An International Journal of Optimization and Control: Theories & Applications
ISSN: 2146-0957 eISSN: 2146-5703
Vol.13, No.1, pp.35-45 (2023)
https://doi.org/10.11121/ijocta.2023.1238

RESEARCH ARTICLE

The effect of marketing and R&D expenditures on firm profitability and stock return: Evidence from BIST

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ARTICLE INFO

Article history:
Received: 2 March 2022
Accepted: 21 July 2022
Available Online: 24 January 2023

Keywords:
R&D expenditures
Marketing expenditures
Profitability
Stock return
Panel-data analysis

AMS Classification 2010:
91G50; 90B60; 91B82; 91G80;

ABSTRACT

This study aims to determine the effects of R&D and marketing expenditures of companies that force marketing and finance to act together on stock return, return on assets, and return on equity. To this end, the quarterly frequency data of nine companies that were continuously traded in the BIST Technology Index between March 2009 and December 2020 were examined with panel-data analysis. In line with the purpose of the research, analyzes were carried out in three different models. First of all, we determined which tests should be performed on the models based on the cross-sectional dependence, homogeneity/heterogeneity, and panel unit root test results obtained for the established models. The results of panel least squares test carried out to determine the effect of R&D and marketing expenditures on stock return showed that the effect of R&D expenditures on stock return was not statistically significant while marketing expenditures had a positive and significant effect on stock return. Analyzes should be continued with cointegration tests according to the characteristics of the two models established to determine the effect of R&D and marketing expenditures on return on assets and return on equity. The results implied a positive and significant relationship between R&D expenditures and return on both assets and equity. While no statistically significant relationship was found between marketing expenditures and return on assets, there was a positive and significant relationship between marketing expenditures and return on equity.

1. Introduction

The interface (approach) of marketing and finance emerges as an important and functional research area that helps to demonstrate the accountability of the marketing department and its activities in the management processes of companies and to create an interdisciplinary bridge for finance and accounting [1]. Srinivasan and Hanssens published the primary study in marketing and finance in 2009. Since then, this research area has become an area of great interest [1]. The discipline of Marketing-Finance has a high-level relationship with marketing with regard to areas such as both asset pricing and corporate finance. This research area focuses on the relationships between marketing-related issues and metrics, including the behavior of financial market participants such as economic and financial analysts, investors, and creditors. The main purpose of this research discipline is to emphasize the significance of marketing considering the investors as stakeholders in order to highlight that marketing and finance should also be taken into account in managerial decisions about firm processes [2].

Marketing departments and their activities are generally carried out in a structure where expenditures are made in companies and return on these expenditures are obtained in the long term. This phenomenon makes it compulsory to evaluate marketing-related activities in managerial processes and to measure them with rational metrics. The high-budget structure of marketing investments and the inability to quantify their return are considered an important leadership problem for the senior managers of the companies. Therefore, the accountability of marketing comes to the fore. The accountability of marketing is defined as the measurement and optimization of the contribution of marketing investments to the performance and value of a firm

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[1]. Marketing includes investment, expenditure, and managerial decision-making processes for a firm within the framework of customer value elements called product, price, promotion, and place (i.e., the 4Ps of marketing). These processes can be defined as marketing inputs. As for marketing outputs, the effect of marketing performance indicators on firm profitability and stock value may be cited [3-4]. It is of utmost importance to reveal the relationship between these input and output elements of marketing in a measurable way in order to provide a quantitative perspective to the decision-making mechanisms of the managers.

The current study aims to investigate the effect of the expenditures made by companies for marketing and therefore R&D/innovation investments on stock return and profitability. To this end, our study primarily touched on the relationship between marketing and R&D expenditures and profitability and stocks theoretically. We presented a summary table by examining the studies conducted on the relevant subject in the literature. Then, the models created to determine the effects of marketing and R&D expenditures on stock return, return on assets, and return on equity were investigated with panel-data analysis method. The findings obtained as a result of the analysis were reported and interpreted. In addition, the results were discussed and evaluated.

2. Conceptual framework

Recent advances in digital channels, alongside data explosion and the emergence of marketing automation, the globalization of markets, and the rise of customer experience as a key priority for companies have increased the significance of understanding how potential marketing outcomes have impacted and may impact firm profitability and firm value [5]. In marketing, innovation is considered to be an important factor that generates firm value, primarily in the market and also in the stock market [6]. Recently, a significant number of studies has focused on the effects of companies' marketing practices and marketing-oriented innovative assets and actions (search engine marketing practices, R&D investments, patents, new product launches, etc.) on the financial performance and value of the firm [7-12].

Operational processes (production, marketing, general management, etc.) in businesses are highly dynamic with the presence of constant innovations. The development and change of the abilities, capabilities, and activities in these processes require firm management to keep up with these changes. It is an important question to be answered by managers whether these practices and investments generate any return for the firm. When the academic literature is examined, various studies are focusing on measuring the effect of these operational activities and practices on the performance of companies in financial proportions [13]. Profitability arises as the most important indicator of firm performance in research. Therefore, the term "performance" is generally used when referring to profitability for companies [14].

The main purpose of examining the relationship between marketing and finance is to investigate the degree to which markets function smoothly [15]. However, there are two different difficulties in determining how successfully this goal can be achieved. *The first difficulty* is related to the capital. The difficulty means that investment decisions must be motivated by *"long-term factors"* (rather than short-term cash flows, for example, without long-term contributions). Therefore, a firm needs investment performance measures that have been proven to create long-term value with regard to management performance. *The second difficulty* is the evaluations to be performed in marketing practices to distinguish between *"effective marketing" and "ineffective marketing"*. To ensure the effectiveness of marketing practices, *inputs* include decisions about marketing actions called "product, price, promotion, and place (4P)" while *outputs* include several potential key performance indicators or metrics for marketing. Expenditure on these marketing practices may affect profitability [3] and stock return [4], thus firm performance. As Abramson et al. [3] and Shulze et al. [4] pointed out, operational activities and expenditures (marketing and innovation expenditures) are of great significance for stock return and profitability, both conceptually and with regard to firm management processes. Analyzing the relationship between these variables is crucial both in order to provide an important input for the decision-making processes of financial investors and to demonstrate its effect on the smooth functioning of the stock markets. Klingenberg et al. [13] suggest that the data is obtained either from the financial reports of publicly traded companies or in the form of perceptual data through surveys in order to analyze the relationship between a firm's operational practices (marketing and innovation) and its performance. The researchers claim that there are inconsistencies in the results obtained with these data (data obtained by making use of financial reports and survey data concurrently) [13]. Therefore, marketing and R&D expenditures, stock return, and profitability are examined through secondary data in the present study.

3. Literature

The studies conducted in the last 20 years in the national and international literature on this research area and their findings are summarized in Table 1.

Table 1. Summary of the literature on the research area

-Author(s) **-Sample** **-Time Period**	**Variables**	**Method**	**Findings**
Wakelin [16] UK stock exchange 1945-1983	Innovation and R&D investments	Least squares method	Separating the firms according to their innovation histories, the rate of return to R&D is much higher for innovative than non-innovative firms.
Hanel and St-pierre [17] Firms in the S&P compustant database 1972-1991	R&D expenditures and operating profit	Regression analysis	It has been determined that R&D has a direct, positive effect on profitability.
Öztürk [18] BIST firms 2002-2006	Market and book value of the firm's equity, monopoly power and R&D investments	Multiple regression analysis	It has been determined that R&D investments have statistically significant and positive effects on firm value.
Çifci et al. [19] BIST firms 2000-2008	Marketing expenses, general management expenses, total asset size and net profit/loss for the period	Panel data analysis	According to the findings of the study; marketing expenditures, general administration expenditures and total asset size have positive impacts on the performance of the business and it has been identified that among them the most important variable is the marketing expenditure.
Ehie and Olibe [20] US manufacturing and service firms 1990-2007	R&D expenditures and market value	Regression analysis	It has been determined that R&D investments contribute positively to firm performance.
Parcharidis and Varsakelis [21] Athens stock exchange manufacturing and computer firms 1996-2004	R&D expenditures and Tobin's q	Panel data analysis	It has been determined that R&D investments have an effect on the market value of the firms.
Topuz and Akşit [22] BIST Food industry 2000-2013	Marketing sales and distribution expenses, return on stock	Panel regression analysis	It has been determined that marketing expenditures have a positive effect on stock returns.
Doğan and Mecek [23] BIST Manufacturing Industry 200-2012	Marketing expenditures, return on assets, return on equity and Tobin's Q	Multiple regression and correlation analysis	A positive and statistically significant relationship was found between marketing expenditures and firm value.
Yücel and Ahmetoğulları [24] BIST technology, software and informatics sector 2000-2014	R&D expenses, change in net income and earnings per share	Regression analysis	There is a positive relationship between the change in R&D expenditures and the change in net profit for the same period. In addition, it has been determined that the effect of R&D expenses on earnings per share has a lag of three periods.
Alper and Aydoğan [25] BIST Chemical industry 2001-2014	R&D expenditures, return on assets, return on equity, firm size and financial leverage ratio	Dinamic panel data analysis	Study findings demonstrated that R&D expenses affected corporate financial performance positively and significantly with one year lag.
Işık et al. [26] BIST firms 2008-2014	R&D spending, sales and profitability	Panel data analysis	The analysis results show that; R&D spending have a positive and significant effect on profitability and sales.
Öztürk and Dülgeroğlu [27] BIST Manufacturing Industry 2007-2015	Marketing expenditure, general administrative expense, and sales	Panel regression analysis	It has been determined that the sales performance is stronger in companies whose marketing expenses are higher than their administrative expenses.
Polat and Elmas [28] BIST Metal Goods, Machinery and Equipment Production industry 2007-2015	R&D investments, profitability in sales and assets, growth and logarithm, liabilities/assets	Panel data analysis	The effect of R&D investments on firm performance has been determined as negative.
Lee et al. [29] Arts and culture firms in the USA 2003-2013	Marketing expenditure and total revenue	Regression analysis	It has been determined that marketing expenditures have a positive effect on total revenue.
Özer and Gülençer [30] Borsa Istanbul cement sector 2009-2013	R&D expenditure and intensity, marketing expenditure and intensity, stock value	Panel regression analysis	It was found that marketing expenditures had a positive effect on the stock value, and although R&D expenditures did not have a significant effect on the stock value directly, it was concluded that the intensity of R&D expenditures positively affected the stock value.

Table 1. *continued*

Serçek et al. [31] BIST Tourism Sector 2012-2015	Marketing expenses/net sales, marketing expenses/cost of operations and sales, debt ratio, firm size, return on asset, return on equity and operating cash flow	Panel data analysis	A statistically insignificant relationship was found between marketing expenses and profitability.
Yıldırım and Sakarya [32] BIST technology and informatics sector 2009-2016	R&D expenditures, return on assets and return on equity	Panel data analysis	It has been concluded that R&D expenditures have a significant and positive effect on the return on assets and equity.
Ayaydın et al. [33] Borsa Istanbul Technology 2008-2018	R&D investments, MV/BV, earnings per share and P/E	Dynamic panel data analysis	The results of the analysis indicated that there is a positive relationship between R & D investments and MV/BV, earnings per share and P/E.
Aydın and Kaya Aydın [34] Airline companies of various countries selected by convenience sampling method 2016	Revenue passenger kilometer, liquidity, Skytrax ranking and fleet numbers	Stochastic frontier analysis	According to the analysis, as the liquidity of the companies increase, the revenue passenger kilometer decreases. As the number of Skytrax ranking increases, revenue passenger kilometer decreases.
Liu et al. [35] Chinese manufacturing firms listed on the Shenzhen and Shanghai Stock Exchange 2012-2016	R&D investment and intensity, Tobin's q	Tobit regression analysis	It has been observed that R&D expenditures have an inverted U-shaped relationship with firm value, and increases in R&D investments exceeding a certain point are likely to result in lower firm value.

There is a significant number of studies in the literature analyzing the effect of marketing expenditures and R&D expenditures directly related to marketing on firm profitability and stock value. Some of these studies are presented in Table 1 with a systematic point of view. The studies in Table 1 were analyzed based on the author and year of the study, information about the samples used in the study, the years covered with the analyzed data, variables examined in the study, analysis methods, and information about the results of the study. Table 1 shows that:

- The relationship between marketing expenditures and firm profitability has been investigated by many authors from 2001 to 2020.
- When the scope of samples is analyzed, companies within the scope of *"BIST, British Stock Exchange, S&P Database, and Shenzhen and Shanghai Stock Exchange"* were investigated. In these stock exchanges and databases, many different fields and industries have been studied such as manufacturing industry, computer companies, food industry, technology, software and information industry, chemical industry, metal goods and machinery industry, art and culture companies, cement industry, tourism industry, technology industry, and airline companies.
- When the variables included in the analyzes are examined, the independent variables such as *"productivity, R&D expenditures, firm monopoly power, marketing expenditures, sales and distribution expenditures, general administrative expenditures, R&D expenditure intensity, and paid passenger mileage"* are associated with dependent variables including *"operating profitability, book value, net profit/loss for a given period, market value, Tobin's Q value, stock return, return on equity, change in net profit, profit per stock, firm size, financial leverage ratio, total revenue, and operating cash flow"*.
- The methods used during the analyzes consist of many causal and relational analyzes such as *"Least Squares Estimation, Regression Analysis, Multiple Regression Analysis, Panel-Data Analysis, Cross-Sectional/Stepwise Regression Analysis, Correlation Analysis, Dynamic Panel-Data Analysis, Stochastic Analysis of Boundary, and Tobit Regression Analysis"*.
- The results of the research have revealed *some positive and significant relationships between marketing and R&D expenditures and firm profitability and stock return*.

4. Dataset and method

Within the scope of the present study examining the effects of companies' marketing and R&D expenditures on stock return and profitability, we conducted research on the companies included in the BIST Technology Index. While analyzing the time period between 2009 and 2020, we determined that 9 companies were traded in the index continuously during the aforementioned period and included these companies in the sample. The dataset of the research consists of quarterly R&D and marketing expenditures, stock returns, return on assets, and return on equity of 9 companies in the BIST Technology Index during the period between March 2009 and December 2020. When the studies in the literature on the relationship or effect between firm performance and marketing and R&D expenditures are examined, the studies focusing on the relationship between innovative corporate/operational practices

and firm performance are in the majority. On the other hand, some other studies analyze the R&D and marketing expenditures of the companies for the activities in the product development and marketing processes. The current study examines the impact of "marketing and R&D expenditures" on both the market and the return on assets (ROA) and return on equity (ROE) of companies. Therefore, the present study differs from other studies and contributes to the literature by comparing the non-operational performance indicators (stock value and stock return) and operational performance indicators (ROA and ROE) of R&D and marketing expenditures. The variables included in the study were obtained from the financial statements published on the official website of Borsa İstanbul's Public Disclosure Platform (www.kap.org.tr). They are separated into dependent and independent variables and presented in Table 2 together with their abbreviations in the analysis.

Table 2. Variables in the model

	Variable name	Abbrevi-ation	Data Period
Dependent Variables	Stock Return	SR	2009:03 – 2020:12
	Return on Asset	ROA	2009:03 – 2020:12
	Return on Equity	ROE	2009:03 – 2020:12
Independent Variables	R&D Expenditures	R&D	2009:03 – 2020:12
	Marketing Expenditures	ME	2009:03 – 2020:12

We preferred to use panel-data analysis since both the variables belonging to the companies and the time-series data of these variables were present in the study. This is because the panel-data analysis method allows the time-series data of the cross-sectional observations of each firm in the sample to be combined and analyzed.

The research models of the current study, conducted to determine the effect of R&D and marketing expenditures on stock return, return on assets, and return on equity, were formed as follows:

$$SR = \beta_0 + \beta_1(\mathrm{ME}) + \beta_2(\mathrm{R\&D}) + \varepsilon \quad \textit{(model 1)}$$

$$ROA = \beta_0 + \beta_1(\mathrm{ME}) + \beta_2(\mathrm{R\&D}) + \varepsilon \quad \textit{(model 2)}$$

$$ROE = \beta_0 + \beta_1(\mathrm{ME}) + \beta_2(\mathrm{R\&D}) + \varepsilon \quad \textit{(model 3)}$$

5. Results

EViews 12, Stata 15, and Gauss programs were used in the present study, and three models established for the purpose of the research were analyzed sequentially. In the first stage of panel-data analysis, cross-sectional dependence tests should be performed. This is because some authors state that the results obtained in the analyzes carried out without considering the cross-sectional dependence will be biased and inconsistent [36]. In addition, it is possible to determine which unit root tests are suitable to apply to the variables based on the results of the cross-sectional dependence test.

5.1. Analysis results of Model 1

$$\boldsymbol{SR = \beta_0 + \beta_1(ME) + \beta_2(R\&D) + \varepsilon}$$

The dependent variable of Model 1 is stock return, and its independent variables consist of marketing expenditures and R&D expenditures. The results of cross-sectional dependence test of these variables are presented in Table 3.

Table 3. Cross-sectional dependence test results of Model 1

	SR		ME		R&D	
Test	Stat.	p	Stat	p	Stat	P
B-P LM	62.47	0.00	739.85	0.00	78.76	0.00
P LM	3.11	0.00	82.94	0.00	5.04	0.00
Bias-cs LM	3.02	0.00	82.85	0.00	4.94	0.00
P CD	3.47	0.00	21.05	0.0	0.48	0.62

Abbreviations: B-P LM: Breusch-Pagan LM, P LM: Pesaran scaled LM, B-cs LM: Bias-corrected scaled LM, P CD: Pesaran CD
H_0:No Cross Section Dependency, p. %5

The cross-sectional dependence tests given in Table 3 have various characteristics depending on the use scenario. For instance, it is assumed that the test developed by Breusch and Pagan [38] (Breusch-Pagan test) will be used when the time dimension (T) is larger than the cross-sectional dimension (N) [39]. Since the time dimension (T=12 years*4 periods) of the present study was larger than the cross-sectional dimension (N=9 companies), the Breusch-Pagan LM cross-sectional dependence test results were evaluated. As a result, H_0 is not supported since the result of test statistics for all variables is $p<0.05$. Therefore, there is a cross-sectional dependence in the series. For this reason, it is appropriate to conduct second generation unit root tests in the further phases of the analysis. The results of the second generation unit root tests Bai and Ng's PANIC and Pesaran's CIPS are presented in Table 4.

Table 4. Unit root test results of Model 1

	SR		ME		R&D	
Test	Stat	P	Stat	P	Stat	P
B-NG	1.47	0.00	1.15	0.00	1.99	0.00
P CIPS	-5.08	< 0.01	-3.78	< 0.01	-2.79	< 0.01

Abbreviations: B-NG: Bai and NG – PANIC, P CIPS: Pesaran CIPS H_0:No Unit Root, p. %5

Table 4 demonstrates that Bai and Ng's unit root test results were $p<0.05$ for all variables. Therefore, the variables did not contain a unit root. In other words,

the series was stationary at level I(0). Since p<0.01 was obtained for all variables in the Pesaran's CIPS unit root test results, H_0 was not supported, and it was confirmed that the series was stationary at level. For this reason, the Panel Least Squares Method (LSM) should be used in the further phases of the analysis. In order to utilize the Panel LSM, it is necessary to determine the fixed, random or pooled effects the model includes. The analysis should be performed once the suitable effect is selected. The results of the tests performed to examine the influences of these effects both on time and horizontal dimension are given in Table 5.

Table 5. Panel OLS effect test results

		Statistics	**P**
Cross Section	Random Effect (Hausman)	0.1503	0.9276
	Fixed Effect (Chow F)	1.4873	0.1597
	Pooled Effect (LM Breusch Pagan)	0.4458	0.5043
Period	Random Effect (Hausman)	1.8882	0.3890
	Fixed Effect (Chow F)	0.8665	0.7182
	Pooled Effect (LM Breusch Pagan)	0.5271	0.4678

Based on the results in Table 5, all significance values were determined to be p>0.05. Therefore, all H_0 hypotheses are supported. The hypotheses of the Hausman test are "H_0: Random effect, H_1: Fixed effect" [40], the hypotheses of the Chow F-test are "H_0: Pooled effect, H_1: Fixed effect", and the hypotheses of the LM test are "H_0: Pooled effect, H_1: Random effect". While the Hausman test carried out for both cross-section and period indicates that the model includes random effects, Chow F-test and LM Breusch-Pagan test results demonstrate that the model contains pooled effects. Since the majority of the tests showed that the pooled effect was suitable for the model, the least squares method was used under the pooled effects for both cross-section and period. The panel LSM results are given in Table 6.

Table 6. Panel OLS results

Variables	Coefficients	Std. Error	t-statistics	P
R&D	-3.61E-07	1.61E-06	-0.2250	0.8220
ME	15.3489	1.69E-06	-0.3011	0.0035
C	30.8184	11.8743	2.5953	0.0098

The results in Table 6 enabled us to determine that marketing expenditures had a positive (15.3489) and significant (p<0.05) effect on stock return. On the other hand, R&D expenditures had no statistically significant effect on stock return. Based on these findings, the model coefficients extracted in line with the purpose of the study are as follows:

$$SR = 30.8184 + 15.3489(\mathrm{ME}) + \varepsilon$$

5.2. Analysis results of Model 2

$$\boldsymbol{ROA} = \beta_0 + \beta_1(\mathbf{ME}) + \beta_2(\mathbf{R\&D}) + \boldsymbol{\varepsilon}$$

Since the cross-sectional dependence tests of the independent variables of Model 2 were performed during the analyzes of Model 1 and the cross-sectional dependence was established, only the cross-sectional dependence tests of the dependent variable, return on assets (ROA), were performed for Model 2. The relevant test results are presented in Table 7.

Table 7. Cross-sectional dependence test results of Model 2

	ROA	
Test	Statistics	P
Breusch-Pagan LM	213.5667	0.0000
Pesaran scaled LM	20.9264	0.0000
Bias-corrected scaled LM	20.8306	0.0000
Pesaran CD	3.4724	0.5581

Since the Breusch-Pagan LM test statistic was p<0.05 for the variable ROA, there was a cross-sectional dependence in the series. In addition, the results of the cross-sectional dependence test for the remains of Model 2 are given in Table 8.

Table 8. Cross-sectional dependence test results of Model 2

Test	**Statistics**	**P**
Breusch-Pagan LM	162.6277	0.0000
Pesaran scaled LM	14.9232	0.0000
Pesaran CD	0.0629	0.9498

The results in Table 8 prove that the presence of cross-sectional dependence in Model 2 was established. Therefore, analyzes should be continued with second generation unit root tests. As the independent variables of all models are the same and the unit root test was carried out for the independent variables in Model 1, unit root test was performed only for the dependent variable of Model 2 at this stage. The results of unit root test performed for ROA are shown in Table 9.

Table 9. Unit root test results of Model 2

	ROA		First Difference ROA	
Test	Statistics	p	Statistics	p
Bai and NG – PANIC	1.3947	0.1631	0.1526	0.0000
Pesaran CIPS	-2.6594	>0.10	-4.8151	<0.01

The unit root test results indicated that the variable ROA had unit root at level and the tests were repeated with the first difference of the series. Accordingly, the variable ROA was I(1). The independent variables of the model are I(0) while the dependent variable is I(1). Therefore, the variables have stationarity at different levels. At this stage, it is suitable to perform homogeneity/heterogeneity tests. The results of the

Hsiao panel homogeneity test are presented in Table 10.

Table 10. Panel homogeneity test results of Model 2

Hypotheses	F Statistics	p
H_1	5.4483	1.32E-10
H_2	1.3298	0.0266
H_3	9.5272	3.81E-12

Specification Tests of Hsiao (1986)
H1 = Null Hypothesis : panel is homogeneous vs Alternative Hypothesis : H2
H2 = Null Hypothesis : H3 vs Alternative Hypothesis : panel is heterogeneous
H3 = Null Hypothesis : panel is homogeneous vs Alternative Hypothesis : panel is partially homogeneous

Table 10 demonstrates that all hypotheses have a value of $p<0.05$ at a significance level of 5%. Therefore, the H_0 hypotheses are not supported. As a result, we determined that not all slope coefficients in Model 2 have equal cross-sectional coefficients. Therefore, the coefficients in the model have a heterogeneous structure. The findings obtained up to this stage of the analysis for Model 2 indicate the presence of cross-sectional dependence, heterogeneity, and stationarity of the variables at different levels. Based on all these results, second generation cointegration tests should be carried out in the further phases of the analysis. Table 11 presents the Westerlund ECM cointegration test results for Model 2.

Table 11. Cointegration test results of Model 2

	Statistics	noCD p value	Bootstrap P value
g-tau	0.330	0.001	0.031
g-alpha	0.788	0.007	0.038
p-tau	-1.222	0.003	0.042
p-alpha	-1.403	0.002	0.044

The bootstrap results of Westerlund ECM g-Tau and g-Alpha tests should be evaluated with regard to heterogeneity and cross-sectional dependence [37]. Since the results had a value of $p<0.05$ at a significance level of 5%, the series were cointegrated. Cointegration coefficients should be determined at the last stage of the analysis for the cointegrated variables. Panel AR Distributed Lag Models (Mean Group) Common Correlated Effects (Panel ARDL MG-CCE) is the panel cointegration estimator that should be applied based on the previously specified characteristics of the model such as cross-sectional dependence, heterogeneity, I(1) for the dependent variable, and I(0) for the independent variables. Panel ARDL MG-CCE test results are presented in Table 12.

The results in Table 12 show that no statistically significant relationship was found between marketing expenditures and return on assets. On the other hand, R&D expenditures have a positive (1.6907) and significant ($p<0.05$) relationship with return on assets. Based on the findings, the model 2 coefficients equation extracted in line with the purpose of the study is as follows:

$$ROA = 4.4047 + 1.6907(\text{R\&D}) + \varepsilon$$

Table 12. Panel ARDL MG-CCE test results of Model 2

ROA	Coefficients	Std. Error	Z	P
R&D	1.6907	5.6987	2.9633	0.0032
ME	5.8813	5.9908	0.9814	0.3269
C	4.4047	0.4159	10.5899	0.0000
R^2	0.979			
Adj. R^2	0.967			
F-Stat	336.45			
	(0.000)			

5.3. Analysis results of Model 3

$$\boldsymbol{ROE = \beta_0 + \beta_1(\text{ME}) + \beta_2(\text{R\&D}) + \varepsilon}$$

The cross-sectional dependence test results of the dependent variable, return on equity (ROE), of Model 3 established for the purpose of the study are shown in Table 13.

Table 13. Cross-sectional dependence test results of Model 3

	ROE	
Test	Statistics	P
Breusch-Pagan LM	169.7672	0.0000
Pesaran scaled LM	15.7646	0.0000
Bias-corrected scaled LM	15.6688	0.0000
Pesaran CD	-0.7353	0.4621

Since the Breusch-Pagan LM test statistic was $p<0.05$ for the variable ROE, there was a cross-sectional dependence in the series. However, cross-sectional dependence for the remains of Model 3 was established based on the Breusch-Pagan LM test results (statistics: 183.8536 and p: 0.000). Therefore, the analyzes should be continued with second generation unit root tests that must be carried out for cross-sectional dependence. The unit root test results for ROE are presented in Table 14.

Table 14. Unit root test results of Model 3

	ROE		First Difference ROE	
Test	Statistics	p	Statistics	P
Bai and NG – PANIC	1.4867	0.6643	5.4442	0.0000
Pesaran CIPS	-6.6594	>0.10	-2.4196	<0.05

The unit root test results in Table 14 demonstrated that the variable ROE was not stationary at level and the tests were repeated with the first difference of the variable. As a result, we determined that the variable ROE was I(1). Following this stage, the analyzes were continued with homogeneity/heterogeneity tests. The Hsiao test results are given in Table 15.

Table 15. Panel homogeneity test results of Model 3

Hypotheses	F Statistics	P
H_1	7.4469	2.12E-15
H_2	4.6172	2.05E-05
H_3	9.6172	2.87E-12

Specification Tests of Hsiao (1986)
H1 = Null Hypothesis : panel is homogeneous vs Alternative Hypothesis : H2
H2 = Null Hypothesis : H3 vs Alternative Hypothesis : panel is heterogeneous
H3 = Null Hypothesis : panel is homogeneous vs Alternative Hypothesis : panel is partially homogeneous

Since all hypotheses had a value of $p<0.05$ at a significance level of 5% in Table 15, the coefficients in the model had a heterogeneous structure. As all the characteristics in Model 2 are also valid for Model 3, all tests in Model 2 were repeated for Model 3 after this stage. Therefore, the first test performed in the continuation of the analysis is the second generation cointegration test. Table 16 demonstrates the cointegration test results for Model 3.

Table 16. Cointegration test results of Model 3

	Statistics	Bootstrap p value
g-tau	0.622	0.003
g-alpha	0.510	0.014

The results of the Westerlund ECM test, one of the second generation cointegration tests carried out with regard to heterogeneity and cross-sectional dependence, had a value of $p<0.05$ at a significance level of 5%. Therefore, the series were cointegrated. Cointegration coefficients should be determined at the last stage of the analysis for the cointegrated variables. Panel AR Distributed Lag Models (Mean Group) Common Correlated Effects (Panel ARDL MG-CCE) test is the panel cointegration estimator that should be applied due to the characteristics of the model such as cross-sectional dependence, heterogeneity, and stationarity of the variables at different levels. Panel ARDL MG-CCE test results are presented in Table 17.

Table 17. Panel ARDL MG-CCE test results of Model 3

ROE	Coefficients	Std. Error	Z	P
R&D	8.7508	1.2007	0.7314	0.0049
ME	2.8407	1.2607	2.2540	0.0247
C	13.1640	0.8750	15.0443	0.0000
R^2	0.8987			
Adj. R^2	0.8769			
F-Stat	411.51			
	(0.000)			

The results in Table 17 point out a statistically significant and positive relationship between R&D expenditures and return on equity. In addition, the relationship between marketing expenditures and return on equity was positive and significant. Based on the findings, the model 3 coefficients equation extracted in line with the purpose of the study is as follows:

$$ROE = 13.1640 + 2.8407(\text{ME}) + 8.7508(\text{R\&D}) + \varepsilon$$

6. Conclusion

Expenditures and investments made for R&D/innovation are crucial indicators for companies in particular and countries in general. This is because the growth, development, and sustainability of countries depend on the R&D investments made by the companies and the emergence of products with high added value as a result [41]. For this reason, companies that have more added value, especially in the technology industry, are supported with R&D investments. Most studies emphasize that R&D activities and expenditures, which are of strategic importance for companies to gain competitive advantage, grow, and be efficient, are also crucial for the markets [42-47]. The reason is that the positive or negative perception of the expenditures by the markets and investors may affect the stock prices in publicly traded companies. In addition, these expenditures may contribute to firm profitability, as well as have a destructive effect on profitability if they become excessive. On the other hand, the effect of marketing expenditures on firm performance, profitability, and stock value is one of the most frequently studied research areas in the literature. The common idea is that the effectiveness of marketing activities is more important than their amount [48]. However, most of the effective activities are proportional to the amount of expenditure.

The present study examines the effects of R&D and marketing expenditures on stock return and profitability and includes research with panel data analysis for companies in the BIST Technology Industry. The quarterly frequency data of R&D expenditures, marketing expenditures, stock return, return on assets, and return on equity were included in the analyzes in three different models in line with the purpose of the study. *Model 1* focuses on "the effect of R&D and marketing expenditures on stock return". Cross-sectional dependency test, the first test to be carried out in panel data analysis for the model, was performed and second generation unit root tests were completed to determine the cross-sectional dependence in the series. Since all the variables were stationary at level, the analysis was continued with panel least squares test. After ensuring that the suitable effect for the model is pooled effect, the coefficients obtained as a result of the findings from the panel least squares method were included in the model:

$$SR = 30.8184 + 15.3489(\text{ME}) + \varepsilon$$

As a result, the effect of R&D expenditures on stock return ($p>0.05$) was not statistically significant; however, we determined that marketing expenditures had a positive and significant effect on stock return.

Cross-sectional dependency tests were performed for *Model 2* that was created to determine the "effect of R&D and marketing expenditures on ROA". After the cross-sectional dependence was established, the analyzes were continued with second-generation unit

root tests. Since ROA, the dependent variable of Model 2, is I(1) and the independent variables are I(0), we decided to continue the analyzes with cointegration tests. In order to determine which cointegration tests are suitable, it is necessary to confirm whether the slope coefficients in the model are homogeneous or heterogeneous in the first place. To this end, the Hsiao test was performed and the coefficients had a heterogeneous structure. Due to the aforementioned characteristics of Model 2, it has been appropriate to continue the analyzes with the Panel AR Distributed Lag Models (Mean Group) Common Correlated Effects (Panel ARDL MG-CCE) test. As a result, no statistically significant relationship was found between marketing expenditures and ROA. On the other hand, R&D expenditures have a positive (1.6907) and significant ($p<0.05$) relationship with ROA. Based on the obtained findings, the Model 2 coefficients equation was formed as follows:

$$ROA = 4.4047 + 1.6907(\text{R\&D E}) + \varepsilon$$

As for *Model 3*, the presence of cross-sectional dependence was established, the dependent variable, ROE, was I(1), the independent variables were I(0), and the homogeneity/heterogeneity test demonstrated that the model coefficients had a heterogeneous structure. Due to the aforementioned characteristics of Model 3, this model was further analyzed with the Panel ARDL MG-CCE test. As a result, a statistically significant and positive relationship was found between both R&D and marketing expenditures and ROE. Therefore, the Model 3 coefficients equation was formed as follows:

$$ROE = 13.1640 + 2.8407(\text{ME}) + 8.7508(\text{R\&D}) + \varepsilon$$

When our findings and the literature are compared, R&D expenditures had a positive effect on profitability, as suggested by [17], [24-26], [32] as well. These studies support the result of the current study. On the other hand, the finding obtained by [28] contradicts the result of the current study. The finding indicating that marketing expenditures have a positive effect on stock return is in line with the result obtained by [22]. The positive effect of marketing expenditures on firm performance was also found by [19], [23], which supports our results. On the other hand, [31] found a statistically insignificant relationship between marketing expenditures and profitability, which contradicts our results.

Companies' R&D and marketing expenditures have an impact on both the markets and the level of profitability. R&D and marketing investments are of utmost importance for maintaining sustainability for companies that can keep up with the requirements of the period and cope with intense competition. For this reason, companies should plan their expenditures and allocate appropriate amounts of R&D and marketing budgets, and governments should support these activities.

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