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Effective Risk Management and Sustainable Corporate Performance Integrating Innovation and Intellectual Capital: An Application on Istanbul Exchange Market

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Abstract: Risk management requires firms to mitigate the negative consequences of market dynamics on their performance outcomes. Traditional risk management solely addresses the threats and negative consequences of risk. However, total (effective) risk management is capable of regulating out-of-control market conditions to boost corporate performance by restraining market volatility and hence providing return sustainability considering the opportunities of risk as well. Based on a sample of 286 firm-year observations drawn from 26 firms listed on Borsa Istanbul, BIST-50 index, the empirical study examines the association between total risk management and firm performance and the moderating role of innovation, intellectual capital, and the pandemic period for the years 2011–2021. The analysis is performed by applying the hierarchical panel regression using ROE and ROI as proxies to measure firm performance. The results have shown that there is a positive association between total risk management and performance measures, especially among firms applying more innovation and intellectual capital investments. However, the effect of innovation on the performance relationship of total risk management (ROE) was found to be negative surprisingly. Moreover, results suggest that total risk management has a lower positive association with firm performance during the pandemic period for both performance measures.

Keywords: effective risk management; innovation; intellectual capital; hierarchical panel regression

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1. Introduction

Risk management refers to the practice firms apply to make sure that the risks to which they are exposed are the risks to which they believe they may be exposed in order to maintain their core business operations. Firms identify the risk and then take any early stage or follow-up actions to handle deflections of real risk exposures from predetermined risk tolerances [1].

Risk management is approached from two viewpoints: the traditional and holistic risk approaches. The traditional approach tends towards solutions which handle downside risk effects, regardless of the fact that risky situations can also provide upside opportunities for companies [2]. In other words, traditional risk management undervalues the moderating influence of opportunities. Financial hedging, insurance contracts, resource management, and management control systems are key decisions taken to improve the firm's profitability in facing foreign market threats based on the traditional viewpoint. Contrarily, the holistic approach evaluates risks integrally and is an effective weapon for minimizing profit variances in the face of external market challenges. [3,4]. This viewpoint allows for the consideration of both possible turndowns and opportunities while also taking into account the market's dynamic conditions [5,6]. It is also referred to as operational improvement, which is accomplished by the systematic diagnosis, evaluation, and elimination of project risks [7,8]. Effective risk management, therefore, covers price fluctuations, accidents, political uncertainty, issues with raw material supply, economic growth, environmental crises, etc. These practices are applied to reduce the potentially risky impacts of crises and

are crucial in convincing major investors to increase their investment in the organization. Thanks to such contributions, firms will be able to provide even more profitable investment options resulting in long-term sustainability and competitive advantages [9]. Modern or total risk management emerged when both traditional risk managers and financial risk managers began reporting to the chief risk manager using various techniques. Interrelated and massive reports necessitated a new strategy that integrates different techniques and creates a single framework to handle challenges. [10]. Traditional risk management primarily focuses on finance departments and generally ignores marketing, sales, and product development in evaluating risk [9]. Furthermore, while the traditional approach is task-by-task or department-by-department with a focus exclusively on financial risk management, the holistic viewpoint incorporates the decision-making process at different levels and eliminates risk accumulation inside the organization [11]. It is based on integrating into a complete model that addresses all critical capital planning issues as well as other obstacles in order to make a management system effective. Ineffective risk management, on the other hand, results in additional costs and high variance inefficient outcomes for both the firm and its shareholders, which could result in negative impact on firm performance [9].

Firms will be less affected by the economic consequences of market fluctuations as they improve in controlling the negative effects of external factors and responding to changing environmental conditions. In other words, efficient risk management helps firms adapt to external changes, resulting in lower profit volatility and higher performance [10]. Effective risk management is believed to provide a powerful decision-making system that enhances corporate performance in order to balance the relationship between risk and expected return [12]. Pagach and Warr (2011) similarly suggested that since an effective risk management system is provided by the cooperation of all units and resources operating in the firm, the performance is expected to improve considerably [13]. Anderson (2008) provided three reasons why effective risk management improves firm performance. These are capital availability, transaction cost, and specific assets [9].

Firstly, a sustainable earnings ratio lowers the level of business risk perceived by investors while simultaneously increasing the firm's solvency with regard to its liabilities [9]. Accordingly, low-risk firms will have wider access to funding opportunities with lower interest costs. Due to the low chance of bankruptcy for the firm, future dividend payments may be expected to increase. High demand for the firm's shares among investors is also possible because of the low volatility in the rate of return. Thus, the decrease in both debt and equity costs will lead to increase the firm performance. Secondly, the firm's relationship with its shareholders may be damaged due to poor risk management practices [8]. While there is a reasonable chance for investors to exchange and modify their stocks of publicly listed corporate shares, for other key stakeholders, such as suppliers, partners, and employees, the same flexibility may not have been provided. The ineffectiveness of risk management will adversely affect the company's relationship with the shareholders and also raise the cost of business transactions ultimately. This situation may lead customers and suppliers to demand higher premiums for stock transactions [3]. Thirdly, the capital invested by stakeholders is divided into two major categories: specific and general investments. Investments with greater value than others are referred to as specific investments. An example of a supplier's specific investment is the production systems they designed specifically for the firm, while the purchase of products that require highly personalized information is considered customers' specific investments. Moreover, specific investments cannot be re-traded on other platforms without suffering severe value loss. It does not, however, show variations in exchange transactions of general investments. High fluctuations in the rate of return, along with an increasing total risk level, raise the likelihood of bankruptcy. Accordingly, these factors may cause a situation in which investors reject to make long-term investments in the firm. Firm-specific assets are key resources to seek funding for profitable projects. Poor risk management instead may cause such assets to be spent for other purposes, resulting in loss of potential future opportunities [14]. Effective risk management is anticipated to drive stakeholders, owners, employees, and suppliers

to raise their investment in firm's specific assets. Such investments can be employed for technical advances, enhance the firm performance, and generate a competitive advantage, either directly or indirectly [15]. As a result, a lower level of risk resulting from effective risk management should encourage key stakeholders to invest in the firm-specific resources which are needed to ensure the sustainability of business relationships.

In this study, firm-specific investments are proxied by innovation and intellectual capital investments (9). Innovation and intellectual capital are considered as functional factors affecting risk management. Due to the global market implications in all economic sectors, there will always be a connection between innovation and risk management. In order to survive and reduce the uncertainty in the fast-changing global market, organizations need to apply innovative risk management practices which consequently impact profitability and firm performance [16]. Profit loss is, therefore, unavoidable for businesses that ignore innovation and modern risk management techniques [17]. Intellectual capital has received more prominence in firm value development with respect to the shift from manufacture-based to knowledge-based economic systems [18]. The relationship between risk management and firm performance is also considered to be moderated by intellectual capital. Intellectual capital is a key factor in determining firms' success in the current competitive and knowledge-based economy. Intellectual capital refers to knowledge-based assets such as specific supplier and customer information, information technology, brands, and patents that can increase shareholders' value [19,20]. Even though intellectual capital increases the necessity for financial reporting, it actually improves the firm value. A firm's valuable intellectual capital might also assist in addressing some major concerns including risk management and internal control oversight [21]. Furthermore, investors' perceptions of the risky future cash flows are decreased as a result of effective intellectual capital investments due to minimizing information asymmetries and risk levels. Such practices reduce the equity cost and consequently increase the firm value and performance [18,22].

2. Literature Review

Risk management is currently regarded as one of the most critical concerns of executives. Considering the marginal effects and applications of risk management, as well as the growing importance of the topic, empirical studies have been conducted to determine whether risk management has a basically promising impact on firm performance. However, few empirical studies have been done to examine the performance impacts of effective risk management due to the complexity in developing appropriate and reliable risk management metrics (9).

Considering the traditional and holistic approaches of risk management, several lines of evidence suggest that using single derivatives is less associated with market price variations (Minton and Schrand, 1999), although studies focusing on more general risk indicators, such as cash flow volatility (Allayannis and Weston, 2001, Shin and Stulz, 2000), show a positive association with market returns [23–25]. Gordon et al. (2009) argued that the relationship between risk management and firm performance depends on five firm-specific factors: environmental uncertainty, industry competition, firm complexity, firm size, and board audits [26]. They suggested that these factors should be taken into account for effective enterprise risk management practices. Mansoor et al. (2019) reported a significant and negative association between total risk management and firm performance based on the Pakistani energy industry between 2011 and 2015. The likely reason for this finding was suggested to be the strict risk management practices and avoiding risky investments which consequently leads to weak firm performance [27]. Moreover, in terms of enterprise risk management, the study by Önder and Ergin (2012) on Istanbul Exchange Market suggests that the firm performance is irrelevant for risk management applications [28]. Similarly, Pagach and Warr (2011), McShane et al. (2011), and Quon et.al (2012) rejected the positive effect of corporate risk management on firm performance [13,29,30], while Mu et al. (2009), Dabari and Saidin (2014), Gordon et al.(2009), Hoyt and Lienberg (2011) and Lam (2001), Wang et al. (2018), Malik et al. (2020), Shad and Lai (2019), Florio and Leoni (2019), Al-

Nimer et al. (2021), and Saeidi et al. (2021) proved a positive relationship between risk management and firm performance [11,26,31–39]. This view is also supported by Fraser and Simkins (2007) who suggests that risk management improves company performance by reducing capital costs, strengthening investor confidence, and improving the firm's rating which indicates the firm's ability to repay debt [40]. A broader perspective has been adopted by Andersen (2008) who investigated the impact of total risk management on firm performance by conducting a comprehensive analysis of the negative consequences of risk and its opportunities together. The hierarchical panel regression method was used to study the data from 1386 US-based corporations operating in four-digit SIC code industries between 1996 and 2000. He showed that firms practicing total risk management have higher performance advantages, especially the ones operating in information-intensive industries with high innovation investments [9]. Likewise, Jafari et al. (2011) conducted a study on the Tehran Stock Exchange from 2003 to 2008, including ROA and ROI as performance indicators. Similarly, he discovered a positive and statistically significant relationship between total risk management and firm performance, notably in companies with higher intellectual capital, industries with rapid knowledge growth, and firms with higher R&D spending [3]. Mohammed and Knapkova (2016) conducted a similar study on the Prague Stock Exchange between 2009 and 2014, using ROE as a performance criterion. Their findings also demonstrated a positive and meaningful association between total risk management and firm performance in firms with higher intellectual capital investments [8].

There are relatively few historical studies in the area of assessing the performance impacts of effective risk management partly due to the complexity of defining appropriate and accurate risk management metrics. Total risk management also provides the firm to effectively address the strategic risks, including difficult-to-quantify competitor behavior, technological changes, political factors, etc. As a result, using a broader formulation and realistic measurements of total risk management is required to be applied in empirical studies [9]. The scope of research on the performance relationship of total risk management has been mostly limited to the United States, as well as Iran and the Czech Republic thus far. Little is known about total risk management in Turkey, where corporate governance codes have expanded their focus on risk management implications in past few years. Turkish companies are mostly family firms, highly concentrated businesses that belong to a group of companies. The Turkish Commercial Code was adapted from continental civil law. Civil law nations appear to have poor investor protection according to La Porta et al. (1999) [41,42]. Since Turkish firms and the underdeveloped capital market in Turkey have considerably different features than US and European firms, the findings might extend the knowledge of total risk management among the global community in new scenarios.

3. Theoretical Framework and Hypothesis Development

Market fluctuations render risk management strategies that exclusively consider traditional risk predictors ineffective [43]. The possibility of bankruptcy rises due to the ineffective reaction of the firm to external threats. This leads investors to steer clear of specific investments that are of great importance for the growth and development of the firm. Effective risk management, in contrast, is expected to boost firm performance by persuading investors to invest in the firm which results in sustainable resource allocation. Corporate risk is generally defined as the volatility of earnings or cash flows over time. However, total risk management allows the firm to deal with the risk posed by external factors and stabilize the firm's returns over time. Taking into consideration the literature review, the impact of innovation and intellectual capital is determining on the performance effect of risk management. Innovation is discussed from a technological and economic point of view. Effective product development is what is meant by innovation, and a company is considered innovative if significant R&D funding is provided. However, the innovative expression has recently shifted to emphasize more the hardware and organizational assets [44]. Innovative industries often include firms with automated technologies and high knowledge, such as computer and pharmaceutical firms. These firms require appro-

priate investments to support innovative developments and provide long-term competitive advantage [3]. Sustainable innovation relies on stakeholders' relationships with shareholders and also consistent R&D expenditures, which require firm-specific investments. Regular R&D research is also realized by increasing the investments made by the shareholders in firms' specific assets, which provides a competitive advantage and increases the firm performance. Moreover, the process of global economic growth has been fundamentally changed by the rapid development in high technology, especially in areas such as communications and programming. As a result, knowledge, as among the most crucial capital, has successfully been superseded by tangible and financial capital, particularly in competitive high-tech industries. Intellectual capital, which is based on the knowledge economy, provides more precise information on knowledge management and creates an effective measurement model in which financial and non-financial indices are successfully combined. Moreover, it provides a comprehensive reflection of the firm's operations [45]. Milost (2007) claims that intellectual capital, also known as human capital, encourages innovative initiatives, provides a strong competitive advantage in most cases, and also argues that any excess market value over book value is mainly due to intellectual capital [46]. Furthermore, the key factor for corporate competitiveness is global development. The role of Asian nations has been significantly strengthened in the global system. As a result, China is vying for political power on the world stage, and China, Japan, and South Korea are all major players in terms of economy and finance [47]. In addition, the majority of global pandemics have originated in Asia, mostly in China, Indonesia, and India. Examples include the Black Death, the Asian Flu, the Hong Kong Flu, the SARS epidemic, the Bird Flu, COVID-19, and Cholera. As the outbreak spread throughout the globe in 2019, affecting both supply and demand, the operations of several industries and corporations were paralyzed and severely interrupted. Particularly, highly globalized industries are more vulnerable to pandemic disruption [48]. Moreover, the outbreak has had a negative impact on more than 94% of Fortune 1000 companies [49–51]. Overall, the impact of COVID-19 is likely to be more devastating than most natural disasters, 9/11, or even the Great Recession [52]. The unique circumstances of the pandemic showed that firms could be exposed to serious risks due to the lack of prior planning. Only 20% of 500 senior board members worldwide surveyed by Ernst and Young in 2019 expressed confidence in their firms' capacity to deal with a major risk [53]. It should be noted that some pandemics have started worldwide economic crises. Since corporate risks have increased during crises and pandemics, risk management has become a vital obligation for corporations and authorities in order to form public-private cooperation for sustainable growth [48]. Based on the above arguments and assumptions, the following four hypotheses were developed:

H_1: Total risk management has a positive and significant effect on firm performance.

H_2: Innovation has a positive and significant effect on the performance relationship of total risk management.

H_3: Intellectual capital has a positive and significant effect on the performance relationship of total risk management.

H_4: Crisis and pandemic periods have a negative and significant effect on the performance relationship of total risk management.

4. Research Methodology

This study set out with the aim of assessing the effect of total risk management on firm performance covering 26 firms listed on the Istanbul Exchange Market and the BIST-50 market index from the year 2011 to 2021. The sample period of 2011 was used because for the first time in 2011, the 378th and 625th articles of the Turkish Commercial Code emphasized risk management in joint-stock and limited companies, imposing the obligation of early identification of risk on the board of directors. According to this regulation, the

board of directors of firms listed on the Istanbul Stock Exchange is required to form an expert committee in order to early detect the factors endangering the existence and development of the company, implement the required precautions in place, and manage the risk. All the yearly data are gathered from the database of Borsa Istanbul (BIST) and Public Disclosure Platform (KAP). An initial objective of this study is to identify the effect of total risk management on firm performance while integrating the effect of intellectual capital, R&D investments, and the pandemic period using hierarchical panel regression.

In line with the objective of our study, firm performance is considered as the dependent variable using both ROE and ROI ratios. The total risk management, innovation, intellectual capital, and COVID-19 dummy are used as independent variables while including financial leverage as the control variable. Total risk management was calculated by dividing the standard deviation of annual net sales between 2011 and 2021 by the standard deviation of economic returns (ROA, ROI) in the same period. In measuring total risk management, the standard deviation of corporate sales represents the market risk, while the standard deviation of economic returns (ROA, ROI), indicates the firm risk [9]. Considering the control variable, financial leverage, according to Gordon et al. (2009), has an effect on risk management efficiency and company performance. Long-term liabilities, in particular, carry significant risks, such as failure to make debt and interest payments on time [25]. Furthermore, Byoun et al. (2013) took a different approach, claiming that project firms use higher leverage when project risk level is high, while using less leverage when risk-balancing measures, such as repurchase agreements, are provided [54].

The definition of the variables and the correlation between variables are presented in Tables 1 and 2 below. Moreover, based on each dependent variable, four models are developed separately for ROI and ROE variables.

$$ROI_{it} = \beta_0 + \beta_1\ RISK\text{-}ROI_{it} + \beta_2\ INOV_{it} + \beta_3\ INTCAP_{it} + \beta_4\ LEV_{it} + e_{it} \quad (1)$$

$$ROE_{it} = \beta_0 + \beta_1\ RISK\text{-}ROE_{it} + \beta_2\ INOV_{it} + \beta_3\ INTCAP_{it} + \beta_4\ LEV_{it} + e_{it} \quad (2)$$

$$ROI_{it} = \beta_0 + \beta_1\ RISK\text{-}ROI_{it} + \beta_2\ LEV_{it} + \beta_3\ COVID_{it} + \beta_4\ INTCOVROI_{it} + e_{it} \quad (3)$$

$$ROE_{it} = \beta_0 + \beta_1\ RISK\text{-}ROE_{it} + \beta_2\ LEV_{it} + \beta_3\ COVID_{it} + \beta_4\ INTCOVROE_{it} + e_{it} \quad (4)$$

Table 1. The Definition of Variables.

Variables		Description
Dependent Variables		
Return on Equity	ROE_{it}	Net Profit/Total Equity
Return on Investment	ROI_{it}	Net Profit/(Paid-in Capital+Retained Earnings+Long-term Debt)
Independent Variables		
Total Risk Management(ROE)	$RISK\text{-}ROE_{it}$	Standard Deviation of Net Sales/Standard Deviation of ROE
Total Risk Management(ROI)	$RISK\text{-}ROI_{it}$	Standard Deviation of Net Sales/Standard Deviation of ROI
Innovation	$INOV_{it}$	R&D Expenditures/Net Sales
Intellectual Capital	$INCAP_{it}$	Market Value of Outstanding Stocks/Book Value of Firm
Pandemic Period	$COVID_{it}$	A Dummy Variable that takes Value of 1 for Pandemic Years and 0 for Others.
The Interaction Term between RISK-ROE and INOV	$INTROEINOV_{it}$	RISK-ROE*INOV
The Interaction Term between RISK-ROE and INCAP	$INTROECAP_{it}$	RISK-ROE*INCAP
The Interaction Term between RISK-ROI and INOV	$INTROIINOV_{it}$	RISK-ROI*INOV
The Interaction Term between RISK-ROI and INCAP	$INTROIINCAP_{it}$	RISK-ROI*INCAP
The Interaction Term between RISK-ROE and COVID	$INTROECOV_{it}$	RISK-ROE*COVID
The Interaction Term between RISK-ROI and COVID	$INTROICOV_{it}$	RISK-ROI*COVID
Control Variables		
Leverage	LEV_{it}	Long-term Debt/Total Equities

Table 2. Correlation Matrix.

	ROI	ROE	RISK-ROI	RISK-ROE	INOV	INTCAP	LEV	COVID
ROI	1							
ROE	0.420 ***	1						
RISK-ROI	−0.058	0.058	1					
RISK-ROE	−0.049	−0.005	0.256 ***	1				
INOV	0.444 ***	0.195 **	−0.053	−0.056	1			
INCAP	0.122 *	0.463 ***	0.251 ***	−0.043	0.072	1		
LEV	0.351 ***	0.231 ***	0.105	0.020	0.139 *	0.430 ***	1	
COVID	0.185 **	0.168 **	0.091	0.088	0.088	0.232 ***	−0.030	1

The *, **, and *** denotes the significance level at 1%, 5%, and 10%, respectively.

Regarding the developed models, β_0 indicates the regression coefficient, β_1, β_2, β_3, and β_4 the independent variable coefficients, e_i the error, i the firm in the same cross-section, and t the time period.

5. Results

The hierarchical panel regression is used for the analysis. For this purpose, first, a correlation analysis was conducted to verify that no multicollinearity between variables exist. The correlation matrix is presented in Table 2 below which provides a general overview of the structure of the relationship between all dependent and independent variables. A strong correlation between the variables, which is not desirable, is shown when the correlation coefficient approaches the absolute value of 1. Due to the low correlation between the variables, it can be said that there is no multicollinearity issue in the estimated model.

Table 3 provides descriptive statistics for the dependent, independent, and control variables used in the study. Table 3's findings reveal that the firms in the BIST-50 index have an average return on equity of 0.177, with values ranging from 0.867 to −0.932. This indicates that firms generate an average 17.7% profit from their total equity. Moreover, the mean value of return on investment is 0.505 with the maximum and minimum values of 6.939 and −0.200, respectively, indicating that firms generate an average 50.5% profit from their total investment. The observed maximum ROI value could be attributed to the extremely low paid-in capital and long-term debt values in comparison to the firm's net profit. The standard deviation values for ROE (0.183) and ROI (0.901) suggest that the variation in performance is greater among firms regarding ROI. The average value for innovation variable is 0.009. The value reveals that firms use an average of 0.09% of their sales revenue for R&D investments. Lastly, the mean value for financial leverage is found to be 0.661, which implies that long-term debts finance more than 66% of the firm's assets.

Table 3. The Descriptive Statistics of Variables.

	Mean	Median	Maximum	Minimum	Std. Dev.	Obs.
ROI	0.505	0.205	6.939	−0.2	0.901	286
ROE	0.177	0.151	0.867	−0.932	0.183	286
RISK-ROI	19.389	1.288	414.227	0.0000471	51.181	286
RISK-ROE	37.626	2.423	838.015	0.000499	105.175	286
INOV	0.009	0.003	0.071	0	0.012	286
INCAP	1.672	1.054	14.22	0.108	1.794	286
LEV	0.661	0.458	4.469	0.021	0.699	286
COVID	0.185	0	1	0	0.389	286

The results of hierarchical panel regression for ROE and ROI are presented in Tables 4 and 5, respectively. Before applying the regression analysis, essential diagnostic tests (Since it may be misleading to apply unit root tests for panels with a cross-section (N) larger than time dimension (T) [55], unit root test was not applied in order to avoid skewed regression results) were performed to ensure the robustness of the results, namely, endogeneity, autocorrelation, heteroscedasticity, and cross-section tests.

Table 4. The Results of Hierarchical Regression Analysis for ROE.

Performance: ROE									
	Variable	**Coef.**	**R2**	**Δ2e**	**F-Stat**	**Hausman**	**Hetro Wald**	**Wooldridge**	**Pesaran**
Block 1			0.2805	0.2805	122.76 ***	42.77 ***	2780.48 ***	0.503	5.853 ***
	LEV	−0.142 ***							
	INOV	1.581 *							
	INCAP	0.036 ***							
Block 2			0.2827	0.0022	123.56 ***	44.8 ***	2856.2 ***	0.5	5.223 ***
	LEV	−0.142 ***							
	INOV	1.621 *							
	INCAP	0.036 ***							
	RISK-ROE	6.14×10^{-15} ***							
Block 3			0.2861	0.0034	126.11 ***	41.96 ***	2765.48 ***	0.509	4.628 ***
	LEV	−0.143 ***							
	INOV	1.588 *							
	INCAP	0.037 ***							
	RISK-ROE	1.31×10^{-14} ***							
	INTROEINOV	-1.11×10^{-12} ***							
Block 4			0.2896	0.0035	104.44 ***	44.62 ***	2792.53 ***	0.411	4.919 ***
	LEV	−0.143 ***							
	INOV	1.654 *							
	INCAP	0.035 ***							
	RISK-ROE	2.90×10^{-15} *							
	INTROEINOV	-2.55×10^{-12} ***							
	INTROECAP	1.60×10^{-14} **							

The *, **, and *** denotes the significance level at 1%, 5%, and 10%, respectively.

Table 5. The Results of Hierarchical Regression Analysis for ROI.

Performance: ROI									
	Variable	**Coef.**	**R^2**	**ΔR^2**	**F-Stat**	**Hausman**	**Hetro Wald**	**Wooldridge**	**Pesaran**
Block 1			0.1977	0.1977	125.92 ***	25.34 *	1.80×10^5 ***	2.381	7.972 ***
	LEV	−0.269 ***							
	INOV	33.532 ***							
	INCAP	0.088 ***							
Block 2			0.1978	0.0001	123.28 ***	24.75 *	1.80×10^5 ***	2.404	8.015 ***
	LEV	−0.267 ***							
	INOV	33.514 ***							
	INCAP	0.089 ***							
	RISK-ROI	4.93×10^{-15} **							
Block 3			0.198	0.0002	96.11 ***	27.3 *	1.70×10^5 ***	2.404	7.955 ***
	LEV	−0.268 ***							
	INOV	33.521 ***							
	INCAP	0.089 ***							
	RISK-ROI	6.36×10^{-15} *							
	INTROIINOV	0.0067 *							
Block 4			0.21	0.012	35.06 ***	27.24 *	1.40×10^5 ***	2.573	6.948 ***
	LEV	−0.271 ***							
	INOV	33.187 ***							
	INCAP	0.127 ***							
	RISK-ROI	1.26×10^{-14} **							
	INTROIINOV	0.0196 **							
	INTROICAP	0.004 ***							

The *, **, and *** denotes the significance level at 1%, 5%, and 10%, respectively.

The Hausman specification test, with the null hypothesis of random effect, was conducted to decide between the fixed and random effect model, and the findings rejecting the null hypothesis imply that the fixed effect model is the powerful estimator for all models. Furthermore, the Wooldridge (2002) autocorrelation test with the null hypothesis of no serial correlation was conducted to test the correlation between the values of the same parameters at different time periods [56]. The results of the test rejected the presence of autocorrelation in all models. In addition, to evaluate the equality of the variance of all observations in the data set, the heteroscedasticity test was applied by using the modified Wald test with the null hypothesis of homoscedasticity. Based on the findings of the modified Wald test and the P-values, the null hypothesis is rejected, and the presence of the heteroscedasticity problem is accepted in all models. Lastly, the Pesaran (2015) model with the null hypothesis of cross-section dependency was performed to examine the

inter-unit correlation [57]. Considering the results of the Pesaran test, the null hypothesis was accepted, and the cross-section dependency was detected in all models.

The robust standard error is used for the estimation of regression models correctly. Thus, the Driscoll–Kraay standard error was computed to handle the mentioned problems, which provides robustness against cross-section dependency and heteroscedasticity [58]. The results of diagnostic tests for all estimated models are also presented in regression results tables (Tables 4 and 5).

Based on the results of Table 4, the hierarchical panel regression for return on equity as an indicator of firm performance revealed that at stage one, ROE is positively and significantly associated with innovation and intellectual capital while its correlation with leverage is found to be negative. With respect to the first research question, it was found that once total risk management is included in the model at stage 2, it is significantly and positively associated with firm performance, and accounted for an additional 0.22% of the variation in ROE. That is, the first hypothesis is supported, indicating that firms employing total risk management achieve higher performance gains. INTREOCAP represents the interaction term between total risk management (ROE) and intellectual capital. Adding the interaction term of intellectual capital to the regression model at stage 4 explained an additional 0.35% of variation in ROE. The coefficient of INTROECAP is found to be significant and positive, implying that total risk management has a higher positive correlation with performance in firms with higher intellectual capital investments, which provides support for hypothesis 3. The outcomes thus far are in line with those of Mohammed and Knapkova (2016).

Moreover, INTROEINOV is used as the interaction term between total risk management and innovation. The introduction of INTROEINOV to the model at step 3 contributed significantly and negatively to the performance by an extra 0.34% change of R^2. Despite the increased R^2 value, the significantly negative coefficient of interaction term at stage 3 implies that in firms with a higher level of innovation investments, there is a lower positive relationship between total risk management and firm performance, i.e., hypothesis 2 is rejected for the model which firm performance is defined by return on equity. This outcome is contrary to that of Andersen (2008). Technical innovation, according to Edquist (1997), is the introduction of new knowledge or creative combinations of already-existing knowledge into the economy. In other words, innovations are mostly seen as the outcomes of active learning processes [59]. Moreover, innovation investments are higher in sectors with high industry dynamism. Innovation, industry dynamism, and intellectual knowledge interact together to determine their effect on firm performance. Firms in stable industrial sectors gain most from training investments (innovation), while those in dynamic circumstances profit more from intellectual capital [60].

Hence, it seems possible that the negative impact of innovation on the performance effect of total risk management with reference to ROE is due to the interaction between innovation and intellectual capital as well as the unstable fluctuations in the Turkish market. It also accords with the promising effect of intellectual capital on performance effect of risk management for both performance measures.

We also test the total risk management implementation on the firm performance proxied by ROI. The hierarchical panel regression results for ROI are presented in Table 5 below. As shown in Table 5, the association of ROI is significant and positive with innovation and intellectual capital and negative with leverage, which accounted for 19 percent of variation in ROI. The addition of total risk management at the second step explained an additional 0.01% of ROI variation. The coefficient of total risk management is found to be significant and positive, indicating that in firms applying effective risk management, return on investment shows higher values. Hence, hypothesis 1 is accepted. The introduction of interaction terms of innovation and intellectual capital at stages 3 and 4 explained an extra 0.02% and 1.2% of variation in ROI, respectively. The coefficients of added variables were found to be significantly positive in both stages. These results support H_3 and H_4 with reference to ROI and highlights that firms with higher innovation and intellectual capital investments record

higher operating performance than firms with less innovation and intellectual capital. The results are consistent with those of Andersen (2008) and Jafari et al. (2011).

Furthermore, the impact of the pandemic period was investigated on the association between total risk management and firm performance. Hierarchical panel regression results considering the COVID-19 period are reported in Tables 6 and 7, respectively, for ROI and ROE.

Table 6. The Results of Hierarchical Regression Analysis considering COVID-19 for ROI.

Performance:	**ROI**								
	Variable	**Coef.**	**R^2**	**ΔR^2**	**F-Stat**	**Hausman**	**Hetro Wald**	**Wooldridge**	**Pesaran**
Block 1			0.0201	0.0201	22.50 ***	3.90 *	9.0×10^{-5} ***	2.378	18.089 ***
	Risk-ROI	8.90×10^{-15} **							
	LEV	−0.165 ***							
Block 2			0.1247	0.1046	29.86 ***	4.29 *	13661.69 ***	2.448	15.268 ***
	Risk-ROI	-2.46×10^{-14} ***							
	LEV	−0.128 ***							
	COVID	−0.0441 ***							
Block 3			0.1253	0.0006	143.49 ***	3.96 *	1376.94 ***	2.453	15.308 ***
	Risk-ROI	-5.55×10^{-15}							
	LEV	−0.122							
	COVID	−0.0446							
	INTCOVROI	-2.00×10^{-4}							

The *, **, and *** denotes the significance level at 1%, 5%, and 10%, respectively.

Table 7. The Results of Hierarchical Regression Analysis considering COVID-19 for ROE.

Performance:	**ROE**								
	Variable	**Coef.**	**R^2**	**Δo^2**	**F-Stat**	**Hausman**	**Hetro Wald**	**Wooldridge**	**Pesaran**
Block 1			0.1608	0.1608	26.82 ***	2.32 *	3837.38 ***	0.689	9.377 **
	Risk-ROE	7.12×10^{-15} **							
	LEV	−0.108 **							
Block 2			0.2182	0.0574	59.02 ***	2.46 *	19644.17 ***	0.656	5.381 ***
	Risk-ROE	4.00×10^{-15} *							
	LEV	−0.104 ***							
	COVID	0.076 **							
Block 3			0.2201	0.0019	64.25 ***	2.19 *	3931.39 ***	0.683	4.716 ***
	Risk-ROE	8.18×10^{-15}							
	LEV	−0.103							
	COVID	−0.0801							
	INTCOVROE	-1.12×10^{-14}							

The *, **, and *** denotes the significance level at 1%, 5%, and 10%, respectively.

The results revealed that at stages 2 and 3, COVID-19 and the interaction term of COVID-19 and total risk management variables contributed significantly and negatively to the regression model for both ROI and ROE and provides support for hypothesis 4. Thus, total risk management has a lower positive association with firm performance during the pandemic period.

6. Conclusions

The aim of the present research was to examine the performance relationship of total risk management on the BIST-50 index of the Turkish Stock Exchange considering the moderating role of innovation and intellectual capital. This approach is used to examine whether effective risk management results are positively correlated with performance while evaluating the practicability of the firm-specific investment justification in order to generate business opportunities. Based on the data of firm-year observations, four separate regressions by making the ROI and ROE ratios as dependent variables were computed over one crisis, four firm-specific, and six interaction term factors. The research shows that the effectiveness of total risk management to minimize earnings volatility in the presence of unstable economic conditions leads to higher economic performance. Such a positive performance is particularly obvious among firms prioritizing intellectual knowledge and R&D investments. Hierarchical panel regression analysis revealed that

total risk management positively affects the firm performance in terms of both performance measures ROI and ROE. This implies that firms with effective risk management strategies perform at a higher level. Moreover, when intellectual capital was integrated into the models, its impact on the performance effect of total risk management for both ROI and ROE performance indicators was found to be significant and positive. This indicates total risk management has a higher promising association with corporate performance among firms emphasizing intellectual capital investments. However, following the addition of the innovation interaction term to the model, a significantly positive association was recorded for ROI while its impact on ROE was found to be significantly negative. Thus, in firms with higher innovation investments, while the performance effect of total risk management is positive on return on investment, its effect on the return on equity is found to be significantly negative. This result may be explained by the fact that the R&D expenses might have been incurred using equity assets, which leads to reduce in return on equity in short term.

Another possible explanation for this is the interaction between innovation and intellectual capital as well as the unstable fluctuations in the market conditions. Regarding the control variable, the effect of LEV was detected to be significantly negative in all stages for both ROI and ROE models describing that in firms using more financial leverage, the efficiency of effective risk management on firm performance was found to be decreased. Furthermore, the impact of total risk management on performance was examined throughout the pandemic period, and it was observed that during COVID-19, the performance effect of total risk management considerably decreased for both ROE and ROI performance measures. Given the significant detrimental consequences of COVID-19, it appears that additional emphasis on pandemic prevention is necessary. In general, therefore, it seems that if firms can manage the adverse circumstances brought on by risk exposure, invest in intellectual capital and innovation, and develop irreplaceable assets, they may enhance their corporate performance and achieve a competitive advantage. The outcomes could have been impacted by firms' structure and the differences in risk management strategies used by family and non-family businesses. Family businesses make up the majority of the companies traded on the Turkish market. Since the study was limited to the BIST-30, it was not possible to apply mentioned distinction. However, a further study could assess the effects of total risk management, R&D and intellectual capital investments on firm performance by taking into account the firm structure considering family firms and using larger indices in order to establish a greater degree of accuracy on this matter. Overall, this study strengthens the idea that managers should integrate a larger range of risks in risk evaluations in order to include key strategic risk elements, as well as take company development activities into consideration to boost adaptability and potential possibilities. Business entrepreneurship must be developed to profit from opportunities and prevent environmental challenges, keeping in view that investment in firm-specific investor interactions increases firm value. However, traditional risk management practices remain important in order to reduce negative losses arising from financial and operational risks. These results also address the relevance of integrated thinking and reporting as firms include financial and non-financial capital in their annual disclosures. Integrated disclosures also help executives improve their corporate governance and strengthen their credibility with institutions and other stakeholders in society [61]. Given that operating performance is greater in firms with higher levels of total risk management and higher innovation and intellectual capital investments, this study suggests that investors should notice higher risk management attention of firms to better evaluate the risk assessment process.

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