THE EFFECT OF RESEARCH AND DEVELOPMENT INVESTMENT ON FIRMS' FINANCIAL PERFORMANCE: EVIDENCE FROM MANUFACTURING FIRMS IN TURKEY[1*]

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Abstract

Following recent literature, we present a model of endogenous firm performance with research and development (R&D) investment as one of the main mechanisms of firm performance. The purpose of the study is to enhance the analysis of the variables influencing firms' financial performance: thus we focus our investigation on the study of the effect of research and development investment on firm's financial performance. Return on assets used as a measure of financial performance. Capital structure, liquidity, efficiency and firm size factors determining firm performance also are investigated. Manufacturing firms registered Istanbul Stock Market (BIST) were classified according to the sectoral approach. The sectoral approach is an aggregation of the manufacturing industries according to technological intensity and based on the Statistical Classification of Economic Activities in the European Community (NACE) at 3-digit level. The level of R&D intensity served as a criterion of classification of economic sectors into high-technology, medium high-technology, medium low-technology and low-technology industries. Our study evidences a positive effect of R&D intensity on the firm performance by using GMM system estimators for a sample of 145 manufacturing firms registered BIST for the 2008–2013 periods. This paper gives empirical support to those recommendations from policy makers and business leaders for maintaining the R&D expenditures especially in high-technology sectors even when facing a recession.

Keywords: R&D, innovation, firm performance, generalized method of moments, Turkey

1. Introduction

During the last few decades scholars have increasingly stressed the importance of research and development (R&D) in the manufacturing sector. Technology-based companies in this sector put forth large expenditures for R&D in order to maintain their competitive advantage and ensure their future viability (Lee et al., 2011). This implies that due to increasing competition, firms should innovate at an extraordinary pace by developing and improving new products and services, and by generating ideas expressly intended to become commercially viable and profitable business ventures (Ehie and Olibe, 2010). Innovativeness is one of the fundamental instruments of growth strategies to enter new markets, to increase the existing market share and to provide the company with a competitive edge (Gunday et al, 2011). Companies have become more motivated to carry out R&D as a result of the fact that most of the world`s economies have embarked policies reforms on market-oriented liberalization aimed at promoting economic performance (Salim and Bloch, 2009). Additionally, the spillover effects from R&D are beneficial not only to firms but also to economies. Therefore, corporate R&D activities as well as public R&D activities will produce R&D spillovers that will eventually yield benefits to the entire society (Bednyagin and Gnansounou, 2012).

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Due to the rising costs of R&D and the increasing dependence of companies on technology for competitive advantage, managers seek evidence of the impact of R&D on performance. Past studies have documented that a firm's R&D investment consistently and positively affects its market value (Chauvin and Hirschey, 1993; Bae and Noh, 2001). Corporate R&D investment also plays a vital role in a firm's future growth (Bae and Noh, 2001). As firms and industries continue to evolve, R&D has increasingly become a critical element of firm success and survival (Jimenez and Sanz-Valle, 2011; Bell, 2005) and sustainable competitive advantage (Johannessen, 2008; Mumford and Licuanan, 2004). Taking 883 firms in the United States during 1957-1965 as sample and using Cobb-Douglas production function, Griliches (1980) found that R&D was positively correlated with operating performance. Then, Jaffe (1986), Hall (1993) and Klette (1996) used similar methods to study the same subject; they all supported the conclusions of Griliches (1980). The evidence, suggests that R&D investment creates value for the firm because it provides competitive advantage through differentiation strategies that produces new and better products and services. In the last few decades a large number of studies have attempted to map the channels and mechanisms through which new knowledge is transformed into better performance (Hashi and Stojcic, 2013). The evidence from this literature is inconclusive thus calling for further research.

There are different the definition of R&D. Generally, scholars accept the definition of R&D put forth by the Organization for Economic Cooperation and Development (OECD, 2008): ''R&D comprise creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society, and the use of this stock of knowledge to devise new applications.'' R&D is the basis of innovation and the key to improve the core competence of listed companies. Increasing R&D activity has been considered key to innovation (Cardoso and Teixeira, 2009). R&D capability is a source of innovation (Wang et al, 2013). As noted by Mone et al. (1998), innovation capability is the most important determinant of firm performance. Another study by Renko (2011) shows innovativeness is a key determinant of return on assets. Moreover, R&D is also known as innovation cost because it is the cost of discovering new knowledge concerning the manufacturing processes of a company, its products and its services (Khazabi, 2008). R&D expenditures were used as a proxy for innovation inputs (Zhong et al, 2011; Morbey and Reithner, 1990). R&D innovation efforts are the most important activities of high-technology firms; that is, R&D investments are one of the most crucial elements to scientific and technological progress (Verma and Sinha, 2002). Innovation is a key element for firms to be successful and competitive in the long run in the knowledge-based economy (Sum, 2013).

One of the ways in which this study is different from prior empirical studies is that it focuses on investigating R&D as a factor of enhancing the financial performance of firms. As a result, the following research question has been put forth: What is the impact of R&D on the financial performance of firms? The main purpose of this study is to investigate the impact of R&D on firm's financial performance. The study aims to make significant contributions to existing literature in accounting and finance in the follows ways: First, most prior researchers on Turkey have focused on product, process, organization and marketing innovations, but ignored effects of R&D on financial performance. That is, a few studies examine effects of R&D on financial performance. For example; Gunday et al. (2011) revealed that product, organization and marketing innovations have positive effects on firm performance in manufacturing industries. Atalay et al. (2013) show that technological innovation has significant and positive impact on firm performance, but no evidence was found for a significant and positive relationship between nontechnological innovation and firm performance. This study focus on relationship between R&D and financial performance for a

sample of 145 manufacturing firms registered BIST for the 2008–2013 periods. Second, it is widely assumed by policymakers and business leaders that higher R&D investment translates into competitive advantages and triggers a firm's financial performance. This means that understanding the empirical relationship between R&D and firm´s performance is important for board of directors and general managers of firms as well as other policy makers when they have to make strategic economic policies and decisions about R&D investments. Third, manufacturing firms registered Istanbul Stock Market (BIST) was classified according to the sectoral approach in the study. The sectoral approach is an aggregation of the manufacturing industries according to technological intensity and based on the Statistical Classification of Economic Activities in the European Community (NACE) at 3-digit level. The level of R&D intensity served as a criterion of classification of economic sectors into high-technology, medium high-technology, medium low-technology and low-technology industries. Fourth, to estimate the relationship between R&D intensity and financial performance in Turkish manufacturing companies, we use dynamic panel estimators, namely the dynamic estimators: System Generalized Methods of Moments (System GMM).

The present article is organized as follows: following this introduction, previous studies, the theoretical background of firms' financial performance and influencing factors are provided in Section 2; Section 3 describes the data set and discusses the empirical approach used; empirical analysis, including major findings are presented in Section 4; Section 5 concludes the paper and future lines of research.

2. Theory and Literature Review

As the knowledge economy era, the competition between enterprises has become increasingly fierce, and business becomes increasingly international, the product life cycle has been shortened dramatically (Ehie and Olibe, 2010). In this background, technological innovation has become the key to survival and development. Through technological innovation, enterprises can develop or introduce new products or lower costs, to meet customer needs better, to increase market competitiveness; also to be the first to enter new business areas or markets, and form new profit growth, which can improve corporate profitability (Gunday et al, 2011). Investments R&D represent one way for firms to search for innovations that may strengthen existing product-market positions, and/or provide opportunities to enter new product-market domains (Katila and Ahuja, 2002), thereby improving performance. A firm can use this knowledge in different ways to develop innovations and competencies, and improve its performance. As a result, R&D has been regarded as a significant factor in enhancing the specialization patterns of a company's competitive advantage internationally, helps in the maintenance or improvement of existing products, creation of new products and innovation of the production processes of companies thereby improving firm´s performance (Salim ad Bloch, 2009).

R&D efforts have long been recognized as the driving forces of progress and innovation, and much evidence in the literature relates these efforts to economic performance. Earlier studies on R&D intensity or innovation typically reported a positive relationship between R&D intensity or innovation and measures of firm performance. The existing literature on R&D provides evidence that R&D efforts influence firms' financial performances (Lin et al., 2006; Griliches, 1986; Jaffe, 1986). Henderson and Cockburn (1994) and Hagedoon and Cloodt (2003) stated that R&D efforts can demonstrate the innovative competences of firms and that these efforts have been found to affect firm performance, particularly in high-tech industries.

A series of related articles by Jaffe (1986), Cohen and Klepper (1996) found that R&D expenditures are strongly correlated with performance at the firm level. Griliches (1986)

highlighted the significant relationship between a firm's R&D expenditures and that firm's productivity. On the basis of a sample of Japanese manufacturing firms in 1982, Goto and Suzuki (1989) find that the growth of productivity is positively related to the growth of R&D investment in a firm's core activity. Similarly, Wakelin (1998) finds that R&D intensity had a positive and significant effect on productivity growth. Morbey and Reithner (1990) and Del Monte and Papagni (2003) found a positive relationship between R&D activity and sales growth in their empirical study of Italian manufacturing firms. Privately financed R&D expenditures are often considered one of the key factors that explain efficiency at the firm level. Similarly, O'Mahony and Vecchi (2009) found that firms' investments in R&D capital, specifically R&D and human capital, have a significant impact on their productivity and performance.

Recent studies on R&D intensity or innovation typically reported a positive relationship between R&D intensity or innovation and measures of firm performance. Xin et al. (2010) found that technologically innovative products have a statistically significant positive effect on operating performance. Ehie and Olibe's (2010) research showed that after controlling for firm size, industry concentration and leverage, R&D investment positively affects firm performance. Gunday et al. (2011) revealed that product, organization and marketing innovations have positive effects on firm performance in manufacturing industries. Atalay et al. (2013) found that technological innovation has significant and positive impact on firm performance in Turkish automotive supplier industry. As seen earlier studies, many of these researches find a positive relationship between R&D intensity or innovations and firm performance, but there are also some studies indicating a negative link or no link at all (Capon et al., 1990 and Chandler and Hanks, 1994). Consequently, R&D efforts have the potential to provide competitive advantages that result in improved firm performance. All of the above studies attest that a firm's investment in R&D efforts may directly impact the firm's performance. Given the significant evidence that R&D is a source of future economic profit for different country firms or industries (e.g. Griliches, 1986; Jaffe, 1986; Henderson and Cockburn, 1994; Hagedoon and Cloodt, 2003; Lin et al., 2006; O'Mahony and Vecchi, 2009; Ehie and Olibe, 2010), there is a strong possibility that R&D can result in higher economic profits. Basing on the above mentioned theoretical and empirical findings in the literature, R&D intensity has a positive impact on firm performance.

Following recent literature, we present a model of endogenous firm performance with R&D investment as one of the main mechanisms of firm performance. Capital structure, liquidity, operating efficiency and firm size factors determining firm performance also are investigated.

There is two different theories pertaining to the relationship of profitability with capital structure: Static trade-off theory and the pecking order theory. According to the Static trade-off theory, more profitable firms are supposed to have more debt-serving capacity and more taxable income to shield. Therefore, according to this theory, when firms are profitable they are likely to prefer debt to other sources in order to benefit from the tax shield (Chakraborty, 2010). The Static trade-off theory assets that a company's target debt-equity ratio holds the key to its capital structure. The theory that states that more profitable firms have lower expected bankruptcy costs and higher tax benefits (see, for details Jensen, 1986; Hart and Moore, 1995). Hence a positive relationship is expected between profitability and leverage. However, The Pecking order theory provides a contrary view. The Pecking order theory postulates a company's capital structure stems from a hierarchy of decisions. Companies would give first preference to the use of internal funds or retained earnings for meeting the financing requirements of their investment projects. Myers and Majluf (1984) pecking order theory which states that firms tend to use internally generated funds first before resorting to

external financing expects a negative relationship between profitability and leverage. Firms with higher profitability will prefer internal financing to debt and hence a negative relationship is expected between profitability and leverage. Myers (1984) refers to this as a 'pecking order theory' which states that firms prefer to finance new investment, first internally with retained earnings, then with debt, and finally with an issue of new equity. The pecking order theory, which postulates a negative correlation between the profitability and the degree of the financial leverage (Myers, 1984; Myers and Majluf, 1984). Empirical studies generally find a negative relationship between leverage and profitability (e.g. Titman and Wessels, 1988; Rajan and Zingales, 1995; Booth et al., 2001; Fama and French, 2002; Joeveer, 2013; Chakraborty, 2013). Consequently, a positive relationship would confirm the static trade-off theory and a negative relationship would confirm the Pecking order theory.

Hadlock and James, (2002) in his study on undervalued firms found a positive relationship between the use of debt finance and firm performance. Ebaid (2009) found the relation of short term debt and total debt to total assets is negative and statistically significant with the performance. Gleason et al (2000) for European countries, Chen and Zhao (2004) for USA, Huang and Song (2006) for China, Deesomsak (2004) for Malaysia, Shah and Khan (2007) for the Pakistani firms, Durukan (1997), Albayrak and Akbulut (2008) and Şahin (2011) for Turkey, Seppa (2008) for Estonia found that a negative relation exists between leverage and and profitability. The empirical studies support the view that optimal capital structure decisions are very critical to the success of the firm and these decisions vary across industries and countries. The importance of the optimal capital structure decisions is much more crucial in the capital intensive industries compared to the other industries as huge amount of capital and resources are required to operate these firms.

The optimal working capital theory that states that for managing liquidity efficiently, a company's management has to decide on the optimum level of current assets and current liabilities it should carry. Very low levels of current assets expose the company to the risk of not having enough cash for meeting its maturing liabilities, losing customers through a strict credit policy or running out of inventory when an unanticipated upsurge in demand for its products occurs. Conversely carrying very high levels of current assets would reduce aforementioned risks but adversely affect profitability due to excessive investment in these assets, which at least in part would remain unproductively tied up, either as cash or inventory. Thus the issue of liquidity management boils down to the management deciding on the appropriate trade-off between risk and return. On one hand, the possible catalyzing effect of liquidity on profitability, as a consequence of the greater possibility of meeting short-term commitments, seems not to be sufficiently relevant for greater liquidity to mean increased profitability. On the other hand, the possible restrictive effect of liquidity on profitability, as a consequence of managers investing in unprofitable projects also seems insufficiently relevant for greater liquidity to mean diminished profitability (Serrasqueiro, 2009). Adams and Buckle (2003) obtain a negative and statistically significant relationship between liquidity and profitability for firms in Bermuda, while Goddard et al. (2005), in the context of Belgian, French, Italian, Spanish and British companies, find positive relationships between liquidity and profitability. As explained by Eljelly and Abuzar (2004), if efficient liquidity management improves profitability, an inverse relationship should be expected between liquidity and profitability indicators. Eljelly and Abuzar (2004) studied the linkage of profitability with liquidity, as indicated by the current ratio and cash cycle. Through correlation and regression analysis a significant inverse relationship between firm profitability and liquidity was found. Albayrak and Akbulut (2008) and Şahin (2011) also found inverse relationship between firm profitability and liquidity for Turkish manufacturing firms.

A number of studies from the literature have shown the importance of firm size in influencing the performance. Large size companies are usually diversified and therefore less likely to go bankrupt. The Static trade-off theory's argument is that larger size companies have a higher preference for debt financing because of a lower probability of bankruptcy. In support of this is the assumption that large firms being more diversified, are less likely to go bankrupt (Titman and Wessels, 1988). Larger firms have more capabilities and resources, achieve economies of scale. Firm size could therefore be inversely related to bankruptcy and thus directly related to profitability. Furthermore, bigger size companies can be expected to be more resourceful and therefore efficient in collecting receivables from their own credit customers. All these factors contribute towards the greater ability of larger companies in maintaining lower levels of liquidity and cash cycle, as compared to smaller size companies (Frank and Goyal, 2003). Firm size is used as a control variable in the study to check the differences of firm's operating environment in the model. The size of the firm is measured by taking natural log of the totals assets and will be used to check the effect of firm size on the performance. Eljelly and Abuzar (2004) found that through correlation and regression analysis a significant inverse relationship between firm profitability and liquidity was found, while company size and profitability exhibited a direct and strong relationship. Şahin (2011) and Albayrak and Akbulut (2008) also found a positive relationship between firm size and profitability for Turkish manufacturing firms.

3. Methodology and Data

3.1. Method

We examine the effect of R&D investment on firm financial performance with the panel data methodology, because of the benefits it provides. Baltagi (2005) and Hsiao (2002) indicate panel data methodology controls for individual heterogeneity, reduces problems associated with multicollinearity and estimation bias, and specifies the time-varying relation between dependent and independent variables. Additionally, it is really important to add the lagged values of the variables to the research model as an explanatory variable while examining the economic and financial relations as the result of fact that the economic and financial behavior is largely influenced by past experiences and old patterns of behavior in this period. In this case, panel data model established becomes dynamic panel data model structure instead of static panel data. In econometrics literature, dynamic panel data analysis is based on the Generalised Method of Moments (GMM), which was the first developed by Hansen (1982). Arellano and Bond (1991) proposed the GMM estimator for panel data to control the potential endogenous explanatory variables. Arellano and Bover (1995) and Blundell and Bond (1998) developed a dynamic panel GMM estimator that estimated with a level-equation and a difference equation, which is called a 'system GMM'. The resulting system of regression equations in differences and levels has better asymptotic and finite sample properties than the Arellano-Bond (1991) differences GMM estimator. Thus, this study analyzed the proposed models using the dynamic panel system GMM estimator, which produces unbiased and consistent estimates after controlling for endogeneity and firm-specific effects even when the sample period is short. We therefore estimated our models using the GMM estimator based on Arellano and Bover (1995) and Blundell and Bond (1998), which allows us to control for endogeneity by using instruments. In particular, we use the GMM-System (GMM-SYS) estimator developed by Arellano and Bover (1995) and Blundell and Bond (1998) methodology to deal with endogeneity. It is especially appropriate for this situation where we have (i) few time periods and many individuals; (ii) a linear functional relationship; (iii) more importantly, in a period of economic and financial behavior is largely influenced by past experiences and old patterns of behavior, economic or financial relations lagged values of the

variables examined in the research model. Thus, adding the lagged value as an explanatory variable is important to research the model. We conducted a serial correlation test for panel GMM estimators developed by Arellano and Bond (1991). The significant serial correlation means our estimated coefficients were biased. Thus, in order to produce robust results we tested the serial correlation and the test results were insignificant. Also, it is necessary to test the results of dynamic panel data estimation model that are realized under the conditions of GMM with first and second-order autocorrelation tests suggested by Arellano and Bond (1991). According to the results, it is expected that second-order autocorrelation would be significant statistically. The models that do not have the second-order autocorrelation are the suitable models. The fact could be tested by the Wald test that whether the model estimate is done correctly or not (Roodman, 2006).

3.2. Models and Variables

Our study adopts the dynamic panel data approach and GMM System to estimate the parameters. The independent variable with lagged periods is included in *Eq. (1)* as shown below. Beyond the dynamic panel data, the model that establishes the relationship between R&D investment and firm performance is based on the earlier literature. According to the earlier literature discussion and this study' purpose of research, we modify the studies of Ehie and Olibe (2010), Ciftci and Cready (2011), Hung and Chou (2013) and Wang et al. (2013) to establish the relationship between R&D investment and firm performance. We estimate the following transformed model:

$$Performance_{it}=\alpha+Performance_{it-1}+\beta_1 Size_{it}+\beta_2 Liquidity_{it}+\beta_3 Leverage_{it}$$
$$+\beta_4 Asset_{it}+\beta_5 Inventory_{it}+\beta_6 Accounts\ receivable_{it}+\beta_7 Accounts\ payable_{it}$$
$$+\beta_8 Research\ and\ development_{it},+\beta_9 Industry_{it}+v_{it} \qquad Eq.\ (1)$$

Where subscripts *i* and *t* indicate firm and time period, respectively. β_0 that is common to all recipient firms. In Eq. (1) $Performance_{it}$, is firm profitability in the current period. $Performance_{it}$ is dependent variable. $Performance_{it-1}$ is firm profitability in the previous period. Firm´s performance is generally measured using accounting-based indicators and these indicators have been regarded as the most important criterion for evaluating the performance of firms (Sher and Yang, 2005). We use return on assets *(Roa)* following the studies such as Artz et al. (2003), Lev et al. (2005), Shu-Ching and Wenching (2006), Sher and Yang (2005), Renko (2011). Many researchers have used Roa as the measure of profitability (Vijayakumar and Devi, 2011; Delmar et al, 2013) because it truly reflects the positions of the company. It reflects that how much income is earned through the assets of the firm. Because this study aims to investigate the performance implications of R&D expenditures at the corporate level, we measured firm performance in terms of profitability, rather than in terms of "innovative outputs" such as productivity or number of patents.

The control variables employed in our study are firm size (*Size*), firm liquidity (*Liq*), firm leverage (*Lev1* and *Lev2*), firm operating effectiveness rates (Asset, inventory, accounts receivable, accounts payable) and industry dummy. $Size_{it}$, firm size as a log of total assets. Fallowing studies (Rahaman, 2011; Wu and Yeung, 2012), we use the natural logarithm of total assets as measures of the size of the firm to control for size in my regression analysis for that purpose which is mainly adopted by other researches. *Size* is measured as a natural logarithm of a firm's total assets to avoid any compounding effect of firm size on firm

performance by controlling for economies and diseconomies of scale, a proxy commonly used in related literature Graves and Langowitz (1993), as a surrogate for firm size. $Liquidity_{it}$, is firm liquidity in the current period. Liquidity (*Liq*) will be measured by making use of Current ratio, which is composed out current asset/current liabilities, following Adams and Buckle (2003), Goddard et al. (2005), Serrasqueiro (2009) and Rahaman (2011). $Leverage_{it}$, is firm financial leverage in the current period. Leverage is a proxy for firm risk and it controls for cross-sectional variation in firm valuation due to differences in capital structure (Ehie and Olibe, 2010). We use two leverage variables: *Lev1 and lev2*, fallowing studies (Joeveer, 2013 and Drobetz et al, 2013). *Lev1* is defined as long term debt + current liabilities to total equity. *Lev2* is defined as interest coverage ratio.

We use four main operating effectiveness rate to measure the effects of them on firm performance: $Asset_{it}$ is firm's asset turnover rate in the in the current period. $Inventory_{it}$ is firm's inventory turnover rate in the in the current period. *Accounts receivable* $_{it}$, is firm's accounts receivable turnover rate in the current period. *Accounts payable* $_{it}$, is firm's accounts payable turnover rate in the current period.

Research and development $_{it}$, is firm's research and development intensity in the current period (R&D). $R\&D_{it-1}$ is firm's research and development intensity in the prior period. We measure R&D intensity by dividing company R&D expenditures by its net sales following the studies such as Cohen and Levinthal (1990), Katila and Ahuja (2002), Hall and Bagchi-Sen (2007), Chen and Miller (2007) and Alessandri and Pattit (2012). Ehie and Olibe (2010) also used R&D expenditures to net sales instead of the capitalized R&D to sales as a measure of R&D intensity. This is preferred to using absolute R&D investment level as it relates to firm size and may confound the relationship R&D investment has on the market performance of a firm (Hall and Bagchi-Sen, 2007). Research assessing R&D performance has focused on measures of performances derived mainly from R&D expenditures. Generally accepted innovation performance measures are R&D expenditures, the numbers of patented or patentable process and products and the new product announcements to the market (Alpkan et al., 2005)[2]. R&D intensity has been used as a measure of firm-level dedication to knowledge creation (Hall et al., 2005).

Additionally, firm performances and characteristics may vary not only over time but also across industries. In order to capture these variations and avoid biased estimates, a number of dummy variables have been included for high- and low-tech firms, firm size, year and the industry to which each firm belongs. $Industry_{it}$, *is* an aggregation of the manufacturing industries according to technological intensity and based on the Statistical Classification of Economic Activities in the European Community (NACE) at 3-digit level. The level of R&D intensity served as a criterion of classification of economic sectors into high-technology, medium high-technology, medium low-technology and low-technology industries.

3.3. Data

We analyze a sample of 145 firms from manufacturing companies in Turkey, covering the quarterly period from 2008:Q1 to 2013:Q1. The data base comes from the Public Disclosure Platform (KAP) and Istanbul Stock Exchange (BIST) in Turkey. We had a balanced panel of 3045 samples belonging to 4 classified sectors according to the Industry according to the NACE code of industrial sectors developed by the OECD and Eurostat. The selection of knowledge- intensive sectors follows Eurostat and OECD's classification which is based on

[2] Coad and Rao (2008) has used two indicators for innovation in a firm: the patents applied for by a firm and the amount of R&D undertaken. In research and development the literature, different types of innovation inputs have been used, such as R&D expenditures (Lee et al, 2011; Zhong et al, 2011; Morbey and Reithner, 1990).

the ratio of R&D expenditure to GDP or R&D intensity (Delmar et al, 2013). Manufacturing firms registered Istanbul Stock Exchange (BIST) were classified according to the sectoral approach. The sectoral approach is an aggregation of the manufacturing industries according to technological intensity and based on the Statistical Classification of Economic Activities in the European Community (NACE) at 3-digit level. The level of R&D intensity served as a criterion of classification of economic sectors into high-technology, medium high-technology, medium low-technology and low-technology industries (available on the web at http://epp.eurostat.ec.europa.eu/cache/ITY_SDDS/en/htec_esms.htm). The dependent and independent variables are shown in Table 1.

Table 1: Variables Description

Firm performance Variable	Roa	Return on Asset in the current year
	Independent variables	Description
Firm Variables	Firm size (Size)	Natural logarithm of a firm's total assets
	Liquidity (Liq)	Current ratio (Current asset/current liabilities)
	Financial leverage (lev1)	Total debt to equity ratio (long term debt + current liabilities to total equity)
	Financial leverage (lev2)	Interest coverage ratio (pre-tax profit + interest expense to interest expense).
	Asset turnover rate (Asset)	Net sales to total assets
	Inventory turnover rate (Inventory)	The cost of goods sold to inventories
	Accounts receivable turnover rate	Net sales to accounts receivable
	Accounts payable turnover rate	The cost of goods sold to accounts payable
Research and Development variable	Research and Development intensity (R&D)	R&D Expenditure/Net Sales
Industry Variables	High technology industry (H)	Industry intensty dummy
	Medium-High technology industry (M-H)	Industry intensty dummy
	Medium-Low technology industry (M-L)	Industry intensty dummy
	Low technology industry (L)	Industry intensty dummy

4. Empirical Results and Discussion

The findings of this research are presented under two separate titles. First is the presentation of sample. The second is the findings of analysis of panel data.

4.1. General Characteristics of the Sample

Table 1 provides descriptive statistics of all variables. During the entire period 2008–2013, used as an indicators of firm performance, the mean value of Roa is 0,7%. In addition, the average R&D intensity, R&D Expenditure/Net Sales, is above 0.5%. As can be seen from Table 2; financial leverage variables, total sales are average 1,447, 1,443, 7,939, respectively. These findings implying that the sample contains firms which although R&D and profitability is low, leverage is very high.

Table 2: Descriptive statistics

Roa	3045	0,007	0,222	-8,447	1,855
Size	3045	7,939	0,875	4,791	10,672
Lev1	3045	1,447	8,408	-76,344	281,824
Lev2	3045	1,443	38,907	-988,408	638,917
Liq	3045	3,706	90,434	0,004	4851,345
Asset	3045	0,596	0,755	-0,008	26,904
Inventory	3045	14,225	96,521	-0,723	1392,74
Accounts payable	3045	4,958	6,804	-6,700	162,486
Accounts receivable	3045	7,437	43,699	-0,029	103,885
R&D	3045	0,005	0,034	-0,133	1,086

Table 3 shows the distribution of technology intensity of the sample. As observed, 5 firms in high technology industry, 84 firms in medium technology industry, the remaining 56 firms in low technology industry in the sample in in terms of technology intensity. 3,5% of the sample is high, 38% medium-high, 20% medium-low and 39% of low-level tech industry segment. Therefore, it can be said the sample contains mid-level technology-intensive companies.

Table 3: The Distribution of Technology Intensity of the Sample

High technology industry	5	3,45
Medium-High technology industry	55	37,93
Medium-Low technology industry	29	20,00
Low technology industry	56	38,62
Total	145	100

Table 4 reports the correlation coefficients between the variables. Some of correlation coefficients were statistically significant variable pairs are as follows: Roa-Size, Roa-Lev1, Roa-Lev2, Roa-R&D, R&D-Size, R&D-Lev1, R&D-Liq.

Looking at the issue in terms of firm performance, there is a negative statistically correlation between Size and R&D variables. This means that small firms have a more R&D expenditure. That relationship between performance and the other variables is not significant statistically in the correlation analysis are set out.

Table 4: The Correlation Matrix (N: 3045)

Roa	1,000								
Size	0,180*	1,000							
Lev1	-0,001**	-0,026*	1,000						
Lev2	0,055*	0,119**	-0,083	1,000					
Liq	0,030	-0,024	-0,004*	0,005	1,000				
Asset	0,164**	0,261	0,013*	0,036*	-0,008*	1,000			
Inventory	-0,002	-0,298*	0,004*	-0,004*	-0,004	0,058	1,000*		
Accounts payable	0,065	0,156	-0,020	0,018**	0,003*	0,151**	0,018**	1,000	
Accounts receivable	-0,412	-0,043*	-0,009**	-0,021*	-0,003*	0,079	-0,024	-0,015*	1,000
R&D	0,013***	-0,081**	-0,001*	-0,011	-0,002	-0,032**	0,001	-0,023	-0,014

*, ** and *** show the statistical significance levels at 0.10, 0.05 and 0.01 respectively.

The next part of the study, beyond a simple correlation analysis, relationships between firm performance and the independent variables in the models are set out by using panel data analysis in detail below.

4.2. Panel Data Estimations

In this section, the findings of the system generalized method of moments of Arellano and Bover / Blundell and Bond dynamic panel data analysis models are presented. The findings of the firm performance models are shown in Table 5. Models 1, 2, 4, and 5 in Table 5 include terms of R&D intensity at concurrent time period *t* and lag time period $t - 1$, in addition to the control variables. From the Wald test results to test the overall significance of the performance models in the table, all the models are significant. In addition, second-order autocorrelation (AR2) to test Arellano and Bond autocorrelation test applied for the presence of second-order autocorrelation (AR2) is not significant. Thus, that the second-order autocorrelation is not to be required condition for suitability models is satisfied. As a result of these tests, instrumental variables used for estimating the growth models are valid and models are appropriate by using System GMM. Finally, performance models provide the conditions for the overall significance, autocorrelation and instrumental variable regression. Table 5 reports the empirical results from our estimations of firm growth, modeled by Eq 1.

Table 5: System Dynamic Panel Data Robust Estimations

Roa Lagged	0,388*** (0,000)	0,388*** (0,000)	0,387*** (0,000)	0,443* (0,094)
Size	0,057* (0,065)	0,056* (0,074)	0,046* (0,065)	0,045* (0,068)
Liq	-0,002* (0,081)	-0,002 (0,138)	-0,003* (0,090)	-0,002* (0,076)
Lev1	-0,145*** (0,000)	-0,147*** (0,000)	-0,147*** (0,000)	-0,143*** (0,001)
Lev2	0,001* (0,078)	0,001* (0,089)	0,001* (0,067)	0,001 (0,106)
Asset	0,158* (0,068)	0,160* (0,067)	0,169* (0,068)	0,170* (0,065)
Inventory		0,001* (0,054)	0,001* (0,060)	0,001* (0,055)
Accounts payable			-0,002 (0,197)	-0,001* (0,094)
Accounts receivable				0,002* (0,095)
R&D	0,203** (0,048)	0,204** (0,047)	0,210** (0,045)	0,207** (0,041)
H	0,140* (0,057)	0,136* (0,078)	0,243* (0,087)	0,234* (0,095)
M-H	0,369* (0,099)	0,356 (0,109)	0,289* (0,079)	0,286 (0,179)
M-L	0,429** (0,036)	0,415 (0,107)	0,336* (0,084)	0,334* (0,081)
L	0,926* (0,088)	0,917* (0,089)	0,857* (0,085)	0,851* (0,093)
Wald Chi2 Test	2129,38***	2140,80***	2181,53***	3676,84***
Arellano-Bond first order -AR(1)	-1,27 (0,004)	-1,27 (0,003)	-1,28 (0,008)	-1,26 (0,0079)
Arellano-Bond second order -AR(2)	1,03 (0,305)	1,04 (0,308)	1,03 (0,299)	-1,01 (0,309)
Number of observations	2900	2900	2900	2900
Number of groups	145	145	145	145

*, ** and *** show the statistical significance levels at 0.10, 0.05 and 0.01 respectively. Numbers in parentheses are probability.

As observed in Table 3, the effect of R&D intensity on financial performance is statistically significant positive in all cases. This finding is consistent with hypothesis implying that there

is a positive relationship between firm research and development investment and firm financial performance. A positive relationship between such R&D intensity and financial performance is consistent with the punctuated equilibrium framework suggest that R&D has been regarded as a significant factor in enhancing the specialization patterns of a company's competitive advantage internationally, helps in the maintenance or improvement of existing products, creation of new products and innovation of the production processes of companies thereby improving firm´s financial performance. According to this result, when we study the sample in average conditions, an increase in the R&D investment positively influences firm's return on assets. That is, the firms which undertake intense R&D expenditures reinforce their financial performance. These results suggest that R&D intensity, the investment in knowledge generation and innovation makes a strong contribution to financial performance. A firm has to offer and/or the processes used to deliver the products and services and also to strengthen the competitive power in today's business world based on new technology innovation. So, R&D has also been known as one key strategic factor to firm's sustainable competitive capability. This finding is in line with those obtained in previous literature for different sectors and countries. The existing literature on R&D provides evidence that R&D efforts influence firms' financial performances (Lin et al., 2006; Griliches, 1986; Jaffe, 1986). Henderson and Cockburn (1994) and Hagedoon and Cloodt (2003) stated that R&D efforts can demonstrate the innovative competences of firms and that these efforts have been found to affect firm financial performance, particularly in high-tech industries. This result also is consistent with studies such as Jaffe (1986), Morbey and Reithner (1990), Cohen and Klepper (1996), Del Monte and Papagni (2003), Xin et al. (2010), Ehie and Olibe's (2010), Gunday et al. (2011) and Atalay et al. (2013).

Firm size is observed to be positively associated with profitability. The finding in the paper is that the profitability of the manufacturing sector firms is positively and significantly related to the size of the firms. Large size companies are usually diversified and therefore less likely to go bankrupt. Firm size could therefore be inversely related to bankruptcy and thus directly related to profitability (Frank and Goyal, 2003). The significance of the coefficient of the size variable suggests that the firms in manufacturing sector increase their profitability by increasing the sales, either by enhancing the volume or the prices per unit. Furthermore, bigger size companies can be expected to be more resourceful and therefore efficient in collecting receivables from their own credit customers. All these factors contribute towards the greater ability of larger companies in maintaining lower levels of liquidity and cash cycle, as compared to smaller size companies. This finding is consistent with the studies such as Eljelly and Abuzar (2004), Titman and Wessels (1988) and Şahin (2011).

Liquidity is observed to be negatively associated with profitability. This evidence is in line the Theory that states that for managing liquidity efficiently, a company's management has to decide on the optimum level of current assets and current liabilities it should carry. Thus the issue of liquidity management boils down to the management deciding on the appropriate trade-off between risk and return. As explained by Eljelly and Abuzar (2004), if efficient liquidity management improves profitability, an inverse relationship should be expected between liquidity and profitability indicators. This implies that the manufacturing sector firms in Turkey have adopted active and effective liquidity management strategies. This finding confirm findings of the studies such as Adams and Buckle (2003), Eljelly and Abuzar (2004), Albayrak and Akbulut (2008) and Şahin (2011).

Financial leverage is observed to be negatively associated with profitability. This piece of evidence is in line with the Pecking Order Theory, which postulates a negative correlation between the profitability and the degree of the financial leverage (see, for detail Myers, 1984;

Myers and Majluf, 1984). This implies that the manufacturing sector firms in Turkey give first preference to the use of internal funds or retained earnings for meeting the financing requirements of their investment projects. They would next go for debt financing in case the internal sources are insufficient and as a last option external financing through a new equity issue would be used. This finding is consistent with studies such as Titman and Wessels (1988), Chen and Zhao (2004, 2005) for USA, Gleason *et al* (2000), Rajan and Zingales (1995) for European countries, Huang and Song (2006) for China, Deesomsak (2004) for Malaysia, Shah and Khan (2007) for the Pakistani firms, Şahin (2011), Albayrak and Akbulut'un (2008), Durukan (1997) for Turkey, Seppa (2008) for Estonia. However, this finding is in contrast to the Static trade off theory that states that more profitable firms have lower expected bankruptcy costs and higher tax benefits (see, for details Jensen, 1986; Hart and Moore, 1995). Financial leverage2 (Lev2), interest coverage ratio (pre-tax profit + interest expense to interest expense), has also positive sign in financial performance regression as expected, implying that interest coverage ratio has a encourage effect on firm financial performance.

We use four main operating effectiveness rate to measure the effects of them on firm performance. Firm's asset turnover rate, firm's inventory turnover rate and firm's accounts receivable turnover rate in the current period have positive sign in financial performance, while firm's accounts payable turnover rate in the current period has a negative sign in financial performance as expected. This means that these firm have increased financial performance by using efficient of assets, reducing their inventories, collecting accounts receivables as soon as possible and jumping to pay accounts payables.

Finally, we have evaluated the differences among the sectors as defined by the Eurostat codification. All of the effect of industry technology intensity on firm financial performance is significantly positive in all cases, shows industry technology intensity is the main determinant of firm financial performance. Those firms included in the all technology industry obtain a clear market response to their R&D efforts.

Conclusion

The main purpose of the study is to enhance the analysis of the variables influencing firms' financial performance: thus we focus our investigation on the study of the effect of research and development investment on firm's financial performance. Our study evidences a positive effect of R&D intensity on the firm financial performance by using GMM system estimators for a sample of 145 manufacturing firms registered BIST for the 2008–2013 periods. A positive relationship between such R&D intensity and financial performance is consistent with the punctuated equilibrium framework suggest that R&D has been regarded as a significant factor in enhancing the specialization patterns of a company's competitive advantage internationally, helps in the maintenance or improvement of existing products, creation of new products and innovation of the production processes of companies thereby improving firm´s financial performance. These results suggest that R&D intensity, the investment in knowledge generation and innovation makes a strong contribution to financial performance. This paper gives empirical support to those recommendations from policy makers and business leaders for maintaining the R&D expenditures especially in high-technology sectors even when facing a recession.

Following recent literature, we present a model of endogenous firm financial performance with R&D investment as one of the main mechanisms of firm financial performance. Capital structure, liquidity, operating efficiency and firm size factors determining firm financial performance also are investigated. Firm size is observed to be positively associated with

profitability. The finding in the paper is that the profitability of the manufacturing sector firms is positively and significantly related to the size of the firms. Financial leverage is observed to be negatively associated with profitability. This piece of evidence is in line with the Pecking Order Theory, which postulates a negative correlation between the profitability and the degree of the financial leverage. We use four main operating effectiveness rates to measure the effects of them on firm financial performance. Firm's asset turnover rate, firm's inventory turnover rate and firm's accounts receivable turnover rate in the current period have positive sign in financial performance, while firm's accounts payable turnover rate in the current period has a negative sign in financial performance as expected. This means that these firm have increased financial performance by using efficient of assets, reducing their inventories, collecting accounts receivables as soon as possible and jumping to pay accounts payables. Finally, we have evaluated the differences among the sectors as defined by the Eurostat codification. All of the effect of industry technology intensity on firm financial performance is significantly positive in all cases, shows industry technology intensity is the main determinant of firm financial performance. Those firms included in the all technology industry obtain a clear market response to their R&D efforts.

The study aims to make significant contributions to existing literature in accounting and finance in the follows ways: First, most prior researchers on Turkey have focused on product, process, organization and marketing innovations, but ignored effects of R&D on financial performance. That is, a few studies examine effects of R&D on financial performance. Second, it is widely assumed by policymakers and business leaders that higher R&D investment translates into competitive advantages and triggers a firm's financial performance. This means that understanding the empirical relationship between R&D and firm´s financial performance is important for board of directors and general managers of firms as well as other policy makers when they have to make strategic economic policies and decisions about R&D investments. Third, manufacturing firms registered Istanbul Stock Market (BIST) was classified according to the sectoral approach in the study. Fourth, to estimate the relationship between R&D intensity and financial performance in Turkish manufacturing companies, we use dynamic panel estimators, namely the dynamic estimators: System Generalized Methods of Moments. Further research should examine the interrelationship using other various financial performance measurements. It is also necessary to further examine the relationships among financial performance, cost reduction, efficiency gain and profits in the banking industry and tourism industries due to its differences from the manufacturing industry. The non-financial performance construct such as customer satisfaction improvement, corporate image improvement can be used performance measures for further research.

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