Effective innovation via better management of firms: The role of leverage in times of crisis [*]

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Abstract

The relationship between innovation activities and firm performance has been well established in the context of major economies. However, in the case of emerging economies, firms are more financially constrained, and they tend to suffer from weaker-management practices, which can be a drag on their performance despite greater innovation. Hence, whether better-managed firms benefit more effectively from innovation via greater access to finance remains unexplored. Using quarterly firm-level data during 1992–2015 from Turkey, this paper aims to uncover whether innovation intensity, in the traditional sense, namely R&D and intangibles, and better managerial practices, in the modern form, contribute to the performance of Turkish firms. By considering the financial constraints before and after the 2008 global financial crisis and by undertaking an impact evaluation of improved accounting regulation, we find that all types of innovation activities boost profitability. In addition, R&D activities, along with better management quality, help improve firm performance. Furthermore, although higher debt level, in general, is harmful, firms with better management quality make more effective use of innovative activities with greater access to debt-finance, boosting their performance. Lastly, those better-managed firms in an emerging economy outperformed even during times of financial stress following the global financial crisis. The above findings survive a battery of robustness checks.

Keywords: profitability, global financial crisis, financial-leverage, R&D, innovation, management quality

1. Introduction

Traditionally, knowledge stocks were recognized as critical in improving firm performance in many studies such as Hall et al. (2013, 2007), Hall (2011, 2010), Hall and Oriani (2006). However, investments in those activities might differ depending on firm attributes like firm size, the industry in which they operate (e.g. Mallick and Sousa, 2017; Mallick and Yang, 2011) and the capital structure of a firm. Therefore, that capital structure choice may influence the investments directed to innovation activities and hence the firm performance. On the other hand, there is a second strand of the literature arguing that the differences in firm performance are the consequence of differences in quality of management (see Bloom et al., 2019; Bloom and Van Reenen, 2007, 2010; Bloom et al., 2012; Keller, 2011, 2009). However, studies focusing on management quality do not incorporate the role of innovative activities in firm performance, as well as how those activities

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are affected at a time of financial crisis, or in financially constrained firms. Thus, the first contribution of this paper is to integrate these two strands of the literature to investigate the role of innovation and management in firm performance in an emerging economy, following the recent financial crisis.

While analyzing firm performance, a firm's ability to finance its activities is a crucial aspect emphasized in the literature on financial constraints (see studies such as Brown et al., 2012; Borisova and Brown, 2013). While the earlier literature reviews how investment decisions matter in shaping the firm-level investment behavior (Peltonen et al., 2012, 2011), financing constraints remain critical in driving investment in knowledge capital. There is a view in some studies that innovation activities diminish during uncertain times when a firm uses excessive borrowing to maintain its business. Lenders, in general, require tangible assets as collateral, and they are less inclined to finance R&D based projects. So, in those times, the common practice is to reduce expenses, which may affect R&D when a firm is already financially constrained.

On the other hand, Archibugi et al. (2013) have an alternative argument, suggesting that firms may choose to maintain R&D activities during crisis times because of the initial investment and if they do not experience any financial constraint. The question is whether innovation-intensive firms with different debt-equity structures display differences in their performance. In other words, whether innovation-intensive firms perform better if they have higher debt-level. Despite the market-based equity financing system, debt finance remains the dominant form of corporate financing, including short-term bank loans.

At a general level, financing type and R&D investment may jointly influence firm performance, particularly so during crisis times. Nemlioglu and Mallick (2017) analyzed this for the UK firms and found that intangibles were helpful along with higher R&D activity; this is because of the change in the valuation of intangibles in the post-crisis period. However, Brown et al. (2012) argue that R&D intensive firms are more likely to be financed by equity than debt, as the issues such as lack of collateral and asymmetric information could drive R&D investment below the optimal level. Degryse et al. (2018) showed that not all SMEs in the UK had faced the same difficulty accessing the debt market. Raising capital is a challenge that many small firms face, as they cannot easily access the equity market, turning to debt financing, more so during crisis times. This problem is more acute in many emerging economies like Turkey, where access to finance for innovation activity can be costly and scarce (see, e.g., Bose et al., 2020).

Although prior literature has well established the relationship between innovation activities, leverage, and firm performance in the advanced economies such as the UK, Europe and USA, studies exploring the same in the

context of emerging economies are limited (see, for instance, Bose et al., 2020; Vig, 2013). Firms in those countries are more financially constrained and generally suffer from weaker-management practices. More innovative firms can ease their financial constraint, but weaker management practices can be a drag on their performance. Besides, there are inconsistencies in the valuation of firm-level intellectual capital in emerging markets, such as Turkey. As there has been no specific regulation on the reporting standard of organizational and intellectual capital, Turkish firms followed different approaches to report managerial practices.

Although there have been earlier attempts to improve accounting standards in accordance with EU accession criteria, those attempts have gained momentum in the aftermath of the Global Financial Crisis. An important development with reference to the wider adoption and application of IFRS is the new Turkish Commercial Legislation Act (adopted in 2008), which mandates all companies (listed or non-listed) to prepare and present their financial statements in accordance with IFRS. Turkish Capital Markets Board (CMB) imposed that they report in Turkish Financial Reporting Standards (TFRS) which is the translated version of IFRS, to make firm-level performance comparable for foreign investors,[1] so as to attract foreign capital and thereby help ease their financial constraints, during crisis times.

Hence, using firm-level quarterly data from Turkey during 1992–2015, this paper explores whether better management quality could have made any difference to the impact of innovation on firm profitability in the post-crisis regime and following the policy implementation regarding better accounting practices in 2008.Our research adds to the literature in many ways. First, we examine the role of R&D and intangibles on the performance of Turkish firms. Second, we investigate whether the impact of innovation varies for companies that use a higher level of debt financing. Third, we explore whether better-managed firms make more effective use of innovation via greater access to finance and perform better. Fourth, by asserting a temporal variation using the global financial crisis as well as incorporating a policy shift in the reporting standard via Difference-in-Differences (DID) framework, we assess how better management can aid innovative firms those who have unconstrained financing access. To sum up, our main research question focuses on whether innovation-intensive firms with higher leverage perform better during crisis times if they have better management practices.

[1] Full compliance was required by 2013.

Our findings are as follows. First, we find that different types of intellectual capital, namely R&D activities, and intangible assets, contribute to the performance of Turkish firms. Following the crisis, R&D intensive firms also indirectly benefit from intangibles regardless of their debt structure. Also, firms with better-management quality benefit more effectively from innovation combined with higher leverage. This suggests that Turkish firms who are more financially constrained could benefit significantly by focusing on R&D investment in the post-crisis period. Our results remain unchanged with three robustness checks: namely by replacing the intangible assets with total assets; using alternative indicators for firm profitability (such as market to book value, return on invested capital, cash flows to sales) disaggregating firms as high and low innovation-intensive firms.

The rest of the paper is structured as follows: Section 2 reviews the literature and develops hypotheses. Section 3 discusses the data and methodology. Section 4 presents the results and conducts various robustness checks. Finally, Section 5 concludes the paper.

2. Literature Review

2.1. Impact of Innovation on firm performance: R&D intensity and intangible assets

Conventionally, productivity was measured by two factors, namely: capital and labor. The capital input was measured by the investment in physical goods, plants, and machinery. However, with the rise of the idea of a knowledge economy, the need for recognizing and incorporating R&D investment in product or process development has become pertinent while strengthening managerial practices to create better organizational capabilities (see Haskel and Westlake, 2018).

Prior literature mainly argues that R&D intensity and patents explain the changes in the valuation across firms. For instance, Hall et al. (2007) investigate quality-weighted patents in European firms and find that patents in software and business are considerably more valuable than others, especially if they are taken out in the US. Helmers and Rogers (2011) found that patentees in high-tech start-ups and SMEs have higher asset growth than non-patentees. On the other hand, Thomson and Webster (2013) find that SMEs, highly leveraged firms, and firms with less ability to patent are more likely to pursue an external R&D strategy, despite the risks. Moreover, in a cross-country setting, Kim et al. (2012) estimated the role of intellectual property protection on firm performance and cross-country growth. They found that patentable innovations matter for firm growth, while utility model innovations contribute to the performance of technologically lagging firms. Those minor innovations can then gradually lead to patentable inventions later. Gao and Chou (2015) argue that patent

protection plays a vital role in firm valuation for globally diversified firms, especially for those with higher R&D intensity. In a more recent theoretical and empirical analysis, Chu et al. (2021) also establish that countries with stronger patent protection tend to exhibit greater innovation and growth in the short-run when the number of firms is fixed.

Similarly, also at an aggregate level, Nemlioglu and Mallick (2020a) and Nemlioglu (2019) uncovered that higher intellectual property (IP) supported by more vigorous enforcement leads to higher capital stock. Also, Chen et al. (2014) find that substantial patent rights stimulate R&D activities in more-capital-intensive sectors in countries with more innovation capability. He and Wintoki (2016), and Carosi (2016) uncovered that the increase in the average liquidity of US firms could be explained by their R&D investments. Findings of Carosi (2016) reveal that the impact of R&D intensity on the market to book ratio is greater in more patent-intensive firms and increases with the R&D of local firms.Hall (2011) argues that the effect of product innovation on revenue is positive, but the influence of the process innovation is less observable. Also, Hall et al. (2013) find that only 4% of all R&D or innovation-intensive firms apply for patents. This finding supports the idea that parts of knowledge assets could also be kept within firms' intangible assets rather than formal protection such as patents. So, in general, the literature is in favour of the impact of R&D and intangibles on firm performance, which leads to the following hypothesis.

Hypothesis 1: Intangible assets and R&D intensity improve firm performance, both directly and jointly.

2.2. The Impact of Quality of Managerial Practices on Firm Performance

Earlier studies such as Fung et al. (2007), Du et al. (2015) and Doong et al. (2011) point out gaps in the traditional production function, that is, the absence of skilled human capital. Also, Doong et al. (2011) find that social, financial, and human capital are essential aspects influencing firm performance. Early studies such as Abeysekera and Guthrie (2004); Striukova et al. (2008) argue that an enterprise with greater human capital can innovate more, leading to better performance. Following an extensive review of the literature, we have grouped the literature into three strands as below.

First-strand of literature exploring the financial performance across firms finds that the quality of management is a vital aspect in creating performance differences across firms (Bloom et al., 2019) and countries (Bloom et al., 2014). Earlier studies on managerial practices, notably, Bloom and Van Reenen (2010, 2007) find that those practices influence firm performance across countries such as the US, UK and Europe. Similarly, organizational and technological innovation capabilities are found to induce firm performance in Spain (see

Camisón and Villar-López, 2014). Moreover, the literature also argues that higher-quality management practices are indispensable sources of competitive advantage (see Mol and Birkinshaw, 2009; Armbruster et al., 2008) through organizational innovation in better firm performance. Bloom et al. (2014) discussed that technological innovations have a wide range of effects on productivity. The impact is much higher when firms are more decentralized and have stronger "people management" practices – structured policies over hiring and a strong emphasis on ability and effort when determining promotion, dealing with underperformance and pay (see Bloom et al., 2012a, 2012b).

Their methodology has first been used in (Bloom and Van Reenen, 2007), and it is based on scoring firms as 1 to 5 for the "worst" to "best" across eighteen critical management practices. A firm is given a low score if it fails to track performance, has no effective targets, does not take ability and effort into account when deciding on promotions (e.g., completely tenure-based) and has no system to address persistent employee underperformance. In contrast, a high scoring organization frequently monitors and tries to improve its processes, sets comprehensive and stretching targets, promotes high-performing employees and fixes (by re-training, rotating and, if unsuccessful, exit) underperforming employees.

However, in general, the impact of the quality of management has commonly been overlooked in the literature in innovation-firm performance relationship due to the difficulty of its measurement (Mol and Birkinshaw, 2009). Therefore, there is a gap in the literature on this aspect which we aim to address in this paper. A similar concept that was used in the second strand of literature is organizational capital. For instance, recent studies such as Hasan and Cheung (2018) as well as the earlier studies such as Edvinsson and Sullivan (1996), Edvinsson (1997), Bontis (1998) use the term organizational capital or strategic innovation; whereas, García-Meca et al. (2005), and García-Meca and Martínez (2007) use the term intellectual capital and decompose it into categories such as human capital, customers, organizational innovation, R&D and strategy. Interestingly, Hasan and Cheung (2018) find that organizational capital is higher in the firms either in the early stages or at the decline stage, rather than mature-ones.

The third strand of the literature is first noted in earlier studies such as Verschoor (1999), Simpson and Kohers (2002), Stanwick and Stanwick (1998) and Hillman and Keim (2001), investigating the organizational performance from the corporate social responsibility (CSR) point of view and found that participating in CSR activities positively influences firm profitability and increases shareholder value. Consequently, following the review, it is arguable that, regardless of the terms used, better organizational performance leads to greater firm

performance. In other words, better managerial quality improves firm profitability. The above arguments lead to the second hypothesis as follows:

Hypothesis 2: Firms with better management quality are more profitable directly and indirectly via innovation.

2.3. The Impact of Financial Leverage on Innovation-Firm Performance Relation in the pre-and-post-crisis periods

It is well known that innovation leads to performance differences across firms. However, the debate on how innovation might affect the performance of financially constrained firms is still an ongoing issue. Although the role of R&D at the firm and country-level growth has widely been addressed, the results of the studies on how financing frictions affect R&D are mixed (see Hall and Lerner, 2010). For instance, in countries such as Sweden and the UK (see Brown et al., 2012); and the US (see Brown et al., 2009; Brown and Petersen, 2009), R&D intensities are high in young firms. On the other hand, interestingly, in Germany and the UK, R&D is not related to cash flows (see Bond and van Reenen, 2003). Besides, the US and the UK are more cash-flow sensitive than European firms (see Hall, 2010); however, investment flows to R&D in those markets are as high as in Europe (see Brown et al., 2012). R&D spending, by its nature, is more sensitive to future earnings variability than physical assets (see Li, 2011). Therefore, due to their vulnerability to this fluctuation, more R&D intensive firms might be reluctant to use debt and instead use more equity financing. In summary, many of the early studies argue that the capital structure of R&D-intensive firms customarily exhibits less leverage than others, and therefore more likely to be financed by equity (Hall, 2002; Hall et al., 2009; Clausen and Hirth, 2016).

On the other hand, empirical findings of Cumming (2005) support the argument that the mix of financing instruments minimizes the costs arising from a type of agency problem. In contrast, high-technology firms tend to be financed with convertible preferred equity. Additionally, according to Tian et al. (2017), the role of openness for innovation to access financing in Chinese firms is mainly driven by private and manufacturing firms. Therefore, the first strand of the literature argues that financial constraint impairs innovation activities in some firms.

However, Hall (2010) finds little evidence that the intangible nature of R&D investments alone leads to lower innovative activity without any additional factor such as financial crisis when the true valuation of intangibles can get reflected on firm performance (see Nemlioglu and Mallick, 2017). As found by Guney et al. (2017), the used credit lines and investments in R&D have a positive relationship. The effect is more substantial for

financially constrained firms than for unconstrained firms. Therefore, although the 2008 economic crisis has severely reduced the short-term willingness of firms to invest in innovation, this reduction has not occurred uniformly. A few firms even increased their investment, despite the adverse macroeconomic environment (see studies such as Archibugi and Filippetti, 2011; Filippetti and Archibugi, 2011; Archibugi et al., 2013). A few others have directed their focus on long-term debt obligations to short-maturity debts (see Datta et al., 2019). Archibugi et al. (2013) argue that this is due to being committed to R&D activities because of previous agreements. Furthermore, Archibugi et al. (2013) also find that exploitation strategy could explain increased innovation investment before the crisis.

Interestingly, the crisis was found to lead to a concentration of innovative activities within a small group of fast-growing new firms which were already highly innovative before the crisis. So, the presence of in-house R&D activity explains increases in innovation spending following the financial crisis. Filippetti and Archibugi (2011) find that this persistence can be due to various firm-specific characteristics—such as managerial differences and innovation intensity. Of course, the supply-side of capital, namely, financial development, also matters for firm capital structure decisions, which positively affect firms' leverage (see Antzoulatos et al., 2016).

On the other hand, Kieschnick and Moussawi (2018) find that a public firm's capital structure choice also depends on its governance features. The more power that insiders possess, the less debt that the firm uses as it ages. Czarnitzki and Kraft (2009) find that while the market for equity capital might exert insufficient control on top managements' behavior, this weakness may be mitigated by a suitable degree of debt-financing. Crummenerl et al. (2015) argue that the managerial approach based on the excessive use of leverage contributed to the overall increase in risk premium during the recent financial crisis. More recently, Sharma and Tarp (2018) find that an internal locus of control in a top manager expects higher revenue and an increased likelihood of undertaking innovations.

At an aggregate level, governance features, such as the regulatory environment, also matter in the firm's access to debt financing. Also, McNamara et al. (2017) argue that the inefficient capital regulatory environment may lead to lower debt levels and lower investments. Interestingly, Huang and Shang (2019) find that firms surrounded by more trusting environments have less need to use financial leverage in their capital structure and less short-term debt in their debt structure. Moreover, larger firms use higher levels of debt, as they are likely to have lower default risks and enjoy better reputations. According to Aktas et al. (2015), firms converge

to their optimal working capital level by adjusting their investment levels to performance. Xu et al. (2013) find firms with under-investment problem can overcome this if the firm has stronger political connections. Therefore, following this extensive review of the literature, we argue that the impact of leverage on the innovative and less innovative firms as well as better managed firms may portray differences in the period following the financial crisis. The arguments above lead to the next hypothesis.

Hypothesis 3: Leverage has an adverse effect on firm performance in general, but firms with better management quality or higher innovation-intensity benefit from leverage, even in the post-crisis period.

3. Data and Methodology

3.1. Data Description

This paper investigates the role of innovation and management quality on profitability using firm-level quarterly data from Turkey, Istanbul Stock Exchange (ISE) "BIST100" over the period 1992-2015, obtained from Thomson Reuters DataStream. Firm performance is assessed by a profitability measure called profit margins as our dependent variable, which is calculated as total profit over total sales. All the variables in the analysis are used on a logarithmic scale. The variable names and descriptions are listed in Table 1-a. Each variable is a ratio of sales to prevent potential scaling problem due to differences across firms. Intangible assets over sales are the amount of intangible assets divided by total sales. Assets over total sales can also be named total asset turnover, which is one of the standard variables used in similar analyses, in addition to the logarithm of total assets. Therefore, instead of using the log of assets, we incorporated the log of asset turnover variable into our models. Additionally, we have R&D intensity, which is defined as the total amount of R&D investments over total sales, which indicates R&D per unit of output (see Carosi, 2016). The description of the main variables can be found in Table 1-a below.

Furthermore, we incorporated a quality variable by adding modern innovation activities such as "better quality of management" or "better management practices". These are factors in addition to the traditional innovation concept. They aim to investigate whether those modern practices play any role in exploring firm performance following the financial crisis, especially in financially constrained firms. As per the related literature discussed in the previous section, human and organizational capital can be considered the main attributes of better-management quality. Thus, we generated a quality variable to capture the management practices presented in the next subsection. The managerial practices concept has first been used in (Bloom and Van Reenen, 2007b), and the methodology is based on scoring firms as 1 for "worst practice" to 5 for "best practice" across eighteen

key management practices. This tool measures management practices in three key areas. First one is monitoring and mainly questions how well the organizations monitor what goes on inside the firm and use this information for continuous improvement. Second one is the targets and ensure whether organizations set the right targets, track the right outcomes, and take appropriate action if the two are inconsistent. Finally, third one is the incentives and people management that examine whether organizations promote and reward employees based on performance, prioritizing careful hiring, and trying to keep their best employees.

Similarly, we create our managerial quality variable by taking the above attributes into account and designing an index based on six dimensions by using Principal Components Analysis (PCA). Table 1-b below presents descriptive statistics of the main variables of interest, along with their correlations. The summary statistics show that in the post-crisis period, the profit margins have declined from an average of 0.20 to 0.17. In contrast, the firm leverage has increased from 27.52 to 32.74, indicating that the Turkish firms heavily relied on debt-finance in the post-crisis period. Interestingly, the ratio of total intangible assets to sales has increased following the crisis from 0.056 to 0.112. This finding is parallel to what Nemlioglu and Mallick (2017) observed using UK firms between 1992-2014. In that sense, it is possible to conclude that the financial crisis had various effects on the innovation and firm performance relationship in different markets.

Moreover, the second part of Table 1-b classifies the firms into two categories using a dummy variable: firms with high or low management quality. The results show that firms with high management quality benefit from greater performance in terms of profits, sales, and higher levels of innovation shown by R&D and intangibles. To increase the credibility in the analysis, we added market to book values (MTBV) and return on invested capital (ROIC), and total assets, which again showed that high management quality firms performed better. Also, firms with high management quality found to be more debt intensive than the others, indicating those firms are more innovation-oriented and benefiting from debt-financing in covering their innovation expenses.

Table 1-a Description of the variables

Variable notations	Explanations
PM	Profit Margin calculated as Net Profit /Net Sales
Int	Intangible assets ratio calculated as Total Intangible Assets/Total Sales
R&D	R&D intensity
Mng	Quality of Management
DtoC	Financial Leverage (Total Debt/Total Capital)
TotA	Total Assets
Dum_MQ	Dummy of Managerial quality- 1 if the company is quality intensive 0 otherwise
Crisis	Dummy variable related to the financial crisis (1 if year>=2008, 0 otherwise)
IPbased	Dummy variable separating firms as per IP (1 if total intangibles of a company are above the average, 0 otherwise)

Notes: A more detailed description of each variable as it was given in DataStream is available upon request.

Table 1-b Panel 1: Summary statistics of main variables

Variable	Obs	Mean	Std. Dev.	Min	Max		PM	Int	RnDintens	Dtoc
PM	9600	0.189	1.222	-4.99	28.71	PM	1			
Int	9600	0.0820	0.436	-0.247	14.5	Int	-0.0072	1		
RnD	9600	0.0099	0.0407	0	0.634	RnD	-0.02	0.0736	1	
Dtoc	9600	0.296	0.355	-6.37	4.77	Dtoc	-0.0695	0.0256	-0.1004	1
pre-2008						**Pre- 2008**				
PM	6400	0.201	1.389	-4.99	28.71	PM	1			
Int	6400	0.06	0.53	-0.24	14.5	Int	0.0101	1		
RnD	6400	0.01	0.027	0	0.28	RnD	-0.0235	0.0128	1	
Dtoc	6400	0.275	0.2603	0	0.998	Dtoc	-0.1304	-0.0034	-0.1184	1
post-2008						**Post-2008**				
PM	3200	0.172	0.9104	-1.523	17.97	PM	1			
Int	3200	0.112	0.2675	0	3.44	Int	-0.0767	1		
RnD	3200	0.0096	0.051	0	0.63	RnD	-0.0616	0.3121	1	
Dtoc	3200	0.328	0.462	-6.373	4.766	Dtoc	-0.0084	0.0659	-0.096	1

Notes: Summary statistics belong to the main variables during the whole sample period, pre-and post-financial crisis periods, respectively. All correlations are significant at 5% level.

Table 1-b Panel 2: Summary statistics of classified by quality of management

Low Management Quality						
	Variable	Obs	Mean	Std. Dev.	Min	Max
firm performance	Net profit	8220	44,337	128,097	-636,853	1,200,000
	Net Sales	8220	911,620	2,072,028	0	25,000,000
	MTBV	8220	2.35	4.69	-14.42	71.31
	ROIC	8220	15.53	21.90	-238.04	118.97
innovation	RnD	8220	3,375	9,439	0	89,636
	Intangible	8220	97,008	398,080	-11,473	3,000,000
	Totalassets	8220	6,306,820	23,900,000	7	240,000,000
	Dtoc	8220	25.21	38.43	-637.27	476.59
High Management Quality						
firm performance	Net profit	1380	611,039	902,998	-2,600,000	4,400,000
	Net Sales	1380	6,523,921	10,100,000	135	85,000,000
	MTBV	1380	3.06	4.04	0.26	36.42
	ROIC	1380	16.70	18.56	-61.70	100.73
innovation	RnD	1380	16,470	26,651	0	138,180
	Intangible	1380	500,728	1,159,643	-690,802	11,000,000
	Totalassets	1380	10,100,000	24,800,000	997	200,000,000
	Dtoc	1380	40.81	22.97	0.00	88.67

Note: Firms are classified as high or low managerial quality, using a dummy variable. The results are presented in levels rather than the logarithmic values to show the exact amounts.

3.1.1. Construction of Managerial Practices Index: A Principal Components Analysis

Previously, the literature discussed that better-managed firms outperform others (see Keller, 2009; Bloom et al., 2012; Nemlioglu and Mallick, 2017). Therefore, this paper introduces six important attributes forming the quality of management index following Nemlioglu and Mallick (2017). Parallel to Capelle-Blancard and Monjon (2014), who investigated the impact of the environment, social and governance (ESG hereinafter) activities on the financial performance of funds, we use a dataset which is obtained from Thomson Reuters DataStream. This data is created via the survey named ASSET4, and each variable here is a score for each firm, taking values between 0 – 100 in each period. Table 1-d lists the data which we use in generating the managerial quality variable "Mng".

Table 1-d Description of Managerial Practice Index data

Variable	Name	Explanations
X_1	Integration of Vision and Strategy	Does the company integrate vision and strategies on economic (financial), social and environmental dimensions into its day-to-day decision-making processes?
X_2	Workforce Training and Development	Does the company claim to provide and/or monitor regular skill and business management training for its employees/managers?
X_3	Training and Development Improvements	Does the company set specific objectives to be achieved on employee training and career development?
X_4	Internal Promotion	Does the company claim to favor promotion from within?
X_5	University Partnerships	Does the company claim to cooperate with schools or universities?
X_6	Product Innovation	Does the company have an environmental product innovation policy (eco-design, life cycle assessment, and dematerialization)?

Notes: Source of variable descriptions and questions: Thomson Reuters DataStream and a detailed explanation of each question are available upon request.

Since the managerial quality indicators are correlated (see Appendix A), we combine them into one component by using the PCA and then create the management quality index presented in Table 2. This index helps overcome the problem of multicollinearity and over-parameterization. Following the PCA, the below eigenvalues of the six components are obtained as presented in the first column of Table 2, indicating that the first component with eigenvalue being greater than 1 is relevant, which explains 88% of the variation of the sample variance. Hence, using weights from the first component (i.e., 0.4074, 0.4239, 0.4152, 0.3984, 0.4010 and 0.4030), we create our management quality index as shown in Table 2.

Management Quality Index $(MNG) = \sum_{i=1}^{n} w_i . X_i$

where w_i are the component's loadings or weights, and *Xi's* are the parameters.

$MNG = 0.4074 * X_1 + 0.4239 * X_2 + 0.4152 * X_3 + 0.3984 * X_4 + 0.4010 * X_5 + 0.4030 * X_6$

Table 2. PCA for Managerial Quality Index

	PC1	PC2	PC3	PC4	PC5	PC6
Eigen value	5.30962	0.277623	0.16188	0.123474	0.0806152	0.0414801
Proportion	0.8849	0.0463	0.0279	0.0206	0.0134	0.0069
Variable						
X_1	**0.4074**	0.1558	0.5625	-0.6819	0.1008	0.1353
X_2	**0.4239**	-0.1289	-0.1956	-0.0628	0.267	-0.8308
X_3	**0.4152**	-0.2563	-0.2332	-0.1162	-0.8317	0.048
X_4	**0.3984**	-0.6833	0.0628	0.2679	0.3772	0.3955
X_5	**0.401**	0.5006	-0.6275	-0.0554	0.2503	0.3593
X_6	**0.403**	0.4195	0.4397	0.6654	-0.1479	-0.0609

Notes: The table presents the results of the PCA. PC1 to PC6 indicates principal components from 1 to 6. As PC1 is 5.30962 we only take this component. We take corresponding weights of the PC1 for 6 variables to form the MNG index.

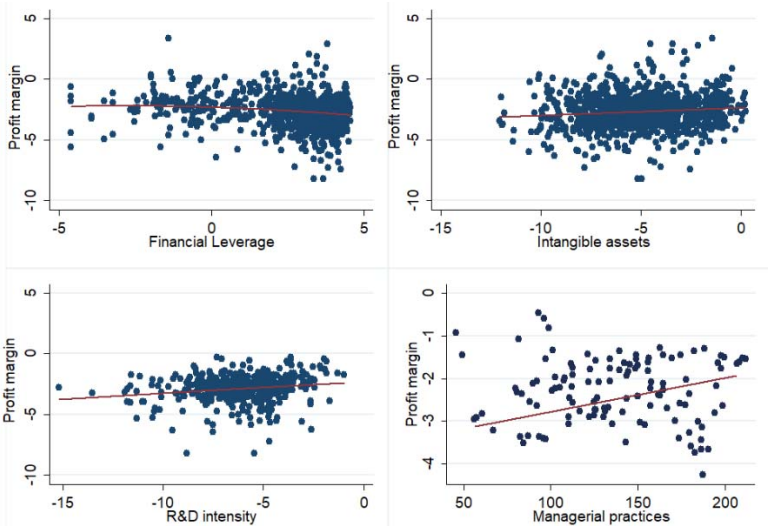
After explaining the construction of the MP variables, their summary statistics are as follows (see Table 3).

Table 3 Summary Statistics for MQ variables

Variable	Obs	Mean	Std.Dev.	Min	Max
X_1	9600	2.34	11.63	0	92.71
X_2	9600	3.50	15.85	0	92.62
X_3	9600	2.36	10.33	0	100
X_4	9600	3.65	17.17	0	92.07
X_5	9600	2.97	14.64	0	81.61
X_6	9600	2.63	13.12	0	96.22
Mng	9600	7.13	31.75	0	211.97

Figure 1 illustrates the scatter plot of profit margin on the y-axis and other explanatory variables on the x-axis (all on a logarithmic scale). The linear fit shows a positive relationship between profit margins and intangibles, R&D and managerial practices, whereas the financial leverage tends to show a non-linear fit. Figure 1 indicates that each innovation element has a positive impact on firm performance, whereas leverage adversely affects the performance of Turkish firms. All the scatter plots are constructed with a 95% confidence interval. The plots have the following R^2: 0.58, 0.15, 0.35, 0.50, consecutively.

Figure 1 Scatter Plot Analysis



Notes: The figures above present scatter plots.

3.2. Methodology

Parameters of the benchmark models are estimated via Fixed Effects by including time and firm-fixed effects. However, to address the potential endogeneity and unobserved heterogeneity in the data, the estimations use the Dynamic System GMM approach (see Arellano and Bond, 1991; Arellano and Bover, 1995; and Blundell and Bond 2000, 1998). Arellano and Bond (1991), Arellano and Bover (1995), and Blundell and Bond (1998) devised dynamic panel estimators designed for situations with a dynamic process, with current realizations of the dependent variable influenced by past ones. This argues against cross-section regressions, which essentially assume away fixed effects. The idiosyncratic disturbances may have individual-specific patterns of heteroskedasticity and serial correlation. Some regressors can be predetermined but not strictly exogenous, independent of current disturbances, and some regressors can be influenced by past ones. To reduce the weak correlation problem, Blundell and Bond (2000) recommend an extended version of difference GMM and a system composed of equations in first differences and equations in levels, along with the use of system GMM. Therefore, we use this extended version of GMM, namely, system GMM.

In our estimations, we draw internal instruments from variables' lags and limited maximum lagged variables to be instrumented to lag two as we only encounter order one serial-correlation. This is to prevent the over-identification problem, as suggested by Roodman (2009a, 2009b). As also discussed in Roodman (2009a, 2009b), there is no specific formula to determine how many instruments are considered "too many instruments". However, empirically, it is reasonable that to prevent overidentification, the number of individuals or groups must be greater than the number of instruments used. Therefore, restricting the number of instruments could be necessary for some panels. For that reason, we used $y_{i,t-1}$ and $y_{i,t-2}$ for lagged

variables, and if the data are transformed by differencing, they are $\Delta y_{i,t-1}$and $\Delta y_{i,t-2}$. Following diagnostic tests are conducted to ensure the validity of dynamic GMM estimations: Sargan test, Arellano and Bond test, and the Wald Chi-Square test.Sargan (1958) test checks for the joint validity of the instruments. In other words, it investigates the existence of the overidentification of the model. Besides, as discussed in detail by Roodman (2009b), Sargan test is more powerful in detecting this than the Hansen test. Also, as argued by Roodman (2009a), Sargan test is not so vulnerable to the instrument proliferation problem as in the Hansen test. Therefore, we reported Sargan test results rather than the Hansen test.

Arellano and Bond (1991) developed the AR test for the autocorrelation in the idiosyncratic disturbance term. To encounter that, we conducted the AR (1) and AR (2) test, and the results showed only order-1 serial correlation due to the dynamic nature of our model, including lagged dependent variable. Finally, the Wald Chi-square test examines the validity of the model. In all our models, we reject the null at less than 1% level; therefore, the coefficients are not simultaneously equal to zero. In other words, removing the variables from the model causes harm to the fit of the model.

In addition to that, the impact of a new program or policy-implementation could be measured by using a 'natural experiment', via the implementation of Difference-in-Differences (DID) approach (see Bertrand and Mullainathan, 2003) or nonparametric matching estimator (see Abadie and Imbens, 2006; Imbens and Wooldridge, 2009) that compares the differences between pre and post-implementation periods. Leverage might have a different effect on firm performance in bad times if firms focus on innovative activities. Although some Turkish firms are more innovation-intensive, the managerial practices have only recently been given importance and thus recorded in data form as a result of the implementation of TFRS. This has been the accounting standard, following the financial crisis, which can be considered as a "regulatory change" to deal with identification in a DID framework. Thus, this accounting standard implementation in the post-global financial crisis period is worth investigating. In the recent literature, program evaluation technique has been used by Vig (2013) in assessing the impact of a security law on firms with high and low-tangibility. Therefore, parallel to Vig (2013), who classified Indian firms as low- and -high tangibility firms, we explore the channels through which managerial quality impacts firm performance and capture the mean difference in profit margins among the Turkish firms with high- and low-quality of management after the global financial crisis. We test whether the heterogeneity in the quality of management matters for the innovation-firm performance

relationship by using two approaches. The first one is by using the DID models. The second one is by adding interaction terms to observe the joint impact of managerial quality and innovation on firm performance. Primarily, we separate the sample into two categories as firms with high- or low-management quality. High quality refers to firms with stronger managerial practices. In contrast, low quality refers to weak practices, which get captured through a dummy variable based on companies recording the data on the managerial practices or not (based on the DataStream survey indicators discussed above).

According to White and Sarbarwal (2014), there are different methods under Quasi-Experimental Design techniques. Methods such as Propensity Score Matching (PSM) or Regression Discontinuity Design (RDD) are mostly known as the 'single-difference effect' as they compare the outcomes of the treatment and control groups. However, when there is an inter-temporal difference taking place in determining the outcome, a 'double difference' method, which compares the changes in outcome over time between treatment and comparison groups, would be more accurate. This is known as DID (see Duan et al., 2016, for details on the various impact evaluation) and is one of the most widely used techniques in Quasi-Experimental Design; however, it comes with limitation as follows. This method is best used in conjunction with other matching methods such as PSM or RDD. If DID is used without matching, the researchers should test the 'parallel trends assumption'. Nevertheless, we have addressed this limitation by using matching techniques. Specifically, we used Kernel-based PSM for matching the sample in the DID estimations.

In addition to the DID methods, single and double difference impact estimates may also be estimated using OLS regression. This approach is applied to the same matched data, including a program or policy dummy variable on the right-hand side of the regression equation. Variables that capture other confounding factors can also be included on the right-hand side to eliminate the remaining effect of any discrepancies in these variables between treatment and comparison groups on the outcomes after matching. Following this method, we also ensured the credibility of our results.

As we found the same results from DID and GMM regression with interactions, we can eliminate the possibility of a selection bias, which otherwise would not give the same results. This is also parallel to the argument of Loi and Rodrigues (2012), who suggest that IV (instrumental variable) regressions and DID estimations are used when there is the possibility of results being driven by observable or unobservable factors. However, the drawbacks of IV regression are that valid instruments are usually not easy to find, and the

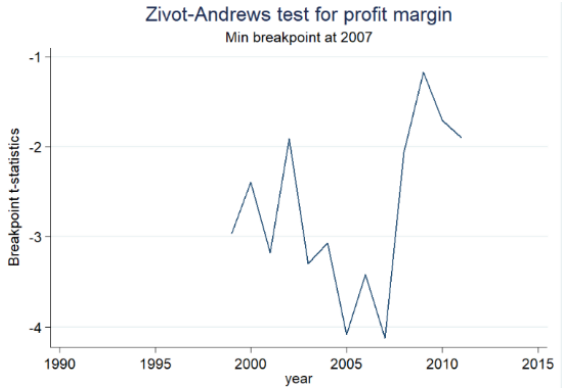
dynamic nature of the data is not addressed. This is best addressed using Dynamic System GMM that solves the issue of choosing the appropriate instrument by drawing "internal instruments" by incorporating the lagged-dependent variable that addresses the need for dynamics. Therefore, we used the Dynamic System-GMM method in conjunction with DID estimations to address any possible hindrance in the data.

4. Empirical Results

4.1. Benchmark Analysis: Testing for a Structural Break in the Pre- and Post-Crisis

In Table 4, we find that all types of innovation, including intangibles, R&D intensity, managerial quality, boost firm performance, whereas the impact of financial leverage is negative on firm performance. The same results also hold when the sample is disaggregated by firm size in columns 5 and 6. So, we can see that the benchmark result still holds even after considering the role of size heterogeneity in the innovation-firm performance relationship. However, it is known that following the recent financial crisis, firms substantially reduced their capital expenses to reduce their vulnerability. Therefore, firms that chose to maintain their investment in innovation could benefit or would at least be less vulnerable to the financial crisis. According to Archibugi et al. (2013), the recent crisis has reduced the short-term willingness to invest in innovation as well as reduced profits. Therefore, it is worth investigating whether the financial crisis empirically has led to any temporal change in profit margins. This also helps us to show that the results in the pre-and post-financial crisis are driven due to a structural break rather than any selection bias (Nemlioglu and Mallick, 2020b). Therefore, we ran the Zivot-Andrews unit root test to empirically confirm the existence of a structural break and kept maximum lags at four due to having quarterly data. The results show that the year 2007 has shown a significant difference and has a minimum critical value. Therefore, this empirically justifies the existence of a structural break in 2007. Graph 1 below presents the structural break drawn from the test and shows the critical values of the test. Columns 7 and 8 of Table 4 present the pre- and post-crisis differences.

Graph 1 Testing for a structural break in profit margins



Notes: This graph presents the result of the structural break test, conducted using the Zivot- Andrews test of a unit root. As structural break tests need time-series data, we have taken average of profit margin variable across firms in each year. By this, we obtained a single observation for each period and then on this new series, we ran the Zivot-Andrews test of a unit root. In our specifications, we allowed breaks and imposed four lags. Minimum t-statistic -4.123 at 2007 (obs 16). Critical values: 1%: -5.57 5%: -5.08 10%: -4.82

The estimated parameters of the following regression are presented in Table 4:

$$logPM_{i,t} = \alpha_0 + \alpha_i + \alpha_t + \beta_1 logInt_{i,t} + \beta_2 RnDintensity_{i,t} + \beta_3 Mng_{i,t} - \beta_4 DebtRatio_{i,t} + \varepsilon_{i,t}$$

Table 4 Benchmark results

	(1) ALL	(2) ALL	(3) ALL	(4) ALL	(5) SME	(6) Large	(7) Pre-Crisis	(8) Post-Crisis
Int	0.0361**	0.0439*	0.0323*	0.0485*	0.0647**	0.0233	0.00075	-0.0023
	[0.0182]	[0.0287]	[0.0293]	[0.0287]	[0.0311]	[0.0603]	[0.003]	[0.0056]
RnD		0.0684**	0.0698**	0.0705**	0.0669*	0.146**	0.0131***	0.0056
		[0.0340]	[0.0340]	[0.0328]	[0.0362]	[0.0639]	[0.00339]	[0.0052]
Mng			0.0221*	0.028**	0.0216*	0.04**	0.0105	0.0747**
			[0.0011]	[0.0012]	[0.0018]	[0.002]	[0.0189]	[0.0304]
DtoC				-0.0133***	-0.0112***	-0.0207***	-0.0194***	-0.0222***
				[0.00327]	[0.00380]	[0.00658]	[0.0034]	[0.0056]
Constant	-2.447***	-2.221***	-2.295***	-1.887***	-1.883***	-1.493***	0.185***	0.155***
	[0.140]	[0.294]	[0.297]	[0.297]	[0.324]	[0.459]	[0.0269]	[0.0412]
Observations	9600	4500	4150	4150	2910	1240	2490	2430
r2	0.0821	0.0562	0.0641	0.198	0.140	0.472	0.341	0.317
r2_a	0.0114	0.0519	0.0452	0.125	0.120	0.165	0.192	0.117

Notes: Standard errors are in brackets. ***, **, * indicate 1, 5, and 10% significance level. The table estimates the model using FE estimations, including time and firm fixed effects.

Although leverage hampers the performance of Turkish firms, as shown in the literature, such as Nemlioglu and Mallick (2020b, 2017), who find that UK firms with higher leverage perform better if they are better managed or more innovation-intensive. Therefore, we explore whether the impact of financial leverage might be different if the firms are innovation intensive. Here we introduce the following debt interactions. "RnDxDtoC", "intxDtoC" and the triple interaction "RnDxintxDtoC". We also add "RnDxint" interaction to see whether firms focusing on both might perform better. We find that although leverage has a direct negative impact throughout (see Table 5), the indirect impact is positive if firms have more intangible assets. Also, debt-intensive firms do not seem to benefit from R&D alone, whereas they could benefit from R&D in the presence of higher intangible assets.

Table 5 Impact of innovation and leverage on firm performance

	(1)	(2)	(3)	(4)	(5)
L.PM	0.00180	-0.0156	-0.000141	0.0348*	-0.0122
	[0.00151]	[0.0247]	[0.0112]	[0.0198]	[0.0227]
Mng	0.0811***	0.0745***	0.0661***	0.087***	0.0940***
	[0.0013]	[0.006]	[0.004]	[0.001]	[0.006]
DtoC	-0.037***	-0.0292***	-0.038***	-0.04***	-0.05
	[0.003]	[0.008]	[0.037]	[0.0014]	[0.008]
Int	0.013***	0.0296***	0.0260***	0.0209***	0.0028
	[0.004]	[0.004]	[0.00215]	[0.001]	[0.0061]
RnD	0.0182***	0.0362***	0.0326***	0.0353***	0.0313***
	[0.0008]	[0.003]	[0.002]	[0.00245]	[0.00534]
RnDxint		0.00507***	0.00331***	0.00313***	0.00174**
		[0.007]	[0.0004]	[0.0003]	[0.0008]
Debt interactions					
RnDxintxDtoC			0.00435***	0.00239***	0.008***
			[0.001]	[0.003]	[0.002]
RnDxDtoC				-0.00125***	0.0016
				[0.002]	[0.00124]
intxDtoC					0.0068***
					[0.0001]
Constant	0.272***	0.349***	0.350***	0.341***	0.272***
	[0.00494]	[0.0211]	[0.0121]	[0.0162]	[0.0349]
Observations	4760	4760	4760	4760	4760
p> Wald(chi^2)	0.00001	0.00001	0.00001	0.00002	0.00002
r2_a	0.0149	0.0238	0.091	0.156	0.216
Sargan	45.24	46.36	45.13	42.59	41.99
p> Sargan (chi^2)	0.999	0.999	0.999	0.999	0.999
AR (1)	-2.533***	-2.466***	-2.429***	-2.500***	-2.568***
AR (2)	0.915	0.920	0.912	0.975	0.976

Notes: Standard errors are in brackets. ***, **, * indicate 1, 5, and 10% significance levels, respectively.

4.2. Exploring the channels: Do better managerial practices matter in innovation-firm performance relationship following a policy shift after the Global Financial Crisis?

Earlier literature shows that better management practices are crucial qualities in uncovering the reasons for performance differences across firms. Additionally, various studies explain better firm performance with greater innovation. However, the literature on the role of management quality on innovation-firm performance relationship in an emerging market is limited (see, for instance, Mallick and Yang, 2011).

Besides, it is a challenging task to determine the "threshold" in quasi-experimental design techniques, especially when the "policy change" in "the impact evaluation" is less evident. Here, we practically know that the 2007 Global Financial Crisis has led to many changes in the global economy and financial systems all around the world, especially in an emerging market economy like Turkey. Thus, we reviewed the accounting and finance literature following the recent global financial crisis in the context of Turkey, which confirms that there has been a regulatory change starting from the year 2008, as discussed below.

With the internationalization of capital markets and the increased volume of international investments, companies that are traded in Turkish Stock market need to provide high quality financial information to access financial resources. In addition to that, with the ongoing attempts of becoming a member of EU, Turkey has attempted to adapt its accounting standards to IFRS, as the EU Member States, by the virtue of Article 10 of the EU Treaty, are required to take appropriate measures to ensure compliance with international accounting standards.

The Turkish CMB is the regulation-setting body for registered firms in Turkish capital markets. The CMB played a major role in the development of national accounting standards for listed firms prior to 2008, including the voluntary adoption of IFRS in 2003 and the mandatory adoption in 2005. Turkish Accounting Standards Board (TASB) finalized communiqués related with the Turkish Accounting Standards, Turkish Financial Reporting Standards (TFRS) and Interpretations prepared by the Board as fully compliant with the IFRS/IAS by May 2007. According to the above regulation, all the companies that are traded in the stock market must prepare their annual reports in accordance with the Turkish Commercial Code as well as tax legislation in Turkey. Additionally, those attempts have been working in parallel with the "New" Turkish Commercial Code, that was initiated in the parliament in 2005 and accepted in 2008. In 2008, Turkish CMB assigned its standard-setting role to the TASB with the following regulation sequence: XI, No: 29 related to "The guideline of financial reporting in capital markets" (CMB, 2008, XI/29). According to this directive, all companies should prepare their financial reports in accordance with the TFRS for the periods starting from 1 January 2008. Overall, the efforts of preparing unified accounting standards are continuous and evolving. However, we particularly focus on the regulatory effort following the 2008 crisis for our "causal impact evaluation".

In summary, the above-mentioned regulation plays an important role as the guidance on how to report intangible assets, to ensure the necessary disclosure of intellectual capital in annual reports for companies that are traded in ISE (Istanbul Stock Exchange). This regulation played an essential role for the Turkish companies to provide more transparent information on their intellectual capital, such as research and development, innovation elements, intangible assets as well as human capital. The reason for the imposition of IFRS is to provide transparent and comparable financial information to foreign investors, as Turkey aimed to improve attracting greater foreign investment flows. Because of the compliance of IFRS, some of those firms have to adapt to better standards in terms of disclosures of non-financial items (such as e.g. environmental, social and governance "ESG" items). This particularly, has made a difference in firms introducing better management practices. The financial crisis of 2008 and Turkey's attempts to improve accounting practices coincided. Therefore, the temporal change cannot be separated from those efforts in accounting practices. Since then, there are efforts in improving managerial practices. Therefore, it is arguable that the crisis and compliance with reporting standards have made difference to the quality of management practice of firms. Hence that is an intervention for good managerial practice. Degree of disclosure of ESG and intangible items especially, improved with the international standards. Therefore, we estimate the impact of the 2008 policy shift in Turkey

regarding IFRS covering innovation elements of firm-level knowledge assets. Even though the policy change has occurred, not all companies have actually chosen to follow the imposed disclosure standard, especially the parts relating to intellectual and human capital as well as ESG items. This is the main reason why we consider the impact evaluation technique and separate the treated and non-treated groups based on their "managerial-practices".

Therefore, we estimate whether Turkish firms that have better managerial practices perform better in the post-crisis periods. To estimate the impact of management quality among firms, we use a quasi-natural type of experiment that is DID estimation. To analyze the quality of managerial practices (MP), we separated our sample into two groups, namely, high and low MP-intensive firms using a dummy variable. Then we conducted DID analysis by matching firms based on their covariates. Specifically, we used the Kernel-based Propensity Score Matching technique as an option in order to match the characteristics of high and low management quality firms, using firm-level intangibles, R&D intensity, and debt to match the high- and low-management quality firms. Table 6 shows that, following the crisis, firms with better management quality tend to achieve greater profitability as compared to poorly managed ones.

Table 6 Impact of MP in explaining innovation-firm performance relationship: DID estimation

		Profit Margin (log)	std.er.	|t|	P>|t|
Before the Global Financial Crisis (pre-intervention)	*low MQ (control)*	2.292			
	high MQ (treated)	2.397			
	Diff (T-C)	0.105	0.342	2.22	0.027**
After the Global Financial Crisis (post-intervention)	*low MQ (control)*	2.593			
	high MQ (treated)	2.933			
	Diff (T-C)	0.34	0.173	1.96	0.050**
	Diff-in-Diff	0.235	0.383	1.98	0.049**

Notes: Our dependent variable is profit margins (in logs). We use DID approach using the Kernel Densities. The pre-crisis period starts with 1992 till 2007 and post-crisis is 2008-2015. We separate the sample as high- and low-managerial practices intensive firms depending on whether they focus on any MP measures.

Furthermore, Table 7 explores the role of managerial practices in innovation-firm performance relationship following the financial crisis, using interaction terms in a Dynamic System GMM setting. Our results suggest that firms with better management practices benefit in terms of greater profitability following the crisis. Columns 3 and 4 use the management practices index as constructed by PCA, namely, "Mng", whereas column 5 replaces that variable with a dummy taking value 1 if the firm is MP intensive, 0 otherwise. In both specifications, MP contributes to firm performance. Also, better-managed firms tend to benefit indirectly from leverage and innovation in the post-crisis period. Additionally, we find that firms with higher R&D intensity in terms of intangibles benefit from leverage in boosting their performance. High debt firms benefit from both greater levels of R&D or intangibles in the pre-and post-crisis period.

Table 7 Impact of management quality on firm performance following the financial crisis

	(1) Pre	(2) Pre	(3) Post	(4) Post	(5) Post
L.PM	0.00239***	0.00182	0.152***	0.111***	0.0827***
	[0.0005]	[0.002]	[0.0210]	[0.0362]	[0.007]
Int	0.0646***	0.000926	0.0226***	0.0180*	0.0374***
	[0.002]	[0.0024]	[0.00823]	[0.009]	[0.0038]
RnD	0.0941***	0.0303***	0.0122**	0.0159*	0.0112***
	[0.003]	[0.002]	[0.0055]	[0.008]	[0.00221]
DtoC	-0.0285***	-0.0125***	-0.0289***	-0.0137***	-0.0133***
	[0.0017]	[0.0017]	[0.004]	[0.001]	[0.0015]
RnDXint	0.0114***		0.0289**		
	[0.0044]		[0.0120]		
Mng			0.0441***	0.0442***	
			[0.0001]	[0.005]	
dum_MQ					0.0499***
					[0.009]
Debt interactions					
RnDxDtoC		0.00251***		0.0061***	0.008***
		[0.00970]		[0.0021]	[0.009]
intxDtoC		0.0078***		0.0077**	0.0041***
		[0.0002]		[0.004]	[0.00980]
intxRndxDtoC	0.00156***	0.00144***	0.00697	0.0019***	0.00204***
	[0.0038]	[0.0014]	[0.006]	[0.0017]	[0.0018]
Constant	0.651***	0.286***	0.223***	0.324***	0.354***
	[0.0198]	[0.0219]	[0.0370]	[0.0183]	[0.0112]
Observations	2230	2230	2030	2400	2400
p> Wald (chi^2)	0.0001	0.0001	0.00001	0.00001	0.0001
r2_a	0.19	0.264	0.109	0.116	0.114
Sargan	34.06	30.59	39.49	35.50	39.69
p>Sargan (chi^2)	0.999	0.999	0.279	0.961	0.612
AR (1)	-2.222***	-2.025***	-2.345***	-2.284***	-2.219***
AR (2)	-1.060	0.377	1.196	1.372	1.232

Notes: Standard errors are in brackets. ***, **, * indicate 1, 5, and 10% significance levels, respectively.
Pre indicates the period between 1992-2007, whereas post, indicates 2008-20015 period.

To explore the impact of better managerial practices in innovation-firm performance relationship, we investigate the indirect impact of better management quality across firms along with higher R&D intensity, debt, and both of them using a triple interaction (see Table 8). The first five columns investigate whether R&D, along with better management quality, contribute to firm profitability in the post-crisis, whereas column 6 considers the whole sample period. The results in the first 6 columns suggest that high-debt companies can benefit from higher levels of R&D or intangibles. Also, companies can still get higher profit margins by focusing on R&D investments if they have better managerial quality in the post-financial crisis period, regardless of their debt intensity, as shown by the triple interaction (i.e. RnDxMngxlogdtoc). Additionally, high-debt firms benefit from focusing on greater managerial quality in the pre-and post-crisis periods (see Columns 7 to 12).

The first five columns in Table 8 investigate the joint impact of R&D and better managerial quality in the period following the global financial crisis (2008 onwards), whereas column 6 includes all periods. Columns 7-8 investigate the impact in the post-crisis periods and 9-10 pre-crisis by replacing the managerial quality variable with a managerial quality dummy (dum_MQ is one if managerial intensive, 0 otherwise, and "D" indicates that the parameters of the model were estimated using the dummy variable for managerial quality). Columns 11-12 look into all sample periods. Table 8 shows us that innovation intensity, both in traditional form, namely R&D and intangibles, and modern form, in better managerial practices, contribute to the

performance of Turkish firms. Firms always benefit from higher R&D and innovation intensity despite the financial crisis. This result holds even in the presence of greater debt levels.

Table 8 Impact of management quality in debt-firm performance relation following the Global Financial Crisis

	(1) Post	(2) Post	(3) Post	(4) Post	(5) Post	(6) ALL1	(7) PostD1	(8) PostD2	(9) PreD1	(10) PreD2	(11) ALL2	(12) All3
L.PM	0.172***	0.110***	0.122***	0.160***	0.109***	0.0036***	0.180***	0.0926***	0.00269**	0.00348*	0.0043***	0.0028***
	[0.0367]	[0.0222]	[0.0134]	[0.0208]	[0.0175]	[0.0002]	[0.0435]	[0.0237]	[0.00113]	[0.00188]	[0.00015]	[0.00022]
Int	0.0295*	0.029***	0.048***	0.021***	0.0572***	0.08***	0.0002	0.0345***	0.0045***	0.0392***	0.0246***	0.009***
	[0.0151]	[0.0059]	[0.00724]	[0.00560]	[0.0077]	[0.004]	[0.00577]	[0.00861]	[0.00083]	[0.00364]	[0.00219]	[0.00029]
RnD	0.011	0.026***	0.019***	0.026***	0.0184***	0.01***	-0.0011	0.0110*	0.019***	0.061***	0.0232***	0.014***
	[0.009]	[0.0034]	[0.0035]	[0.0070]	[0.0034]	[0.0008]	[0.0045]	[0.0064]	[0.0026]	[0.0033]	[0.0018]	[0.00067]
Mng	0.027***	0.014***	0.024***	0.013***	0.0045	0.0793***	0.0098	-0.0629	0.0187***	0.08	0.0173	-0.00029
	[0.053]	[0.004]	[0.00033]	[0.0035]	[0.00048]	[0.084]	[0.096]	[0.0462]	[0.00336]	[0.008]	[0.0130]	[0.005]
DtoC	-0.03***	-0.02***	-0.02***	-0.03***	-0.02***	-0.02***	-0.02***	-0.02***	-0.02***	-0.02***	-0.02***	-0.002***
	[0.045]	[0.0053]	[0.003]	[0.004]	[0.00024]	[0.001]	[0.0065]	[0.046]	[0.0021]	[0.007]	[0.004]	[0.007]
RnDxint	0.005**	0.006***	0.0077***	0.0049***	0.0082***			0.005***		0.007***	0.0035***	
	[0.023]	[0.005]	[0.0011]	[0.0094]	[0.0011]			[0.00123]		[0.0006]	[0.0003]	
RnDxmng	0.0004***	0.0002***	0.0003***	0.00013**	-0.004***	0.014***						
	[0.009]	[0.00006]	[0.00004]	[0.00005]	[0.00014]	[0.0012]						
Debt interactions												
intxDtoC		0.0041**		0.0028**								
		[0.002]		[0.0014]								
RnDxDtoC			0.004***	0.00185	0.0056***							
			[0.001]	[0.002]	[0.0012]							
Mngxdtoc						0.0015	0.003***	0.004***	0.001***	0.004**	0.001***	0.0015***
						[0.0001]	[0.00102]	[0.00062]	[0.00023]	[0.0018]	[0.0001]	[0.00007]
RnDxMngxdtoc					0.001***		0.00415	0.004***	0.004***	0.0025***	0.0033***	0.0029***
					[0.003]		[0.0036]	[0.0013]	[0.0004]	[0.0005]	[0.0003]	[0.0001]
Constant	0.176***	0.278***	0.317***	0.298***	0.334***	0.224***	0.109**	0.209***	0.257***	0.446***	0.275***	0.258***
	[0.0633]	[0.0233]	[0.0212]	[0.0354]	[0.0228]	[0.007]	[0.0477]	[0.0479]	[0.0184]	[0.0246]	[0.0146]	[0.00296]
Obs	2040	2030	2030	2030	2030	4760	2400	2400	2230	2230	4630	4630
p> Wald (chi^2)	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001
r2_a	0.118	0.178	0.165	0.134	0.158	0.102	0.278	0.169	0.778	0.108	0.35	0.241
Sargan	25.25	33.66	36.68	36.14	37.99	44.93	17.75	30.62	27.44	32.77	43.68	45.06
p>Sargan (chi^2)	0.861	0.845	0.741	0.9537	0.911	0.999	0.98	0.9217	0.999	0.999	0.999	0.999
AR (1)	-2.637***	-2.279**	-2.286**	-2.411***	-2.324***	-2.375**	-2.74***	-2.44***	-1.965**	-2.112**	-2.371***	-2.360***
AR (2)	1.333	1.099	1.113	1.351	1.131	0.696	1.337	1.145	0.332	-0.356	0.797	0.770

Notes: Standard errors are in brackets. ***, **, * indicate 1, 5, and 10% significance levels, respectively. The first five columns investigate the joint impact of R&D and better managerial quality in the period following the global financial crisis (2008 onwards) whereas, column 6 for all sample period. Columns 7-8 investigate the impact in the post-crisis periods and 9-10 pre-crisis by replacing the managerial quality variable with a managerial quality dummy (dum_MQ is one if managerial intensive, zero otherwise, and "D" indicates the model was run using the dummy variable). Column 11-12 look into all sample period.

4.3. Robustness Checks

To ensure the credibility of the results, this paper conducted three robustness checks. As the first robustness check, intangible assets are replaced with total assets in the first 5 columns of Table 9, after which the results remain unchanged. The reason for replacing the intangible assets with total assets is the potential over-valuation of the intangibles, which have declined following the Global Financial Crisis (see Nemlioglu and Mallick (2017)). Therefore, we find total assets contributing to better firm performance. Also, the results reveal that even if the debt has a direct negative impact, companies with higher levels of total assets can overcome the adverse impact of debt on firm performance.

Furthermore, debt intensive companies can also benefit from R&D if they have a higher level of total assets. As a second robustness check in Table 10, we replaced the dependent variable with alternative performance indicators (see Carosi, 2016), after which the results remain unchanged. Those variables are: Market to Book Value (MTBV), Return on Invested Capital (ROIC), Cash flows to sales (CF to Sales). So, intangible assets and R&D intensities play a direct positive role in firm performance regardless of the indicators used. Firms

with a high debt level can only benefit if they have greater R&D or intangible assets, both individually and jointly.

As the third robustness check, Table 11 replaces the company classifications from high and low managerial practices companies to intellectual property (IP) based and non-IP based companies. The reason for using intangibles in the classification is to differentiate between high and low knowledge-intensive firms, as those firms get a better valuation and face lower uncertainty (see Nemlioglu and Mallick, 2020b). This helps define firms into a 2-sector setting while controlling for industry variability. We preferred this classification because the traditional manufacturing and service sector division is not useful in the context of innovation, as both sectors can be innovation-intensive, as shown in Nemlioglu and Mallick (2020b). Therefore, any firm with above-average intangible assets is classified as being IP-based, and the rest is classified as non-IP based. The first six columns replace the original intangible variable and estimate the models using the "IP-based" variable, whereas column 7 estimates the same model using the original variable (Int). The last column only takes IP-based companies into account and estimate the models. We find that both R&D intensity and being IP-based can have a positive impact on firm performance. In contrast, IP based companies with high debt can only benefit from R&D investment in the presence of better management. This reveals that knowledge-intensive firms benefit more from better management, even with higher debt.

Table 9 Robustness Check 1: Replacing intangibles with total assets in innovation-performance relation

	(1)	(2)	(3)	(4)	(5)
L.PM	0.0737***	0.0100	0.0196	0.0122	0.138***
	[0.00515]	[0.0265]	[0.0279]	[0.0176]	[0.0378]
logTA	0.0330***	0.0501***	0.0564***	0.0235**	0.100**
	[0.00246]	[0.00493]	[0.00897]	[0.0099]	[0.0439]
RnD		0.0733***	0.0741***	0.0717***	0.234***
		[0.053]	[0.014]	[0.00514]	[0.0595]
Mng			0.083	0.03***	0.022***
			[0.005]	[0.028]	[0.0004]
DtoC	-0.153***	-0.165***	-0.163***	-0.202***	-1.120***
	[0.00265]	[0.0122]	[0.00948]	[0.0425]	[0.354]
RnDxDtoC					-0.078**
					[0.0302]
TAxDtoC				0.0042	0.0492**
				[0.0032]	[0.0214]
TAxRNDxDtoC					0.00162*
					[0.0012]
Constant	-2.422***	-2.526***	-2.595***	-2.286***	0.621
	[0.0349]	[0.0883]	[0.182]	[0.104]	[0.862]
Observations	5910	2590	2590	2590	2590
p>Wald (chi^2)	0.00001	0.00001	0.00001	0.00001	0.00001
r2_a	0.168	0.136	0.126	0.132	0.185
Sargan	78.60	34.00	36.20	38.70	35.73
p> Sargan (chi^2)	0.999	0.999	0.999	0.999	0.999
AR (1)	-3.652***	-2.602***	-2.662***	-2.624***	-3.053***
AR (2)	-2.057	-1.694	-1.693	-1.883	-1.787

Notes: Standard errors in brackets. ***, **, * indicate 1, 5, and 10 % significance levels, respectively.

Table 10 Robustness Check 2- Investigating the innovation-performance relation with alternative performance indicators

	(1) MTBVpost	(2) MTBVall	(3) ROICpost	(4) ROICall	(5) CFpost	(6) CFall
L.logmtbv	0.258***	0.303***	0.231***	0.333***	0.395***	0.0381***
	[0.0127]	[0.0157]	[0.0152]	[0.0141]	[0.0107]	[0.00252]
Int	0.142***	0.0581***	0.172***	2.184***	6.164***	2.564***
	[0.0306]	[0.0202]	[0.0462]	[0.260]	[1.218]	[0.139]
RnD	0.173***	0.0503***	0.0659**	0.0540	3.679***	0.993***
	[0.0181]	[0.0113]	[0.0312]	[0.227]	[0.754]	[0.257]
dum_MQ	0.149	-0.0168	0.0828	0.0448***	0.0587***	0.0706***
	[0.146]	[0.0542]	[0.152]	[0.071]	[0.0064]	[0.0082]
DtoC	0.0547***	0.173***	-0.148***	-0.186***	0.0773**	-0.176***
	[0.0021]	[0.0014]	[0.0023]	[0.0226]	[0.0302]	[0.0133]
RnDxDtoC	0.0243***	0.0475***	0.0551***	0.160**	1.596***	0.848***
	[0.00676]	[0.00647]	[0.00996]	[0.0737]	[0.212]	[0.0595]
intxDtoC	0.0626***	-0.00108	0.00410	0.415***	1.802***	0.0886
	[0.00911]	[0.00258]	[0.0131]	[0.0750]	[0.391]	[0.121]
intxRndxDtoC	0.0132***	0.0492***	0.0130***	0.0732***	0.547***	0.157***
	[0.0057]	[0.0048]	[0.022]	[0.0148]	[0.0332]	[0.0190]
Constant	1.853***	0.828***	3.213***	6.218***	61.54***	39.15***
	[0.0785]	[0.121]	[0.174]	[1.438]	[3.315]	[1.521]
Observations	2200	3820	2030	4380	2030	4570
p> Wald (chi^2)	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001
r2_a	0.218	0.130	0.130	0.337	0.373	0.547
Sargan	40.82	43.19	39.42	36.39	38.48	45.26
p> Sargan (chi^2)	0.566	0.999	0.627	0.999	0.7065	0.999
AR (1)	-3.925***	-4.033***	-2.962***	-3.732***	-1.863*	-2.540***
AR (2)	-1.172	-1.601	0.683	-0.758	0.711	1.184

Notes: Standard errors in brackets. ***, **, * indicate 1, 5, and 10 % significance levels, respectively. The first two columns use the MTBV as an alternative dependent variable. Secondly, ROIC is used in the next two columns, and CFtoSales used in the last two columns. "Post" indicated post-crisis period whereas "all" indicates all sample period

Table 11 Robustness Check 3 - Innovation-firm performance relationship in IP based and non-IP based sectors, in the presence of leverage and management quality

	ALL	ALL	ALL	ALL	ALL	ALL	ALL	ONLY IP-based companies
L.PM	0.298***	0.293***	0.245***	0.0814***	0.0628***	0.0388***	0.0275	0.163
	[0.0277]	[0.0276]	[0.0221]	[0.00338]	[0.00411]	[0.0106]	[0.0178]	[0.280]
IPbased	0.152**	0.143*	0.229***	0.458***	0.396***	0.305***		
	[0.0758]	[0.0790]	[0.0611]	[0.0543]	[0.0540]	[0.0775]		
Int							0.0727***	
							[0.0104]	
DtoC		-0.0705***	-0.158***	-0.0672***	-0.0735***	-0.232***	-0.250***	-3.625**
		[0.0184]	[0.0222]	[0.0028]	[0.0348]	[0.0328]	[0.0396]	[1.706]
RnD				0.0755***	0.0770***	0.169***	0.161***	2.189**
				[0.0120]	[0.0131]	[0.0231]	[0.0166]	[1.025]
Mng					0.0320***	0.0877***	0.0887***	0.0367**
					[0.00654]	[0.00177]	[0.00574]	[0.0182]
RnDxDtoC						-0.0278***	-0.0261***	-0.762**
						[0.0053]	[0.0055]	[0.374]
RnDxMngxDtoC						0.000295***	0.000257***	0.00147*
						[0.0000879]	[0.0000253]	[0.000765]
Constant	-1.727***	-1.515***	-1.477***	-2.045***	-2.131***	-1.592***	-1.265***	6.766*
	[0.0835]	[0.100]	[0.0920]	[0.0506]	[0.0547]	[0.130]	[0.127]	[3.554]
Observations	9600	9600	9600	9600	9600	3660	3530	2600
p> Wald (chi^2)	0.01	0.01	0.01	0.0001	0.0001	0.00001	0.0001	0.01
r2_a	0.59	0.521	0.103	0.413	0.0834	0.326	0.186	0.258
Sargan	51.54	50.69	51.58	37.35	34.96	40.99	42.58	72.67
p> Sargan (chi^2)	0.861	0.994	0.855	0.545	0.654	0.999	0.999	0.999
AR (1)	-4.785***	-4.801***	-4.388***	-3.227***	-3.239***	-3.194***	-3.305***	-0.858
AR (2)	-1.611	-1.374	-1.370	-2.200	-2.259	-1.970	-1.833	-0.960

Notes: Standard errors in brackets. ***, **, * indicate 1, 5, and 10 % significance levels, respectively. IPBased is a dummy variable that takes value 1 if the company has intangible assets above the average, 0 otherwise. The first six columns indicate the parameters of the models were estimated using the IP-based variable, whereas column 7 estimates the same model by using the original variable (Int). The last column only takes IP-based companies into account and estimate the models.

5. Conclusions

Firms traditionally focused on R&D activities to differentiate their performance from other firms. However, during recent decades, in addition to the traditional form of innovation such as R&D activities, the focus on better managerial strategies has been emphasized as the modern form of innovation. Therefore, only traditional innovation is not enough to perform better without improving the quality of management. Thus, firms that focus on both forms of innovation tend to outperform others. Hence, by focusing on the firm-level quarterly data from the Turkish companies traded in Istanbul Stock Exchange between 1992-2015, this paper examines the role of innovation and quality of management in firm performance in light of the possible financial constraints following the global financial crisis. Using alternative methods, namely FE, Dynamic System GMM and DID methods, and following a policy intervention in the reporting standards inducing better

disclosure on knowledge assets, this paper investigated whether innovative firms with easier access to finance (or high leverage) performed better in the presence of greater managerial efficiency, following the recent global financial crisis.

This paper finds that the quality of management provides better performance in the context of Turkish firms both directly and indirectly. Although debt is detrimental to firm performance, firms that are more innovative and better- managed tend to achieve better performance regardless of their debt level. Therefore, firms focusing on R&D and intangibles both individually and together tend to outperform others. Additionally, high debt intensive firms can perform better only if they have better managerial quality and R&D intensity. In other words, firms with better management quality can ease their financial constraints, and thus, they will be able to benefit from investing in innovation activities.

Furthermore, the results of this paper remain unchanged following three robustness checks. The first robustness test replaces the intangible assets with total assets to explore the indirect role of total assets in the debt-firm performance relationship. The second robustness check validates the previous empirical findings by replacing the dependent variable with alternative performance measures such as MTBV, ROIC, CF to Sales, and the results remain the same. The third robustness test uses IP-based and non-IP based company classification as an alternative to high- and low-managerial practices firms. The results still hold even when we classify firms as per their focus on intangible assets.

Overall, our contributions can be summarized as follows. First, the innovation-intensive firms, namely, firms focusing on R&D together with intangible assets, are likely to perform better. Second, we show that leverage adversely affects firm performance over the sample period; however, better-managed firms can ease their financial constraint with greater access to debt as well as in their ability to innovate, which then improves their profitability. Thirdly, using a DID setting, we find that firms with better management quality tend to outperform others in the post-crisis period, following a policy implementation on the reporting standards, and particularly of knowledge assets. Finally, our results remain robust even with alternative profitability measures, focusing on total assets as an alternative to intangible assets or sectoral classification based on their knowledge-intensity.

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Appendix A: Correlation Matrix for the managerial quality aspects

	X_1	X_2	X_3	X_4	X_5	X_6
X_1	1					
X_2	0.8959	1				
X_3	0.8684	0.9326	1			
X_4	0.821	0.9116	0.8961	1		
X_5	0.8388	0.8986	0.8575	0.7585	1	
X_6	0.8737	0.8714	0.8416	0.7941	0.8618	1

Note: All the correlations are significant at 5% significance level, where X_i's are defined as:

Variable	Name	Explanations
X_1	Integration of Vision and Strategy	Does the company integrate vision and strategies on economic (financial), social and environmental dimensions into its day-to-day decision-making processes?
X_2	Workforce Training and Development	Does the company claim to provide and/or monitor regular skill and business management training for its employees/managers?
X_3	Training and Development Improvements	Does the company set specific objectives to be achieved on employee training and career development?
X_4	Internal Promotion	Does the company claim to favor promotion from within?
X_5	University Partnerships	Does the company claim to cooperate with schools or universities?
X_6	Product Innovation	Does the company have an environmental product innovation policy (eco-design, life cycle assessment, and dematerialization)?