the test process. The first hypothesis in their method has been built upon the fact that there is a term d_{mt} which illustrates the vector or the deterministic terms should be included in the regression where m is the index of the model, m= 1, 2, 3 and $d_{1t}= 0$, $d_{2t}=\{1\}$ and $d_{2t}=\{1t\}$.

A second assumption of the Unit Root Test is referred to the error process v_{it}. It is regarded that it is distributed independently among the cross section units and follows a stationary invertible ARMA (Autoregressive moving-average) for each cross sectional unit:

$$V_{it}= \Sigma_j^{\infty}= 1\theta_{ij}v_{it-j} +\varepsilon_{it} \qquad (8.2)$$

A third assumption focuses on each i= 1,2,…..N and t= 1,…..,T, so $E(v^4_{it}) <\infty$, $E(\varepsilon^2_{it})\geq B_e>0$ and $E(v2it) + 2\Sigma^{\infty}_{j=1}E (v_{it}v_{it-j})<Bv<\infty$. This assumption is known as the weak convergence of panel unit root test in Phillips (1987) and Phillips-Perron (1988).

The test procedure is structured in three steps starting with the main assumption:

$$\Delta yit = \delta\iota + \beta yit\text{-}1 + \Sigma^{pi}_{L=1}\theta_{iL}\Delta y_{it\text{-}L} + \alpha_{mi}d_{mt} + \varepsilon_{i,t}\ ,\ \ m = 1,2,3 \qquad (8.3)$$

Where the term pi is considered as unknown, it is proposed a three step procedure:

Step 1: Perform separate regressions Augmented Dickey Fuller (ADF)for each cross sectional panel unit.

For each cross sectional unit i, it is applied the ADF regression in (8.1):

$$\Delta yit = \delta\iota + \beta yit\text{-}1 + \Sigma^{pi}_{L=1}\theta_{iL}\Delta y_{it\text{-}L} + \alpha_{mi}d_{mt} + \varepsilon_{i,t}\ ,\ m = 1,2,3. \qquad (8.4)$$

The lag order pi is possible to vary across individual in the panel. According to Campell and Perron they proposed Hall method (1994) in order to select the appropriate lag level:

For a standard sample length T, it is chosen a maximum lag order $p_{max}$and then t-statics of $\theta_{iL}$is used for determining whether a smaller lag order should be selected. This statistics follows the standard normal distribution under the null hypothesis that $\theta_{iL}=0$, when $\beta_1=0$ and $\beta_i<0$. There is a regression between Δy_{it-1} and Δ_{yit-L} with L = 1,2….,p_i and the appropriate deterministic variables, d_{mt}. Afterwards, the residuals e_{it} and u_{it-1} are saved from these regressions which are:

$$eit = \Delta yit\text{-}\Sigma^{\,pi}{}_{L=1}\pi_{iL}\Delta y_{it\text{-}L}\text{-}a_{mi}d_{mt} \qquad (8.5)$$

$$u_{it\text{-}1} = y_{it\text{-}1}\text{-}\Sigma^{\,pi}{}_{L=1}\pi_{il}\Delta y_{it\text{-}L}\text{-}\alpha_{mi}d_{mt} \qquad (8.6)$$

For eliminating the heteroskedasticity across cross sectional units, residuals e_{it} and $u_{it-1}$are further normalized as $\tilde{e}it = \hat{e}it\hat{\sigma}$, $\tilde{u}it{-}1 = \hat{u}it{-}1\ \hat{\sigma}\varepsilon i$, where $\hat{\sigma}$ is the standard error of the regression (8.3).

Step 2: Assessing the ratio of long-run to short-run standard deviation.

Based on the null hypothesis of the unit root, the long run variable for each of the three models is estimating as following:

Model 1: $\hat{\sigma}_{yi}^2 = \frac{1}{T-1}\Sigma_{t=1}^{T}\Delta y_{it}^2 + 2\Sigma_{L=1}^{\bar{k}} w_{\bar{k}L}[\frac{1}{T=1}\Sigma_{t=2+L}^{T}\Delta y_{it}\Delta y_{it-L}]$

Model 2: The term Δy_{it} is replaced in the above equation with Δy_{it}- $\overline{\Delta y}_{it}$, where $\overline{\Delta y}_{it}$ is the mean value of $\Delta y_{it}$of each cross sectional unit i , so : $\hat{\sigma}_{yi}^2 \frac{1}{T-1}\Sigma_{t=2}^{T}(\Delta y_{it}-\overline{\Delta y})^2 + 2 \Sigma_{L=1}^{\bar{k}} w_{\bar{k}L}$ $[\frac{1}{T=1}\Sigma_{t=2+L}^{T}(\Delta y_{it}-\overline{\Delta y})\Delta y_{it-L}$

Model 3: In case that the data contains time trend, then the latter should be removed before the estimation of the long-run variance.

The reduction of lag parameter $\bar{K}$ depends on the data. Andrews (1991) proposes o process to determine the parameter $\bar{K}$ and to verify the consistency of $\hat{\sigma}_{yi}^2$. The sample covariance weights $w\bar{\bar{k}}L$ depend on the on kernel choice. If the Bartlett kernel is used, for instance, then: $w\bar{\bar{k}}L$= 1- $\frac{L}{\bar{k}+1}$. For each cross-sectional unit i, it is defined the ratio of the long-run standard deviation divided by the innovation standard deviation: $s_i = \sigma_{yi}/ \sigma_{ei.}$ The estimated value is $\hat{s}$= / $\hat{\sigma}_{\varepsilon i}$. The average standard deviation of the ratio is S_n= (1/N) $\Sigma_{i=1}^{N} S_i$ and its estimated value is $\hat{S}_N$ = (1/N) $\Sigma_{i=1}^{N} \hat{s}_i$. This important statistic will be used in order to adjust the mean of t-statistic (Levin, Lu, 1992)

Step 3rd: Compute the panel t-statistic.

In this step , a pool of cross-sectional and time series observations for estimation of the following equation with dependant variable $\hat{e}_{it}$=$\delta\tilde{u}_{it-1}$ + $\tilde{w}_{it}$ according to the total

number of N$\tilde{T}$, where $\tilde{T}$=T-$\bar{p}$-1 is the mean of the observations' number per individual unit of the panel and $\bar{p} \equiv \frac{1}{N}\Sigma_{i=1}^{N} p_i$ is the average value of time lag for the individual ADF regressions (Levin ,Lu, 1992). The conventional null hypothesis of t-statistic for testing the null hypothesis η=0 s given by the ratio:

$$t_\delta = \frac{\hat{\delta}}{s\hat{\delta}} \qquad (8.7)$$

where $\hat{\delta} = \frac{\Sigma_{i=1}^{N}\Sigma_{t=2+pi}^{T}\tilde{u}it-1\tilde{e}it}{\Sigma_{i=1}^{N}\Sigma_{t=2+pi}^{T}\tilde{u}2it-1}$, $s\hat{\delta} = [\Sigma_{i=1}^{N}\Sigma_{t=2+pi}^{T}\tilde{u}^{2}_{it-1}]^{-1/2}$ and $\hat{\sigma}\tilde{\varepsilon}^2$ =[$\frac{1}{N\tilde{T}}\Sigma_{i=1}^{N}\Sigma_{t=2+pi}^{T}(\tilde{e}_{it}-\hat{\delta}\tilde{u}_{it-1})^2$]. Under the null hypothesis that δ=0 , the asymptotic results indicate that t-statistic (t_n) follows a standard normal distribution at the model 1 but diverges to negative infinite for model 2 and 3. It is easy though the computation of the adjusted t-statistic:

$$t_\delta^* = \frac{t\delta - N\tilde{T}\hat{S}N\hat{\sigma}_{\tilde{\varepsilon}}^{-2}\, s\hat{\delta}\mu_{m\tilde{T}}^*}{\sigma_{m\tilde{T}}^*} \qquad (8.8)$$

where t_δις is the test statistic which depend on the estimator of δ, $\hat{\delta}$ and $\sigma_{m\tilde{T}}^*$ is the standard deviation ,$\hat{S}_N = (\frac{1}{N})\Sigma_{i=1}^{N}(\frac{\widehat{\sigma yi}}{\hat{\sigma}ei})$ with $\hat{\sigma}_{yi}$ to be the estimation of the long-run standard deviation of $y_i$and $\hat{\sigma}_{ei}$ is the long-run standard deviation of the disturbance error, μ_T^* is the average adjustment , and $\sigma_T^*$is the standard deviation. This adjusted t-statistic follows the normal distribution asymptotically.

8.2.2 Breitung Unit Root Test

Breitung (2000) proposed a pooled Unit Root Test which does not contain structural biased factors. Breitung (2000) generalizes thetest procedure in a model with heterogenic trends and short-run dynamics, yet has a limited power when the

trend parameter is heterogeneous across cross sectional units. This is the general conclusion for this test, which has been confirmed by Phillips and Sul (2004). The Breitung method presents some differences from LLC in two distinct ways:

- Firstly, the autoregressive portion is removed when constructing the standardized proxies and not the exogenous components
- Second, the proxies are transformed and trend is removed.
- The general model is the following:

$$\Delta y_{it}=a\ y_{it-1} + \Sigma_{j=1}^{pi}\beta_{ij}\Delta\ y_{it-1} + v_{i,t} \quad (8.9)$$

From the above model, it will be generated the errors parameter estimators in order to estimate:

$$\tilde{e}_{it}= \Delta y_{it}-\Sigma_{j=1}^{pi}\hat{\beta}_{ij}\Delta\ y_{it-1} \quad (8.10)$$

$$\tilde{f}_{it-1}= y_{it-1} - \Sigma_{j=1}^{pi}\hat{\beta}_{ij}\Delta\ y_{it-j-1} \quad (8.11)$$

In this stage of the process there is no correction for the mean or the trend. The variables $\tilde{e}_{it}$ and $\tilde{f}_{it-1}$ standardized with the standard deviation of the relationship in order to be estimated, $\hat{e}_{it}$ and $\hat{f}_{it=1}$ which are transformed as following:

$$e_{it}^{*}= \sqrt{\frac{T-t}{T-t+1}}\ \ (\hat{e}_{it} - \frac{1}{T-t}(\hat{e}_{it+1}+\ldots.+\hat{e}_{iT})) \quad (8.12)$$

$$f_{it-1}^{*} = (\hat{f}_{it-1} - \hat{f}_{i1}) - \frac{t-1}{T}(\hat{f}_{iT} - \hat{f}_{i1}) \quad (8.13)$$

This test is based on the following pooled regression:

$$e_{it}^{*} = \varphi^{*} + f_{it-1}^{*} + v_{i,t} \quad (8.14)$$

Test hypothesis are the following:

$H_0 : \varphi^* = 0$, there is a unit root

$H_1 : \varphi^* < 0$, there is stationarity

Breitung test is one-side test and developed a test statistic $t_{B,}$ which follows the normal standard deviation. Null hypothesis is rejected when $t_B < z$

8.2.3 Im Pesaran& Shin Unit Root Test

Im, Pesaran and Shin suggested a test which is upon the average of ADF statistics which are calculated in each cross sectional unit and follows the normal distribution. The test permits the heterogeneity across the cross sectional units with β as dependent variable factor having a lag order and this factor ıı suggested to be different in each cross sectional unit. In addition, it permits the autocorrelation and heteroskedasticity of the residuals and the existence of unit root in some cross sectional units. This specific test has been developed in order to loosen the restriction of the hypothesis of correlation of first order in LLC.

Initially, it is regarded a stochastic process $\{y_{i,t}\}$ of a panel cross sectional units i=1,2,….N and each cross sectional units which includes t=1,2,…,T time observations, and this stochastic procedure is estimated by an autoregression first order process. This test is applied in Model 2 of LLC:

$$\Delta y_{it} = \delta\iota + \beta\, y_{it-1} + v_{it} \qquad (8.15)$$

or the general form which is the following:

$$\Delta yit = \delta\iota + \beta yit\text{-}1 + \Sigma^{pi}_{L=1}\theta_{iL}\Delta y_{it-L} + \varepsilon_{i,t\,,m} = 1,2,3 \qquad (8.16)$$

Where i= 1,2,…,N, t= 1,2,……,T.

The hypotheses that are going to be tested are the following:

H_0: $\beta_i=0$, $\delta_i=0$ for all cross sectional units i

H_1 : $\beta_i< 0$,i = 1,2,…..,N_1, there is a stationarity for some cross sectional units

&

H_1 : $\beta_i= 0$,I = N_1 + 1,….N, there is a unit root for some cross sectional units

Therefore, there is a generation of model with a linear trend for each cross sectional units N. So instead of pooling the data as it occurred in LLC test, in this case unit root tests are separated for each single one cross section unit from the N units of the panel. The test estimates for each cross sectional units, one test statics t, t_{iT}(i= 1,2,…..,N), with E($t_{iT)}$ = μ and V ($t_{i,T}$) = σ^2 and it is assessed the mean value of t-statistics in order to be applied the IMP unit root test in the panel. Then, the t-statistics is the following:

$$\bar{t}= \frac{1}{N}\Sigma_{i=1}^{N} t_{i,T}(p_i) \qquad (8.17)$$

The $\bar{t}$ has a better performance when N and T are small. The standardized statistic is given in the following formula:

$$W_{tbar}= \frac{\sqrt{N}(\bar{t}- N-1\Sigma_{i=1}^{N} E[ti,T(pi)I\beta i=0)]}{N-1\Sigma_{i=1}^{N} Var[ti,T(pi)I\beta i=0]1/2} \qquad (8.18)$$

Where $\Sigma_{i=1}^{N} E[ti, T(pi)I\beta i = 0)]$ is the sum of the expected values of $t_{i,t}(p_i)$ and $\Sigma_{i=1}^{N} Var[ti, T(pi)I\beta i = 0]1/2$ is the sum of the variance of $t_{i,T}(p_i)$. The null hypothesis is rejected when the test statistic $IW_{tbar}I< z$.

8.2.4 Fischer Unit Root Test

Those test proposed by the Maddala and WU (1999) aconsist of an alternative approach of Fischer results (1932) in order to be generated test which are contrast probabilities values from other individual tests of unit root. Specifically, they suggested the use of a non parametric test as Fisher , which is based on the combination on the combination of probabilities values of the statistic tests for unit root presence in each cross sectional unit. Fischer and Im, Pesaran and Shin (IPS) (2003) tests combines' information which is based on individual test of unit root and and loosen the restrictive hypothesis of LLC test that β coefficient is mutual. Maddala and Wu (1999) indicated that IMP (2003) is a robust and precise test with which it is tested the significance of the results by N independent tests of one hypothesis and proposed this test which combines the probabilities values.

Fisher test is characterized as a precise and not parametric test which can be calculated for each random choice of unit root test in each cross sectional unit. It is assumed the following model:

$$y_{it}=d_{it} + x_{it} \qquad (8.19)$$

where i= 1,2,…..,N and t= 1,2,…..,T. Additionally, the dependent variable $\{y_{it}\}$ is a combination of a non stochastic process, $d_{it}$and a stochastic process, x_{it}which are analyzed in the two following relationships:

$$d_{it}= a_{i0} + a_i1+\ldots..+a_{imi}t^{mi} \qquad (8.20)$$

and

$x_{it}=p_i x_i(t-1) + u_{it}$, $u_{it} \sim I(0$ (8.21)

The hypotheses tested are the following:

H_0: $p_i= 1$, There is unit root,

H_1: $Ip_iI< 1$ for infinite number N, there is stationarity in series

It is supposed that $DF_{iTi}$is a statistic generated by the unit root test for the cross sectional unit i of the model (5.2) which follows specific hypotheses:

- As $T_i \rightarrow \infty$ then $DF_{iTi} \Longrightarrow DF_i$
- The term u_{it} is independent from u_{js} for all t and s observations , when $i \neq j$
- $N_{k/N} \rightarrow k$ as $N \rightarrow \infty$

Fischer Test uses the following formula to assess the test statistic which combines p_i from each cross sectional unit and it bases in the subsequent relationship:

$P= -2 \Sigma_{i=1}^{N} \ln(p_i) \rightarrow x_N^2$ (8.22)

Fischer test has some specific advantages comparing other unit root test since it can be used in a non-balanced panel and applied for each p_i from other unit root test and permits the use of different number of time lags per SDF regression.

8.3 Estimation of Panel Data

This subsection will analyze briefly two methodologies which have been applied to the present thesis. The first is the methodology of FEand it is included in the group of methodologies which estimate static panel data models. It is assumed that there is a sample of N cross sectional units and T time periods, then a linear model is described as:

$$Y_{it}=a_{it} + X'_{it}\beta_{it} + u_{it} \quad (8.23)$$

where i= 1,…..,N and t=1,…..,T. The terms $a_{it}$and β_{it} = ($\beta_{it1,.....,} \beta_{itK}$)' are two vectors 1X1 and KX1 dimensions which vary across cross section units and time periods. The term X_{it} = (X_{it1},…,X_{itK}) is the vector of exogenous variables with Kx1 and the term u_{it} is the error term which follows the normal distribution with mean 0 and variance σ^2 (Tsanana, 2016).

There are two hypotheses developed for the estimated regression coefficients of the relationship (8.23)

1. The parameters remain fixed across time but they can differ among the cross sectional unit.
2. The parameters are fixed for all cross-sectional units for a given time but they may vary across time , so as:

$$Y_{it}= a_t + X'_{it}\beta_t + u_{it} \quad (8.24)$$

8.3.1 Fixed Effect Estimation

It is assumed that the model (8.23) is written as it follows

$$Y_{it}= a+\beta_1 X_{it,1} + \beta_2 X_{it,2}+….+\beta_m X_{it,m}+u_{it} \quad (8.25)$$

where the variable $Y_{it}$is the dependent for i units, i=1,2,…N and t time observations , t=1,2,….T,

the term $X_{it,m}$refers to i cross sectional units , i=1,2,…N, m explanatory variables , m=1,2,…k and t time observations, t=1,2,…T.

The term u_{it}, is the idiosyncratic error term. Regarding the term u_{it} it can be said that:

$$u_{it} = \delta_i + \varepsilon_{it} \quad (8.26)$$

Replacing (8.25) to (8.26) the model has the following form:

$$Y_{it} = a + \beta_1 X_{it,1} + \beta_2 X_{it,2} + \ldots + \beta_m X_{it,m} + \delta_i + \varepsilon_{it} \quad (8.27)$$

In the above relationship the term δ_i includes the omitted individual characteristics for i=1,2,…N units and is defined as the unobserved heterogeneity. The term ε_{it} is the standard idiosyncratic normally and independently distributed disturbance term, known as idiosyncratic error.

The term δ_i of the function (8.27) defines whether the method will be fixed or random effects. The term δ_i is a parameter which will be estimated for each cross sectional unit (Tsanana, 2016). Based on the theory (Wooldridge, 2013, 5th edition) it is well-known that if the term δ_i which concentrates all the unobservable individual characteristics will be ignored, then the estimators are biased and inconsistent. In this case, the unobservable characteristics δ_i is correlated with the explanatory variable of the model. This problem could be eliminated with an alternative method, defining as the transformation of fixed effects. This transformation includes the estimation of the observation's deviation for each cross sectional unit by the respective mean of the cross sectional unit. This dissertation uses FE model for controlling for omitted variable bias.

Even there is an explanatory variable for each cross sectional unit i in the model, then from the general form of the model (8.27) it can be derived the following equation:

$$Y_{it} = a + \beta_1 X_{it,1} + \delta_i + \varepsilon_{it} \quad (8.28)$$

For each cross sectional unit i , it is calculated the mean of the equation (8.28), summing the time series t=1,2,…..,T and dividing then with the total number of sample T resulting in the following equation:

$$\bar{Y}_i = \alpha + \beta_1 + \bar{X}_{i,1} + \delta_i + \varepsilon_{it} \quad (8.29)$$

Where $\bar{Y}_i = \Sigma_{t=1}^{T} \frac{Yit}{T}$, $\bar{X}_{i,1} = \Sigma_{t=1}^{T} X_{it,1}/ T$ and $\bar{\varepsilon}_i = \Sigma_{t=1}^{T} \varepsilon_{it}/ T$

Calculating the deviations described above, it should be subtracting by parts the equations (8.28) and (8.29) so for each t:

$$Y_{it} - \bar{Y}_i = (\alpha-\alpha) + (\beta_1 X_{it,1} - \beta_1 \bar{X}_{i,1}) + (\delta_i - \delta_i) + (\varepsilon_{it} - \bar{\varepsilon}_i) \Rightarrow$$

$$Y_{it} - \bar{Y}_i = \beta_1 (X_{it,1} - \bar{X}_{i,1}) + (\varepsilon_{it} - \bar{\varepsilon}_i) \Rightarrow$$

$$\ddot{Y}_{it} = \beta_1 \ddot{X}_{it,1} + \ddot{\varepsilon}_{it} \quad (8.30)$$

where $\ddot{Y}_{it} = Y_{it} - \bar{Y}_I$, $\ddot{X}_{it,1} = X_{it,1} - \bar{X}_{i,1}$ and $\ddot{\varepsilon}_{it} = \varepsilon_{it} - \bar{\varepsilon}_I$is the time-deterministic observations for t=1,2,…T. The FEtransformation which is called the within transformation has eliminated the effect δ_i where includes all the unobservable characteristics. In addition it has also disappears the observable effects which are constant a. Then, a pooled OLS method is applied in (8.30) A pooled OLS estimator that is based on the time-demeaned variables is called FE estimator (Wooldridge , 2013) and uses the time variation on the dependent and explanatory variable for each cross-sectional observation. The general time-demeaned equation form for each cross-sectional unit i and is :

$$\ddot{y}_{it} = \beta_1 \ddot{x}_{it2} + \ldots + \beta_\kappa \ddot{\chi}_{itk} + \ddot{u}_{it}, \; t=1,2,\ldots,T \quad (8.31)$$

The statistical test for detecting the existence of the FE is the F-statistic and the test hypotheses are :

H_o: $\beta_1=\beta_2=\ldots=\beta_m$, the coefficients β are mutually statistical insignificant → there is no fixed effect.

H_1: $\beta_1\neq0$ or $\beta_2\neq0$ ….$\beta_m\neq 0$, the coefficients β are mutually statistical significant →there is fixed effect

The critical value of F-test is $F_{a\ (N-1),\ (NT-N-m).}$ If F is greater than F_a then the null hypothesis is rejected implying that there is a FEin the model. This Panel FEmethod.

8.3.2 Pooled OLS Estimation

The main assumptions for pooled OLS method to estimate consistent estimators of the parameter β are described as follows:

Assumption 1: $E(x_t' u_t)=0$ for t=1,2,…T.

Assumption 2: $[\Sigma_{t-1}^{T} E(\Sigma_{t-1}^{T} E(x_t' x_t]=K$

Based on the assumption 2, it can be said that the perfect linear dependencies between the predictor variables. The homoscedasticity and no serial correlation assumptions should be added in order to apply the pooled OLS regression.

Assumption 3: $E(u_t^2 x_t' x_t)=\sigma^2 E(\chi_t' x_t)$ for t observations t=1,2,…..,T and $\sigma^2=E(u_t^2)$ for all t.

The assumption 3 defines a clearly strong homoscedasticity and it can be expressed alternatively as $E(u_t^2|xt)=\sigma^2$for all time observations. Interpreting the assumption for

homoscedasticity, it can be said that the conditional variance does not depend on $x_t$but in addition the unconditional variance is the same across the time period.

Assumption 4: $E(u_t u_s x_s' x_s)=0$ where $t \neq ss$ and t,s=1,….,T. Assumption 4 basically restricts the conditional covariances of the errors across different time periods to be zero. The same assumption can be expressed as $E(u_t u_s \mid x_t x_s)$.

According to the theorem for Large Sample Properties of Pooled OLS, under the assumption 1 &2 the pooled OLS estimator the pooled OLS estimator is consistent and asymptotically normal (Wooldridge,2010). In case that the assumptions for homoskedasticity and no serial correlation hold, then $Avar(\hat{\beta})=\sigma^2[E(X_t' X_i]^{-1}/N$, so the appropriate estimator of Avar(($\hat{\beta}$) is

$$\hat{\sigma}^2 (X'X)^{-1}=\hat{\sigma}^2(\Sigma_{t=1}^{N}\Sigma_{t=1}^{T} x_{it}' x_{it})^{-1} \quad (8.32)$$

where $\hat{\sigma}^2$ is the usual OLS variance estimator from the pooled regression (Wooldridge,2010).

The F statistic test is used in order to test the linear restrictions on the K x 1vector β:

$$F=\frac{(SSRr-SSRur)}{SSRur} \cdot \frac{(NT-K)}{Q} \quad (8.33)$$

where $SSR_{ur}$is the sum of squared residuals and $SSR_r$is the regression using the NT observations imposing the restrictions (Wooldridge,2010)

Under certain assumptions, the method of pooled OLS estimator is able to obtain a consistent estimator of the parameter β in model:

$$y_{it}= x_{it}\beta+v_{it} \quad (8.34)$$

where t=1,2,…..,T and $v_{it} \equiv c_i + u_{it}$ for each t=1,…..,T is defined as the composite errors (Wooldridge,2010)For each t observation, the composite error $v_{it}$is the sum of the unobserved effect and an idiosyncratic error. The assumption for pooled OLS estimation in order to be consistent for equation….refers to the lack of correlation among the variable $x_{it}$and v_{it}, so $E(x'_{it}\ v_{it})=0$ and $E(x'_{it}c_{it})$(Wooldridge, 2010).

According to theory composite errors will be serially correlated because of the presence of the term c_i in each time period. The method of pooled OLS requires the robust variance matrix estimator and robust test statistics (Wooldridge, J., 2010). Therefore, it is important for the method of pooled OLS a large –N sample and fixed-T asympototics.

CHAPTER 9 EMPIRICAL RESULTS & ANALYSIS

9.1 Specification of Profitability Models

According to the Industrial Organization literature, the profitability of a firm is the result of either efficiency or market power. Empirical studies provide evidence that both efficiency and market power play a vital role for the firm performance (Oustapassidis et al. 2000; Notta et al, 2010). The following equation describes the above argument:

y_{it}^{*} =f (R&Dint, CAI, LIQ, LEV, LSIZE, LAGE, DummyCrisis,R&D*Crisis, L(1)GPM, L(1)RoE) **(9.1)**

where y_{it}^{*} is the dependent variables (GPM, ROE) and it is the desired level of the dependent variable. The y_{it}^{*} is the function of the determinants presenting in the equation (9.1).

A partial adjustment model is adopted. According to Bhattaracharya and Bloch 2000 and McDonald,1999 profitability is adapted in a long-term steady-state level as a result of the factors which affect the entry conditions of a firm to an industrial sector. Any possible deviation from the actual level of profitability towards the desired level results in changes in profits. This adjustment processes is presented in the algebraic formulae:

$\Delta y_{it} = y_{it} - y_{t-1} = k(y_{it}^{*} - y_{t-1})$ **(9.2)**

where Δy_{it} is the change in profitability between two periods. The parameter k measures the partial adjustment and takes the value between zero and one. Replacing the value of y_{it}^{*} in equation (10.2) and solving for y_{it} following dynamic equation is received

$y_{it} = k\beta_0 + (1-k)y_{it-1} + \beta_1 X_1 t + \ldots + \beta_n X_n t + u_t$ **(9.3)**

Based on the existing literature, profitability is affected by R&D expenditure and other firm –specific factors as size and age , financial ratios as liquidity and leverage ratios and other variables. In addition, taking into consideration the partial adjustment process the general form of the profitability equations to be estimated are the following:

Model 1: $\mathbf{GPM_{it} = \beta_o + \beta 1 RDint_{it} + \beta 2 GPM_{it-1} + \beta_3 LSIZE_{it} + \beta_4 LIQ_{it} + \beta_5 LEV_{it} + \beta_6 CAI_{it} + \beta_7 LAge_{it} + \beta_8 DCris + \beta_9 RD*Cris + u_{it}}$ **(9.4)**

Model 2: $\mathbf{ROE_{it} = \beta_o + \beta 1 RDint_{it} + \beta 2 ROE_{it-1} + \beta_3 LSIZE_{it} + \beta_4 LIQ_{it} + \beta_5 LEV_{it} + \beta_6 CAI_{it} + \beta_7 LAGE_{it} + \beta_8 DCris + \beta_9 RD*Cris + u_{it}}$ **(9.5)**

where the dependent variable in model 1 is the GPM for the firm i and year t. The independent variable with one time lag in the right side indicates the possibly impact of the profitability of the previous period on the profitability of the current one. There is empirical evidence that the profitability of the previous year affects positively ($\beta_2>0$) the profits of the current year (Oustapassidis, 1997, Notta , 2000) so a positive it sign is expected. R&D intensity ratio, liquidity ratio, capital intensity, and the size of the firm i for the year t are expected to have positive signs too[(β_1,,β_3, β_4, and β_6)>0)].

Age of the firm i for the year t is expected to have either negative or positive ($\beta_7>0$, $\beta_7<0$) sign in alignment with inconclusive empirical evidence. T he leverage ratio is expected to have a negative sign ($\beta_5<0$).The dummy variable is expected to have a negative coefficient ($\beta_8<0$).

An interaction term has been constructed and included in the two models. RD*crisis measures the marginal effect of RD intensity ratio on profitability through the impact of financial crisis on RD. The coefficient of RD*crisis is expecting to be negative ($\beta_{10}<0$) and a one-year lag of profitability (GPM_{t-1})has been used as independent variable for capturing the effect of the profitability of previous year in the current period in line with the theory. A positive coefficient is expected ($\beta 2>0$).

The term u_{it} is the disturbance error of the model and the parameters β_1,β_2, β_3, β_4, β_5,β_6,β_7, β_8, β_9 are the parameters of the explanatory variables and $\beta_0$is the constant variable.

Concerning the model 2, the dependent variable is the financial ratio, ROE for the firm i and the year t respectively. The profitability of the previous year is measured as ROE of the previous year. All other variables and the expected coefficient signs remain the same.

9.2 Descriptive Statistics Analysis

The following tables 18 and 19 present the descriptive statistics for the aforementioned variables of the model:

Table 18. Descriptive Statistics of Dependent Variables

Variable	GPM	ROE
Mean	0.558976	0.478187
Maximum	26.92166	108.0508
Minimum	0.069764	-28.10233
Std.dev	1.479844	7.124870

Source: Statistical Data Base, ICAP S.A and author's computations. Annual data have been used for the period 1998-2016.

Notes: GPM is the ratio of Gross Profit to total sales. ROE is the ratio of net profit before taxes to average total assets. The statistical package for the computations is EVIEWS9

Table 19. Descriptive Statistics of Explanatory Variables.

Variable	RDint	LIQ	LEV	SIZE	L(1) ROE	L(1)GPM	CAI
Mean	0.071807	2.149364	1.261544	7.157394	0.497078	0.566707	0.943395
Maximum	0.755564	64.08546	1.639772	8.576186	108.0508	26.92166	32.77743
Minimum	0.000959	0.036172	0.711389	4.640288	28.10233	0.069764	0.021199
Std.dev	0.133996	4.958771	0.296590	0.680567	7.320163	2.261688	2.990891

Source: Statistical Data Base, ICAP S.A and author's computations. Annual data have been used for the period 1998-2016.

Notes: RDint: the research and development expenditures to firm's sales. LIQ: The ratio of current assets to current liabilities. LEV: The ratio of total liabilities to average total equity. Size: the natural logarithmic of firm's total assets. CAI: The ratio of average total equity to sales. The statistical package for the computations is EVIEWS9.

Obviously, there are significant differences between the maximum and minimum values in both the dependent variables and the explanatory ones. The sizes of all the 13 firms of the sample seems to vary considerably. The variables with the largest difference among the maximum and minimum values are liquidity ratio, RD intensity ratio. Concerning the dependent variables ROE presents the greatest difference. The variable Age of the firm and the interaction RD*crisis have excluded since they are not present substantial information.

9.3 Unit Root Test of Model Variables

Table 20 shows the results from the five conventional unit root tests (Levin, Lin and Chu, Breitung, ADF-Fischer Chi Square, PP-Fischer Chi Square):

Table 20: Results of Panel Unit Root Test for the Dependent Variable

Unit Root Test		LLC	BREITUNG	IPS	ADF-Fischer	PP-Fischer
Variables	GPM	-4.83993 (0.0000)	-1.48257 (0.0005)	-2.05219 (0.0000)	46.8253 (0.0074)	40.1959 (0.0373)
	ROE	-5.59775 (0.0000)	-3.03259 (0.0000)	-5.58319 (0.0000)	122.180 (0.0000)	117.754 (0.0000)

Numbers in parenthesis includes p-values. Probabilities for Fisher tests are computed using an asymptotic Chi-square distribution. All other tests assume asymptotic normality.

Concerning the Unit Root test for the dependent variables, the null hypothesis assuming common Unit Root process it can rejected at 1% and 5% significance level. So, the alternative hypothesis for stationary at level can be accepted. Unit root tests have been conducted with including in the equation intercept term and/or time trend. The lag length was selected through the automatic selection based on the Schwarz info criterion.

Table 21: Results of Panel Unit Root Test for the explanatory Variables

Unit Root Test		LLC	BREITUNG	IPS	ADF-Fischer	PP-Fischer
Variables	RDint	-1.88112 (0.0300)	-	-4.44715 (0.0000)	68.0079 (0.0000)	61.0175 (0.0001)
	LIQ	-4.59803 (0.0000)	-	-3.07909 (0.0010)	57.1121 (0.0004)	56.8016 (0.0004)
	LEV	-1.95276 (0.0254)	-	-2.42096 (0.0077)	38.2370 (0.0476)	38.2370 (0.0476)
	LSIZE	-11.1110 (0.0000)	-5.06368 (0.0000)	-5.67168 (0.0000)	79.0884 (0.0000)	54.6138 (0.0000)
	RD*cris	-2.62339 (0.0044)	-	-3.36990 (0.000)	51.1008 (0.0023)	25.9158 (0.001)
	LAGE	-2.15527 (0.000)	-	-15.5781 (0.0000)	18.4207 (0.000)	18.4207 (0.000)
	CAI	-3.36654 (0.0004)	-2.23232 (0.0128)	-1.94388 (0.0260)	47.1478 (0.0068)	41.7361 (0.0261)

Numbers in parenthesis includes p-values. Probabilities for Fisher tests are computed using an asymptotic Chi-square distribution. All other tests assume asymptotic normality.

Concerning the Unit Root test for the explanatory variables of the model, the null hypothesis assuming the existence of common unit root it can be rejected at 1% and 5% significance level. So, the alternative hypothesis for stationarity at level can be accepted. Unit root tests have been conducted including in the equation intercept term and/or time trend. In case of unit root test with only intercept term the statistical package EVIEWS omits the values of Breitung test. The lag length was selected through the automatic selection based on the Schwarz info criterion.

Overall, the series of the model variables are stationary at level meaning that the problem of spurious regression in case of unit root cannot be an issue for these models. Consequently, the traditional multiple linear regression analysis can be applied since the results it is expected to be accurate.

9.4 Granger Causality Test

In this section unit, the direction of the relationship between the dependent variables (GPM, ROE) and the main explanatory variable the research and development intensity ratio is investigated, through the application of the Granger Causality test. The Granger causality test examines whether the information provided by the lagged values of one variable allows for a more accurate prediction of another variable's present value. It has to be pointed out that the Granger causality test does not establish causality direction between two variables but it causation rather indicates, that there is a correlation between the past values of one variable and the present value of another and to show the flow of information between series . For applying Granger Causality test the time series have to be stationary, which has been established in the previous section. Results are presented in the following Table 22 and 23:

Table 22: Results of Granger Causality Test for GPM and R&D intensity ratio

Number of Lags=2			
Null Hypothesis:	Obs	F-statistic	Prob
RDint does not Granger Cause GPM	221	1.64398	0.1956
GPM does not Granger Cause R&DINT		4.33392**	0.0143

Notes: asterisks *, ** and *** implies statistical significance at levels 1%, 5% and 10% respectively.

Table 23: Results of Granger Causality Test for GPM and R&D intensity ratio

Number of Lags=3			
Null Hypothesis:	Obs	F-statistic	Prob
RDint does not Granger Cause GPM	221	3.40521	0.0187
GPM does not Granger Cause R&Dint		3.72283	0.0123

Notes: asterisks *, ** and *** implies statistical significance at levels 1%, 5% and 10% respectively

Results show:1) the null hypothesis that the lagged value of R&D intensity ratio does not Granger cause profitability (GPR) for the significance level of 1%, 5% and 10% respectively including until 2 lags of the variables is not rejected (see table 22).

2) it is failed to accept the null hypothesis that the lagged value of GPR does not Granger cause the R&D intensity ratio for the significance level of 5% and, therefore the alternative hypothesis, H_1: GPR does Granger cause R&D intensity ratio. including until 2 lags of the variable is accepted (see table 22).

3) the null hypothesis that lagged value of R&D intensity ratio does not Granger cause GPR for the significance level of 5% including until 3 lags of the variables is rejected (see table 23)

4) it is failed to accept the null hypothesis that lagged value of GPR) does not Granger cause R&D intensity ratio for significance level of 5% and, therefore, the alternative hypothesis H_1: lagged value of GPR does Granger cause R&D intensity ratio including until 3 lags of the variable is accepted. Consequently, in this case the bidirectional causality is indicated (see table 23).

Table 24: Results of Granger Causality Test for ROE and R&D intensity ratio

Number of Lags=2			
Null Hypothesis:	Obs	F-statistic	Prob
RDint does not Granger Cause ROE	221	1.63030	0.1983
ROE does not Granger Cause RDint		47.2909*	0.0009

Notes: *, ** and *** implies statistical significance at levels 1%, 5% and 10% respectively

Table 25: Results of Granger Causality Test for ROE and R&D intensity ratio

Number of Lags=3			
Null Hypothesis:	Obs	F-statistic	Prob
RDint does not Granger Cause ROE	221	1.54361	0.2044
ROE does not Granger Cause RDint		23.9488*	0.0003

Notes: *, ** and *** implies statistical significance at levels 1%, 5% and 10% respectively

Based on the results of table 24 & 25, the null hypothesis that lagged values of R&D intensity ratio does not Granger cause the ROE for the significance level of 1%, 5% and 10% respectively including until 2 and 3 lags respectevely of the variables is not rejected. On the contrary, the null hypothesis that the ROE does not Granger cause the variable of R&D intensity ratio for significance level of 1% is not accepted and, therefore, the alternative hypothesis H_1: ROE does Granger cause R&D intensity ratio including until 3 lags of the variables is accepted confirming the unidirectional Granger causality, i.e the direction of causality is therefore from ROE to R&D intensity ratio.

9. 5 Results of empirical analysis

Tables 26 and 27 present the results of the empirical estimation of the models with gross profit margin and ROE as dependent variables respectively using two methodologies: the pooled OLS and the FE. The sample comprises of 13 Greek

pharmaceutical firms which conduct R&D and their expenditures on R&D are recorded in their balance sheet. The time period is 18 years from 1998 until 2016 and the total balanced panel of observations is equal to 234. The statistical package EVIEWS9 has been used for the analysis.

Table 26: Empirical Results of profitability equations. Dependent variable: Gross Profit Margin

	Pool.OLS		FE	
Model	(1)			
Variable	Coefficient	p-value	Coefficient	p-value
RDint	5.156570	0.0000*	5.820058	0.0000*
LIQ	-0.077998	0.0248**	-0.042587	0.2456
LSIZE	-0.537531	0.0151**	-2.295484	0.0000*
LEV	0.762885	0.0750***	1.822703	0.0009*
L(1)GPM	0.406840	0.0000*	0.341452	0.0000*
DCris	0.328681	0.1580	0.084913	0.7597
LAGE	0.682180	0.1797	6.612774	0.0003*
CAI	0.340258	0.0000*	0.290333	0.0000*
RD*Cris	-4.673299	0.0062*	-3.215222	0.0593***
R-sq	0.600379	-	0.673346	-
Adj R-sq	0.584323	-	0.640989	-
Prob(F-stat_	0.000000	-	0.000000	-
F-statistic	37.39237	-	20.80974	-
Obs.	234	-	234	-

Note: *, ** and *** implies the statistical significance at 1%, 5% and 10% level of significance respectively. EVIEWS9

Results of the empirical estimation of the model where profitability is measured by the gross profit margin ratio (Model 1) (see table 26) show that seven independent variables found to be statistically significant at 1%,5% and 10% level of significance. Two independent variables found to be statistically insignificant. The model (1) has a moderate explanatory power (adjusted R-squared =0.584323) using Pooled OLS while the application of the FE method improves the explanatory power of the model, i.e., adjR^2=0.640989. In addition, the F-statistic is highly statistically significant (p-value=0.000) both for Pooled OLS and FE.

Leverage has a positive and statistically significant coefficient at 10% level of significance for Pooled OLS while the FE method improves the statistical significance up to the 1% level of significance and the positive sign is maintained. The positive coefficient signifies that the leverage ratio under some specific conditions may increase profitability. The one year lag of gross profit margin has a positive and statistically significant at 1% impact on profitability using both Pooled OLS and FE methodologies. This finding is in line with the empirical literature and it denotes that an increase in profitability of the previous year may boost profits of the current year.

Size is entering the model with a negative and statistically significant coefficient at 5% and 1% level of significance with Pooled OLS and FE methodologies respectively. This result contradicts both theoretical and empirical literature where in most cases larger size leads to higher profits.

Capital intensity is statistically significant at 1% level of significance and has a positive coefficient for both methodologies. An increase in capital intensity is expected to improve profitability.

Age has a positive coefficient but it is statistically insignificant when using Pooled OLS, although when using the FE methodology the variable's coefficient turns to statistically significant at 1% level of significance while it maintains its positive sign. Liquidity is statistically significant at 5% level of significance with a negative coefficient when Pooled OLS is applied while is found to be statistical insignificant with the FE method.

The R&D intensity ratio is statistically significant at 1% level of significance with a positive coefficient for both Pooled OLS and FE methodologies. An increase in RD intensity is expected to cause an increase in profitability in line with results of empirical research.

The interaction term RD*Crisis has a negative and statistically significant at 1% coefficient in the model (1). This term indicates that the effect of RD intensity ratio on profitability has been negatively affected, i.e., reduced by the last financial crisis in Greece. So the marginal effect of the RD intensity ratio depends on the financial crisis in the following way:

$$\frac{dgpmi,t}{dRDi,t} = \beta_1 + \beta_9 \qquad \textbf{(9.6)}$$

When the FE methodology is applied the coefficientsβ_1 and$\beta_9$maintain their positive and negative signs respectively, thus there is a worsening effect of R&D expenditures on firm profitability due to financial crisis. A possible justification for this result is that in conjunction with the cost-contentment measures and fiscal

adjustments established in the health sector during financial crisis, R&D spending decreases profitability in the industry.

The Dummy variable for the financial crisis has a positive coefficient but statistically insignificant for both Pooled OLS and FE methodologies. The effect of financial crisis seems not to affect profitability in a direct way, the sign of dummy variable for crisis, but its effects is rather indirect through its impact on R&D intensity as it seems from the sigh of interaction term RD*Crisis. A possible explanation for this observation is that an uncertainty and turbulent environment during a financial crisis worsen the effect of investments in R&D on firm performance and increase a possible risk of failure for the Greek pharmaceutical industry.

Table 27 shows the results of the empirical estimation of model (2) where profitability is measured with the ratio ROE. Similarly, to model (1) the two methodologies of Pooled OLS and FE have been applied on the same panel data set 234 observations. The analysis conducted with the statistical package EVIEWS9.

Table 27: Empirical Results of profitability equations. Dependent variable: Return of Equity.

	Pool.OLS		FE	
Model	(2)			
Variable	Coefficient	p-value	Coefficient	p-value
RDint	3.443894	0.0030*	2.930258	0.0246**
LIQ	0.018962	0.6358	0.024540	0.5132
LEV	-1.451688	0.0014*	-0.226942	0.6919
L(1)ROE	0.360793	0.0613***	0.212461	0.2507
DCrisis	0.332114	0.1797	1.078443	0.0004*
LAGE	-0.585508	0.3055	-1.65911	0.0000*
CAI	-0.746557	0.0002*	-1.065545	0.0001*
RD*Crisis	-4.042178	0.0209**	-3.528066	0.0367**
SIZE	1.246964	0.0000*	1.416092	0.0008*
R-sq	0.379384	-	0.528840	-
Adj R-sq	0.348005	-	0.469235	-
Prob(F-stat_	0.000000	-	0.000000	-
F-Statistic	12.09021	-	8.872460	-
Obs	234	-	234	-

Note: *, ** and *** implies the statistical significance at 1%, 5% and 10% level of significance respectively. EVIEWS 9.

The explanatory power of the model is rather moderate, i.e., Adjusted $R^{2=}0.348005$ but the model is statistically significant, i.e., (Prob F-statistic=0.000) when the Pooled OLS methodology is applied while the FE methodology improves the explanatory power up to Adjusted R^2=0.469235 .The F-statistic is highly significant (Prob F-statistic=0.000000).

The R&D intensity ratio shows a positive coefficient using both Pooled OLS and FE methodologies, and it is statistically significant at 1% and 5% level of significance respectively. This finding confirms existing empirical evidence. The interaction term RD*Crisis has been found negative and statistically significant at 5% level of significance using both Pooled OLS and FE methodologies. The marginal effect of RDint on profitability which depends on the effect of economic crisis is the following:

$$\frac{dRoe}{dRDR}=\beta_1+\beta_9 Crisis \qquad \textbf{(9.7)}$$

So, taking into consideration the FE estimations, the coefficient of β1 (2.930258) is positive and β9is negative (-3.528066), this means that the effect of R&D intensity ratio on profitability becomes rather negative during the financial crisis.

Size has a positive and statistically significant coefficient at 1% level of significance for both the two methodologies. It is interesting to note that Size in with model 1 has a negative and statistically significant coefficient. In the case of model (2) the positive coefficient confirms past empirical evidence and asserts that an increase of the firm's size is expected to cause an increase in profitability.

Leverage has a negative coefficient and it is statistically significant at the1% level of significance for Pooled OLS. This finding means that an increase in the leverage ratio of a firm will decrease profitability. Using FE methodology, leverage becomes statistically insignificant.

Three variables (Dcrisis, Age and Liquidity) are statistically insignificant using the Pooled OLS in model (2). Using FE, age turns to statistically significant at the 1% level of significance, and it has a negative coefficient implying that the older the firm

is, the lower its profitability becomes. In line with the empirical literature, this variable has an uncertain effect on profitability (Agiomirgiannakis et al., 2006). A negative sign indicates that older firms may develop bureaucratically routines which prohibit them from increasing their profitability. The dummy variable for financial crisis turns to statistically significant at 1% level of significance when the FE methodology is applied and has a positive coefficient indicating that financial crisis is a positive factor. A possible explanation for this result may be the significant increase of exports by the Greek pharmaceutical industry during the period of financial crisis (IOBE, 2019) in order to offset the loss of the measures of fiscal adjustment which affect negatively sector's profitability.

Capital Intensity ratio coefficient is negative and statistically significant at the 1% level of significance using both methodologies. The negative coefficient implies that an increase in capital intensity is expected to reduce profitability.

Empirical analysis is complemented with the application of tests for detecting the presence of heteroskedasticity and autocorrelation

Based on the White[4] test for heteroskedasticity, the null hypothesis for equal variances of the errors ($H_0= \sigma_i^2=\sigma^2$) is rejected (p-value=0.000) for model (1) for both methodologies. Thus, model (1) suffers from heteroskedasticity. Table 28 presents the results:

[4]White test for Heteroskedasticity proposed by Halbert White in 1980 and it is used to detect heteroskestic errors in the regression analysis.

Table 28: Wald test for Heteroskedasticity. Model (1). Dependent variable: gross profit margin

Wald test for Heteroskedasticity Null Hypothesis: Homoskedasticity	Asymptotic Statistic Test: Chi^2	p-value
Pooled OLS	1803,93	0.000
FE	2270,44	0.000

Note: GRETL Statistical Package

Table 29: Wald test for Heteroskedascticity. Model (2) Dependent variable: Return of Equity

Wald test for Heteroskedasticity Null Hypothesis: Homoskedasticity	Asymptotic Statistic Test: Chi^2	p-value
Pooled OLS	112,701	0.000
FE	82,0052	0.000

Note: GRETL Statistical Package

Table 29 indicates that model (2) suffers from heteroskedasticity as well for both methodologies. Wooldridge autocorrelation test has been applied additionally in order to detect potential issues of autocorrelation in panel data. The following tables present the results:

Table 30: Test for autocorrelation. Model (1). Dependent variable: gross profit margin

Wooldridge Test for autocorrelation Null Hypothesis: No-first order autocorrelation	Test Statistic (12)	p-value
Pooled OLS	t(12)=34,0864	0.003
FE	F(1,12)=30.2938	0.000

Note: GRETL Statistical Package

Table 31: Test for autocorrelation. Model (2). Dependent variable: Return of Equity.

Wooldridge Test for autocorrelation Null Hypothesis: No-first order autocorrelation	Test Statistic (12)	p-value
Pooled OLS	t(12)=2,46368	0.029
FE	F(1,12)=16,6878	0.001

Note: GRETL Statistical Package

Tables 30 and 31 report the existence of autocorrelation in models (1) and (2) for Pooled OLS and FE methods. Therefore, the assumptions for homoskedasticity and no autocorrelation are violated and consequently models (1) and (2) are not efficient models they cannot be used.

In this case, the methodology of Feasible Generalized Least Square (FGLS) estimation will be used correcting for autocorrelation and heteroskedasticity ((Mwangi, Makau and Kosimbei, 2014; Kalsie and Shrivastav,2016; Aquino and Poshakwale, 2007).Table 32 and 33 presents the results for the estimation of profitability (gross profit margin and return of equity) with the FGLS method.

Table 32: Empirical Results of profitability equations. Dependent variable: Gross profit margin.

Feasible Generilized Least Square		
Model (1)		
Variable	**Coefficient**	**P-value**
RDint	4.418213	0.000*
LIQ	-0.0832838	0.001*
LEV	0.0179667	0.145
L(1)GPM	0.3509014	0.000*
DCrisis	0.6194644	0.021**
LAGE	0.0268696	0.963
CAI	-0.1793493	0.141
RD*Crisis	-3.678953	0.000*
SIZE	-.7296669	0.001*
Wald chi2(10)	186.45	
Prob> chi2	0.0000	
Log likelihood	-473.7635	
Panels	Homoskedastic	
Correlation	No autocorrelation	
Numb of Obs	246	

Note: *, ** and *** implies the statistical significance at 1%, 5% and 10% level of significance respectively. STATA 12.

Table 32 reports the results after the estimation of profitability equation with gross profit margin as dependent variable. The FGLS method applied as a solution for the

diagnostic problems of the previous two methodologies. Panels are homoscedastic and there is no autocorrelation. Wald chi2 for 10 degree of freedoms is equal to186.45 and the model is highly significant (Prob> chi2=0.000).

The independent variable RD intensity ratio is statistically significant at 1% level of significance and has a positive coefficient. Comparing with the other two methodologies, this variable was statistical significant also and the coefficient was positive as in FGLS. The positive sign in FGLS indicates that an increase in R&D intensity ratio expenditures will increase profitability.

According to (9.6) the marginal effect of RD on profitability which depends on the effect of financial crisis is negative demonstrating that the effect of RD intensity ratio in profitability becomes more damaging because of the financial crisis. Overall, this interaction term was statistically significant in model (1) using all three methodologies.

Liquidity has a negative coefficient and it is statistically significant at 1% level of significance. Liquidity ratio was shown as statistically insignificant in model 1 except in the case of Pooled OLS. A negative coefficient signifies that an increase in current liquidity will decrease profitability. In addition age of the firm is statistically insignificant and has a negative coefficient in this model. It seems that after the correction of heteroskedasticity and autocorrelation, this variable can not affect profitability.

Leverage is statistically insignificant in this model using the FGLS estimation method. The dummy variable for economic crisis is statistically significant implying that crisis may affect positively profitability since its coefficient is positive.

Size has a negative coefficient and it is statistically significant at 1% level of significance. The negative coefficient indicates that an increase in size will decrease profitability. Industry-level factors may are responsible for this finding. The one year lag of gross profit margin shows a positive coefficient and it is statistically significant at 1% level of significance indicating that the profitability of the previous year boosts the profitability of the current period. Capital intensity ratio is statistically insignificant using the FGLS method.

Table 33 reports the results of the FGLS regression of profitability equation using ROE as dependent variable.

Table 33: Empirical Results of profitability equations. Dependent variable: Return of equity.

Feasible Generalized Least Square		
Model (2)		
Variable	**Coefficient**	**P-value**
RD	5.70057	0.000*
LIQ	0.0673899	0.067**
LEV	0.1616158	0.000*
L(1)ROE	-0.0064449	0.007*
DCrisis	0.1883577	0.623
LAGE	-1.202556	0.146
CAI	-1.591211	0.000*
RD*Crisis	-7.162665	0.007*
SIZE	0.4004443	0.028
Wald chi2(10)	116.30	
Prob> chi2	0.0000	
Log likelihood	-562.7416	
Panels	Homoskedastic	
Correlation	No autocorrelation	
Numb of Obs	246	

Note: *, ** and *** implies the statistical significance at 1%, 5% and 10% level of significance respectively. STATA 12.

According to table 33, R&D intensity ratio is positive and statistically significant at 1% level of significance. The positive coefficient denotes that the increase of RD

intensity is expected to increase profitability. The main variable of this model has been found positive and statistically significant when profitability is measured both with gross profit margin and ROE indicating the importance of R&D in determining profitability. The interaction term RD*crisis has a negative and statistically significant coefficient at 1% level of significance. The marginal effect of RD on profitability turns to negative because of the financial crisis.

Liquidity has a positive coefficient and it is statistically significant at 10% level of significance. An increase in liquidity ratio is expected to affect positively profitability. Size of the firm is positive and statistically significant at 5% level of significance. The dummy variable for economic crisis is statistically insignificant. This result signifies that economic crisis may not affect profitability. In addition, age of the firm is statistically insignificant as well. One year lag of profitability measured as L(1)ROE shows a negative impact on profitability of the current year since its coefficient is negative and statistical significant at 1% level of significance. Leverage is statistically significant at 1% level of significance and affects positively profitability while capital intensity is found negative and statistically significant at 1% level of significance.

9.6 Discussion of the results and Hypothesis testing

The profitability equations have been constructed using two main dependent variables, gross profit margin and return on assets. The explanatory variables are nine and they have been selected on the basis of the empirical literature. Pooled OLS and FE methodologies have been applied for estimating profitability equations. Diagnostic tests for heteroskedasticity and autocorrelation have been applied in both equations and for both methodologies used, i.e., Pooled OLS and FE. Because of the existence of heteroskedasticity and autocorrelation, it has been decided the use of the FGLS .

FGLS estimation was conducted because of the specific violations of classical linear regression assumptions; the variance of the errors varies from one cross-sectional unit to another and so the classical assumption of homoskedasticity was violated. In addition, auto-correlation were present in the model. FGLS method allows estimations of models with heteroskedasticity across panels and first-order autocorrelation within panels. (Mwangi, Makau and Kosimbei, 2014; Kalsie and Shrivastav,2016; Aquino and Poshakwale, 2007). The results which they emerged are the following:

The explanatory variable RD intensity ratio has been found positive and statistically significant in both cases, i.e., profitability is measured with gross profit margin (GPM) and, ROE. This positive relationship reveals the essential role of R&D and by extension innovation in the profitability of the firms in the pharmaceutical industry. This finding reveals a strategic opportunity for the Greek pharmaceutical industry to exploit the highly educated personnel available in the country organize, manage, and execute innovation and engage in research programs and co-operation with research institutes. The state should provide the institutional framework for those companies in order to boost their investments in R&D. The mechanisms of rebate and claw back which subtracts a significant percentage from their revenues should be revised by the state authorities and a percentage should be redirected into R&D investments by the Greek pharmaceutical firms.

Therefore, the econometric findings, verify the first research hypothesis, i.e., H_1: Research and Development expenditures have a positive effect on profitability in the Greek pharmaceutical firms.

An interesting result is about the effect of the interaction term RD*crisis, which has been constructed and introduced to the analysis in order to investigate the indirect,

through the R&D intensity ratio influence of the financial crisis of the 2010-15 period. This interaction term's coefficient was found negative and statistically significant for both equations, i.e., with GPM and ROE dependent variables. Institutional changes reflecting to the reduction of pharmaceutical expenditure have been imposed as part of the fiscal adjustment program. In turn, this lowered total revenues and the profit margin of the Greek pharmaceutical firms, thus diminishing the positive effect R&D expenditures might have to profits. Therefore, the second research hypothesis is accepted:

H_2: Research and Development expenditures via the impact of financial crisis have a negative effect on profitability in the Greek pharmaceutical firms.

Regarding the impact of Size on profitability there are two contradictory results: in model (1) where profitability is approached by GPM there is a negative and strongly statistically significant relationship while in model (2) the impact is positive and statistically significant, although at a lower level of significance, i.e., 5%. These findings are rather contradictory. Industrial economics theory explains that large firms achieve increasing profitability through the exploitation the of advantages economies of scale economies, thus for increasing profitability and additionally a large firm is less risky achieving lowering both average production costs of production and capital cost. However, inter-industry structural factors affect small and large firms in a different way and profitability may vary because of the economies of scale. In the case of this dissertation though, The explanation of this contradictory result may be the different way of profitability ratios' construction. Therefore, concerning the model (2) the hypothesis H_3 is accepted while for model (1) the same hypothesis H_3 is rejected:

H_3: Firm size has a positive effect on the profitability in the Greek pharmaceutical firms.

With respect to the impact of liquidity, this research recorded a negative and strongly statistical relationship between profitability and liquidity in the case that profitability is measured as GPM. This negative relationship indicates that a high liquidity ratio may be a sign of financial mismanagement affecting negatively the profitability. This result is in line with the survey of Perobeli, Pereira and David (2007)where they indicated a trade off between liquidity and profitability. The greater use of resources in current assets, the lower the profitability for a firm despite a lower solvency risk. In addition, the decision of reducing liquidity and by extension risk may lead to lower profits since higher risk increases the returns (Arnold, 2008).

Thus, when profitability is measured as GPM the fourth hypothesis of the thesis is rejected:

H_4: Liquidity ratio has a positive effect on the profitability in the Greek pharmaceutical firms.

On the other side, when profitability ratio changes to ROE, the impact of liquidity ratio on profitability is positive and statistical significant at 10%. A positive relationship shows that a high liquidity ratio verifies financial strength an element which is vital for the business survival. A high liquidity implies that the firm has the ability to convert quickly assets into cash, ensuring the required liquidity and covering more easily debts. Based on this result, the fourth hypothesis is accepted:

H_4: Liquidity ratio has a positive effect on the profitability in the Greek pharmaceutical firms.

Leverage ratio in model (1) has a positive but no statistical significant impact on profitability while in model (2) there is a positive and statistical significant impact on the dependent variable. The different way of measurement of profitability may play a role for the different results. The findings in model (2) are consistent with the empirical research where leverage ratio up to an optimal level can affect positively the profitability and help to boost firm growth. Leverage ratio can affect positively firm's profitability up to a certain point where marginal benefits from debt equals marginal loss of bankruptcy costs (Cheng, Tzeng, 2011). Therefore, for model (1) hypotheses H_5 and H_6 are rejected while for model (2) the hypothesis H_6 is rejected and the hypothesis H_5 is accepted:

H_5: Leverage ratio has a positive effect on the profitability in the Greek pharmaceutical firms.

H_6: Leverage ratio has a negative effect on the profitability in the Greek pharmaceutical firms.

The age of the firm was included in both models since is firm-related factor that affects profitability as empirical studies have been indicated. Nevertheless, in this empirical study, age has a statistical insignificant impact on profitability. So, for both model (1) & (2) the next hypotheses are rejected:

H_7: Firm age has a statistically significant positive effect on the profitability in the Greek pharmaceutical firms.

H_8: Firm age has a statistically significant negative effect on the profitability in the Greek pharmaceutical firms**.**

Capital intensity is entering in the model (1) with a negative but is statistical insignificant and there is no impact on profitability when it is measured by GPM. So, the hypothesis H_9 is rejected.

H_9: Capital intensity ratio has a positive effect on the profitability in the Greek pharmaceutical firms.

On the contrary, in model (2) there is a negative also but statistical significant relationship between capital intensity and profitability. Although the efficient and intensive use of capital assets is expecting to increase the profitability, in this case the negative sign may be explained by the fact that those firms need more assets in order to generate revenue increasing at the same time operational costs and depreciation. Therefore, for model (2) hypothesis H_9 is rejected:

H_9: Capital intensity ratio has a positive effect on the profitability in the Greek pharmaceutical firms.

The models (1) and (2) have been enriched with two additional variables, the one year lag of profitability and a dummy variable for capturing the effect of economic crisis. In model (1) one year lag for profitability ($GPM_{i,t-1}$) has a positive and statistical significant coefficient and it is consistent with the empirical literature (Nottaet.al, 2000). On the other side, in model (2) the one year lag for profitability ($ROE_{i,t-1}$) was negative but statistical significant. It is suggested that the different measurement of profitability affects the sign of the coefficient. Another possible explanation suggests that the negative relation can be based on the fact that pharmaceutical companies invest heavily on R&D projects. A decision for investment in a new R&D project can be made after a year when high net income is achieved. This is because the company in this case has the opportunity to retain the net income,

or at least a high portion of it, and invest it to research and development projects of the upcoming years. The R&D projects will increase the expenses of the next year and the higher expenses will decrease the net income of the following year. As a result the return on equity of the following year will be lower too. This procedure may be an explanation of the negative relation between return on equity of year (t) and year (t-1).

Lastly, the coefficient of dummy variable is positive in both models but only in model (1) is statistical significant. However, the positive sign is an interesting finding denoting that economic crisis in Greece increased profitability. The Greek pharmaceutical industry has been developed an outstanding export activity during the last decade generating revenues which offset losses from the crisis in the internal market. It is undoubted that these two variables reinforced the accuracy of the results.

To sum up, it is obvious from the conclusions that the different measurement of profitability leaded to different results for the explanatory variables. Although GPM and ROE are profitability ratios, they estimate in different way profitability. The results though are in line with other empirical works (Notta et al.,2000; Voulgaris and Lemonakis, 2014; Liargovas and Skandalis, 2004) which signifies that results do not vary according to econometric method. Research and Development intensity ratio impact is an interesting and strong evidence that its role should be strengthen more for the industry survival.

CHAPTER 10 CONCLUSIONS

10.1 Conclusions and Limitations

The aim of this thesis is to give prominence to the role and effect of R&D and other factors to the competitiveness of the Greek pharmaceutical firms. According to IOBE and ICAP GROUP reports, this industry plays a vital role for the Greek economy and holds a dominate position in the processing industry in Greece contributing significantly in all the basic sizes of the Greek economy. In addition, Greek pharmaceutical industry reveals a great extent of adaption and it was one of the sectors that had the least loss in terms of employment and value-added during the financial crisis in Greece.

The concept of firm competitiveness provided the theoretical framework of the study. It has been presented a plethora of definitions about firm competitiveness and techniques for its measuring, addressing an overall issue's analysis. It has been highlighted the importance of profitability, market share, productivity and efficiency as a major determinants of firm competitiveness. RBV has been additionally employed as a managerial framework in this chapter in order to explain how the change of attention from industry structure towards the firm resources increase firm's competitiveness.

In chapter three, it has been presented the theoretical context of innovation, its driving factors and the relationship of competition with innovation. Innovation is considered as powerhouse for firm's growth and survival. This thesis includes as main variable innovation using R&D as a proxy. The development of a theoretical framework about the main determinants of innovation shed some light on the essential

understating of why and how this variable has been used in order to examine its impact on firm competitiveness.

Pharmaceutical industry has a dramatic impact on public health and wellbeing. It is a sector characterized as a cornerstone of the economy. Chapter four develops basic aspects of this industry such as pharmaceutical innovation and provides the reader with some important data from the global pharmaceutical industry. The chapter closes with the presentation of the market structure and characteristics of the industry.

In chapter five it has been analyzed the Greek pharmaceutical industry. This sector is strongly competitive and contributes significantly in the Greek economy, in employment and health system. Statistical data has been provided for showing the vital capabilities of the industry. In addition, demand side has been discussed in the chapter altogether with a comprehensive analysis of the opportunities of further exploitation.

A comprehensive study of empirical literature provided an insight for the key determinants of firm competitiveness in chapter six. This study selected profitability as a main proxy for firm competitiveness since the large heterogeneity of this industry and the difficulty of collecting data has been creating certain issues for using market share as a proxy additionally to profitability. As main factors of profitability according to review are the research and development intensity ratio, capital intensity of a firm, size of a firm, liquidity, leverage and age of a firm. A comprehensive systematic review provides the appropriate framework for developing eight research hypotheses of the dissertation. Although the extended empirical work, the results demonstrate a wide variety and can be characterized as mix and inconclusive.

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Then, in chapter seven, data collection has been followed for pharmaceutical firms under study. All the selected firms are member of the Hellenic Pharmaceutical Association producing branded-generics and have in house R&D departments. The main criterion for the selection of the data sample was the expenditures of R&D recorded in their financial balance sheets while firms which couldn't meet this criterion were excluded, so thirteen firms were finally selected. Annual balance sheets from those firms used for gathering all the needed data for the period 1998-2016. The sample was collected through the DATA PRISMA data base of ICAP GROUP S.A and other additional sources. Two profitability ratios, GPM and ROE have been constructed as the main dependent variable of the model for measuring firm competitiveness. The main explanatory variable was selected the R&D intensity ratio since there is an increasing interest in the empirical research for the role of R&D in firm profitability. A group of control variables as firm size and age, liquidity ratio, leverage ratio, capital intensity ratio, lagged profitability , which affect firm competitiveness have been incorporated in the model in order to investigate their impact on profitability and to avoid spurious results. A dummy variable also has been incorporated in order to capture the effect of financial crisis. An interaction term of R&D intensity ratio and the dummy variable has been constructed for investigating the marginal effect of R&D intensity ratio under the light of financial crisis. In addition, it has been described thoroughly the methodology used for the econometric estimation of the variables in chapter eight.

Chapter nine includes the specification of the profitability equations and describes the process of specification. Two models have been constructed in order to be estimated with the three different methods. Before the regression analysis, unit root tests have been applied to all variables for examining the existence or not of unit root in the series of the model. All the variables have presented a stationarity at level and so the standards regressions techniques could be used in the analysis. Descriptive statistics gives some specific information about the variables of the model. Granger causality test has been applied in order to examine the potential causality of relationship between profitability and R&D intensity ratio.

Two methodologies, Pooled OLS and FE, have been used initially for the regression analysis methodologies. Diagnostic residual tests detected the problems of heteroskedasticity and autocorrelation and therefore those two methodologies are rejected. The FGLS was proposed according to the theory as a solution to those issues.

The results vary according to different financial ratio for profitability and the statistical significance of the explanatory variables may differ according to profitability measure. More specific, R&D intensity ratio has a positive sign and is statistical significant at 1% level of significance for both GPM and ROE. Liquidity ratio has been found with a negative sign and statistical significant at 1% of significance for GPM while for ROE has a positive sign and is statistical significant for 10% level of significance. Leverage found positive but not statistical significant for GPM while for ROE is still positive but statistical significant at 1% level of significance. Lagged profitability has been found positive and statistical significant at 1% of significance in contrast with ROE where lagged profitability seems to affect current profitability negatively and is statistical significant at 1%.

Financial crisis surprisingly has a positive sign in case of GPM but is statistical insignificant while it is positive and statistical significant for ROE. The experience of the firm named as age seems that has no significant impact on profitability while capital intensity affects negatively the profitability only in the case of ROE and is statistical significant at 1% level of significance. Size of the firm has a negative sign and it is statistical significant at 1% level of significance for GPM while it is positive and statistical significant at 5% level of significance in the case of ROE. Lastly, the interaction term has a negative sign and it is statistical significant at 1% level of significance for both GPM and ROE. It is obvious that these empirical findings did not vary systematically based on estimation methodology but major with the measure of profitability

Limitations have been set during the research process of the study. The selection of those firms was a demanding process since there is a significant heterogeneity within this sector and great effort has been made by the author in order to classify properly the sample of the analysis. Another limitation during the research was the change from Greek Accounting Standards to International Accounting Standards resulting to a merge of the Research and Development expenditures category in balance sheet from other more general categories. As a consequence, data in this expenditure category was not possible to be used and some firms have been excluded.

10.2 Policy implications and Suggestions for Further Research

The expecting outcome of this study was to shed light into the relationship between R&D and firm competitiveness in a very specialized industry with certain characteristics. Despite the limitations, the study concluded in some interesting findings.

The positive impact of R&D intensity ratio on profitability implies the substantial effect of R&D on the survival and growth of the industry. Greek pharmaceutical industry has an increasing dynamic presence in R&D while further augmentation is essential and more incentives should be given for R&D investments' attraction. State has a key role to support domestic pharmaceutical industry through active policies, a more efficient institutional environment with tax incentives for R&D investments and interconnection of the mechanism of claw back and rebates with the investments in R&D and innovation efforts and clinical trial carrying out.

The second important finding of this study refers to the negative sign of interaction term (R&D intensity ratio * dummy crisis). The latter indicated that R&D expenditures decreased the profitability through the marginal effect of the crisis and this may occur because of the creating of a anti-development context where profitability decreased considerably and has resulted in the negative impact of R&D. So, this finding highlights the necessity of a structural change in the institutional framework.

In addition, the engagement of the industry with international business was crucial for its growth and survival. Financial crisis seems to boost the export activities of the industry with positive spillover for its competitiveness.

The contribution of R&D in the Greek pharmaceutical industry will achieve the progress of the pharmaceutical science in the interest of public health and welfare. It will verify the entirety of the Greek pharmaceutical market with excellent quality drugs. The creation of new production facilities with in-house R&D departments may reduce the exclusively dependence of the Greek pharmaceutical market from imported drugs.

Further exploration of this field has a crucial importance for Greece in order to restructure and reinforce firms' competitive advantage and their productivity creating multiple benefits for the Greek economy as a whole.

Market share is a determinant that has to be investigated. Measuring market share and using it as dependent variable, it will be interesting to study the potential change in the determinants of firm competitiveness. Market share offers firms a degree of market power and the role of concentration is a vital determinant of profitability. So, the inclusion of market share as independent variable of the firms in Greek pharmaceutical industry will reveal more information about firm competitiveness and profitability.

A worthwhile future exploration may use more interaction terms aiming at examining in depth the behavior of R&D variable. The interaction between R&D intensity ratio and size of R&D and exports will provide more insights about this measure and its connection to profitability and more precise results will be available.

REFERENCE

Abor, J. (2005) 'The effect of capital structure on profitability: an empirical analysis of listed firms in Ghana', *Journal of Risk Finance*, 6(5), pp. 438–445.

Abuzar, M.A.E., (2014) 'Liquidity - profitability tradeoff: An empirical investigation in an emerging market' *International Journal of Commerce and Management, 14(2).*

Adamou, A. and Sasidharan, S. (2011) 'The Impact of R&D and FDI on Firm Growth in Emerging-Developing Countries: Evidence from Indian Manufacturing Industries', *SSRN Electronic Journal*, pp. 1–28.

Aghion, P., and Howitt, P. (1990) 'A model of growth through creative destruction', *National Bureau of Economic Research*, 60(2), 323–352.

Aghion,P., Bloom, N., Blundell, R., Griffith, R. and Howitt. R., (2005) 'Competition and Innovation: An Inverted-U Relationship', *Quarterly Journal of Economics*, 120(2), pp. 701-728

Aghion,P., Harris,C., Howitt, P. and Vickers, J., (2001) 'Competition, Imitation and Growth with Step-by-Step Innovation', *Review of Economic Studies*, 68, pp. 467–492.

Agiomirgianakis, G., Voulgaris, F. and Papadogonas, T. (2006) 'Financial factors affecting profitability and employment growth: the case of Greek manufacturing', *International Journal of Financial Services Management*, 1(2/3), p. 232.

Ahuja, G. and Katila, R. (2001) 'Technological acquisitions and innovation performance of acquiring firms: a longitudinal study', *Strategic Management Journal*, 22(3), pp.197–220.

Aiginger, K., (2006) 'Competitiveness: from a dangerous obsession to a welfare creating ability with positive externalities' . *Journal of Industry*, 2, pp.161–177.

Ajitabh A.& Momaya K., (2004) ' Competitiveness of Firms: Review of Theory, Frameworks and Models', *Singapore Management Review*, 26(1),pp. 45–61.

Akben-Selcuk, E. (2016) 'Factors Affecting Firm Competitiveness: Evidence from an Emerging Market', *International Journal of Financial Studies*, 4(2), p. 9.

Alexander, D. et al., (2005). International Financial Reporting and Analysis (2nd edition), UK: Thomson Learning.

Altomonte, C., Aquilante, T. and Ottaviano, G. I. P. (2012) *The triggers of competitiveness : The EFIGE cross-country report competitiveness, Bruegel Blueprint.*

Amato, L. and Wilder, R.P., (1985) 'The effects of Firm Size on Profit Rates in U.S. Manufacturing', *Southern Economics Journal*, 52(1) pp. pp181-190.

Ambastha, A. and Momaya, K., (2004) 'Competitiveness of Firms: Review of theory, frameworks and models', *Singapore Management Review,* 26(1), pp.45-61.

Anastassopoulos, G., (2004) 'Profitability Differences Between MNE Subsidiaries and Domestic Firms: The Case of the Food Industry in Greece', *Agribusiness,* 20, pp.45-60.

Apostolou, A. K., and Dimitras, A., (2010) 'Credit risk modelling and Change of Accounting Standards: Evidence from the adoption of IFRS in Greece', *Journal of Financial Decision Making,* 6(2), pp.109-126.

Aquino, K. P. and Poshakwale, S. (2006) 'Price determinants of American depositary receipts (ADR): A Cross-sectional analysis of panel data', *Applied Financial Economics,* 16(16), pp. 1225–1237.

Arlington, S. & Davis, N. (2013) 'Managing innovation in pharma: Pharmaceutical industry perspectives on the Global Innovation Survey 2013', *PWC Innovation Survey,* pp. 1–20. Available at: https://www.pwc.com/gx/en/pharma-life-sciences/assets/pwc-managing-innovation-pharma.pdf.

Arnold, G. (2008) Corporate Financial Management 4th edition, Prentice Hall:Essex.

Arrow, K. (1962) Economic welfare and the allocation of resources for invention. In C. K. Rowley (Ed.), Readings in industrial economics (pp. 219-236). London: Palgrave

Asimakopoulos, I., Samitas, A. and T. Papadogonas (2009), 'Firm-specific and Economy Wide Determinants of Firm Profitability: Greek Evidence using Panel Data', *Managerial Finance,* 35(11), pp. 930-939

Astarlıoğlu, M. (2012) 'Moderating effect of Porter's diamond framework between firm strategies and export performance: A conceptual model', *LAÜ Sosyal Bilimler Dergisi,* 3(2), pp. 35-64

Atkinson, R. D. (2013) 'Competitiveness, Innovation and Productivity: Clearing up the Confusion', *The Information Technology & Innovation Foundation*, (August), pp. 1–7.

Balcaen, S., and Ooghe. H., (2006) '35 years of studies on business failure: an overview of the classic statistical methodologies and their related problems', *The British Accounting Review,* 38, pp. 63-93.

Baltagi, B.H. and Kao, C., (2000) 'Nonstationary Panels, Cointegration in Panels and Dynamic Panels: a Survey', *Advances in Econometrics,* 15, pp. 7-5.

Bardia S.C., (2004) 'Liquidity Management: A case Study of Steel Authority of India Ltd", The Management Accountant, pp. 463 – 67.

Barney et al., (2001) 'Resource-based theories of competitive advantage: A ten year retrospective on the resource-based view', *Journal of Management,* 27, pp. 643–650.

Barney, J. (2002) Gaining and sustaining competitive advantage. 2nd Ed. Upper Saddle River, NewJersey: Prentice Hall

Barron D.N., West, E. and Hannan, M.T., (1994) 'A time to growth and a time to die: Growth and mortality of credit unions in New York, 1914-1990', *American Journal of Sociology*, 100(2), pp. 381-421.

Baumann,HD. and Kaen F.R., (2003) 'Firm size, employees and profitability in U.S manufacturing industries. SSRN, 13, pp71-79.

Baysinger, B. and Hoskisson, R. E. (1989), 'Diversification strategy and R&D intensity in multiproduct firms', *Academy of Management Journal*, 32 (2), pp. 310-332.

Becker, B. (2013) 'The Determinants of R&D Investment: A Survey of the Empirical Research', *Discussion Paper Series*, (July)

Bessler, W. and Bittelmeyer, C., (2008) 'Patents and the performance of technology firms:evidence from initial public offerings in Germany', *Financial Markets and Portfolio Management*, 4,pp. 323–356.

Bhattacharya and Bloch, 2004, Determinants of Innovation, Small Business Economics 22, pp. 155–162

Blacconiere, W., and Patten, D., (1994) 'Environmental Disclosures, Regulatory Costs, and Changes in Firm Value', *Journal of Accounting and Economics*, 18 (3), pp.357-377

Blanc, L. (2015) 'What drives EU exports of pharmaceuticals?', *College of Europe Bruges Campus*, p. 58.

Blundell, R., Griffith, R., & Van Reenen, J. (1999) 'Market share, market value and innovation in a panel of British manufacturing firms', *The Review of Economic Studies*, 66(3), pp. 529–

Buckley P.J., Pass C.L. and Prescott K., (1992). The Meaning of Competitiveness. Servicing International Markets: Competitive Strategy of Firms. *Blackwell Publishers*, Cambridge.

Buckley, P.J., Pass, C.L. and Prescott, K., (1998) 'Measures of International Competitiveness: A Critical Survey', *Journal of Marketing Management*, 4(2), pp 174-200.

Burton-Jones, A. (1999) Knowledge Capitalism – Business, Work, and Learning in the New Economy. Oxford University Press, Oxford.

Cainelli, G., Evangelista, R. and Savona, M. (2006) 'Innovation and economic performance in services: A firm-level analysis', *Cambridge Journal of Economics*, 30(3), pp. 435–458.

Campbell, J. and Perron, P., (1991) 'Pitfalls and opportunities: what macroeconomists should know about unit roots. In: Blanchard, O., Fischer, S. (Eds.), NBER Macroeconomics Annual. MIT Press, Cambridge, MA.

Castellaci, F., Clausen, T.H., Nås O. and Verspagen, B, (2009) 'Historical fingerprints? A taxonomy of Norwegian innovation', Innovation, pp. 116–145.

Cefis, E. and Ciccarelli, M., (2005) 'Profit differentials and innovation', *Economics of Innovation and New Technology*, 14, pp. 43-61.

Cerrato, D., and Depperu, D., (2011) ' Unbundling the construct of firm-level international competitiveness: A conceptual framework', *Multinational Business Review*, 19(4), pp.311–331.

Chang, Y., (2002) 'Non linear IV Unit Root Tests in Panels with Cross-Sectional Dependency', *Journal of Econometrics*, 110, pp. 261-292.

Chang, Y.,(2004) 'Bootstrap Unit Root Tests in Panels with Cross-Sectional Dependency', *Journal of Econometrics*, 120, pp.263-293.

Chao-Hung W. and Li-Chang H., (2010) 'The Influence of Dynamic Capability on Performance in the High Technology Industry: The Moderating Roles of Governance and Competitive Posture', *African Journal of Business Management*, 4(5), pp.562–577.

Cheng, C.M. and Tzen, Z.C.,(2011) 'The Effect of Leverage on Firm Value and How The Firm Financial Quality Influence on This Effect', *World Journal of Management, 3(2), pp.30-53.*

Chikán, A., (2008) 'National and firm competitiveness: a general research model', *International Business Journal*, 18 (1/2), pp.20–28.

Chudnovsky, D., Lopez, A. and Pupato, G. (2006) 'Innovation and Productivity in Developing Countries: A Study of Argentine Manufacturing Firms' Behaviour (1992–2001)' , *Research Policy*, pp. 266-288.

Clark J.M., (1961). Competition as a Dynamic Process. *Brookings Institution*, Washington.

Coad, A., Segarra, A. and Teruel, M. (2013) 'Like milk or wine: Does firm performance improve with age?', *Structural Change and Economic Dynamics*, 24(1), pp. 173–189.

Cohen, W. 1995. Empirical studies of innovation activities, in Stoneman P. (ed.), Handbook of the Economics of Innovation and Technical Change, Oxford, Blackwell

Collins, N. and Preston L., (1969) 'Price Cost Margins and Industry Structure', *Review of Economics and Statistics*, 51, pp.271-286.

Courvisanos, J. and Verspagen, B. (2004), 'Innovation and investment in capitalist economies, 1870-2000: Kaleckian dynamics and evolutionary life cycles', in Randall

Wray, L. and Forstater, M. (Eds), Contemporary Post-Keynesian Analysis, Edward Elgar, Cheltenham, pp. 205-26

Crepon, B., Duguet, E. and Mairesse, J., (1998) 'Research, Innovation, and Productivity' NBER Working Paper No. 6696.

Dasgupta, P., & Stiglitz, J. (1980a) 'Industrial structure and the nature of innovative activity', *The Economic Journal*, 90(358), pp. 266–293.

Davies, H. &P.D. Ellis (2000), "Porter's 'Competitive Advantage of Nations': Time for a final judgment?," Journal of Management Studies, 37(8), pp.1189-1213.

Delmar, F., and Wiklund, J. (2008) ' The effect of small business managers' growth motivation on firm growth: A longitudinal study', *Entrepreneurship: Theory and Practice*, 32(3),pp. 437–457

Dickey, D. A. & Fuller, W.A., (1981) 'Likelihood ratio statistics for auto-regressive time series with a unit root', *Econometrica*, 49, pp. 1057-1072.

Dierickx, I., and Cool, K. (1989) 'Asset stock accumulation and sustainability of competitive advantage', *Management Science*, 35 pp. 1504-1511.

Dirickx Y., Van Landeghem G., (1994), 'Statistical failure prevision problems', Tijdschrift voor Economie en Management, Vol. 39(4), pp. 429-462.

Doh, L. and Prince, D.R. (2015) 'The impact of Research and Development on Revenue generation and Investment valuation of Info-tech corporation', *Journal of Business Economics and Finance*, 4(4), 696-709.

Douglas, T.J. and Ryman, J.A., (2003) 'Understanding competitive advantage in the general hospital industry: evaluating strategic competencies', *Strategic Management Journal*, 24 (4), pp.333-347.

Duan, Y. and Niu, J. (2020) 'Liquidity creation and bank profitability', *North American Journal of Economics and Finance*, 54, p. 101250.

Ehiedu, V., (2014) 'The Impact of Liquidity on Profitability of Some Selected Companies: The Financial Statement Analysis (FSA) Approach', *Research Journal of Finance and Accounting*, 5(5), pp.81-90.

Elion,S., (1985) 'Framework for Profitability and Productivity Measures', *Journal of Applied Analytics*, 15(3), pp. 31–40

Ellis, J., and Williams, D.,(1993) , Corporate Strategy and Financial Analysis. UK: Pitman publishing.

Epifa (2016) 'the Pharmaceutical Industry : a Key Asset To Scientific and Medical Progress the Pharmaceutical Industry', p. 28.

European Commission (1999) Sixth Periodic Report on the Social and Economic Situation of Regions in the EU, European Commission, Brussels.

European Commission (2020) 'The 2020 EU Industrial R&D Investment Scoreboard', Policy Report, Joint Research Centre (JRC), pp. 1-113.

European Commission. (2009). *Pharmaceutical Sector Inquiry Final Report*. *July*, 533.

Eurostat Statistics Explained, (2012) [Available at: **(https://ec.europa.eu/eurostat/statisticsexplained/index.php/Glossary:Innovation]**

Eurostat, (2008), NACE REV.2 Statistical classification of economic activities in the European Community, Office for Official Publications of the European Communities [Available at: https://ec.europa.eu/eurostat/documents/3859598/5902521/KS-RA-07-015-EN.PDF.pdf/dd5443f5-b886-40e4-920d-9df03590ff91?t=1414781457000].

Fagerberg, J., (1988) 'International competitiveness' *The Economic Journal*, 98(391), pp.355–374.

Fama, E. F. and French, K. R. (1998) 'Taxes, financing decisions, and firm value', *Journal of Finance*, 53(3), pp. 819–843.

Feeny, S. (2000) 'Determinants of Profitability: An Empirical Investigation Using Australian Tax Entities*', Available at: http://www.ecom.unimelb.edu.au/iaesrwww/home.html.

Fischer, C. and Schornberg, S (2008), 'The competitiveness situation of the EU meat processing and beverage manufacturing sectors' , *Food Economics-Acta Agriculturae Scandinavica Section C,* 4(3), pp. 148-158.

Fischer, C., and Schornberg, S., (2007) 'The competitiveness situation of the EU meat processing and beverage manufacturing sectors', Agribusiness, 23(4), pp. 473- 495.

Fontana, R. and Guerzoni, M., (2008) 'Incentives and uncertainty: an empirical analysis of the impact of demand on innovation', *Cambridge Journal of Economics*, 32(6), pp.927-946.

Forsman, H.(2011) 'Innovation capacity and innovation development in small enterprises. A comparison between the manufacturing and service sectors', *Research Policy*, 1(4), pp.97-109.

Foster, J. (1991), 'The Institutionalist (evolutionary) School", in Mair, D. and Miller, A.G. (Eds), A Modern Guide to Economic Thought. An Introduction to Comparative Schools of Thought in Economics, Edward Elgar, Aldershot, pp. 207-32.

Frees, E., (2004) Lognitudinal and Panel Data, Cambridge University Press.

Gale, B.T., (1972) 'Market Share and rate of return', *Review of Economics and Statistics*, 4, pp.412-423.

Gambardella, A. *et al.* (2000) 'M P RA Munich Personal RePEc Archive Global Competitiveness in Pharmaceuticals: A European Perspective GLOBAL COMPETITIVENESS IN PHARMACEUTICALS A EUROPEAN PERSPECTIVE.

Garcia-Vega, M., (2011) 'Does technological diversification promote innovation? An empirical analysis for European firms' *Research Policy* 35, pp.230–246.

Geroski, P. A. and Walters, C. F., (1995) 'Innovative Activity over the Business Cycle, *The Economic Journal*, 105 (431), pp. 916–928.

Geroski, P. A., (1990) 'Innovation, Technological Opportunity, and Market Structure', *Oxford Economic Papers*, 42(3), pp. 586–602.

Geroski, P. and Machin, S., (1992) 'Do innovating firms outperform non-innovators?', Business Strategy Review, 3(2), pp. 79-90.

Geroski, P., Machin, S. and Reenen, J. Van (1993) 'The Profitability of Innovating Firms', *The RAND Journal of Economics*, 24(2), p. 198.

Ghafoorifard, M., Sheykh, B., Shakibaee, M. and Joshaghan, N.S., (2014) 'Assessing the relationship between firm size, age and financial performance in listed companies on Tehran Stock Exchange', *International Journal of Scientific Management and Development*, 2(11), pp. 631-635.

Gilbert, R. (2006) 'Looking for Mr. Schumpeter: Where Are We in the Competition--Innovation Debate?', *Innovation Policy and the Economy*, 6, pp. 159–215.

Gill, A. & Obradovich, J. (2012) 'The Impact of Corporate Governance and Financial Leverage on the Value of American Firms', *International Research Journal of Finance and Economics*, pp.1-14.

Goddard, J., Tavakoli, M. and Wilson. (2005) ' Determinats of Profitability in European Manufacturing and Services: Evidence from a Dynamic Panel Model', *Applied Financial Economics*, 15(18), pp.1269-82.

Golec, J. H. and Vernon, J. A. (2006) 'European Pharmaceutical Price Regulation, Firm Profitability, and R&D Spending', *NBER Working Papers*. Available at: https://ideas.repec.org/p/nbr/nberwo/12676.html

Goswami, S. and Sarkar,A., (2011) 'Impact of working capital management on liquidity, profitability – An empirical study with reference to sail' , International Journal of Marketing and Management Research, 2(11), pp.47-63.

Grabowski, H. G. (1968), 'The determinants of industrial research and development: A study of the chemical, drug, and petroleum industries', *Journal of Political Economy*, 76 (2), pp. 292-306

Grabowski, H.G., Baxter, N.D, (1973) 'Rivarly in Industrial Research and Development: An Empirical Study', *Journal of Industrial Economics*, 21, pp: 209-235.

Grant, R.M. (1991), ' Porter's Competitive Advantage of Nations: An Assessment' *Strategic Management Journal*, 12, pp 535-548.

Griliches, Z., (1986) 'Productivity, R&D and Basic Research at the Firm Level in the 1970s', *American Economic Review*, pp. 143-154.

Gunday, G. *et al.* (2008) 'Modeling innovation: Determinants of innovativeness and the impact of innovation on firm performance', in *Proceedings of the 4th IEEE International Conference on Management of Innovation and Technology, ICMIT*, pp. 766–771.

Gurbuz, A.O., Aybars, A. and Kutlu, O., (2010) 'Corporate governance and financial performance with a perspective on institutional ownership: Empirical evidence from Turkey', Journal of Applied Management Accounting, 8,pp. 21–38.

Hadri, K., (2000) 'Testing for Unit Roots in Heterogeneous Panel Data', *Econometrics Journal*, 3, pp. 148-161.

Hajiheydari, A., Dastgir, M., and Soltani, A. (2011) 'The Effect of Research and Development Costs on the Profitability of Pharmaceutical Companies', *Interdisciplinary Journal of Contemporary Research in Business*. 3(8), pp. 914-918.

Hall, A., (1990) 'Testing for a Unit Root in Time Series with Pretest Data-based Model Selection', North Carolina State University, Working Paper Series.

Hall, B.H., Moncada-Paternò-Castello, P., Montresor, S., Vezzani, A., (2016) 'Financing constraints, R&D investments and innovative performances: new empirical evidence at the firm level for Europe', *Economic Innovation and New Technology*. 25 (3), pp.183–196.

Hansen, G. S., and Wernerfelt, B. (1989) 'Determinants of firm performance: The relative importance of economic and organizational factors', Strategic *Management Journal*, 10, pp. 399–411

Hanusch, H. and Pyka, A. (2007b), 'Elgar Companion to Neo-Schumpeterian Economics', Edward Elgar, Cheltenham, pp. 1-16.

Harris, F.H., (1986) 'Market Structure and Price-Cost Performance Under Endogenous Profit Risk', *Journal of Industrial Economics*, 35, pp.35-60.

Haskel, J. and Scaramozzino, P., (1997) 'Do other firms matter in oligopolies?' *The Journal of Industrial Economics*, 1, pp. 27-45.

Hatsopoulos, G., Krugman, P.R. and Summers, L.H., (1988) 'U.S. competitiveness: beyond the trade deficit', *Science*, 241(4863), pp.299–307.

Hay, D.A. & Morris, J.D.,1979. Industrial Economics: Theory and Evidence, Oxford University Press, New York.

Hernández, H. *et al.* (2014) EU R & D Scoreboard Report, p. 570.

Hsia, C., (2003) Analysis Of Panel Data 2nd edition, Cambridge University Press.

Huergo, E., & Jaumandreu, J. (2004) 'How does probability of innovation change with firm age?', *Small Business Economics, 22*(3–4), 193–207.

Ibhagui, O. W. and Olokoyo, F. O. (2018) 'Leverage and firm performance: New evidence on the role of firm size', *North American Journal of Economics and*

Finance, 45, pp. 57–82.

Im, K.S., Pesaran, M.H., and Shin, Y.,(2003) 'Testing for Unit Roots in Heterogeneous Panels', *Journal of Econometrics*, 115(1),pp. 53-74.

Ioannis Lazaridis, I. and Tryfonidis, D., (2006) 'Relationship between Working Capital Management and Profitability of Listed Companies in the Athens Stock Exchange', *Journal of Financial Management and Analysis*, 19(1), pp.26-35.

Iraj, H., Nebojsa, S., (2010) ' *The impact of innovation activities on firm performance using a multi-stage model: Evidence from the community innovation survey 4',* Center for Social and Economic Research (CASE), Network Studies & Analyses, No. 410.

Jakobson, R. and Aaker, D.A. (1985) 'Is Market Share All It's Cracked up to be?' *Journal of Marketing*, 49, pp.11-22.

Jarrar, N.S and Smith,M., (2011) 'Product Diversification: The Need for Innovation and the Role of a Balanced Scorecard' Journal of Applied Management Accounting Research, 9 (2), pp. 43-60.

Kalsie, A. and Shrivastav, S. M. (2016) 'Analysis of board size and firm performance: Evidence from NSE companies using panel data approach', *Indian Journal of Corporate Governance*, 9(2), pp. 148–172.

Kamien, *M.L.*, and Schwartz, *N.L. (1975)*, 'Market Structure and Innovation', *Journal of Economic Literature, Vol 13 (1): pp, 1-37.*

Kemp, R. G. M. *et al.* (2003) *Innovation and firm performance*. Available at: www.eim.nl/smes-and-entrepreneurship.

Kemp, R.G.M., Folkeringa, M., De Jong, J.P.J. and Wubben, E.F.M., (2003) 'Innovation and Firm Performance', Scales Research Reports, Zoetermeer: EIM Business and Policy Research.

Kharub, M., & Sharma, R. (2017) 'Comparative analyses of competitive advantage using Porter diamond model (the case of MSMEs in Himachal Pradesh)', *Competitiveness Review*, 27(2), pp. 132-160.

Kiveu, M. N., Namusonge, M. and Muathe, S. (2019) 'Effect of innovation on firm competitiveness: The case of manufacturing SMEs in Nairobi County, Kenya', *International Journal of Business Innovation and Research*, 18(3), pp. 307–327.

Klette, T. and Griliches, Z., (2000) ' Empirical patterns of firm growth and R&D-investment: A quality ladder model interpretation', Economic Journal, 110, pp. 363—87 .

Klomp, L. and Van Leeuwen, G., (2001) 'Linking Innovation and Firm Performance: A New Approach', *International Journal of the Economics of Business*, pp. 343-364.

Kohler,W., (2006) 'The 'Lisbon goal' of the EU: rhetoric or substance?', *Journal of Industry*, Competition and Trade, 6(2), pp.85–113.

Krugman P., (1990) The Age of Diminished Expectations, Cambridge, *The MIT Press*.

Krugman P., (1994). Competitiveness: A Dangerous Obsession. *Foreign Affairs*, 73(2), pp.28–44.

Krugman PR, Obstfeld M. International economics: theory and policy. 3ª ed. New York, New York, USA: Harper Collins; 1994

Krugman, P. (1996) ' Making sense of the competitiveness debate', *Oxford Review of Economic Policy*, 12(3), pp.17–25.

Kumar, R. (2014) 'An Empirical Study on Relationship between Leverage and Profitability in Bata India Limited', *International Journal of Advance Research in Computer Science and Management Studies*, 2(5), pp. 1–9.

Kumar, R. et al., (2014) 'An Empirical Study on Relationship between Leverage and Profitability in Bata India Limited', *International Journal of Advance Research in Computer Science and Management Studies*, 2(5), pp.1-9.

Lafuente, E., Leiva, J. C., Moreno-Gómez, J., & Szerb, L. (2020). A nonparametric analysis of competitiveness efficiency: The relevance of firm size and the configuration of competitive pillars. *BRQ Business Research Quarterly*, *23*(3), 203–216.

Laitinen E.K., (1994) 'Traditional versus operating cash flow in failure prediction', *Journal of Business Finance and Accounting*, 21(2), pp. 195-217.

Lalinsky, T. (2015) 'Firm Competitiveness Determinants: Results of a Panel Data Analysis', *SSRN Electronic Journal*. doi: 10.2139/ssrn.2548947.

Laureti, T., and Viviani, A., (2010) 'Competitiveness and productivity: a case study of Italian firms', *Applied Economics*, 1, pp.1-11.

Lee, J. (2009) 'Does size matter in firm performance? Evidence from US public firms', *International Journal of the Economics of Business*, 16(2), pp. 189–203.

Lee, J., & Karpova, E. (2018), 'Revisiting the competitiveness theory in the new global environment: review and analysis of the competitiveness definition', *International Journal of Competitiveness*, *1*(3), 189.

Lee, S. (2010) 'Effects of capital intensity on firm performance: The u.s. restaurant industry', *Journal of Hospitality Financial Management*, 18(1), pp. 1–13.

Levin, A. & Lin, C.-F., 1992. Unit root tests in panel data: asymptotic and finite-sample propertie. San Diego: UC , Working Paper 92-23.

Levin, A. & Lin, C.-F., 1993. Unit root tests in panel data: new results. San Diego: University of California, Economics Working Paper Series.

Levin, A., Lin, C.-F. & Chu, C.-S. J., 2002. Unit root tests in panel data: asymptotic and finite-sample properties. Journal of econometrics , 108(1), pp. 1-24

Liargovas, P. and Skandalis, K. (2004) 'Factors Affecting Firm Competitiveness: The Case of Greek Industry', *Research Paper University of Peloponnese, Department of Economics,* pp. 1–29.

Lome, O., Heggeseth, A. G. and Moen, Ø. (2016) 'The effect of R&D on performance: Do R&D-intensive firms handle a financial crisis better?', *Journal of High Technology Management Research,* 27(1), pp. 65–77.

Lyroudi K., Lazaridis Y., (2000) ' The cash conversion cycle and liquidity analysis of the food industry in Greece', SSRN, DOI :10.2139/ssrn.236175.

Maddala, G.S. and Wu, S., (1999) 'A Comparative Study of Unit Root Tests with Panel Data and a New Simple Test', *Oxford Bulletin of Economics and Statistics*, 61(1), pp. 631- 652.

Maja P. and Josipa V., (2012) 'Influence of firm size on business success', *Croatian Operational Research Review (CRORR), 3,* pp.213-224.

Majumdar, S. K. (1997) 'The impact of size and age on firm-level performance: Some evidence from India', *Review of Industrial Organization*, 12(2), pp. 231–241.

Makris, I. A., (2016) 'The effect of innovative activity in firm performance and development: Analysing data from eurozone', *International Journal of Business and Economic Sciences Applied Research,* 9(2), pp. 87-92.

Martin, S., (1983) 'Market, Firm and Economic Performance', Salomon Brothers Monograph Series in Finance and Economics, N.Y.U. Graduate School of Business.

McDonald, J., (1999) 'The Determinants of Firm Profitability in Australian Manufacturing' *The Economic Record,* 75(229), pp.115-126.

Miller, B., (2004) 'Firms Technological Resources and the Performance Effects of Diversification: A Longitudinal Study', *Strategic Management Journal* 25(11) pp. 1097 – 1119.

Modigliani, F. and Miller, M.H., (1963) 'Corporation Income Taxes and the Cost of Capital: A Correction,' *American Economic Review,* 53, pp. 433-443.

Moen, Ø., Tvedten, T. and Wold, A. (2018) 'Exploring the relationship between competition and innovation in Norwegian SMEs', *Cogent Business and Management*, 5(1), pp. 1–15.

Murphy, J. E. (1968) 'Effects of Leverage on Profitability, Growth and Market Valuation of Common Stock', *Financial Analysts Journal*, 24(4), pp. 121–123.

Myers, S. and Marquis, D. G. (1969). Successful Industrial Innovation, Washington, National Science Foundation.

Negash,M., (2015) 'Investment Analysts Journal Debt, tax shield and bankruptcy costs: Some evidence from JSE, Investment Analysis Journal, 30(54), pp.33-44.

Nelson, R. R., and Winter, S. G. (1982).An evolutionary theory of economic behavior and capabilities. Cambridge: Harvard University Press, pp.195–307.

Nelson, R., and Winter, S. (1982) 'The Schumpeterian Tradeoff Revisited'. The American Economic Review, 72(1), pp. 114-132.

Nelson,R., (1959) 'The simple economics of basic scientific research', *Journal of political economy*, 67(3), pp.297-306.

Nicoletti, G. and SCARPETTA S., (2003) 'Regulation, Productivity and Growth: OECD Evidence', *Economic Policy*, 36, pp. 9-72.

Nord, L. J. (2011) *R&D Investment Link to Profitability: A Pharmaceutical Industry Evaluation*, *Undergraduate Economic Review*, 8(1).

Nordhaus, W. D. (2004) 'Schumpeterian Profits in the American Economy: Theory and Measurement', *NBER Working paper*, (April), pp. 1–35.

Nunes, P. M., and Serrasqueiro, Z. (2015) 'Profitability Determinants of Portuguese Knowledge Intensive Business Services: Empirical Evidence Using Panel Data Models', *Applied Economics Letters*, 22(1), pp.51-56.

Nunes, P.J.M., Serrasqueiro, Z. M. and Sequeira, T.N.,(2009) 'Profitability in Portuguese Service Industries: a Panel Data Approach' , *The Service Industries Journal*, 29(5), pp. 693-707.

OECD (2005) The Measurement of Scientific and Technological Activities: Guidelines for Collecting and Interpreting Innovation Data, Oslo Manual, 3rd ed., OECD, Paris.

OECD (2005). Oslo Manual: Guidelines for Collecting and Interpreting Innovation Data, 3rd ed. Paris: OECD Publishing.

OECD Data 2019: Pharmaceutical Spending [Available at: https://data.oecd.org/healthres/health-spending.htm].

Oughton, C. and Whittam, G.,(1996),Competitiveness, EU industrial strategy and subsidiarity, in Devine. *Competitiveness, Subsidiarity and Industry Policy*, Routledge, London.

Pathirawasam, C., (2013) 'Internal Factors which Determine Financial Performance of firms: With Specail Reerence to Ownership Concentraion' ,*Innovation and Knowledge Management*, pp.62-72.

Penrose, E. T. (1959) The Theory of the Growth of the Firm. Oxford: Basil Blackwell.

Perobelli, F. F. C., Pereira, J. F. & David, M. V., (2006) 'Relação Liquidez-Retorno: Existiria também uma "Estrutura de Liquidez', *EnAMPAD*, pp. 1-16.

Phillips, P. A., (2007) 'The Service Industries Journal Performance implications of capital structure: evidence from quoted UK organisations with hotel interests

Performance Implications of Capital Structure: Evidence from Quoted UK Organisations with Hotel Interests'.

Phillips, P.C.B. and Perron, P., (1988) 'Testing for a unit root in time series regression', *Biometrika* 75, pp.335–346.

Phillips, P.C.B., (1987) 'Time series regression with a unit root', *Econometrica*, 55, pp.277–301.

Porter, M. (1990a). The Competitive Advantage of Nations (First Free Press Edition 1990). New York: Free Press.

Porter, M. (1990b). The competitive advantage of nations. Harvard Business Review: International Business, 73-91.

Porter, M., (1998). The Competitive Advantage of Nations- with a New Introduction. *Macmillan Business*, pp 33.

Porter, M.E. (1987) 'From competitive advantage to corporate strategy', *Harvard Business Review*, 65 (3), pp. 43-59.

Porter, M.E. (2004), Building the microeconomic foundations of prosperity: findings from the business competitiveness index. The Global Competitiveness Report 2003–2004. Oxford University Press: New York.

Porter, M.E., (2004) .Building the microeconomic foundations of prosperity: findings from the business competitiveness index. The Global Competitiveness Report 2003–2004. *Oxford University Press*: New York.

Porter, M.E.,(1990) Competitive Advantage of Nations, Free Press, New York.

Powell, T.C., (2001) 'Competitive advantage: logical and philosophical considerations', *Strategic Management Journal*, 22(12), pp.875–888.

Rao, J., Yu, Y., and Cao, Y. (2013) 'The Effect That R&D Has on Company Performance: Comparative Analysis Based on Listed Companies of Technique Intensive Industry in China and Japan', *International Journal of Education and Research*, 1(4), pp. 1-8.

Rao, J., Yu, Y., & Cao, Y. (2013) 'The effect that R&D has on company performance: comparative analysis based on listed companies of technique intensive industry in China and Japan', *International Journal of Education and Research*, *1*(4).

Reitenga, A.L., (2000) 'Environmental Regulation, Capital Intensity, and CrossSectional Variation in Market Returns', *Journal of Accounting and Public Policy*, 19 (2),pp. 189-198.

Robb, A. M. and Robinson, D. T. (2014) 'The capital structure decisions of new firms', *Review of Financial Studies*, 27(1), pp. 153–179.

Roberts P W (1999) 'Product innovation, product-market competition and persistent profitability in the US pharmaceutical industry', *Strategic Management Journal*, 20, pp.655-670.

Rojas, M., Cerda G., García B., Barcenas R., (2013) 'Innovation and competitiveness in SMEs: the local experience in San Luis Potosi, México', *Journal of Marketing Management*, 4(1), pp. 74–92.

Rosli, M. M. and Sidek, S. (2013) 'The Impact of Innovation on the Performance of Small and Medium Manufacturing Enterprises: Evidence from Malaysia', *Journal of Innovation Management in Small & Medium Enterprise*, (April 2020), pp. 1–16.

Ruland, W., Zhou, P., (2005) 'Debt, Diversification, and Valuation', Review of Quantitave Financial Accounting, 25, pp.277–291.

Rumelt, R. (1984) Towards a strategic theory of firm. Competitive Strategic Management. R. Lamb, ed., New Jersey: Prentice Hall, pp. 557-570.

Schmookler, J. 1966. in Invention and Economic Growth, Cambridge, MA, Harvard University Press.

Schumpeter J., 1950. Capitalism, Socialism and Democracy. *Harper & Row*, New York.

Schumpeter, J. (1934) The theory of economic development: an inquiry into profits, capital, credit, interest and the business cycle. Harvard Economic Studies, Vol. 46, Harvard College, Cambridge, MA

Schumpeter, J.A.1943. Capitalism, Socialism, Democracy. 3rd edition, London: George Allen and Unwin.

Scott B.R. &Lodge G.C., 1985. US Competitiveness in the World Economy. *Harvard Business School Press*, Boston.

Shin, N., Kraemer, K. L., and Dedrick, J. (2009) 'R&D, Value Chain Location and Firm Performance in the Global Electronics Industry' *Industry and Innovation*, 16(3), pp.315-330.

Simon F., (2010) 'Determinats of profitability: an empirical investigation using Australian tax entities'. Melbourne Institute Working paper No.100

Singh, M., Nejadmalayeri,A. and Mathur I., (2007) 'Performance impact of business affiliation: An analysis of the diversification-performance link in a developing economy', *Journal of Business Research*, 60, pp.339-347.

Siudek, T. and Zawojska, A., (2014) 'Competitiveness in the economic concepts, theories and empirical research', *Acta Science Policy*,13(1), pp.91–108.

Śledzik, K. (2013) 'Schumpeter's View on Innovation and Entrepreneurship', *SSRN Electronic Journal*, (October).

Srivastava, S., Sultan, A. and Chashti, N. (2017) 'Influence of innovation competence on firm level competitiveness: an exploratory study', *Asia Pacific Journal of Innovation and Entrepreneurship*, 11(1), pp. 63–75.

Statistics, O. H. (2019) 'Public-funding-of-health-care-Brief-2020 OECD.pdf', 2017, pp. 2017–2020.

Stiglitz, J. E., (1969) 'A Re-Examination of the Modigliani-Miller Theorem. *American Economic Review*, 59(5), pp.784-794.

Stinchcombe, A.L., (1965) Social Structure and Organizations, In JG March, (ed), Handbook of Organizations, Rand McNally, Chicago.

Stoevsky, G., (2005) 'Innovation and Business Performance of Bulgarian Companies (structural econometric analysis at firm level)', Economic Research and Projections Directorate Working Paper. Bulgarian National Bank.

Stonehouse, G., & Snowdon, B. (2007) 'Competitive advantage revisited: Michael Porter on strategy and competitiveness' *Journal of Management Inquiry*, 16(3), pp. 256-273.

Tahu,G.P. and Susilo, D.D.B., (2017) 'Effect of Liquidity , Leverage and profitability to the firm value in Manufacturing company of Indonesia Stock Exchange', *Research Journal of Finance and Accounting*, Vol.8 (18).

Tailab, M.M., 2014 'Analyzing Factors Effecting Profitability of Non-Financial U.S. Firms', *Research Journal of Finance and Accounting, 22.*,

Teece, D. J., Pisano, G., & Shuen, A., (1997) 'Dynamic capabili- ties and strategic management', *Strategic Management Journal*, 18, pp. 509-533.

Teece, D.J., (1980) 'Economics of Scope and the Scope of an Enterprise' , *Journal of Economic Behavior & Organization,* 1(3), pp.223-247.

Tubbs, M. (2007) 'The relationship between R&D and company performance', *Research Technology Management*, 50(6), pp. 23–30.

Tyson D'Andrea L., (1992). Who's Bashing Whom: Trade Conflict in High Technology Industries. *Institute for International Economics*, Washington, D.C

Varis, M. and Littunen, H. (2010) 'Types of Innovation, sources of information and performance in entrepreneurial SMEs', *European Journal of Innovation Management*, 13(2), pp.128-154.

Vassilakis, S. (2008) Learning-by-doing. S.N. Durlauf, L.E. Blume (Eds.), The New Palgrave Dictionary of Economics (2nd ed.), Palgrave Macmillan.

Vijayakumar A, Tamizhselvan P., (2010) 'Corporate size and profitability: An empirical analysis. College Sadhana' , *Journal for Bloomers of Research*, 3(1), pp. 44-53

Vlados, C. (2019c) 'Porter's diamond approaches and the competitiveness web', *International Journal of Business Administration*, 10(5), pp. 33–52.

Voulgaris, F. and Lemonakis, C. (2014) 'Competitiveness and profitability: The case of chemicals, pharmaceuticals and plastics', *Journal of Economic Asymmetries*, 11, pp. 46–57.

Vurur, N. S. and İlarslan, K. (2016) 'Analysis of the relationship between R&D expenditure and profitability: A sample application from BIST', *Journal of Multidisciplinary Developments*, 1(1), pp. 103–112.

Wamugo Mwangi, L., Stephen Makau, M. and Kosimbei, G. (2014), 'Relationship between Capital Structure and Performance of Non- Financial Companies Listed In the Nairobi Securities Exchange, Kenya', *Global Journal of Contemporary Research in Accounting, Auditing and Business Ethics (GJCRA) An Online International Research Journal*, 1(2), pp.72-90

Wang, C. L., and Ahmed, P. K. (2007) 'Dynamic capabilities: A review and research agenda', *International Journal of Management Reviews*, 9(1),pp. 31–51.

Wonglimpiyarat, J. (2017) 'The role of government in Porter's Diamond model: Comparative cases of Singapore and Thailand', *International Journal of Technology, Policy and Management*, 18(1), pp. 73-88.

Wooldridge, J. M. (1975) *Introductory Econometrics 6th Edition, Economica*

Wooldridge, J., (2010) Econometric analysis of cross section and panel data 2nd edit, Cambridge, Massachusetts: MIT press.

World Competitiveness Yearbook (2012) Ministerial Report on the OECD Innovation Strategy. IMD World Competitiveness Center. [Available at http://www.imd.org/wcc/wcy-world-competitiveness-yearbook.4.]

World Economic Forum (2015) Methodology: The 12 Pillars of Competitiveness [Available at : http://reports.weforum.org/global-competitiveness-report-2014-2015/view/methodology/].

Wysokinska, Z., (2003) 'Competitiveness and its relationships with productivity and sustainable development', *Fibres Textiles in East Europe*, 11(3), pp.11–4

Yassin Almajali, A., Ahmed Alamro, S. and Zakarea Al-Soub, Y. (2012) 'Factors Affecting the Financial Performance of Jordanian Insurance Companies Listed at Amman Stock Exchange', *Journal of Management Research*, 4(2).

Yoon, E. and Jang, S. (2005) 'The Journal of Hospitality Financial Management The Effect of Financial Leverage on Profitability and Risk of Restaurant Firms', *Journal of Hospitality Financial Management*, 13(1), pp. 37–41.

Zhang, J., Ebbers, H. & Mulder, R., (2012) 'Competitiveness of Chinese Industries - A Comparison with the EU', *Review of European Studies*, 4 (1), pp. 203-209.

Zouaghi, F. and Sánchez, M. (2016) 'Has the global financial crisis had different effects on innovation performance in the agri-food sector by comparison to the rest of the economy?', *Trends in Food Science and Technology*. Elsevier Ltd, pp. 230–242.

GREEK REFERENCE

Αθανασιάδης, Θάνος . Μανιάτης, Γ. and Ντεμούσης, Φ. (2012) *Η ΑΓΟΡΑ ΦΑΡΜΑΚΟΥ ΣΤΗΝ ΕΛΛΑΔΑ Ετήσια Έκθεση 2012* Ίδρυμα Οικονομικών και Βιομηχανικών Ερευνών. Αθηνα. [Διαθέσιμο στην ηλεκτρονική ιστοσελίδα http://iobe.gr/]

Εθνικός Οργανισμός Φαρμάκων, 2021. Στοιχεία Πωλήσεων Φαρμάκων 2000-2013. Αθήνα. [Διαθεσίμο στην ηλεκτρονική ιστοσελίδα: https://www.eof.gr/web/guest/stats].

Ελληνική Στατιστική Αρχή (ΕΛΣΤΑΤ) 2019: Συστήματα Λογαριασμών Υγείας 2019 [Διαθέσιμο στην ηλεκτρονική ιστοσελίδα https://www.statistics.gr/el/statistics/-/publication/SHE35/]

Η Φαρμακευτική αγορά στην Ελλάδα Γεγονότα & Στοιχεία 2013. Ίδρυμα Οικονομικών και Βιομηχανικών Ερευνών. Αθηνα. [Διαθέσιμο στην ηλεκτρονική ιστοσελίδα: http://iobe.gr.]

Η Φαρμακευτική αγορά στην Ελλάδα Γεγονότα & Στοιχεία 2019. Ίδρυμα Οικονομικών και Βιομηχανικών Ερευνών. Αθηνα. [Διαθέσιμο στην ηλεκτρονική ιστοσελίδα: http://iobe.gr]

ICAP, (2018) Κλαδική μελέτη για τα Γενόσημα Φάρμακα . [Διαθέσιμη στην ηλεκτρονική σελίδα: www.icap.gr]

Κουσουλάκου, Κ. Βίτσου, Ε. (2008) *Η Αγορά Φαρμάκου στην Ελλάδα Ετήσια Έκθεση 2008 Παρατηρητήριο Οικονομικών της Υγείας*. Αθηνα. Available at: http://iobe.gr/.

Παπαδόγγονας, Θ. (1999). Οι Δαπάνες για Έρευνα και Ανάπτυξη στην Ελληνική Βιομηχανία. Οικονομικό Πανεπιστήμιο Αθηνών.

Τσανανα, Ε. (2016). *Η Δυναμική Κατανομών Επιλεγμένων Μακροοικονομικών Μεταβλητών: Εμπειρικές Προσεγγίσεις για τις Χώρες της Κεντρικής και Νότιας Ανατολικής Ευρώπης*. Αριστοτέλειο Πανεπιστήμιο.