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RESEARCH ARTICLE

Does Tax Planning Affect R&D Expenditures? A Study of Borsa Istanbul (BIST) Manufacturing Sector

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Abstract
Tax planning, which has an important place in financial planning, is the systematic way of avoiding tax in accordance with the laws. In this process, R&D expenditures constitute a tax shield for firms to decrease their tax base. The purpose of this study is to examine whether tax planning affects R&D expenditures. The sample includes 564 firm-year observations over the period 2008-2019 for listed firms operating in the BIST-Manufacturing sector and spending R&D. As the past values of R&D expenditures have an effect on current period expenditures, the dynamic relationship between variables was analyzed by the Generalized Method of Moments (GMM) and System GMM. The findings show that tax planning has a positive effect on R&D expenditures. However, the change in firm size negatively affects R&D expenditures. The study focuses only on certain firms listed in the BIST-Manufacturing sector that made R&D and hence the results might have a limited explanatory capacity for the other sectors. Nevertheless, the findings highlight the need for firms to establish units to carry out tax planning practices that can reduce the tax burden through various means, especially R&D incentives.

Keywords
R&D, Tax planning, GMM, System GMM, Panel data

Introduction

R&D activities are a crucial factor of innovation. These enable firms to produce products that create added value and increase firms' profitability (Göçer, Kutbay, Gerede & Aslan, 2014). For this reason, firms mainly consider economic returns in the performance measurement of R&D investments with a high level of uncertainty. Expenditures made in the R&D process constitute R&D costs. In terms of accounting practices, expenditures made in the due course of *the research phase are being expensed*; expenditures made during *the development phase are capitalized depending on the fulfillment of all conditions in IFRS*. R&D tax incentives lay the groundwork for firms' strategic tax planning in that they minimize R&D costs and potential risks (Nar, 2015). In general, the firm's owner, shareholders, and board expect to profit as much as possible and have as little tax burden as possible. Tax planning represents the most important tax relief of the corporate income tax (Hodžić, 2013). This is the reason

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why R&D tax planning is important for increasing R&D investments in SMEs as well as larger firms because R&D expenditures constitute a *tax shield* that decreases the firm's′ tax base (Ernst & Spengel, 2011).

In this study, the relationship between tax planning and R&D expenditures is examined. In this context, the research sample includes 564 firm-year observations over the period 2008-2019 for listed firms operating in the BIST-Manufacturing sector and spending R&D. The remaining headings of the study are as follows: tax and tax planning, R&D, tax incentives, and Turkey's R&D ecosystem, literature review, data set and methodology and findings. The final part makes a general conclusion of the study and gives insights for future research.

Tax and Tax Planning

Taxes are the economic values that governments take from the income and wealth of individuals or institutions, based on unilateral taxation power, to meet public expenditures. They are taken directly or indirectly from sources such as income *(income tax, corporate tax)*, wealth *(property tax, motor vehicle tax, etc.)*, expenditure *(value-added tax, special consumption tax, etc.),* and transactions or documents *(stamp tax, etc.)*. The main function of the tax system is to provide finance for public services. In addition, promoting economic growth by increasing savings and capital accumulation is another function of the tax system (İbiş, 2004). Although taxes are a source of financing for economic and social services, they are a burden for taxpayers. The tax policy implemented in states due to an increase in the tax burden of registered taxpayers may lead to a reduction in investment and employment. For this reason, taxpayers pay less or no tax either legally *(tax avoidance/tax planning)* or illegally *(tax evasion)* to alleviate or avoid the tax burden. To minimize this burden completely or partially, taxpayers benefit from tax loopholes by not causing taxable events and by staying within legal limits, or they act against the tax laws (Taşkın & Peker, 2019).

There are different concepts of tax avoidance, tax aggressiveness, tax risk, tax evasion, and tax planning in the literature regarding the reduction or complete elimination of tax burden. *Tax avoidance* is the process of taking legal action to decrease the tax payable amount based on tax provisions (Ünsal, Atabey Ertürk & Bıyık, 2019). It prevents tax debt from rising by benefiting from tax flaws/loopholes (Kirchler, Maciejovsky & Schneider, 2003). Excessive implementation of tax avoidance activities is called *tax aggressiveness* (Huang, Ying & Shen, 2018). There is no economic substance to a transaction made in this context. There is a complexity in these transactions, and taxpayers can make fictitious transactions with parties not related to tax. This type of planning adversely affects the fairness and efficiency characteristics of the tax system (Taşkın & Peker, 2019). In other words, aggressive tax planning means that taxpayers reduce the tax burden in a professional manner by taking the risk of facing a penal sanction (Kahriman, Mastar Özcan & Tepekule, 2015). *Tax risk*

points out the uncertainty related to the business' future tax payments. Tax payments of a business vary depending on reasons such as changes in national and international tax law, the extent to which aggressive tax positions are fulfilled against businesses, or the firm's ability to pursue tax-preferential investments (Ünsal et al. 2019). *Tax evasion* is the deliberate failure of the taxpayer to pay the tax partially or completely by violating the tax laws through illegal practices, although the tax debt arises. Taxpayers can fraudulently use discounts and exemptions to hide their real tax liabilities and evade taxes through illegal *income-reducing* or *expense-increasing* activities (Amadasun & Igbinosa, 2011). Factors such as *(a) attitude to the government (b) perception towards basic religious belief and taxation culture (c) the penalties deterrence (d) the availability and ease of tax evasion, and (e) the return on unpaid taxes* are effective in tax evasion (Feige, 1989). In addition, high tax rates, disproportionate distribution of the tax burden, and inequalities in the tax system can also be determinants of tax evasion (Wallschutzky, 1984).

Tax planning is a systematic planned study that transforms the organizational structures and business processes in accordance with the legal regulations in a way that minimizes the tax burden of taxpayers with the deductions, allowances, exemptions, and exceptions included in the relevant national or international legislation (Amadasun & Igbinosa, 2011). In the literature, there are various simultaneously used phrases for legal tax liabilities reduction such as *tax planning, tax optimization, tax avoidance, tax minimization, tax management, etc.* (Vrzina, 2018). Tax planning is the research efforts and regulations aimed at collecting the financial needs of the state, stimulating economic growth, developing local/regional/national economic activities, increasing investments, and ensuring economic efficiency and productivity from the most appropriate sources at the *macro (state) level* (Nar, 2015) and reducing the tax burden by benefiting from exemptions, exception and allowances, tax incentives and privileges provided that they are not against the law at the *micro (individual/corporate) level* (Ünsal et al. 2019). Tax planning *is not tax evasion* but simply decreases the tax burden by using the rights recognized by the laws in a conscious and willing manner. In other words, tax planning is a systematic way of avoiding taxes (Taşkın & Peker, 2019). Therefore, it is a legal business process that aims to decrease the tax burden without causing tax incidence (Peker & Kılıçer, 2017). In this context, tax planning, which has an important place in financial planning, consists of transactions aimed at gaining tax advantage in accordance with the laws. Therefore, it is a legitimate and acceptable tax avoidance situation (Taşkın & Peker, 2019). Taxpayers have the right to decrease their tax burden, granted by the OECD. In this context, tax planning that allows the tax burden to benefit from discounts and exceptions within the legal framework is considered legitimate. From this point of view, the OECD (2013) regards tax planning as the only method of tax burden reduction adopted by governments. Therefore, it can be expressed as avoiding tax within legal limits (Eicke, 2008).

Factors such as simplicity and clarity of tax legislation, the efficiency of tax administration and tax auditing, the deterrence of tax penalties, accounting and consultancy services, the efficiency of public administration, tax ethics and awareness, lack of tax amnesties, and

the establishment of a modern and effective tax system that values the taxpayer lead to tax planning (Peker & Kılıçer, 2017). It can be implemented in ways such as restructuring of the company and its affiliated group of companies *(transfer, merger, and acquisition)*, reviewing the production and sales cost structure and marketing activities, comparison of production and investment financing methods within the alternative financing methods, evaluation of general administrative expense policies, evaluation of incentives and discounts in financial legislation, evaluation of avoidance of double-taxation treaty, establishment of companies abroad, evaluation of free zone, technology development zone and offshore applications, review of collection and payment processes and cash flow status of the company (İbiş, 2004).

Firms can benefit from the law's loopholes in order to make complex and aggressive tax planning. Loopholes can provide a possibility for taxpayers to make tax planning without violating the rules. Hoffman's (1961) tax planning theory is about firms not being economically responsive to pay tax above what is required by tax law, because its effect is always a counter-effect on firms' performance. Therefore, Hoffman states the presence of loopholes as a reason for exercising tax planning practices. The loopholes and flaws in legislation have actually arisen due to the law complexity, which leads to an open interpretation/judgment and provides unexpected tax benefits (Slemrod, 2004). It represents an opportunity for tax planning. However, the tax planning effectiveness based on the loopholes is ensured only as long as it is not detected by the tax office (Ftouhi & Ghardallou, 2020).

However, the globalization process and the mobility of capital have paved the way for multinational businesses to transfer their activities to countries with lower tax rates or to make their profits in these countries. In this context, multinational firms use international tax planning strategies to decrease their tax burdens. Thus, multinational firms increase after-tax incomes by decreasing taxes. To be successful in international tax planning, multinational firms use particular techniques which require specialization and elaborative knowledge of the different tax systems such as *thin capitalization, transfer pricing, contract manufacturing*, *restructuring, treaty shopping, and tax havens* (Ftouhi & Ghardallou, 2020).

For firms, taxes reduce profits and cause cash outflows like costs and expenses. Therefore, taxes are considered a cost element (Taşkın & Peker, 2019) just like other operational expenses that increase profitability by decreasing when managed correctly (Garbarino, 2011). A firm's financial position, liquidity, operational results, performance, and cash flows can be adversely affected by corporate taxes (Taylor & Richardson, 2014). Corporate tax planning aims to minimize the taxes that cause cash outflow with practices within tax legislation, thus providing significant cost savings. It contributes to the tax burden reduction of the firm at the *national* or *international level* and thus to the maximization of profits with the reduction of costs (Eicke, 2008). In this process, taxes and other liabilities to be paid are alleviated by practices determined within the legal limits. Thus, the tax burden can be minimized without

facing any penal sanctions. As such, it is crucial to apply correct tax planning methods in minimizing the tax burden (Kahriman et al. 2015). Therefore, it is a complex and costly process and requires certain professional expertise.

Corporate tax planning is a way to increase a firm's expected after-tax cash flows. It consists of legal practices that decrease the resources' transfer from shareholders to the tax office. Corporate tax planning thus aims to achieve an optimal tax position. It involves the elaborative knowledge and application of tax policies such as incentives, tax allowance, tax exemption, and tax exception. As a result, corporate tax planning can be stated as a legal action of transferring economic value through tax liability minimization by benefiting from tax laws' loopholes. It is carried out in order to decrease the tax burden legally, transform tax savings into reinvestment, and achieve economic growth. Corporate tax plans are affected by the capital structure, firm size, accounting period, market structure, and policies (Fagbemi, Olaniyi & Ogundipe, 2019). Corporate tax policies are important in terms of investment and efficiency, and due to their increasing role in tax planning, *R&D tax incentives* have become important (Sterlacchini & Venturini, 2019).

R&D, Tax Incentives, and Turkey's R&D Ecosystem

Today, countries allocate more resources to high-tech R&D investments for economic growth and being competitive internationally. In this process, the success and efficiency of the commercial enterprise, qualified workforce, and R&D activities are important. In order to support these activities, countries and firms are provided with favorable conditional loans and grants, and direct or indirect incentives through tax implementations (Göçer et al. 2014). The fact that the increment of R&D expenditures enhances the total factor productivity growth is an important reason why governments give high priority to R&D (Hodžić, 2013). Besides, R&D activities are supported because net R&D spin-offs are beneficial for society. In other words, the private sector does not invest too much in R&D, as the social return of R&D investments is higher than its private return. In addition, firms allocate fewer resources to R&D investments, which include high uncertainty and risk, because they cannot predict the expected return. Therefore, government intervention is made with some incentive policies to increase R&D investments. (Warda, 2001).

R&D investments' social returns are greater than private returns due to the presence of positive externalities. In addition, these investments have a high level of risk and uncertainty compared to other investment types. Therefore, large firms are able to eliminate these risks and uncertainties in a wider investment portfolio compared to SMEs. However, most of the time, firms that invest in R&D use their own resources in project finance due to limited access to external finance. This situation may be caused by the information asymmetry, which increases monitoring costs between the creditors and the firm. Such problems systematically

reduce the firms' R&D investments (Sterlacchini & Venturini, 2019). To prevent this situation, governments develop R&D policies to increase the firms' R&D investments. At this point, many countries have started to give tax-related R&D incentives such as tax deduction, tax credits, tax exemption, accelerated depreciation on R&D assets, tax allowance, reduced social security contributions, income tax withholding incentives, loans, patent-related incentives, etc. (Ernst & Young, 2019).

Within the framework of R&D ecosystem in Turkey, a number of incentives are given to firms, technology development zones, and design and R&D centers regarding R&D and innovation activities with specific laws and regulations *(Income Tax Law, Corporate Tax Law, 5746-Supporting Research, Development and Design Activities, 6676-Supporting Research and Developing Activities, Law on Amending Some Laws and Decree Laws, 4691-Technology Development Zones, TUBITAK-Scientific and Technological Research Council of Turkey, etc.)*. It can be said that these incentives increase R&D expenditures and intensity, which are macro and microeconomic R&D indicators. R&D intensity is calculated as R&D expenditures/GDP (Hughes, 1988) and R&D expenditures/Total Assets or Net Sales (Grabińska & Grabiński, 2017) respectively. Turkey's R&D intensity was calculated as 1.06% in 2019 and has increased since then. However, it is below the average *(2.47%)* of OECD and developed countries (OECD, 2020). In terms of R&D intensity, the private sector's ratio is higher than other sectors. The private sector's R&D expenditure was 37% in 2006, it reached 64.2% as of 2019 (TUBITAK, 2020).

Literature

Studies within the scope of tax planning literature deal with issues such as tax planning, tax avoidance, aggressive tax planning/tax aggressiveness or tax risk and evaluate them through various measurement methods. In empirical studies, tax planning, tax avoidance, aggressive tax planning, and tax risk are analyzed through models established with various variables. Empirical studies on tax planning in the literature are as follows chronologically.

Cheng, Guo, Weng & Wu (2021) examined whether patents have an incremental effect on tax planning beyond the R&D effect and income shifting is the underlying channel through which patents facilitate tax planning aggressively. The results showed a significant and positive relation between patents and corporate tax planning, and the effect is incremental to the R&D effects on tax planning. It was also determined that R&D facilitates tax planning via tax credits and deductions, whereas patents are used to avoid taxes aggressively.

Vu & Le (2021) examined the effect of tax planning on firm value by using the effective tax rate. The data was obtained from audited financial statements and other statistical documents of 513 non-financial firms listed in Vietnam for the period of 2015-2019. The results showed that tax planning affects firm value negatively.

Olurankinse & Mamidu (2021) examined the effect of tax planning on the Nigerian Development Banks' financial performance. The data was obtained from financial statements and reports of selected banks for the period of 2012-2019. Pooled regression analysis was used to examine the effect of ETR, tax savings, capital intensity, and firm size on the banks' financial performance. The results showed that tax planning has a significant effect on financial performance in terms of capital intensity and firm size.

Gayatri & Wirasedana (2021) analyzed the effect of tax planning, company size, and cash holding on earnings management for the infrastructure, utility, and transportation firms listed on the Indonesia Stock Exchange. The data was obtained from the financial statements of 27 firms for the period of 2016-2019. The results showed that tax planning has a significant negative effect on earnings management, while company size and cash holding have a significant positive effect on earnings management.

Chen, Chang & Lee (2020) analyzed the effect of the CFO *(chief financial officer)*'s accounting expertise on corporate tax avoidance. They empirically examined whether an expert CFO in accounting is more likely than a CFO without such expertise to exploit tax-planning opportunities, resulting in greater corporate tax avoidance. The study showed that expert CFOs in accounting are negatively associated with corporate effective tax rates. The study also suggested that the accounting expertise and compensation schemes of CFOs can have a significant effect on the aggressiveness of corporate tax planning.

Fagbemi et al. (2019) investigated the corporate tax planning and financial performance of systemically important banks *(SIBs)* in Nigeria by using *Pooled OLS*. Due to the overburdening and multiplicity of Nigeria's tax system, SIBs carry out the corporate strategies to determine the loopholes which postpone, minimize, or fully avoid tax payments in an effort to decrease their negative effect on a firm's financial performance. The study concluded that the effective tax rate *(ETR)* has a negative and thin capitalization positive effect on financial performance. However, lease options and capital intensity have an insignificant impact.

Ünsal et al. (2019) analyzed tax planning in the Turkish banking sector by performing binary logistic regression analysis through two different models, which were based on the cash effective tax rates *(Cash ETR)* and the GAAP effective tax rate. The study showed that asset profitability and sector shares increase the tax planning probability by 3.73% and decrease it by 36.1% respectively *(first model)*. The asset profitability and leverage ratio decrease the tax planning probability by 10.9% and increase it by 5.6% respectively *(second model)*.

Sterlacchini & Venturini (2019) examined the R&D tax incentives' effect on the manufacturing firms' research activity in Italy, Spain, France, and the United Kingdom. They investigated whether the R&D investment decisions are affected by the tax incentives and how effective the firm size is. The analysis was performed on data (2007-2009) for a cross-sectional

sample. The study showed that R&D tax incentives have a statistically significant effect on the R&D expenditure intensity over the sales in all countries except for Spain and the tax incentives are driven only by the small firms' behavior. In terms of the cost-benefit ratio, R&D tax policies have additional effects in the United Kingdom and Italy.

Vrzina (2018) examined whether tax planning affects the market value and profitability of Serbian firms by using OLS regression. The sample consists of 23 non-financial companies listed on the Belgrade Stock Exchange. The data set consists of 92 company-year observations for 2013-2016. The study showed that tax planning has a positive significant impact on profitability. However, it does not affect market value.

Lynch (2014) analyzed the timing and magnitude of tax avoidance, the effects of various costs on corporate tax *(preparation of tax returns, filing, planning, reporting, internal audit, etc.)* with a regression model. The study showed that the increases in the related costs in the current period increased tax avoidance. Besides, there was a two-year lag between costs and tax avoidance returns. The study also concluded that the internal audit complex increases the costs.

Neuman (2014) analyzed the determinants of tax strategies. Bivariate probit regression analysis was performed using 4,668 observations *(1,137 firms)* for the period 2000-2010. The study showed that tax incentives and practices affect the choice of tax planning decisions and strategies. Within the framework of the analysis, sustainability and minimization were discussed as tax planning tools. While sustainability in tax planning refers to the maximization of business value, minimization means the lowest possible tax burden.

Graham, Hanlon, Shevlin & Shroff (2014) investigated tax planning's incentives and disincentives by analyzing the survey responses *(nearly 600 participants-corporate tax executives)*. The study showed that reputational concerns have an important effect on why firms do not implement tax-planning strategies. The study further concluded that the GAAP ETR and earnings per share are important indicators in terms of tax planning strategy.

Taylor & Richardson (2014) investigated the association between corporate tax avoidance and the firm's tax position, the directors' tax expertise, and the key management's performance-based remuneration incentives. The data set consists of 200 publicly listed Australian firms for the 2006-2010 period. The study showed that the firm's tax position, the directors' tax expertise, and the key management's performance-based remuneration incentives are positively related to corporate tax avoidance.

Göçer et al. (2014) examined the R&D tax policies' efficiency for Australia, Canada, Denmark, England, France, Netherlands, Spain, Turkey, and the USA for the period 1999-2013 through panel data analysis. The causality was determined from R&D expenditures to inno-

vation and from tax incentives to R&D expenditures. The study showed that tax incentives have a positive impact on R&D expenditures and innovation, respectively.

Hodžić (2013) examined tax incentives for R&D and calculated the B-Index in Austria and Croatia. R&D tax incentives provide tax relief within corporate tax. B-Index is a way to determine differences in tax systems in the private sector to invest in R&D. The study showed that R&D tax incentives were better in Croatia *(1.09)* than Austria *(1.25)* and emphasized that tax incentives encourage firms to invest in R&D.

Armstrong, Blouin & Larcker (2012) examined the relationship between the tax director's incentives and Cash ETR, GAAP ETR, the book-tax gap and tax aggressiveness' measures by using a data set which is detailed executive compensation information. The study showed that the tax director's incentive shows a strong negative association with the GAAP ETR.

Frank, Lynch & Rego (2009) examined tax and financial reporting aggressiveness. The study concluded that there is a strong positive association between them. Besides it was stated that firms could implement earnings management of financial profits via aggressive financial reporting *(book income managed upward)* and aggressive tax reporting *(taxable profits-taxable income managed downward)* simultaneously.

Elschner & Ernst (2008) measured the R&D incentive's impact on R&D cost and total tax payments. R&D tax incentives were analyzed by using different economic settings and models. The study showed that the specific R&D tax incentives' design, the interaction with the tax system and the firm's profitability relative to R&D expenditures level strongly affects the tax subsidy amount for R&D.

In the literature, most of the studies reported on tax incentives for R&D, R&D incentives' efficiency, R&D tax incentives' effect on investments, R&D incentive's impact on R&D cost and total tax payments, the determinants of tax planning strategies, the corporate tax planning and financial performance, profitability, market value relationship in terms of different sectors, tax and financial reporting aggressiveness. There is no study in Turkey or in international literature directly addressing the impact of tax planning on R&D expenditures by using GMM and System GMM. From this aspect, our study will contribute to tax planning literature by exploring its impact on R&D expenditures for Turkey.

Data Set and Methodology

This study examines the relationship between tax planning and R&D expenditures. In this context, the financial statements of 182 companies operating in the BIST-Manufacturing sector were examined and it was determined that there were 47 companies that regularly spend R&D. These companies have generally focused on R&D investments since 2008. For this reason, the sample includes 564 firm-year observations over the period 2008-2019 for listed

firms operating in the BIST-Manufacturing sector and spending R&D. The data were drawn from financial statements, comprehensive income statements, and annual reports available in the investor relations section of the firms' official websites. The findings determined that a significant portion of BIST-Manufacturing companies does not have *"Development Costs"* in their financial statements and there is no information about R&D expenditures in their footnotes. The fact that R&D expenditures are reported in the comprehensive income statement indicates that the firms within the scope of the analysis have adopted the *R&D expensing approach*.

The previous literature about tax planning presents several tax planning measures. Slemrod (2004) and Frank et al. (2009) measure tax planning by *aggressive tax returns* and *tax savings,* which are identified as downward manipulation of taxable profit. The other one is the *Cash Effective Tax Rate (Cash ETR)* which measures the current cash outflows for income taxes as a percentage of pre-tax book income (Dyreng, Hanlon & Maydew, 2008; Armstrong et al. 2012). It expresses the permanent and temporary differences between the taxable and the accounting profit. By focusing on current taxes paid, Cash ETR prevents overestimating the current tax burden (Hanlon & Shevlin, 2002). Another tax planning measure is based on *tax litigation,* which is a direct measure of tax evasion (Graham & Tucker, 2006). Graham, Raedy & Shackelford (2012), and Armstrong et al. (2012) used the difference between taxable and accounting income as a tax planning measure. The Generally Accepted Accounting Principles Effective Tax Rate (GAAP ETR) captures the change in corporate tax planning. It is the ratio of total tax expense to pre-tax book income. GAAP ETR indicates the cumulative effects of various tax incentives and the neutrality level of the tax system in firms (Dyreng et al. 2008). However, the comparison of the R&D tax incentives across the tax jurisdictions is measured through the B-Index, which is calculated as the present value of before-tax income (Warda, 2001). Among the tax-planning methods briefly explained above, ***Cash ETR*** and ***GAAP ETR*** are frequently used in the literature (Blouin, 2014). Therefore, the tax planning calculations in this study will be made by considering these two variables. Table 1 contains detailed information about the measurements and definitions of the variables used in the research models.

Table 1
Variables

Variables	Definitions	Measurement and References
R&D1	R&D Intensity	R&D/Total Assets (Grabińska & Grabiński, 2017)
R&D2	R&D Intensity	R&D/Net Sales (Grabińska & Grabiński, 2017; Ullah, Akhtar & Zaefarian, 2018)
CASH ETR	Cash Effective Tax Rate	Cash Tax Paid/ Pre-Tax Book Income (Dyreng et al. 2008)
GAAP ETR	Generally Accepted Accounting Principles Effective Tax Rate	Total Tax Expense/Pre-Tax Book Income (Dyreng et al. 2008)
ROA	Return on Assets	Net Profit/Total Assets (Ullah et al. 2018; Lanis & Richardson, 2011)
LEV	Financial Leverage	Total Liabilities/Total Assets (Stickney & McGee, 1982)
SIZE	Firm Size	Logarithm of Total Assets (Stickney & McGee, 1982)

Variables	Definitions	Measurement and References
CAPINT	Capital Intensity	Net Property, Plant and Equipment/Total Assets (Taylor & Richardson, 2014)
INVENINT	Inventory Intensity	Inventory/Total Assets (Taylor & Richardson, 2014)
AUDT	Big 4 Audit Firms	If the firm employs a Big 4 external auditor equals to 1 otherwise 0 (Taylor & Richardson, 2014)

The study includes several control variables such as return on assets *(ROA)*, financial leverage *(LEV)*, firm size *(SIZE)*, capital intensity *(CAPINT)*, inventory intensity *(INVENINT)*, and Big 4 audit firms *(AUDT)*. The calculation methods for the variables are shown in Table 1. There is no sign prediction for ROA because of the conflicting results in prior research (Graham et al. 2014; Lanis & Richardson, 2011). In terms of SIZE and LEV, larger firms that achieve scale economies via tax planning strategies and have higher debt-to-equity ratios, are more inclined at minimizing the tax burden (Rego, 2003). CAPINT, however, is positively associated with tax planning due to depreciation while INVENINT is associated negatively (Stickney & McGee, 1982). AUDT is included to control audit quality and firm monitoring. There is no sign prediction for AUDT because of the conflicting results in prior research (Taylor & Richardson, 2014; Rezaee, 2005). Table 2 contains detailed information about the descriptive statistics of the variables used in research models.

Table 2

Descriptive Statistics

Variables	Mean	Std. Dev.	Minimum	Maximum
R&D1	0.006636	0.01083	-0.000043	0.143094
R&D2	0.006599	0.010945	-0.000043	0.142276
CASH ETR	3.148922	72.13203	-5.06628	1713.039
GAAP ETR	1.500865	37.73894	-90.899	883.3666
ROA	0.046977	0.08219	-0.28436	0.406006
LEV	0.548658	0.229784	0.06061	1.588400
SIZE	8.890889	0.67514	7.527012	10.74438
CAPINT	0.322542	0.156128	0.037485	0.768199
INVENINT	0.184810	0.106558	0.031166	0.744297
AUDT	0.654255	0.476033	0	1

Since the past values of R&D expenditures affect the current period, the relationship between R&D expenditures and tax planning is considered dynamically. However, the fact that the lag of the dependent variable is included in the model as an explanatory variable causes Ordinary Least Squares *(OLS)* estimators to be biased and inconsistent (Baltagi, 2014). In addition, the fixed effect panel data *(FE)* method does not take into account the endogeneity problem[1], and the time period must be large in order to obtain consistent estimators in this method (Baltagi, 2014). However, the Generalized Method of Moments *(GMM)* allows for obtaining accurate and consistent estimators in cases where the number of individuals *(N)* is

1 The endogeneity problem is that the lags of the dependent variable are included in the model as an independent variable. This situation causes a correlation between the dependent variable and the error terms (Yerdelen Tatoğlu, 2020).

larger than the time period (Şen, 2020). GMM produces more consistent and accurate estimators than OLS and FE models by taking into account the endogeneity problem with the help of instrumental variables (Ullah et al. 2018).

The number of instrumental variables, validity of instrumental variables and autocorrelation tests test the consistency of GMM. According to Roodman (2009), the number of instrumental variables must be equal to or less than the number of individuals. When the number of instrumental variables exceeds the number of individuals, the obtained estimators will be biased (Roodman, 2009). The validity of the instrument variables is tested using the Sargan test under the null hypothesis *"over-definition constraints are valid"*. Sargan tests whether the econometric model is valid and the over-definition constraints on whether the instrumental variables are specified correctly. Instrumental variables will cease to be valid when they are determined exogenously (Ullah et al. 2018). In addition, the efficiency of the coefficients is examined with the autocorrelation test proposed by Arellano & Bond (1991). Autocorrelation tests the null hypothesis, which suggests that there is no second-order autocorrelation.

In light of these explanations, the relationship between tax planning and R&D expenditures has been examined by GMM. In this context, research models are as follows:

Model 1: $$R\&D1_{i,t} = \beta_0 + \beta_1 R\&D1_{i,t-1} + \beta_2 CASH\ ETR_{i,t} + \beta_3 ROA_{i,t} + \beta_4 LEV_{i,t} + \beta_5 SIZE_{i,t} + \beta_6 CAPINT_{i,t} + \beta_7 INVENINT_{i,t} + \beta_8 AUDT_{i,t} + \varepsilon_{i,t}$$

Model 2: $$R\&D1_{i,t} = \beta_0 + \beta_1 R\&D1_{i,t-1} + \beta_2 GAAP\ ETR_{i,t} + \beta_3 ROA_{i,t} + \beta_4 LEV_{i,t} + \beta_5 SIZE_{i,t} + \beta_6 CAPINT_{i,t} + \beta_7 INVENINT_{i,t} + \beta_8 AUDT_{i,t} + \varepsilon_{i,t}$$

Model 3: $$R\&D2_{i,t} = \beta_0 + \beta_1 R\&D2_{i,t-1} + \beta_2 CASH\ ETR_{i,t} + \beta_3 ROA_{i,t} + \beta_4 LEV_{i,t} + \beta_5 SIZE_{i,t} + \beta_6 CAPINT_{i,t} + \beta_7 INVENINT_{i,t} + \beta_8 AUDT_{i,t} + \varepsilon_{i,t}$$

Model 4: $$R\&D2_{i,t} = \beta_0 + \beta_1 R\&D2_{i,t-1} + \beta_2 GAAP\ ETR_{i,t} + \beta_3 ROA_{i,t} + \beta_4 LEV_{i,t} + \beta_5 SIZE_{i,t} + \beta_6 CAPINT_{i,t} + \beta_7 INVENINT_{i,t} + \beta_8 AUDT_{i,t} + \varepsilon_{i,t}$$

In these models β_0 shows the constant term; β_n the slope parameters; $\varepsilon_{i,t}$ the error term. The subscripts indicate the value of the variable of time *t* for firm *i*. ROA, LEV, SIZE, CAPINT, INVENINT, and AUDT are control variables in models as aforementioned.

GMM, introduced into the literature by Arellano & Bond (1991), is based on the transformation of Anderson & Rubin's (1950) first differences model with instrumental variables. The model obtained from this transformation is estimated with Generalized Least Squares *(GLS)* (Yerdelen Tatoğlu, 2020). Thus, besides the error term being autocorrelated, appropriate results can be obtained in the case of constant and heteroscedasticity (Çağlayan Akay, 2018). In cases where this method is weak, the System GMM developed by Arellano & Bover

(1995) and Blundell & Bond (1998) generates strong estimators. The System GMM is based on the use of instrumental variables generated by considering orthogonal deviations. These instrumental variables are created by averaging the possible future values of each variable (Yerdelen Tatoğlu, 2020). One-step and two-step[2] estimation results can be obtained using both methods. However, Hwang & Sun (2018) argue that two-step GMM predictions are asymptotically stronger in their studies. At the same time, the two-step GMM offers more effective and consistent coefficients by preventing unnecessary data loss (Ullah et al. 2018). Therefore, step two of the study discusses GMM. In addition, since Windmeijer (2005) suggested the use of robust standard errors in the two-step GMM, the models were solved with robust standard errors.

Findings

In the study, two different solutions were made with GMM and System GMM. The results obtained were compared. GMM results made under two-step and robust standard errors are shown with diagnostic test results in Table 3 and Table 4.

Table 3
GMM and System GMM (R&D1) Results

Variables	**GMM**		**System GMM**	
L.R&D1	0.4366705***	0.4369478***	0.63989009***	0.6387732***
Cash ETR	0.00000257***	-	0.00000300***	-
GAAP ETR	-	0.00000491***	-	0.00000560***
ROA	-0.0029019	-0.0029097	-0.0012923	-0.0013321
LEV	-0.0005172	-0.0004735	0.0003717	0.0003866
SIZE	-0.0040479*	-0.004022*	0.0001581	0.0001584
CAPINT	0.0034098	0.0034377	0.0090622	0.0090582
INVENINT	0.0065074	0.0064855	0.0007277	0.0007029
AUDT	-0.0002104	-0.0002089	-0.0013694	-0.0013616
Wald Test Statistics	442.12***	495.09***	5287.09***	5139.17***
Number of Firms	47	47	47	47
Number of Instrumental Variables	17	17	27	27
Sargan Test Statistics	7.06 (0.57)	7.07 (0.63)	21.64 (0.26)	21.63 (0.30)
AR (1)	-1.07 (0.29)	-1.09 (0.27)	-1.13 (0.26)	-1.13 (0.26)
AR (2)	-1.06 (0.29)	-1.05 (0.29)	-1.09 (0.27)	-1.09 (0.27)

Note: ***, * denotes 1% and 10% statistical significance, respectively. Values in parentheses show probability values of diagnostic tests.

According to the empirical findings in Table 3 where the R&D1 value is considered as the dependent variable, it has been determined that *tax-planning (Cash ETR and GAAP ETR) has a positive effect on the R&D expenditures*. Similarly, Sterlacchini & Venturini (2019), Göçer et al. (2014), Hodžić (2013), and Elschner & Ernst (2008) although not directly, revealed that

2 For detailed information on the difference between one-step and two-step GMM estimates, see: Windmeijer (2005).

R&D tax incentives and related tax planning strategies have a positive effect on the R&D investments and expenditures. In addition, R&D expenditures are positively affected by their past value. However, according to the result obtained from the GMM, the SIZE has a negative effect on the R&D1 variable. In addition, the other control variables had no statistically significant effect on the dependent variable.

Table 4
GMM and System GMM (R&D2) Results

Variables	**GMM**		**System GMM**	
L.R&D2	0.4568091***	0.4570419***	0.726343***	0.722649***
Cash ETR	0.0000185***		0.00000179***	
GAAP ETR		0.00000301***		0.0000315**
ROA	-0.0071826	-0.0071917	-0.0113066	-0.0113043
LEV	-0.0018642	-0.0018379	0.0019343	0.001969
SIZE	-0.0022695	-0.0022692	-0.0001248	-0.0001261
CAPINT	-0.0005609	-0.0005431	0.0081333	0.0081222
INVENINT	0.0043792	0.0021673	-0.0057007	-0.0057152
AUDT	0.0011181	0.0011171	0.0000494	0.0000474
Wald Test Statistics	738.78***	494.86***	11202.96***	10683.07***
Number of Firms	47	47	47	47
Number of Instrumental Variables	17	17	27	27
Sargan Test Statistics	7.89 (0.53)	7.92 (0.54)	7.10 (0.42)	7.06 (0.42)
AR (1)	-0.95 (0.34)	-0.95 (0.34)	-1.06 (0.29)	-1.05 (0.28)
AR (2)	-1.09 (0.28)	-1.09 (0.28)	-1.14 (0.25)	-1.15 (0.25)

Note: ***, ** denotes 1% and 5% statistical significance, respectively. Values in parentheses show probability values of diagnostic tests.

According to the empirical findings in Table 4, where the R&D2 value is the dependent variable, the study showed that *tax planning (Cash ETR and GAAP ETR) has a positive effect on the R&D expenditures*, as in the R&D1 model. Similarly, Sterlacchini & Venturini (2019), Göçer et al. (2014), Hodžić (2013) and Elschner & Ernst (2008) stated that R&D tax incentives and related tax planning strategies have a positive effect on the R&D investments and expenditures as previously mentioned in the R&D1 model. In addition, R&D expenditures are positively affected by its past value. However, according to the result obtained from the GMM and System GMM, the control variables do not have a statistically significant effect on the dependent variable.

The diagnostic tests in Tables 3 and 4 reveal that the number of instrumental variables detected is smaller than the number of firms. In addition, considering the Sargan test statistics, the null hypothesis cannot be rejected. In this case, it can be stated that the instrument variables are determined correctly and the over-definition constraint is valid. AR (1) and AR (2) values, which show the first and second-order autocorrelation test statistics, respectively, show that the null hypothesis, which suggests that there is no autocorrelation problem, cannot be rejected. Therefore, it was determined that there is no autocorrelation problem in the analyzed models. In addition, Wald statistics show that the models are statistically significant.

Conclusions

Tax planning, which is the natural right of taxpayers, is not resisting taxation, but complying with it in order to reduce the tax burden within legal limits. Tax incentives *(discounts, exceptions, exemptions, etc.)* provided for R&D and innovation activities minimize the tax burden as expense and deduction items in terms of corporate tax. Therefore, it can be stated that tax planning has an important role in increasing R&D expenditures. This study examines whether tax planning affects R&D expenditures. The results show that *tax planning has a positive effect on R&D expenditures.* The high fixed investments and production costs of the firms in the BIST-Manufacturing sector, together with high technology R&D expenditures, can affect the competitive level of the firms. At this point, it can be said that firms tend to increase their R&D expenditures in order to reduce the impact of an important cost element such as *tax* by taking advantage of tax incentives for R&D activities in terms of tax planning. However, *the change in firm size negatively affects R&D expenditures.* The negative impact of firm size on R&D expenditures in terms of tax planning is related to strategic sustainability for small firms operating in the BIST-Manufacturing sector, because, small firms tend towards R&D activities in order to minimize their production costs, increase their productivity and provide competitive advantage. As such, their tendency to benefit from R&D incentives at the maximum level in this process increases. Contrary to this situation, the decrease in R&D expenditures in terms of tax planning for large firms operating in the BIST-Manufacturing sector is possible due to the R&D capacity reaching a sufficient level. The study contributes to the literature by investigating the tax planning effect on R&D expenditures within the dynamic relationship between variables.

Tax is a cost that firms have to manage. This cost can be reduced through effective and successful tax planning. In this context, it is necessary to know and analyze the legal legislation well and to implement practices that can reduce the tax burden. In fact, while firms adopt an R&D expensing approach, tax planning contributes both to income smoothing and minimizing the tax burden. In addition to firms' increasing their R&D investments and benefiting from the discounts, exemptions and exceptions offered within this scope also bring tax savings. Therefore, it may be beneficial for firms to establish units to carry out tax planning practices that can reduce the tax burden of firms through various means, especially incentives for R&D investments.

The study is subject to several limitations. First of all, the data were drawn from the annual reports and financial statements, hence the possibility of errors in hand-collected data can be stated as a limitation. The study focuses only on certain firms listed in the BIST-Manufacturing sector that made R&D. Hence, the results might have limited explanatory capacity for other sectors. In order to generalize the findings, it may be useful to conduct the research in different sectors and analyze it comparatively. In future research, the tax planning

effect on R&D expenditures or firms' financial performance can be investigated in different sectors by making comparisons.

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