Araştırma Makalesi / Research Article

The Effect of Board Structure on Sustainable Innovation Capability: A Research on Turkey

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Abstract

The continuous development of information technology under intense competition environment and shortening in the product life cycles based on short-term changes in customer demands lead to complexity and uncertainty in business environments. This situation features the sustainable innovation capabilities of enterprises, highlighting their significance. In this context, the objective of this study is to determine the impact of board structure on the innovation capabilities of businesses. In line with this purpose, the data of the companies included in the Istanbul Stock Exchange 100 Index for the years 2009 – 2017 were examined by panel data analysis method. As a result of regression analysis using the robust estimator developed by Beck-Katz (1995), it was found that gender diversity and role duality in the board of directors had a statistically significant negative impact on sustainable innovation capability. However, it was also observed that the ratio of foreign members in the board of directors and the size of the enterprise had a statistically significant positive impact on sustainable innovation capability.

Keywords: Board of directors, sustainability, innovation, innovation capability, Turkey.

Yönetim Kurulu Yapısının Sürdürülebilir İnovasyon Yeteneği Üzerindeki Etkisi: Türkiye'de Bir Araştırma

Öz

Yoğun rekabet koşulları altında bilgi teknolojisinin sürekli olarak gelişim içerisinde olması ve müşteri taleplerinde ortaya çıkan kısa süreli değişimlere bağlı ürün yaşam döngülerinde meydana gelen kısalmalar, işletmelerin çalışma ortamlarında karmaşıklığa ve belirsizliğe sebebiyet vermektedir. Bu durum, işletmelerin sürdürülebilir inovasyon yeteneklerini ön plana çıkarmakta ve önem arz eder bir konuma getirmektedir. Bu çerçevede çalışmanın amacı, yönetim kurulu yapısının işletmelerin inovasyon yetenekleri üzerindeki etkisini tespit etmektir. Söz konusu amaç doğrultusunda, Borsa İstanbul 100 Endeksi' nde yer alan şirketlerin 2009 – 2017 yıllarına ait verileri, panel veri analizi yöntemi ile incelenmiştir. Beck-Katz (1995) tarafından geliştirilen dirençli tahminci kullanılarak gerçekleştirilen regresyon analizi sonucunda; yönetim kurulu cinsiyet çeşitliliğinin ve rol ikiliğinin sürdürülebilir inovasyon yeteneği üzerinde negatif yönde istatistiksel açıdan anlamlı etkisinin olduğu tespit edilmiştir. Bununla birlikte, yönetim kurulu yabancı üye oranı ve işletme büyüklüğünün sürdürülebilir inovasyon yeteneği üzerinde ise pozitif yönde istatistiksel açıdan anlamlı etkisinin olduğu görülmüştür.

Anahtar Sözcükler: Yönetim kurulu, sürdürülebilirlik, inovasyon, inovasyon yeteneği, Türkiye.

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INTRODUCTION

In today's business world, the working environments of businesses are imbued with uncertainty and confusion. In order for the enterprises to survive in such a competitive environment and to cope with global competition, it is essential that they should increase their capacity and invest in research-development. On the other hand, the changes and developments in information technologies and the short-term changes in customer demand reveal the need to place emphasis on innovation for sustainable growth in a normal economy. This fact brings the sustainable innovation capabilities of enterprises at the forefront. In addition to all these, the most important element that influences the sustainable innovation is the corporate governance structure, which provides a balance among the enterprise owners, shareholders, stakeholders, partners, and all other business interest groups, and which regulates the relationships and creates a transparent management approach. By creating an environment conducive to developing and facilitating strategic decision-making processes, a well-designated corporate governance contributes to the emergence of innovation capability and to its sustainability.

In both domestic and foreign literature, the number of studies examining the effects of the board structure on financial performance is quite high. However, the number of studies addressing the impact of the board structure on the innovation ability is quite small, which are mostly in foreign literature, and very few studies on this subject have been found in domestic literature. It was observed that mostly survey method was used to measure innovation ability in these studies. As per our study, the concept of innovation ability was measured through the content analysis method and answers were sought for research questions using the panel data method, which allows examining multiple firms within multiple periods. Therefore, there is a gap in the literature in terms of the way the subject is handled.

In this context, this study aims at determining the effect of the board of director's structure on the innovation capabilities of the enterprises. In line with this purpose, initially, certain terms such as the corporate governance, sustainability, and innovation were separately discussed and theoretically explained, particularly emphasizing the relationship between the sustainability and innovation capability. Subsequently, the data of the companies listed in the BIST-100 (Istanbul Stock Exchange) index for the years 2009–2017 were examined through the panel data analysis. As a result of the regression analysis conducted through the Beck-Katz (1995) robust estimator, it was determined that gender diversity and role duality in the board had a statistically significant negative impact on sustainable innovation capability. However, it was also observed that the ratio of foreign members in the board and the size of the enterprise had a statistically significant positive impact on sustainable innovation capability.

1. CORPORATE GOVERNANCE

Emerged in the 1990s with a fast entry into the business world, *corporate governance* has recently become a management philosophy that has attracted the attention of states, economies and academic circles. The foundation of corporate governance is based on the management of companies in such a way as to provide high benefits to their shareholders and then to all stakeholders (Güner and Kurnaz, 2019: 300-301).

Corporate governance can be defined as "the entire relationships of companies with various participants in improving their performance and determining their roadmaps" (Minow and Robert, 1996). Aiming a more transparent and fair management of companies with a responsibility and accountability, corporate governance is seen as a management approach in which the trust element is prioritized in terms of its structure and functioning. It is expected that an effective management mechanism as a result of good corporate governance will increase the success of companies (Önder and Kavak, 2019: 170). Corporate governance has two main objectives that explain and demonstrate its significance. First, to ensure ability to reach the reliable and accurate information about the company by preventing the large shareholders and managers to deceive the minority shareholders in the company, and second, to ensure

that managers work to increase the value of the company, not for their own interests (Bushman and Abbie, 2003: 65).

The global impact of globalization and developments in information technologies indirectly affect the capital markets. As a result of this effect, international barriers in the capital markets are eliminated, opening the way for the possibility to invest in different countries. In this way, in order to minimize the problems that may arise related to management and communication, the need for international compliance emerged (Boz *et al.*, 2019: 120). Based on these needs, the concept of corporate governance has gained importance. In this context, the corporate governance is also identified by certain practices that regulate the relationships among certain segments such as the shareholders, managers, lenders, employees, etc. (Jesover and Kirkpatrick, 2005:2).

There are three important contributions that corporate governance provides both to the management of companies and to corporate law in general (Tırpancı, 2019: 117). The first of these is that corporate governance provides a holistic perspective to companies by taking into consideration that both internal controls and external legal regulations have an effect on the company. The second is that it ensures the judicial power to perceive the corporate law from a different standpoint. In this way, the responsibilities of company managers became more questioned. Finally, it becomes more clear for the public that corporate governance and the legal regulations of countries in this regard are superior in comparison to the countries where these practices are weak (Hopt, 2000: 7).

Corporate governance practices are not only vital for a business but they also interact indirectly with innovation capacities that promote sustainability. A number of characteristics of the board of directors that guide corporate governance practices and make strategic decisions on behalf of shareholders as the executive branch of the company may also affect sustainability, and therefore, innovation capability (Tuan, 2019: 233-234).

2. SUSTAINABILITY AND INNOVATION

In today's developing and changing economic world, innovation is an important competitive tool, affecting both corporate management and the sustainability need of companies. Due to its homogeneous nature, this concept seems to have a wide variety of definitions. In its most general definition, innovation can be expressed as "developing distinctive, different, and new ideas and putting them into practice and embodying them" (Yorgancılar, 2011: 394).

Higgins (1996) describes the concept of innovation as "the creation of organizational processes, the development of existing products, or the creation of new products that have a significant impact for segments such as a person, group, etc." According to Cumming (1998), innovation is described as "the first successful practice of a product or value creation process". In another source, innovation is expressed as "the first presentation of an idea, tool, system, policy, program, product, service or process by the enterprise" (Güleş and Bülbül, 2004: 125).

The concept of "sustainable innovation", which is one of the sub-genres of innovation and which is also called as supportive innovation, is a genre that fuels the competition between firms in the same sector and drives companies to innovate. The continuity of the innovation process in the industry is thus protected since existing-technologies-based performance parameters do not change (Yorgancılar, 2011: 401).

There are certain motives forcing companies to be sustainable. Some of these motives emerge from financial concerns of companies. Another part is related to a sense of social responsibility, which is thought to be necessary in the formation of a corporate identity. On the other hand, the main motive that drives companies to be sustainable is the desire to make profit. From this standpoint, sustainable innovation capability involves certain goals such as feeling themselves responsible about minimizing the environmental damage they cause, responding the changing consumer habits through innovations particularly implemented in production and marketing processes, or being disposed to display a

sustainable vision in order to keep up with other rival companies in globalizing environment, and ultimately ensuring profit maximization (Kuşat, 2012: 228).

The innovation capabilities that companies develop can demonstrate quite positive outcomes. Experience shows that the involvement of innovation in governance has some positive results (Akyos, 2005: 33). Some of the successes of this capability are listed as follows (Yorgancılar, 2011: 408-409):

●In addition to creating a more open/participatory governance culture, it is able to make more efficient use of resources by generating public value.

●By improving the image of the public sector, it enables citizens to have more confidence in their governing organizations.

●Innovation in governance encourages a culture of continuous improvement and this increases the spiritual satisfaction of employees.

●Successful innovation in one area can open doors to innovation in other areas.

Nevertheless, increasing innovation activities to high levels in order to achieve sustainable competitive advantage in global terms and to increase the level of household welfare also depends on the ability of countries to achieve innovative activities. In this context, investments in these activities are increasing in each passing day by both developed and developing countries.

Table1: Product Innovative Firms (2019)

Country	FIRM SIZE %			ECONOMIC SECTOR %	
	Total	SMEs	Large	Manufacturing	Services
FRA	28	26	57	31	26
ITA	31	31	62	35	26
JPN	16	15	37	19	14
TUR	32	31	42	36	28
USA	31	30	39	34	29
RUS	4	2	14	8	3

Source: OECD, Innovation Indicators Tables, 2019.

Table 1 contains data from national innovation statistics published by the OECD. The innovation data in this table are discussed within the scope of product innovation. The data obtained is evaluated concerning the company-size and from a sectoral point of view, and the data is organized as a percentage of the total companies in each group based on the number of companies participating in the national innovation research. Accordingly, examining the mentioned data, it is observed that 32% of the companies participating in the national innovation survey in Turkey, 31% of SMEs and 42% of large enterprises are engaged in product-based innovation activities. Examining this case from a sectoral point of view, 36% of the production sector and 28% of the service sector conduct innovative activities. On the other hand, examining the data contained in Table 1 for the United States, 31% of the companies participating in the survey, 30% of SMEs and 39% of large enterprises are engaged in innovation activities. These data are 34% in the manufacturing sector and 29% in the service sector.

Table 2: Innovation Capabilities Ranking (2020)

Country	Score (0–100)	Rank
Switzerland	66.08	1
Sweden	62.47	2
United States of America	60.56	3
United Kingdom	59.78	4
Netherlands	58.76	5
Turkey	34.90	51

Source: The Global Innovation Index 2020: Who Will Finance Innovation?, 2020.

Table 2 contains data concerning The Global Innovation Index published by the World Intellectual Property Organization (WIPO) in 2020. In this index, which includes 131 countries, world economies are ranked depending on their innovation capabilities. Accordingly, Switzerland ranks first with a score of 66.08. On the other hand, the last place among the top five countries is the Netherlands with 58.76 points. Furthermore, it is observed that Turkey is ranked as the 51st with a score of 34.90 among 131 countries.

Table 3: Innovation Capabilities Ranking of Turkey

Year	Rank	Innovation inputs	Innovation outputs
2018	50	62	43
2019	49	56	49
2020	51	52	53

Source: The Global Innovation Index 2020: Who Will Finance Innovation?, 2020.

In the report prepared within the scope of the Global Innovation Index, Turkey's success over the last 3 years is shown in Table 3. Accordingly, in 2020, Turkey was ranked as the 52th country concerning the innovation inputs, while it was ranked as the 53rd country concerning the innovation outputs. Therefore, it is possible to mentioned that Turkey has performed better in innovation inputs compared to the innovation outputs in 2020.

Table 4: Innovative Enterprises (%)

Economic Activity	Innovative Enterprises					
	2004-2006	2006-2008	2008-2010	2010-2012	2012-2014	2014-2016
General	58.2	37.1	51.4	48.5	51.3	61.5
Industry	60.8	41.1	52.2	49.8	54.2	64.5
Manufacturing	61.5	41.6	53.0	50.4	54.7	65.3
Service	53.6	31.10	50.3	47.0	47.8	57.7

Source: TÜİK, Yenilikçi Girişimler ve Yenilik Türleri, 2014-2016.

On the other hand, data on innovative enterprises in Turkey for the years 2004 - 2016 are given in Table 4. The data in question were examined in four dimensions. These dimensions are general, industry, manufacturing and service. Accordingly, when the values in the table are examined over the years, it is

possible to say that there have been noticeable increases in all areas of economic activity in general. In this context, it can be stated that the level of importance attributed to the innovation activities conducted in the light of information and technological developments in Turkey is increasing every day.

3. LITERATURE

Studies conducted on the impact of innovation capabilities that businesses have on company elements are among the attractive topics in the current literature. Zhang (2004), Azubuike (2013), Saunila et al., (2014), Aramburu et al., (2015), Rajapathirana and Hui (2017), Hoang and Ngoc (2019), Al-kalouti et al., (2020) and YuSheng and Ibrahim (2020) investigated the effects of innovation ability on various performance indicators of firms. Additionally, some other studies in the literature on the subject are given below.

Some of the previous studies conducted in the literature in this subject are presented below.

In a previous research conducted by Burmaoğlu and Şeşen (2011), it was aimed to identify the factors affecting the organizational innovation capabilities of Turkish companies. According to the results of the research, knowledge, cooperation, network development potential and market size were listed as the most important factors in the formation of organizational innovation.

Similarly, in a study conducted by Kuşat (2012), it was investigated how businesses play a role in the implementation of sustainable development. In the research, where a broad theoretical assessment was made, it was explained how organizational learning is an important value for corporate sustainability, what the dynamics of sustainability within the company are, and how it can be used towards sustainability.

On the other hand, another research conducted by Boz et al., (2019), it was aimed to determine the impact of the interaction between corporate social responsibility and corporate governance on enterprises in the Istanbul Stock Exchange (BIST) corporate governance index. According to the results, the productivity values of Izocam Holding, Egeli & Co Investment Holding, and Mensa Industrial Corporation were determined as the highest with a value of "1,00". On the other hand, the lowest three values and companies were determined as İş Real Estate Investment Trust with 0.41, Arçelik with 0.47, and Vestel and Şekerbank with 0.52.

In addition, in a study conducted by Önder and Kavak (2019), it was aimed to establish a relationship between corporate governance structures and financial performance of companies in insurance sector in Turkey. According to the results, it was determined that there was a statistically significant relationship between the financial success of insurance companies and corporate governance structures in Turkey.

In another study, Tırpancı (2019) addressed the concept of corporate governance in Turkey, analyzing its impact on the financial performance of companies. As the conclusion of the analysis, it was determined that companies included in the Corporate Governance Index performed better than other companies traded on the Borsa Istanbul Stock Exchange. On the other hand, another result was revealed that compliance with Corporate Governance Principles has a positive impact on company performance.

Additionally, in a different study conducted by Tuan (2019), it was aimed to identify the effect of certain features of the board of directors, which guides corporate governance practices and makes strategic decisions as the company's executive branch, on sustainability reports. According to the results, there was a statistically significant positive relationship between the size of the company's board of directors and the presence of foreign members on the board of directors and the sustainability reports published.

Finally, using the data of certain private companies in China, Xu and Bai (2019) examined the relationship between board structure and sustainable innovation capability. The results indicated that the central leadership structure had a positive impact on the sustainable innovation capability of Chinese

companies. Moreover, another positive effect of sustainable innovation capability was revealed on the business expansion of companies.

4. RESEARCH METHOD

This part includes explanations about the research sample, the procedure of dataset formation, research model, hypotheses, and the measurement of the examined variables[3].

4.1. Dataset and Sample of the Research

In this research, companies listed in the BIST 100 Index were examined in testing the hypotheses created in accordance with the relevant literature. The final sample consists of 486 observations between 2009 and 2017 and covers four main sectors: manufacturing, technology, telecommunications and commerce. The main reason for starting the dataset in 2009 and ending it in 2017 is to achieve the maximum number of observations, depending on the difficulties experienced in data collection.

In the context of the application phase of the research, the first dataset was generated from the financial statements of the companies listed under the abovementioned index that were disclosed to the public in the 2009-2017 period. The data was obtained from the Public Disclosure Platform (2020). On the other hand, the second dataset was comprised of the data related to the board characteristics of the companies. This mentioned dataset was generated from the information obtained from business activity reports, corporate governance compliance reports, and the official internet addresses of the enterprises.

In addition, financial institutions such as banks, insurance companies, investment trusts, finance leases and holdings were not included in the sample because they are subject to different regulations than the companies included in the index. On the other hand, information about the corporate governance structures of some companies could not be provided. Therefore, these companies were excluded from the scope of the study. The companies that comprise the final sample of the research are included in Appendix 1. Finally, the dataset used in this research is the balanced panel dataset.

4.2. Model and Hypotheses

The panel data model used in this research is empirically explained below.

Model:

$$SIC_{it} = \beta 0 + \beta 1\, GD_{it} + \beta 2\, RD_{it} + \beta 3\, FMBD_{it} + \beta 4\, SBD_{it} + \beta 5\, TR_{it} + \beta 6\, TA_{it} + u_{it}$$

While SIC_{it} is the natural logarithm of the intangible fixed assets of the company *i* in the year *t*; GD_{it} is the proportion of the female board members to the number of the whole board members of the company *i* in the year *t*, $FMBD_{it}$ is the proportion of the foreign board members to the number of the whole board members of the company *i* in the year *t*. Additionally, SBD_{it} is the natural logarithm of the number of the board members of the company *i* in the year *t*, and TR_{it} is the natural logarithm of the revenue of the company *i* in the year *t*. Lastly, TA_{it} is the natural logarithm of the total assets of the company *i* in the year *t*, and u_{it} is the error term.

Table 5: Research Hypotheses

Hypothesis	Explanation
H_1	The size of the board of directors has a statistically significant effect on the sustainable innovation capabilities of enterprises.
H_2	Role duality has a statistically significant effect on the sustainable innovation capabilities of enterprises.
H_3	Gender diversity on the board of directors has a statistically significant effect on the sustainable innovation capabilities of enterprises.
H_4	The proportion of foreign members in the board of directors has a statistically significant effect on the sustainable innovation capabilities of enterprises.

Tribo *et al.* (2007), Mat Rabi *et al.* (2010), Choi *et al.* (2012), Minetti *et al.* (2015), Shapiro *et al.* (2015), Bobillo *et al.* (2017) and Blibech and Berraies (2018) examined the effects of various administrative elements on innovation performance. Unlike these studies, in this study, the impact of board elements on innovation ability was investigated. Hypotheses developed for this purpose are shown in Table 5.

4.3. Measurement of the Research Variables

The explanations concerning the dependent, independent and control variables of the research are given in Table 6.

Table 6: Research Variables

Variable Type	Variable	Reference	Measurement	Symbol
Dependent Variable	Sustainable Innovation Capability	Hall (1993), Den Hertog *et al.* (1997) and Xu and Bai (2019)	Logarithm of the Intangible Fixed Assets	SIC
Independent Variable	Proportion of the Foreign Members in the Board of Directors	Ujunwa et al., (2012), Sunday and Godvin (2017), AlQudah *et al.* (2019)	Number of Foreign Members in the Board / Number of Total Members in the Board	FMBD
	Role Duality	Chang et al. (2008), Aygün and İç (2010), Mezghanni (2010), Doğan *et al.*, (2013)	"1" if the General Manager is also the chairman of the board, if not "0"	RD
	Size of the Board of Directors	Cheng and Courtenay (2006), Laksmana, (2008), Samaha *et al.*, (2012)	Logarithm of the total number of the members of the board	SBD
	Gender Diversity in the Board of Directors	Baraco and Brown (2008), Müller (2014)	Number of Female Members in the Board / Number of Total Members in the Board	GD
Control Variable	Revenue	Anagnostopoulou and Levis (2008), Coad and Rao (2010), Doğan and Yıldız (2013)	Logarithm of the Total Revenue	TR
	Size of the Enterprise	Saliha and Abdessatar (2011), Xu and Bai (2019)	Logarithm of the Total Assets	TA

5. RESEARCH FINDINGS

This part of the research includes the descriptive statistics, correlation matrix, and tests concerning the panel regression analysis as well as general assessments about the obtained empirical findings. The variables were analyzed while the logarithms of the research model were taken, while the same variables were demonstrated in descriptive statistics and correlation matrix without taking the logarithms.

5.1. Descriptive Statistics

The descriptive statistics about the dependent, independent, and control variables used in the estimation model are given in Table 7.

Table 7: Descriptive Statistics

Variable	Observation	Average	Std.Deviation	Min.	Max.
SIC	495	354.919.429	1.083.681.256	1.880	8.482.480.000
GD	495	0.1175	0.1197	0	0.5
RD	495	0.0556	0.2291	0	1
FMBD	495	0.1180	0.1925	0	1
SBD	495	8.1461	2.2656	3	16
TR	495	4.013.464.136	6.951.869.350	761.919	53.948.110.000
TA	495	4.287.375.444	7.845.624.922	37.289.412	68.647.000.000

When the descriptive statistics were examined over 486 observations in the 2009-2017 period, it was seen that the average value for the intangible fixed assets was 354.919.429 TL, which was used in the measurement of the sustainable innovation capability, the average value of the number of the female board members was 0.1175, the average value of the number of the foreign board members was 0.1180, the average value of the volume of the board of directors was 8.1461, the average value of the revenues of the enterprises was 4.013.464.136 TL, and lastly, the average of size of assets of the enterprises was 4.287.375.444 TL.

5.2. Correlation Coefficients Table

Table 8 includes the table of correlation coefficients that determine the direction and level of the relationship between the dependent variable of the research and the independent variables of the research such as the gender diversity of the board, the foreign member proportion of the board, the volume of the board, and the control variables.

Table 8: Correlation Coefficients Table

	SIC	GD	FMBD	SBD	TR	TA
SIC	1.0000					
GD	-0.2143**	1.0000				
FMBD	0.3450**	-0.2949**	1.0000			
SBD	0.2408**	-0.2099**	0.2266**	1.0000		
TR	0.2880**	-0.1612**	0.1164**	0.4014**	1.0000	
TA	0.4798**	-0.1452**	0.0765	0.2670**	0.7673**	1.0000

*Note 1: * p < 0.01, ** p < 0.05, *** p < 0.10.*

Note 2: Dummy variable (RD) was not included.

While examining the correlation matrix, the correlation coefficient between variables was evaluated as very weak, weak, strong and very strong based on being close to the values of -1 and +1 (Tan, 2016: 144). Additionally, Gujarati (2003) states that if the correlation coefficient between two variables exceeds 0.80 (close to 1), it will threaten the results of regression in terms of reliability. In such a case, one of the variables, where the relation coefficient is 0.8 and over, must be removed from the model (Ocak and Arıkboğa, 2017: 107). Accordingly, when the values in Table 8 were examined, it was determined that there was no coefficient at 0.8 level, and it was observed that there was a weak relationship between variables in general.

5.3. Unit Root Test

In order to prevent a possible spurious regression problem arising from models established using non-stationary variables in panel data analyses, the stationarity status of the variables should be investigated before the estimation of the models. For this reason, unit root testing is important to prevent these problems (Kaya, 2014: 297).

In the context of the research, the stationarity of the variables was examined through the Levin, Lin and Chu and Dickey-Fuller unit root tests.

Table 9: Unit Root Tests Results

Variables	Levin, Lin ve Chu		Dickey-Fuller	
	Constant (p-value)	Constant & Trend (p-value)	Constant (p-value)	Constant & Trend (p-value)
SIC	0.000*	0.000*	0.000*	0.000*
GD	0.000*	0.000*	0.000*	0.003*
FMBD	0.000*	0.024**	0.069**	0.990
SBD	0.000*	0.000*	0.000*	0.000*
TR	0.001**	0.000*	0. 046**	0.000*
TA	0.971	0.000*	0.999	0.000*

*Note 1: * p < 0.01, ** p < 0.05, *** p < 0.10.*

Note 2: Dummy variable (RD) was not included.

Evaluating the results of the unit root test performed using the LLC and Dickey-Fuller test in Table 9 in general terms, it is observed that all of the variables included in the analysis are stationary at the level.

5.4. Likelihood Ratio Test and Hausman Test

Whether the model is one-way or two-way is determined through certain tests applied in context of the Likelihood Ratio (LR) Test. These include testing the existence of time effects, testing the existence of unit effects, and testing the existence of both unit and time effects (Tatoğlu, 2016: 177). Accordingly, Table 10 contains the results of the LR test.

Table 10: LR Test Results

Test Type	Probability Value
Testing Unit and Time Effects	0.0000*
Testing Unit Effects	0.0000*
Testing Time Effects	1.0000

*Note : * p < 0.01, ** p < 0.05, *** p < 0.10.*

When the LR results given in Table 10 are examined, it is understood that there are unit effects in the research model. Accordingly, one-way model estimation will fit to the mentioned model. On the other hand, Hausman test was implemented in order to determine which method will be used among the fixed effects or random effects model. According to the mentioned test statistics, rejection of the H_0 hypothesis means that the fixed effects model is valid.

Table 11: Hausman Test Results

Test Type	Probability Value
Hausman Test	0.1391

*Note : * p < 0.01, ** p < 0.05, *** p < 0.10.*

When the results of the Hausman Test in Table 11 are examined, it is seen that the H_0 hypothesis cannot be rejected. Accordingly, the relevant result suggests that the random effects model should be preferred over the fixed effects model.

5.5. Tests Concerning the Assumptions

In the panel data model examined within the scope of the research, it is important to investigate the assumptions about autocorrelation, heteroscedasticity and inter-unit correlation problems. It is stated that if these assumptions are included in the model, they will cause inconsistencies in the expected results (Ün, 2018: 75). Therefore, these assumptions need to be statistically tested before the analysis.

Table 12: Autocorrelation, Heteroscedasticity and Inter-Unit Correlation Tests Results

Test Type	Test Value		
Modified Bhargava et al., Durbin-Watson		0.831	
Baltagi-Wu LBI		1.155	
Levene, Brown and Forsythe Test	W0:0.000	W50: 0.000	W10: 0.000
Pesaran CD test		0.485	

*Note : * p < 0.01, ** p < 0.05, *** p < 0.10.*

Table12 contains the assumptions tests for the research model. First, the problem of autocorrelation in the model was tested through the Modified Bhargava et al. (1982) Durbin-Watson test, and the Baltagi-Wu LBI test, and since the obtained test values were less than 2 (Tatoğlu, 2016: 238), it was determined that there was an autocorrelation problem in the research model. Subsequently, the heteroscedasticity problem was investigated with the Levene, Brown and Forsythe test, which was suitable for use within the scope of the random effects model, and it was observed that there was a heteroscedasdicity problem in the corresponding model. Finally, the hypothesis of inter-unit correlation was examined with Pesaran CD test, and it was concluded that there was no inter-unit correlation problem in the research model.

5.6. Regression Analysis

The Beck-Katz (1995) robust estimator was preferred for the regression analysis of the model created in the scope of the study. The main reason for the preference of this estimator is that it generates effective results in case of varying variance problems and autocorrelation problems in the created model (Tatoğlu, 2016: 276). Accordingly, below are the regression results for the model of the research.

Table 13: Analysis Results

Dependent Variable: SIC
Interval of Years: 2009 – 2017
Number of Companies: 54
Number of Total Observations: 486

Variables	Coefficients	Std. Deviation	z - Statistics	P>|z|
GD	-0.978	0.452	-2.16	0.030**
RD	-0.497	0.253	-1.97	0.049**
FMBD	0.578	0.348	1.66	0.097***
SBD	0.043	0.259	0.17	0.869
TR	-0.206	0.155	1.32	0.185
TA	0.961	0.157	6.13	0.000*
Constant	-7.677	1.886	-4.07	0.000
	R^2 = 0.8508	Wald chi2 (7) = 203.84	Prob > chi2 = 0.0000	

*Note : * p < 0.01, ** p < 0.05, *** p < 0.10.*

$$SIC = -7.677 + -0.978\ GD + -0.497\ RD + 0.578\ FMBD + 0.043\ SBD + 0.206\ TR + 0.961\ TA$$

The regression equation created by the model of the research is as shown above. Accordingly, when the coefficients of β were examined in the regression equation, it was observed that the variable with the highest level of influence on sustainable innovation capability was TA, while the variable with the least impact was determined to be GD.

When the regression results in Table 13 are examined, it is seen that the size of enterprise (TA) variable, one of the control variables of the research, has a statistically significant positive effect on the innovation ability of the enterprises (at 1% significance level). In addition, the board of directors' foreign member proportion (FMBD) variable has a statistically significant positive effect on the dependent variable innovation capability at 10% significance level. However, board of directors' gender diversity (GD) variable and role duality (RD) variable, which was used as the dummy variable in the research, were found to have a statistically significant negative effect on sustainable innovation capability at a 5% significance level. On the other hand, it is possible to say that the independent variables of the research, volume of the board of directors (SBD), and another control variable, revenue (TR), have not statistically significant effect on sustainable innovation capability.

In addition, the examination of the findings obtained as a result of the regression analysis in terms of developed hypotheses is as follows:

● The H_1 hypothesis developed as "The size of the board of directors has a statistically significant effect on the sustainable innovation capabilities of enterprises." was rejected.

● The H_2 hypothesis developed as "Role duality has a statistically significant effect on the sustainable innovation capabilities of enterprises." was not rejected.

● The H_3 hypothesis developed as "Gender diversity on the board of directors has a statistically significant effect on the sustainable innovation capabilities of enterprises." was not rejected.

● The H_4 hypothesis developed as "The proportion of foreign members in the board of directors has a statistically significant effect on the sustainable innovation capabilities of enterprises." was not rejected.

6. CONCLUSION

The hypotheses, which were developed within the scope of the study to determine the effect of the board structure on innovation capability, were examined by panel regression analysis. According to the empirical findings, it is possible to say that any increase in the number of female members in the board will have a negative impact on the innovation capabilities of businesses. This result can be attributed to the risk-taking tendencies of female managers. Actually, Mueller (2004) states that there is a wide gap between the risk-taking levels of male and female managers in developing countries. However, considering the fact that developing market types are generally in more conservative and traditional cultures, women, who are already risk-averse managers, are especially careful not to take unnecessary risks including innovation (Na and Shin, 2019: 20). The findings of this study on gender diversity are similar to those obtained by Quintana-García and Benavides-Velasco (2016).

Another variable of the study, role duality, was determined to have a statistically significant negative effect on innovation capability. Accordingly, it is possible to infer that execution of the position of chairman of the board and chief executive officer by the same individual negatively affects the innovation capabilities of the enterprises. According to the agency theory, dual practices in management play an important role in the independence and effectiveness of the board of directors (Yasser *et al*., 2014: 66). When the leadership structures of the majority of companies in Turkey are examined, it is seen that the roles of CEO and chairman are characterized by separate individuals. Empirical findings on the mentioned variable are similar to those reached by Rechner and Dalton (1991), Mallette and Fowler (1992) and Jermias (2007).

However, it was concluded within empirical findings that the increase in the number of foreign members on the board of directors will positively impact the innovation performance of the enterprises. Nielsen (2010) noted that ethnic differences widely take place in boards of directors today. This indicates the fact that there is an increase in the number of foreign members in the executive positions. The impact of ethnic diversity on innovation capability determined in this study is in parallel with the results of studies conducted by Miller and Triana (2009), Cook and Glass (2015) and Makkonen *et al*. (2018).

On the other hand, empirical results indicate that the volume of the board of directors does not have a statistically significant effect on innovation capability. The results obtained from the analysis are in parallel with those obtained by Driver and Guedes (2012), Shapiro *et al.* (2015), Balsmeier *et al*., (2017) and Blibech and Berraies (2018).

Finally, in future studies, different variables can be examined in relation to the structure of the board of directors. Furthermore, through sectoral separations in the selection of samples, sectoral comparisons can be employed on findings.

AUTHOR STATEMENT

Research and Publication Ethics Statement

This study has been prepared in accordance with the ethical principles of scientific research and publication.

Author Contribution

All authors have contributed to the study equally.

Conflict of Interest

There is no conflict of interest arising from the study for the authors or third parties.

NOTES

[3] STATA 15.0 program was used in the analysis.

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APPENDIX

Table App 1. Companies Comprising the Sample

Number	BIST Code	Number	BIST Code
1	AKSA	28	BUCIM
2	ALKIM	29	KAREL
3	ANACM	30	KERVT
4	ARCLK	31	KLMSN
5	ASELS	32	LOGO
6	AYGAZ	33	TUPRS
7	BRISA	34	ADANA
8	CEMTS	35	BTCIM
9	EGEEN	36	BIMAS
10	ECILC	37	BRSAN
11	EREGL	38	CCOLA
12	FROTO	39	CLEBI
13	KARSN	40	CIMSA
14	THYAO	41	DOAS
15	OTKAR	42	ENKAI
16	ZOREN	43	GUBRF
17	SASA	44	HEKTS
18	SODA	45	INDES
19	TATGD	46	IPEKE
20	TOASO	47	KRDMD
21	TRKCM	48	KARTN
22	TTKOM	49	KORDS
23	TTRAK	50	KOZAL
24	SISE	51	MGROS
25	ULKER	52	NETAS
26	VESTL	53	TRCAS
27	YATAS	54	TCELL