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RESEARCH ARTICLE

Intellectual Capital and Firm Value: An Investigation of Turkish Manufacturing Companies

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Abstract
This paper investigates whether intellectual capital and its components (human, relational, innovation, and process capitals) have meaningful information on firm value. Full sample consists of 148 listed Turkish manufacturing firms over the period of 2005–2017. We show that our extended Ohlson models explain the substantial part of the unexplained variation in firm market values. Specifically, we find that higher levels of measures of human capital, relational capital, process capital, innovation capital, and overall intellectual capital are directly associated with higher stock prices. Furthermore, we find that intellectual capital and its components have lagged effects on market values of firms, and human capital has a moderating effect on the relationship between other intellectual capital components and firm market values. Our main finding still holds when we re-estimate our model by addressing potential endogeneity issues and alternative conditions. Based on our findings, we recommend firm managers to do convenient resources planning on these components to raise the firm's value. Moreover, we recommend accounting standards setters to create a separate financial reporting standard, which includes detailed information on these components that are value-relevant in making business valuation decisions.

Keywords

Intellectual Capital, Human Capital, Relational Capital, Innovation Capital, Process Capital, Firm Value

Introduction

Especially after the 1970s, the business environment has changed from the traditional economy into the knowledge economy. With this economic transformation, successful companies mostly concentrated on intangibles and have started to invest heavily in intangible assets rather than financial and physical sources (Tseng and Goo, 2005). This is because, in the knowledge economy, unique resources of a firm provide competitive advantages, and thus higher performance (Barney, 1991). According to the resource-based view theory, in order for a resource to be seen as a source of continuous competitive advantage, the resource needs to be inimitable and rare, no adequate substitutes must be available, and finally, it must contribute to the value of the company.

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In the literature, these characteristics are merged under the concept of "Intellectual Capital (IC)". Since IC has become an important value determinant in today's organizations, it can be argued that an effective assessment cannot be made in capital markets without the IC knowledge of firms. IC assets, such as human resources, innovation capabilities, knowledge, and processes should be regarded in valuation of companies (Wang, 2008). Therefore, many conceptual frameworks have been developed to understand, measure and systematize IC because of the critical role of it in value creation in the knowledge economy.

In this paper, the main objective is to contribute to the examination of the growing gap between market values and book values of firms. We argue that IC might be considered to be value-relevant to market participants because it might have the power to provide a competitive advantage for firms and affect the decisions of related information users. Therefore, we investigate whether IC and its components (human, relational, innovation, and process capitals) have meaningful information on firm value.

The main motivation in this paper is to answer whether market values of Turkish manufacturing firms are positively affected by their IC level. This is because the manufacturing industry is an important and crucial sector in the Turkish economy. The Turkish economy expanded rapidly after the millennium by increasing competitiveness, fostering foreign trade, and attracting foreign investments (Özkara and Atak, 2015). During that period, the highest contribution to the overall productivity growth of Turkey came from the manufacturing industry (Atiyas and Bakis, 2015). Many researchers in the IC literature have focused on the manufacturing sectors in other countries (Cisneros and Hernandez-Perlines, 2018; Tseng and Goo, 2005; Xu and Li, 2020; Xu and Liu, 2020). Therefore, we believe that it is crucial to analyze whether IC has meaningful information on firm value and affects the decisions of related information users in the context of Turkish manufacturing industry which is the industry with the highest number of publicly traded firms in Borsa Istanbul.

Following previous studies (i.e. Alfraih, 2017; Eloff and de Villiers, 2015; Liu et al., 2009; Tseng and Goo, 2005; Tseng et al., 2015; Wang, 2008), in order to examine our research purposes, we based our experimental model on Ohlson (1995) valuation model by separately adding measures of IC components into the model in exchange for 'other information' . Our sample consists of 148 listed Turkish manufacturing firms over the period 2005–2017.

Our empirical findings confirm Ohlson model suitability, implying that book value and abnormal earnings have explanatory power on the market value of Turkish manufacturing companies. More importantly, we report that our extended Ohlson models explain the substantial part of the unexplained variation in firm market values. Specifically, we show that higher levels of measures of IC components and IC score are directly associated with higher stock prices. Furthermore, we find that IC and its components have lagged effects on market values of firms, and human capital has a moderating effect on the relationship between other IC components and firm market values.

To the best of our knowledge, there is no study that investigates the direct and lagged effects of the overall intellectual capital on firm market value and the moderating effect of human capital on the relationship between other IC components and market value in the context of the Turkish manufacturing companies. Moreover, and most importantly, we add to the literature by following recent studies (Liu et al., 2009; Tseng et al., 2015; Wang 2008), which consider the components of IC as human, relational, innovation, and process capitals.

The rest of the paper is organized as follows. In Section 2, we discuss conceptual framework and hypotheses. In Sections 3 and 4, we describe data, empirical methodology, and empirical evidence, respectively. Section 5 is devoted to discussion. Section 6 concludes the paper.

Conceptual Framework and Hypotheses

Intellectual Capital and its Components

Stewart (1998) defines *intellectual capital* (IC) as the intellectual materials (such as intellectual property, information, knowledge, and experience) that can be used to form value and wealth. IC aggregates "hidden" assets of corporations that are not fully included in balance sheets (Roos and Roos, 1997), and it is a non-financial capital that captures the gap between market and book values of firms (Liu et al., 2009). IC is often discussed in three major components: (i) structural/organizational, (ii) relational/customer, and (iii) human. On the other hand, especially in recent studies, it is seen that innovation and process capitals, which are sub-components of organizational capital, are treated as different IC components based on the framework drawn by Edvinsson and Malone (1997). As process and innovation capitals may need different managerial activities, it is thought that it will be more appropriate to consider them by separating from structural capital (Tseng and Goo, 2005). Therefore, we follow studies (i.e. Liu et al., 2009; Tseng ve Goo 2005; Wang 2008) in which innovation and process capitals are addressed as separate IC components. Thus, we consider IC by dividing it into four components, i.e. human, relational, innovation, and process capitals.

Human capital (HC) is competencies, qualifications, talents, and skills owned by individuals and/or groups within companies and cannot be viewed as an entity, which is legally owned by companies (Stewart, 1998). Therefore, it is an asset that employees take with them when they leave the firm. HC consists of human-related items such as problem-solving ability, career paths, employee satisfaction, employee retention, knowledge, and experience. *Relational capital (RC)* can be expressed as the whole of the relations between the firm and its external stakeholders, such as market, customers, suppliers, trade associations, partners, competitors, society, and state. Among these stakeholders, customers stand out as the most important group. RC consists of external stakeholder-related items such as brands and values of brands, customer loyalty, organizational reputation, stakeholder support, distribution channels, license agreements, and networks. *Innovation capital (INC)* is the capacity of organi-

zations to produce new services and products and to protect intellectual property rights. INC consists of patents, trademarks, copyrights, design rights, trade secrets, know-how for tech transfer, and so on. *Process capital (PC)* is related to the development of an organizational environment that will support employees for value creation by ensuring order and stability within a firm. PC consists of organizational structures such as administrative systems, performance management systems, norms, routines, policies, and culture. INC and PC, unlike HC and RC, can be viewed as entities, which are legally possessed by companies.

Related Literature and Research Hypotheses

There are many studies in the literature that examine the effects of IC on market value in order to investigate whether IC has meaningful information on firm value. For example, Wang (2008) examines the influence of IC on the market values of the US Standard & Poor's 500 publicly traded electronic companies by using the Ohlson value-relevance model and reports the positive relationship between IC and market value. Similarly, Liu et al. (2009) and Tseng et al. (2015) examine the influence of IC on the market values of the Taiwanese IT companies by using the Ohlson value-relevance model. Both studies report that the involvement of IC into valuation models presents significant information. Alfraih (2017) finds that the level of IC disclosure of Kuwait companies is positively related to their market value, implying that IC disclosure is positively valued by investors. Nazir et al. (2020) examine the effect of IC on performance in the context of financial institutions in three countries (such as China, Hong Kong, and Taiwan). They report that IC efficiency positively influences the profitability of financial institutions. Besides, there are studies in the literature that report a positive relationship between IC and firm performance in the context of the Turkish firms (such as Bayraktaroglu et al., 2019; Gülcemal and Çıtak, 2017; Özer et al., 2015; Yılmaz and Acar, 2018). In general, these studies report that IC is one of the leading factors that explain the value together with physical and financial capital in the modern competitive environment.

IC has become an important value determinant in today's companies because it is a unique resource of firms that contributes to value creation and sustainable competitive advantages. Therefore, IC can be regarded to be value-relevant to market participants because it is thought to affect decisions of related information users (see Wang, 2008). Based on these arguments and the findings of prior IC studies, we conjecture that, all else equal, market values of firms are positively affected by their IC level. This leads to our main hypothesis:

H: The higher the intellectual capital of Turkish manufacturing companies, the higher the market values will be.

We also believe that examining the effects of individual IC components will shed more light on understanding the nexus between IC and firm value. Therefore, as supplementary hypotheses, we argue that firm value is positively affected by IC components.

H_1: The higher the human capital of Turkish manufacturing companies, the higher the market values will be.

H_2: The higher the relational capital of Turkish manufacturing companies, the higher the market values will be.

H_3: The higher the innovation capital of Turkish manufacturing companies, the higher the market values will be.

H_4: The higher the process capital of Turkish manufacturing companies, the higher the market values will be.

Data and Empirical Methodology

Sample

To conduct the empirical analysis, we retrieved firm-level data from the FINNET database. We restrict our sample to listed Turkish manufacturing firms. We set the starting point of our sample at 2005, because we aimed to exclude the effects of inflation accounting, which was applied in 2003 and 2004 and ended in 2005. To avoid the effect of outliers and misreported data, we winsorized all variables at their 5th and 95th percentiles. After the data cleaning steps, our sample consists of 1,540 firm-year observations of 148 listed manufacturing firms over the period 2005–2017. Variables and their operational definitions are provided in Table 1.

Table 1
Research Variables

Constructs	Variables	Operational definitions
Firm value	Stock Price	*Stock price* is the closing price of firms' shares at the last official disclosure of the annual financial statements at time t+1.
Financial capital	Book Value	*Book Value per Share* defined as shareholder's equity value divided by ordinary shares outstanding.
	Abnormal E.	*Abnormal Earning* defined as net income at time t minus [book value at time *t-1* multiple by cost of capital (=the annual weighted average cost of TRY denominated fixed rate coupon bonds)] divided by ordinary shares outstanding.
Human capital	HC_SPE	*Sales per Employee* defined as net sales (in thousands of TRY) divided by number of employees.
Relational capital	RC_MEPS	*Marketing Expenses per Share* defined as sales, marketing and distribution expenses divided by ordinary shares outstanding.
Innovation capital	INC_RDPS	*R&D expenses per Share* defined as research and development expenses divided by ordinary shares outstanding.
Process capital	PC_AEPE	*Administrative Expenses per Employee* defined as general, managerial and administrative expenses (in thousands of TRY) divided by number of employees.
Intellectual capital	IC_Score	*Intellectual Capital Score* is the average of four indicators of intellectual capital components. Before averaging the indicators, they were standardized (zero mean and unit variance).

Constructs	Variables	Operational definitions
Control variables	Leverage	*Leverage* defined as total liabilities divided by shareholder's equity value.
	Liquidity	*Liquidity* defined as the ratio of current assets to current liabilities.
	Size	*Firm Size* defined as the natural logarithm of total assets.
	Crisis	*Crisis* denotes a dummy variable, which equals one for 2007 and 2008 and to zero otherwise to control the effect of the global financial crisis on the financial statements of firms.

Measures of IC Components

Organizations usually measure their IC to evaluate and manage its effects on value creation. As the highest value creation objectives in organizations that are unique are achieved in different ways, there are several methods to measure IC. There are two measurement trends: Monetary measurement, which quantifies the value of IC with monetary figures, and non-monetary measurement, which often uses Likert-type scales (Sydler et al., 2014). Depending on research goals, both measurement methods have advantages as well as disadvantages. In line with our objectives in this paper, however, we decided to use proxy variables for each component. The main reason for using proxy variables is that using these indicators will allow us to benchmark IC of firms with others by relying on publicly available financial statements data of firms , and thus provide reliable and consistent testing opportunities.

Kucharčíková et al. (2015) recommend that indicators should clearly reflect the company's performance and the achievement of current and future objectives. Moreover, Sydler et al. (2014) draw attention to the source of indicators and suggest that the best approximation for components is a measurement procedure based on income statement data in the absence of market prices. Wang (2008) suggests that one or two proxy variables will be sufficient to keep the analysis simple while still providing a meaningful picture. Therefore, following suggestions of previous studies, we decided to use one proxy variable for each IC component.

Lajili and Zeghal (2005) consider net sales per employee as a signal indicating whether human resources are used effectively in the accomplishment of the corporate goals of firms. Similarly, Samudhram et al. (2014) assert that sales per employee is an important human resource indicator for investors. This is because an increase in the value of net sales per employee means that employees create more value, and thus contribute more to the performance of firms. Therefore, we select sales per employee as a proxy indicator for human capital, following the works of Etebar and Darabi (2011), Lajili and Zeghal (2005), Samudhram et al. (2014), and Wang (2008).

Previous studies report that firms that spend more marketing and advertising expenses are more valuable in stock markets (Huang and Wang, 2008). This is because these expenses are seen as intangible capital investments, which have a positive effect on future cash flows. According to Sydler et al. (2014), these findings can be explained by the positive relationship between marketing expenses and brand value because a stronger brand value increases

customer loyalty, establishes greater business partnerships, and increases the effectiveness of marketing communications. Therefore, we select marketing expenses per share as a proxy indicator for relational capital, following the works of Etebar and Darabi (2011), Huang and Wang (2008), Sydler et al. (2014), and Tseng et al. (2015).

The most important function of innovation capital is the adequacy and quality of research and development activities conducted by a company. R&D activities enhance knowledge accumulation of firms through new scientific knowledge flow (Sydler et al., 2014). Therefore, we select research and development expenses per share as a proxy indicator for innovation capital, following the works of Etebar and Darabi (2011), Sydler et al. (2014), and Tseng et al. (2015).

Finally, process capital is about culture, systems, and routines within a firm. Providing order and stability within a firm is one of the important duties of a top management team. The benefits provided to a top management for the order and for the implementation of stronger culture, systems, and routines can be an appropriate indicator of process capital. Therefore, we select administrative expenses per employee as a proxy indicator for process capital, following the works of Etebar and Darabi (2011), Huang and Wang (2008), and Liu et al. (2009).

Empirical Procedure

Ohlson (1995) has developed a benchmark model on how a firm should be valued by simply using accounting information. It has become a widely used model in value-relevance studies that examine whether any information influences the decisions of market participants, since it allows a direct relationship between accounting information and market value of a firm (Barth, 2000). In this paper, we benefit from Ohlson's (1995) residual income model (OM), which needs publicly available data from the financial statements of companies, because we aim to examine the effects of IC on firm value with a method which should allow us a benchmark both across firms and within firms over time and with consistent measures. Similarly, Sydler et al. (2014) argue that OM provides reliable and transparent tests in incorporating IC measures to firm outcomes.

OM regresses stock price on book value, abnormal earnings, and other information. OM is generally modified to test the value relevance of basic accounting information by removing other information, which is hard to measure. However, it is claimed that removing other information from the model will disrupt the suitability of the model (see Al-Hares, 2011). Therefore, following previous studies (i.e. Eloff and de Villiers, 2015; Liu et al., 2009; Wang, 2008; Tseng and Goo, 2005; Tseng et al., 2015), we examine the effect of IC on market value by including IC measures in the OM in response to the other information. OM and our extended OM take the following form, respectively:

$$Stock\ Price_{it} = \alpha + \beta_1 Book\ Value_{it} + \beta_2 Abnormal\ E._{it} + \beta_3 Z_{it} + \varepsilon_{it} \quad (1)$$

$$Stock\ Price_{it} = \alpha + \beta_1 Book\ Value_{it} + \beta_2 Abnormal\ E._{it} + \beta_3 IC_{it} + \beta_4 Z_{it} + \varepsilon_{it} \quad (2)$$

All variables are defined in Table 1. The stock price is the closing price of firms' shares at the last official disclosure of the annual financial statements at time t+1. This is because financial statements for time t do not become publicly available until the release date at time t+1. IC_{it} is the overall IC score or one of the measures of four IC components. Z_{it} denotes a set of firm-level control variables, and ε_{it} is the error term. These control variables are leverage, liquidity, and firm size. We also control the effect of the global financial crisis on the financial statements of firms by including Crisis dummy variables .

Equations (1)─(2) are estimated using a panel data method, since, in the data set, there is both the firm dimension representing the cross-section and the year dimension representing the time-section. Initially, we run model specification tests to specify which technique is more suitable for our data set (i.e. F (Chow) test to decide pooled or fixed effects; Breusch-Pagan Lagrange Multiplier test to decide pooled or random effects; and Hausman test to decide random or fixed effects). According to the results in Appendix A, we utilize the fixed effects regression model. Later, to ensure validity of the statistical results, we investigated whether assumptions of the underlying regression models are violated. Untabulated results show that our fixed effects models seem to have serial correlation, heteroscedasticity, and cross-sectional dependence problems.[1] Therefore, we estimate Equations (1)─(2) using the Driscoll-Kraay standard errors method, which is robust to heteroscedasticity, cross-sectional dependence, and temporal dependence problems.

Descriptive Statistics

Table 2 displays the descriptive statistics of the variables employed in this paper. The full sample mean (median) of stock price is 8.350 (2.720), while the mean (median) of book value is 6.035 (2.828). On average, our sample firms have positive abnormal earnings. Specifically, mean (median) abnormal earnings is 0.038 (-0.047). The full sample means of measures of human, relational, innovation, and process capitals are 433.7, 1.237, 0.060, and 17.27, respectively, while the mean (median) of the overall IC score is 0.007 (-0.148).

Table 3 reports the correlation matrix for the variables. All paired correlation coefficients between stock price and other variables are statistically significant at the 5% significance level. Stock price is positively correlated with all variables, except for leverage, in line with the findings in Table 4, while it is positively correlated with leverage. A high correlation value (over 0.70) among the variables in the same regression models is not desirable as it may lead to a multicollinearity problem. As can be seen in Table 3, there is no high correlation coefficient value among the independent variables. Moreover, we computed the variance inflation

1 We do not report the results of assumptions tests in the interest of brevity, but they are available upon request.

factor to see if there is any multicollinearity problem and untabulated results show that there isn't any collinearity problem amongst the variables.

Table 2

Descriptive statistics

Variables	N	Mean	St. Deviation	Median	Minimum	Maximum
Stock Price	1,689	8.350	13.40	2.720	0.622	53.29
Book Value	1,689	6.035	7.840	2.828	0.579	32.29
Abnormal E.	1,540	0.038	0.861	-0.047	-1.692	2.406
HC_SPE	1,382	577.4	433.7	441.0	112.9	1782.4
RC_MEPS	1,682	0.834	1.237	0.324	0.016	4.650
INC_RDPS	1,683	0.031	0.060	0.001	0.000	0.224
PC_AEPE	1,382	27.89	17.27	23.93	7.394	70.93
IC_Score	1,382	0.007	0.616	-0.148	-0.857	2.217
Leverage	1,689	0.441	0.213	0.423	0.109	0.832
Liquidity	1,689	2.228	1.573	1.643	0.687	6.567
Size	1,689	19.54	1.373	19.42	17.35	22.32

This table reports the descriptive statistics of the variables. Operational definitions of research variables are displayed in Table 1. The sample includes 148 listed manufacturing firms over the period 2005–2017. We winsorized all variables at their 5th and 95th percentiles.

Table 3

Correlation Matrix

Variables		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Stock Price	(1)	1.00										
Book Value	(2)	0.63	1.00									
Abnormal E.	(3)	0.29	0.22	1.00								
HC_SPE	(4)	0.21	0.23	0.26	1.00							
RC_MEPS	(5)	0.58	0.63	0.07	0.06	1.00						
INC_RDPS	(6)	0.32	0.22	0.15	0.00	0.39	1.00					
PC_AEPE	(7)	0.18	0.21	0.10	0.63	0.00	-0.09	1.00				
IC_Score	(8)	0.53	0.53	0.23	0.69	0.60	0.54	0.62	1.00			
Leverage	(9)	-0.05	-0.19	-0.10	0.10	0.05	0.13	-0.07	0.09	1.00		
Liquidity	(10)	0.06	0.13	0.19	-0.10	-0.06	-0.02	0.07	-0.04	-0.53	1.00	
Size	(11)	0.14	0.13	0.20	0.44	0.15	0.21	0.20	0.41	0.14	-0.20	1.00

This table reports the correlation matrix for the variables. Operational definitions of research variables are displayed in Table 1. The sample includes 148 listed manufacturing firms over the period 2005–2017. All paired correlation coefficients between *Stock Price* and other variables are statistically significant at the 5% significance level. We winsorized all variables at their 5th and 95th percentiles.

Empirical Results

Table 4 presents our main results on the effect of IC on market value. In Models 1-7 of the table, we examine the impact of the basic OM, measures of human, relational, innovation, and process capitals, the overall IC score, and the measures of four IC components together on stock price, respectively.

Table 4
Intellectual Capital and Firm Value

	Basic Model	Human Capital	Relational Capital	Innovation Capital	Process Capital	Intellectual Capital	Intellectual Capital
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Book Value	0.294***	0.303***	0.113**	0.229***	0.303***	0.129**	0.117**
	(4.93)	(6.47)	(2.32)	(3.49)	(6.56)	(2.07)	(2.06)
Abnormal E.	2.075***	1.377***	2.128***	2.195***	1.671***	1.715***	1.588***
	(5.71)	(4.07)	(5.42)	(5.54)	(4.74)	(4.33)	(3.90)
Leverage	0.567***	0.909***	0.309**	0.502***	0.794**	0.658**	0.678**
	(2.97)	(2.74)	(2.05)	(3.10)	(2.26)	(2.42)	(2.61)
Liquidity	-0.011	0.380***	0.099	-0.010	0.340**	0.432***	0.436***
	(-0.13)	(3.05)	(1.44)	(-0.13)	(2.40)	(3.21)	(3.29)
Size	3.511***	1.796***	3.774***	3.367***	2.625***	1.852***	1.668***
	(5.13)	(2.99)	(4.82)	(4.94)	(4.28)	(3.18)	(2.91)
Crisis	-1.712***	-1.843***	-1.586**	-1.641**	-2.043***	-1.834***	-1.777***
	(-2.64)	(-2.82)	(-2.41)	(-2.41)	(-3.33)	(-2.84)	(-2.66)
HC_SPE		0.006***					0.005***
		(4.52)					(4.34)
RC_MEPS			1.605***				1.183***
			(5.12)				(5.38)
INC_RDPS				27.276***			17.985**
				(3.30)			(2.16)
PC_AEPE					0.077***		0.030**
					(3.23)		(2.26)
IC_Score						5.090***	
						(4.20)	
Observations	1,540	1,318	1,537	1,537	1,318	1,318	1,318
R-squared	0.852	0.881	0.856	0.855	0.879	0.883	0.884
F - value	1203***	171.7***	276.7***	2349***	147.7***	310.5***	350.5***

This table presents the regression results where the dependent variable is stock price. Columns (1)-(7) analyze the effects of variables of basic model, human capital, relational capital, innovation capital, process capital, intellectual capital, and four intellectual capital components, respectively. Operational definitions of research variables are displayed in Table 1. The sample includes 148 listed manufacturing firms over the period 2005–2017. We winsorized all variables at their 5th and 95th percentiles. Models are estimated using fixed effects regression models with Driscoll-Kraay standard errors methods. Constant terms are included but not reported. T-statistics are in parentheses. *, ** and *** indicate two-tailed statistical significance at the 10%, 5% and 1% levels, respectively.

We begin by considering the coefficient estimates of book value and abnormal earnings variables in the Table to support our results with the findings of previous studies. In all models, the coefficient estimates on book value and abnormal earnings are consistently positive and statistically significant at the 5 percent level, which is consistent with the findings of previous studies (Liu et al., 2009; Tseng et al., 2015; Wang, 2008). Therefore, our empirical findings confirm OM's suitability, implying that book value and abnormal earnings have explanatory power on the market value of Turkish industrial companies. This supporting evidence builds our confidence that our evidence on the relationships between IC and the firm market value is robust.

We now turn to test our hypotheses. First, Table 4 shows that the coefficient on *HC_SPE* in Column (2) is 0.006, and it is significant at the 1 percent level. This result confirms that

our human capital measure has a positive effect on the stock price of firms, as expected and in line with H_1, which predicts that the higher the human capital of Turkish manufacturing companies, the higher the market values will be. This finding is theoretically rational. This is because human resources, knowledge, and skills have become crucial within the new economic landscape, since they have been a critical ingredient to gain a competitive advantage (Hitt et al., 2001). Therefore, it can be expected that firms with higher HC may have higher market values because higher HC will probably lead to better performance, and investors will see such companies more valuable.

Second, Table 4 shows that the coefficient on *RC_MEPS* in Column (3) is 1.605, and it is significant at the 0.01 level. This result confirms that our relational capital measure has a positive effect on the stock price of firms, as expected and in line with H_2, which predicts that the higher the relational capital of Turkish manufacturing companies, the higher the market values will be. This finding is theoretically rational because RC is the strength of the relationships between the firm and its external stakeholders. Firms that have strong relationships with all of their stakeholders will increase their brand values, customer loyalty, and stakeholder support. Thus, firms with higher organizational reputations in the markets will gain investor trust and increase their market value.

Third, Table 4 shows that the coefficient on *INC_RDPS* in Column (4) is 27.276, and it is significant at the 0.01 level. This result confirms that our innovation capital measure has a positive effect on the stock price of firms, as expected and in line with H_3, which predicts that the higher the innovation capital of Turkish manufacturing companies, the higher the market values will be. It can be argued that INC will have a systematic effect on the market values of today's companies because innovation activities allow the production of new technological assets, and markets see such spending as an investment that will generate future cash flow. Therefore, we believe that this finding is theoretically rational.

Fourth, Table 4 shows that the coefficient on *PC_AEPE* in Column (5) is 0.077, and it is significant at the 0.01 level. This result confirms that our process capital measure has a positive effect on the stock price of firms, as expected and in line with H_4, which predicts that the higher the process capital of Turkish manufacturing companies, the higher the market values will be. This finding is theoretically rational because the better the culture and routines in a firm, the stronger the stability in the firm. Investors attribute more value to stable firms.

Fifth and last, Table 4 shows that the coefficient on *IC_Score* in Column (6) is 5.090, and it is significant at the 0.01 level. This result confirms that our overall IC score has a positive effect on the stock price of firms, as expected and in line with H, which predicts that the higher the intellectual capital of Turkish manufacturing companies, the higher the market values will be. Moreover, Column (7) shows that the explanatory capacity of the model significantly increases from 0.852 to 0.884 when measures of four IC components are included in OM. A significant increase in R-squared reveals the incremental explanatory power of IC on firm

market value, implying that IC is value-relevant to market participants because it affects the market value, and thus decisions of related information users.

Additional Tests: Lagged and Interaction Effects of IC and its Components

In this subsection, to further support our findings, we check whether the results persist when we re-estimate our models by considering potential simultaneity issues. Moreover, by doing so, it will be investigated whether IC has lagged effects on firm value. Columns (1)-(5) of Table 5 analyze the one time-lagged effects of variables of human capital, relational capital, innovation capital, process capital, and overall IC score, respectively. Overall, Table 5 shows that our findings are robust, and IC and its components have lagged effects on market values of firms in Turkish industrial companies. Specifically, Table 5 shows that the coefficients on *HC_SPE, RC_MEPS, INC_RDPS, PC_AEPE*, and *IC_Score* continue to hold their positive signs, and they are highly significant.

Table 5
Lagged Effects of Intellectual Capital and Its Components on Firm Value

	Human Capital	Relational Capital	Innovation Capital	Process Capital	Intellectual Capital
	(1)	(2)	(3)	(4)	(5)
Book Value	0.317***	0.144**	0.235***	0.311***	0.164***
	(5.78)	(2.03)	(3.72)	(5.78)	(3.19)
Abnormal E.	0.467*	1.100***	1.144***	0.743***	0.782***
	(1.97)	(4.39)	(4.52)	(3.26)	(3.18)
Leverage	1.584***	0.752***	0.937***	1.440***	1.269***
	(3.91)	(2.85)	(3.46)	(3.12)	(3.14)
Liquidity	0.532***	0.190	0.097	0.495**	0.556**
	(2.69)	(1.51)	(0.83)	(2.35)	(2.52)
Size	0.977*	3.197***	2.812***	1.754***	1.224**
	(1.77)	(2.88)	(2.95)	(2.64)	(1.99)
Crisis	-3.620***	-3.059***	-3.181***	-3.667***	-3.588***
	(-6.92)	(-4.44)	(-4.63)	(-6.81)	(-6.95)
HC_SPE	0.006***				
	(3.40)				
RC_MEPS		1.308***			
		(3.06)			
INC_RDPS			23.248***		
			(2.89)		
PC_AEPE				0.071***	
				(3.82)	
IC_Score					4.188***
					(3.36)
Observations	1,174	1,388	1,388	1,174	1,174
R-squared	0.899	0.863	0.863	0.897	0.899
F - value	186.1***	964.2***	1359***	263.4***	286.7***

This table presents the regression results where the dependent variable is stock price. Columns (1)-(5) analyze the lagged effects of variables of human capital, relational capital, innovation capital, process capital, intellectual capital, and four intellectual capital components, respectively. Operational definitions of research variables are displayed in Table 1. The sample includes 148 listed manufacturing firms over the period 2005–2017. We winsorized all variables at their 5th and 95th percentiles. Models are estimated using fixed effects regression models with Driscoll-Kraay standard errors methods. Constant terms are included but not reported. T-statistics are in parentheses. *, ** and *** indicate two-tailed statistical significance at the 10%, 5% and 1% levels, respectively.

Table 6

Interaction Effects of Intellectual Capital Components on Firm Value

	Human Capital × Relational Capital	**Human Capital × Innovation Capital**	**Human Capital × Process Capital**
	(1)	**(2)**	**(3)**
Book Value	0.101	0.033	0.130**
	(1.35)	(0.51)	(2.23)
Abnormal E.	1.521***	1.341***	1.592***
	(3.98)	(3.83)	(3.97)
Leverage	0.618**	0.253	0.720***
	(2.33)	(1.29)	(2.76)
Liquidity	0.435***	0.289***	0.453***
	(2.96)	(2.65)	(3.51)
Size	1.774***	1.926***	1.782***
	(2.91)	(3.14)	(3.21)
Crisis	-1.748**	-1.674**	-1.872***
	(-2.61)	(-2.51)	(-2.79)
HC_SPE	0.006***	0.010***	0.005***
	(3.79)	(6.45)	(3.51)
RC_MEPS	1.208***	1.166***	1.232***
	(4.20)	(5.21)	(5.61)
INC_RDPS	20.486**	37.550***	18.212**
	(2.20)	(3.68)	(2.15)
PC_AEPE	0.028**	0.032**	0.028**
	(2.06)	(2.41)	(2.24)
HC × RC	0.003*		
	(1.70)		
HC × INC		0.138***	
		(6.90)	
HC × PC			0.000***
			(3.01)
Observations	1,318	1,318	1,318
R-squared	0.886	0.895	0.884
F - value	424.9***	266.1***	978.6***

This table presents the regression results where the dependent variable is stock price. Columns (1)-(3) analyze the interaction effects between human capital and relational capital, human capital and innovation capital, and human capital and process capital, respectively. Operational definitions of research variables are displayed in Table 1. The sample includes 148 listed manufacturing firms over the period 2005–2017. We winsorized all variables at their 5th and 95th percentiles. Models are estimated using fixed effects regression models with Driscoll-Kraay standard errors methods. Constant terms are included but not reported. T t-statistics are in parentheses. *, ** and *** indicate two-tailed statistical significance at the 10%, 5% and 1% levels, respectively.

Further, an interesting question would be to ask whether HC strengthens or weakens the effects of other IC components on firm value. There are many scholars who argue that IC components are interrelated and operate in an interactive way to contribute value creation processes by forming a higher IC (see Ferraro and Veltri, 2011; Giuliani, 2013; Kamukama et al., 2010). More specifically, the ability of IC to effectively contribute to value creation depends on the interactions among components. Therefore, in Columns (1)-(3) of Table 6, we analyze the interaction effects between human capital and relational capital, human capital and innovation capital, and human capital and process capital, respectively. The Table shows

that HC has a moderating effect on the relationship between other IC components and market values of firms in Turkish industrial companies. Specifically, Table 6 shows that the coefficients on *HC* × *RC, HC* × *INC,* and *HC* × *PC* take positive signs, and they are statistically significant. This implies that higher levels of HC lead to a greater impact of other IC components on market values of firms.

Robustness Tests

In this section, we check whether our main finding still holds when we re-estimate our model by addressing potential endogeneity issues and alternative conditions. Firstly, to deal with potential endogeneity problems which have deleterious effects on OLS estimates, we use two-step system generalized-method-of-moments (system-GMM) estimator for dynamic panel data (Arellano and Bover, 1995; Blundell and Bond, 1998). Robust standard errors are computed using the finite-sample correction for the two-step covariance matrix. We treat the lagged dependent variable as predetermined, all remaining firm-level variables as endogenous, and the crisis dummy variable as exogenous. The predetermined variable is instrumented by its own one-to six-period lags. Endogenous variables are instrumented by their own two-to seven-period lags. The exogenous variable is instrumented by its own instrument. We collapse the matrix of instruments. Column (1) of Table 7 presents the result. Hansen test, which has a statistically non-significant p-value, confirms the validity of our instruments in the regression analysis. Significant AR(1) and insignificant AR(2) statistics confirm that the model is correctly specified. Irrespective of the statistically insignificant results on our control variables coefficients, our main variables, such as *Book Value*, *Abnormal E.*, and *IC_Score* have statistically significant and economically meaningful coefficients. Our conclusion on the effect of IC on the market value of firms in Table 4 continues to hold when we use the two-step system GMM approach.

Secondly, in column (2), to reduce the noise led by firms with non-consecutive observations and provide more consistency, we re-estimate the IC model by using a balanced panel data subsample, which allows observation of the firms in every time period. Thirdly, in column (3), in order to reduce business-cycle effects and measurement error, we re-estimate the IC model by using three-year averages of all variables (between 2006 and 2017).[2] Fourthly, in column (4), to control for unobserved systematic variations over time such as technological changes that have homogeneous impacts on all firms, we re-estimate the IC model by adding year dummies in the model.

Taken together, our robustness checks do not alter our main finding. The results consistently show that intellectual capital has a positive and statistically significant effect on the market value of firms. This implies that firms with higher IC levels have higher valuations in the market.

2 We thank Reviewer 2 for highlighting this important point.

Table 7

Robustness of the Main Result

	System-GMM	Balanced Panel	Three-Year Averages	Year Effects
	(1)	(2)	(3)	(4)
Stock Price$_{t-1}$	0.859***			
	(21.36)			
Book Value	0.194**	0.129*	0.087	0.174***
	(2.51)	(1.808)	(0.804)	(3.39)
Abnormal E.	0.814**	1.676***	3.200**	1.496***
	(2.56)	(3.645)	(5.839)	(3.69)
Leverage	0.295	0.752**	1.557**	0.839**
	(0.86)	(2.442)	(4.297)	(2.33)
Liquidity	-0.135	0.501***	0.657*	0.536**
	(-0.48)	(3.451)	(2.797)	(2.79)
Size	-0.611	1.918**	1.346**	-0.103
	(-1.37)	(2.902)	(5.678)	(-0.17)
Crisis	0.540	-1.842**		
	(1.65)	(-2.568)		
IC_Score	2.665**	5.190***	7.760**	3.671***
	(2.48)	(3.658)	(5.215)	(4.13)
Observations	1,318	1,146	416	1,318
AR(1) Test	0.000	-	-	-
AR(2) Test	0.903	-	-	-
Hansen Test	0.215	-	-	-
R-squared	-	0.883	0.903	0.891
F - value	1325.6***	372.2***	29.99***	284.3***

This table presents the robustness of the regression results where the dependent variable is stock price. Column (1) reports the two-step system-GMM results of the IC model. Column (2) reports the Driscoll-Kraay standard errors regression results of the IC model by using a balanced panel data subsample. Column (3) reports the Driscoll-Kraay standard errors regression results of the IC model by using three-year averages of all variables. Column (4) reports the Driscoll-Kraay standard errors regression results of the IC model by adding year dummies in the model. Coefficients of year dummies are not reported for brevity. Operational definitions of research variables are displayed in Table 1. We winsorized all variables at their 5th and 95th percentiles. Constant terms are included but not reported. T-statistics are in parentheses. *, ** and *** indicate two-tailed statistical significance at the 10%, 5% and 1% levels, respectively.

Discussion

Our evidence shows that higher levels of IC are directly associated with higher stock prices. This implies that both IC and its components (human, relational, innovation, and process capitals) have meaningful information on the market values of Turkish manufacturing companies. We attribute our results to IC influencing market value by shaping the power to gain a competitive advantage because IC, which are inimitable, rare, and non-substituted, has all the properties of the resource-based view theory's unique resource, which provides competitive advantages, and thus higher valuation in the market.

In this respect, this paper makes several important contributions to the IC literature. First, this paper shows that the value creation function proposed by resource-based theory is fulfil-

led with IC. This result is also in line with previous studies (Cisneros and Hernandez-Perlines, 2018; Nazir et al., 2020; Ramírez et al., 2020; Sardo and Serrasqueiro, 2017; Tseng and Goo, 2005; Tseng et al., 2015; Wang, 2008; Xu and Li, 2020; Xu and Liu, 2020) showing a positive relationship between IC and the outcomes of firms. Therefore, the results allow us to assert that IC is an important resource in today's companies because it is a unique resource of firms that contributes to value creation and sustainable competitive advantages. Consequently, firm managers should do convenient resource planning on IC to raise the firm's competitive advantages and value.

Second, this paper adds to the literature which uses IC as a value determinant of firms in business valuation models. This literature investigates the effect of IC on market value by including IC measures to Ohlson's (1995) residual income model in response to the other information. Our results are in line with previous studies (i.e. Alfraih, 2017; Eloff and de Villiers, 2015; Gümrah and Adiloğlu, 2011; Liu et al., 2009; Silvestri and Veltri, 2012; Tseng and Goo, 2005; Tseng et al., 2015; Wang, 2008) which conclude that IC has become an important value determinant in today's companies and ,hence, it should be taken into account in the valuation. Moreover, we also add to this literature by following recent studies (Liu et al., 2009; Tseng et al., 2015; Wang 2008), which consider the components of IC as human, relational, innovation, and process capitals.

Third, this paper adds to the literature on the relationship between IC and firm performance and/or market value in the context of Turkish firms. Our results are in line with previous studies (i.e. Bayraktaroglu et al., 2019; Gülcemal and Çıtak, 2017; Özer et al., 2015; Yılmaz and Acar, 2018). These studies, as well as ours, report a positive relationship between IC and firm performance in the context of the Turkish firms by clarifying that IC is one of the leading factors that explain the value together with physical and financial capital for Turkish manufacturing firms in the modern competitive environment.

Fourth, this paper also adds to the IC literature with new empirical evidence of the moderating effect of HC on the relationship between other IC components and market value. This evidence shows that HC strengthens the effects of other IC components on firm value, implying that HC is the most important component in the organization in value creation. This finding is consistent with Sardo and Serrasqueiro (2017) , who report that HC is the key factor of firms' wealth.[3] Therefore, Turkish manufacturing firms should conduct considerable investments in HC to enable employees to create more value, and thus contribute more to the firm's performance.

3 Moreover, according to the unreported results of Table 4, Model 7 on standardized beta coefficients, the IC component that has the most influence in explaining the change in the stock price is HC (standardized $\beta = 0.17$). The second factor is RC with a standardized beta of 0.11.

Conclusions

In the transformation of the business environment from the traditional economy into the knowledge economy, resource-based theory tries to explain why some companies invest not only in physical and financial resources but also in intangibles. The resource-based view theory indicates that a firm's unique resources provide competitive advantages (Samudhram et al., 2014). In that sense, it is suggested that IC should be taken into account in the valuation of today's companies (Wang, 2008). Therefore, IC can be regarded to be value-relevant to market participants because it is thought to have the power to provide a competitive advantage and affect the decisions of related information users.

In this paper, we investigated whether IC and its components (human, relational, innovation, and process capitals) have meaningful information on market values of Turkish manufacturing companies. We based our experimental model on Ohlson (1995) valuation model. We estimated our models using fixed effects regression models with Driscoll-Kraay standard errors method. Our findings confirm our main hypothesis that the higher the intellectual capital of Turkish manufacturing companies, the higher the market values will be. Specifically, we found that higher levels of measures of IC components and IC score are directly associated with higher stock prices. Furthermore, we found that IC and its components have lagged effects on market values of firms and HC has a moderating effect on the relationship between other IC components and firm market value.

Based on our findings, we recommend firm managers to do convenient resources planning on these components to raise the firm's value. Moreover, we recommend accounting standards setters to create a separate financial reporting standard, which includes detailed information on these components that are value-relevant in making business valuation decisions. On the other hand, it may be recommended that firm managers should not ignore the strong demand for disclosure of IC-related information, but voluntarily disclose relevant IC information, even if no obligation exists. This is because information about decisions and activities of employees that may be able to create value for firms and provide a competitive advantage is not often disclosed, and analysts make extra efforts to get information about value creators within the company (see Huang et al., 2013). Not disclosing related information may cause negative effects at all levels. For example, at firm level, business model and future business opportunities may not be properly understood. At market level, it may lead to anomalous market behavior, and the result may also be the misallocation of resources at macro level (Starovic and Marr, 2003). In that sense, as a final word, an important issue to be addressed is that measuring IC with more reliable proxies can lead to more accurate results. In the paper, IC is proxied with one variable for each component in order to overcome the disadvantages of the lack of data. However, when you have more reliable proxies, the number of these proxy variables can also be increased. The biggest obstacle to overcome these two issues is that there is not much information disclosed by the companies related to IC.

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Appendix A

Model Specification Test Results

	F (Chow) Test	Breusch-Pagan LM Test	Hausman Test
	F-value	**Chi-bar-square**	**Chi-square**
Basic Model	26.84***	3344.3***	208.8***
Human Capital Model	29.94***	3276.3***	222.2***
Relational Capital Model	24.89***	2883.7***	382.6***
Innovation Capital Model	26.43***	3223.6***	238.2***
Process Capital Model	29.11***	3300.4***	244.3***
Intellectual Capital Model	27.71***	3216.2***	175.1***

*, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.