THE CONTRIBUTION OF ENTREPRENEURSHIP TO REGIONAL ECONOMIC GROWTH: A CASE STUDY ON TÜRKİYE

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Abstract

The aim of this study is to determine the contribution of entrepreneurship to regional economic growth in Türkiye by using econometric methods. Data for the period 2009-2021 are used in the study. The data was obtained from the regional statistics page of the Turkish Statistical Institute (TSI). The study estimated the Cobb-Douglas production function through the method of System Generalized Method of Moments developed by Arellano and Bover (1995) and Blundell and Bond (1998). According to the results of the study, which investigated the contribution of entrepreneurship to regional economic growth in 26 Level-2 regions in Türkiye, entrepreneurship made a positive contribution to regional growth. A 1 percent increase in entrepreneurial activities increases regional income by 2.70 percent, and the results obtained are statistically significant at 1 percent level. When theory and application results are evaluated, it is seen that entrepreneurship is an important factor in terms of mobilizing intra-regional resources and developing the competitive structures of the regions. In this context, it is important to consider entrepreneurship and promote entrepreneurial activities in the design of regional economic policies. The originality of the study is that no econometric study could be identified on the contribution of entrepreneurship to economic growth at the regional level in Türkiye.

Keywords: *Entrepreneurship, Regional Economic Growth, Generalized Method of Moments*
JEL Classification: *L26, R11, C13*

GİRİŞİMCİLİĞİN BÖLGESEL EKONOMİK BÜYÜMEYE KATKISI: TÜRKİYE ÜZERİNE BİR UYGULAMA

Öz

Bu çalışmanın amacı, Türkiye'de girişimciliğin bölgesel düzeyde ekonomik büyümeye olan katkısının ekonometrik yöntemle belirlenmesidir. Çalışmada 2009-2021 dönemi verileri kullanılmıştır. Veriler Türkiye İstatistik Kurumunun (TÜİK) bölgesel istatistikler sayfasından elde edilmiştir. Bu veriler yoluyla oluşturulan Cobb-Douglas üretim fonksiyonu ise Arellano ve Bover (1995) ve Blundell ve Bond (1998) tarafından geliştirilen Sistem Genelleştirilmiş Momentler Yöntemi kullanılarak tahmin edilmiştir. Türkiye'de 26 Düzey-2 bölgesinde girişimciliğin bölgesel ekonomik büyümeye katkısının incelendiği çalışma sonuçlarına göre girişimciliğin bölgesel büyümeye pozitif katkı sağladığı belirlenmiştir. Girişimci faaliyetlerindeki yüzde 1'lik artış bölgesel geliri yüzde 2,70 artırmakta ve elde edilen sonuçlarında istatiksel olarak %1 seviyesinde anlamlı olduğu görülmektedir. Teori ve uygulama sonuçları değerlendirildiğinde girişimciliğin bölge içi kaynakların harekete geçirilmesi ve bölgelerin rekabetçi yapılarının geliştirilmesi açısından önemli bir faktör olduğu görülmektedir. Bu çerçevede bölgesel ekonomi politikalarının oluşturulmasında girişimciliğin dikkate alınması ve girişimci faaliyetlerinin teşvik edilmesi önem arz etmektedir. Türkiye'de bölgesel düzeyde girişimciliğin ekonomik büyümeye katkısı konusunda ekonometrik bir çalışmanın tespit edilememesi çalışmanın özgünlüğünü oluşturmaktadır.

Anahtar Kelimeler: *Girişimcilik, Bölgesel Ekonomik Büyüme, Genelleştirilmiş Momentler Yöntemi*
JEL Kodları: *L26, R11, C13*

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1. Introduction

Modern economic models mainly aim at achieving economic growth and increasing employment opportunities. In today's world, as opposed to the definition of neoclassical production function, regional economic efficiency is not only associated with labor, capital or natural resources but also with a culture of entrepreneurship (including knowledge intensive skills). There are a lot of economic and non-economic variables which may affect economic growth, and one of these variables is entrepreneurship. Entrepreneurs are central actors of changes and can take action to create, disseminate and execute new ideas in a rapid manner. In this process, they also ensure that resources are used effectively and make attempts to benefit from different job opportunities. Policy makers are often interested in entrepreneurship due to its striking capacity to offer advantages in terms of creating direct and indirect employment and prosperity.

In this context, institutional growth processes are directly related to entrepreneurial capacity. Institutional growth necessitates the development of new products and the establishment of new units, each of which requires specific production factors. If key elements such as entrepreneurial capabilities are absent, or if the institutional structure does not allow for the development of these competencies, the combination of production factors will not be possible, and as a result, new investments will not take place (Munyo and Veiga, 2024:333).

Entrepreneurship is regarded as an important factor for regional economic growth through establishing a new company, re-evaluating potential risks and resources, and raising awareness on innovative and competitive practices. Moreover, entrepreneurship is considered a critical mechanism that facilitates the transfer of knowledge from its source of creation to firms that commercialize new ideas, thereby enabling the transformation of knowledge into economic output and the creation of economic value (Acs et al., 2012:297). In recent years, many studies on the dynamics of regional growth have acknowledged that entrepreneurship contributed to regional economic growth positively. These studies draw attention to various situations in which entrepreneurship can affect regional economic growth. Entrepreneurs integrate themselves into new markets via innovative products or production methods and thus contribute to productivity through increasing market competition. From a technical point of view, they introduce feasible ideas to the market and shed light on customer preferences by offering a variety of products and services in the market. As a result of such learning process, it becomes possible to reveal a dominant design for different product and market combinations, and the dissemination of knowledge plays a vital role in this process.

Entrepreneurship is one of the key drivers of change that enhances and strengthens the competitive advantage of regional systems, and the attractiveness of a location plays an important role in fostering entrepreneurial activity. This attractiveness directly influences the level of economic development at various spatial scales and the direction of future transformations. Furthermore, in market economies, entrepreneurship is increasingly recognized as a decisive societal factor in shaping competitive geographical areas and expanding development processes. In the context of business formation and growth, entrepreneurship is addressed within the framework of microeconomic policy principles (Ziolo and Rachwal, 2012:136).

The present study firstly describes in which ways entrepreneurship contributes to regional economic growth at a theoretical level. Later, a literature review is presented in order to analyze applied studies on this topic in the existing literature and establish a link between entrepreneurship and regional economic growth. Finally, an econometric model is designed for Level-2 regions in Türkiye to measure the effects of entrepreneurship on regional economic growth.

It has been observed that the studies on the contribution of entrepreneurship to regional economic growth are quite limited and there is no such study conducted with this method at regional level in Türkiye. Originality of this study comes from the fact that it includes the

entrepreneurship factor into the formation of regional economic policies and fills an existing gap in the subject.

2. Theoretical Framework

Nowadays, productive structures in an economy require not only producing a higher number of similar products and services more efficiently to meet the total demand but also designing new products, production plans and organizations (Malecki, 1993: 119). Given the significance of space and other local factors in the evaluation of economic performance in a modern world, unlike conventional economic approaches, recent economic development and growth approaches have strictly underlined the decisiveness of regional and local elements. Regions and cities in them often emerge as the focal point. Regional decision-making processes are closely related with production, consumption, and trade, and can affect production and distribution mechanisms at an international level.

Economic development arises from the reorganization of the means of production through new combinations. These innovative entrepreneurial initiatives encompass five fundamental cases: the introduction of a new product, the alteration of production methods, the opening of new markets, the utilization of new sources of raw materials, and the restructuring of industrial organization. Such transformative processes typically originate not from existing firms but from newly established entrepreneurial ventures (Schumpeter, 1934:48). When entrepreneurs successfully adapt to the environments in which they operate, they also tend to develop distinctive resource structures that support their success. In this context, it is important to make a clear distinction between the conditions that foster innovation and those that promote entrepreneurship. Although the two concepts are closely related, they represent fundamentally different mechanisms. Entrepreneurship enables the implementation of innovation as a key instrument in the commercialization of new ideas and their transformation into economic value. However, while external environments and available resources may facilitate innovative activities, these factors alone may not be sufficient to trigger new firm formation or entrepreneurial behavior (Feldman, 2001:887). Given those technological advancements, the dissemination of knowledge and innovations are particular characteristics of economic growth, current conditions which lead to these specific factors are now under close scrutiny. Within this framework, entrepreneurship bears utmost importance in the formation and development of these factors, as it plays a central role in the local economic process of change as an indispensable actor. It can facilitate the creation, dissemination and adoption of new ideas, which occurs not only through an effective use of existing resources but also taking initiative as far as available job opportunities are concerned (Fischer and Nijkamp, 2009: 182-183).

In the concept of entrepreneurship, economic development is characterized by the use of existing resources and innovations. One of the first scholars to have used the concept of entrepreneurship, French author Richard Cantillon (1755) defined entrepreneurs as individuals who undertook a risk. Later, the importance of risk taking was also stressed by other scholars. In the 19th century, Jean-Baptiste Say, a French philosopher, defined entrepreneurship as the capacity to direct coordination of resources and factors of production towards a more efficient and productive field. In the upcoming years, his definition was broadened, and an entrepreneur was defined as a capable person who takes evaluative decisions about the effective distribution and coordination of scarce resources (Mcquad, 2002: 910). Nevertheless, if entrepreneurship is to be defined as a factor of production, an increase in output is not only correlated with an increase in labor, capital and knowledge but also with the allocation of these resources to different entrepreneurs in an economy (Acs and Storey, 2004: 873).

On the other hand, entrepreneurship can help establish a new company, which, in return, creates new companies and new employment fields and introduces new products and processes to a given market. Meanwhile, newly established companies challenge the existing ones, encouraging the latter to increase their current production quality and service standards and offer

price discounts for their products (Fischer and Nijkamp, 2009: 189). Furthermore, newly established companies can enable entrepreneurs to transform their existing resources into high income resources. While entrepreneurs fulfill these tasks through their individual efforts, they provide an opportunity for a constant redistribution of existing resources to increase efficiency. If entrepreneurship is non-existent in an economy, resources will yield a lower income, which will prevent existing resources from reaching their full economic potential. Newly established companies and fund transfers will probably supply completely new products and services which would be otherwise unavailable. Even though these new products and services cannot readily replace existing products and services in a market, they will surely threaten existing companies, which will eventually force them to decrease their prices and costs and increase their product and service quality. Therefore, reallocation of existing resources can also be a suitable option for these companies. However, it is not always possible for entrepreneurs to acquire perfect knowledge, as they cannot always execute their short, middle- and long-term plans to their excessively optimistic and incorrect conclusions. As a result, they are very likely to fail in achieving customer satisfaction. Even such negative experiences can lead to some positive outcomes. For example, an unsuccessful entrepreneur's wrong decisions will be monitored by other potential entrepreneurs, which will greatly guide them in the establishment of new companies in the future (Acs and Storey, 2004: 873).

Audretsch and Keilbach (2004: 951) state that newly established companies can affect economic output positively via different mechanisms, the first of which is the dissemination of knowledge. Similarly, internal growth models designed by leading economists such as Romer, Lucas, Grossman and Helpman draw attention to the importance of dissemination of knowledge as an important mechanism. Much less attention has so far been paid to different mechanisms for the dissemination of knowledge, turning it into a crucial topic in terms of entrepreneurship approaches. In the existing literature, the dissemination of knowledge through entrepreneurship revolves around the internalization of knowledge. According to this, a company increases its capacity to adapt to new ideas and technologies developed by other rival companies, thus obtaining external profits thanks to their investments in information. As a result, a company's external investments in knowledge acquisition within time may result in other innovations. Internal growth theories assume that economic actors can benefit from new investments in knowledge automatically. The basic assumption under this approach is the idea that new information will be always available and accessible for all actors in the economic process. Another perspective holds that technological progress is the only means of avoiding long-term diminishing returns through the continuous generation of new ideas. Such explanations underscore the need for models that conceptualize technological progress as an endogenous rather than exogenous process, and that address the problem of diminishing returns to capital (Barro and Sala-i-Martin, 2004:61). Entrepreneurs constantly strive to transform inventions and technical possibilities into economic realities. Investment and financing decisions have significantly influenced the efforts directed toward research and technological advancement. Schumpeter (1942, 1950) identified profit-driven firms in competitive markets as key actors and emphasized that the new technologies created by these firms are shaped both by the laws and ethics of capitalism, and by publicly available scientific knowledge (Nelson, 1989:230). Because knowledge is considered as public property, all actors in knowledge-based economies can reach the dissemination of knowledge free of charge, which will increase their rates of economic growth. However, various studies have reported that this is not always valid, since investment in knowledge does not necessarily bring a higher competitiveness and economy growth. In this sense, entrepreneurship can contribute as a channel for the dissemination of knowledge such as creating an organizational model for a newly established company or obtaining information from existing companies. This points to, from an economic perspective, the transformation of knowledge into a new product or service within the scope of a settled organization, which emerges in a newly established organization as the core of entrepreneurship. Thus, entrepreneurship must be acknowledged as the mechanism in the transfer and dissemination of knowledge. It facilitates the dissemination of knowledge through

commercializing ideas which would not be otherwise followed or commercialized (Audretsch and Keilbach, 2008: 1698). Another possible outcome is that newly established companies will increase competitiveness in the market and thus affect economic outputs positively. Jacobs (1969) and Porter (1990) suggest that when it comes to knowledge externality, competitiveness is more suitable than a monopoly structure. Jacobs refers to competitiveness in terms of concretizing new ideas from different economic actors. It does not only mean that a higher number of newly established companies will pave the way for new ideas and a higher competitiveness. In addition, increasing competitiveness will also make it easier for new specialized companies to take part in some specific production fields. This is particularly necessary to complement outputs and services obtained from smaller and specialized companies and contributes to production remarkably. A third path is that a variety of companies will rise as a result of newly established firms, which will contribute to economic output. However, a higher number of companies cannot ensure this effect, as the variety of local companies must also be increased. Various studies revealed that the degree of local differences as opposed to local similarities would affect the potential for economic growth significantly. Again, Jacobs underlines that the dissemination of knowledge and innovative structures are more likely to emerge in larger cities where economic activities are diversified. Jacobs also argues that industrial differences in a local economic environment contribute to knowledge externality, innovative activities and a resulting economic growth. As such, entrepreneur capital driven by newly established companies may contribute to economic output and growth through the dissemination of knowledge, as it increases competitiveness and diversification (Audretsch and Keilbach, 2004: 952-953).

Schumpeter also elaborates on the innovative role of entrepreneurship and, within this scope, stresses the fact that innovative entrepreneurship is the basis of the capitalist system and that its creative destruction is concretized by new products, processes and organizational structures. These developments will result in the birth of countless innovation opportunities, new companies and industries (Fischer and Nijkamp, 2009: 185). Schumpeter put forwards the idea that innovative entrepreneurship is the main driving force for economic development, since an entrepreneur's economic activities will support the creative process. His theoretical stance assumes that a higher number of entrepreneurs will increase economic growth (Wong et al., 2005: 336). Within this framework, entrepreneurs who introduce innovative practices act as the operators of new productive components such as changing industrial and organizational structures, bringing new output resources, opening up to new markets, and introducing new products and production methods. Such innovative behaviors in a company will uncover new opportunities for entrepreneurship activities, motivating decisions and advantageous allocation of existing resources. It must be also noted that small and medium-size companies are also main actors in terms of innovation. After all, it will only be possible to offer opportunities thanks to innovations, price competition and effectiveness (Mcquaid, 2002: 911). Therefore, it can be contended that knowledge and innovation has been long associated with entrepreneurship at a national and regional level. The most striking point of their mutual relationship is the commercialization of knowledge through new entrepreneurships (Fritsch and Storey, 2014: 945).

3. Literature Review

It is seen that there are applied studies on this subject in the literature. Although different effects were observed in accordance with time, location and methodology, these studies usually underlined the importance of entrepreneurship as a decisive factor for regional economic growth. For example, based on Cobb-Douglas production function, Audretsch and Keilbach (2004) aimed to analyze how entrepreneurship affected economic growth in 327 different regions of Western Germany between 1989 and 1992. The rate of new start-ups was used to represent entrepreneurship, and a positive correlation was found between entrepreneur activities and economic growth. In another study, Audretsch and Keilbach (2008) reached similar results in 440 different regions of Germany with the same variables. Mueller (2007) applied Cobb-Douglas production function to the data between 1990 and 2002 in different regions of Western Germany

to analyze how increasing entrepreneurship affected economic output. Approaching the number of newly established companies as an indicator of entrepreneurship, this study concluded that entrepreneurship affected regional economic growth positively.

Braunerhjelm and Borgman (2004) attempted to determine the effects of geographical concentration and entrepreneurship in 143 industries and 70 regional labor markets in Sweden between 1975 and 1999. The authors used the rate of self-employed individuals as an indicator of entrepreneurship to analyze the effect of geographical concentration and entrepreneurship at a regional level. The findings of the study reported that these variables could be accepted as important indicators of regional economic development.

Matejovsky et al. (2014) studied the relationship between entrepreneurship and regional economic growth in different Canadian states based on the regional data between 1987 and 2007. Using panel data random effects on their model, the authors found out that an increase of around 1 percent in entrepreneur capital increased economic growth by nearly 0.031 percent as far as the link between entrepreneurship and regional growth was concerned. Additionally, their panel VAR model for the same period indicated that entrepreneurship was a driving force for long-term economic growth. Therefore, from a political perspective, the elimination of barriers to entrepreneurship is likely to encourage economic growth.

Audretsch et al. (2015) focused on the contribution of entrepreneurship to economic growth based on Cobb-Douglas production function in 127 different European cities between 1994 and 2009. This study also relied on the number of newly established companies as an indicator of entrepreneurship and suggested that entrepreneurship affected economic growth positively both in middle- and medium-size cities as well as large cities.

Aparicio et al. (2018) conducted a study on Colombia using the regional data 2001 and 2012. In this study, they estimated Cobb-Douglas production function via unbalanced panel fixed effects method and revealed that a change of nearly 1 percent in entrepreneurship levels affected regional economic growth by 0.19 percent in Colombia.

Rico and Cabrer-Borras (2019) studied the total factor productivity of entrepreneurship in different regions of Spain between 2003 and 2016. The results of this study indicated that entrepreneurship led to a higher rate of regional economic growth when it facilitated human capital, R&D expenditure and newly established companies. To put it differently, it became evident that entrepreneurship activities and newly established companies affected total factor productivity and regional economic growth positively. Likewise, Gonzales-Pernia and Pena-Legazkue (2015) attempted to measure the effect of export-oriented entrepreneurship on regional economic growth. The authors benefited from Cobb-Douglas production function based on the regional data in Spain between 2003 and 2013. The results obtained from a two-stage least squares and system GMM demonstrated that export-oriented entrepreneurship affected economic growth positively and significantly.

Nurmalia et al. (2020) analyzed 33 provinces in Indonesia between 2008 and 2013 using panel data fixed effects method to determine the role of entrepreneurship on regional economic growth. According to their findings, entrepreneurship capital affected regional economic growth in Indonesia significantly.

Novejarque Civera et al. (2021) analyzed the socioeconomic factors influencing regional entrepreneurship by using data from 19 regions of Spain covering the period 2000–2017. The study found that economic growth, unemployment rate, firm size, and human capital were key determinants of new firm formation rates. In particular, human capital and R&D investments were identified as having a strong impact on entrepreneurship. The study highlights that entrepreneurship and innovation at the regional level are of critical importance in supporting economic growth.

Xu et al. (2021) applied the Mixed Geographically Weighted Panel Regression with Spatial Autoregression (MGWPR-SAR) method to examine the spatial variation in the impact of entrepreneurship on regional economic growth across 31 provinces and cities in China. The findings revealed that the effect of entrepreneurship on economic growth is neither uniformly positive nor constant across all regions. In particular, entrepreneurship was found to have a growth-promoting effect in the eastern coastal and central regions, whereas in the less developed western regions, its impact turned negative, indicating that entrepreneurship may hinder economic growth. These results underscore the spatial heterogeneity of entrepreneurship's influence on regional economic development.

Huang and Chen (2021) examined the impact of entrepreneurship on economic growth at the city level by using data from Zhaoqing, Shantou, and Meizhou -three cities in China's Guangdong province- covering the period from 2003 to 2017. In their study, gross domestic product (GDP) was used as the dependent variable, while public expenditure, labor, fixed and financial capital, and entrepreneurship were included as independent variables. The analysis, conducted through multiple regression models, revealed that the effect of entrepreneurship on economic growth varied depending on the city context. Specifically, it was found that Meizhou benefited less from entrepreneurship due to its structural limitations in supporting entrepreneurial activity.

Del Monte et al. (2022) designed an estimation model based on the current and previous data at NUTS-3 geographical level in Italy and concluded that regions with a higher level of entrepreneurship and innovation displayed a higher economic growth compared to other regions and that entrepreneurship strengthened the positive effect of innovation, thus playing a very critical role in economic growth.

Zhang and Geng (2023) estimated the effect of entrepreneurship on economic growth in China between 2014 and 2018 using panel data fixed effects method and demonstrated that despite regional differences in terms of the effect of entrepreneurship on economic growth, entrepreneurship played a visible role in encouraging economic growth.

Liu et al. (2023) investigated the impact of entrepreneurship on local economic growth in micropolitan areas of the United States for the period 2010–2015. In the study, newly established single-unit firms were used as an indicator of entrepreneurship. The findings indicate that population growth and the density of small businesses foster general entrepreneurship, while human capital and proximity to major metropolitan areas support high-tech entrepreneurship. The results suggest that entrepreneurship promotes economic growth in small cities and that policy design should account for regional differences.

Inácio Júnior et al. (2024) analyzed the impact of innovative entrepreneurship on regional growth in Brazil based on 2023 data. Using a sample of 101 entrepreneurial cities, the study employed Necessary Condition Analysis (NCA) and clustering methods. The findings revealed that factors such as bureaucratic structure, urban infrastructure, transportation accessibility, level of economic development, access to finance, secondary education level, entrepreneurial orientation, presence of support institutions, and the intensity of innovation inputs constitute necessary conditions for entrepreneurial outcomes to varying degrees. The study concludes that these conditions shape entrepreneurship structures that support regional economic growth and highlights the importance of designing entrepreneurship policies tailored to the specific characteristics of cities to foster regional development.

Mendoza et al. (2025) examined the effects of migrant entrepreneurship on regional growth in their study conducted on El Hierro Island in Spain. The research emphasized that through their entrepreneurial activities, migrants contributed to economic diversification and the development of social capital on the island, promoted innovative business models within local communities, and enriched the local entrepreneurial culture. Based on qualitative research methods, the study found

that despite limited resources, migrant entrepreneurs had a positive impact on regional development.

International studies have comprehensively demonstrated the impact of entrepreneurship on regional economic growth through various methodological approaches. In the context of Türkiye, however, the number of academic studies specifically focusing on this issue remains considerably limited.

Demirdağ (2016) examined the relationship between entrepreneurship, innovation, and regional development across 26 NUTS-II regions in Türkiye. Using data from the years 1995, 2000, 2005, and 2010, the study conducted an analysis of the mediating effect of innovation in the relationship between new firm formation and regional economic development. The findings suggest that entrepreneurship contributes more significantly to regional development in regions with higher levels of innovation. In particular, innovation was found to have a statistically significant effect on this relationship in the years 2000, 2005, and 2010, while no such effect was observed for 1995. These results underscore the critical role of innovation capacity in promoting regional development

Sevinç and Eren (2016) analyzed the impact of entrepreneurial activities on regional economic growth in their study focused on the TR71 region. The study found that project-based supports provided by the Ahiler Development Agency between 2011 and 2015 led to an increase in the number of patents, utility models, and trademark registrations. This increase contributed significantly to the emergence of new investments and the development of entrepreneurial capacity. In this context, the study highlights entrepreneurship as a structural factor shaping regional economic growth.

4. Econometric Method and Model

Because economic events and behaviors bear the traces of historical periods in the past, it is crucial to take temporal lagged values of variables into consideration in an economic analysis. These variables are also included in dynamic panel data analysis (Baltagi, 2005: 136; Tatoğlu, 2013: 66). However, internality arises as a serious problem in dynamic panel data models, and instrumental variables are used to overcome this problem (Akay, 2015: 80). The method is usually employed for error terms which are constantly varied and non-autocorrelated. However, error terms may be negatively autocorrelated when the first difference is taken. Developed by Arellano and Bond (1991), Generalized Method of Moments (GMM) is used to eliminate negative autocorrelation problems. In GMM estimation, the first difference model is transformed and evaluated using instrumental variable matrix. As a result, the method is also called two-step instrumental variables model (Tatoğlu, 2013: 75-80; Baltagi, 2005: 136-137). Generalized moments estimator evaluates internality problem and individual effects together. All linear momentum restrictions of a dynamic panel data model are effectively used in GMM. Thus, variable deviations from the periodic data can also be employed, eliminating the need to add time-specific constants to the current model. Furthermore, individuals effects are also removed after the first difference transformation is applied (Caselli et al., 1996: 369). Hodey (2015: 73), "The consistency of this method is based on two main assumptions. Basically, the first of these assumptions is that error terms do not display a second-order serial correlation. The second assumption is related to instrument validity ensured by Arellano-Bond serial correlation and Sargan tests. The instrument validity is accepted if the null hypothesis is rejected by both tests. Given these considerations, the System GMM method developed by Arellano and Bover (1995) and Blundell and Bond (1998) was designed to address endogeneity issues that arise particularly when lagged values of the dependent variable are included in the model. System GMM provides more robust estimates by employing both the levels and first differences of the variables as instruments. It stands out for producing more consistent and reliable results than Difference GMM, especially in cases with small sample sizes (Blundell and Bond, 1998:120–123). Moreover, it enhances the reliability of the

analysis by providing robust standard errors in the presence of model assumption violations such as heteroskedasticity and autocorrelation (Roodman, 2009:92–98).

In the present study, Cobb-Douglas production function is estimated using System Generalized Method of Moments by Arellano and Bover (1995) and Blundell and Bond (1998) in order to analyze the contribution of entrepreneurship to regional economic growth in Level-2 regions in Turkish economy. It can be observed that Cobb-Douglas production function is widely used at a regional and national level in the existing literature. In addition to labor, capital and technological development, entrepreneur capital is also integrated into the method as a new output (Audretsch and Keilbach, 2004; Mueller 2007; Wong et al., 2005; Aparicio et al., 2018; Rico and Cabrer-Borras, 2019; Gonzales-Pernia and Pena-Legazkue, 2015). Cobb-Douglas production function can be formulated as follows:

$$Y = AK^{\beta}L^{\varphi}E^{\gamma} \tag{1}$$

In this function, *(Y)* is the gross domestic product per capita (GDPpc), *(A)* is the level of technology or technological changes, *(K)* is the private capital stock, *(L)* is the labor force, and *(E)* is the entrepreneurship activities at a regional level. The logarithmic expression of this production function in the system GMM is given as follows:

$$lnY = \alpha + \lambda Y_{t-1} + \beta lnK + \varphi lnL + \chi lnP + \gamma lnE + \varepsilon_{it} \tag{2}$$

Here, represent income per capita, lagged value, private capital, labor force, technology and sensitivity to entrepreneurship activities, respectively. In this model, because the data for private capital stock, an independent variable, were not available, industrial power generation was used as a value converging to these data. It can be noted in the existing literature that applied studies resorted to industrial power generation data in case of unavailable private capital stock data (Moody, 1974: 50; Schnorbus and Israilevich, 1987: 5). The number of patent ownerships (P) is denoted by the level of technological development in the model. Various applied studies in the existing literature suggest that patent ownership can be used as an indicator of technological development and innovation (Audretsech, 2004: 174; Wong et al., 2005). On the other hand, it can be also seen in the existing literature different criteria were used to measure entrepreneurship such as self-employment, business ownership rates and new firm start-ups as well as newly established companies and their activities in industrial demography (Wennekers et al., 2005: 295; Audretsch and Thurik, 2001: 17; Wennekersand and Thurik, 1999: 47). The above-mentioned model takes entrepreneurship activities into account as an indicator of entrepreneurship (E).

The model was applied to Level-2 data between 2009 and 2021. The reason why this specific period was selected for analysis is the limitation of private capital stock data to this time interval. While income per capita, labor force, industrial power generation data as an indicator of private sector investments and regional entrepreneurship data were obtained from the official website of Turkish Statistical Institute (TSI), patent ownership data as an indicator of technological development were collected from Turkish Patent and Trademark Office.

In panel data analyses, structural characteristics specific to cross-sectional units, differences in geographical location, and various external factors may lead to interactions among units-this phenomenon is referred to as cross-sectional dependence. The literature emphasizes that ignoring such dependence can compromise the consistency and reliability of the estimated model parameters, thereby undermining the validity of statistical inferences (Baltagi, 2021:287). Within this framework, in order to conduct unit root and other empirical tests reliably in panel data analyses, it is essential first to test whether cross-sectional dependence exists in the dataset. For this purpose, the CD (Cross-Sectional Dependence) test developed by Pesaran (2004) can be effectively employed, particularly when the cross-sectional dimension (N) is larger than the time dimension (T). The null hypothesis (H_o) of the CD test states that there is no cross-sectional

dependence among the units, whereas the alternative hypothesis (H_1) suggests the presence of cross-sectional dependence (Pesaran, 2004:10).

$$CD=\sqrt{\frac{2T}{N(N-1)}}\sum_{i=1}^{N-1}\sum_{j=i+1}^{N}\rho_{ij}$$ (3)

In the presence of cross-sectional dependence in panel datasets, the validity of conventional unit root tests may be compromised—a point widely emphasized in the literature. In this regard, the CIPS (Cross-sectionally Augmented Im, Pesaran, and Shin) test developed by Pesaran (2007) has emerged as a robust alternative unit root test that accounts for cross-sectional dependence. This test incorporates both the level and first-difference terms of the cross-sectional averages of the panel into the individual unit root equations, thereby integrating the dependence structure into the model. The CIPS statistic is computed as the arithmetic mean of the CADF (Cross-sectionally Augmented Dickey-Fuller) test statistics calculated for each cross-sectional unit (Pesaran, 2007:280).

$$CIPS=\frac{1}{N}\sum_{i=1}^{N}t_{i}^{CADF}$$ (4)

In this method, the null hypothesis (H_0) states that 'all series contain a unit root,' whereas the alternative hypothesis (H_1) posits that 'at least some series are stationary.' The CIPS test is frequently preferred for panel datasets exhibiting cross-sectional dependence, particularly because it yields reliable results when the cross-sectional dimension (N) exceeds the time dimension (T) (Pesaran, 2007:280; Baltagi, 2021:287).

In dynamic panel data analyses, when lagged values of the dependent variable are included in the model, traditional fixed effects estimators and ordinary least squares (OLS) methods may produce biased and inconsistent results. As a solution to this problem, the System GMM (Generalized Method of Moments) approach developed by Arellano and Bover (1995) and Blundell and Bond (1998) enables more robust and consistent estimation by simultaneously incorporating both the first-differenced and level equations of the variables. The basic model can be specified as follows (Arellano and Bover, 1995:30; Blundell and Bond, 1998:124):

$$y_{it}=\alpha y_{it-1}+\beta X_{it}+\mu_i+\varepsilon_{it}$$ (5)

In this model, due to the correlation between y_{it-1} and the error components, it is necessary to eliminate fixed effects through differencing and to instrument the endogenous variables using appropriate lags. In this regard, the System GMM method estimates the model by simultaneously incorporating the moment conditions for both the first-differenced equation and the level equation.

$$\Delta y_{it}=\alpha\Delta y_{it-1}+\beta\Delta X_{it}+\mu_i+\Delta\varepsilon_{it}$$ (6)

In doing so, it minimizes common panel data problems such as endogeneity and heterogeneity. This method is particularly well-suited for panel datasets with a short time dimension (T) and a large cross-sectional dimension (N). The validity of the model is assessed through various test statistics (Arellano and Bover, 1995:35; Blundell and Bond, 1998:124). The Wald χ^2 test assesses the joint significance of all independent variables in the model; a significant result indicates that the explanatory variables contribute meaningfully to the model. The AR(1) and AR(2) autocorrelation tests examine the presence of autocorrelation in the error terms. While first-order autocorrelation [AR(1)] is expected due to differencing, the absence of significant second-order autocorrelation [AR(2)] is a necessary condition for the consistency of the model. The Hansen test evaluates the validity of the instrumental variables. Failure to reject the null hypothesis (H_0) indicates that the instruments are appropriate and that the overidentifying restrictions of the model are valid (Arellano and Bond, 1991:281).

4.1. Estimation Results

The study presents descriptive statistics for the variables used in the model, correlation relationships among the variables, cross-sectional dependence analysis, unit root test results, and the findings obtained through the Panel System GMM method. The corresponding tables summarizing the empirical results are provided below.

Table 1: **Descriptive Statistics**

Variable	Number of Obs.	Mean	Std. Deviation	Min.	Max.	Skewness	Kurtosis	JB Test
LY	338	10.7	0.43	9.79	12.34	0.57	3.51	0.0002
LK	338	6.35	0.52	4.89	7.24	-0.65	2.91	0.0001
LL	338	1.64	0.06	1.41	1.75	-1.52	5.64	0.0000
LP	338	1.21	0.64	0.30	3.20	0.71	3.05	0.0000
LE	338	5.00	0.32	4.42	6.02	0.51	3.82	0.0002

The descriptive statistics presented in Table 1 indicate that the variables included in the model generally exhibit statistically meaningful characteristics. Although some variables display mild deviations from normality in terms of skewness and kurtosis, such deviations are common in panel data analyses and do not pose methodological concerns. While the Jarque-Bera tests highlight deviations from the normality assumption, the use of robust standard errors in the presence of such departures is considered a precautionary measure that enhances the reliability of the estimations.

Table 2: **Correlation Matrix Among the Variables**

Variable	LY	LK	LL	LP	LE
LY	1.0000				
LK	0.6833	1.0000			
LL	0.1274	0.1943	1.0000		
LP	0.8680	0.7306	0.3012	1.0000	
LE	0.8658	0.7227	0.1482	0.8451	1.0000

The correlation analysis reveals significant relationships between the income variable (*ly*) and other production factors. The results indicate strong positive correlations between income and the number of patents (*lp*) at 86.80%, as well as between income and the level of entrepreneurship (*le*) at 86.58%. These findings suggest that regional income levels are closely associated with innovation capacity and entrepreneurial activity. The correlation between income and the capital variable (*lk*) is also relatively strong (68.33%), indicating the substantial contribution of physical investment to economic output. In contrast, the relationship between income and the labor supply variable (*ll*) is notably weak, with a correlation of only 12.74%. Additionally, the high correlation coefficient between *lp* and *le* (84.51%) points to a strong structural link between innovation and entrepreneurship. These findings suggest that regional income levels may be shaped particularly by knowledge-, innovation-, and entrepreneurship-based Dynamics.

Table 3: **Pesaran (2004) CD Test Results**

Variable	CD Test
LY	64.84***
LK	51.33***
LL	20.41***
LP	36.49***
LE	62.23***

CD test statistics are denoted with *** when significant at the 1% level ($p < 0.01$). Since the p-values for all variables are 0.000, a high degree of cross-sectional dependence is evident.

According to the Pesaran (2004) CD test results presented in Table 3, all variables included in the model exhibit statistically significant cross-sectional dependence. The test statistics for the variables LY, LK, LL, LP, and LE are all high and significant at the 1% level, indicating strong interdependence among the units. In particular, the fact that the p-values are 0.000 for all variables demonstrates that this dependence is statistically robust. Therefore, it is essential to employ panel data estimation techniques that account for cross-sectional dependence in the subsequent analysis.

Table 4: **Pesaran (2007) CIPS Unit Root Test**

Variable	CIPS Unit Root Test Result
LY	−2.692***
ΔLY	−2.358***
LK	−1.896
ΔLK	−2.243***
LL	−2.094*
ΔLL	−2.632***
LP	−2.130**
ΔLP	−2.538***
LE	-1.77
ΔLE	-2.235***

The symbol Δ denotes the first difference of a variable, while ***, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

The results of the Pesaran (2007) CIPS unit root test presented in Table 4 indicate that the variables in the panel dataset are generally non-stationary at level but tend to become stationary at their first differences. The variable LY is stationary at level at the 1% significance level, whereas the other variables (LK, LL, LP) are generally non-stationary in levels. However, once first-differenced, all these variables become statistically significant at the 1% or 5% levels, suggesting that they do not contain a unit root in first differences. These findings imply that the variables follow an I(1) process and highlight the importance of accounting for first-difference stationarity when selecting appropriate panel data estimation techniques.

Table 5: **System GMM Estimation Results**

Variable	Coefficient	Standart Deviation	P-Value
d_LK	0.3416	0.1216	0.005
d_LL	0.1296	0.0760	0.088
d_LP	0.0099	0.0148	0.505
d_LE	2.7055	0.2537	0.000
_cons	0.0352	0.0039	0.000
Test	**Statistic**		**P-Value**
Wald χ² Test	2579.68		0.000
AR(1) Test	z = -3.05		0.002
AR(2) Test	z = -0.57		0.565
Hansen Testi	χ²(30) = 23.32		0.802

To analyze the contribution of entrepreneurship to regional economic growth, the estimation results obtained by applying the GMM method to 26 different NUTS-2 regions in Türkiye are presented in Table 5. In line with the structural characteristics of the system GMM method, various specifications using different instrument sets and lag lengths were tested during the estimation process to enhance model validity and the reliability of the results. Since employing an excessively high number of instruments relative to the number of observations can weaken the validity of statistical tests and lead to model overidentification (instrument proliferation), particular attention was paid to controlling the number of instruments. Accordingly, the instrument structure was simplified, and lag lengths were restricted with the aim of obtaining more efficient and consistent estimates.

The estimation results generated using the system GMM method provide insights into the effects of production factors included in the model on economic growth. According to the findings, the coefficients of capital (d_LK) and labor (d_LL) are estimated as 0.34 and 0.12, respectively. The capital variable is positive and statistically significant at the 1% level, while the labor variable is positive at the 10% significance level. These results indicate that capital accumulation and labor supply are fundamental components supporting growth. The coefficient of the variable representing entrepreneurial activities (d_LE) is estimated at 2.70 and is also positive and statistically significant at the 1% level. This finding demonstrates that entrepreneurial activities have a strong and direct impact on economic growth. On the other hand, the lagged patent variable (d_LP), which is used in the model as a proxy for technological development, did not yield statistically significant results, despite being theoretically appropriate. In the literature, international organizations such as the OECD (2023), World Bank (2023), and UNESCO (2023) commonly use a range of indicators to measure technological capacity, including not only patent counts but also R&D expenditures, the number of R&D personnel, broadband internet subscriptions, high-tech product exports, the density of research institutions, the number of scientific publications, and the share of science and engineering graduates in higher education. However, due to data limitations at the regional level, these indicators could not be included in the analysis, preventing a more comprehensive measurement of the level of technological development.

The Wald χ^2 test result for the estimated model (χ^2 = 2579.68, p <0.01) indicates that the independent variables included in the model are jointly significant. According to the Arellano-Bond autocorrelation tests, the p-value of the AR(1) test is 0.002, suggesting the presence of first-order autocorrelation, while the AR(2) test yields a p-value of 0.565, indicating the absence of second-order autocorrelation. This supports the validity of the model's dynamic specification. Furthermore, the Hansen overidentification test result (p = 0.802) suggests that the instruments used are appropriate and that the model is not overidentified, thereby confirming the correctness of the model specification.

5. Conclusion

Modern regional development approaches plan to improve competitive and innovation qualities in a geographical region and take action using intraregional resources, both of which make entrepreneurship a central concept for regional economic growth. In particular, innovative practices introduced by newly established companies strengthen the role of entrepreneurship in the commercialization of knowledge. These newly established companies also open up new and productive areas of use for existing resources and increase product variety, quality and standards, thus contributing to regional economic growth greatly. Contrary to traditional approaches which take into account only production factors in regional economic growth, many economic and non-economic factors such as entrepreneurship are also taken into consideration in today's world. Therefore, a solid culture of entrepreneurship must be prioritized for effective regional economy policies in the future. Furthermore, various studies on different countries in the existing literature clearly indicate that entrepreneurship has always been a significant element for regional economic growth.

Within this framework, in the present study, a Cobb-Douglas production function was estimated using GMM in order to determine the contribution of entrepreneurship to regional economic growth in Türkiye. Given the data between 2009 and 2021, the findings of the present study demonstrated that an increase of 1 percent in entrepreneurship activities increased regional income by 2.70 percent. Moreover, it is evident that all results—except for the patent variable—are statistically significant. The findings related to entrepreneurship are consistent, in terms of both the functional form employed and the empirical outcomes, with previous studies in the literature such as Aparicio et al. (2018), Gonzales-Pernia and Peña-Legazkue (2015), Audretsch et al. (2015), Mueller (2007), and Audretsch and Keilbach (2004). Therefore, it can be argued that

entrepreneurial activities should be strongly supported at the regional level as a component of long-term regional economic policies in Türkiye.

When the theoretical and practical results of the study are evaluated, it is seen that entrepreneurship can contribute to regional economic growth through new company establishments and the development of the competitive structure of the regions. Especially in recent years, internal regional development approaches based on improving the competitive structures of the regions by mobilizing intra-regional resources have come to the fore in regional economic policies. Entrepreneurial activities are seen as the main element of developing these policies. In this context, encouraging entrepreneurship at the regional level should be seen as an important regional economic policy tool, and it is important that the scope and nature of entrepreneurship encouraging policies be clarified by economic managements.

With the current study results, it is noteworthy that there are some points for new research. In particular, research on which entrepreneurial activities contribute more to regional economic growth, as well as determining whether the differences in the contribution of entrepreneurial activities to regional growth at the regional level also develop depending on regional development differences, is a point that needs to be investigated.

The findings reveal the positive impact of entrepreneurship on regional economic growth, highlighting the necessity of regional development policies that promote entrepreneurial activity. Within this framework, the following policy recommendations may be proposed for policymakers.

- Entrepreneurial activities may generate different impacts depending on the unique socioeconomic structures of each region. Therefore, policies aimed at supporting entrepreneurship should be designed with consideration for regional disparities, and uniform incentive mechanisms should be avoided in implementation.
- Supporting newly established ventures operating particularly in knowledge- and technology-intensive sectors can enhance regional competitiveness. In this regard, expanding access to finance, mentoring programs, and networking support mechanisms is essential.
- Given entrepreneurship's contribution to regional growth through knowledge diffusion and innovation, structures that promote research and development collaboration and technology transfer mechanisms should be made more effective.
- In relatively less developed regions where entrepreneurial activity remains insufficient, the government may organize educational programs to raise awareness and promote entrepreneurship.

While this study reveals the impact of entrepreneurship on regional economic growth at a general level, conducting more in-depth analyses in the following areas would be valuable for future research.

- Entrepreneurial activities are not homogeneous. Subcategories such as innovation-driven, opportunity-driven, socially oriented, or technology-based entrepreneurship may have differing impacts on regional growth. A comparative analysis based on these distinctions would be beneficial.
- The contribution of entrepreneurial activities to regional growth may vary across sectors (e.g., manufacturing, services, high-tech, etc.). Sector-specific analyses could facilitate the development of more targeted policy interventions.
- The relationship between the contribution of entrepreneurship to growth and the level of regional development should also be explored. It would be useful to examine whether the magnitude of this impact differs between more developed and less developed regions.

Such future research would not only deepen the understanding of the entrepreneurial dynamics underlying regional economic development but also contribute to the design of more effective, evidence-based regional policy frameworks.

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