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The Contribution of R&D Expenditure to Regional Level of Income in Türkiye

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ABSTRACT: *Research and development (R&D) is defined as systematic activities that improve information capacity. R&D investments increase technological capacity in a country and directs its level of income. To this end, nations adopt various R&D policies to improve technological and innovative structures at a regional level. In today's world, scientific practices, educational activities, university/industry collaboration and technology transfer are integrated to mobilize local actors and encourage R&D at a regional level.*
It can be observed that various studies have so far been carried to analyze the impact of R&D expenditure on the level of income in regional and national economic growth. The present study investigates the contribution of R&D expenditure to the level of regional income in neighboring Level 1 regions (12 regions) with similar economic, social and geographical conditions in Türkiye. Combining Cobb-Douglas production function, Generalized Method of Moments (GMM) and annual statistical data between 2010 and 2019, econometric analysis results demonstrated that regional R&D expenditure increased the level of regional income in Türkiye.
KEY WORD*: R&D Expenditure, Regional Development, GMM*

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I. INTRODUCTION

Today, R&D occupies a central position in developed economies, and R&D activities create employment opportunities along with economic growth and a higher level of income, thus offering industrial competitive strength. Depending on changing economic conditions, it can be stated that R&D comes to the forefront in different fields such as public health and welfare, national security, energy, agriculture, transportation and environmental protection. As such, companies, governments, universities and non-profit organizations allocate a certain budget to their R&D activities.

R&D policies are based on the principle of creating new goods and services or improving existing ones. Scientists, engineers, sector representatives and R&D employees need a significant amount of investment in human capital, materials and equipment for effective R&D studies. According to Statista, the total global R&D expenditure is estimated to reach nearly 2.5 billion US dollars in 2022. The US and China are leading countries in terms of R&D expenditure, spending 680 and 550 billion US dollars, respectively, on R&D in 2022. However, when considered in terms of its ratio to total gross domestic product, smaller countries with a technology-heavy economy such as Israel and South Korea invest a larger amount of their gross domestic product on R&D activities.

Technology policies play a significant role in the success of R&D activities. Their success does not solely depend on technology and industry but also requires concentrating on the region at a spatial level. In this respect, it is of vital importance to employ strategies which can function harmoniously at the urban, regional and national level. Regional structures in R&D policies are strengthened by several factors such as the prioritization of innovation regions, establishment of technology-based clusters, concentration on the commercialization of universities, incentives for new enterprises and inter-company technology transfer. Basically, R&D benefits from the integration of technology into economic growth models in order to improve the contribution of labor and capital to economic growth. As a social phenomenon which entails productive information, techniques and organization, technology reveals itself in new products, processes and systems and transforms into a replicable product through practical applications and an accumulation of knowledge (Mejía 2017). From a microeconomic perspective, while a firm's technical capacity proves its own level of technology, the sum of technological structures in all firms in a region can be said to define technology at a macro level (Bayraktutan and Bıdırdı 2016).

Regional structures are often likely to pave the way for a mechanism which improves economic activities in that region. The critical aspect of information, technology and innovation in these structures is now undeniable. Spatial interactions play a facilitating role in information transfer and emergence of R&D activities and innovative practices. One of the most common arguments in regional analysis is that firms in an economic system tend to converge each other due to their frequent and repeating connections (Marshall's secrets of industry, Saxenian's local networks, Isard's industrial complexes and Becatti's industrial zones and so forth) which often require face-to-face communication (Torre 2008).

The impact of R&D expenditure related with production factors on the level of income allows for estimation models at a national level. However, the analysis of R&D expenditure on regional economic growth and the elimination of regional imbalances to explore its contribution to regional level of income bear importance for the effective transfer of regional funds and implementation of regional policies. The present study, which focuses on the contribution of R&D expenditure to the level of regional income in Türkiye, presents its theoretical framework and a brief literature review and discusses the results of the proposed econometric model.

II. THEORETICAL FRAMEWORK

R&D is considered as a fundamental component of economic growth. Therefore, it is often argued that the most decisive factor for economic growth is new information obtained from R&D investments. New information can also be a source of upcoming innovations which contribute to long-term economic growth. At the same time, within a regional framework, it can be noted that budget allocation for local R&D activities depends on complex interactions among different local factors, ranging from entrepreneurs to research universities, human capital, social capital and industrial structures. It is often these local factors which determine whether R&D will contribute to regional growth. Thus, a more comprehensive approach is needed to deal with diverse socio-economic factors and interactive environment among them for a healthier analysis of R&D and its impact on regional growth (Koo and Kim 2009).

It is widely acknowledged that innovative capacity of any given organization or society is affected, to a large extent, by their respective level of technology. To put it another way, technologically developed regions and nations are more likely to produce more technological innovations compared to technologically underdeveloped ones. Taking this assumption into account, there is one traditional remedy for every society which attempts to maximize its technological capacity: increasing investments in research and development (R&D). Higher investments in R&D activities will result in a higher technological capacity, innovation and economic growth (Rodriquez-Pose 2001).

On the other hand, the benefits of R&D activities for a region is directly proportional to the local distribution of economic gains from R&D in that region. In this sense, the most crucial factor in local R&D allocation is the ability to maintain local R&D knowledge within the regional borders. This is why information storage can be considered as regional absorptive capacity, which is defined as the ability to benefit from economic value of new information. Although the number of studies on regional absorptive capacity is still limited in the existing literature, the concept offers useful insight into an important element of local R&D funding mechanism. A region can take advantage of local R&D activities only if it bears the potential to recognize the value of new information obtained from those activities. In other words, locally sourced new information is likely to contribute to local factors when powerful local storage factors can absorb and benefit from these new ideas and innovations (Koo and Kim 2009). There are numerous potential sources which affect the absorption of local information in a given region. Research universities, for instance, play a huge role in regional growth from many perspectives. It is also essential that many regional actors reach a similar level of technological development in the related fields in order to optimize the most recent locally sourced new information. At this point, research universities give local actors this opportunity through the local dissemination of fundamental information and skills. In addition, they also produce highly qualified labor force. Another important role of research universities as a part of regional information storage mechanism is spatial interaction between academic and industrial research. Preserving their scientific and professional knowledge, highly skilled engineers and scientists are often employed either by universities or firms. Such a flow of human capital can be regarded as an effective driving force for the localization of R&D activities. Secondly, after Lucas, a number of studies has emphasized the importance of human capital for regional growth. Since the level of human capital is usually measured by their level of education, it is clear that regional income or output determines economic growth rate in a region. The presence of highly qualified employees and dissemination of information among their ranks has turned out to be critical for regional growth. In addition, such local employees also indicate that benefits of R&D activities can be maintained within certain geographical regions and thus affect regional growth process in a positive way. Social capital is also accepted as another significant factor for creating regional information. As such, the significance of a cooperative culture, networks and social interactions in encouraging regional innovations has already been underlined by many studies. It was reported that a powerful social capital could facilitate information flow among local actors and, consequently, promote other regional innovations and growth potential in the future (Rodríguez-Pose and Crescenzi 2008; Koo and Kim 2009).

When we look at the historical development of economic growth theories, it can be stated that post-Keynesian Harrod-Domar's model draws attention to the importance of investments and saving. However, Solow and Swan's neoclassical growth models criticized post-Keynesian growth models and argued that increasing saving and investments did not contribute to economic growth in the long-term. It was also suggested by neoclassical growth models that exogenous technological progress was a notable factor during economic growth process. In the following years, Romer (1990) and Lucas (1988) pioneered the emergence of internal technological progress which integrates R&D developments into economic growth model as an internal variable (Das 2020). Although neoclassical growth model contributes to an understanding of economic growth process to a certain extent, it still poses some problems since it assumes that technological specialization is an open access tool for everyone and firms do not make profit on technological innovations. If the theoretical assumption that technology is an open access tool for every individual in the society was valid, firms would not be willing to invest in R&D activities. Similarly, they would not urge themselves to support other R&D activities within their regional borders. Under these circumstances, new innovations would easily flow into that region or a region could spend millions of dollars on R&D, only to see another region benefit from those R&D activities. However, in real life, it is well known that large firms are actively involved in R&D activities and new product development and many regions support R&D activities only within their regional borders. Thus, it can be easily argued that these technological attempts and R&D expenditure models contradict with neoclassical assumptions in the past. In this respect, internal growth offers a new theoretical framework to explicate the role of deliberate R&D investments in economic growth. The theory defines technology as a public interest which can be partially excluded and puts forward the idea that firms and regions may expect extra income from their deliberate R&D investments. In addition, production and acquisition of information in an R&D process create productive external effects (Rodríguez-Pose and Crescenzi 2008; Koo and Kim 2009). However, the level of technology varies remarkably in a certain region or country based on the budget allocated to R&D activities. Technology as an internal factor in economic growth models allows increasing and differentiating return of investments.

Contrary to neoclassical growth model, contingent capture or convergence may not be always possible, since the dynamic potential of any field or region is usually determined by the economic and technological capacity of R&D investments in that field or region. It must be thus acknowledged that any possible convergences are not automatic and performed internally. Therefore, as a general rule, a certain share of investment in R&D activities is directly related to a higher regional and national economic growth capacity (Rodriquez-Pose 2001).

III. LITERATURE REVIEW

A number of studies can be found in the current literature related to the impact of R&D activities on national and economic growth. Despite the use of various measurement and estimation approaches, it was often reported by different researchers that R&D displayed a positive and statistically significant impact on the productivity and economic growth. The results of a meta-analysis based on the econometric estimations between 2000 and 2010 indicate that the output elasticity of R&D was at a level of 0.10 (OECD, 2015: 31).

Kuo and Yang (2008) examined the impact of R&D expenditure on economic growth by analyzing the way in and the degree to which the dissemination of information capital and technology contributed to regional economic growth in China and found out that R&D capital and import of technology contributed to regional economic growth significantly at a similar rate. Along with the dissemination of R&D, their analysis also stresses the presence and significance of international dissemination of information, as they estimated their models based on Cobb-Douglas production function using static and dynamic (GMM) method in a study on 31 different provinces between 1996 and 2004. Wang and Wu (2015), similarly, using panel data fixed effects method based on Cobb-Douglas production function, revealed a strongly positive correlation between R&D expenditure and economic growth in different Chinese provinces between 1997 and 2013. Their study analyzed government and private enterprise R&D expenditures separately and observed that private enterprise expenditure contributed to regional growth more than that of the government.

Sterlacchini (2008) demonstrated that recent economic growth in EU regions was positively and considerably affected by the intensity of R&D expenditures and information base and educational acquisitions obtained thanks to the participation of highly educated individuals. According to the analysis, the two most decisive factors that increased GDP per capita growth recorded by different regions of twelve countries in the former EU-15 between 1995 and 2002 were the population of higher education graduates and intensity of R&D expenditure. Mannasoo et al. (2018) studied the driving forces of total factor productivity (TFP) growth in 99 European regions of 31 countries between 2000 and 2013 in order to estimate the impact of human capital and R&D expenditure on TFP using GMM. It was shown that while TFP growth was affected by human capital in a given region to some extent, it was much less affected by R&D expenditure and that the impact of both factors varied depending on the level of regional productivity. It must be also noted that the interaction between TFP and human capital and R&D expenditure revealed some striking outcomes. When the statistical results of developed and developing regions were compared, it was observed that while TFP displayed a positive impact in terms of human capital and R&D in developed regions, developing regions could not enjoy the same level of contribution, since it was likely that their underdeveloped institutions mitigated the positive impact of human capital and R&D expenditure. Bednar and Halaskova (2018) benefited from explanatory spatial data analysis (ESDA) in order to identify static and dynamic components of convergences and divergences in innovation performance and R&D expenditure in NUTS-2 regions of Western Europe between 2009 and 2012 and reported that R&D expenditure was a decisive factor for innovation performance in the most NUTS-2 regions of Western Europe.

Bronzini and Piselli (2009) relied on Cobb-Douglas production function and panel co-integration method to estimate the long-term relationship among TFP, R&D, human capital and public infrastructure in Italian regions between 1980 and 2001 and found a long-term relationship between level of productivity and three different types of capital. While human capital displayed the highest effect on the level of productivity among these four factors, it was also observed that regional productivity was positively affected by R&D activities and public infrastructure of neighboring countries. They also indicated that R&D activities in other regions, similarly, contributed to the level of regional productivity in a positive way and that the dissemination of information was likely to occur not only between the nearest regions but also among remote areas. Finally, although empirical research and R&D efforts increased national economic growth importantly, the results of their study suggest that incentives for R&D activities can be considered as an ineffective tool in eliminating regional differences.

Bengoa et al. (2017) benefited from panel data co-integration method for the estimation of long-term effects of R&D activities on TFP in Spanish regions between 1980 and 2007. According to the analysis results, public R&D capital displayed a direct effect on the level of productivity, whereas private R&D capital did not yield such significant outcomes. In addition, the authors drew attention to a positive spatial dissemination from public R&D capital stocks and concluded that an increase of 1% in public R&D capital stock in neighboring regions resulted in an average increase of 0.15% in the level of productivity.

Goschin (2014), similarly, employed panel data co-integration method to shed light on the economic impact of regional R&D investments in eight different development regions of Romania between 1995 and 2010 and argued that R&D was one of the major driving forces for regional economic growth in Romania. Establishing a link between R&D expenditure and a positive regional economic growth, the author suggested that an innovation-driven growth strategy (as a result of larger investments in R&D activities) was likely to contribute to a higher regional economic growth and that R&D expenditure could be used as a reliable tool to improve regional economic performance, increase competitive strength for regional economies and minimize existing regional differences.

Kaneva and Untura (2018) applied GMM and spatial error panel modelling to measure the feasibility of various expenditures on R&D and technological innovations in 80 Russian regions between 2005 and 2013. The regression analysis results demonstrated that R&D and/or technological innovation expenditure displayed a positive and statistically significant effect on the economic growth in Russian regions.

Rodriguez-Pose and Peralta (2015) drew on panel data random effects and GMM to perform an analysis on 31 different Mexican states between 2000 and 2010. Their findings clearly indicated that in addition to positive social filters and an effective dissemination of information, direct investments in R&D for fields which could benefit from being surrounded by wealthy neighboring regions living in good social conditions affected regional economic growth positively.

Koo and Kim (2009) resorted to Cobb-Douglas production function for analysis of the data for 48 different states in the US between 1992 and 2000 to explore the impact of R&D on regional growth mechanism using spatial panel data method. The estimated results from the proposed models showed that commercialization and storage of information factors such as entrepreneurship, academic research, human capital, social capital and industrial structure played vital roles in regional R&D allocation mechanism. The authors recommended local governments to pay particular attention to R&D and innovation-based commercialization and storage of information to adopt more effective regional technology policies. In other words, they found it necessary to discuss R&D policies in a wider framework which addresses regional issues such as entrepreneurship, academic research, human capital, social capital and industrial structure.

There are also several studies on the impact of R&D expenditure on economic growth in Türkiye. However, more often than not, they remain at a national level, thus limiting the number of studies on regional growth. Tuncer and Algoni (2021), for instance, examined the impact of education ratio and R&D expenditure on regional economic growth in Level 1 regions using panel data fixed effects method. According to their analysis results, both education ratio and R&D expenditure increased regional income per capita, while the former contributed to regional income per capita at a higher rate than the latter. Thus, the authors concluded that educational and R&D expenditures needed to be increased in Level 1 regions in Türkiye to implement more effective regional economic growth policies and achieve national goals. Baykul (2018), too, evaluated the impact of R&D expenditure and labor force on regional economic growth in Level 1 regions between 2010 and 2014 using panel least squares and random effects methods. The proposed model indicated that regional R&D expenditure and labor force affected regional economic growth positively. Dindaroğlu and Yıldız (2018), in a similar way, used panel data fixed effects method to determine the impact of regional R&D expenditure and labor force on Level-1 data between 2010 and 2014. The authors found out that both R&D expenditure and labor force displayed a positive and statistically significant effect on regional economic growth and that on a statistical basis, the former contributed more compared to the latter. Kesikoğlu and Saraç (2017) explored the relationship between R&D expenditure and regional GDP in Level 1 regions between 2010 and 2014 and found a positive correlation between R&D and economic growth in all regions. The highest level of impact was observed in northern eastern Anatolia, whereas the lowest level of impact was surprisingly observed in western Anatolian region.

In the light of the literature review above, the present study is the first one to combine Cobb-Douglas production function with GMM in Türkiye, although it can be seen that this approach was frequently used by various studies abroad (See Kuo and Yang, 2008; Mannasoo et al., 2018; Silaghi et al., 2014; Szarowska, 2017, Kaneva and Untura, 2018).

IV. ECONOMETRIC METHOD AND MODEL

Relying on Level 1 regional data between 2010 and 2019, the present study proposes an econometric model based on Cobb-Douglas production function using GMM to estimate the impact of R&D expenditure on regional economic growth in Türkiye. In the proposed model, regional income, labor force, regional R&D expenditure and approximate industrial electricity consumption data for private sector investments were extracted from Regional Statistics section of Turkish Statistical Institute (TURKSTAT).

Because economic events and courses of action are often influenced by those events and actions in the past, lagged variables must be taken into account to analyze economic relations. These lagged variables are included in the dynamic panel data. An example of a dynamic panel data model is presented below (Baltagi, 2005; Tatoğlu, 2013; Hodey et al., 2015; Hesse, 2008).

$$Y_{it} = \alpha Y_{it-1} + \beta X_{it} + \varepsilon_{it} \qquad (1)$$

The error term in this equation is divided into two components. Since $\varepsilon_{it} = \mu_t + \nu_{it}{}'$, the model can be written as follows:

$$Y_{it} = \alpha Y_{it-1} + \beta X_{it} + \mu_i + \nu_{it} \qquad (2)$$

In this model, Y_{it} is the income as a dependent variable. Y_{it-1} represents the lagged value of the dependent variable and matrix of all explanatory variables. βX_{it} denotes a vector of the potential determinants of the dependent variable. μ_i is a time invariant unobserved effect, and, finally, ν_{it} is an individual specific error term.

The most important drawback of the proposed model is the use of lagged dependent variable as an independent variable. A correlation between Y_{it-1} and error term in the model leads to an internality problem, and instrumental variables method is used as a solution to it (Akay, 2015).

Instrumental variables method, which is also known as Anderson-Hsiao method, obtains the first difference of dynamic panel data model and uses Y_{it-2} or $\Delta Y_{it-2} (= Y_{it-2} - Y_{it-3})$ variables instead of $\Delta Y_{it-1} (= Y_{it-1} - Y_{it-2})$ independent variable correlated with the error term. The model is considered suitable for estimations if error terms are non-autocorrelated and with constant variance. However, the first-difference error terms are usually negatively autocorrelated, which makes Generalized Method of Moments (GMM) by Arellano and Bond (1991) a better option.

In this method, the first difference model is firstly transformed via instrumental variable matrix to estimate the transformed model in the second step. Therefore, it is also known as two-step instrumental variables model. The data model of such a dynamic model without an explanatory variable except the lagged value of the dependent variable can be defined as follows (Tatoğlu, 2013; Baltagi, 2005):

$$Y_{it} = \alpha Y_{it-1} + \varepsilon_{it} \qquad \varepsilon_{it} = \mu_i + \nu_{it} \qquad (3)$$

The first difference of this model can be expressed as follows:

$$Y_{it} - Y_{it-1} = \alpha (Y_{it-1} - Y_{it-2}) + (\nu_{it} - \nu_{it-1}) \qquad (4)$$

Generalized moments estimator is a method which deals with internality problem and individual effects simultaneously. The method successfully exploits all restrictions of linear momentum suggested by a dynamic panel data model. Thus, all variables are obtained as deviations from periodic data, which eliminates the need to include time-specific constants and individual effects thanks to the first difference transformation (Caselli et al.; 1996: 369). The consistency of the method is actually based on the assumption that error terms do not exhibit second-order serial correlation and that instruments are valid. Instrument validity is checked by Arellano-Bond serial correlation and Sargan tests. The null hypothesis rejected by both tests verifies the instrument validity (Hodey, 2015: 73).

On the other hand, the first difference transformation may remain insufficient due to a possible data loss on an unbalanced panel or large instrumental variables with a lagged dependent variable and a smaller T. In this case, Arellano and Bover (1995) and Blundell and Bond (1998) agree that system GMM estimation proves to be more effective, since, unlike the first difference transformation, it does not rely on the difference between the current and previous period and calculates the mean difference of all possible values for a variable in the future (Tatoğlu, 2013: 83).

One of the main reasons for selecting system GMM estimation technique is that it gives the opportunity to use it when the number of horizontal cross-sections is higher than time periods. Additionally, from a technical point of view, it can analyze various problems such as endogeneity, heteroscedasticity and simultaneous reverse causality. Considering the strong correlations among explanatory variables in the designed empirical models and the higher number of horizontal cross-sections than that of time periods, GMM offers the most suitable model. It was introduced by Arellano and Bond (1991). Allowing both level and first-order difference variables, system GMM estimation was later structured by Blundell and Bond (1998).

In the existing literature, production function has been commonly used to estimate economic benefits of R&D. Many studies have been conducted within the scope of production function to associate economic output with several different inputs, including R&D. It is widely preferred thanks to its simplicity and lesser data requirement. Econometric studies often utilize R&D expenditure data rather than R&D staff data to formulate indicators for R&D input (OECD, 2015). The present study, which aims to determine the impact of R&D expenditure on the level of regional income, resorts to Cobb-Douglas production function and GMM developed by Arellano and Bover (1995) and Blundell and Bond (1998) to estimate the system. The logarithmic calculation of production function containing specialization value for export goods and R&D expenditure is given below.

$$ln\,Y = \alpha + \beta Y_{t-1} + \phi\, ln\,K + \lambda\, ln\,L + \mu\, ln\,A\,G + \in$$

In this model, Y, which is the dependent variable, represents regional income per capita, while Y_{t-1} represents income per capita in t-1 period. K denotes private capital stock, which is another independent variable. Since no data were obtained for regional private capital stock in the proposed model, industrial electricity consumption data were used as approximate data, which is a frequently preferred method in empirical studies in the current literature (Moody, 1974; Schnorbus and Israilevich, 1987). Finally, L and AG represent labor force and R&D expenditure in the proposed model, respectively.

V. ESTIMATED RESULTS

Based on the system GMM technique, the estimated results for the impact of R&D expenditure on the level of regional income in Level 1 regions in Türkiye are given below.

Table 1 The impact of r&d expenditure on the level of regional income in level 1 regions in Türkiye (2010-2019)

Income per Capita as a Dependent Variable (Y)			
Variables	**Coefficient**	**Standard Deviation**	**Probability**
$ln\,Y_{t-1}$	0.8717	0.0253	0.000
$ln\,K$	0.0142	0.0377	0.706
$ln\,L$	0.4710	0.1020	0.000
$ln\,A\,G$	0.0925	0.0165	0.000
Tests		**Statistics**	**Probability**
Wald Test		10299.45	0.0000
Sargan Test		11.42644	1.0000
Arellano-Bond Test for AR(1)		-2.1577	0.0309
Arellano-Bond Test for AR(2)		0.19707	0.8438

The estimated results clearly indicate that the lagged value of the dependent variable, labor force, private sector investments (albeit statistically insignificant) and regional R&D expenditure increase the level of regional income per capita. As it was observed that the coefficient of regional R&D expenditure was statistically significant at a rate of 1%, it affected the level of regional income positively, which overlaps with regional studies in Türkiye (Tuncer and Algoni, 2021; Baykul, 2018; Dindaroğlu and Yıldız, 2018; Kesikoğlu and Saraç, 2017). Even though approximate industrial electricity consumption data used for private sector investments in the proposed model were found to be statistically insignificant, the lagged value of labor force and dependent variable was statistically significant at a rate of 1%.

Meanwhile, three different tests were performed in order to check the consistency of the system GMM technique. Firstly, Wald test was used to check the significance of the proposed model. The second test, Sargan, was used to check the validity of instrumental variables. Finally, according to Arellano-Bond test, which aims to eliminate autocorrelation problem, there was a first-order negative autocorrelation, whereas no second-order autocorrelations were found, thus yielding the intended result for the proposed model.

VI. CONCLUSION

Economic development emerges as an important issue as a result of economic growth and welfare in a society which results from a number of social, cultural and political changes. As R&D activities in a country are closely related to the accumulation of human and physical capital, technical know-how, level of information and technological and innovative capacity, they set certain foundations for economic development and enhance national competitiveness. Technological changes and R&D capacity may cause different levels of regional and national income. Therefore, national development policies are implemented to carry out specific spatial plans for regional development and encourage R&D activities, which will eventually improve levels of technology and technological innovations for existing firms in a given region.

Given that technological development and R&D are internalized in various growth models, studies on the impact of these factors are increasing day by day. Spatial approaches at a regional level require the establishment of high technology firms in a region for technological development. Production equipment are modernized with the latest technology, and different cooperative activities are held in order to support high technology firms and create innovations. Regional R&D activities attach particular importance to clustering, networks, interactive learning and share of information, innovation, and institutional culture as a whole ecosystem which will contribute to economic growth in a positive way.

It is evident in the existing empirical studies on the topic that R&D activities display a positive and statistically significant impact on productivity and economic growth. It was reported in the current literature that information capital and dissemination of technology contributed to regional income and that economic growth was heavily affected by the intensity of R&D expenditures and information base and educational acquisitions obtained thanks to the participation of highly educated individuals. In addition, it was also suggested that R&D activities affected local productivity positively and that the dissemination of information did not only occur between the nearest regions but also among remote areas. In this respect, it is argued that R&D policies must be discussed in way to bring various regional fields together such as entrepreneurship, academic research, human and social capital and industrial structures.

Within this framework, the present study attempted to analyze the impact of regional R&D expenditure on the income per capita in Level 1 regions (12 regions) in Türkiye using GMM approach. The results suggest that R&D expenditure increases the level of regional income per capita.

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