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Research Article

Effects of Intellectual Capital on Firm Performance Using RIM*

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Abstract

In today's socioeconomic world, it is frequently thought that the intellectual capital has an important role in a firm's performance. Nonetheless, some of the recent findings support this idea whereas some point to the opposite, warranting further research to test the relationship in this context. In this study, we intend to determine the intellectual capital's (IC) potential effects on a firm's performance using a sample from a developing country, Turkey and measuring it with the help of *Residual Income Model (RIM)*. For this purpose, nine-year data, obtained after the examination of the financial statements of 85 enterprises from 11 different sectors operating in Istanbul Stock Exchange in the period of 2007-2016, were used. With the purpose of forming an inclusive empirical model, the intellectual capital values were analysed on traditional performance indicators in the form of *return on asset (ROA)*, *asset turn-over rate (ATO)*, *market/book value (MB)* and *return on equity (ROE)*, using the panel analysis method appropriate to the data set. Moreover, in order to distinguish the intellectual capital effect from the effects of other assets of the firm as well as to determine the existence of the sectoral effect, *firm size* and *leverage ratio* and *dummy variables* representing the sectors were added to our regression models. The results showed that intellectual capital has a positive effect on *return on asset* and *market/book value* at firm level and on *asset turn-over* rate across sectors. When these findings are taken together, it can be inferred that intellectual capital has a significant, although not as strong as expected, impact on firm performance in the context of Turkey. With these outcomes, our study produces significant results in terms of the interaction between intellectual capital and firm performance in a developing country and contributes to understanding of the concept of intellectual capital.

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1. INTRODUCTION

In the historical process, we can see that socio-economic developments took place in three stages. In the first of these stages, people moved from the primitive society to the agricultural society leaving a historical mark; in the second one, they moved from the agricultural society to the industrial society where mass production and consumption accelerated. Finally, in the last stage they transitioned into knowledge society where qualified human capital and knowledge came to the fore. While different factors were the pioneers of change at each stage, there were radical changes in the production factors which were taken into consideration. Mechanization that started with the steam engine has been the driving force in the transition from an agricultural society based on labour and soil-intensive natural resources, to an industrial society. In the transition from the industrial society to the information society, the raw material that constituted the essence of production has been replaced by knowledge, the role assigned to the employees with Taylorism was left behind. Subsequently, the employees who work with their intellectual power as well as their physical strength have a more active position, and new information-oriented institutions and rules have emerged in the management of the condition coming forth. In addition to that, within the capital structure, together with tangible assets such as machinery and equipment the weight of intangible assets in business activities and the investments made in such assets have also increased (Guthrie, 2001; Kandemir, 2008). In this transformation process and in the new economic and social environment as the new production factor in the capital structure, intellectual capital refers to the knowledge and knowledge-based assets that lead the transformation through the basic element, namely human (Nazir et al., 2017).

In the economic and social environment where firms are no longer viewed from a purely financial perspective but regarded as the sum of interdependent assets (Rossi, 2014), intellectual capital is considered as leading resource in increasing firm performance and market value as well as providing wealth and growth (Camfield et al., 2018). Indeed, this notion that intellectual capital affects firm performance is consistent with both the Recourse Based Approach (RBA), which argues that a firm must effectively identify and manage its tangible and intangible resources to achieve higher performance (Abdullaha and Sofiana, 2012) and with Knowledge Based Approach (KBA), which suggests that differences in performance between firms occur due to the different levels of knowledge that firms have and their different abilities in using and developing knowledge. However, there is a lack of empirical research showing the link between knowledge-based variables and firm performance. Therefore, more research is required to further functionalize the findings obtained by observing and measuring these variables reliably (Kirsimarja and Aino, 2015). There is no definitive and generally accepted conclusion about the relationship between intellectual capital and the performance of firms (Zhicheng et al., 2016). In this context, this study aims to contribute to a better explanation of this relationship by investigating the possible effects of intellectual capital on a firm's performance and at the same time distinguishing the differences across sectors.

A universally acceptable measure of intellectual capital still does not exist (Zhicheng et al., 2016). The difficulty in presenting intellectual capital due to its intangible nature makes it necessary to determine what constitutes intellectual capital. It also makes it necessary to examine components and the relationship between these components. An increasing number of methods have been used to make the evaluations of these components (Kim et al., 2012; Nazir et al., 2017). RIM was used to measure the intellectual capital to achieve the stated purpose of this study. The use of a different method such as RIM, apart from the methods that are frequently used, will increase the validity and reliability of the results obtained so far (Oliveira et al., 2016).

2. THEORETICAL BACKGROUND

One of the theoretical approaches in the field of strategic management that tries to understand the performance differences between firms is the RBA. RBA states that the superior performance achieved is a result of business-specific resources and capabilities, which are difficult and costly to obtain by other competitors. It advocates that firms must determine business-specific resources and capabilities first and then compete with these kinds of resources and capabilities not attained by competitors in order to achieve superior performance (Welnerfelt, 1984; Barney 1991; Theriou et al., 2009; Cantürk and Çiçek 2016). While resources are considered as phenomena to be selected by the firm, the capabilities are considered as phenomena that firms should be build (Rahmeyer, 2007). Within the scope of the main elements put forward in this way, RBA states that if the firms give the necessary importance to their internal assets, they can achieve performance superiority, and the performance differences between firms depend on their internal assets, namely their resources and capabilities (Özilhan, 2010).

The other theoretical approach that tries to understand the firm performance differences is KBA. Within the framework of the issues expressed by KBA, it is stated that the greatest reality that enables the firm to operate should be sought in intangible resources related to knowledge and skills, because these resources necessarily contain information about what, why and how the enterprise operates (Kirsimarja and Aino, 2015). As intangible resources are generally recognized as being rare, socially complex, and almost impossible to replicate, they may have a superior probability of gaining competitive advantage and may be the main determinants of a firm's performance (Curado and Bontis, 2006). Differences in performance between firms occur due to the different stocks of information they have and their different abilities in using and developing knowledge (Kirsimarja and Aino, 2015). In this context, while knowledge-based resources are at the basis of performance superiority, taking advantage of this situation seems to be highly dependent on socio-cultural conditions within the business and industry (Reihlen and Ringberg, 2013).

3. INTELLECTUAL CAPITAL

Intellectual capital, which in its simple form corresponds to the accumulation of knowledge obtained through networks (Kerimov, 2011; Özdemir and Karakoç, 2018), is defined in various ways in literature. For instance, Stewart (1991, 1997), referring to information, perceives IC as the sum of everything that employees have and that gives the company a competitive advantage in the market (Yıldız, 2010; Oliveira et al., 2016; Efe, 2018) while describing it as intellectual material that can be used to create wealth and that includes intangible aspects such as knowledge, intellectual property, and experience (Zhicheng et al., 2016). On the other hand, Edvinson (1997) defines it as an information that can be transformed into value (Obeidat et al., 2017; Özdemir and Karakoç, 2018). It is emphasized that the IC contains intangible assets that are not explicitly listed on the balance sheet, but which positively affect the performance of the firm, thus revealing the relationship between employees, ideas and information and measuring values that cannot be measured (Özkan et al., 2017; Altan, 2018). In addition, Chen (2008) describes it as the sum of invisible assets, knowledge and abilities that create value for a business in achieving its goals and provide competitive advantage (Yıldız, 2010). With a similar expression, it is argued that the most common form is the definition as 'having knowledge, experience, professional expertise, skills and technological capabilities that will provide competitive advantage to firms and the ability to establish relationships in line with these objectives' (Obeidat et al., 2017). Despite the differences in definitions, there is no major difference in terms of content (Erdoğan and Dönmez, 2014). We can see that creating value and gaining superiority through intangible concepts such as knowledge, experience and learning are emphasized in almost all definitions. Nevertheless, with the common emphasis, the notion of knowledge is placed into the basis of the term (Özkara, 2008). In today's economy, welfare and development are predominantly determined by IC, and IC has more important role than physical capital (Nazir et al., 2017).

The diversity seen in the definitions is also evident when it comes to deciding how to reveal intellectual capital assets and how to determine the factors in its formation. In this context, although the researchers have not yet agreed on a precise model of intellectual capital, some consensus has been reached (Oliveira et al., 2016). The models that are put forward consist of three common basic elements and most of them adopt a triple segmentation (Zhicheng et al., 2016). In terms of reflecting these three component dimensions, the most accepted framework of intellectual capital is conceptualized as *human, structural* and *relational* capital components (Obeidat et al., 2017; Nazir et al., 2017).

Human capital generally consists of a mixture or sum of the qualified knowledge, competence, skills, experience, attitude, ability, commitment, creativity and abilities of employees, especially professional (Obeidat et al., 2017).

Structural capital is considered to be related to the whole of the system, norms, culture, structure and processes in the firm and is expressed as IC embedded in these relevant elements (Oliveira et al., 2016; Özdemir and Karakoç, 2018).

Relational capital includes the relationships that bind internal resources with external stakeholders such as customers, shareholders, suppliers, competitors, corporate structures and society in its environment. It is seen as the sum of all entities that organize and manage these relationships (Obeidat et al., 2017).

These three component dimensions are interrelated and intertwined (Obeidat et al., 2017). They form the basis to understand the impact of intellectual assets on firm performance (Oliveira et al., 2016).

4. IC AND PERFORMANCE RELATIONSHIP IN OTHER STUDIES AND PERFORMANCE INDICATORS AS DEPENDENT VARIABLES

Since the beginning of the 21^{st} century, the idea of testing the interaction between traditional financial indicators and intellectual capital indicators has developed. Within the scope of this idea, the existence of various empirical studies examining the possible impact of intellectual capital on financial data in the current period stands out (Titova, 2011). For example, Firer and Williams (2003) investigated the relationship between the value-added efficiency they obtained through physical, human and structural capital, which is expressed as the main components of the firm resource base, and the three traditional dimensions of firm performance. Findings from the analysis showed that the relationships between value added efficiency and profitability, productivity, and market valuation were often limited and complex, while physical capital remained the most important source of corporate performance in South Africa, despite efforts to increase the intellectual capital base. In another study, Mehralian et al., (2012) empirically examined the relationship between the intellectual capital components of firms operating in the Iranian pharmaceutical industry and traditional performance measures. The findings showed that the intellectual capital could explain profitability, not productivity and market valuation, from firm performance indicators. Xu and Liu (2020) examined the effect of the intellectual capital and its components on the performance of firms operating in the Korean manufacturing industry. The regression results obtained from the mentioned study showed that physical capital was the most effective factor for firm performance, while human capital was a performance enhancing component. On the other hand, studies executed with the Turkish sample were conducted using more limited number of firms, sectors and performance indicators, usually using the Value-Added Intellectual Coefficient (VAIC) measurement method. Erdogan and Dönmez (2014) used data from 7 firms in the İstanbul Stock Exchange as *fabricated metal products, machinery and electrical equipment* sector in 2008-2011 and firm performance indicators in the form of ATO and ROA. The results obtained showed that firm efficiency and profitability were positively affected by IC elements. In another study in which IC was measured by the help of VAIC, Ozkan and his colleagues (2017) showed that the impact of *capital employed efficiency* compared to *human capital efficiency* was greater on the performance indicator ROA, using data from 44 banks operating in Turkey between 2005 and 2014.

In the light of the studies carried out, we can say that the results achieved in the literature are sometimes controversial, pointing to the need for additional research (Titova, 2011). There is no definite and widely accepted conclusion about the relationship between intellectual capital and the performance of firms, and the findings are far from reaching a scientific consensus (Milost, 2013; Zhicheng et al., 2016). More studies are required to further functionalize the findings (Kirsimarja and Aino, 2015). In this sense, with this study, we aimed to measure intellectual capital and determine its possible effects on firm performance. Within the scope of this study, more than one performance indicator has been adopted in order to overcome the insufficiency of one or a few performance indicators seen in some studies and to create an inclusive empirical model (Lee and Lin, 2019). The indicators we used in this study and their calculation methods are presented below:

- ROA = Net Profit / Total Assets
- ATO = Net Sales / Total Assets
- MB = Market Value / Book Value
- ROE = Net Profit / Equity

5. CONTROL VARIABLES

Adding control variables to the study may help to obtain more precise and accurate results (Komnenić and Pokrajčić, 2012). In this study, in line with Titova's (2011) point, we paid special attention to the addition of control variables in order to try to separate the intellectual capital effect from other factors related to the tangible or financial assets of the firms. We used firm *size* and *leverage* that are used by various researchers as control variables, with the idea that they may have an effect on performance criteria. While taking the number of employees employed by firms for size, the leverage ratio is measured as the ratio of total debt to total assets. The addition of the aforementioned control variables made it possible to control whether the intellectual capital variables selected to explain the variance in the performance of the firms are really important in explaining the variance in question (Pucci et al., 2015).

6. DATA

In literature, some studies limit their study sample to certain sectors considered to be mostly technology-dependent or knowledge-intensive. However, intellectual capital is considered important to all businesses, not only businesses that are strictly technologically classified (Nazir et al., 2017). In this context, financial statements of all firms traded in Istanbul Stock Exchange between 2007 and 2016 were analysed. A data pool was created over the variables of *research and development expenses*, *personnel salary and wage expenses*, *advertising promotion expenses*, *net profit*, *net sales*, *equity amount*, *share market value*, *stock amount*, *personnel amount*, *total debt* and *total assets*. We wanted to limit the data related to the variables we use to those reflected in the financial statements and balance sheets. Therefore, the firms included in our sample were limited to the sectors reflected in *table 1*.

Table 1. Sectoral Distribution of Sampling Selection

	Sector Type	*Firm Amount*	*Sample Percentage*
1	Technology	10	11.76
2	Textile, Wearing Apparel and Leather	12	14.12
3	Food, Beverage and Tobacco	10	11.76
4	Paper and Paper Products, Printing and Publishing	3	3.53
5	Chemicals, Petroleum Rubber and Plastic Products	13	15.29
6	Basic Metal	5	5.88
7	Electrical Equipment and Machinery	6	7.06
8	Fabricated Metal Products	5	5.88
9	Transportation Vehicles	6	7.06
10	Wood Products Including Furniture	4	4.71
11	Non-Metallic Mineral Products	11	12.94
		85	100.00

7. ASSUMPTIONS AND LIMITATIONS

The most important limitation of this study was that IC is intangible and hard to measure. Therefore, we made an important assumption that we could use RIM to reflect the true value of IC. The difficulty in using RIM was finding the related variables to be used in the model since clearer expressions and indicators are not used in financial statements. To overcome this difficulty, proxies were incorporated in this study. In literature, some activities under the control of the firm and the investments related to these activities are used as proxies to express three intellectual capital elements detailed in section 2. For instance, providing a relatively satisfactory salary, bonus and social assistance system by the firm may induce the employees' stronger feeling of identity and satisfaction (Lee and Lin, 2019). That is why these payments are associated with human capital and the employee expenses are considered as investments in human capital (Kallunki et al., 2005). On the other hand, the study of Cheng et al., (2005) indicates that R&D investments can provide additional information about structural capital (Rossi, 2014), while the results of Titova (2011) indicate that it can be used as a proxy to express structural capital. Finally, advertising expenditures are taken as an indicator of customer capital by Liu et al. (2009), while they are chosen to act as a proxy to represent relational capital by Titova (2011). In that sense, the proxy indicators related to the elements of intellectual capital are chosen in consistence with other studies and are similar to those used by Sydler et al., (2014) as wages and salary expenditures for human capital, R&D expenditures for structural capital and finally advertising expenditures for relational capital. Despite the fact that proxies were used to express the elements of the IC, just 42% of the 204 firms examined in the period of 2007-2016 reported the variables regarding these proxies in their financial statements.

8. HYPOTHESIS

The study was based on the use of resource-based and knowledge-based approaches. Our conclusions led us to believe that IC constitutes an important part of the firm resources and an increase in this sort of resources would be reflected as a direct increase in the performance of the firm. Thus, as illustrated in *Figure 1*, we assumed that investments in intellectual capital, such as research and development of firms and their relations with employees and external actors, would increase the firm's activity efficiency and profitability, by increasing the intellectual capital level of the firm.

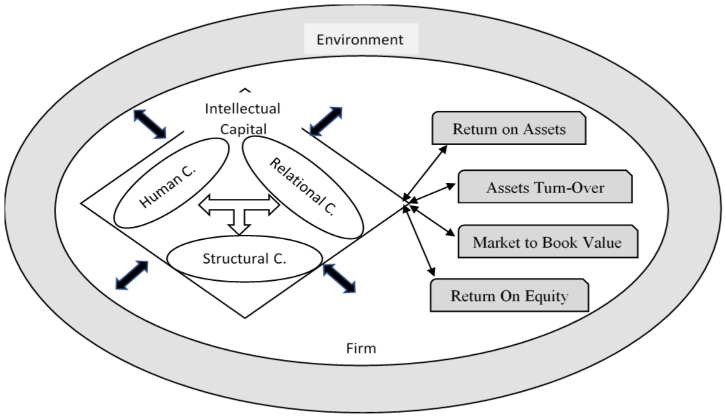

Figure 1. Intellectual Capital Firm Performance Interaction

In this context, the hypotheses of the study were expressed as follows:

H1: (a) There is a positive relationship between intellectual capital and return on assets of firms, (b) this relationship continues on a sector basis.

H2: (a) There is a positive relationship between intellectual capital and the asset turnover rate of firms, (b) this relationship continues on a sector basis.

H3: (a) There is a positive relationship between intellectual capital and the market / book value of firms, (b) this relationship continues on a sector basis.

H4: (a) There is a positive relationship between intellectual capital and the return on equity of enterprises, (b) this relationship continues on a sector basis.

9. MEASUREMENT OF IC USING RIM

Based on the studies of Ohlson (1995) and Myers (1999), the market value of a firm is measured as the sum of the book value at a certain time and the infinite number of reduced residual earnings (Sydler et al., 2014). In this context, the business market value is:

$$MV_t = BV_t + \sum_{i=1}^{\infty} E\left[\frac{NI_{t+i}^R - r_f BV_{t+i-1}}{(1+r_f)^i}\right] \quad (9.1)$$

MV_t, which is stated as *market value* at time t, was evaluated over the average stock price in the last ten days of the year in our study.

BV_t, which is stated as *book value* at time t, is calculated by dividing the total equity of the company by the number of shares.

NI_{t+i}^R, which is stated as *earnings per share* reported for the period t, is calculated by dividing the net earnings of a firm by the number of stocks in conversion, excluding convertible bonds.

r_f, which is stated as *cost of capital*, corresponds to the risk-free interest rate in the risk-free environment. This rate actually expresses the same value as the nominal risk-free rate in inflationary economies. Therefore, the interest rate of treasury bills or government bonds is generally used to indicate the risk-free interest rate (Başar, 2004; Sayılgan, 2013). In this context, the risk-free interest rate used in this study was calculated over the annual average simple returns of treasury bills and government bonds issued between 2008 and 2016.[1] Examining these bills and bonds, the annual average simple rate of return was found to be 10.15%, and this value was taken as the r_f value in our calculations.

Again, in the light of the studies of Ohlson (1995) and Myers (1999), with the autoregressive structure assumptions on risk-free environment and time series, the market value of a firm can be expressed as a function of the current book value and current abnormal earnings as shown below (Sydler et al., 2014).

$$MV_t = \beta_1 BV_t + \beta_2\left(NI_t^R - r_f BV_{t-1}\right) + \beta_1 v_t \qquad (9.2)$$

In this function, abnormal gain is defined as the result of current earning subtracting the previous period book value multiplied by the risk-free interest rate, while v_t includes other information at time t.

IC is obtained by summing up human, structural and relational capital at time *t*. In this context, the IC at the end of a period is calculated as follows:

$$\begin{aligned} IC_t &= \propto (H_t + S_t + R_t) + (1-\delta)(IC_{t-1}) \qquad (9.3) \\ &= \propto (IE_t) + (1-\delta)(IC_{t-1}) \end{aligned}$$

In this equation, with IE_t, intellectual capital investment, with H_t, human capital investment, with S_t structural capital investment and lastly with R_t, relational capital investment is expressed. The equation assumes that these three types of intellectual capital items contribute to the total intellectual capital at the rate of accumulation $\propto$, and each year the accumulated intellectual capital is depreciated at the depreciation rate δ. Within the framework of this assumption, the accumulation rate $\propto$ and the depreciation rate δ take values between 0 and 1.

In addition to the two assumptions regarding the accumulation and depreciation rate, it is also assumed that the items that create the IC have a constant growth coefficient expressed as *g*. As the firms subject to the analysis are traded in Istanbul Stock Exchange, we assumed that the said growth coefficient was to be at the average Istanbul Stock Exchange 100 Index level of return in the period of 2008-2016. In the aforementioned period, the Istanbul Stock Exchange 100 Index average annual real return was found to be 2.45% as a result of calculation using the Turkey Statistical Institute data. During this period, again within the framework of Turkey Statistical Institute data, the average annual domestic producer price index was 7.50%. In this sense, the growth coefficient was taken as 9.95% based on the sum of the annual average real return and the average producer price index.

Within the framework of the assumptions made, using the value of IC_{t-1} repeatedly as the time goes towards infinity, IC_t expressed by the equation *9.3* above appears in the following form:

$$\begin{aligned} IC_t &= \propto (IE_t) + \left[1 + \left(\frac{1-\delta}{1-g}\right)^1 + \left(\frac{1-\delta}{1-g}\right)^2 + \cdots + \left(\frac{1-\delta}{1-g}\right)^t\right] \qquad (9.4) \\ &= \propto (IE_t)\left(\frac{1+g}{\delta+g}\right) = \propto (IE_t)\emptyset \end{aligned}$$

On the other hand, in order to capitalize the investments related to intellectual capital; it is possible to report the net income shown in the accounting system by arranging it to include the expenditure items that reveal the intellectual capital and their depreciation. In such a presentation, the net earning is reflected as in the equation below:

[1] http://www.tcmb.gov.tr/wps/wcm/connect/tr/tcmb+tr/main+menu/istatistikler/piyasa+ verileri/ihale+yontemi+ile+ satilan +hazine+bonolari+ve+devlet+tahvilleri?veri

$$NI_t^A = NI_t^R + \alpha IE_t - \delta IC_{t-1} \quad (9.5)$$

Such a display in the accounting system makes the book value of capital equal to the sum of the reported book value and intellectual capital. Therefore, by incorporating all these intellectual capital items, the assumptions, and characteristics of these items into the market value equation expressed in *equation 9.2* above, the representation of market value in the following equation is obtained. In order to express equation in a meaningful and simple way, the items that make up the intellectual capital need to be rearranged over the existing stock numbers, just like other equality items.

$$MV_t = \beta_1(BV_t + IC_t) + \beta_2\left[(NI_t^R + \alpha IE_t - \delta IC_{t-1}) - r_f(BV_{t-1} + IC_{t-1})\right] + \beta_3 v_t \quad (9.6)$$

$$= \beta_1 BV_t + \beta_1 IC_t + \beta_2 NI_t^R + \beta_2 \alpha IE_t - \beta_2 \delta IC_{t-1} - \beta_2 r_f BV_{t-1} - \beta_2 r_f IC_{t-1} + \beta_3 v_t$$

$$= \beta_1 BV_t + \beta_1 \alpha (IE_t)\emptyset + \beta_2 NI_t^R + \beta_2 \alpha IE_t - \beta_2 \delta \alpha (IE_{t-1})\emptyset - \beta_2 r_f BV_{t-1} - \beta_2 r_f \alpha (IE_{t-1})\emptyset + \beta_3 v_t$$

$$= \beta_1 BV_t + \beta_2\left(NI_t^R - r_f BV_{t-1}\right) + (\beta_1 \alpha \emptyset + \beta_2 \alpha) IE_t - \beta_2 \alpha \emptyset (IE_{t-1})\left(\delta + r_f\right) + \beta_3 v_t$$

$$= A_0 + A_1 BV_t + A_2\left(NI_t^R - r_f BV_{t-1}\right) + A_3 IE_t + A_4 IE_{t-1}$$

$$A_0 = \beta_3 v_t$$

$$A_1 = \beta_1$$

$$A_2 = \beta_2$$

$$A_3 = \alpha(\beta_1 \emptyset + \beta_2)$$

$$A_4 = -\beta_2 \alpha \emptyset \left(\delta + r_f\right)$$

$$\emptyset = \left(\frac{1+g}{\delta + g}\right)$$

After introducing the market value equation, the step to be taken to calculate the intellectual capital values is to calculate the relevant parameters (α, δ, β_j). However, before calculating the parameters, both sides of the equation are proportioned to the book value BV_{t-1} at time t-1 to alleviate the problem of the heteroscedasticity of error terms. Accordingly, model becomes as:

$$\frac{MV_t}{BV_{t-1}} = A_0 + A_1 \frac{BV_t}{BV_{t-1}} + A_2 \frac{NI_t^R}{BV_{t-1}} + A_3 \frac{IE_t}{BV_{t-1}} + A_4 \frac{IE_{t-1}}{BV_{t-1}} + \varepsilon_t \quad (9.7)$$

At this stage, before running the model, the diagnostic and descriptive statistics of the variables in the model were examined. For this purpose, Stata package program was used. Since it is common to assume that the data set has a normal distribution as many standard methods for the calculation of confidence intervals and hypothesis tests require at least approximately normal distribution (Siegel, 2003), distribution of the data set was checked. After having observed that the normal distribution condition was provided for each variable in the data set worked on, the level of the relationship between the independent variables and the dependent variable was examined. Correlation, which should be at a satisfactory level in accordance with the sample size in terms of ensuring internal validity and reliability for the size and degree of the relationship in question (Karasar, 2016; Sevüktekin and Çınar, 2017; Aslan, 2019), is presented at Table 2.

Table 2. Correlation Coefficients for the Variables

	MV	BV	NI	IE	IEt
MV	1.0000				
BV	0.3822	1.0000			
NI	0.3976	0.5427	1.0000		
IE	0.3462	0.1990	0.0410	1.0000	
IEt	0.2518	0.0687	-0.0117	0.8865	1.0000

Correlation coefficients between 0.25 and 0.40 indicated a moderate relationship between the dependent variable and the independent variables. We considered existence of this moderate level of relationship to be sufficient in terms of internal validity. On the other hand, 'multiple connection between variables', which manifests itself as a very high level of relationship between independent variables, is considered to be an undesirable condition for the internal validity of the model used. Variance Increase Factor (VIF) test was used to detect this situation. The VIF values reached for each variable are reflected on the *table 3* at a moderate level, showing that there is no alarming situation that will cause multiple correlation problems. The VIF value for IE and IEt variables, which is slightly high when compared to the VIF value of the other two variables, was attributed to the IEt variable derived from the IE variable.

Table 3. Variance Increase Factor Values for Independent Variables

Variable	VIF	1/VIF
IE	5.14	0.194732
IEt	4.94	0.202259
BV	1.54	0.647915
NI	1.42	0.705213
Mean VIF	3.26	

Among the unit root test alternatives offered by the Stata package program Fisher-type Phillips-Perron (PP) Unit Root Test was used in order to control the stationarity assumption, which has very important place in preventing the emergence of spurious regressions as stated by Granger and Newbold (1974). Stata package program implements this application using four methods suggested by Choi (2001). After the lag value determined within the framework of *Akaike information criterion* in terms of each variable was included in the model, we observed that the H_2 hypothesis, in which the series contains the unit root, was strongly rejected by these four methods, and the alternative H_2 hypothesis, in which the series is stationary, was accepted. In other words, we concluded that all variable series in the model were stationary at their current levels (Karamanoğlu, 2014; Göral, 2015; Sevüktekin and Çınar, 2017; StataCorp, 2019).

In addition to the basic values mentioned above, descriptive statistical values specific to the panel data type are presented in Table 4, since the data set is panel data.

Table 4. Descriptive Statistical Values Specific to Panel Data

Variable		Mean	Std. Dev.	Min	Max	Observations
MV	overall	1.578106	1.368703	-2.528544	5.713116	N = 655
	between		1.016149	-.2954397	3.818745	n = 83
	within		.949121	-3.077828	6.008154	T-bar = 7.89157
BV	overall	1.048363	.3178669	.0979747	2.001681	N = 655
	between		.1338251	.5609347	1.26611	n = 83
	within		.293972	.2732861	2.104221	T-bar = 7.89157
NI	overall	.0484427	.2467561	-.6903013	.968713	N = 655
	between		.1697624	-.3724364	.4591768	n = 83
	within		.1831754	-.4857414	.9601451	T-bar = 7.89157
IE	overall	.1122976	.1245858	-.2639296	.4903596	N = 655
	between		.1149745	-.1509285	.3731484	n = 83
	within		.0581235	-.2856493	.3004448	T-bar = 7.89157
IEt	overall	.1084749	.1117487	-.2284674	.4466954	N = 655
	between		.1052957	-.1001636	.3436533	n = 83
	within		.0480278	-.1629994	.2950038	T-bar = 7.89157

Although we observed that the variability in the cross-section and time dimension for our dependent variable MV and one of the independent variables NI took very close values to each other, we observed that the variation in the cross-section dimension for the other three independent variables was significantly different compared to the time dimension. This situation indicated that it would be appropriate to choose an estimation method that took into account the variability in cross section and time dimensions. On the other hand, choosing the estimation method according to the test results obtained by using certain tests, produces more reliable results that are not affected by subjective judgments. For this purpose, three types of estimation method used in literature were compared in pairs over the process reflected in *figure 2* (Bayraktutan and Demirtaş, 2011; Park, 2011).

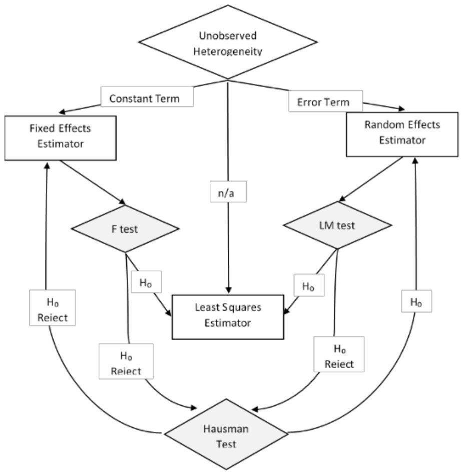

Figure 2. Estimation Method Selection Process

In the first stage of the comparison process, the results of the *F test* and the *Breusch-Pagan LaGrange multiplier test* showed unit effects that should be considered in the data. These effects could not be expressed using the classical *pooled least squares estimator*. In the second stage, with the *Hausman Test*, we concluded that the aforementioned effects were not correlated with the explanatory variables. Therefore, these effects have been treated as a random variable, such as an error term. The *random effects estimator* was the best predictor that could be used for estimation.

On the other hand, it is also important to check whether the assumptions regarding the residues are met and make estimates by appropriate methods in case of their existence because estimations made by ignoring such assumptions prevent the effectiveness of the results as they will cause standard errors deviate. Thus, *t* statistics and confidence intervals lose their validity while the insignificance and unreliability of the model are inevitable (Baltagi, 2005; Coşkun and Güngör, 2015; Tatoğlu, 2016). In this context, in the first step, the existence of heteroscedasticity assumption was tested using *Levene, Brown and Forsythe's Tests*. *Snedecor F table* was used to compare the obtained results. According to the results of these two test statistics, there was heteroscedasticity due to the rejection of the H_0 hypothesis. For the other assumption regarding the residues, the *Durbin-Watson Test (DW)* proposed by Bhargava, Franzini and Narendranathan and the *Local Best Invariant (LBI) Test* proposed by Baltagi-Wu were used to determine autocorrelation. In the output, the results of both tests were less than the critical value of *two*. In this case, the H_0 basic hypothesis was rejected, and we concluded that there was autocorrelation in the model.

Thus, in order to prevent problems that may arise due to the detection of both heteroscedasticity and autocorrelation in our *model 9.7,* the model was run with the help of Stata using the *robust random effects estimator* developed by Arellano (1987), Froot (1989) and Rogers (1993).

Table 5. RIM Result with Robust Random Effects Estimator

```
Random-effects GLS regression                    Number of obs      =        654
Group variable: F                                Number of groups   =         83

R-sq:  within  = 0.2951                          Obs per group: min =          3
       between = 0.2472                                         avg =        7.9
       overall = 0.2826                                         max =          9

                                                 Wald chi2(4)       =     242.12
corr(u_i, X)   = 0 (assumed)                     Prob > chi2        =     0.0000

                                      (Std. Err. adjusted for 83 clusters in F)
```

MV	Coef.	Robust Std. Err.	z	P>|z|	[95% Conf.	Interval]
BV	.6687281	.1775609	3.77	0.000	.3207151	1.016741
NI	1.466116	.2923713	5.01	0.000	.8930787	2.039153
IE	4.801799	1.056368	4.55	0.000	2.731356	6.872242
IEt	-1.445685	.7999226	-1.81	0.071	-3.013504	.1221347
_cons	.4709197	.1766475	2.67	0.008	.124697	.8171424
sigma_u	.84137493					
sigma_e	.85444406					
rho	.49229378	(fraction of variance due to u_i)				

With the results obtained, the values for the coefficients A_1, A_2, A_3 and A_4 in the model were found as 0.6687, 1.4661, 4.8018 and -1.4457, respectively. When these values were transferred into *equation 9.6*, together with the values for the assumptions of risk-free interest rate r_f and IC growth coefficient g, calculations regarding the results of the accumulation rate α and depreciation rate δ were as follows:

$$A_3 = \alpha(\beta_1 \emptyset + \beta_2)$$

$$4{,}8018 = \alpha\left(0{,}6687\left(\frac{1+0{,}0995}{\delta+0{,}0995}\right)+1{,}4661\right)$$

$$A_4 = -\beta_2 \alpha \emptyset (\delta + r_f)$$

$$-1{,}4457 = -1{,}4661\alpha\left(\frac{1+0{,}0995}{\delta+0{,}0995}\right)(\delta+0{,}1015)$$

$$\delta = 0{,}0869$$

$$\alpha = 0{,}8873$$

By placing the *accumulation rate* and *depreciation rate* coefficients obtained as a result of the calculations above in the *equation 9.4*, we calculated the IC value of each observation within the review period.

10. ANALYSIS

In this study, the effect of intellectual capital on the firm performance was analysed by the help of models shown below such as *model 10.1*. As we brought together the variables we calculated in the previous section in each model in our analysis, we gathered a new data pool. This new data pool showed the characteristics of panel data after analysis of the descriptive statistics that such results illustrated in Table 4. In order to benefit from the cross-section and time dimensions features of this data set, a panel data approach was taken for each model. In that sense, following the same process as depicted in *figure 2*, a proper panel data estimator was looked at each model. To this end, the effect of IC on *return on assets* has been investigated by using the *model 10.1* first.

$$log\left(\frac{ROA_t}{BV_t}\right) = A_0 + A_1 log\left(\frac{IC_t}{BV_t}\right) \quad (10.1)$$

Since it was determined that the model has the characteristics of the random effects model after the statistical process, it was run using the random effects estimator. With the obtained determination coefficient, we found out that 4.68% of the variability in ROA was explained by the help of the univariate model. By evaluating the *F-test* value and the *t-test* value together, we observed that IC has a significant positive effect on ROA. In order to confirm this firm-based effect, control variables were added to the model and the statistical process was repeated. After the addition of the control variables, the test result made with the robust random effects estimator was reflected in the *table 6*. According to this result, the model preserved its significance and the explanation level of the variability in return on assets increased to 17.45%.

Table 6. Effect of IC on Return on Assets

```
Random-effects GLS regression                   Number of obs      =       609
Group variable: F                               Number of groups   =        79

R-sq:  within  = 0.0304                         Obs per group: min =         3
       between = 0.3471                                        avg =       7.7
       overall = 0.1745                                        max =         9

                                                Wald chi2(3)       =     19.97
corr(u_i, X)   = 0 (assumed)                    Prob > chi2        =    0.0002

                                     (Std. Err. adjusted for 79 clusters in F)
```

ROA	Coef.	Robust Std. Err.	z	P>|z|	[95% Conf.	Interval]
IC	.0003656	.000171	2.14	0.032	.0000305	.0007007
SIZE	.0074622	.0179082	0.42	0.677	-.0276371	.0425616
LEVERAGE	-.1248862	.0331083	-3.77	0.000	-.1897773	-.0599951
_cons	.0520092	.0437691	1.19	0.235	-.0337766	.137795
sigma_u	.03976214					
sigma_e	.05895959					
rho	.31262534	(fraction of variance due to u_i)				

Most importantly, the statistical significance of intellectual capital and its positive coefficient was preserved. This situation pointed to the existence of a positive effect in the context of cause and effect extending from intellectual capital to return on assets. An above-average unit of intellectual capital increase results in a small positive increase in return on assets by 0.04%. Another firm-based significant result on the return on assets was about the leverage ratio. However, the relationship between leverage ratio and return on assets was a negative relationship.

In order to see whether the aforementioned result obtained on firm basis continued on a sectoral basis, dummy variables representing the sectors (*S*) were added to the univariate model. According to the *F test* statistic result the model still preserved its significance. However, even with a small differentiation, neither the intellectual capital nor the fixed coefficient was found to be statistically significant. To confirm this result, control variables were added to the model. The result obtained by adding the control variables to the model was reflected in Table 7. However, this time again, a significant relationship between intellectual capital and return on assets was not observed on a sectoral basis.

Table 7. The Effect of IC on Return on Assets on a Sectoral Basis

```
Random-effects GLS regression                   Number of obs      =       609
Group variable: F                               Number of groups   =        79

R-sq:  within  = 0.0296                         Obs per group: min =         3
       between = 0.4854                                        avg =       7.7
       overall = 0.2443                                        max =         9

                                                Wald chi2(13)      =     64.37
corr(u_i, X)   = 0 (assumed)                    Prob > chi2        =    0.0000

                                     (Std. Err. adjusted for 79 clusters in F)
```

ROA	Coef.	Robust Std. Err.	z	P>|z|	[95% Conf.	Interval]
IC	.000298	.000187	1.59	0.111	-.0000684	.0006644
SIZE	.0174329	.0178015	0.98	0.327	-.0174575	.0523233
LEVERAGE	-.1223254	.0353477	-3.46	0.001	-.1916057	-.0530451
S1	.0270533	.0198743	1.36	0.173	-.0118996	.0660063
S2	-.0292523	.0147552	-1.98	0.047	-.0581719	-.0003327
S3	.0053743	.0199928	0.27	0.788	-.0338109	.0445595
S4	.0153165	.0256941	0.60	0.551	-.0350429	.065676
S5	.0011398	.0162933	0.07	0.944	-.0307944	.033074
S6	-.0041987	.0174782	-0.24	0.810	-.0384554	.0300579
S7	.0364007	.0174239	2.09	0.037	.0022505	.0705509
S8	.0384784	.0287263	1.34	0.180	-.0178241	.0947809
S9	-.001875	.0236331	-0.08	0.937	-.048195	.044445
S10	.0364642	.0300617	1.21	0.225	-.0224558	.0953841
S11	0	(omitted)				
_cons	.0199585	.0457397	0.44	0.663	-.0696896	.1096066
sigma_u	.03714611					
sigma_e	.05895959					
rho	.2841463	(fraction of variance due to u_i)				

In the second stage of the analysis of the relationship between intellectual capital and firm performance, the possible effect of intellectual capital on asset turn-over was analysed using *model 10.2* below.

$$log\left(\frac{ATO_t}{BV_t}\right) = A_0 + A_1 log\left(\frac{IC_t}{BV_t}\right) \quad (10.2)$$

Since the properties of the random effects model dominated the model, the *z-test* and *F-test* result obtained by using the random effects estimator, with the value of 3.72%, showed that the model was significant as a whole. The determination coefficient of 7.65% indicated that 7.65% of the change in ATO could be explained by the IC variable used in the model. In order to determine the reliability of the relationship that emerged here, the statistical test process was repeated with the addition of the control variables to the model. Since the model has shown the characteristics of the fixed effects model at this stage, the result of the practise made with the robust fixed effects estimator was shown in *table 8* below.

Table 8. The Effect of IC on Asset Turn-Over

```
Regression with Driscoll-Kraay standard errors   Number of obs      =       615
Method: Fixed-effects regression                 Number of groups   =        79
Group variable (i): F                            F( 3,     78)      =     72.69
maximum lag: 2                                   Prob > F           =    0.0000
                                                 within R-squared   =    0.1316
```

ATO	Coef.	Drisc/Kraay Std. Err.	t	P>|t|	[95% Conf.	Interval]
IC	-.0007091	.0012341	-0.57	0.567	-.0031659	.0017478
SIZE	.7642186	.0794653	9.62	0.000	.6060154	.9224218
LEVERAGE	.140267	.1293795	1.08	0.282	-.1173077	.3978418
_cons	-1.149121	.2408708	-4.77	0.000	-1.628658	-.6695843

According to the result of the *F-test* statistic, the model was found to be significant while the determination coefficient increased to 13.16%. However, the positive result in the *F-test* statistic and determination coefficient did not continue in the same way for the IC which is at the centre of the analysis. IC lost its statistical significance, and its coefficient became negative. Although the model was significant in general, the insignificance of IC and its coefficient taking an opposite sign compared to the single model has led to the conclusion that the IC has no effect on the asset turn-over rate. Instead of intellectual capital it has been observed that the size as a control variable had a significant effect on asset turn-over and this effect was positive.

In the second phase of the intellectual capital asset turn-over interaction, dummy variables representing the sectors are added. By adding the sectoral effect to the model, the fact that the *F-test* statistic result was obtained as 0.56% showed that the model preserved its significance in general. IC variable coefficient and constant coefficient were also significant and positively signed. The control variables added to the model in the second stage of this phase were used to confirm such an effect on a sectoral basis. The result of the model obtained using the *fixed effects estimator* was shared at *table 9*.

Table 9. The Effect of IC on the Asset Turn-Over on a Sectoral Basis

Source	SS	df	MS		
Model	53.9881809	13	4.15293699	Number of obs =	615
Residual	174.647949	601	.290595589	F(13, 601) =	14.29
Total	228.63613	614	.372371547	Prob > F =	0.0000
				R-squared =	0.2361
				Adj R-squared =	0.2196
				Root MSE =	.53907

ATO	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
IC	.0024324	.0009283	2.62	0.009	.0006093	.0042555
SIZE	.1004131	.0763787	1.31	0.189	-.0495884	.2504147
LEVERAGE	.5974931	.1038749	5.75	0.000	.3934912	.8014951
S2	-.3761752	.0897344	-4.19	0.000	-.5524063	-.1999441
S3	.0886257	.0936269	0.95	0.344	-.09525	.2725014
S4	-.0734406	.1269404	-0.58	0.563	-.3227412	.17586
S5	.0905551	.0842742	1.07	0.283	-.0749526	.2560628
S6	.3309477	.112615	2.94	0.003	.1097809	.5521144
S7	.2013725	.1141143	1.76	0.078	-.0227387	.4254837
S8	.0352998	.1120353	0.32	0.753	-.1847285	.2553281
S9	-.2949446	.1095929	-2.69	0.007	-.5101762	-.079713
S10	.013576	.1297404	0.10	0.917	-.2412236	.2683757
S11	-.2499595	.087831	-2.85	0.005	-.4224524	-.0774665
_cons	.3922293	.1755125	2.23	0.026	.0475371	.7369216

According to this result, the model preserved its significance in general and the IC and its constant coefficient were also significant. The determination coefficient with the value of 21.96% expressed the rate of change that can be explained in the dependent variable. *T-test* values of *textile, wearing apparel and leather, basic metal, transportation vehicles* and *non-metallic mineral products* sectors showed that the fixed coefficients of these sectors differ significantly from the *technology* sector which was the base sector. This result led to the conclusion that the effect of IC on asset turn-over rate could be expressed separately for each sector. The fact that the IC coefficient remained positive despite the addition of control variables indicated the existence of a positive effect on a sectoral basis in cause effect relationship extending from the IC to ATO. This effect was experienced at least in the *textile, wearing apparel and leather* sector with a constant coefficient of 0.01605 and the highest in the *basic metal* sector with a constant coefficient of 0.72318.

After examining the possible effect of intellectual capital on asset return and asset turn-over above, the possible effect of intellectual capital on market/book value, included in the study as another performance indicator, has been investigated. To achieve this goal the following *model 10.3* was used.

$$log\left(\frac{MB_t}{BV_t}\right) = A_0 + A_1 log\left(\frac{IC_t}{BV_t}\right) \quad (10.3)$$

After the statistical process followed within the framework of basic statistical values, the model revealed to have the characteristics of the random effects model. Therefore, it was run using the robust random effects estimator. Obtained *F-test* value being 0.9% showed that the model was significant as a whole. Increasing the IC by one unit above the average caused an increase of 0.52% on the MB value. The statistical test process was repeated by adding control variables to the model in order to confirm the existence of the said relationship on a firm basis and, if possible, to reveal the cause effect relationship. After the aforementioned process, the result of the model obtained by using the robust fixed effects estimator was presented in Table 10.

Table 10. The Effect of IC on Market/Book Value

```
Regression with Driscoll-Kraay standard errors   Number of obs     =       602
Method: Fixed-effects regression                 Number of groups  =        78
Group variable (i): F                            F(  3,      77)   =     52.99
maximum lag: 2                                   Prob > F          =    0.0000
                                                 within R-squared  =    0.0803
```

MB	Coef.	Drisc/Kraay Std. Err.	t	P>|t|	[95% Conf.	Interval]
IC	.0113542	.0033213	3.42	0.001	.0047406	.0179678
SIZE	-.1284707	.1473114	-0.87	0.386	-.4218051	.1648637
LEVERAGE	.6310593	.1607199	3.93	0.000	.3110251	.9510936
_cons	1.032638	.3371896	3.06	0.003	.361208	1.704068

According to this result, while the model preserved its significance in general, the explanatory power also increased with the increase in determination coefficient from 2.31% to 8.03%. In addition to this positive development in the explanatory power of the model, the most important indicator for analysis was that the significant and positive effect of intellectual capital continued. The continuation of the positive effect was extremely important as it showed that, in the context of cause effect relationship, the expansion in IC would mean an increase in the MB value. In addition, leverage ratio, one of the control variables, also had a significant effect on the MB value. In fact, this effect, with a coefficient about 0.63, appeared as an effect above the IC effect.

With the addition of the sectoral effect, the model continued to maintain its statistical significance in general terms, and the coefficient of determination increased to 19.70%. However, despite this positive development in the determination coefficient, IC coefficient has lost its statistical significance. Although the *z-test* value seemed significant at the 10% level, a result of 6.2% that is above the accepted significance level, 5%, was encountered. After addition of the control variables to the model in order to confirm this indication, the result obtained using the fixed effects estimator was given in the Table 11.

Table 11. Effect of IC on Market/Book Value on a Sectoral Basis

Source	SS	df	MS
Model	138.465814	13	10.6512165
Residual	447.42785	588	.760931718
Total	585.893664	601	.974864666

Number of obs	= 602
F(13, 588)	= 14.00
Prob > F	= 0.0000
R-squared	= 0.2363
Adj R-squared	= 0.2194
Root MSE	= .87231

MB	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
IC	.0012439	.0011618	1.07	0.285	-.0010379	.0035258
SIZE	-.0202824	.0969575	-0.21	0.834	-.2107076	.1701428
LEVERAGE	1.149119	.1739076	6.61	0.000	.807563	1.490674
S2	-.8156543	.1429251	-5.71	0.000	-1.09636	-.5349485
S3	.1005315	.1497735	0.67	0.502	-.1936246	.3946877
S4	-.6055712	.204354	-2.96	0.003	-1.006924	-.2042185
S5	.214235	.1376357	1.56	0.120	-.0560824	.4845524
S6	-.5255778	.1755212	-2.99	0.003	-.8703027	-.1808529
S7	-.3460497	.1817496	-1.90	0.057	-.7030072	.0109078
S8	.6760036	.1875596	3.60	0.000	.3076353	1.044372
S9	.1238062	.1784038	0.69	0.488	-.22658	.4741924
S10	-.0757381	.2137752	-0.35	0.723	-.4955941	.3441179
S11	-.2034003	.1417893	-1.43	0.152	-.4818755	.0750749
_cons	.9805503	.235368	4.17	0.000	.518286	1.442815

Within the scope of the result, the *t-test* value of the IC, which is the main focus of the study, was not found to be statistically significant. Despite the improvement in the determination coefficient, it was not possible to talk about a significant effect of IC on MB on a sectoral basis. However, the effect of leverage ratio was statistically significant. Accordingly, an increase in the leverage ratio by one unit above the average causes an increase of 115.91% on the MB value. At the same time, this effect differs on a sectoral basis over the fixed coefficient.

Finally, the possible effect of intellectual capital on return on equity was analysed using following *model 10.4*.

$$log\left(\frac{ROE_t}{BV_t}\right) = A_0 + A_1 log\left(\frac{IC_t}{BV_t}\right) \tag{10.4}$$

Using the robust random effects estimator was suitable for the regression as we determined that it has the characteristics of the random effects model. The fact that the *F-test* value was 2.49% as a result of the regression showed that the model was statistically significant as a whole. This value was also same as the significance level of the IC variable and indicated the existence of a significant relationship between the IC and dependent variable, the return on equity. In order to confirm this positive relationship, control variables were added to the model. The values obtained using the random effects estimator once again after the addition are shared in Table *12* below.

Table 12. Effect of IC on Return on Equity

```
Random-effects GLS regression                   Number of obs      =       606
Group variable: F                               Number of groups   =        79

R-sq:  within  = 0.0695                         Obs per group: min =         3
       between = 0.2138                                        avg =       7.7
       overall = 0.1087                                        max =         9

                                                Wald chi2(3)       =     31.73
corr(u_i, X)   = 0 (assumed)                    Prob > chi2        =    0.0000

                                    (Std. Err. adjusted for 79 clusters in F)
```

ROE	Coef.	Robust Std. Err.	z	P>|z|	[95% Conf.	Interval]
IC	.0010129	.0005424	1.87	0.062	-.0000501	.0020759
SIZE	.0633902	.0590085	1.07	0.283	-.0522643	.1790448
LEVERAGE	-.3829962	.0814076	-4.70	0.000	-.5425522	-.2234403
_cons	-.0023908	.1350919	-0.02	0.986	-.267166	.2623844
sigma_u	.12219471					
sigma_e	.16934652					
rho	.34238977	(fraction of variance due to u_i)				

As a result of the test, there has been an increase in the determination coefficient, that is, the explanation power of the change in the return on equity variable of the model. Despite this positive development, it was observed that the IC lost its statistical significance, albeit with a small difference. However, it came out that the leverage ratio added as the control variable has a significant negative relationship with the ROE.

While there was no significant relationship between IC and ROE at the firm level, in order to investigate the existence of a relationship on a sectoral basis, dummy variables representing the sectors were added to the univariate model used above. As a result of the test repeated after adding the dummy variables, the effect of the IC variable on the ROE was significant with the *z-test* value of 2.8%. In addition, the *technology* and the *textiles, wearing apparel and leather* sectors' *z-test* values differed from other sectors pointing to a significant sectoral effect on the dependent variable. Therefore, in order to confirm this positive picture, control variables were added to the model at the last stage.

Table 13. Effect of IC on Return on Equity on Sectoral Basis

```
Random-effects GLS regression                   Number of obs      =       606
Group variable: F                               Number of groups   =        79

R-sq:  within  = 0.0695                         Obs per group: min =         3
       between = 0.3836                                        avg =       7.7
       overall = 0.1929                                        max =         9

                                                Wald chi2(13)      =     93.55
corr(u_i, X)   = 0 (assumed)                    Prob > chi2        =    0.0000

                                    (Std. Err. adjusted for 79 clusters in F)
```

ROE	Coef.	Robust Std. Err.	z	P>|z|	[95% Conf.	Interval]
IC	.0006869	.000569	1.21	0.227	-.0004282	.001802
SIZE	.1033695	.0551771	1.87	0.061	-.0047758	.2115147
LEVERAGE	-.3797906	.0783892	-4.84	0.000	-.5334306	-.2261506
S1	.1339439	.0491779	2.72	0.006	.037557	.2303308
S2	-.0820187	.0353692	-2.32	0.020	-.1513411	-.0126963
S3	.0303419	.0453527	0.67	0.503	-.0585478	.1192316
S4	.0338472	.0716126	0.47	0.636	-.1065109	.1742053
S5	.0194076	.0383411	0.51	0.613	-.0557396	.0945548
S6	.0127097	.0412912	0.31	0.758	-.0682195	.0936388
S7	.1469308	.0558609	2.63	0.009	.0374455	.2564161
S8	.0786888	.091144	0.86	0.388	-.0999501	.2573277
S9	.044795	.0983569	0.46	0.649	-.1479809	.2375709
S10	.0557818	.0811784	0.69	0.492	-.1033249	.2148886
S11	0	(omitted)				
_cons	-.1330161	.1314797	-1.01	0.312	-.3907115	.1246793
sigma_u	.11413265					
sigma_e	.16934652					
rho	.31234664	(fraction of variance due to u_i)				

After the control variables were added to the model, as can be seen in *table 13*, the IC coefficient became statistically insignificant despite the positive development experienced as the determination coefficient increased from 12.39% to 19.29%. According to the model test result, the only significant variable was the leverage ratio added as the control variable. From the negative sign of the coefficient of this variable, we concluded that it has negative relation with ROE.

11. EVALUATION OF ANALYSIS RESULTS

The estimation results obtained in the first stage showed that IC has a positive and significant effect on ROA of the firms, albeit small. In addition to IC, the leverage ratio as one of the control variables, has also been found to be negatively correlated with ROA. After the addition of the sectoral effect to the model with dummy variables, the existence of a statistically significant relationship between IC and ROA ceased to continue because of a slight deviation above the threshold value. In addition, a significant and inverse strong relationship between the leverage ratio and ROA has also been found at sectoral level. Therefore, the H1 (a) hypothesis was validated within the scope of the first findings. However, the relationship in the sectoral context did not continue to exist, therefore H1 (b) hypothesis was rejected. The increase in the leverage ratio, which reflects the knowledge about the company's financial resources, indicates that debts have increased. As debts increase, interest charges that require fixed cash outflows also increase. In this context, especially in an environment where there is high interest rate, such as Turkey, increased leverage creates a negative impact on a firm's profitability increasing the risk they take. Therefore, statistically significant, and negative relationship revealed in terms of leverage ratio confirms the validity of the model's results as one of the economically expected outcomes. Furthermore, the said case was found to be in compliance with the results of other studies such as one made by Ozkan et al., (2017) using a sample from Turkey or one made by Forte et al., (2019) using other countries' sample.

Regression results of the model regarding the effect of IC on the other performance indicator, ATO, led to the conclusion that there is no significant relationship between the two variables. Instead, as a control variable in the model, the *size* has a significant and enhancing effect on the asset turn-over rate. On the other hand, the results obtained over the sectors indicated the existence of a significant and positive effect of IC on the ATO on sectoral basis. While this effect was minimal in the *textile, wearing apparel and leather* sector, it was at the highest level in the *basic metal* sector. In terms of control variables, this time, a significant and highly positive effect of the *leverage ratio* was observed. Therefore, the effect of IC emerged with the effect of the *leverage ratio* on sectoral basis. This result led us to reject the H2 (a) hypothesis and accept the H2 (b) hypothesis. We conceived that the segregation in some sectors such as *textile, wearing apparel and leather* may have prevented the emergence of the effect of intellectual capital on a firm basis.

In terms of the results regarding the relationship between IC and MB, which is another interaction, the findings indicated the existence of a significant and positive effect of IC on the MB at firm level. In addition to this finding, the *leverage ratio*, one of the control variables, has a significant, positive and even stronger relationship with the MB. Hence, the H3 (a) hypothesis was accepted. However, with the inclusion of all the control and dummy variables in the model, the existence of this significant relationship in terms of IC has come to an end. In other words, statistically significant effect of IC on the MB could not be seen on a sectoral basis. Therefore, H3 (b) hypothesis was rejected. However, the effect of the *leverage ratio* continued its existence on a sectoral basis, and even this effect differed by sectors. In this context, the increase in the amount of debt is expected to increase the amount of investments to be made, which creates a positive effect on MB in turn.

In the last step of the pursuance regarding the effect of IC on performance indicators, the effect of IC on ROE was analysed. The analysis results obtained were found far from confirming the existence of a firm-level relationship in this context. However, the results pointed out the existence of a negative and significant relationship between the *leverage ratio* used as the control variable and the ROE. In the analysis made on a sectoral basis, the existence of a significant relationship between ROE and the IC variable was not detected either. Hence, the H4 hypothesis was to be rejected completely. On the other hand, the existence of a negative and significant relationship between the *leverage ratio* and ROE has been witnessed at this level too. This, on the other hand, emerged as one of the expected situations similar to the situation expressed in the ROA results, thus confirming the validity of the model.

Table 14. Research Results

Performance Indicators	Intellectual capital			
	Firm Base	Control Variable	Sectoral Base	Control Variable
ROA	+	LEVERAGE (-)	Not Significant	LEVERAGE (-)
ATO	Not Significant	SIZE (+)	+	LEVERAGE (+)
MB	+	LEVERAGE (+)	Not Significant	LEVERAGE (+)
ROE	Not Significant	LEVERAGE (-)	Not Significant	LEVERAGE (-)

Within the scope of the analysis results, which are also brought together in Table 14 above, while the positive effect of the *intellectual capital* on firm basis in terms of *return on assets* and *market / book value* ratio and on a sectoral basis in terms of *asset turn-over* rate were asserted, the existence of effect in terms of *return on equity* at expected level could not be revealed. Thus, according to the research results, among four hypotheses whose validity was tested, one was rejected, the remaining three were partially accepted. In other respects, the *leverage* ratio from the control variables was the most powerful variable in accordance with economic expectations. In this case, it is not possible to say that these results are very different from the results obtained by some researchers such as Firer and Williams (2003) and Mehralian et al., (2012). Again, with this result, stronger findings were obtained than the studies conducted so far in the Turkish environment. Those studies such as Erdogan and Dönmez (2014) and Ozkan et al., (2017) used more limited sample and indicators. In this context, in general terms, it is possible to say that the obtained result shows that firms which increase the amount of intellectual capital can increase their performance over time. On the other hand, it also points out that market participants treat intellectual capital as an asset that represents significant economic benefits to the business. Our results contribute to the literature by not just strengthening and increasing the awareness about the possible effects of IC on firm performance but also by presenting and applying new ways in using measurement methods in a developing country.

12. CONCLUSION

In the social economic environment where knowledge stands out, we are witnessing the increasing importance of intellectual capital, namely knowledge and knowledge-based assets through the basic human element. In the face of its growing importance, the managerial implications of its use are discussed. However, the findings of studies on the influence of intellectual capital on firm performance are far from reaching a consensus on this issue. Although some of the findings identify a positive relationship between intellectual capital and financial performance, there are also some results that indicate the opposite. On the other hand, in studies, some developed Asian, European, and North American countries are often used as a sample area, while those related to emerging markets are found to a smaller extent. In studies of emerging markets, we also see that the VAIC measurement method is used more often to measure intellectual capital. Therefore, in this study, we aimed to measure intellectual capital and determine its possible effects on firm performance by using a developing country sample and a method other than the measurement methods that are often used in the literature.

When the results obtained in terms of each performance indicator used within the framework of our study's goal were evaluated together, positive effect of intellectual capital on firm performance was determined. This effect, which was determined at the firm level in relation to *return on asset* and *market/book value ratio*, did not diverge across sectors. But the effect in question in terms of *asset turn-over rate* arose from differentiation across sectors. Decomposition in some sectors, such as *textile, wearing apparel and leather*, could be an obstacle to the emergence of the impact of intellectual capital on the basis of firm. Thus, the results show that firms that increase the amount of intellectual capital can improve their performance over time, by regarding intellectual capital as an important asset that provides economic benefits. But intellectual capital must be managed more effectively in order to capture the expected level of impact. In this context, the findings can increase the awareness in a developing country, Turkey, about the interaction between intellectual capital and firm performance, and about the importance of intellectual capital in terms of firm performance while encouraging the use of different intellectual capital measurement methods.

On the other hand, the most important limitation of the research may be due to the measurement method and the various proxies used in this measurement method. Along with this fact, the points encountered in the analysis process also indicate that clearer explanations and indicators that will facilitate the measurement of intellectual capital should be included in financial reports. These explanations and indicators can also support the need to capitalize various intangible assets to reflect possible contributions to the creation of firm value. Given that captured performance is the result of processes, it may be beneficial to include measurement methods focused on operational processes in subsequent studies, thus reflecting the dynamic structure of intellectual capital in the analysis, in order to enrich measurement methods and increase the validity of results.

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