Hacettepe University Graduate School of Social Sciences

Department of Economics

IMPACTS OF EU PRE-ACCESSION FUNDS ON REGIONAL GROWTH IN TÜRKİYE: A SPATIAL ANALYSIS

Mehmet Selim USLU

Ph. D. Dissertation

Ankara, 2023

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The jury finds that Mehmet Selim USLU has on the date of 19/6/2023 successfully passed the defense examination and approves his Ph. D Dissertation titled “IMPACTS OF EU PRE-ACCESSION FUNDS ON REGIONAL GROWTH IN TÜRKİYE: A SPATIAL ANALYSIS”.

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ABSTRACT

USLU, Mehmet Selim. Impacts of EU pre-Accession Funds on Regional Growth in Türkiye: A Spatial Analysis, Ph. D. Dissertation, Ankara, 2023.

This thesis aims to investigate the influence of Instrument for pre-Accession Assistance (IPA) funds, which is a part of its candidacy process for joining the European Union (EU), on the regional growth in Türkiye. Our study focuses on analyzing the economic growth impacts of these funds and their spatial dimension, considering their implementation through the decentralized implementation system (DIS) method.

As there is currently a dearth of empirical data on this subject, the aim of this study is two-fold. Firstly, our aim is to establish a comprehensive data set on EU pre-accession funds at regional level. Secondly, in order to close this gap, this thesis examines the effects of EU pre-accession, particularly IPA, funds on Türkiye's regional growth by using the established comprehensive data set. To our knowledge, it will be the first study to analyze the impacts of EU pre-accession funds on regional growth of Türkiye by using spatial econometrics techniques.

After conducting the required statistical selection processes, we apply spatiotemporal fixed-effect Spatial Durbin Model with log-transformed spatially-lagged variables to estimate the model. As far as our main explanatory variable, IPA funds is concerned, our estimation results point out that there is no statistically significant impact of IPA funds on the growth of the local economy. Our estimation results also address the other important determinants of regional growth in Türkiye.

Our results show that there is a pattern of conditional regional convergence, where regions having lower initial GDP points tend to experience more rapid economic growth, gradually catching up to regions with higher initial GDP levels. The coefficients of the employment rate as well as innovation variables are significantly positive in the model’s main estimation part, which shows the positive influence of an increase in employment and innovation on regional economic growth. Our findings also reveal that spatial interactions between provinces play a crucial part in economic growth and highlight the importance of spatial analysis.

Keywords

Instrument for pre-accession assistance (IPA) funds, interregional output growth spillovers, effect of spatial autocorrelation, Spatial Durbin panel model, determinants of regional growth.

ÖZET

USLU, Mehmet Selim. AB Katılım Öncesi Fonlarının Türkiye'de Bölgesel Büyümeye Etkisi: Mekansal bir Analiz, Doktora Tezi, Ankara, 2023.

Bu tez, Avrupa Birliği (AB) üyeliği adaylık sürecinin bir parçası olan Katılım Öncesi Yardım Aracı (IPA) fonlarının Türkiye'nin bölgesel büyümesi üzerindeki etkisini araştırmayı amaçlamaktadır. Çalışmamız, bu fonların ekonomik büyüme etkilerini ve mekansal boyutlarını, merkezi olmayan uygulama sistemi (DIS) yöntemiyle uygulanmalarını göz önünde bulundurarak analiz etmeye odaklanmaktadır.

Halihazırda bu konuda ampirik veri eksikliği olduğu için, bu çalışmanın amacı iki yönlüdür. İlk olarak amacımız, bölgesel düzeyde AB katılım öncesi fonlarına ilişkin kapsamlı bir veri seti oluşturmaktır. İkinci olarak, bu tez, bu açığı kapatmak için, oluşturulan kapsamlı veri setini kullanarak AB'ye katılım öncesi fonların, özellikle IPA'nın Türkiye'nin bölgesel büyümesi üzerindeki etkilerini incelemektedir. Bildiğimiz kadarıyla, AB katılım öncesi fonlarının Türkiye'nin bölgesel büyümesi üzerindeki etkilerini mekansal ekonometri teknikleri kullanarak analiz eden ilk çalışma olacaktır.

Gerekli istatistiksel seçim işlemlerini yaptıktan sonra, modeli tahmin etmek için logaritmik dönüştürülmüş mekansal gecikmeli değişkenler yardımıyla uzay-zamansal ve sabit etkili Mekansal Durbin Modelini uyguluyoruz. Ana açıklayıcı değişkenimiz olan IPA ile ilgili olarak, tahmin sonuçlarımız, IPA fonlarının yerel ekonominin büyümesi üzerinde istatistiksel olarak anlamlı bir etkisinin olmadığına işaret etmektedir. Tahmin sonuçlarımız Türkiye'deki bölgesel büyümenin diğer önemli belirleyicilerini de ele almaktadır.

Sonuçlarımız, başlangıçtaki GSYİH düzeyi düşük olan bölgelerin daha hızlı ekonomik büyüme gerçekleştirme eğiliminde olduğu ve başlangıçtaki GSYİH düzeyi daha yüksek olan bölgeleri kademeli olarak yakaladığı bir koşullu bölgesel yakınsama modeli olduğunu göstermektedir. İstihdam oranı ve inovasyon değişkenlerinin katsayıları, modelin ana tahmin kısmında anlamlı olarak pozitiftir. Bu, istihdam artışının ve inovasyonun bölgesel ekonomik büyüme üzerindeki olumlu etkisini göstermektedir. Bulgularımız ayrıca iller arasındaki mekansal etkileşimlerin

ekonomik kalkınmada çok önemli bir rol oynadığını ortaya koymakta ve mekansal analizin önemini vurgulamaktadır.

Anahtar Sözcükler

Katılım öncesi yardım aracı (IPA) fonları, bölgeler arası çıktı büyümesi yayılmaları, mekansal otokorelasyon etkisi, Mekansal Durbin panel modeli, bölgesel büyüme belirleyicileri.

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LIST OF ABBREVIATIONS

EU	: European Union
IPA	: Instrument for pre-Accession Assistance
DIS	: Decentralized implementation system
OECD	: Organization for Economic Cooperation and Development
NUTS	: Nomenclature of Territorial Units for Statistics
HDI	: Human Development Index
SME	: Small and Medium-sized Enterprises
SDM	: Spatial Durbin Model
BMA	: Bayesian Model Averaging
ERDF	: European Regional Development Fund
CAP	: Common Agricultural Policy
GMM	: Generalized Method of Moments
EAGGF	: European Agricultural Guarantee Fund
EAFRD	: European Agricultural Fund for Rural Development
CF	: Cohesion Fund
GLS	: Generalized Least Squares
EEC	: European Economic Community
ESIF	: European Structural and Investment Funds
ESF	: European Social Fund
EIB	: European Investment Bank
ERC	: European Research Council
LIFE	: L'Instrument Financier pour l'Environnement
PHARE	: Poland and Hungary: Action for the Restructuring of the Economy

ISPA	: Instrument for Structural Policies for Pre-Accession
SAPARD	: Special Accession Programme for Agriculture&Rural Development
CARDS	: Community Assistance for Reconstruction, Development, and Stabilization of Western Balkans
ENI	: European Neighborhood Instrument
DCI	: Development Cooperation Instrument
EBRD	: European Bank for Reconstruction and Development
SDG	: Sustainable Development Goals
ECHO	: European Civil Protection and Humanitarian Aid Operations
TURKSTAT	: Turkish Statistic Institution
CFCU	: Central Finance and Contracts Unit
TAIB	: Transition Assistance and Institution Building Component
RCOP	: Regional Competitiveness Operational Programme
EOP	: Environmental Operational Programme
TOP	: Transport Operational Programme
TEN-T	: Trans-European Networks
IPARD	: IPA for Rural Development
TKDK	: Agriculture and Rural Development Support Institution
GNS	: General Nesting Spatial Model
SEM	: Spatial Error Model
SAR	: Spatial Autoregressive Model
SAC	: Spatial Autoregressive Combined Model
SLX	: Spatial lag of X Model
SDEM	: Spatial Durbin Error Model
GSPRE	: Generalized Spatial Random-effects Model

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INTRODUCTION

Since the early 1960s, Türkiye has pursued a path toward European Union (EU) membership, seeking to harmonize its social, political, and economic systems with the EU's. Throughout this process, EU has provided Türkiye with pre-accession financial assistance through various programs. The purpose of these fund allocations is to support Türkiye's regional development initiatives to reduce regional disparities, support its reforms, strengthen its key institutions, and foster economic growth across the country. The main objective of EU pre-accession funds, particularly the Instrument for pre-Accession Assistance (IPA), is to offer targeted provisions for the social, economic, as well as regional development of Türkiye.

Despite Türkiye having received a significant amount of EU pre-accession funds, of which is detailed within a chronological perspective in sections 2.4 and 2.5 of this study, we are aware of no empirical study that examines how EU funding affects regional development in Türkiye due to absence of published data on data EU pre-accession funds. As there is currently a dearth of empirical data on this subject, the aim of this study is two-fold. Firstly, our aim is to establish a comprehensive data set on EU pre-accession funds at regional level. Secondly, in order to close this gap, this thesis examines the effects of EU pre-accession, particularly IPA, funds on Türkiye's regional growth by using the established comprehensive data set.

Spatial econometrics techniques are employed for the estimation of our model. First Law of Geography, which states that topics are more connected when they are closer together than when they are more apart, is taken into account in spatial econometrics (Tobler, 1970). This approach builds on recent theoretical advancements in spatial econometrics and uses the latest empirical data available for analysis. To our knowledge, it will be the first study that analyzes the impacts of EU pre-accession funds on regional growth of Türkiye by using spatial econometrics techniques.

Four primary chapters make up this study. Chapter 1 aims to establish a comprehensive theoretical framework that integrates regional development and growth theories. The chapter explores the topics of regional development and growth in detail, covering various aspects including the concepts of development and regional development, classification of statistical region units,

development indicators of a region, regional development policy approaches from historical perspectives, theories, strategies, and policies of regional development.

Furthermore, Chapter 1 delves into the historical perspectives of regional development policy approaches, including the different theories of regional development that have emerged over the years. It also discusses the various strategies and policies for regional development, along with examining the factors that affect regional growth, such as economic, social, political, and environmental aspects.

Chapter 2 provides a summary for EU Regional Policy, EU-Türkiye relations as well as development of EU pre-accession funds to Türkiye. This chapter provides an overview of Türkiye's path to becoming an EU member and the resources that the EU contributed to help achieve its regional development objectives. It begins by providing a brief history of EU-Türkiye relations dating back to 1963, when Türkiye formally ratified the EU's association treaty. The rationale behind EU financial aid and the criteria for eligibility are discussed accordingly. The chapter also delves into the different financial aid tools available within the EU regional development policy and highlights the financial aid provided specifically to recipient countries, and EU-Türkiye pre-accession financial cooperation.

More specifically, it examines the IPA funds utilization and value-added. Overall, the second chapter offers insights into EU allocated financial aid to support the journey toward EU membership and its regional development policies. IPA is a major funding source for Türkiye to support its regional development efforts.

Chapter 3 provides a perspective on the determinants of regional growth, discussing the main approaches used to study them and exploring the social, environmental, economic, as well as political determinants of regional growth. The impact of IPA financing for Türkiye is revealed in empirical research that highlights how EU funds affects regional economic growth.

In Chapter 4, an empirical examination of the results of EU IPA supporting regional development in Türkiye is provided. It starts with the specification of the model, and then the data and research technique are described. We provide a detailed explanation of how the data on IPA funds was constructed as well as descriptions of other variables used in the analysis. Next, we present the

estimation methods used in the study, including data model testing, spatial dependence, spatial weight-matrix, and spatial panel model selection strategy.

This chapter also provides information on spatial model selection, including testing for spatial panel data model selection, spatiotemporal modeling, spatially-lagged explanatory variables, dependent and explanatory variables logarithmic transformations, short-run, long-run, direct and indirect effects of independent variables, and local and global spatial effects.

Lastly, we provide model estimation results, which include final model structure as well as estimation outcomes, aiming to offer policymakers more precise insights based on empirical data, contributing to the current literature on regional growth.

Concludingly, this thesis aims to provide comprehensive impact analyses of the pre-accession funds on Türkiye's regional growth. It offers insights into the effectiveness of EU financial aid, regional development policy tools, and IPA funds in promoting regional growth. The study results hold significant policy inferences for both correspondents, particularly within their shared objectives of promoting sustainable economic growth and reducing regional inequalities contexts.

CHAPTER 1

REGIONAL DEVELOPMENT AND GROWTH

Regional development has always been a central policy objective for both the EU and Türkiye, as it helps to address regional disparities, reduce inequalities, and promote sustainable economic stability. Regional development has also been a key focus for economists, geographers, and sociologists since the early 1900s. While it is an often-overlooked economic process, its implications can inform policy decisions worldwide and devise viable solutions when addressing global challenges.

Regional differences arise depending on factors such as geographical conditions, natural resources, demographic structure, capital accumulation, quality of infrastructure, and the talents of entrepreneurs. This can lead to disparities in economic development between different regions. Appropriate policies should be implemented to reduce these interregional differences.

This specific branch of economics focuses on understanding how population, wealth concentration, land use patterns, environmental concerns, transportation infrastructure, and housing costs — among other factors— affect economic development at local levels.

Regional development has also been a key goal and challenge for policymakers in all countries. Following World War II, there was a growing focus on economic development and associated policies, leading to increased attention to regional development challenges. It was during the 1950s that regional development emerged as a distinct scientific discipline, marking a significant point in its history. (Pires Manso, J. R., et al., 2015)

Among these fields of economics, regional development policies started to gain utmost importance in the 1950–1970 period and were transformed by economic, political, social, and cultural changes. However, top-down regional development policy practices and theories lost their importance with the widespread acceptance of liberalization and globalization policies in the 1970s.

In the 1990s, there was a global consensus that the national economies should be integrated. For this reason, the inward-oriented industrialization strategy has been abandoned, and the outward-

oriented, or in other words, export-oriented industrialization strategy for integration with the world has come to the fore. The shift in the global production system has resulted in a transition from uniform national development policies that encompassed the entire country to region-specific development policies that prioritize local concerns and sensitivities. Therefore, in the post-1990 period, a transition from top-down development policies to bottom-up development policies has been observed.

The primary objective has been to address regional disparities by implementing suitable economic and political measures. Researchers have empirically analyzed the magnitude, causes, and dynamics of these disparities, both within and between countries, resulting in sustained interest in the spatial growth model, which is a recent addition to economic growth theory. Recently, there has been a shift in the focus of analysis from cross-country comparisons to individual country-level assessments.

The social sciences face a significant challenge in comprehending the regional development process. The geographic entities, along with other scales of the economy, are susceptible to intricate and multifaceted economic development processes that are subject to numerous factors. Given this complexity, there is a difficult question about the objective of social science in understanding these phenomena. (Baynes, T. M., 2009)

Different theories provide different perspectives on the factors that drive economic development and the mechanisms through which it occurs. Although no single theory can entirely account for this phenomenon, a combination of theories can enhance our comprehension of this significant concept.

As elaborated in Chapter 3 of this study, there have been plentiful researches that have endeavored to assess the theories' predictions using empirical data. While there is no clear consensus on which theory best explains economic growth, there is some solid evidence that supports the importance of both technological progress and institutional development in driving the growth.

Enhancing a nation's well-being requires a diverse range of government activities and policy measures. These may involve strategies aimed at boosting investment inflows, promoting trade, and generating employment opportunities. The formulation and implementation of such policies

are contingent upon a variety of factors, including leadership style, cultural orientation, economic philosophy, global events, and natural occurrences.

In order to navigate through these factors, nations must consistently evaluate and adapt their macroeconomic policies. The path to industrialization in developed economies has historically been marked by a series of transformative events and policy interventions. It is worth noting that progress toward development is not always straightforward and may involve a trial-and-error approach. (Adewale, 2017)

It is believed that regions within the same country are more likely to converge due to their shared socioeconomic characteristics. Therefore, it is indispensable to examine models focusing on regional interactions and the impact of proximity. The common sense of the underlying principle is to reevaluate the conventional regional growth model through the lens of the well-known First Law of Geography, which suggests "while everything is connected, the level of relatedness decreases with increasing distance". (Tobler, 1970)

In this thesis, we investigate how the spatial interactions between the provinces may have been influenced by IPA funds and their potential impact on regional growth. This study employs an analytical approach, leveraging the latest theoretical progressions in spatial econometrics, and utilizing the most recent data available for the analysis. Therefore, literature on economic development is of great importance in understanding the subject.

1.1. DEVELOPMENT CONCEPT

The development concept plays a significant role in shaping public policy around the world. Development is frequently linked with the notions of "growth", "advancement" and "expansion". It is typically viewed as “a means of generating employment opportunities and wealth, as well as enhancing the standard of living”. Additionally, it refers to a process of economic growth and reorganization that aims to improve a community's overall well-being. It is an array of interrelated adaptations that are woven into the economic system, all aimed at enhancing economic prosperity. (Agbenyo, 2020)

Development is a multifaceted and intricate concept that involves different social, economic, and political transformation dimensions, which necessitate substantial modifications to social

structures, attitudes, and institutions while simultaneously accelerating economic growth, reducing inequality, and eradicating poverty. It is perceived and experienced differently by different individuals and communities.

While the economic growth is a gauge for country economic performance as determined by the increase in its national product, nevertheless, it fails to provide a comprehensive overview of an economy's well-being since it overlooks factors like social, organizational, and institutional elements. A more comprehensive perspective involves employing the notion of development, which not only examines the quantitative aspect of growth, such as a rise in national income, but also the qualitative enhancements in well-being. Therefore, development is a dynamic process that entails both innovation, change, and should be viewed from a long-term standpoint, with an emphasis on overall well-being. (Pires Manso, J. R. et al., 2015)

The notion of development is characterized as the advancement of human life on both material and spiritual fronts. This is achieved by modifying the social, economic, and political assemblies of society and promoting social welfare. Development does not only include economic growth determined by general numbers but also structural and social changes. (Hartmann, D., 2018)

Growth refers to the numerical alteration in the economy's scale concerning investment, output, consumption, and income, whereas development relates to the qualitative modification in the economy's structure, encompassing technological and innovative advancements in institutions and behavior. (Barzel, Y., 1971)

Unlike growth, the development includes the following elements;

- Sustainable growth,
- Basic production and consumption pattern changes,
- Advancement in technology,
- Modernization of social, political, and institutional aspects,
- Enhancement of human welfare and well-being.

While growth concentrates on the "quantitative shift" in investment, income, output, as well as consumption size of the economy, development is described as "qualitative improvements" in

social and economic structures, encompassing advancements in institutions, behaviors, and technology. (Duman, A., & Duman, A., 2021)

Yeldan (2002: 20) defines development within this framework as an expansion of fast-paced growth, which involves "attaining a higher status in the global labor division and raising the living standards". Under this general approach, Adelman and Yeldan (2000: 143) underline the following five imperatives for the realization of development:

1. Achieving sustainable economic growth,
2. Facilitating structural changes in production and consumption patterns,
3. Encouraging technological progress,
4. Fostering social, political, and institutional modernization,
5. Promoting comprehensive improvements in living standards.

As can be seen, behind the development lie the investments made in human beings and the increase in living standards. In that case, development is a complex process that is influenced by economic, political, cultural, psychological, and technological factors.

The national economy views regions as its foundational components. Hence, countries must cultivate competitive and dynamic regions to accomplish their own economic and social objectives. Regional economic policy centers on enhancing competitiveness as its primary focus. (OECD, 2003) In this framework, regions have become an important competitive advantage in a world with strong international competition. (Boschma, 2004)

The strategy of promoting competitiveness, initially employed nationwide, is swiftly adopted in regional, urban, and local policies. To improve the national economy's overall competitive edge, the regional foundations of national competitiveness must be strengthened, and regional-level intervention mechanisms should take action to enhance the competitiveness of all regions. (Gardiner, B., Martin, R., & Tyler, P., 2004)

Regional development offers numerous benefits for the national economy:

- Achieving rapid progress by utilizing resources from different regions for economic activities,

- Attaining a balance between population and resources throughout the country,
- Arranging the economic landscape and urbanization in a manner conducive to economic growth, and
- Reducing disparities in welfare levels between different regions.

The concepts of regional growth and regional development are interrelated and have different meanings. Development is the improvement in the aggregate capacities of elements such as productive activities, value added (labor and capital), institutions, households, and their quality of life in a regional or national economy. On the contrary, regional economic growth relates to the outcome that stems from these factors in the region. (Giarratani, F., et al., 2013)

Economic growth provides only limited quantitative data about the structural characteristics of the national or regional economy, whereas development denotes a qualitative transformation. Development is a concept related only to underdeveloped economies, while the growth process is related to both developed and underdeveloped economies. (Han & Kaya, 2006)

Regional development covers a range of investigations that consider the outlook of a region as formed by the interplay between the region, its neighboring regions, and its global surroundings. It adopts participation and sustainability as fundamental principles and aims to enhance the well-being of the region by developing human resources and mobilizing economic and social potential.

The economist H.W. Singer once said “underdevelopment is like a giraffe that is easily recognizable but difficult to define”. In other words, it is a concept defined by images of development (Singer, 1978). Despite being a topic of discussion for many years, the concept of development has yet to be fully explained, which is due to its multifaceted nature.

Among the various issues that have been widely studied in recent years, economic development is one of the most widely studied. A topic requires knowledge from various social sciences and has resulted in the creation of new literature. To understand this literature, one must have a philosophical background, be well versed in economics, have a good understanding of history, be familiar with the mathematical sciences, have knowledge of geography and anthropology, and have taken advanced courses in social psychology. (Mayer-Foulkes, D., 2008)

The "regional development" concept appeared in economic literature in the wake of World War II. It involves a collection of research that prioritizes regional development, participation, and sustainability as fundamental principles and strives to promote the region's welfare by developing human resources and stimulating economic and social potential. In the EU, those policies began to gain importance with the enlargement process. With the first enlargement in 1973, it was observed that regional differences emerged increasingly. (Pike A., 2017)

The emergence of regional policies in Türkiye dates back to the 1960s, during which the policies aimed to reduce regional disparities and foster nationwide economic advance. Regional development principle, as a foundation for investment distribution, was incorporated into the five-year national development plans, which commenced in 1963. Türkiye has prioritized reducing regional inequalities as a candidate for EU membership and, since 2001, has implemented institutional and legislative rules to align with the regional policies of the EU.

Along with globalization processes, regional development is handled as a global problem for all countries in the world. Regional development is acknowledged as a worldwide challenge by global foundations including the World Bank, United Nations, European Union, and OECD. Therefore, “regional development agenda” has begun to be evaluated at a global level widely, such as in sustainable development, democratization, and security perspectives. (Barca, F., 2012)

1.2. STATISTICAL REGION UNIT CLASSIFICATION

The size and content of the spatial unit that the word “region” refers to may vary according to the context in which the word is used. The concept of “region” can sometimes represent a neighborhood, sometimes a city, a region consisting of several provinces, a piece of land, or a continent formed by several countries.

The etymological root of the word region comes from the Latin “regio: environment-area”. Region is a multidimensional, multi-meaning concept that can hardly be drawn. For this reason, the geographical, cultural, ethnic, urban, and administrative criteria used make it necessary to define different regions. (Toktas, Y., 2018)

The notion of a region is a dynamic and adaptable concept typically linked to a rather large land area with distinctive topographical, political, or cultural characteristics that distinguish it from other

areas. For statistical reasons, such as NUTS-2, regions are sometimes referred to as territorial entities in the European Union. (Medeiros, 2022)

Although the determinants of the concept of the region are complex, it is sometimes seen that it covers larger areas than a state. But the distinctive feature of the area taken as a basis is the existence of a medium spatial unit between the state and the existing local governments. A region, as a part of a state, shows the division of public organizations within the state.

During the EU candidacy process, Türkiye was asked to identify the target regions and NUTS regions at three levels to comply with the EU regional policy. Within this context, the Statistical Regional Unit Classification investigation was carried out in 2002. Following the Statistical Regional Unit Classification analysis, Türkiye was categorized into 12 Level_1 (NUTS-1), 26 Level_2 (NUTS-2), and 81 Level_3 (NUTS-3) regional units.

In the definition of NUTS-2, it was foreseen to bring units together with socioeconomic, cultural, and geographical similarities. There is no administrative division in Türkiye corresponding to NUTS-1 and NUTS-2 levels. For this reason, to solve this problem, provinces in Level_3 were grouped, and NUTS-1 and NUTS-2 levels were determined. (Kılıç, S.E., 2009)

1.3. DEVELOPMENT INDICATORS OF A REGION

Regional development refers to the process of improving and enhancing the overall well-being and economic prosperity of a specific geographic area over a period. It is a multifaceted concept that encompasses the region's social, economic, and cultural aspects. The process involves a number of fundamentals, including changes in the indicators, economic growth, as well as the complex dynamics of the region. (Nijkamp, P., & Abreu, M. A., 2009)

As indicators of the development or welfare level of a region, several widely accepted indicators can be used (Bleys, B., & Whitby, A., 2015), including:

Gross Domestic Product (GDP): This estimates complete economical production of any unit and is frequently utilized as a general gauge of the region's overall economic well-being.

Human Development Index (HDI): This assesses a region's overall prosperity by considering factors like life expectancy, education, and standard of living.

Poverty rate: This determines the proportion of people who are impoverished. It is frequently employed as a gauge of economic disparity.

Employment rate: This measures the percentage of the population that is employed and is often used as the activity indicator of economy.

Infant mortality rate: A measure of under-one-year-old newborn deaths for every one thousand live deliveries and is often used as a gauge of a population's overall health and well-being.

Education level: A measure for the level of education in the observation unit.

Access to basic services: This measures the availability of basic services such as healthcare, sanitation, and electricity in a region and is employed as a gauge of overall well-being.

GDP per capita and the unemployment rate are the two metrics that are most frequently utilized; however, one should use them with extreme caution since there are important handicaps encountered both in the calculations and in the comparisons to be made within the countries.

For example, in some agricultural regions, when the unemployment rate is taken as a basis, a low rate may be encountered, which may not show the situation of that region correctly because there is a chance of employing more people than what is necessary to work in the unit area or because there is “covert unemployment” in the area. (Noorderhaven, N., et al., 2004)

Local development includes micro-scale developments in settlements such as provinces, districts, towns, and villages, while regional development includes micro- and macro-scale developments as a result of the planning made in the provinces in a certain region and their settlements.

1.4. REGIONAL DEVELOPMENT POLICY APPROACHES BY HISTORICAL PERSPECTIVES

Regional policies refer to the strategies and actions taken by governments to address economic and social disparities among different regions within a country. These policies have become increasingly important since the 1950s, as countries have sought to promote economic development and address issues such as poverty and unemployment in specific regions.

The methods and plans employed in regional policy have transformed over time in reaction to varying global circumstances and the progress of regional development. The evolution of any society from industrial one to the information can be examined by dividing it into three distinct periods, each representing different regional development paradigms. (Diez, M. A., 2001)

The first period, which spanned from 1945 to 1980, is referred to as the conventional era of regional policies. The "welfare state" philosophy predominated during this time, and the state played a significant role by actively influencing growth.

After 1945, regional development gained prominence as the aftershocks of World War II diminished and the reconstruction of physical infrastructure and production capital began. During this period, regional problems in many countries aggravated, the non-agricultural population and the problems experienced in the traditional heavy industry caused an increase in unemployment, and intense migration to large urban centers was experienced. As a result, overcrowding occurred in the centers where large concentrations were experienced, and the need for infrastructure emerged. There was a prevailing consensus that the solution to these problems could be achieved with proper planning and state intervention. (Bachtler & Mendez, 2016)

Four different policy tools were applied to problematic areas characterized by lethargic economic growth, low levels of income, and low employment rates within framework of eliminating differences at the local level and achieving equalization concerning living standards, infrastructure, and employment (Dall'Erba, S., & Le Gallo, J., 2008). These tools are:

– Financial incentives such as grants, loans, tax relief, depreciation allowance, insurance share allowance, transportation subsidies, worker training assistance, and rental fee subventions;

– Infrastructure investments implemented, specifically in countryside and zones with low population density;

– Realization of investment objectives and fulfillment of social commitments through state owned/controlled industrial enterprises;

– Keeping development of the manufacturing industry under control or relocating the administration centers of public and private sector enterprises to channel development dynamics from very dense areas to more suitable regions.

The second period is the crisis experienced in the late-1970s and, as a result, transition passé (1980–2000), in which the understanding of strong state intervention weakened and internal growth dynamics gained importance.

The economic crisis that emerged in the late 1960s and intensified with the two oil shocks during mid- and late-1970s resulted in decline of the highly centralized, state-driven regional policies that had gained prominence within the development economy framework. Consequently, nation-states were impacted by the economic depression, and their dwindling resources rendered them incapable of implementing the policies they maintained at regional level. (Cammett, M., 2016)

During this period, efforts were made to revive the global economy by relocating business activities to areas with low labor costs. This was done in an attempt to maintain profitability. Additionally, there was a trend towards downsizing the welfare state, reducing its functions, and limiting its tools and influence as an economic and social actor. (Bachtler & Mendez, 2016)

These advancements have made "Endogenous Regional Development" idea, which is grounded on awareness for using local properties, clearer. This concept, which emerged with the adaptation of the endogenous growth concept to regions, emphasizes the importance of unique information resources of the regions and the externalities brought about by the agglomeration in the region. (Johansson, B., Karlsson, C., & Stough, R., 2001)

The “Regional Development Based on Endogenous Growth” approach views regions as economic units with untapped and underutilized resources. Rather than relying on external resource transfers for development, regional policies aim to mobilize and utilize existing resources within the region. As a result, it has become essential to enhance the institutional capacity in the region and foster collaboration to develop and implement strategies and policies for regional development.

The third period, which continues from the beginning of the 2000s to the present, is characterized as the novel regional architype period, where global competition dynamics are emphasized at the highest level and competition based on innovation and the information society comes to the fore instead of classical competition elements.

The 2000s marked a decade where the world was largely perceived as unipolar and technological advancements resulted in a changeover from the industrial society to the information one, as well as a shift from a nation-state world to a globalized world. (Tekeli, 2004)

Today's approach to regional development places significant emphasis on local expertise, institutionalization, and relationships among local entities as key factors. States have started defining measures in practice to increase the economic contribution of regions with specific potential and accumulation. Nevertheless, they also strive to reduce their expenditures and resource transfers in return. (Martin R. L., 2005)

The region is now at the forefront of development and growth processes as the consequence of advancements in globalization processes. The relevance of regional networks, clusters, and specialization, as well as the application of local tacit knowledge at regional level, are some of the primary factors contributing to the growing significance of regional economies and to success of regions in providing flexibility and adaptability in the face of uncertainties. (Park, S. O., 2001)

The major three periods of the Regional Development Policy approach, along with their characteristics, are shown, below.

Table 1: Characteristics of Regional Development and Growth Policies by Periods

Periods	1950–1970	1970–2000	2000–present
Source of Regional Growth	External Demand, Government Redistributive Decisions Decisions of Transnational Firms	Endogenous (bottom-up) Approach	Developing from the Inside (Technical and Organizational Innovation)
Elements of Regional Development Dynamics	Capital Accumulation Investment Dynamics Vertically Integrated Economy	Human Capital Development Vertical Dissolve Horizontally Integrated Economy	Driven by technical as well as organizational innovations Semi-Vertical Integration Creating Social Capital

	Trade Dependencies (Input-Output Relations)	Collective Entrepreneurship Non-Trade Interdependencies	Social Embedded Economic Relationships Non-Trade Interdependencies
Reasons for Comparative Advantage	Given Advantages (Geographic Advantages) Economies of Scale + Economies of Aggregation	Historically Accumulated Advantages Economies of Scope + Economies of Aggregation Commonly Used Infrastructures	Historically Accumulated Advantages Network Externalities (Local Networks, Supra-Local Networks)
Spatial Reflection of the Growth Dynamics of Regional Economy	Growth Pole Spreading Effect Backwashing Effect	New Industrial Spaces	Innovative Learning Zone Regional Innovation Systems Innovative Environment Location Dependent = Route Dependent
Management Style	Strong Nation State-Welfare State Inequality Sensitive-Redistributor	The Welfare State's Crisis Growing Influence of Local Governments	Country as Global Governance Partner New Players of State Public Domain (NGOs)
State Policy Tools	Direct Investments in Producer Activities Infrastructure Development Regulatory Measures Control overflows (capital, goods, labor)	De-centralization of Supply-Side Policies Infrastructure Development Regulatory Measures Importance Given to Local Institutions	Transnational Networking (Global/Local) LAN Formation Formation of Innovation System Openness to Corporate Innovation
Actors of Steering Mechanism of the Social System	Well-structured Bureaucracy Planning-Programme Oriented Bureaucracy	Bureaucracy Based on Delegation of Authority Principle Horizontal Relationships	Governance (Multi-Actor Steering and Partnership) Increased Self-Management Capacity

		Contract Relations Balance of Competition and Cooperation	

Source: Adapted from (Tekeli, 2004)

In the process of the fundamental transformations mentioned above, the "New Regionalism" paradigm, which means ensuring the development of the skills, communication networks, and institutional competence required to face the effects of globalization and compete in the global market, has come to the fore.

The new regionalism is a third approach to regional development that emerged as an alternative. It is often referred to as the "third way" of addressing regional development issues, as it is an alternative to traditional top-down, state-driven methods and free market approaches that turned out to be insufficient. (Söderbaum, F., 2003)

The new regionalism emphasizes that the mechanisms necessary to support economic development should be developed by the regions themselves rather than by the state. In the new approach, there is an improvement of the local supply infrastructure, a bottom-up approach, and an orientation towards long-term policies specific to the region.

Presently, regional development is based on a new strategy that prioritizes human capital, regional learning, and networks for knowledge transfer, high-quality production factors and systems, and local business cultures. The decision-making process has also shifted to lower levels of management, which is one of the unique hallmarks of the new strategy. (Asheim, B. T., 2019)

This shift in regional policies is also reflected in the efforts of international organizations like the EU and OECD. "Regional Development Policies Committee of the OECD", which was established as a platform to exchange views in the international arena to develop innovative strategies related to regional development in OECD member countries and to ensure that successful policies are spread to member countries, puts forward policy recommendations in this context.

Although today's regional development policy varies from country to country due to the historical processes, economic conditions, and different political approaches of the countries, some common features are seen in country practices. (OECD, 2018)

Main ones are:

– emphasizing an approach that targets all regions, not just certain backward regions,

– enhancing competitiveness by maximizing the potential and contribution of each region to national development through the optimal utilization of its resources and opportunities, rather than redistributing growth among regions.

– moving towards an approach that puts more emphasis for human capital development, intangible production factors, behavioral patterns to improve institutional infrastructure, inter-actor networks in regions, the business environment, and the skills of regions,

– aiming to increase inter-institutional relations and interaction to ensure inter-firm cooperation, technology transfer, and information flow, instead of meeting the needs of individual actors such as individual firms,

– focusing on identifying, developing, and sustaining regional competitive advantages,

– seeing innovation and entrepreneurship as the main tools for unlocking the potential of regions,

– existence of intervention areas in regional policies, such as physical infrastructure, business models, research and technology, social capital, as well as the environment,

– taking a proactive approach to development with multi-annual operational programs that include measures for the business/investment environment and non-physical infrastructure,

– comprising an approach that involves local government, NGOs, and business sector (especially SMEs) involvement, with the central government taking the lead in enhancing the investment environment and providing essential infrastructure through regional coordinating units,

– giving regions greater duties and powers in economic development.

1.5. THEORIES OF REGIONAL DEVELOPMENT AND GROWTH

Regional development concept began to receive significant attention only following World War II's end. This increased focus resulted in the emergence of various theories of regional development put forward by scholars in the field. There has been considerable scholarly discussion and

competing viewpoints in recent years on the best and most efficient policy measures to advance development in various regions of the world. (Capello & Nijkamp, 2009)

Numerous hypotheses and individual claims about regional development currently coexist and continue to exist. These hypotheses or proposals would be difficult to categorize into distinct categories, even if that were possible. It is feasible to move theories from one group into another by adding new propositions. It is also possible to increase the scope of a theory by building cordial relationships with diverse theories of social change and development. Generally speaking, ideas about regional development are pragmatic in nature and aim to address real-world issues. As a result, political decisions heavily influence both the questions asked and the variables used.

Regional development theories propose different explanations for why some regions experience economic growth and development while others do not. These theories often have corresponding models that are used to analyze and understand the dynamics of regional development. The important consideration is not whether some models are better than others are, but whether they are appropriate for their intended purpose. The overall usefulness of a theoretical instrument can be determined by its ability to adapt and provide answers to questions posed in various ways.

A major limitation of regional development theory is its tendency to overlook the insights that can be gleaned from the experiences of underdeveloped regions and to neglect their unique circumstances, which can create challenges when crafting policies and allocating funds aimed at reducing underdevelopment in lagging regions.

The problem is that the funds and policies could be designed based on the experiences of prosperous areas, assuming that less developed areas will progress along the same path as developed areas and that success and failure are symmetrical processes. However, this presumption has been discredited because advanced and less advanced countries and locations might have distinct economic potential factors. (Petrakos, G., et al., 2008)

In research on this subject, Artelaris et al. (2007) discovered that the top 10 characteristics that encourage economic development differ across advanced and less advanced locations. The top 10 characteristics that encourage economic development, as identified by Artelaris et al. (2007):

Advanced regions:

- Human capital: The availability of skilled labor is a key factor in economic development.
- Research and development: The capacity to innovate is essential for economic growth.
- Infrastructure: A well-developed infrastructure, such as roads, bridges, and airports, is important for businesses to operate efficiently.
- Financial markets: A well-functioning financial system provides businesses with the capital they need to grow.
- Openness to trade: Trade allows businesses to access new markets and raise their sales.

Less advanced regions:

- Political stability: A stable political environment is critical for businesses to invest.
- Rule of law: A strong legal system protects property rights and guarantees that businesses are treated fairly.
- Access to credit: Access to credit allows businesses to flourish.
- Education: The accessibility of education helps to create a skilled workforce.
- Infrastructure: A well-developed infrastructure, such as roads, bridges, and airports, is indispensable for businesses to operate efficiently.

This shows that a generalized approach to policymaking might not be appropriate for both sorts of areas. It is unrealistic to assume that implementing a missing factor will lead to success in regions that have structurally different resources.

As the European economic space becomes more integrated, regional inequalities are not only high but may even increase further due to a mix of factors that affect different areas in distinct ways. Furthermore, it is becoming increasingly obvious that no single explanation can fully account for the complex mechanisms of spatial change. It is a difficult notion to consider that current models of convergence and divergence could work better together than in competition to explain the connection between inequality and growth. (Petrakos, 2009)

While traditional economics focused on generation, distribution, and consumption as well as use of national resources, neoclassical economists focused more on the problem of resource allocation. In this framework, neoclassical economics has played a pioneering role in analyzing regional imbalances and putting forward regional development policies.

Solow-Swan (1956)'s growth model is the foundation of neoclassical growth theory and is used as a starting point to explain theories of regional growth. The model regards technology as a crucial element that propels economic growth and presupposes steady saving rates, constant returns to scale, and marginal returns on inputs that are positive but diminish over time.

The process of capital accumulation leads to regional convergence, and the expansion rates of the labor force, capital stock, and technical advancement are seen as the main forces behind the regional expansion. However, the growth rate eventually slows down stemming from diminishing marginal returns of capital, limited technological advancements, as well as absence of externalities in the long run. (Nijkamp, P., & Abreu, M. A., 2009)

Neoclassical growth theories rely on suppositions of steady returns-to-scale and perfect competition, which over time reduce the capital's longstanding marginal product. The mobility of factors across regions is expected to ensure that returns on capital and wages converge across regions, making regional disparities short-lived. Regional convergence is anticipated to result from self-correcting changes in costs, wages, capital, and labor. (Ball & Mankiw, 2023)

In contrast to conventional neoclassical growth theories, "pure agglomeration theories" or "new economic geography theories" propose that the process of growth is spatially cumulative and selective which may exacerbate regional inequality and result in long-term income disparities between regions. These theories combine the cumulative causation theories of Myrdal (1957), the export base model of Kaldor (1964), and Perroux's (1955) polarization theory.

The cumulative causation theory argues that development in one region can lead to underdevelopment in another region due to the uneven distribution of resources, technologies, and markets. They claim that factors such as imperfect markets, externalities, and economies of scale, in addition to capital and labor availability, play a role in causing income divergences between regions. (Petrakos, 2009)

Pure agglomeration theories state that when a dominate business or sector establishes operations in a particular area, it may lead to a concentration of capital, labor, and output there due to favorable externalities and scale economies. A self-reinforcing cycle of economic activity and the concentration of production elements can then be set off by this, further promoting demand, output growth, wealth, and migration.

According to the idea, if industrial polarization starts to occur in a certain area, endogenous variables, including economies of scale, factor mobility, and externalities, may eventually lead to a long-term increase in production and regional income inequalities. Furthermore, the theory suggests that the initial location choices of dominant firms and sectors could be impacted by historical and geographical considerations.

Over the years, several theoretic viewpoints, including urban development models, path dependency, new economic geography, core-periphery models, as well as endogenous growth models, have all provided varying degrees of support for this central claim. (Boschma, R., 2008)

The debate between these two schools (i.e., convergence vs. divergence) of thought has been ongoing for several decades, with evidence supporting both perspectives. Recent studies indicate that both convergence and divergence can coexist, contingent on contextual and analytical levels. Moreover, it is noteworthy that neoclassical theories rely on formal models and are more conducive to empirical testing. Conversely, divergence theories are qualitative in nature, accentuating the roles of historical processes as well as structural aspects in configuring regional development patterns. (Petrakos, 2009)

Endogenous growth theories by Romer (1986, 1990) and Lucas (1986) and new economic geography models developed by Krugman (1991) have been used to create new regional growth theories in the field of regional economics. These theories emphasize how important scale economies, externalities, and rising returns are in driving regional growth variances. Additionally, they emphasize how endogenous factors are crucial for boosting productivity and increasing returns, which in turn causes regional income disparities to widen over time.

Supporters of endogenous growth theories argue that variables such as research and development (R&D) efforts play a significant role in driving disparities in regional incomes and growth, as well as influencing investments in physical and human capital. (Mıhçı, S., & Köksal, M., 2010)

Most recent perceptions of economic geography focus on how economic activity is distributed geographically and how geography affects growth. According to theories in this subject, spatial determinants and agglomeration effects, such as scale economies and externalities, which result from factors like transportation costs, regional market size, and labor mobility across areas, are what lead to regional growth inequalities. (Fujita, M., & Mori, T., 2005)

Understanding the advance of regional "centers" and "peripheries", as well as the concentration of industries in certain places requires an understanding of the interaction between external economies of scale and transportation costs. Businesses prefer to locate in areas with large markets because of the increasing returns and reduced transportation costs. Consequently, the central regions are expected to exhibit higher levels of economic activity and income compared to peripheral regions. (Martin, R., & Sunley, P., 1996)

The variation in the level of development between regions is attributed to differences in households, as a macroeconomic unit, having different populations, different quality and levels of productivity in the workforce, different income levels, and different consumer preferences in all regions of the country, as well as entrepreneurs creating and operating in different sectors that are suitable to the conditions of the region. Therefore, all regions in a country have different levels of income, employment rates, productivity, comparative advantages, and development levels. The main determinants of regional development are innovation, infrastructure, and human resources. (Crescenzi, R., 2005)

In conclusion, the recent theories of regional growth underline the reputation of factors such as social capital, spending in R&D, and increasing returns, alongside geographic considerations like market size and transportation costs, to account for the disparities in income across regions.

Despite the advancements in the theoretical understanding of economic growth, a comprehensive framework supported by empirical evidence is still lacking. This is due in part to the complexity of the phenomenon and the focus of theoretical models on specific factors. However, the growth of empirical studies has been hindered by contradictory and inconclusive findings. This highlights the need for continued research to gain a deeper understanding of the complex economic growth nature.

Theories for regional development could be categorized into three primary classifications:

- Theories that stimulate the development process internally
- Theories that stimulate the development process externally and
- Theories that stimulate the development process spatially. (Dawkins, C. J., 2003)

1.5.1. Theories of Internal Stimulation for Development

These theories, which are also called “endogenous growth theories”, place a strong emphasis on the contribution of internal elements, such as innovation and technical advancement, to economic progress. They suggest that growth and development are not solely determined by external factors, but rather by the region's capacity to produce novel concepts and technologies.

These ideas contend that investments in human capital, R&D, and technical innovation can bring higher productivity and longstanding economic progress. More specific theories such as the "Sectoral Theory" and the "Linear Stages Theory," which are used to analyze and understand the dynamics of regional development within an endogeneity context, have been developed.

1.5.1.1. Sectoral Theory

The Sectoral Theory of Development is an endogenous theory of regional development that emphasizes how different economic sectors contribute to an economy's overall development and growth. According to this theory, development takes place when specific segments, including agriculture, services, and manufacturing, are expanded as well as modernized.

Employment as well as production shift from primary sectors, like agriculture, to secondary sectors, like manufacturing, and lastly to tertiary sectors, like services, during this process. The theory also stresses the significance of government intervention and investment in key sectors to encourage economic growth and development. (Barcenilla-Visús, S., et al., 2014)

It suggests that the success of a country's key sectors significantly shapes its economic development. Economic growth and development specifically take place as employment moves from primary sectors (like agriculture) to secondary (manufacturing) and tertiary (services) sectors. However, an increase in employment in a sector, particularly agriculture, may eventually result in a drop in per capita income. As a result, the industrial sector is ready to grow as labor moves from agriculture to industry. Government involvement and investment in vital industries are also considered be crucial elements in fostering economic development.

The industrial sector, characterized by strong demand elasticity for its products, has some important share for driving economic growth. As demand elasticity of any manufactured good increases, its contribution to economic growth becomes more pronounced. Conversely, the agricultural sector, with its low demand elasticity for its goods, contributes less to overall economic development. Therefore, it assumes the demand elasticities of the goods of different sectors in a regional economy are different from each other. (Hesse, H., 2009)

The theory suggests that economic development begins with advancements in a primary sector and subsequently spreads to the secondary and tertiary sectors that are associated with it. This is driven by the income elasticity of products in these sectors and the variations in average earnings per worker across different sectors. By highlighting the differences in demand and productivity elasticities between sectors, the theory provides insight into the significant factors that contribute to the growth of an economy. (Krüger, J. J., 2008)

The theory assumes internal dynamics as the basis for the development of the region. It links economic development to intensifications in specialization and division of labor, the volume of economic activity, and individual income, overlooking factors that may come from outside the region.

1.5.1.2. Theory of Linear Stages

The theory of linear stages of development, also known as the "unilinear theory of cultural evolution," posits that all societies pass through a series of distinct and universal stages of development in a linear, unilinear fashion. The theory was first proposed by anthropologist Lewis Henry Morgan in the 19th century and later popularized by cultural evolutionists such as Herbert Spencer and Julian Steward. (Steward, J. H., 1972)

According to the theory, the political, cultural, and economic structures of societies are similar to each other. For this reason, underdeveloped countries will ensure their development by following development strategies in the development path of developed countries. According to this theory, every society should follow a certain development line and see underdevelopment as a transitory phase in the process of development. (Mercado, R. G., 2002)

According to Rostow's theory, all societies will go through a five-stage progression, which involves the “traditional society, preconditions for take-off, take-off, drive to maturity, and age of high mass consumption”, as he explains in his analysis. Rostow's "The Stages of Economic Development (1960)" is widely regarded as the most authoritative exposition of his theory.

Although economists find Rostow's portrayal of economic transformation, especially the take-off phase, to be intriguing, economic historians tend to view his stage definitions as insufficiently precise for accurately describing the economic growth histories of different nations. (Tsiang, S. C., 1964) This model of cultural evolution has been widely criticized for its “Eurocentric bias” and its failure to account for the diversity and complexity of human societies and cultures.

1.5.2. Theories of External Stimulation for Development

Various theories of regional development propose that external factors, such as government policies or access to markets, can stimulate economic growth and development.

They have been developed into more specific theories/models such as the "export-based model", “import substitution industrialization (ISI)”, and "structural change theory", which are used to analyze and understand the dynamics of regional development within its exogeneity context.

1.5.2.1. The Export-Based Model

The export-based or export-led growth model is a theory of development that places a strong emphasis on the role that exports play in promoting economic development. According to this theory, a country can achieve economic development by increasing its exports, especially manufactured goods and natural resources. To attain this objective, governments can adopt policies that facilitate the growth of export-oriented sectors, such as investing in infrastructure, education, and training, as well as offering incentives to companies for exporting. The theory also suggests that a country can attract foreign investment by creating a conducive environment for business through policies such as low taxes and relaxed regulations. (Loayza, N. et al., 2017)

The Export-Based Model, which is based on static analysis, is one of the most widely used methods in regional economic analysis. The multipliers obtained from the model can be used to estimate changes in income or employment created by regional exports.

Foreign trade is one of several variables that helps make it possible for growth to occur. Smith and Ricardo were the first theorists to stress the significance of commerce in economic research. A nation may increase its competitiveness by concentrating on producing the good in which it has a comparative advantage; as a result, it will export that good and experience higher prosperity than in the pre-trade scenario in which it must produce both items. (Feenstra, 2015)

According to export-based development theories, a region's competitiveness in foreign trade is a very important determinant of its overall economic performance and success. It highlights indirect impacts of the region's export-based sectors in generating income, investment, and productivity growth and the multiplier effect on the region's non-tradable activities. There has been a global trend towards an export-oriented growth strategy in the last three decades. The growth seen in exports creates an increase in production, employment, and consumption. (Loayza, N. et al., 2017)

Export industries allow for the growth of the domestic market, which enables the utilization of economies of scale and lower unit costs. The export sector allows a country to specialize in products that have lower unit costs, and use abundant production factors intensively, and trade based on comparative advantages. This situation requires efficient use of resources. International competition further improves this efficiency by forcing companies to adapt to modern technology and produce quality products. (Bernard, A. B., et al., 2007)

Proponents of this theory argue that exports stimulate economic growth by increasing productivity, creating jobs, and generating foreign exchange. It must be stressed that some critics of the export-led growth paradigm argue that enhancing the export sector is not a universally applicable solution for development and that a country's unique circumstances and institutional framework are what determine a country's success in this aspect.

1.5.2.2. Import Substitution Industrialization (ISI) Theory

The ISI industrial policy aims to promote economic development by building local capacity to substitute imports and reduce economic leakage, as well as by protecting domestic industries from foreign competition through import tariffs and other protectionist measures. It suggests that by protecting domestic industries, a country can encourage the development of a strong industrial base and reduce dependence on imports. (Adewale, 2017)

Apart from its role in encouraging import substitution and minimizing economic outflow, the industrial policy of ISI is also viewed as a means of accomplishing economic diversification. Empirical data from developed economies demonstrates that this objective can be attained through the policy's mechanisms, including lowering tariffs on input materials, imposing high import tariffs on domestically produced goods, introducing exchange rate disparities, and eventually removing export tariffs. These steps enable developing economies to gain the industrial expertise required to compete in the export of manufactured products. (Balassa, 1975)

Following World War II and the worldwide economic downturn, the ISI policy gained popularity in developing nations as a means of augmenting exports and expanding the economy. The BRICS countries, as well as Türkiye, all implemented the ISI policy at different points during their industrialization journeys. Despite all five nations reaping substantial gains from its adoption, the degree of benefit widely varied among them.

1.5.2.3. Structural Change Theory

The theory of Structural Change suggests that increased productivity and economic growth may be achieved by redistributing labor and resources from minimal-productivity sectors like agriculture to strong-productivity sectors like manufacturing or services. It considers how emerging nations might change their internal economic structures to go from traditional subsistence farming to a more modern, urbanized, and diversified industrial and service economy. (Buera, F. J., et al. 2012)

The process encompasses changes in the organization and distribution of production and employment across all sectors of the economy, including new industries emergence and decline of aging ones. Many authors have documented this process of structural change.

Arthur Lewis' theory, also recognized as "Dual Sector Model", focuses on the transference of labor to the industrial sector from the agricultural sector as the driving force for economic development in developing nations. He argues that in a developing economy, there is an excess supply of labor in the agricultural sector, leading to low wages and high profits.

As the industrial sector grows and becomes more profitable, it attracts labor from agriculture, leading to higher wages and lower profits in agriculture. This process continues until wages in agriculture become equal to those in industry and the economy reaches a state of development. The theory is widely acknowledged for its comprehension of the process through which the economy is transformed from conventional agricultural to contemporary industrialized one. (Agbenyo, 2020)

As per Sewell's definition, “structure” encompasses any repetitive pattern of social conduct or the systematic connections between various components of a social system or society. Social structure is deemed one of the most crucial yet challenging concepts to comprehend in the field of social sciences. (Sewell, 1992)

It is believed that structural change has two primary underlying factors. The structural change can be driven either by differences in income elasticities of demand for different sectors (demand-side explanation) or by differences in productivity growth across sectors (supply-side explanation). In growth models, it is often assumed that people's preferences are similar across all goods and that consumer spending is the same for both wealthy and poor people.

It is also a widely held belief that productivity growth is uniform across all sectors. These assumptions simplify analysis but do not accurately reflect reality, making it difficult to use these models to fully understand the process of structural change. (Syrquin, 2012)

The idea of structural change emphasizes the significance of understanding and addressing the underlying social and economic forces that both facilitate and hinder economic progress. It emphasizes the need for policy interventions that support and encourage structural change to accomplish sustainable economic progress and development. (Schilirò, 2012)

1.5.3. Theories of Spatial Stimulation

There is a growing understanding that the economy and spatial structure of a region are interconnected and cannot be studied separately. This has led to a need for a more holistic approach that considers both economic and spatial factors in analyzing regional development.

The interdependent, yet dynamic, correlation between a region's economy and its spatial arrangement is crucial since transformations in one can instigate alterations in the other. For instance, as sectors of a growing regional economy undergo technological advancements, there may be changes in their placement, leading to a distinct spatial arrangement. Likewise, replacing pre-existing sectors with novel ones that have specific location prerequisites can also trigger changes in the region's spatial structure. (Barkley, D. L., et al., 1996)

Numerous theories have been proposed that emphasize the significance of spatiality in fostering regional development. All these theories underscore the crucial role of spatial factors in propelling regional development, and each of them advocates for encourage economic development based on the unique requirements of a given region.

1.5.3.1. Growth Pole Theory

Growth Pole Theory of regional development is an economic theory that proposes that the emergence of a few significant sectors, or "growth poles," in a given area may foster regional economic development. The idea contends that by focusing resources and investments in key growth poles, a "domino effect" may be produced, wherein the rise of these vital businesses promotes the growth of related industries and infrastructure in nearby areas.

The theory was first proposed by French economist Jean Fourastié in the 1950s and later developed by French economist Pierre-Paul Guiraud. The growth pole and growth center theories gained significant attention in the 1960s and 1970s as a means for accelerating regional economic progress.

These concepts were seen as strategic tools for driving economic development in specific regions. Several countries, including Italy, Spain, France, and Brazil, have implemented these theories and provided interesting examples of their application. The theories have been applied in many other

countries as well, and they were seen as useful to spur economic development and reduce regional disparities. (Fischer, S., & Thomas, V., 1995)

According to this theory, the growth poles are supposed to be centers of economic activity with a high potential for generating positive externalities and spillover effects that can stimulate development in the surrounding areas.

The growth poles are formed in two ways. In a backward region, economic activity may start suddenly when there is no economic activity. Alternatively, a backward region can be turned into a growth pole by state intervention. According to the theory, the most effective method to eliminate regional imbalances is to establish growth poles in certain regions.

These growth poles create economic vitality from the closest to the most distant regions. As soon as there is economic activity in a region, it becomes a center of attraction, starts to receive labor and capital immigration, and gradually strengthens. Labor and capital migrating to the developing region cause the underdeveloped regions to fall further behind. This negative effect, which causes the flow of resources to the developing area, is called “the spray effect”. On the other hand, economic activities and innovations concentrated at the growth pole begin to spread from the center to the periphery. (Higgins, B., & Savoie, D. J., 2017)

Although the Growth Pole Theory is criticized since it ignores the social and cultural aspects that affect economic development and for not addressing the potential negative externalities and uneven development that may arise from concentrating economic activity in a few key regions, it is still a valuable framework for considering how to stimulate economic growth in regions with limited economic foundations. (Kourtit, K., et al., 2015)

1.5.3.2. Theory of Central Place

Theory of Central Place is a development theory, which aims at clarifying how distribution, along with function of human settlements, specifically urban centers such as cities and towns, can stimulate economic progress in any region. It explains how size and spacing of settlements in a region are determined by the range and intensity of goods. German economist and geographer

Walter Christaller (1954) first proposed the theory by considering economic relations between cities and their surroundings. (Van Meeteren, & Poorthuis, 2017)

According to this theory, not all settlements can be considered central places, but only those that offer products and services to their surrounding population. The theory is based on three main assumptions: first, that the periphery of the central city is a flat and homogeneous area with no restrictions on the movement of factors. Second, that consumers will purchase goods and services from the nearest center; and third, that entrepreneurs will supply goods and services as long as there is sufficient demand, and cease supply when demand falls below a certain threshold. These assumptions lead to the formation of a hierarchical structure of central settlements and establishments, based on their size and distribution. (Gore, C., 2013)

The theory views the city as a hub for providing products and services to its surrounding areas. Spending in surrounding areas on goods and services from the central city generates an inflow of money from the periphery to the center. Additionally, the central city offers a wider range and variety of goods and services than smaller settlements, thus creating a complementary relationship between the city and its surrounding areas and forming a mutually interconnected system. (Scott, A. J., 2008)

However, there are several critiques of the Central Place Theory. One of the main criticisms is that it assumes a homogeneous and flat periphery, which is not always the case in reality. Critics argue that the periphery is often not homogeneous and that factors such as transportation, natural resources, and land use patterns can affect the distribution of settlements.

The theory also does not consider the role of government policies, changing demographics, innovations, and globalization in the urban system. The Central Place Theory is criticized for oversimplifying the urban system since it only considers goods and services and overlooks other significant factors such as housing, education, healthcare, and culture, which also influence the urban system. (Bayulken, B., & Huisingh, D., 2015)

1.5.3.3. Industry Foci Theory

The Industry Foci Theory is a regional development theory that suggests that the concentration of particular industries with a competitive advantage in a region is what drives its economic growth. It argues that by developing these industries, a region can create a "multiplier effect," in which the growth of the targeted industries leads to the advance of other industries as well as sectors.

The theory also suggests that government policies and investments in infrastructure, education, and other areas can be used to support the development of these targeted industries. It should be noted that the application of this theory relies on the unique context and economic circumstances of a particular region. (Martin & Sunley, 1996)

Theoretically, this theory is based on a range of economic theories, including comparative advantage, the multiplier effect, and regional clustering. It suggests that a region's economic growth and development can be enhanced by focusing on the development of specific industries that have a comparative advantage in the region, and by creating a supportive environment for these industries to flourish. (McGahey, R. M., 2008)

It is also important to note that while industry foci can be a strong aspect of regional development theory, it is not the only aspect, and other factors such as government policies, infrastructure, education, and innovation are essential to the expansion and development of a region's economy.

1.6. STRATEGIES FOR REGIONAL DEVELOPMENT AND GROWTH

As rapid technological change, the acceleration of capital mobility, and interregional competition emerged during the 2000s, regional development became a focal point, and it was concluded that it would be possible to increase the chance of success in this competition with regional intervention strategies. The strategies for regional development can be categorized into four main groups, with a particular focus on investment policy, encompassing various policies. (Coe, N. M., et al., 2004)

Growth-Based Regional Development Strategy: This approach prioritizes and emphasizes the optimal distribution of production factors in a given area, depending on investment policy preferences. The growth pole approach, cluster economies, and regional export models constitute the content of this strategic approach. In this strategy, the determination of a center within the cluster and the possibilities and potentials of developing this center as the focal point of regional activities are emphasized.

Stability-Based Development Strategy: Influencing the economic structure of the region in a positive direction is the main objective. Policies are applied to ensure the diversification of the economic structure in the region. Establishing and developing structural policies that promote resilient structures during crises and ensure healthy living and working conditions is crucial for maintaining stability in the region. The fact that the regional stability policy includes a structural dimension necessitates the coordination of regional and structural policies.

Development Strategy Based on Interregional Balancing and Equalization: In this strategy, it is aimed to distribute economic activity, income, and welfare from region to region in a balanced way and to create a balanced and relatively equal level of economic resource endowments in the region. These can be achieved through a relatively equal and balanced distribution of infrastructure facilities, which is a prerequisite for the economic activities of the region. Thus, in this approach, the infrastructure of the region gains importance.

Integrated Regional Development Strategy: The above-mentioned strategies could be emphasized to initiate regional progress, as well as diversify economic structures of regions, and attain a stable structure. However, this priority and weight need to be supported and complemented by two other approaches, namely growth and structuralizing strategies.

At every stage of regional development, it is expected to integrate strategic priorities for growth and balance among themselves, considering the unique characteristics of regional development. This entails creating a comprehensive regional development strategy that aligns with the actual conditions of the region. (Pike, A., et al., 2017)

1.7. POLICIES OF REGIONAL DEVELOPMENT AND GROWTH

Regional development policies take relevant economic models, which are simplified logical representations of the real world, as their basis. Besides the strategy-based approaches that are listed before, it is possible to promote the development of regions by making use of various policies. Some examples of policies that can be used to promote regional development include:

Economic development policies: The aim of these policies is to promote the growth of the economy and the creation of jobs in a specific area. Examples include tax incentives for businesses, infrastructure investments, and training programs for workers.

Education and training policies: These policies concentrate on enhancing the skills and workforce education within a region. Examples include investments in primary and secondary education, vocational training programs, and university-industry collaborations.

Social welfare policies: These policies focus on addressing poverty and inequality in a region. Examples include income support programs, housing assistance, as well as access for basic services including healthcare, sanitation, etc.

Environmental policies: These policies focus on protecting the natural environment and promoting sustainable development in a region. Examples include regulations on pollution, incentives for renewable energy, and conservation programs.

Infrastructure development policies: These policies focus on improving transportation, communication, and other basic infrastructure in a region. Examples include building new roads and public transportation systems, and upgrading communication networks.

Innovation and entrepreneurship policies: These policies focus on promoting innovation and entrepreneurship in a region to boost productivity and competitiveness. Examples include incubators, accelerators, and venture capital funds. (Nijkamp, P., et al., 1987)

CHAPTER 2

EU REGIONAL POLICY AND EU-TÜRKİYE PRE-ACCESSION FINANCIAL COOPERATION

The European Union has been a collection of countries having diverse cultures, languages, histories, and economic systems. Despite being one of the wealthiest regions globally, significant discrepancies persist among its member states and regions. The two major enlargements in 2004 and 2007 have exacerbated this inequality, making economic and social unity a crucial goal for the EU. (Mora, T., et al., 2004)

The fact that each European Union member countries has some different social and economic structure has made it inevitable to offer various financial aid opportunities to their member countries to ensure harmony and balance within the Union. In this context, it also offers some financial aid opportunities for future members, i.e., candidate countries. (Ay & Turgan, 2015)

Türkiye has a prolonged record of pursuing entry into the EU, with its initial formal request for accession dating back to 1987. Nevertheless, the process of accession to the EU is intricate and protracted, and Türkiye's advancement towards membership has been sluggish and contentious. After 60 years, it has solely achieved the candidate country status for full membership.

Despite these challenges, Türkiye has made some progress toward EU membership in recent years. In 2005, the EU started talks regarding Türkiye's prospective participation in the Union, and Türkiye has since made significant progress in aligning its laws and regulations with those of the EU.

Türkiye, which attained the status of a candidate country during the Helsinki Summit in 1999, has somehow been benefiting from the financial aid opportunities of the Union since the Ankara Agreement was signed in 1963. These aids have increased both in significance and in amount after Türkiye's candidacy status for the last two decades.

Since our study aims to analyze how financial aid provided by EU to Türkiye based on its candidacy status affects Türkiye's economic growth, firstly, brief information is given about the EU financial aid, that is applied to member countries as well as to candidate countries through relevant policy instruments. Finally, factual comments were made at the end of this chapter.

2.1. EUROPEAN UNION FINANCIAL AID

2.1.1. Rationale of the EU Financial Aids

The EU's integration and enlargement process, which was initiated in the 1950s with six-member countries and has continued to thrive, has encouraged non-member European countries to seek membership. However, these countries often struggle to achieve the necessary development and changes internally, prompting the EU to provide assistance.

The EU, which set out with the aim of becoming an “economic union” upon signature of Treaty of Rome in 1957, is now rapidly advancing towards becoming a “social, economic and political union”. In this sense, the ultimate goal of the EU, which has been adopted since its establishment, is to create an economically and socially balanced, developed, and peaceful region with a common policy. (Liikanen, I., 2016)

The European Union offers grants from the Union budget and loans from reserves of European Investment Bank to both its member states and candidate countries, per its enlargement strategy and with the aim of encouraging deeper integration.

Financial aid from the European Union can be an effective tool for supporting the development and integration of candidate countries into the EU. It offers a range of financial assistance programs for candidate countries, including loans, grants, and other forms of financial support. These programs are designed to assist candidate countries in achieving the requirements for EU membership and to support their economic, social, and political development. Furthermore, this assistance has allowed candidate countries to confront social and economic difficulties and enhance the welfare of their populations. (Börzel, T. A., et al., 2008)

However, efficacy of the aid in candidate nations relies on various factors, such as the competence of the initiatives, the ability of the recipient nations to assimilate and employ the funds efficiently, and the wider economic and political environment in which the aid is furnished. Both the EU and candidate nations must carefully assess the efficacy of financial aid programs and take steps to make sure they are accomplishing their defined objectives.

2.1.2. Regional Policies of the European Union

The European Union, itself, serves as a developmental model and a remarkable demonstration of how to combine social welfare governance models with a market economy successfully. As the largest official aid donor and trading entity globally, examining the EU's development policies has been critical for a comprehensive understanding of futures of development policies.

Necessity to "strengthen economic unity and ensure balanced growth by minimizing inequalities across different regions and addressing the underdevelopment of less advantaged regions" has been detailed in Article 158 of the Treaty of Rome (1957). To define these regions, a uniform classification scheme was required as the basis for determining eligibility for funding social and economic cohesion.

In the early 1970s, Eurostat partnered with national statistical authorities to establish “Nomenclature of Territorial Statistical Units, (NUTS)". Its goal was to define consistent and comparable territorial units based on area and population size and to gather and produce standardized regional statistics. (EUROSTAT, 2022)

Despite being a wealthy region, the European Union has disparities in income and potential among its 242 regions (NUTS-2 regions, which have a population between 800.000 and 3 million), which can lead to underdevelopment. EU Regional Policy serves as both a tool for solidarity and a means of promoting integration in the member economies. Solidarity and cohesion principles form the policy foundation, which aims to promote harmony and reduce income inequalities and potential differences among regions to ensure economic integration.

EU Regional Policy aims to address the socioeconomic disparities among different regions in the EU with varying levels of development. It finances various projects for regions to increase their competitiveness and economic growth, and encourages the sharing of good practices and ideas. The policy aligns with the EU's growth and employment policies within Lisbon Strategy. It was established to find solutions to 21st-century challenges and to determine the kind of Europe one wants to see in the future. (Dudek & Wrzochalska, 2017)

EU regional policies initially emerged as a consequence of the negative economic and social burdens brought on by World War II. Although “common regional policy” had not been mentioned

in the Treaty of Rome, it helped lay the foundations of common regional policies that would later emerge in the treaties that shaped the EU. Both in the period of its establishment and its recent enlargements, the Union has faced regional and economic problems. Since these problems are the underlying reasons for the EU's regional policies, their elimination has also become its main goal.

When the first law merging pre-existing financial instruments under the name "EU Cohesion Policy" was established in 1988, the EU regional policy assumed the existing form some 35 years ago. Despite the fact that reducing regional disparities was already a goal when the European integration process began in the late 1950s, "cohesion" became a fully developed and explicit goal by the end of the 1980s in order to promote the inclusion of less developed regions and nations in the single market and encourage investment in EU priorities that supported growth and employment. In the 1993 Treaty of the European Union, "cohesion" was formally recognized as an objective. The effort for harmonization has to be strengthened once 10 more countries are included in 2004, and further followed by Bulgaria and Romania in 2007. (Gänzle & Mirtl, 2019)

The EU's regional policies have evolved along with changes in regional development theory and practices, moving from centralization to decentralization in terms of organization and administration, similar to global trends. This transformation and local dynamics are emphasized in EU documents including Council of Europe Charter of Local Authorities Autonomy (1985), the European Union Agreement (Maastricht, 1992), and the European Urban Charter (accepted at the European Conference of Local and Regional Authorities, 1992). These documents emphasize the entitlement of citizens to engage in the public services provision, importance of autonomous local government, the promotion of local democracy, and the principle of proximity in services related to regional security, environment, employment, health, and culture. (Calabro, A. R., 2021)

European Union Regional Policy is instigated through Structural Funds and overseen by the European Commission Directorate General for Regional Policy (DG Regio). These funds are used to transfer budgetary contributions from member nations to the EU's least developed regions. The Cohesion Fund, in particular, also targets the member nations with the lowest levels of prosperity. (OECD (GOV/RDP), 2010)

The execution of EU regional policy is guided by five basic ideas:

- concentration on specific objectives: refers to the focus on certain geographical regions that meet specific criteria, which is determined by the creation of NUTS-2 statistical regions,
- multi-annual programming: involves planning the allocation of resources over a set period, typically several years. This is done within the framework of the EU budget, which sets revenue and expenditure plans for multi-annual financial frameworks. The annual budget is then adopted based on these frameworks, ensuring that regional policy resources are distributed consistently and predictably.
- partnerships between European Commission and relevant member states governments of the, wherein EU and states discuss development of substantial regional policy projects,
- additionality: refers to the requirement that EU funding should be used to provide additional support to national and regional development efforts rather than simply replacing or displacing existing funding sources, and
- proportionality: refers to the requirement that the EU does not fund a project entirely, but rather necessitates the participation of nationwide, regional, and local sources. This indicates that the EU's contribution to the project's finances is inversely proportionate to the contributions from the other funding sources.

Beyond any doubt, “regional policy” (synonyms: structural policy or cohesion policy) has the strongest, most intended, and most straight effect, and has an ever-increasing importance in the EU policy set (Bornschier, 2000). Infrastructure, environmental protection, human resource development, and productive investment will enhance competitiveness of the least developed regions as well as increase their potential for sustainable growth and job creation. This economic boom is intended to lessen developmental differences.

2.1.3. Criteria

At the Copenhagen Summit held on 22 June 1993, economic, political, and compliance criteria with the Community acquis (criteria) were accepted for the full membership of the candidate countries. (Hillion, C., 2014)

These criteria require that the debt-to-GDP ratio of the member states cannot be higher than 60% and that the budget deficit-to-GDP ratio cannot be more than 3%. Additionally, the three member

states having the lowermost average annual inflation rates should differ from their respective member states' inflation rates by no more than 1.5 percentage points. The states must also accept expected regular changes in the European Monetary System's exchange rate mechanism without resorting to devaluation.

While the Union puts forward those conditions for both current and would-be (candidate) member countries, it also acknowledges that it would be difficult for the countries to fulfill these conditions with their dynamics, and therefore provides financial aid to the related countries from its resources.

To become a member of the EU, new countries are required to adhere to specific standards concerning their political, economic, administrative, and legal institutions, as well as their civil society. Additionally, they must be capable of fulfilling membership obligations, including the adoption and application of all EU regulations and legal guarantees (known as the acquis communautaire). While these institutional criteria were already applied in earlier enlargements, they were formally outlined in the "Copenhagen Criteria", particularly for less advanced countries that may have "weaker" democratic, market economies, and legal institutions. (Kubicek, 2021)

The member states that make up the EU have outstanding institutional quality. The term "institutional quality" denotes the potency and efficiency of a nation's political, legal, and regulatory systems, and is frequently employed as measures of the country's overall governance standard. (Kaufmann, D., et al., 2011)

EU membership brings many benefits that can contribute to institutional improvements and the overall quality of society in candidate countries. For example, EU membership can promote economic development and improve access to funding and investment opportunities. Furthermore, it has the potential to strengthen the protection of fundamental liberties and human rights while advancing legality and democratic institutions. (Henderson, K., 2005)

The amount of aid to be provided depends on various criteria such as economic development, population, and unemployment rates in the countries and regions. This perspective has already been expressed in the first articles of the Founding Treaty. These articles, the founding philosophy of the Union; reveal that "the strong do not oppress the weak among the countries that come together, but on the contrary, there is development in harmony with the understanding of mutual aid and solidarity". (Alvstam, C., 2020)

The Union, which is a regional integration in essence, represents the markets, economies, production methods, and forms of production of various countries sharing certain geography, processes, political and economic decision-making mechanisms, and above all, their efforts to unite their political and strategic powers on a common ground.

Between 1989 and 2013, four successive programming periods saw the deployment of objective regions in the EU's regional approach. In 1989, EU regional approach underwent restructuring, and Objective regions were established. The European Union categorized regions that qualify for financial assistance into three "objectives" based on the magnitude of economic and social difficulties they face. These objectives were referred to as Objective_1, Objective_2, and Objective_3. (EUROSTAT, Guide to Statistics in European Commission Development Cooperation, 2013)

The categorization of regions into specific objective categories by the EU was established by assessing an array of economic and social indicators, comprising but not restricted to GDP per capita, unemployment rate, and educational attainment. These indicators were used to create a composite score for each region, which was then used to place the region into the appropriate objective category. Objective_1 regions are those that face the greatest economic and social challenges and receive the sturdiest funding (65% of the structural funds), while Objective_2 and Objective_3 regions face somewhat lesser challenges.

EU regions, now and then, must fulfill various criteria in order to be eligible for funding from the European Structural and Investment Funds (ESIF), which include the European Regional Development Fund (ERDF), the European Social Fund (ESF), and the Cohesion Fund. (European Commission, 2023a)

These criteria vary depending on the specific fund and the type of project being proposed, but some common requirements include:

Geographical eligibility: Projects must be situated in an eligible area, which is often characterized as having a per capita Gross National Income (GNI) that is below 75% of EU average. Regardless of their degree of national economic development, this help is automatically given to all areas having a GNI per capita below 75% of the entire Union average GNI.

Policy eligibility: The objectives of the regional strategy of the Union must be met through projects, and they must significantly advance territorial, social, and economic integration within the EU.

Financial eligibility: Projects must be financially viable and provide value for money.

Legal eligibility: Projects must comply with EU law and regulations and be compatible with EU policies and objectives.

Environmental eligibility: The environment must not be harmed, and projects must take into account the fundamental concepts of environmentally friendly growth.

Social eligibility: Projects must contribute to social cohesion and not discriminate against any group of people.

Technical eligibility: Projects must be technically feasible and have a clear plan for implementation and management.

According to these standards, EU membership is financially advantageous for less economically developed member countries, as they obtain further funding from EU budget than they underwrite. This financial aid helps to bolster the economic potential of these countries, thereby improving the standard of living for their residents. (European Commission, 2019)

2.2. EUROPEAN UNION REGIONAL DEVELOPMENT POLICY TOOLS

The European Union (EU) employs various regional development policies to foster socioeconomic development. The policies are designed to advance regional cohesion, which involves mitigating social, economic, and regional inequalities between different regions within EU. (McCann, P., & Ortega-Argilés, R., 2015)

To this end, it offers financial aid to member as well as non-member nations. Most broadly, these financial aids can be divided into financial aids provided by/within:

- European Investment Bank (EIB) and
- European Union’s general budget expenditures framework.

The primary objective of the financial assistance offered by the EIB is to support investment projects within member countries. However, the bank offers funding also for non-EU countries, particularly for Western Balkans, the Eastern Neighborhood, and developing nations. (European Investment Bank, 2023)

The Union offers financial support for a variety of policy areas, including economic development, social cohesion, environmental protection, and international cooperation, through its general budget expenditures.

A combination of member state contributions and their own funds, including customs taxes, agricultural levies, and a portion of value-added tax (VAT) revenue generated within the EU, is used to finance the EU's general budget. (Cini, M., & Borragán, N. P. S., 2022)

The EU's general budget expenditures are used to fund a wide range of activities, including:

2.2.1. Cohesion Policy

In order to lessen economic and social inequalities within the EU and to support regional territorial, social, and economic growth, the Cohesion Policy was created. The European Regional Development Fund (ERDF), European Social Fund (ESF), and Cohesion Fund (CF), jointly referred to as "European Structural and Investment Funds (ESIF)" and made available to member states, provide support for this objective. (Bachtler, J., et al., 2016)

ESIF, as an overarching political financial instrument, is expected to:

- diminish socioeconomic disparities among regions and countries within the EU,
- increase competitiveness and high employment in regions not covered by convergence,
- develop cross-border cooperation by increasing interregional cooperation, supporting local and regional initiatives, and supporting integrated regional development by strengthening international cooperation.

In 1975, the concept of redistributing a portion of member states' budgets to underprivileged regions was introduced, leading to the establishment of the ERDF, which missions closing the economic and social development gap between the EU's less developed and wealthier regions by

funding infrastructure, research, development, and assistance to SMEs. The ERDF allocation would be EUR 200.4 billion in the 2021–2027 EU budget period.

From 2021 to 2027, the ERDF will facilitate investments to enhance:

- competitiveness and innovation of Europe and its regions, focusing on SMEs support
- environmentally sustainable, low-carbon, and resilient practices
- connectivity by enhancing mobility and digitization
- social inclusion via investments in equitable access to healthcare, effective and inclusive employment, education, and skills
- sustainable and locally-led urban development across EU. (European Commission, 2021)

European Social Fund was founded in 1958 to foster social inclusion and employment in disadvantaged regions. It provides financial assistance for initiatives that aim to improve employment opportunities, promote social inclusion, and reduce poverty.

It supports the social and economic policies of the Union by cultivating employment along with employment prospects and member states' efforts to increase workforce and business flexibility, make it easier to find work, encourage social inclusion of those from disadvantaged backgrounds, combat discrimination, boost human capital investment, as well as improve capability and efficiency in governmental institutions and public services. (European Commission, 2021)

ESF serves as the primary mechanism through which EU invests in human capital as well as backs the enforcement of the European Pillar of Social Rights. Between years 2021–2027, ESF has been allocated a budget of EUR 88.0 billion, which would allow it to continue playing a vital role in advancing the social, economic, educational, and skill-related policies of the EU. This would entail supporting structural reforms in these domains.

The Treaty on European Union, also referred to as the "Maastricht Treaty," established the Cohesion Fund (CF) in 1994 as a complement to the Structural Funds. It seeks to encourage investments in environmental protection and transportation infrastructure, particularly in the trans-European networks in the EU's regions with lower levels of development. Approximately 167.2 million people, or 34.4% of the EU-27's population, live in regions supported by the Cohesion Fund at the moment. (OECD (GOV/RDP), 2010)

Access to the Cohesion Fund (CF) is allowed for member states with GNIs per capita that are less than 90% of the EU-27 average. The goal of this fund is to strengthen the EU's geographic, social, and economic integration. The CF will allocate 42.6 billion euros to help the following nations from 2021 to 2027: Bulgaria, Croatia, (South) Cyprus, Czechia, Estonia, Greece, Hungary, Latvia, Lithuania, Malta, Poland, Portugal, Romania, Slovakia, and Slovenia.

During 2014–2020 programming period, the ERDF, which accounted for more than 69% of the planned funds, provided the majority of the funds allocated for Cohesion Policy to assist underdeveloped regions. The ESF was the second-largest supplier, providing 18% of funds, followed by the CF, which provided 13%. (European Commission, 2023a)

All eligible European Union member states have access for ESIF's EUR 330.2 billion-budget allocation for the years 2021 through 2027. In particular, in the periphery, the efficacy of EU regional policy in achieving growth, competitiveness, social and economic cohesion, and geographical cohesion has been a major topic of discussion, European Structural and Investment Funds and Cohesion Policy playing a central role. (Marzinotto, B., 2012)

2.2.2. Agricultural Policy

The European Union developed the Common Agriculture Policy (CAP) as a measure to boost rural development and the agriculture sector's ability to compete globally. The CAP, one of the EU's oldest and most complex policies, is crucial to the region's social and economic development. It supports 7 million beneficiaries across the EU, provides high-quality food to 447 million Europeans, and contributes to climate action with some 40% of its budget.

Common Agricultural Policy helps ensure the sustainability of EU agricultural sector while supporting farmers' livelihoods and rural communities. Farmers get direct subsidies to support their earnings and maintain the sustainability of their enterprises. Based on the size of the farms and the types of crops grown, these payments are made. Market measures are designed to stabilize prices and incomes in the agricultural sector and protect farmers from market volatility. Rural development programs provide funding for investments in infrastructure, support for SMEs and development of rural tourism. (Collantes, F., 2020)

Overall budget for Common Agricultural Policy is divided between two distinct funds, commonly known as the "two pillars" of the CAP: the European Agricultural Fund for Rural Development (EAFRD) and the European Agricultural Guarantee Fund (EAGF).

EAFRD (CAP's "first pillar") has an allocation of EUR 77.8 bn and provides financial assistance to support investment in a variety of areas. The EAGF (the "second pillar") is another fund established by the EU to support the agriculture sector in EU member states. Its total allocation amounts to EUR 258.6 bn, is financed through the EU budget, and is managed by the European Commission in collaboration with EU member states. (European Commission, 2023a)

2.2.3. Environment and Climate Action

This policy aims to promote sustainable development and climate action, as well as protect the environment. Funding for these objectives comes from the LIFE program as well as the EAFRD.

The LIFE (L'Instrument Financier pour l'Environnement) program is EU's financial instrument for the environment. Its main goals are to support sustainable development and provide financial aid for the implementation of EU environmental and climatic laws and regulations. The LIFE program provides financial assistance to support a wide range of initiatives. (Schoenefeld, J., 2021)

2.2.4. Research and Innovation

This policy intends to encourage the creation of new technologies and business models while promoting research and innovation within the EU. It is funded through the Horizon Europe program and European Research Council (ERC).

"Horizon Europe" is the Union's innovation and research initiative for the years 2021–2027. Horizon Europe provides financial assistance to support a wide range of initiatives. It provides funding for research projects aimed at developing new technologies and innovative business models as well as addressing significant societal challenges such as health, energy, and climate change. (European Commission, Main Trends in Horizon Europe, 2023b)

2.3. FINANCIAL AIDS PROVIDED TO EU CANDIDATE COUNTRIES

The European Union offers financial support to eligible member states, candidates, and even third countries through a variety of programs and initiatives that aim to support social and economic development and foster collaboration and partnerships with the EU.

As indicated in Section 2.2, the EU's financial aid is typically given in the context of grants, loans, or technical support. The specific terms of the aid, as well as the amount provided, can vary contingent on the recipient countries specific needs and conditions. Recipient countries benefit from various aid instruments concerning its status, i.e., member state, candidate, or non-candidate country.

The aspiration of politicians and citizens of candidate countries to enhance their living conditions and narrow the gap with developed European societies, especially in the long term, drives them towards EU candidacy and ultimately, membership. Therefore, becoming a member of the EU has emerged as the key motivation behind the implementation of reforms in candidate countries.

The EU first started to launch pre-accession aid instruments in 1990 to assist its member states. This situation is the product of likely changes in policy regarding the recruitment of new members. The new policy foresees that candidate countries can become members only if they are successful in a preparation process called “pre-accession”. (Steunenberg & Dimitrov, 2007)

The pre-accession process requires the candidate country to carry out an array of social, economic, political, as well as institutional modifications to comply with “Acquis Communautaire” and its policies. Naturally, the realization of these reforms also imposes significant financial burdens on the candidate country. At this stage, the EU provides special assistance in context of its pre-accession plan, both to reduce candidate countries financial burdens and to accelerate the reforms as envisaged.

The PHARE, ISPA, SAPARD, and CARDS Programs were established to support Central and Eastern European and Balkan countries with their goals of EU accession. These programs were in place until 2007. (Bailey, D., & de Propris, L., 2014)

PHARE, which stands for Poland and Hungary: Action for the Restructuring of the Economy, aimed to improve administrative and institutional structures for these countries to better participate in the EU.

ISPA, or the Instrument for Structural Policies for Pre-Accession, provided funding for large-scale transportation and environmental infrastructure projects.

SAPARD, the Special Accession Programme for Agriculture and Rural Development, supported candidate countries in adapting to the Common Agricultural Policy and developing rural areas.

Finally, CARDS, or Community Assistance for the Reconstruction, Development, and Stabilization of the Western Balkans, aimed to contribute to the process of restructuring, stabilization, and partnership for Western Balkans.

The EU is currently faced with the task of managing five candidate countries (Albania, North Macedonia, Serbia, Montenegro, and Türkiye) and two potential candidates (Bosnia-Herzegovina and Kosovo). These countries exhibit socioeconomic indicators that are below the EU average and even weaker than the weakest EU Member States. Given this reality, the EU must continue to provide technical and financial support to these candidate and potential candidate countries to help them overcome their challenges and achieve sustainable development, particularly in anticipation of future accession. (Steunenberg, B., & Dimitrov, A. L., 2007)

As with the 2007–2013 financial perspective, the IPA, under the title "EU as a Global Actor", has replaced the four previous financial aid programs and has included Türkiye, Croatia, and North Macedonia as candidate countries, as well as the Western Balkan countries (Albania, Bosnia-Herzegovina, Montenegro, Serbia, and Kosovo) as potential candidates. Thus, the countries that will benefit from the assistance have been distinguished into two groupings: "candidate countries" and "potential candidate countries".

All components of IPA are available for candidate countries, while potential candidate countries would only benefit from some of the (i.e., first and second) components. The IPA program aims to bolster the rule of law and democratic institutions, overhaul public administrations, implement fiscal restructurings, endorse the observance of minority rights, human rights, and gender equality, foster robust regional cooperation with civil society, and assist in eradicating poverty and promoting sustainable development. (European Commission, COM (2022) 528 final, 2022a)

Other EU programs and initiatives that offer financial support to candidate states include the European Neighborhood Instrument (ENI) and the Development Cooperation Instrument (DCI).

ENI is an initiative that collects funding from EU budget and is managed by the European Commission in collaboration with the EIB and European Bank for Reconstruction and Development (EBRD). Its purpose is to offer financial aid to countries located in the EU neighborhood. It has served as EU's primary instrument for carrying out its European Neighborhood Policy (ENP) since 2004, which seeks to promote stability, security, and prosperity in EU neighboring countries by providing funding for economic and political reforms.

It also supports the EU's humanitarian aid efforts, providing financial assistance to countries affected by natural disasters, conflicts, and other emergencies. The primary objective of the ENI is to offer support for reform initiatives in EU neighboring countries and to play a role in attaining the Sustainable Development Goals (SDGs), a list of global goals approved by the UN to eradicate poverty, protect the environment, and ensure peace and prosperity for all. (European Commission, External Evaluation of the ENI, 2017)

The IPA and ENI programs offer financial support, which can be in the form of grants or loans, to a broad array of areas, including agriculture, environment, transport, energy, and social development. The exact amount and conditions of the aid may differ based on the specific requirements and situation of the beneficiary nation.

In 2014, the Development Cooperation Instrument (DCI) was created as a financial aid resource for developing nations. The European Union employs the DCI as a significant tool to execute its development cooperation strategy, intending to lessen poverty and encourage sustainable progress in these countries. (European Parliament, Development Cooperation Instrument, 2017)

2.4. EU-TÜRKİYE pre-ACCESSION FINANCIAL COOPERATION

Türkiye's financial collaboration with the EU commenced with Türkiye’s membership application to European Economic Community (EEC), which is EU today, on July 31, 1959. Despite a few years of interruption due to the military intervention in May 1960, Ankara Agreement was signed on September 12, 1963, establishing a partnership relationship that marked a big advancement in developing relations. Implementation of Ankara Agreement marked “official commencement” of partnership and financial relations. (Çakır, A, 2010)

The preamble of the Ankara Agreement highlights the unique challenges faced by Türkiye in developing its economy and the need for economic support within a specific timeframe. The third article of the agreement specifies that Türkiye will enhance its economy with assistance from the Community during the preparation period to meet its obligations in the transition and final periods. The Interim Protocol and Financial Protocol attached to the Ankara Agreement outline the implementation procedures for this preparation period and the Community's support.

The most important turning points for Türkiye in financial cooperation are:

- the Ankara Agreement in 1963,
- membership official application in 1987,
- establishment of Customs Union in 1996,
- status of the candidate country at the Helsinki Summit in 1999, and
- initiation of negotiations on October 3, 2005.

Türkiye has benefited from EU financial aid in the last 60 years and continues to benefit from it. The two major phases of the financial cooperation between Türkiye and the EU are as follows: the first period runs from the Ankara Agreement's entrance into effect to the Helsinki Summit, and the second period runs from the Helsinki Summit to the present. (EU Directorate, Chronology of Turkey- EU Relations (1959–2019), 2020)

2.4.1. pre-Helsinki Period (1964–1999)

In the pre-Helsinki period (1964–1999), the financial aid provided by the Community to Türkiye could be consolidated into the following four categories:

• Financial aid provided by Financial Protocols: To support Türkiye's economic and social development, three separate Financial Protocols and one Supplementary Protocol were contracted between 1964–1981. The type of aid under the Financial Protocols consists of grants and predominantly loans, including EIB and low-interest Community loans.

• Earthquake aids: After the Marmara Earthquake in August 1999, a special budget of 30 million euros was allocated as a grant for emergency and rehabilitation activities. An

exceptional grant of 1 million euros was provided to support post-earthquake rehabilitation activities.

• Financial assistance from the Europe-Mediterranean Programs, and

• Other financial aid.

However, in this 30-year period, i.e., 1964–1993, only 1.005 million euros could be used out of 1.605 million euros allocated from EU resources due to Greece's vetoes. (Foreign Trade Undersecretariat, 2002)

Turkey-EC Association Council Decision of March 6, 1995, which included Türkiye in the Customs Union, was a result of the Turkish economy's fast opening up, particularly during the 1980s. To mitigate the adverse impacts of the Customs Union on Türkiye's economy, which entered into force on January 1, 1996, and to bring Türkiye's economy in line with EU standards, it was decided to provide assistance from EU budget resources. (Karabacak, 2004)

Also, in this period, i.e., 1994–1999, only 755 million euros could be used out of 2.061 million euros allocated from EU resources due to Greece vetoes. (Foreign Trade Undersecretariat, 2002)

2.4.2. EU Membership Candidacy Period (2000–present)

Helsinki Summit, held on December 10–11, 1999, marked a momentous milestone in EU- Türkiye relationship, as the official recognition of Türkiye as a candidate country. This event marked a new phase in the EU-Türkiye financial collaboration with Helsinki Summit serving as the initial step towards providing financial assistance to Türkiye, targeting its accession to the EU, or gaining a pre-accession strategy perspective for these aids. (Müftüler-Baç, M., 2005)

A new era of the EU-Türkiye financial cooperation began with Türkiye's attainment of candidacy in December 1999 and the membership negotiations initiation on October 3, 2005. Consequently, there has been a notable rise in the EU's allocated budget for financial assistance. Between 2000–2006, Türkiye received 2.979 million euros from EU resources, mostly in the form of grants and favorable credits. It is important to note that this amount has surpassed the total amount received between 1964–1999. (European Commission, Turkey 2022 Report, 2022b)

In 2006, when Bulgaria and Romania joined the European Union (EU), European Commission revised its system of financial aid for candidate countries, leading to the discontinuation of programs like PHARE, ISPA, and SAPARD that were previously in place. Instead, the EU consolidated its mechanisms for providing financial assistance to both candidate and potential candidate countries into a unified program known as the "Instrument for Pre-Accession Assistance (IPA)."

2.5. INSTRUMENT FOR pre-ACCESSION ASSISTANCE (IPA)

European Commission, executive arm of EU, manages Instrument for pre-Accession Assistance (IPA), which is funded via EU budget. By providing funds for different programs and initiatives, IPA seeks to help the reform process and advance economic development, social cohesion, and the rule of law in candidate countries, including Türkiye. The IPA's primary objective is to support these nations as they become ready to join the EU.

The IPA is implemented across various policy areas based on the development priorities of the candidate country. Its purpose is to promote regional development, increase civic engagement, and, crucially, support the candidate country's Europeanization process. (Müftüler-Baç, 2013)

The IPA offers financial aid to countries in the process of becoming candidates or potential candidates for EU membership through several different channels, including:

Bilateral assistance: This refers to giving each candidate and potential candidate country financial assistance directly, per their unique developmental objectives.

Multilateral assistance: This refers to financial support extended to international organizations that focus on development matters, including but not limited to the United Nations and World Bank.

Thematic assistance: It refers to financial assistance provided to specific sectors or themes, such as education, health, or the environment.

By consolidating previous mechanisms used for financial assistance, the IPA aims to improve aid efficiency and coherence through a unified framework. This assistance attempts to boost institutional capability, encourage international collaboration, and speed up rural, social, and

economic development. Additionally, it contributes to the EU's humanitarian aid efforts by providing financial assistance to countries affected by natural disasters, conflicts, and other emergencies. (European Commission, Commission Implementing Decision, 2021)

2.5.1. IPA Components

Together with the other candidate nations, the EU has been awarding grant funds to Türkiye since 2007 under the umbrella of the five components. To achieve the goal of supporting Türkiye's development, the EU has allocated a total of EUR 4.8 billion in funds, which are utilized by the appropriate authorities through the following five components:

Table 2: Allocation of Funds for Türkiye by Component under the IPA I (2007–2013), (M€)

Components	2007	2008	2009	2010	2011	2012	2013	Total
I – Transition Assistance and Institution Building	256,7	256,1	239,6	217,8	231,2	227,5	238,5	**1.667,40**
II – Cross-border Cooperation	2,1	2,8	3,0	3,1	5,1	2,1	2,2	**20,40**
III – Regional Development	167,5	173,8	182,7	238,1	293,4	356,06	366,88	**1.778,44**
IV – Human Resources Development	50,2	52,9	55,6	63,4	77,6	83,1	91,1	**473,90**
V – Rural Development	20,7	53	85,5	131,3	172,5	187,38	204,18	**854,56**
Total	**497,2**	**538,6**	**566,4**	**653,7**	**779,8**	**856,14**	**902,86**	**4.794,70**

Source: (https://www.ab.gov.tr/45627_en.html)

2.5.1.1. Transition Assistance and Institution Building Component (TAIB)

TAIB component of the IPA is intended to enhance the institutional capacity of the recipient country to implement the acquis communautaire in various areas. This component is closely

aligned with the EU's enlargement policy, which aims to facilitate the integration of candidate and potential candidate countries into the EU by assisting them in adopting and implementing EU regulations and standards. Furthermore, it is interconnected with other EU policies, including those concerning good governance, rule of law, as well as anti-corruption measures.

TAIB provides funding for projects that enhance the capacity of the recipient country to align with and implement the acquis communautaire. The planning, programming, monitoring, and evaluation of TAIB are overseen by Directorate for EU Affairs in coordination with the Central Finance and Contracts Unit (CFCU). (EU Directorate, TR-EU Financial Cooperation, 2023)

2.5.1.2. Cross-border Cooperation

Projects and initiatives that strengthen collaboration between candidate and potential candidate nations and the EU are funded through the IPA's regional and cross-border cooperation component, as well as between different regions within these countries. This involves aiding the advancement of cross-border infrastructure, promoting economic development and trade, and improving governance at the regional and cross-border levels.

This component of the IPA supports initiatives focused on fostering social and economic cooperation for border regions, particularly on cross-border infrastructure development, economic growth, trade promotion, and enhancing cross-border and regional governance. Directorate for EU Affairs is responsible for planning, programming, monitoring, and evaluating the cross-border cooperation component. (EU Directorate, TR-EU Financial Cooperation, 2023)

2.5.1.3. Regional Development

This component is important in terms of its effect on preparing the candidate country for the use of structural funds (i.e., ESIF) that it will benefit from after becoming a member. The areas of priority include transportation, environment (focusing on water, wastewater, and air quality concerns), energy (with an emphasis on renewable energy and energy efficiency), education, healthcare, as well as support for SMEs. (European Commission, Türkiye IPA, 2023c)

This component consists of three Operational Programmes, namely:

−Regional Competitiveness Operational Programme (RCOP) is designed to boost national economy competitiveness and diminish socioeconomic disparities among regions. The Ministry of Industry and Technology implements the RCOP.

− Environmental Operational Programme (EOP) seeks to protect the environment and improve the overall quality of life by tackling various environmental concerns, including wastewater treatment, ensuring access to clean drinking water, and establishing comprehensive solid waste management facilities. Its goal is to enhance the environmental well-being and living conditions of individuals. Ministry of Environment, Urbanization, and Climate Change implements the EOP.

− Transport Operational Programme (TOP) is aimed at enhancing the transportation infrastructure in the country and establishing a balanced and efficient transportation system that ensures safety and interoperability on the Trans-European Networks (TEN-T) being constructed. The TOP is implemented by the Ministry of Transport and Infrastructure.

2.5.1.4. Human Resources

This component aims to equip the candidate country for utilizing the ESF under the European Employment Strategy framework. It provides support for initiatives related to areas such as employment access, social inclusion, and human capital investment.

The Human Resources Development Operational Program, which is under the supervision of the Ministry of Labour and Social Security, primarily consists of grant programs designed to increase employment prospects during the evolution to an information society and to promote social inclusion by providing financial support for initiatives in the fields of social inclusion, employment, education, and lifelong learning. (European Commission, Türkiye IPA, 2023c)

2.5.1.5. Rural Development

According to the guiding principles of the EU's Common Agricultural Policy (CAP), the IPA's rural component aims to support the development of rural regions in candidate countries. This component provides funding for programs and activities that improve the competitiveness and modernization of the agriculture sector in prospective and candidate nations while also promoting

the long-term sustainability of rural areas. This includes support for the development of rural and agricultural infrastructure, the improvement of the supply chain, and the promotion of environmentaly friendly farming and rural tourism. (European Commission, Türkiye IPA, 2023c)

The Ministry of Agriculture and Forestry, in conjunction with TKDK (Agriculture and Rural Development Support Institution), is in charge of carrying out the IPA for Rural Development Programme (IPARD). As part of this effort, businesses, individual producers, cooperatives, and producer unions engaged in the agricultural, food, fisheries, and alternative sectors can get financial assistance in the form of grant programs. (EU Directorate, TR-EU Financial Cooperation, 2023)

2.5.2. Criteria

IPA has several specific criteria that must be met in order to qualify for financing under the program. These criteria might include things like the country's degree of social and economic development, political and institutional stability, and the adherence of the nation to the ideals and principles of the EU, depending on the precise sort of help being sought. (European Commission, Commission Implementing Decision, 2021)

IPA's key aspects are, as follows:

−Eligibility: IPA is open to countries that are candidates in process of negotiating their accession to European Union or that are considered potential candidates for the EU membership.

− Objectives: The primary goal of IPA is to offer support to potential and candidate countries for their reform efforts and aid in their alignment with EU policies and standards. It strives to bolster the accession process of candidate countries and foster regional cohesion within the EU.

− Funding: The financing of IPA is derived from the EU budget, and its administration is under the responsibility of European Commission, which serves as the EU's executive branch.

−Sectoral priorities: IPA delivers monetary assistance to candidate and potential candidate countries through several different channels, including bilateral assistance, multilateral assistance, and thematic assistance. Sectoral priorities for IPA include support for the modernization of public administration, regional and rural development, and improvement of social and economic cohesion.

- Implementation: IPA is implemented through several different mechanisms, including grants, loans, and technical assistance. It is also implemented through the EU's delegation offices in candidate and potential candidate countries, as well as through international organizations and agencies that work on development issues.

2.5.3. Utilization

One of the main obstacles facing pre-accession funding programs is how well the recipient country can employ these financial aid initiatives to achieve positive outcomes for all societal stakeholders. The formation of institutional frameworks and administrative capacities that are in line with EU objectives, as well as the creation of budget distribution procedures that are specifically suited to the special circumstances of the candidate nation, are necessary for achieving this goal.

The pre-accession strategy of each candidate country determines the policy of that country to prepare for negotiations and full membership. The elements of pre-accession strategy implemented in the candidacy process are the Accession Partnership Document, National Programme, screening process, participation in Community Programs and Agencies, Progress Reports, as well as Financial Cooperation with European Union.

Through a range of programs and projects funded by the IPA, Türkiye has received financial assistance for things like the development of regional and rural regions, modernization of its public administration, and improvement of social and economic cohesion. Apart from the IPA, Türkiye also receives financial aid from the EIB as well as EBRD through other means.

Table 3 and Table 4 show the financial assistance received by various countries, including Türkiye, as a candidate country, under the IPA program during the 2007–2013 and 2014–2020 budget periods. The IPA program provided total funding of around EUR 11.5bn during the 2007–2013 budget period. The beneficiary countries of this program are Albania, Bosnia-Herzegovina, Croatia, North Macedonia, Iceland, Kosovo, Montenegro, Serbia, as well as Türkiye. (European Commission, Türkiye IPA, 2023c)

Upon implementation of IPA between the years 2007–2013, IPA II was established in 2014 and covers the period from 2014 to 2020. The Instrument for pre-Accession Assistance II (IPA II) is

successor of the Instrument for pre-Accession Assistance (IPA) with an overall budget allocation of EUR 12.8bn.

Table 3: Distribution of (2007–2013 budget period) IPA I Funds by Candidate Countries

Countries	2007	2008	2009	2010	2011	2012	2013	IPA-I Total
Albania	61.0	70.7	81.2	94.1	94.4	94.5	95.3	635.3
Bosnia-Herzegovina	62.1	74.8	89.1	105.3	107.4	107.8	63.6	610.1
Croatia	141.2	146.0	151.2	153.5	156.5	156.1	93.5	998.0
N.Macedonia	58.5	70.2	81.8	91.6	98.0	101.8	113.2	615.1
Kosovo	68.3	184.7	106.1	67.3	68.7	68.8	71.4	635.3
Montenegro	31.4	32.6	34.5	33.5	34.1	35.0	34.5	235.6
Serbia	189.7	190.9	194.8	197.9	201.8	202.0	208.3	1385.4
Türkiye	497.2	538.7	566.4	653.7	779.9	860.2	902.9	4799.0

Source: (https://ec.europa.eu/neighbourhood-enlargement/sites/near/files/ipa_ii_factsheet_en.pdf)

Table 4: Distribution of (2014–2020 budget period) IPA II Funds by Candidate Countries

Countries	2014	2015	2016	2017	2018–2020	IPA-II Total
Albania	83.7	86.9	89.7	92.9	296.3	649.5
Bosnia-Herzegovina	39.7	39.7	42.7	43.7	-	165.8
N.Macedonia	85.7	88.9	91.6	94.9	303.1	664.2
Kosovo	83.8	85.9	88.7	91.9	295.2	645.5
Montenegro	39.6	35.6	37.4	39.5	118.4	270.5
Serbia	195.1	201.4	207.9	215.4	688.2	1508.0
Türkiye	620.4	626.4	630.7	636.4	1940.0	4453.9

Source: (https://ec.europa.eu/neighbourhood-enlargement/sites/near/files/ipa_ii_factsheet_en.pdf)

It is seen that approximately 4.45 billion euros have been allocated for Türkiye, which is expected to benefit the most from the IPA budget for the 2014–2020 period. Although Türkiye's share of the IPA budget is relatively high compared to candidate as well as potential candidate countries both over 2007–2013 and 2014–2020 budget periods, it is strikingly low in terms of per capita values. (European Commission, Türkiye IPA, 2023c)

When this financial aid to Türkiye is compared with the financial aid to other former candidate countries, it is clear that Türkiye has been unfairly treated. Central and Eastern European countries, whose relations with EU started only after 1990, received assistance from the Union in a short time, much higher than the aid that Türkiye received over 60 years.

While the annual per capita grant amount for the 1990–2006 period of the 10 countries that became members in 2004 was 31.56 euros, the annual grant amount was 22.52 euros in the countries that became members in 2007. For Türkiye, the annual grant amount for the 1963–2006 period is 0.7 euros.

When the population is taken into account, it is evident that there is a notable difference in the grant-eligible financial aid provided to Türkiye. While Türkiye has a very long history, it has not received the aid it deserves. Therefore, this situation has led to sluggish steps in its relations with the EU. Moreover, most of the aid received during this period was realized after it became a candidate country in 1999. (Kıvılcım & Mercan, 2011)

2.5.4. The Value-added by IPA Funds

The IPA funds' main goal is to strengthen and modernize the economies of candidate nations that are less developed so that they can join the EU's Single Market and Eurozone. Short-term demand impacts and long-term supply implications are two categories into which the IPA funds' immediate effects may be separated.

Demand effects are short-term and include increased investment, demand, employment, and earnings. Supply effects are long-term and include improved human capital, infrastructure, and the efficiency of economic units. Evaluating the long-term effects, particularly the supply-side effects,

can be difficult, and there is no clear consensus on the correct method. Research indicates that to assess the impact of the funds effectively, it is essential to analyze macro-level feedback loops and interactions, considering spillover effects and externalities. (Scotti, F., et al., 2022)

While there is no consensus on the precise percentage of GDP growth attributable to the funds, it is worth noting that the IPA funds do contribute to increasing GDP to some extent. When investment expenditures are made, the GDP growth rate increases. Although the growth rate may return to its prior level when investments conclude, the economy can attain a new, higher level of GDP. Hence, the most significant outcome of the IPA funds is a higher level of GDP rather than a lasting boost in the growth rate.

The financial support provided by the IPA funds can allow candidate countries to implement the best contemporary sectoral policies and improve the efficiency of their government structures. In terms of macroeconomics, some investments may not have been possible with solely national resources. Additionally, EU's involvement can influence prioritizations of certain policy themes, such as gender equality, the environment, innovation, and other politically sensitive issues.

The IPA's implementation requirements have played a vital role in shaping expenditure programming by fostering the growth and evolution of multi-annual programming, promoting partnership-oriented approaches, and establishing formal mechanisms for program monitoring and evaluation. This has also enhanced the management capabilities of various agencies.

Ireland, for instance, has greatly benefited from a substantial multi-annual public investment program in critical economic sectors, as well as support from the EU. Moreover, the provision of EU funds and partnerships conveys a crucial economic and business signal, indicating a strong commitment to capitalizing on available opportunities. (European Commission, Commission Implementing Decision, 2021)

Apart from the evident impacts of the IPA funds, there are also significant indirect benefits, such as fiscal stabilization, advancements in the job market, greater levels of foreign direct investment, and enhanced administrative proficiency. Despite Türkiye experiencing limited benefits from these funds, one noteworthy advantage emerges in the form of enhanced public and local governance, along with an improved project implementation process within the country.

This was made possible through a robust and experienced public administration system. The Operational Programs were implemented through specialized sector-based departments and agencies, which were essential in developing and improving contemporary public management methods.

It is important to note that the IPA funds or any of its predecessor programs cannot be solely credited for the development of EU candidate countries. The IPA funds, when coupled with effective governance strategies, robust macroeconomic policies, the influence of European integration on trade and investment, and advantageous external circumstances, can function as a catalyst for triggering a virtuous economic cycle.

CHAPTER 3

REVIEW OF THE EMPIRICAL STUDIES ON THE DETERMINANTS OF REGIONAL GROWTH

Regional growth or development is a multifaceted and intricate process that is shaped by various factors, conditions, and agents. It is the outcome of interactions between several variables, including institutional, social, cultural, economic, and environmental influences. The results of these interactions differ across regions, and the degree and level of articulation of these dimensions have an impact on the intensity and shape of development in each region. (Rodríguez-Pose & Crescenzi, 2008)

Despite extensive studies across countries, the question of determining regional level economic growth has remained vague over many decades, primarily due to inconclusive results driven by

data limitations. As policymakers often enact structural reforms that affect regions, understanding regional growth is critical for comprehending the macroeconomic state of a country. Regional studies have been instrumental in identifying potential determinants of per capita GDP growth, which has enabled policymakers to make more informed strategic decisions.

By using a regional-level analysis, the researchers are able to incorporate additional explanatory variables that vary within a country's regions, leading to novel insights and approaches to understanding economic growth, while still employing similar cross-country growth factors. Thus far, abundant elements that take part in economic progress have been identified, and scholars are continually investigating further determinants.

However, identifying these additional determinants has also presented challenges for researchers, as it has led to increased uncertainty in the forecast. Overfitting, which happens when there are too many parameters compared to the amount of data, makes linear regressions extremely vulnerable and causes the output to contain random error rather than examining the causal link between variables. Moreover, the lack of dependable techniques for computers to combine the entire collection of variables to get accurate estimations of the marginal effects is another problem that arises. (Srebnijs et al., 2019)

3.1. LITERATURE REVIEW ON THE DETERMINANTS OF REGIONAL GROWTH

The determinants of regional growth and their theoretical keystones are briefly discussed in this part, with an emphasis on the recent research that have been published in academic publications.

A plethora of research that attempted to elucidate the reasons why certain countries or regions grow faster than others has confirmed some of the determinants of growth using cross-country, time series, and panel approaches. Nevertheless, it is difficult to determine the regional policy implications of the research using international or country-level regressions and data analysis.

The institutional quality, educational investment, as well as economic diversity are a few of the factors that affect how the determinants and economic growth relate to one another, which are sometimes not obvious. To understand the interplay and possible trade-offs of policies intended to promote various variables, more study is required. For economists who are interested in the

determinants that cause national and sub-national areas to grow at various rates, examining the factors that determine long- and short-term regional economic growth has been a fascinating topic. (Rodrik, D., 2003)

Cuaresma, Doppelhofer, and Feldkircher (2014) examined regional (NUTS-2) economic development in Europe. The authors chose these areas because they had distinctive conditional convergence traits brought on by certain political, economic, or other reasons. The free trade agreement among European Union member states makes it feasible for its people to move around freely within the area, which has increased labor mobility and accelerated conditional convergence.

In contrast to other regions, the European Union has experienced rapid changes within its member countries, which could have both supportive and adverse outcomes on conditional convergence. The EU's geographic reach expansion could have a helpful impact on conditional convergence as member countries receive extra resources from the EU. However, the outlays associated with meeting EU requirements and potentially inefficient EU policies could also undermine economic value. Economic theory provides limited evidence to explain this effect. (Srebnijs et al., 2019)

Numerous factors, such as technology, infrastructure, innovation, human capital, tourism, and competitiveness have been identified as national and regional growth determinants by Shapiro (2006), Jackson and Murphy (2006), and Bronzini and Piselli (2008). Economic advancement depends on the interaction of creativity, social networks, and intangible as well as tangible local resources, including information and technology, according to Rutten and Boekema's 2007 argument. They suggest that technology alone is insufficient to explain regional economic growth.

Various complex forces, making it difficult to identify the factors that influence their growth and change, shape the economic development processes of cities or regions. He poses a crucial issue regarding the objectives of social science in the context of such intricacy. (Storper, M., 2011) Many researchers, including Goletsis and Chletsos (2011), have concentrated on the problem of reducing social as well as economic disparities among European regions because it is one of European Regional Policy key objectives. (Pires Manso, J. R. et al., 2015)

The studies of Barro and Sala-i-Martin (1991, 1995) were largely accountable for the start of the contemporary regional growth literature. Authors who followed looked at other time periods and

geographical data, including Neven and Gouyette (1994), Armstrong (1995), Broecker (1998), and Walz (1999). The other writers only partially contest Barro and Sala-i-Martin's finding whether any regular pattern of ß-convergence with their famed convergence speed of 2% exists. Quah (1993) even questions and criticizes the convergence notion in all of these investigations.

Studies conducted at the regional level made it possible to pinpoint additional potential drivers of GDP per capita development, which helped regulators make more informed strategic choices. Deller S. C., et al., (2008); Chinese provinces by Ding S. and Knight J. (2008); Spanish regions by Gonzalez and Montolio (2004); and European NUTS-2 regions by Cuaresma J. C., et al., (2014), conducted studies of American regions. Researchers in regional studies also looked at the causes of economic expansion in several other countries.

These studies aimed to understand the elements that influence regional economic development and growth in different contexts. They utilized various methodologies, including econometric models, to analyze influences of human capital, innovation, infrastructure, natural properties, and institutional quality for regional economic growth. These analyses shed light on the intricate and multidimensional character of regional economic growth as well as the requirement for context-specific policy interventions.

According to Lall and Yilmaz (2001), regional disparities and temporal economic behavior have a considerably greater impact on the pace of convergence than public capital and human capital. However, human capital is of great significance at the regional level, according to Kaldewei et al. (2001) and Cuaresma et al. (2014). Meanwhile, the theories that public investments can enhance economic growth are supported by Gonzalez & Montolio (2004) and Kaldewei, C., & Walz, U. (2004). Using a BMA (Bayesian Model Averaging) model, Cuaresma et al. (2014) demonstrates how a rise in the proportion of employees with a higher education is linked with a 0.6 percentage point yearly growth rate for GDP per person in regions across Europe.

It needs to be mentioned that human capital has a spatial impact that affects economic growth (Lall and Yilmaz, 2001). The EU's free movement policy makes it easy for individuals to move, which can aid rapid economic convergence by reducing obstacles to factor mobility. Migration is not at all times beneficial, however, claim Polasek and Berrer (2006), and countries cannot prevent migration in dire circumstances due to free movement. Additionally, they forecast that more than

half of the sample's observed regions will see population decline and shrinkage. Furthermore, Kaldewei and Walz (2001) find scant proof that human capital migration significantly affects economic development.

Universities consist a significant component that affects regional economic growth. They have a direct and indirect impact on growth; they either produce research or supply human capital; both sorts of contributions are beneficial to economic progress. (Magrini, 1998)

Investments and initial income are two crucial factors that influence regional economic growth (Ledyaeva & Linden, 2008; Baejowski et al., 2016). Even though the Solow development model includes investments as a growth engine, their importance at the regional level is diminished (Kaldewei & Walz, 2001). Economic growth has been found to be more influenced by higher investments in a specific industrial sector than by diversified investments across various industries (Magrini, 1998). Focusing on a single industry rather than diversifying the investment portfolio across several businesses has greater benefits. Investments in the industrial sector, according to Polek and Sellner (2013), do not always result in higher economic growth.

An overview of the main subfields of empirical study on the factors influencing regional growth has been provided by this literature review. Section 3.3 gives a more thorough analysis that explores each of these categories. The available evidence indicates these elements have a significant role in promoting regional growth.

3.2. METHODOLOGY OF THE STUDIES FOCUSING ON THE DETERMINANTS OF ECONOMIC GROWTH

Since individual regional growth rates determine general economic growth in the nation as a whole, policymakers must identify the policies and structural reforms that can improve regional growth. Despite the numerous techniques, statistical models, and distinct datasets researchers are exploring to identify alternative determinants of GDP growth, there are still many unidentified factors that require further exploration. (Petrakos, G., Arvanitidis, P., & Pavleas, S., 2007)

An important method for understanding economic growth is spatial effect analysis, which suggests that GDP growth can be positively influenced by neighboring nations. For instance, nations that

are rapidly developing could benefit their neighbors. Research by LeSage (2008) examined how regional dependence affected economic development using a Spatial Durbin Model (SDM). They also compared the findings obtained from these models with those obtained from Bayesian Model Averaging (BMA), using data that was specific to each region.

According to their research, a region's long-term steady-state income is influenced by both its distinctive features, those of the surrounding regions, as well as by the degree of spatial dependency and connectedness between regions. The authors concluded that a region's unique qualities hold beneficial effects on economic development overall, whereas spatial spillover has an adverse effect on nearby regions. (LeSage, J. P., 2008)

One approach to addressing model uncertainty is to calculate the probability of each outcome in the regression. The Bayesian Model Averaging (BMA) approach has been developed because of this and allows for the examination of millions of models to determine the impacts of specific parameter sets on economic growth. BMA integrates the results of numerous linear regressions, taking into account more variables, lowering model uncertainty, and exposing previously hidden variables. (Raftery, A. E., 1995)

Fixed-effects analysis is another approach frequently employed in research on regional economic growth (Cuaresma et al., 2009; Ding, S., & Knight, J., 2011; Cuaresma et al., 2014). This method has demonstrated the importance of national-level influences on specific areas as well as the tendency of capital cities to have greater average development rates. Within the realm of fixed effect factors, there ought to be some additional growth determinants that might account for the expansion of the local economy. While fixed-effect analyses are effective in controlling for certain variables, they have limited explanatory power.

In a nutshell, studying the methods of regional development determinants is an intricate course affected due to multiple conditions and factors. Depending on the unique qualities of the region, these variables and actors interact in various ways and at various speeds.

3.3. DETERMINANTS OF REGIONAL ECONOMIC GROWTH

Regional growth has been a complex phenomenon, which is extensively studied, in academic literature. Understanding the determinants of regional growth is essential for policymakers to develop effective regional development strategies. Potential factors for regional growth are acknowledged within four main categories of determinants: economic (physical infrastructure, innovation), social (human capital, demographic characteristics), political (institutions, policy factors), and environmental (natural resources). (Johansson, B., et al., 2001)

While there may be some overlap between these categories of determinants, as some factors may fit into more than one category, it can be helpful to categorize the literature according to the different types of factors that have been identified. It will help us identify common themes and patterns in the literature, as well as any gaps or areas where further research is needed. In this section, we will explore each of these subtopics in turn, drawing on a range of academic references to present a thorough picture of the determinants of regional growth.

It is important to remember that these variables do not always conflict with one another, and their effects on regional growth may be closely related. In addition, relative relevance of these characteristics may change based on the particular environment and developmental stage of a region.

3.3.1. Economic Determinants of Regional Growth

Economic factors have been considered primary forces behind regional growth. They include availability of production resources, the level of industrialization (physical infrastructure, industry composition), and the level of economic integration (labor market conditions, innovation, etc.). For example, regions with a high level of industrialization or economic integration may experience higher levels of growth than those without.

Similarly, industries with higher productivity, innovation, and competitiveness tend to boost regional growth. The presence of a diverse and well-balanced industry structure is considered essential for long-term regional growth. (Feldman, M. P., & Audretsch, D. B., 1999)

The effect of these determinants is multifaceted and contingent on various actors, including educational, institutional, and infrastructural qualities, as well as how efficiently these determinants are employed in the production process.

3.3.1.1. Physical Infrastructure

Physical infrastructure, which includes transportation networks, communication systems, energy infrastructure, and municipal facilities, is a critical determinant of regional growth. High-quality infrastructure might facilitate the efficient transportation of goods and services and lower transaction costs, and hence attract businesses to a region. (Aschauer, 1990)

Studies have found that regions with better infrastructure tend to have lower transaction costs, and higher levels of connectivity, and are more attractive to investors, leading to higher levels of economic growth. Access to transportation, communication, and energy infrastructure is also necessary for firms to access markets and inputs, which can increase productivity and competitiveness. Additionally, positive economic growth has been associated with the provision of high-quality public services. (Kane, M., 2004)

The favorable association between infrastructure and regional growth has been supported by several studies. For instance, according to Aschauer's (1990) research, a 1% increase in the stock of public capital in the United States corresponded to a 0.6% rise in per capita income. Similarly, Lychagin et al. (2016) found that increased levels of regional productivity in Russia were related to transportation infrastructure improvements. These findings suggest that policies aimed at improving infrastructure can effectively promote regional economic development.

Other studies have indicated that the link between infrastructure and regional growth is complicated and depends on a number of variables, including quality of infrastructure, quantity of public expenditure and degree of complementarity between different forms of infrastructure.

3.3.1.2. Industry Mix

The industry mix of a region is another determinant of regional growth, as it can affect specialization and diversification. A favorable association between industrial mix and regional

growth has been shown in several researches. One such example is the study of Feldman & Storper (2018), which discovered that within the United States, regions with a diversified industrial base frequently had better rates of employment growth. (Feldman & Storper, 2018)

Similarly, Duranton and Storper (2008) find that regions with specialized industries experience higher levels of productivity growth in France. These findings suggest that policies aimed at promoting diversification or specialization can be effective in promoting regional growth.

For example, regions with a strong presence in knowledge-intensive industries such as technology and finance tend to enjoy greater levels of productivity and growth vis-à-vis regions that heavily rely on low-skilled manufacturing or natural resource extraction. Knowledge-intensive industries are characterized by high levels of innovation and technology adoption, which can lead to productivity gains and spillover effects that benefit other industries in the region. In contrast, low-skilled manufacturing or resource extraction industries are often associated with lower productivity levels as well as rates of growth. (Duranton & Storper, 2008)

The mix of industries in a given place can also influence the types and degrees of externalities that arise, such as agglomeration economies or congestion impacts. "Congestion effects" refers to the detrimental effects that result from the crowding of economic activity, such as increased traffic and pollution, while "agglomeration economies" refers to advantages that result from the clustering of economic activity and firms, such as shared knowledge and labor markets.

Hence, economic growth in a region has greatly been influenced by compositions of its industries. It has an impact on the region's productivity, technological progress, and externalities. Therefore, understanding the industry mix of a region and its implications for regional growth is of great importance for policymakers and researchers alike. Policies aimed at promoting the growth of knowledge-intensive industries and reducing the negative externalities associated with congestion effects can be effective in promoting regional growth. (Marrocu, E., et al., 2013)

3.3.1.3. Innovation

The link between innovation and economic growth has been extensively researched in the subject of regional economics, and it has been revealed that the two have a definite positive association. The advancement of novel goods, procedures, and technology is referred to as innovation.

Regions that exhibit high levels of innovation have been found to experience higher levels of economic growth. This is because innovation enhances productivity and competitiveness, which are essential factors for regional growth, as demonstrated by various empirical studies. (Aghion, P., et al., 2009; Audretsch, D. B., et al., 2012)

Regions that invest in research and development, have high levels of patent activity, and are home to innovative firms are more likely to achieve sustainable economic progress. In addition, substantial institutional presence and policies that support innovation, such as technology transfer offices and funding mechanisms, have been found to be critical for regional growth.

Innovation can take many forms, including new products, processes, and services, as well as improvements to existing ones. A rising catalogue of research indicates that innovation is a major determinant of regional growth (Audretsch & Feldman, 1996; Boschma, 2005; Fritsch & Slavtchev, 2010).

According to empirical studies, innovation is closely related to regional economic expansion, as it can boost productivity, attract investment, and create employment opportunities (Audretsch & Keilbach, 2004). Moreover, the formation of new industries and expansion of existing ones can be a result of innovation, which can exert a supplementary positive influence on regional progress. (Breschi & Malerba, 1997; Rosenkopf & Almeida, 2003)

In addition to its impact on regional growth, innovation also plays a key role in regional competitiveness. Regions that are able to foster innovation and create a supportive innovation ecosystem are more likely to attract talented workers, innovative firms, and venture capital, all of which can help drive economic growth (Porter, 1998; Maskell & Malmberg, 1999; Cooke, 2010). Moreover, regions that are able to leverage their innovation assets to create specialized clusters or industry networks can gain a competitive advantage over other regions. (Porter, 1990; Krugman, 1991; Feldman & Audretsch, 1999)

Although innovation is broadly accepted as a critical aspect in regional progress, it should be acknowledged that not all regions have the same capacity to facilitate innovation. There is a quantity of features that can affect a region's capacity to innovate, including the availability of skilled workers, access to capital, existence of research establishments and universities, and strength of local webs and clusters (Griliches, 1992; Lundvall, 1992; Feldman & Florida, 1994). Moreover, regional innovation systems are complex and dynamic, with many interdependent actors and factors that can influence the innovation process. (Cooke, P., 2001)

Future research in this area should focus on figuring out how dynamic and complicated regional innovation schemes function, as well as identifying effective policies and strategies for promoting innovation-led growth.

3.3.2. Social Determinants of Regional Growth

Regional growth is influenced by a variety of social determinants, which are factors that influence the welfare of persons as well as communities. A variety of interconnected elements, such as demographic features, inequality and poverty, social capital, social networks, and human capital, are among the complex and varied socioeconomic drivers of regional growth.

Social determinants are circumstances related to socioeconomic elements that impact regional development and growth. By influencing the environment in which economic development occurs, social determinants have a considerable and subtle impact on regional development. Addressing social determinants can help create more equitable and sustainable regional growth.

3.3.2.1. Demographic Characteristics

Regional growth can also be influenced by demographic characteristics, including population size, density, age structure, gender, and migration. Because of their contribution to a bigger labor force, wider social networks, and better levels of creativity, studies have indicated that regions with a higher number of people of working age tend to have faster economic expansion. (Duranton and Puga, 2004; Bettencourt et al., 2007)

Population growth is positively associated with regional growth, as larger populations provide a larger market for goods and services, as well as a larger pool of labor. (Glaeser et al., 2002) Additionally, the population age distribution in a territory can have an impact on its economic development, as younger populations tend to be more entrepreneurial and innovative than older populations (Acs & Armington, 2004). Migration is also an essential social determinant of regional growth, as it can bring new skills, knowledge, and entrepreneurship to a region. (Boschma & Van Der Knaap, 1997)

Not all demographic factors have a significant influence on regional growth and vary depending on contextual influences such as the quality of institutions, education, and infrastructure. The interplay between population characteristics and regional growth is intricate, and it hinges on several factors, including the quality of public services, social inclusivity and cohesion, and housing availability. (Desjardins, S., et al., 2002)

Empirical investigations on the linking between demographic traits and economic growth have produced varying outcomes. (Combes et al., 2008; Rodríguez-Pose & Ezcurra, 2010). For example, rapid population growth can also strain public resources and lead to increased congestion, pollution, and other negative externalities. (Henderson, 2003; Glaeser & Kahn, 2004)

3.3.2.2. Inequality and Poverty

Inequality and poverty are significant social determinants of regional growth, with important implications for economic development and social welfare. High levels of inequality can reduce social cohesion and undermine public trust in institutions, while poverty may perpetuate intergenerational disadvantage and restrict access to healthcare, education, and other important services. (Galor & Zeira, 1993; Alesina & Rodrik, 1994)

Numerous studies have revealed a negative relationship between regional growth and poverty or inequality. For instance, research conducted by Kuznets (1955) and Acemoglu et al. (2001) found such a relationship. Galor & Zeira (1993) observed that each one percent rise in Gini coefficient, a gauge of income inequality, lowers economic growth by 0.4 percentage points.

Relationships between inequality or poverty and regional growth are not straightforward and are influenced by various factors, such as the effectiveness of public policies aimed at reducing inequality or poverty. Numerous studies that have demonstrated the context-specific nature of the relationship between inequality or poverty and regional growth have identified this complexity. (Bénabou, 1996; Bourguignon & Morrisson, 1998)

3.3.2.3. Social Capital

Social capital, which encompasses informal norms and networks that promote cooperation, trust, and collective action among individuals and organizations, is an essential social factor that influences regional growth (Putnam, 1995). Regions defined by a high degree of social capital frequently demonstrate more efficient governing systems, stronger social cohesiveness, and higher levels of entrepreneurship and innovation. (Boschma & Frenken, 2010)

Social capital is essential for regional growth as it can lower transaction costs and enhance the exchange of information and ideas. Research has proved that districts having substantial levels of social endowment tend to enjoy more effective governance systems, stronger community ties, and higher levels of entrepreneurship and innovation (Knack & Keefer, 1997; Woolcock & Narayan, 2000). A one standard deviation increase in social capital was associated with a 1.1 percentage point increase in per capita income, according to Knack & Keefer (1997).

Social capital and regional growth have a complicated connection with one another, and it depends on several factors, as some studies have suggested. These factors include the quality of governance, the level of economic inequality, and how effectively social capital is utilized in the production process. (Woolcock & Narayan, 2000)

3.3.2.4. Social Networks

The strength of social networks and community connections can influence regional growth by supporting entrepreneurship, innovation, and collaboration. Regions with strong social capital tend to have more opportunities for networking and information sharing, which can help support economic development.

Social networks, defined as the ties and relationships between individuals and organizations, are another important social determinant of regional growth since ideas, resources, and opportunities play critical roles in promoting innovation, entrepreneurship, and knowledge spillovers. Regions with solid social networks tend to have more vibrant and diverse economies and are often characterized by higher levels of social trust and cooperation. (Granovetter, 1973; Burt, 2000)

The correlation between social networks and regional growth is intricate and relies on several factors, such as the level of social stratification, the characteristics of network connections, and the quality of institutions and governance (Portes, 1998; Putnam, 2001). For example, some studies have found that social networks can reinforce existing patterns of inequality and exclusion, particularly if the network ties are based on race, ethnicity, or other forms of social identity. (Portes & Sensenbrenner, 1993; Passy, 2003)

Other studies have emphasized the importance of bridging social networks, which connect individuals and organizations across diverse social and economic groups, in promoting regional growth and reducing inequality. (Granovetter, 1985; Putnam, 2001)

3.3.2.5. Human Capital

It is widely recognized that the knowledge, abilities, and capabilities of any region's workers make up its human capital, which is among the most significant variables determining regional progress. A skilled workforce is often considered essential for economic growth as it enables firms to innovate and adopt new technologies, thus increasing productivity. Regions that possess greater levels of human capital are typically more productive, competitive, and innovative. This can equip them with skill to adjust more effectively for unforeseen variations in global economy.

Numerous studies have examined the effect of human capital on regional growth and identified it as a crucial factor. Regional growth is positively connected with higher levels of human capital, according to studies. Empirical evidence shows that regions with a more skilled workforce tend to have higher economic growth rates. (Bassanini, A., et al., 2001; Acemoglu, D., et al., 2011). These findings suggest that policies aimed at increasing human capital can be effective in promoting regional growth.

Labor market conditions, including labor force education, skills, and mobility, are also crucial determinants of regional growth. Highly skilled and educated labor forces tend to attract innovative and knowledge-intensive industries that drive regional growth. (Acemoglu, D., et al., 2011)

Education and training programs play a crucial role as integrated parts of human capital and are key social factors that determine regional growth. Their significance extends to impacting innovation, productivity, and competitiveness. (Arrow, 1973; Lucas, 2015). Regions that possess higher levels of education are associated with having workforces that are more skilled, higher rates of innovation and entrepreneurship, and more robust social networks and institutions. (Krugman, 1991; Acemoglu, D., et al., 2011). Education programs equip individuals with relevant skills and knowledge, thus increasing their productivity levels.

According to Mankiw et al. (1992), a 1% increase in a region's college-educated population is associated with a 0.2 percentage point increase in per capita income. Furthermore, Madsen et al. (2010) concluded that human capital has a positive and statistically significant impact on regional growth in European countries. Duranton et al. (2015), who discovered that greater levels of education are related to greater regional output levels in United States, have reported similar findings.

Education and regional growth have a complex relationship that relies on numerous factors, including the quality of education, level of inequality as well as exclusion, and degree of connection between education and economic opportunities (Psacharopoulos & Patrinos, 2004). The effect of education on regional progress also varies depending on social networks strength and the extent of labor markets in the regions (Moretti, 2004; Topa, 2011). Other studies underlined the vitality of targeted policies as well as investments to facilitate accession for education and human capital in disadvantaged communities. (Heckman, 2006)

3.3.3. Political Determinants of Regional Growth

Political factors, including government policies and institutional arrangements, are also crucial determinants of regional growth since they influence resources allocation, power distribution, and governance quality in a given region. The factors that determine regional growth from a political standpoint are intricate and diverse, involving various institutional and policy-related elements.

The quality of governance, political stability, institutional arrangements, corruption, infrastructure, and trade all play critical roles in determining regional growth, and policymakers must carefully consider these factors when designing strategies to promote sustainable and inclusive economic development in their communities.

Government policies, such as taxation, subsidies, and regulation, can significantly affect a region's economic growth (Sala-i-Martin & Barro, 1995). Policies that promote entrepreneurship and innovation, including R&D funding, intellectual property protection and education, can foster long-term regional growth. (Audretsch & Keilbach, 2004)

Institutional factors and policy factors are the two primary categories of political variables that affect regional growth. Institutional factors encompass both formal and informal rules and structures that shape economic and political conduct, whereas policy factors refer to the particular programs and policies that governments implement to stimulate economic growth.

3.3.3.1. Institutional Factors

Institutional factors, including the quality of governance, regulatory environments (property rights, contract enforcement), political stability, and corruption level, play critical roles in determining regional growth as they can affect the business environment and allocation of resources.

Robust institutions can create a stable and foreseeable atmosphere for economic endeavors; encourage entrepreneurship and innovation, and lower transaction expenses. Regions with well-functioning institutions tend to have greater economic growth levels, hence become more attractive to investors. (Acemoglu et al., 2001)

Several research studies have established a favorable correlation between institutions and regional growth. One such example is the work of Rodrik et al. (2004), which indicates that developing countries with superior institutions tend to experience higher levels of regional growth. Similarly, Acemoglu et al. (2014) find that institutions that protect property rights and promote competition have been linked with greater levels of regional productivity in the United States. These studies advocate that strategies intended at refining institutions can be beneficial in promoting regional growth.

Regions with high-quality governance tend to own more effective communal establishments, stronger rule-of-law, and better investment climates, all of which contribute to greater economic growth rates (Acemoglu et al., 2001). Good governance as well as strong institutions are essential for promoting economic growth because they improve the rule of law, boost openness, and eliminate corruption. According to empirical research, areas with strong institutions typically see greater economic growth. (Knack & Keefer, 1995; Rodrik et al., 2004)

Alesina et al., (1996) advise that political stability is important for regional growth, as it provides a predictable and stable environment for investment and economic activity. Regions with political stability may experience higher levels of growth than regions with political uncertainty.

Political system, institutional quality, corruption level, civil society involvement, and the stage of economic development are some of the factors that influence the relationship between political stability and regional growth. (Alesina and Perotti, 1996)

Corruption is another important institutional factor that can affect regional growth, as it undermines public trust in government, distorts market incentives, and diverts resources away from productive activities (Mauro, 1995). Regional economies where corruption is prevalent tend to experience slower rates of progress, since investors become less inclined to participate in corrupt settings, and economic activity is more likely to be diverted toward rent-seeking practices. (Wei, S. J., & Kaufmann, M. D., 2000)

3.3.3.2. Policy Factors

The importance of policy issues in regional growth cannot be overstated, as it encompasses areas such as infrastructure, education, innovation, and trade. These policies hold significant influence over a region's economic performance, productivity, and competitiveness since the region's development may be significantly impacted by their use and efficacy.

Infrastructure policies, such as investments in transportation, telecommunications, energy, and other public infrastructure, can facilitate economic activity and promote regional growth by reducing transportation costs and increasing market access. (Rietveld, P., et al., 2002)

Education policies and investments in primary, secondary, and tertiary education systems promote regional growth by developing a skilled workforce that can adapt to economic changes, increase labor productivity, and foster innovation. (Hanushek & Woessmann, 2008)

Innovation policies, such as research and development funding, can also promote regional growth by facilitating technological change and productivity growth (Mowery & Rosenberg, 1993). These policies' main objective is to promote the creation and use of novel technologies, goods, and practices and to ease business ventures, research, and development (R&D) projects.

Trade policies can promote regional growth by increasing market access and promoting specialization (Helpman et al., 2004). These policies include measures that facilitate trade and investment across borders, such as reducing tariffs, non-tariff barriers, free trade agreements, export promotion programs, and promoting foreign investment.

3.3.4. Environmental Determinants of Regional Growth

Environmental determinants refer to factors related to the natural and physical environment that can influence regional growth. Environmental factors' effects on regional development have gained increasing attention from economists and policymakers. They can have a substantial influence on regional growth, and their outcomes can be either favorable or unfavorable, depending on how they are managed and addressed. Some of the key environmental determinants of regional growth include natural resources, climate, and ecological systems. (Levinson, A., 1996)

3.3.4.1. Natural Resources

Natural resources are often seen as a significant determinant of regional growth, as they can provide important inputs for production and generate income through exports. Natural resources refer to the assets that occur naturally, such as minerals, oil, and gas. Natural resources can be a substantial determinant of regional progress, especially for regions having abundant resources. Regions with copious natural resources can experience significant economic growth as these resources attract investment and generate revenue. (Ross, 1999)

The correlation between natural resources and regional growth is complex and subject to various factors. While some research indicates that natural resources contribute to regional growth, that relationship is not universally applicable and is contingent upon several variables. For example, Ross (1999) finds that countries with more natural resources expand their economies at faster rates than the ones with fewer resources.

On the other hand, some studies suggest an adverse connection between regional development and natural resources. Auty (1994), for instance, argues that resource dependency can result in economic volatility and a lack of diversification. Therefore, the natural resources impact on regional progress is reliant on the context and hinges on various factors such as the type of resource, dependence level for resource, as well as the quality of institutions.

3.3.4.2. Climate

Climate is another important environmental determinant of regional growth. Climate can affect agricultural productivity, health outcomes, and energy consumption, among other factors. Certain studies have suggested a favorable connection between climate and regional growth. Dell et al. (2012), for instance, observe that a rise of one degree in temperature corresponds to a 1.3% increase in per capita income in impoverished nations.

Conversely, other studies have discovered an unfavorable link between climate and regional growth. For instance, Burke et al. (2015) assert that climate change is expected to diminish worldwide economic output by 23% by the close of the century.

Therefore, the climate effect on regional progress has been intricate and hinges on a variety of elements such as the stage of development, the kind of climate, and the capacity of regions to adjust to evolving climatic circumstances.

3.3.4.3. Ecological Systems

Ecological systems, including forests, wetlands, and marine ecosystems, can also impact regional growth. Ecosystems offer significant ecological amenities, including water filtration, biodiversity preservation, carbon sequestration, that are indispensable for economic activities.

Many studies have demonstrated a favorable association between ecological systems and regional growth. For example, Costanza et al. (1998) found that loss of wetlands can lead to increased flood damage and reduced water quality, negatively affecting regional economic growth, and estimated that global ecosystems produce $33 trillion worth of ecosystem services annually.

Stern et al. (1996) found that environmental deterioration, i.e., water and air pollution, can exert an adverse effect on economies. Dasgupta et al. (2000) argued that depletion of natural capital, such as deforestation or overfishing, can reduce economic growth in the long run. Barbier (2007) found that loss of biodiversity can reduce the productivity of natural systems, leading to reduced economic growth in agriculture and forestry sectors.

Thus, the influence of ecological systems for regional growth is multifaceted and contingent upon various factors, such as the nature of the ecosystem, the extent of its use, and the capacity of regions to administer these systems sustainably. These circumstances underscore the necessity for sustainable development practices that consider ecological systems.

3.4. EMPIRICAL STUDIES FOCUSING ON THE IMPACTS OF EUROPEAN UNION'S REGIONAL FUNDS ON ECONOMIC GROWTH

The most important and strategic tools the EU uses to support regional development in its member states and to promote the intended path of convergence are its funds. The efficacy of these funds in fostering economic growth and minimizing welfare gaps within the EU is a vital matter. Consequently, from a variety of angles, the effects of EU funding on economic performance have been studied.

Melecký (2018) argues that it has seemed arguably impossible to identify the optimal theory to pinpoint how this type of instrument affects economic performance. Additionally, it appears that the outcomes attained concerning the impacts of the EU cohesion strategy are not definitive. (Maynou et al., 2014)

Majority of evidence implies that the funds may be a useful instrument for encouraging development and plausible convergence. For the countries receiving funding to benefit, it is

essential for them to possess a stable macroeconomic climate, a robust institutional framework, and appropriate microeconomic structures.

Many scholars have concentrated on issues related to regional or national convergence in recent economic growth literature (Mohl & Hagen, 2010). Barro and Sala-i-Martin (2004) suggest two forms of convergence. The first is a phenomenon known as "β-convergence," in which lower-income economies expand more quickly than higher-income ones, eventually catching up to the latter in terms of per capita income or production. The second is "α-convergence," in which there is less variation in per capita income or output levels among some nations or regions. While α-convergence focuses on lowering the variation coefficient of GDP per capita, β-convergence is based on negative correlation between GDP per capita growth rate and GDP per capita initial level.

A study about EU structural funding impacts on β-convergence as well as α-convergence processes was conducted by Ederveen, de Mooij, Nahuis, and Gorter in 2003. When assessing β-convergence through relationship between logarithm of per capita GDP in 1977 and per capita GDP growth rate between 1977 and 1996 for 12 EU member states, the study found a strong catching-up pattern with an approximately 2.1% annual convergence rate. Additionally, the study discovered that the logarithm of per capita GDP standard deviation decreased from 0.282 in 1977 to 0.246 in 1996, pointing to a decrease in per capita income or output level dispersion and supporting the α-convergence process.

Despite the fact that Cappelen, Fagerberg, Verspagen, and Castellacci (2003) analyzed EU aid influences on convergence processes for nearly a similar time frame as Ederveen et al. (2003), their experimental results were not the same. There was no convergence between 1980 and 1990, according to Cappelen et al. (2003) but it appears that regional dispersion has declined since 1990. Nonetheless, the results were different when Spain, Portugal, and Greece were taken out of the model, and there now seems to be a trend toward divergence rather than convergence. Therefore, results showed that process of "β-convergence" is spurred on by inclusion of new member nations. The researches also added that there was no "α-convergence" across nations.

The importance of time period relevance must be emphasized in light of the conclusions reached by Cappelen et al. (2003). Between two particular periods, Puigcerver-Peñalver (2007) discovered

variations in estimated β-convergence values. The convergence of Objective_1 areas was more influenced by the 1989–1993 programming era than by the 1994–1999 program period.

Dall'erba et al. (2008) carried out an analysis of the Structural Funds' role in convergence processes across 145 EU regions between 1989 and 1999. The authors identified major convergence across European Union regions. However, the results show that the funds had no effect on the convergence process. Furthermore, the researchers suggested that in order to get more conclusive results, reviewing the impact of structural funding while considering geographical spillover effects is crucial. Concerning the effectiveness of EU assistance, Boldrin and Canova (2001) have remained unconvinced. Unambiguously, they claimed that the strategies of the EU are "unjustifiable given the state of economic knowledge at the moment."

Parallel to Ederveen et al. (2003), Maynou et al. (2014) attained their research findings by analyzing solely the Eurozone's economic convergence between 1990 and 2010. The convergency rate among Eurozone members was observed to be statistically significant, at roughly -1.6% annually. Furthermore, they highlighted that if EU regional assistance rises by 1%, GDP per resident increases by 0.9% anywhere within the Eurozone's member states.

Antunes et al. (2006) used a panel data technique for 30 NUTS-3 Portuguese areas between 1991 and 2000 to investigate the convergence trend in Portugal from a national perspective. The study describes whether structural funds, specifically the ERDF, affected the convergence speed between Portugal's "littoral" and "interior" areas. The findings were that, while "interior" areas underwent a marginally faster convergence process than "littoral" areas, "littoral" areas nevertheless got more EU funds.

Bondonio et al. (2006) used exclusive company-specific data collection from northern and central Italy from 1995 to 1998 to quantify the employment impacts of incentives at Objective_2 locations. The researchers found that the aid programs that supported businesses that had produced the best investment returns in the years before the incentive were the most successful.

Although there is a substantial amount of published research about the convergence process, some academics interested in examining the role of EU incentive schemes on regional development also exist. Rodriguez-Pose & Fratesi (2004) decided that, despite the EU aid concentration on

developing infrastructure and investing in business processes (for Objective_1) in ten member (Belgium, France, Germany, Greece, Ireland, Italy, Netherlands, Portugal, Spain, and the UK) countries from 1989 to 1999, these policies had negligible effects. Esposti & Bussoletti (2008) obtained similar consequences and concluded that Objective_1 funding exerts a minor influence on economic performance. (See Section 2.1.3 for the explanation of Objective definitions of EU.)

By examining the effects of three programmatic phases (i.e., 1975–1988, 1989–1993, and 1994–1999), Fiaschi et al. (2018), who were analyzing the effects of Objective_1 funds, discovered that while EU aid did support increasing productivity, the effect was primarily driven by the funds targeted to Objective_1 regions. Another conclusion of study is that expenditures directed to Objective_2 showed a negative influence on pace of productivity increase whereas having no meaningful impact on the other Objectives.

Fiaschi et al. (2018), focusing on the influence of Objective_1 funds, found that while EU aid for boosting productivity had some positive effects over the three programmatic phases, the outcome was primarily shaped by funding allocated to Objective_1 regions. They also discovered that, in contrast to the other Objectives, funds allocated to Objective_2 had an adverse impact on productivity growth.

According to Mohl and Hagen (2008), between 1995 and 2005, the 3-year average GDP growth rate for 122 NUTS-1 and NUTS-2 EU areas showed some beneficial but statistically negligible effects from structural funding. Mohl & Hagen (2010) offered data for years 2000–2006, demonstrating a substantial correlation between the research aim and the efficacy of EU funding in a different study. The authors discovered that while funds committed directly to Objective_1 helped economic progress within EU areas, funds given to Objectives 1, 2, and 3 as a whole had no positive or substantial impact on regional growth rates.

Gagliardi & Percoco (2016) discovered that the EU cohesion strategy supported growth in underdeveloped regions during the same period as Mohl & Hagen (2010). However, studies show that the high performance of rural areas close to urban mega corporations is primarily responsible for the significant influence of EU aid on provincial development.

Becker et al. (2018) focused on the distribution of EU subsidies to Objective_1 regions as they examined the impact of EU cohesion policy throughout four programming eras (1989–1993, 1994–1999, 2000–2006, and 2007–2013). The information retrieved acknowledged Mohl and Hagen (2008)'s conclusions that EU aid has a beneficial but transient impact on economic performance. The authors also noted that there was little effect of EU aid on growth in member states that were severely impacted by the economic crisis.

Similarly, Crescenzi and Guia (2014) asserted that the EU cohesion policy boosted economic performance between 1995 and 2013. The findings revealed that EU funding has a greater positive effect in the highest socioeconomic regions.

Beuran, M. (2004)'s study analyzed panel data from 25 Central and Eastern European countries between 1990 and 2000. The results showed that financial aid provided to these countries by various international organizations had a positive impact on their economic performance.

No empirical study that goes into detail about how EU funding affects regional growth in Türkiye is currently available, as far as we know. Our study intends to address the gap in academic research on the effect of EU funding on regional growth in Türkiye because there is presently a lack of empirical data on the topic. While there is plenty of theoretical and descriptive research on how EU funding affects regional growth, there are not many econometric analyses that depend on IPA reimbursement data. This is because of two factors.

First, due to the nature of the IPA mechanism established in Türkiye as an accession candidate to the EU, the implementation system in Türkiye is decentralized. There are a number of accredited institutions (mainly public organizations) that implement the various IPA programs. This brings the necessity to compile different IPA funds reimbursement data from the relevant IPA-accredited institutions, which could bring some bureaucratic burdens. Second, IPA implementation is relevantly very recent in Türkiye, and therefore the data is deemed rather limited in scope to get statistically robust results in academic studies.

However, there are a few academic studies that have used other (other than IPA reimbursements) regional variables or surveys to analyze some aspects of the EU funds for regional development. Within this context, Özdamar, Yavuzaslan, Giovanis and Bahçeci (2002) analyze the effect of

RCOP on employment. Their results show that the impact of RCOP was found to be limited to young people aged 15–24, with no discernible positive effect on individuals over the age of 24.

Tektaş and Kuyucu (2010) conducted an efficiency ex-ante analysis of the projects funded by EU pre-accession funds. They found out that active engagement in multilevel governance has been a crucial feature in confirming the efficacy of regional development funds distributed through IPA funds. Sub-national administrations are more advantageously situated to profit from the EU harmonization effort when they adopt strategies to work with the multilevel governance framework.

Battaglio & Horasanli (2018) study the impacts of EU funding on the insights of Civil Society Organization (CSO) executives in Batman province, whose findings indicate that the implementation of IPA could be a crucial factor in the future, particularly as local officials in candidate countries work to build civil society.

Table 5 summarizes the empirical studies results measuring impacts of European Union's regional funds on regional economic growth and (descriptively) in Türkiye.

Table 5: Literature Review on Impact of European Union's Funds on Economic Growth

Study	Objective(s)	Sample / Time period	Method	Dependent variable(s)	Explanatory variables	Key conclusion(s)
Antunes and Soukiazis (2006)	Determine whether there are any variations in the convergence process between Portugal's "littoral" and "interior" areas by analyzing the significance of ERDF as a conditioning factor impacting the country's convergence process	30 NUTS-III regions in Portugal 1991–2000	Panel: Pooled Ordinary Least Squares (OLS), FE, random effects	per capita GDP	Lagged per capita GDP and per capita ERDF	Conclusions show it's critical to distinguish between the "littoral" and "interior" regions when assessing Portugal's convergence progress. Additionally, structural funds only have a significant (positive) effect in "littoral" Portuguese regions.
Becker et al. (2018)	Explores the regional effect of EU cohesion policy spanning four thematic eras with a focus on assessing the impact of EU transfers throughout the economic and financial crisis	187 NUTS-II regions in 1989–1993 (EU-12), 209 NUTS-II regions in 1994–1999, 253 NUTS-II regions in 2000–2006 and 2007–2013 (EU-25)	Regression discontinuity design [Two-Stage Least Squares (TSLS) approach]	per capita GDP growth, per GDP real sector and public investment, per GDP employment growth	Treatment variable: binary Objective 1 treatment indicator variable Control variables: government-bond-yield spreads	Major findings show: (i) the positive outcomes of Objective_1 for economic growth are transitory; (ii) losing Objective_1 status has an adverse effect on growth; and (iii) the effects are lower during the current financial and economic crisis than they were a few years ago.
Boldrin and Canova (2001)	Examine if EU regions are converging or diverging	185 NUTS-II regions (EU-15) 1980–1996	Not specified	GDP per capita or labor productivity	Initial level of GDP per capita	Outcomes demonstrate there is no convergence nor divergence among EU regions, while there are rare outliers.

Bondonio and Greenbaum (2006)	Address the question: Do corporate investment subsidies endorse hiring in weakening Italian areas?, utilizing unique firm-specific data and supporting evidence from EU Objective_2 regions	All cities in each Italian region comprising at least one Objective_2 areas 1995–1998, includes a pre-treatment period (1986–1991)	Panel: FE	Aggregated employment level and province-sector 1995–1998 employment growth	Treatment assignment, industrial sector, region, set of pre-intervention province-specific observed characteristics, specific pre-intervention (1986–91) employment growth, linear treatment variable expressing the incentives paid	According to findings, business investment incentives given out in Italy between 1995 and 1998 did not lead to the creation of new employment. On the other hand, incentives that were given to the activities that produced the most encouraging economic results prior to program involvement were more successful.
Cappelen et al. (2003)	Analysis of GDP per capita by region and investigation of the impact of regional EU support (objectives 1, 2, and 5b) on growth performance	105 EU regions 1980–1997	Panel: Pooled OLS, FE	GDP per capita	per capita GDP initial level, complementary variables, and EU regional assistance	Conclusions obtained indicate that after 1990, there was a reduction in regional disparity and that the way structural funds were allocated had some positive implications on how well EU regions performed in terms of growth. In contrast, it is more likely to slightly increase if Greece, Spain, and Portugal are excluded from this sample.
Crescenzi and Guia (2014)	The study looks at how the EU's cohesion policy affects growth and how it relates to the EU's agricultural and rural policies	139 NUTS-I/II regions (EU-12) 1995–2013	Panel: FE	GDP per capita growth	per capita GDP initial level, EU policies, regional conditioning factors (e.g., Social Filter Index), policy interactions, spatially lagged variables, control variables	Primary findings, as follows: (i) a significant correlation between EU regional policy payments and regional growth rates; (ii) no obvious connection between spending on rural development and regional growth; (iii) when complemented by CAP funding and located in resource-rich areas, EU cohesion policy is more successful.

Le Gallo and Dall'erba (2008)	Analyze structural funding impact on regional convergence within the EU	206 NUTS-II regions (EU-15) 1989–1999	Cross-sectional: Spatial-lag model with Instrumental Variables	GDP per capita growth	Initial GDP, industrial and agricultural share, unemployment, infrastructure, structural funding transfers, and a dummy for core and periphery EU regions	Results imply there was a major convergence of EU areas. However, there was no proof that structural funds had any influence.
Ederveen et al. (2003)	Evaluation of α- and β-convergence processes within member states and evaluation of the impact of ERDF on growth performance are also goals. There are many analysis varieties	EU-12 1960–1995	Panel: Pooled OLS	GDP per capita growth	Investment in physical and human capital, population growth, ERDF reimbursements as a percentage of GDP, and economical openness	Findings show that economic growth performance has not been improved by EU cohesion funding. Also, there is evidence of a process of convergence among EU nations, with a rate of convergence at 2,1%/year (β- convergence), also among EU regions (α-convergence).
Esposti and Bussoletti (2008)	Utilize an augmented conditional convergence econometric model to examine how Objective_1 funds affect regional growth convergence in EU	206 NUTS-II regions (EU-15) 1989–2000	Panel: first-differences between GMM and system-GMM	GDP growth per labor unit	Initial GDP, all structural funding payments (under Objective 1), human capital, R&D, and infrastructure endowment	Outcomes show structural funds' (under Objective 1 policy) influence on economic growth is rather modest. Furthermore, if the impact is concentrated in certain countries or regions, it could even be negative.

Fiaschi et al. (2018)	Study influence of EU regional strategy on expansion of regional productivity	173 NUTS-II regions (EU-12) 1980–2002	Cross-section and pooled regression with dummies: SDM and OLS	per worker gross value growth rate added of a region	Relationship between funds and regional gross value added with a three-year lag, initial productivity level, investment and employment growth rate, and other control variables	The main conclusions are (i) that both structural and cohesion funds have some beneficial impacts on productivity growth, but that the Objective 1 funds are primarily responsible for this result, (ii) that the favorable impacts are greater for the 1989–1993 and 1994–1999 programmatic periods, and (iii) that these results are robust in the face of potential endogeneity of funds as well as spatial effects.
Gagliardi and Percoco (2016)	Analysis of the impact of EU cohesion strategy on economic growth in the EU's poorest areas (under Objective 1)	1233 NUTS-III regions (EU-25) 1999–2008, focusing on the 2000–2006 programmatic period	Regression discontinuity design (IV estimation)	GDP growth	Demographics, employment, secondary and tertiary education levels, and treatment variables	Results show that the EU's cohesion funds encouraged economic expansion. However, this effect is a result of rural zones close to urban conglomerates performing well. Therefore, the suburbanization of the countryside and favorable geography are opening up novel prospects.

Maynou et al. (2014)	Find out how structural and cohesion funding affect economic convergence within Eurozone through a spatiotemporal econometric model	174 NUTS-II regions (EU-17) 1990–2010	Panel: FE	GDP per capita growth	Lagged GDP per capita Regional level: gross fixed capital formation, several unemployment and employment rate variables, percentage of secondary and university students Country level: external balance, public expenditure rate, structural and cohesion funds (ERDF, EAGGF, FIFG, and CF), Exports & imports rate	According to the findings, the funding significantly impacted both the economic growth of the EU areas that benefited from them and the economic convergence of the Eurozone members. In reality, the growth rate of the nations in the Eurozone rises by 0.9% for every 1% raised by regional funds.
Mohl and Hagen (2008)	The impact of EU cohesion strategy on economic performance was examined using an econometric technique	122 NUTS-I/II regions (EU-15) 1995–2005	Panel: generalized propensity score approach (OLS and logit model)	GDP per capita growth	Structural funds as a percentage of nominal GDP, lagged GDP per person, several indicators of employment and unemployment, and population density	The results demonstrate that structural funding appeared to have an insignificant but positive influence on the economic performance of EU regions. The "dose" of structural funds reimbursements that a locality receives is therefore irrelevant.

Mohl and Hagen (2010)	Paper presents an appraisal workout of the impact on economic growth of EU structural funds while accounting for endogeneity and spatial spillover effects.	126 NUTS-I/II regions (EU-15) 1995–2006	Panel: two-step system GMM and spatial lag model	GDP per capita growth	Initial GDP per capita, investment, population growth, technical progress, Objective 1 payments per capita, and Objective 1+2+3 payments per capita	Despite findings that the total amount of payments made under Objectives 1, 2, and 3 had neither a significant nor positive effect on EU regions' economic growth, funds provided to only Objective 1 regions stimulated regional economic growth.
Puigcerver-Peñalver (2007)	Study influences cohesion policy in EU on eligible regions' growth rates under Objective 1	41 NUTS-II regions (EU-10) 1989–1999	Panel: Pooled OLS, Fixed Effects (FE)	GDP per capita growth	Initial GDP per capita, public & private national expenditure, and several structural funds variables	There is an indication that the structural funding seemed to have a significant effect on economic performance overall. Yet, from 1989 to 1999, the effect was more visible than from 1994 to 1999.
Rodríguez-Pose and Fratesi (2004)	Study examines EU funding allocation to several development axes within Objective 1 to see if the EU objective of achieving greater social and economic cohesion has been accomplished using panel data and cross-sectional analysis	152 NUTS-II regions (EU-8) 1989–1999	Cross-section and panel: OLS, pooled Generalized Least Squares (GLS), FE	GDP per capita growth	Initial GDP, structural funds transfers (distributed according to the ERDF's 4 major axes), and various employment rates	Results indicate that European initiatives have failed to increase social and economic cohesion. Both development funds focused more heavily on infrastructure and less heavily on business support produced no significant returns on their commitments. However, despite the fact that supporting agriculture had a short-term positive effect on economic performance, only investments in human capital and education had a significant (positive) impact on growth over the medium term.

Capello and Lenzi (2016)	Characteristics of the Innovative environment as a mediator in entrepreneurship/ advancement relationship	NUTS-II regions (EU-15)	Spatial lag model; Spatial Durbin model	Annual regional GDP per capita growth	Initial regional GDP (convergence); Annual growth rates for employment, capital, and FDI, as well as the % of individuals (15 and older) with higher education and blue-collar work	Highlighted the importance of adopting a forward-looking perspective has been emphasized, whereby local actors can recognize that the potential expenses of long-term structural inefficiencies may be significant, thus motivating them to implement new measures to prevent a lock-in scenario.
Capello, Caragliu, and Fratesi (2017)	Linking many components of national and regional economies to the performance of regional economies: macroeconomic, sectoral, social, and territorial model	NUTS-II regions (EU-27) 1990–2011	OLS; Fixed effects model; Random effects model Spatial error model	Regional differential growth component	Economic urbanization, regional sectoral organization, migration patterns, population growth, unemployment, territorial capital assets, etc.	Role of macroeconomic factors in regional growth has been underestimated in recent years. During times of turbulence, such as the current crisis, regional growth is heavily influenced by national trends. As a result, a regional growth forecasting model should be able to account for macroeconomic factors while also allowing individual regions to attribute part of their growth patterns to internal factors.
Rodríguez-Pose and Crescenzi (2008)	Incorporating R&D investments, RIS effectiveness, and regional knowledge spillovers effects into explanations of regional growth	NUTS-I and II regions (EU-25) 1995–2003	OLS	Annual regional GDP per capita growth	Spending on research and development, the social filter index, and the accessibility to extra-regional innovation actions	In Europe, innovation policies can yield varied results at regional level, depending on each region's potential to benefit from spillovers in knowledge and favorable socioeconomic conditions (internal conditions). Generally, investing in R&D in essential regions, that benefit from both a location and social filter gain, can show a further favorable impact on economic progress by improving

						performances along with its adjacent regions.
Özdamar, Yavuzaslan, Giovanis & Bahçeci (2022)	Analyze the effect of RCOP on employment.	2 NUTS-II regions (TR-71 and TR-72) 2004–2017	Panel: generalized propensity score approach in DiD(pooled OLS and logit model)	Youth employment	Gender, age, marital status, education level	Impact of RCOP was found to be limited to young people aged 15-24, with no discernible positive effect on individuals over the age of 24. While the program successfully increased youth employment rates, gender inequality in employment persisted across all age groups, including young adults.
Tektaş and Kuyucu (2010)	Conduct an efficiency ex-ante analysis of the projects funded by EU pre-accession funds	7 NUTS-II regions (20 provinces)	Project efficiency analyses are performed by using DEA (data envelopment analysis) as a quantitative instrument	Project acceptance rates	Population, area, overall scheme budget, number of entire projects	Active engagement in multilevel governance has been a crucial aspect in confirming success of regional development funds distributed through IPA funds. Sub-national administrations are more advantageously situated to profit from the EU harmonization effort when they adopt strategies to work with the multilevel governance framework.
Battaglio & Horasanli (2018)	Study the impacts of EU funding on insights of CSO (Civil Society Organization) executives in Batman	1 NUTS-III region with 26 CSOs (Batman)	Multiple regression analysis	CIVICUS Civil Society Index (CSI) Survey Results in Batman Province	4 basic CSI dimensions and a dummy variable for EU IPA financing	The findings indicate that the implementation of IPA could be a crucial factor in the future, particularly as local officials in candidate countries work to build civil society.

CHAPTER 4

EMPIRICAL ANALYSIS OF THE EFFECTS OF EU INSTRUMENT FOR PRE-ACCESSION ASSISTANCE (IPA) FUNDS ON THE REGIONAL GROWTH OF TÜRKİYE

As emphasized in the preceding chapters, this study aims to measure how Türkiye's regional economic growth has been affected by the EU's pre-accession funding. With this aim, we will first introduce the regional growth model used in the study, which is quite streamlined and based on Crescenzi and Guia (2014).

Data and the estimation technique are provided in the second section of the Chapter. In that part, special emphasis is given to the compilation and construction of the IPA funds data, which is one of our study's contributions. Just as the information set utilized in our research, the spatial observations are gathered from regions or territories within the geographic domain. As a result, the models are typically bound to include some effects of spatiality, which are also innate sources of misspecification problems and could be categorized into spatial "heterogeneity" and "autocorrelation".

We will examine in the third section if using a geographical model, defining any spatial interactions, key spatial econometric models, strategies of selection, and spatial panel model estimation. In this respect, we will explain some technical details like Neighborhood Definition and Spatial Weight Matrix, etc.

After selecting the most adequate spatial model, we will go further to improve the robustness of the spatial model by searching for the sub-effect, spatiotemporal modeling, logarithmic transformation, and adding spatially-lagged explanatory variables, if deemed necessary.

Spatial models also enable us to determine positive and negative externalities, namely spatial spillovers. Any effects of a change in a dependent variable on a particular unit, as well as possibly all additional units, might be estimated directly and indirectly since spatial regression, models take

use of the complicated underlying relationship among data. The size of direct and indirect impacts in the short and long term may be quantified using spatial econometric models with lagged dependent and independent variables in location and time. Therefore, we will also talk about the short- and long-term direct and indirect impacts in this chapter.

4.1. SPECIFICATION OF THE MODEL

A typical regional growth model is defined based on Crescenzi and Guia's (2014) model augmented by an 'IPA funds matrix', (**X1** in Equation 4.1) that includes funds allocated within the DIS (decentralized implementation system) system in 81 cities of Türkiye. The IPA funds matrix includes a mixture of various IPA funds (for RCOP, IPARD, and TAIB programs) that are managed and reimbursed by different accredited national authorities all over Türkiye.

The following equation will be estimated for quantitative examination of regional growth impacts of the IPA funds on regional growth in Türkiye:

$$\Delta \boldsymbol{Y}_{it-1,t} = \boldsymbol{\beta}_0 \boldsymbol{Y}_{i0} + \boldsymbol{\beta}_1 \boldsymbol{X1}_{it-1} + \boldsymbol{\beta}_2 \boldsymbol{X2}_{it-1} + \boldsymbol{\beta}_3 \boldsymbol{WX}_{it-1} + \varepsilon_{it} \qquad (4.1)$$

- $\Delta \mathbf{Y}_{\boldsymbol{it-1,t}}$ per capita GDP growth rate
- $\boldsymbol{Y}_{i0}$ natural logarithm of per capita GDP level at the start of each year
- $\boldsymbol{X1}_{it-1}$ (IPA funds matrix) Augmented IPA fund reimbursements to cities, which shows expenditure in each city for IPA funds (2007–2018) for RCOP, IPARD and TAIB programs
- $\boldsymbol{X2}_{it-1}$ the 'Territorial conditioning factors matrix'
- $\mathbf{WX}_{it-1}$ spatially-lagged variables (referring to all independent regressors) matrix
- $\boldsymbol{\varepsilon}_{it}$ idiosyncratic error (*i* signifies unit of analysis, i.e., city; *t* signifies IPA policy programming period, i.e., year (2007–2018)).

$\boldsymbol{Y_{i0}}$ is a logarithmic measure of GDP per capita level of the city_i at the start of each year. With the purpose of controlling for the "initial conditions" of the regions, an independent variable, $\boldsymbol{Y_{i0}}$, "log_gdp", natural logarithm of the per capita GDP level of city during start of the year, has been introduced to our model in line with the relevant literature, which recognizes the significance of controlling for initial conditions when studying regional economic growth. This variable provides

for the customization of the analysis's beginning point and records the initial state of economic development in each city. It is typical to utilize beginning period independent variable values in these models since controlling for the start circumstances is crucial for separating the impacts of different variables on economic growth from the initial economic status of the areas. (LeSage & Fischer, 2008)

$\boldsymbol{X1}_{it-1}$, 'IPA funds matrix': total expenditure in each city for the IPA funds (2007–2018) for RCOP, IPARD and TAIB programs. The IPA funds' impacts for regional growth dynamics are observed by analyzing the respective IPA funds annual reimbursement in each city annually for the 2007–2018 implementation period.

$\boldsymbol{X2}_{it-1}$, 'Territorial conditioning factors matrix': includes the control variables that affect IPA funds' effect on growth. The estimated regional growth model in Crescenzi and Guia (2014) regions includes:

- socioeconomic conditions (industrious structure, demographics, and labor market)
- R&D activities to represent the region's innovative capacity and infrastructural endowment
- access to extra-regional innovative activities can have an impact on internal economic performance via regional knowledge spillovers
- reserve of infrastructure in adjacent regions represents acceptable interregional accessibility and the nonexistence of infrastructural tailbacks

As we will explain in detail later, because of data availability and/or constraints, we employ the following variables as control variables ($\boldsymbol{X2}$) in our model:

- Tertiary Education
- Employment Rate
- R&D Expenditures (a proxy for innovation)
- Stabilized road per area (a proxy for infrastructure)
- Exports
- Energy Consumption
- Governmental Incentives

- Governmental Investments

$\boldsymbol{WX}_{it-1}$, is the so-called "**spatially-lagged variables matrix**" by Crescenzi and Guia (2014). This matrix exposes and contains spatially-lagged values calculated with the contagious neighbors' criteria for control variables to take into account possible exchanges among cities. With the help of this matrix, it is possible to model spatially-mediated interregional spillovers explicitly and minimize the spatial autocorrelation problem.

The relevant tests throughout the model selection processes revealed the indication of spatial heterogeneity defined by the spatial lag/error models. By adding a spatially-lagged explanatory variable matrix to the fundamental model, we will be able to eliminate spatial autocorrelation without compromising the significance of the study's essential variables and adjust for the spatial exogenous interactions conveniently.

4.2. DESCRIPTION OF THE DATA AND METHODOLOGY OF THE STUDY

The analysis relies on cities (NUTS-3 regions), with the aim of maximizing territorial unit homogeneity in terms of autonomy and administrative positions and matching the related range of interest in which the policies under consideration have been put in place.

4.2.1. Construction of IPA Funds Data

The data set for the IPA funds consists of yearly (from 2007 to 2018) IPA funds reimbursements on a regional (81 cities in Türkiye) basis. While other variables' panel data sets are either compiled from relevant statistical and public institutions ($\boldsymbol{\Delta Y_{it-1,t}}$ and $\boldsymbol{X2}_{it-1}$) or computed from available data ($\boldsymbol{Y_{i0}}$ and $\boldsymbol{WX}_{it-1}$), IPA funds matrix was constructed with some arduous effort. To our knowledge, this is the first study that constructs the IPA funds reimbursements for 81 cities in Türkiye.

IPA funds data is compiled from three different public institutions' databases, namely:

1. RCOP (Regional Competitiveness) program, managed by the Ministry of Industry and Technology. RCOP has been implemented since 2010 in 43 cities, whose GDP per capita is 75% or lower than Türkiye's GDP per capita.

2. IPARD (IPA for Rural Development) program, managed by the Ministry of Agriculture and Forestry. IPARD has been implemented since 2012 in 42 cities that are designated by the government.
3. TAIB (Transition Assistance and Institutional Building) program, managed by CFCU (Central Finance and Contracts Unit) and the (former) EU Ministry. TAIB has been implemented since 2001 by CFCU in 81 cities without any regional confinement.

There are 81 cities in Türkiye. 25 cities benefit from both RCOP and IPARD; 18 cities benefit only from RCOP; 17 cities benefit only from IPARD; and 21 cities benefit from neither RCOP nor IPARD. All cities benefit from TAIB without any exception. In Appendix 1, a detailed listing of RCOP and IPARD provinces is presented.

Reimbursement data set was compiled for relevant RCOP (43 cities) and IPARD (42 cities) programs for the available years and the initial IPA funds data-set was formed. No implementation data exists for RCOP before 2010 and IPARD before 2012. To get a sounder and statistically valid year span for the IPA funds matrix, we extended the time period by adding the TAIB expenditures, which were between 2007–2013. This is mainly because the available implementation data span of years for both RCOP (9 years, from 2010 to 2018) and IPARD (7 years, from 2012 to 2018) was deemed rather limited to get statistically robust results.

Both RCOP (Regional Competitiveness Operational Program, analogous to EU Regional Policy) and IPARD (IPA for Rural Development, analogous to RDP) are IPA instruments introduced during the IPA period (2007–2013). However, long accreditation procedures for the relevant implementing institutions (Ministry of Industry and Technology for RCOP, Ministry of Agriculture and Forestry for IPARD) could only make it possible to start relevant OPs by 2010 and 2012, respectively.

The data set of TAIB expenditures was formed for all of the 81 cities between 2001–2006, which is called the “pre-IPA Period”, as well as the data set of TAIB expenditures for the relevant cities between the years 2007–2013, which is called the “IPA-I Period”.

The information about the regional distribution of the TAIB grants provided from EU funds has been combined from the database and archives of the CFCU. It includes results belonging to all

grant schemes that were financed under pre-IPA and IPA-I period programs and managed by CFCU as the Contracting Authority. CFCU has been the central authority for the implementation of EU funds allocated for Türkiye, which has been a candidate country since 1999.

The results, which belong to 59 grant schemes (23 from pre-IPA period and 36 from IPA-I period), have been combined, and the accuracy of the constructed data was cross-checked by using locations and implementation periods of 3483 contracts (2322 from pre-IPA and 1161 from IPA-I period).

Besides these high numbers of programs and contracts, this information/tables also cover a very long time period, starting from 2004, following the foundation of CFCU in 2003, and ending with 2017, when the last grant contracts under IPA-I programs have been signed. Therefore, the raw data contained an extensive amount of information.

Data for TAIB expenditures for 2001–2013 has been added both to RCOP and to IPARD cities' EU IPA funding amounts to complement the missing years for RCOP (2006–2009) and IPARD (2006–2011), respectively. Thus, with the addition of the TAIB reimbursement aggregation to RCOP and IPARD reimbursements, we have been able to cover IPA funds disbursements for the period of 2001–2018 and to construct the IPA funds matrix.

While it would be an easier option to aggregate EU IPA funds commitment data by budget cycle and programming periods (2007–2013 and 2014–2020) due to the hardship of annual expenditure data per IPA program (RCOP, IPARD, and TAIB) in Türkiye, for the sake of accuracy, we have achieved to compile the annual reimbursement data for the IPA programs, which constitutes a novelty on this academic research topic.

4.2.2. Description of the Data for Other Variables

Except for $\boldsymbol{X1}_{it-1}$, 'IPA funds data', all other territorial variables (dependent and independent) for 81 cities were obtained mainly from TURKSTAT (Turkish Statistic Institution) and (former) Ministry of Development. On this front, a great deal of available regional data for years 2000–2018, but especially for 2006–2017, has been gathered.

For analyzing the city growth dynamics using the IPA funds matrix, we started with a wider set of independent variables available on a regional basis. However, depending on their availability within TURKSTAT database, we could compile data for the variables below:

– Environmental (disposal amounts-kg-per capita)	for 2001–2016
– Infrastructure (length of stabilized roads, km)	for 2000–2017
– Energy consumption (kWh per capita)	for 2002–2016
– Financial Strength (credits and disposed amounts per capita)	for 2004–2017
– Governmental Investments (as 1.000 TL)	for 2006–2017
– Tertiary Education (students per vocational school teacher, #)	for 2005–2017
– Migration Statistics (immigration, emigration, and net migration)	for 2008–2017
– R&D Expenditures (as 1.000 TL)	for 2006–2017
– Population (number, #)	for 2000–2017
– Population Density (#/km^2)	for 2007–2017
– Registered Vehicle (number, #)	for 2004–2018
– Employment Statistics (percentage, %)	for 2008–2013
– Agricultural Production (vegetation and husbandry, as TL)	for 2006–2017

Since the data set for some of these variables was missing and incomplete, the following variables are eliminated:

– Environmental (disposal amounts-kg-per capita)	for 2001–2016
– Financial Strength (credits and disposed amounts per capita)	for 2004–2017
– Migration Statistics (immigration, emigration, and net migration)	for 2008–2017
– Population (number, #) (we use population density instead)	for 2000–2017
– Registered Vehicle (number, #)	for 2004–2018
– Agricultural Production (vegetation and husbandry, as TL)	for 2006–2017

The remaining independent variables turned out to be as below:

– Natural log of regional GDP pc level at the start of each year	for 2004–2018
– Augmented EU funds reimbursements to related cities	for 2004–2018
– Tertiary Education (students per vocational school teacher, #)	for 2005–2017
– Employment Statistics (percentage, %)	for 2008–2013
– R&D Expenditures (as 1.000 TL)	for 2006–2017
– Stabilized roads per area, (km/km^2)	for 2000–2017
– Exports (as 1.000 USD per capita)	for 2002–2018
– Energy consumption (kWh per capita)	for 2002–2016
– Governmental Incentives (as 1.000 TL)	for 2004–2017
– Governmental Investments (as 1.000 TL)	for 2006–2017
– Population Density (#/km^2)	for 2007–2017

The data descriptions and their sources are briefed in Table 6.

Table 6: Description of Variables

Variable	Entitlement	Explanation	Unit	Source
GDP per capita growth rate	gdpgrth_r	per capita GDP in 2006–year values	TL	TURKSTAT (2007–2018)
natural log for per capita GDP level at start of year	loggdp_r	controls the "initial conditions" of cities	TL	Produced using yearly GDP values of the cities
EU IPA funds reimbursements	ipa_funds	TAIB+RCOP+IPARD funds	TL[1]	Relevant Ministries
tertiary education	education	students per vocational school teacher	#	TURKSTAT (2006–2018)
employment	emplymnrt	employment rate	%	TURKSTAT (2008–2013)
R&D expenditures	innovation	research and development expenses within the city	TL	TURKSTAT (2006–2017)
stabilized roads per area	roadperarea	regional km's of motorways standardized by 'regional surface'	km/km^2	TURKSTAT (2000–2018)
regional export	export_pc	per capita export amount of the city	TL[2]	TURKSTAT (2004–2016)
energy consumption	electric_pc	per capita electric consumption	kWh	TURKSTAT (2007–2016)
governmental incentives	gov_incentive	Government incentives within city	TL	Min. of Development (2004–2017)
governmental investments	gov_investment	Public investments within city	TL	Min. of Development (2006–2017)

* Missing data are obtained via interpolation for all relevant variables

[1] Calculated from Euro with 2006 real TL value

[2] Calculated from USD with 2006 real TL value

[3] TL nominal values were deflated by using the year 2006 Consumer Price Index.

Missing values occasionally show up in the data. When constructing models with such data, the standard solution is to neglect the observations from the estimation sample. That can be acceptable when observations are independent; however, observations are less likely to be independent in spatial models. Therefore, it's indispensable to eliminate missing observation problems when dealing with spatial models.

As seen from Table 7, some independent variables were missing some important number of observations, such as emplymnrt had only 486 observations, and ipa_funds, export_pc, and electric_pc each had 810 observations out of a possible 972 observations in the data set.

This issue was resolved by using linear interpolation on missing data, as can be seen in Table 7. Before the linear interpolation process, the descriptive statistics are presented below.

Table 7: Descriptive Statistics (before linear interpolation of missing data)

Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
city	972	41	23.39294	1	81
year	972	2012.5	3.45383	2007	2018
gdpgrth r	972	0.033874	0.0516921	-0.14	0.26
loggdp r	972	9.15494	0.368314	8.09	10.24
ipa_funds	810	2896211	6404399	0	8.18e+07
education	972	14.18183	3.542995	4.07	35.59
emplymnrt	486	44.7634	7.585525	22.3	62.8
innovation	972	5772.777	20803.396	5385.93	207557.32
roadperarea	891	0.0875533	0.0239959	0.05	0.2
export_pc	810	176139.9	858607.8	0	1.10e+07
electric_pc	810	2241.5	1494.797	443	8565
gov_incentive	891	445.3653	1424.938	0	31907.92
gov_investment	891	188203.1	379648.5	4016.17	4959361
population_density	972	118.3623	283.3987	10.12	2759.15

Since "Population density" is highly correlated with other (97% with Exports, 81% with Governmental Investments, and %50 with Governmental Incentives, etc.) variables, it is eliminated from our model to avoid multicollinearity. (See "Correlation of Independent Variables" in Appendix 2.)

Table 8: Descriptive Statistics (after the linear interpolation)

Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
gdpgrth r	972	.034	.052	-.14	.26
loggdp r	972	9.155	.368	8.09	10.24
ipa_funds	972	2905724	5700587.9	2777867.5	73065304
education	972	14.182	3.543	4.07	35.59
emplymnrt	972	44.55	7.786	9.8	62.8
innovation	972	5772.777	20803.396	5385.93	207557.32
roadperarea	972	.088	.024	.05	.19
export_pc	972	175483.13	843810.5	21836.77	8726825.5
electric_pc	972	2243.165	1481.54	364	8565
gov_incentive	972	443.525	1167.551	104.18	16270.645
gov_investment	972	186303.17	367746.51	63297.402	4959360.5

With the remaining variables, the model construction has finally become:

$$\Delta \boldsymbol{Y}_{it-1,t} = \boldsymbol{\beta}_0 \boldsymbol{Y}_{i0} + \boldsymbol{\beta}_1 \boldsymbol{X1}_{it-1} + \boldsymbol{\beta}_2 \boldsymbol{X2}_{it-1} + \boldsymbol{\beta}_3 \boldsymbol{WX}_{it-1} + \varepsilon_{it} \quad (4.1)$$

- $\Delta \mathbf{Y}_{it-1,t}$ per capita GDP growth rate as regressand
- $\boldsymbol{Y}_{i0}$ natural log for per capita GDP level at beginning of each year
- $\boldsymbol{X1}_{it-1}$ (IPA Funds Matrix) Augmented IPA fund reimbursements to cities
- $\boldsymbol{X2}_{it-1}$ the 'Territorial conditioning factors matrix' consists of:
    - Tertiary Education
    - Employment Rate
    - R&D Expenditures (proxy for innovation)
    - Stabilized road per area (proxy for infrastructure)
    - Exports per capita
    - Energy Consumption per capita
    - Governmental Incentives
    - Governmental Investments
- $\mathbf{WX}_{it-1}$ Spatially-lagged variables (referring to all independent variables) matrix
- ε_{it} idiosyncratic error (i signifies unit of analysis, i.e., city; t signifies IPA policy programming period, i.e., year (2007–2018))

4.3. ESTIMATION METHOD

Panel data regression is a powerful tool to control unobserved independent variable dependencies on a dependent variable, which can result in erroneous estimators in conventional linear models of regression because of these advantages. Unsurprisingly, use of panel data is primarily driven by the need to solve the problem of missing variables (Wooldridge, 2003). We will, therefore, conduct the necessary selection processes to select the ideal panel data model for our research.

Stata 16.0 statistical software package (throughout all statistical computations) and GeoDa were used in our study.

4.3.1. Data Model Testing

To begin testing for the specified models, we must primarily conclude if the OLS-pooled (Common Effect) outcomes are adequate or whether they should be outlined and processed by means of an individual-effects (Random or Fixed-Effect) data model.

By running a test between random-effect vs. pooled OLS regression, one can conclude the specification of panel data analysis in the model. The Lagrange Multiplier analysis is performed to check if a pooled OLS regression or random-effect panel data regression should be used.

In order to do this, the Breusch and Pagan (1980) test, which was built from the LM test principle, runs random-effects tests based on the pooling model outputs. The Breusch-Pagan Test for Panel (Random) Effects (Appendix 4.1) demonstrates that the null hypothesis is strongly rejected since (Prob > chibar2 = 0.0000), so we settle that OLS estimates are not appropriate. It also demonstrates the statistical significance of individual effects against the OLS-pooled model; therefore, random-effect model estimates are more descriptive than pooled OLS estimates.

In the study of panel data, it is essential to understand the differences between the error component and covariance model. Studies that analyze panel data have used both the fixed-effects and random-effects models. However, differences can be observed between the estimation results of both methods, especially in cases where the cross-sectional units are numerous whereas the time series are relatively fewer.

Under such circumstances, one common-sense approach is as follows: if the cross-section comes from a large population and our goal is to make inferences about the population, the random-effects model is suitable if our goal is to make inferences about specific cross-sectional units, then the fixed-effects model is suitable (Wooldridge, 2003). We use the Hausman's (1978) test, which is based on the differences between fixed and random effects estimates, to distinguish between fixed and random effects. (See Appendix 4.2)

The null hypothesis that there is no association between individual effects and explanatory factors is strictly rejected by the Hausman's specification test (p-value: 0.000), if the preferred model is random effects. The former model is rejected in favor of the latter, using fixed effects.

Panel data structures, nevertheless, frequently violate standard assumptions of homoskedasticity, cross-sectional correlation, and autocorrelation within units (serial correlation) about the error process (Podestà, 2002). Subsequently, we need to check for assumptions about the error process. In this respect, we start with the diagnostics of the residuals of our individual FE model.

A modified Wald test is employed to test any groupwise heteroskedasticity presence. The error variance is identical for all items under the null hypothesis: $\sigma_{i2} = \sigma_2 \; \forall_i = 1, \ldots, N$. Wald test results are presented in Appendix 4.3. Here, at any level of confidence, the null hypothesis is strongly rejected by the overall statistic $\chi^2(N)$, which has p = 0.0000. In contrast, FE (or RE) estimators would be inconsistent and biased if the unobserved components that produce cross-sectional dependency are correlated with the relevant regressors.

In panel models, there are two main methods to check for cross-sectional correlation: Baltagi, Song, and Koh (2003; 2007) LM tests, and Pesaran (2015) Cross-Sectional Dependence Test. When T > N, we can then use Lagrange multiplier (LM) test, which is formulated by Breusch & Pagan (1980).

In our dataset, we have numerous cross-sectional (N) units and relatively fewer time-series (T) observations, which for our model are N=81 and T=12, respectively. The Lagrange Multiplier tests are asymptotically valid within cross-sectional dependence issues for macro panels (i.e., short N and large T (i.e., over 20-30 years)). However, in cases of big N and small T, the LM test might be subject to serious bias and standard techniques, and Lagrange Multiplier CD tests, will not be relevant. Therefore, the Pesaran Cross-Sectional Dependence test must be considered.

The test could be employed for both balanced and unbalanced panel data models. Since our panel data is balanced, a relevant Pesaran CD test version is employed in our study. Cross-sectional Dependence test outcomes are shown, in Appendix 4.4.

Here, reject the null hypothesis (p = 0.0000) and affirm that the dataset should be represented as a "spatial panel data model." For all specified models, the results show cross-sectional dependence presence in individual effects, which requires including spatial effects in the analysis.

Conventionally, serial correlation is to blame for overly optimistic standard errors. To rule out this complication and check the existence of serial correlation, we perform a Wald test with no first-order autocorrelation as the null hypothesis. Outcomes are presented in Appendix 4.5. The null hypothesis (p = 0.0000) is strongly rejected, and as a result, first-order autocorrelation AR(1) is proven to exist.

Consequently, our error structure is characterized by (HPAC):

1. panel heteroskedasticity, $E(u^2_{it}) = \sigma_{ii}$
2. cross-sectional correlation, $E(u_{it}\, u_{jt}) = \sigma_{ij}$
3. autocorrelation (city-specific serial correlation), $u_{it} = \rho_{it} * u_{it-1} + \varepsilon_{it}$

4.3.2. Spatial Dependence

Anselin (1988) indicates that spatial regression models typically include spatial effects that can lead to misspecification issues: spatial heterogeneity as well as autocorrelation. In the model selection process, we will continue with the relevant spatial panel model, which can control for both heterogeneity and autocorrelation of the residuals.

“Spatial autocorrelation arises from the interdependence among spatially arranged observational units, representing a specific form of cross-sectional dependence that signifies the occurrence of shared values alongside geographic proximity.” (Anselin and Bera 1998). Consequently, although positive geographical autocorrelation indicates that values from any location are more likely to be near to those from surrounding areas, negative spatial autocorrelation denotes a spatial concentration of opposing values. Typically, spatial autocorrelation is two-dimensional and multidirectional.

Contrarily, spatial heterogeneity refers to structural interactions that vary throughout the area as either spatially varying regression coefficients or as fluctuating variances of error (i.e., heteroscedasticity) in a model.

Anselin and Rey (1991) differentiate between substantive and nuisance spatial dependences. Substantive spatial dependence indicates the presence of spatial linear relationships, e.g., factor mobility or technological spillovers, which are important factors in the development of regional inequity. Nuisance spatial dependence, conversely, may arise due to measurement or methodological factors, such as a mismatch between the spatial boundaries of the studied method and the boundaries of the observational units. Spatial heterogeneity, which indicates the overall volatility of some crosswise behavioral connections among observational units, is another source of misspecification issues.

The spatial lag model, which includes the spatial lag of the dependent variable, can be employed to integrate the first type of significant dependence into the characteristic cross-sectional specification. This specification can be regarded as a means of accounting for spatial dependence in regional growth resulting from the convergence process that operates on spatially autocorrelated initial incomes. Likewise, it aids in capturing spatial interaction in the data generation process, where a region's growth rate is not only closely linked to its own initial income level but also, indirectly, to that of other regions based on distance. (Magrini, 2004)

It is widely acknowledged that sample data gathered from closely located units exhibit spatial correlation, indicating that observations from nearby units are more similar to each other than observations from distant units. The presence of a cross-section correlation might well specify a spatial relationship in the particular scenario of panel data, however, "one-to-one correspondence" between the two observations is not guaranteed.

If spatially close observations are more likely to exhibit similar values, we cannot handle observations as if they were independent. The violation of the basic assumption of the conventional OLS model occurs when the error terms are not independent and instead exhibit autocorrelation.

Spatial dependence can be associated with the presence of spatial interaction impacts (such as factor mobility, spillovers, etc.) or errors in measurements. Due to the spatial dependence of the

dependent variable, biased estimates occur, leading to an incorrect assessment of the coefficients of the explanatory variables. However, employing an effective spatial model will indeed allow us to find spatial patterns and provide us with detailed information about the true model.

To conclude with the correct spatial model, “one must explore what kind of spatial interaction impacts must be taken into consideration: (1) endogenous spatial interaction impacts, (2) exogenous spatial interaction impacts, (3) interaction impacts among error terms, or (4) some mixture of those”. (Elhorst, 2017)

Moran's I (global) is an inferential statistical tool used for measuring global spatial autocorrelation. Its index values range from -1.0 to 1.0, and the results are always compared to the null hypothesis. However, it is important to note that this tool does not provide information about the location of clusters or the specific type of spatial autocorrelation that is present. Its primary purpose is to assess presence and strength of global spatial autocorrelation in the data.

In addition, the significance test of the local Moran's I is conducted alongside a local Z-test to determine the presence of local spatial dependence. The significance level of the correlation can be obtained from the local Z-test at different levels of significance, such as 0.1, 0.05, 0.01, and so on. If a spatial unit's Z_i value is positive and the local Moran's I_i is statistically significant, it suggests that higher-valued spatial units are surrounded by neighboring units, indicating positive local spatial autocorrelation. (Anselin, L., 1995)

Moran's I (or LISA) statistics can also be utilized to identify the existence of neighborhood effects (spatial autocorrelation) and spatial clusters. Moran's I statistics serve as a diagnostic test to detect spatial autocorrelation within the model. Findings in Appendix 4.6 confirm the notion that the variables are spatially related across cities, so neglecting the independent variables’ spatial effects could result in biased estimations (Moran's I, test statistic: 4.669, p-value: 0.000). The findings indicate necessity for some spatial model; however, it is still not clear which spatial model to go with at this time.

Appendix 4.6 reveals that the hypotheses of "no spatially autocorrelated error term" and "no spatially-lagged dependent variable" were both rejected at 5% and 10% significance levels, respectively.

The literature on spatial dependence examines two fundamental forms of spatial dependence:

- if observations are dependent on their neighbors' values, the "spatial-lag model" is used. (Anselin, 1988)
- "spatial error autocorrelation model" accounts for spatially correlated error terms that may arise due to omitted spatial variables or measurement errors of observed variables. (Anselin, 2001)

Spatial error correlation can also occur due to various factors such as the inappropriate functional form of the regression equation, the absence of a spatial lag component, or the use of an incorrect weighting matrix. If the spatially correlated error structure arises from measurement error, the consequences of not correcting for this form of spatial dependence are that the resulting parameter estimates will be inefficient (though unbiased and consistent), and this could result in a loss of efficiency in the estimates, implying incorrectly that strategic interaction does not exist (Cizek et al., 2015). Ignoring spatial dependency in the dependent variable, on the other hand, comes at an even higher cost due to omitted variables, including an omitted spatial lag variable, and leads to the more fundamental problem of "biased parameter estimates".

A critical distinction exists between both models in which the dependent variable includes spatial lags and those whose disturbances include some spatial dependence. In the spatial lag model, the dependent variable is influenced not only by its own past values but also by the values of the dependent variable in neighboring units, along with a set of observed local characteristics. On the other hand, the spatial error model determines the dependent variable solely based on observed local characteristics, while its error terms exhibit spatial correlation. (LeSage and Pace, 2009)

Spatial lags can also be used to capture dependence in the disturbance process, leading to the specification of a spatial error model (SEM). Unlike the spatial lag model, the spatial error model does not require a conceptual framework for spatial or social interactions. Instead, it represents a specific subset of a non-spherical error covariance matrix. In the spatial error model, dependencies among error terms are taken into account, reflecting spatial inter-correlations.

In conclusion, spatial models can incorporate spatially-lagged independent variables, dependent variables, and/or autoregressive error terms based on the chosen model.

4.3.3. Spatial Weight Matrix

"Spatial interaction is incorporated into a regression specification by including observations of variables at other locations on the model equation's right-hand side for the dependent variable y at the given location_i, y_i. Typically, this is accomplished by employing a variable with spatial-lag or observed values' average at adjacent locations (Anselin 1980)." (Anselin, 2022)

However, incorporating spatial effects is nevertheless technically complex for a variety of factors. For starters, different spatial models can generate distinct spatial correlation patterns. Resultingly, capturing the theoretical spatial interaction requires a clear understanding of how spatial weight matrices must be structured. (Florax and Rey, 1995)

Formally, where z is a (n × 1) observation vector, a spatially lagged variable is constructed as $\sum_j w_{ij} z_j$, where w_{ij} are so-called spatial weights expressing the presence of a neighbor relation amid location_i and location_j. Spatial weights are represented in matrix notation via (n x n) spatial weight matrices, W, within which n denotes cross-sectional (spatial) observation quantities. By convention, the weight matrix's diagonal elements are 0, and the rows are standardized so that their sum equals 1. The spatially lagged variable is then denoted by Wz. (See Equation 4.2.)

By using its local neighbors as weights, spatially-lagged independent variables (Wx) calculate sum of the weighted values for neighborhood:

$$[Wx]_i = \Sigma_{j \neq i} \, w_{ij} \, x_j \qquad (4.2)$$

For which W is "spatial weight matrix", WY is "effect of endogenous interaction amongst dependent variables", WX is "effect of exogenous interaction amongst independent variables", Wu is the effect of interaction amongst different units' disturbance terms, and ε is an identically distributed and independent error term. The combination of these terms with additional exogenous and endogenous variables as well as random effects generates a diverse set of model specifications. (Dogan & Kındap, 2019)

For the discipline of spatial analysis, the spatial weight matrix, W, is essential. Its primary goal, for the spatial model specification, is to associate observations for any variable of any spatial unit within the sample with observations for the same variable in other spatial units. It designates the spatial relationships between units in the sample. (Anselin, 1988)

Therefore, initial stage in calculating spatial correlation between agents or geographical areas is to specify a categorical neighborhood relation in a mathematical structure between geographical areas. The model cannot estimate these relationships innately. “n” cities given, “n*(n-1)/2” pairs of cities would be computed. (Loonis & Bellefon, 2018)

In spatial models, weight matrices are employed in three ways:

1. Introducing ρWy to allow nearby outcomes to influence outcomes.
2. Introducing Wxγ to allow nearby covariates to influence outcomes.
3. Introducing autoregressive errors (I-ρW)-1 to allow for the influence of nearby errors on outcomes.

In spatial econometric analysis, there is no clear consensus on the best kind of weight matrix to use. The weight matrix for most regional science applications, nevertheless, is grounded on some mixture of simple binary contiguity as well as distance relationships.

We used the first-order binary *(taking the value 1 for neighboring units and 0 otherwise)* contiguity queen weight *(sharing a common edge)* matrix to take into consideration potential spatial impacts while calculating regional growth. Since the data set consists of 81 NUTS-3 level regions (i.e., cities), we created a spatial weight matrix W with columns and rows equal to N=81. The influence of bordering cities is leveled by normalizing this NxN spatial weight matrix via row standardization.

Specifically, the model's spatially lag variables are computed by adding every territorial variable via a spatial matrix and by using the “contiguity neighborhood” criterion, which can limit the 'endogeneity' caused by travel-time distance weighting of Turkish cities.

These spatially-lagged indicators put each city in a more comprehensive national setting, thus enabling it to be conceivable to measure exchanges with bordering cities. They are capable of

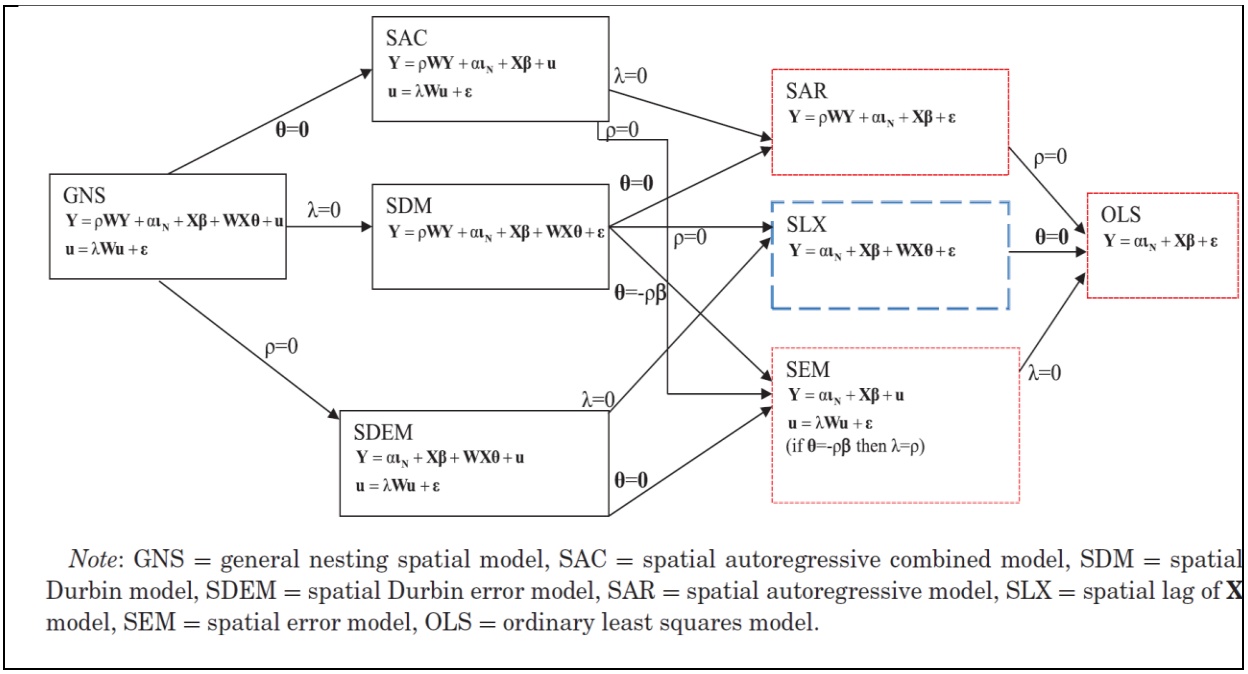
detecting various types of spillovers that are influenced by geographical approachability or peripherality.

Advantageous socioeconomic variables in neighboring cities influence the original performance of the city economy via derivative consequences and human capital mobility enabled by spatial proximity. Approachability to regional innovation initiatives (i.e., spatially-lagged R&D variable) could stipulate some economic growth through local knowledge spillovers as well, while neighboring city infrastructure (i.e., spatially-lagged road_per_area variable) endowment ensures appropriate access to the city and the absence of transportation shortcomings. (Surya et al., 2020)

4.3.4. Strategy for Spatial Panel Model Selection

To search for an appropriate spatial model, one can approach from the left (i.e., General Nesting Spatial model, GNS) either to the right or from the right (OLS model) to the left. Both approaches have some advantages and disadvantages.

Figure 1: Strategy for Spatial Panel Data Model Selection (Top-Down Approach)



Note: GNS = general nesting spatial model, SAC = spatial autoregressive combined model, SDM = spatial Durbin model, SDEM = spatial Durbin error model, SAR = spatial autoregressive model, SLX = spatial lag of **X** model, SEM = spatial error model, OLS = ordinary least squares model.

Source: Elhorst (2017)

For recent literature, a major point of departure for a spatial specification search is the GNS model, which incorporates several traditional models (i.e., SAR, SEM, SLX, SDM, etc.) as special cases (Anselin, 2022). [$Y = \rho*WY + X*\beta + WX*\gamma + u$; where $u = \lambda*Wu+\varepsilon$] is GNS model specification, which encompasses entire sources of spatial processes previously under deliberation and enforces no constraints on the three spatial parameters, (ρ; γ; λ).

It has been deemed a fictive imaginary model that is designed as a preliminary point to pursue an accurate spatial model from the general order to the more specific order. The main appeal of the GNS model approach is that basic models could be attained by imposing zero constraints on specific parameters, although upon closer inspection, this is not always that straightforward. (Anselin, 2022)

However, Cook et al., (2015) have shown that the GNS model approach ensures correct successive interpretation only if no variables in the general model are omitted, which is not an option for growth models where there is an abundance of likely predictors related to economic growth. Besides, contrary to our basic assumption, the GNS might not always be the most general model since one can always add further spatial lags (W2, W3, ...) and error terms that could exhibit local or global spatial autocorrelation.

The GNS model approach is hardly employed in empirical studies, which is majorly due to the lack of formal evidence of the conditions under which the model parameters would yet to be identified and that some overfitting issues would then be inevitable. It is possible to estimate the parameters, even if they are not identified, but sometimes they can either have large impacts on each other or become statistically insignificant, so the GNS model is useless for selecting among traditional ones having lesser impacts of spatial interaction. (Elhorst, 2014)

Therefore, the GNS model approach is deemed to be weakly identified and, consequently, is not the best starting point, to begin with for spatial model specification. False decisions at the beginning can get the whole inference process sidetracked.

Similar hazards are valid for the right (OLS) to the left approach since relying solely on the Lagrange Multiplier tests could lead to false partial conclusions due to possible omitted-variable bias and hence overestimation of β. The approach starts with OLS, i.e., the non-spatial model, and

then through LM tests, it lets us select among SEM, SAR, or non-spatial models. Since the tests devised by Anselin are primarily focused on the non-spatial model residuals, the method has been popularly used until recently. (Loonis & Bellefon, 2018)

As an important guide for empirical researchers written by Cook et al., (2015) settles that (a) researchers who want to theoretically analyze spatial parameters should estimate SDEM, spatial Durbin error model, or SAC, combined spatial autocorrelation model, both of which allow us to discriminate between (direct or indirect) spillovers and spatial clustering in unobservables, (b) researchers that are predominantly interested in unbiased estimates of β (but not necessarily in the spatial aspects) should use SDM. Elhorst (2011) is much more enthusiastic about SDM, just like LeSage in various publications, and lastly, (c) GNS, as a starting specification model, is generally not recommended.

Likewise, Elhorst (2010) connotes multiple available spatial econometric models and recommends strong alternative forms be considered in order to come up with the best specification. In line with Elhorst (2010) and Cook et al. (2015), the commonly proposed procedure is used in the study to test among five different spatial econometric regressions for spatial growth models, a quasi-general-to-specific approach in model selection.

4.3.4.1. Spatial Panel Data Model Selection (top-down approach)

The rationale behind the empirical testing (i.e, Chpt.4.4.1) and result evaluations are given below:

- We start the process with an SDM model as a reference point rather than a SAR or SEM model since, theoretically and as a special case, the SDM model nests the SEM model. Just as using a SDM would have safeguarded us from the biases caused by omitted variables, the likely existence of omitted variables in the SEM model will also result in true data generation process. If there is a high probability that important missing variables have spatial association, some specific spatial model utilization may even be substantiated (Golgher & Voss, 2016). The SDM nests spatial models of both error and lags, and one of its most important features is that its spillover effects are flexible, whereas SAR's are not, and SEM's are even set to zero by its model definition.

- When the SAR, having spatial-lag dependence, is true spatial specification, biased coefficient estimates would have been yielded by an incorrectly chosen SEM model, whereas they would not by the other models (i.e., SAR, SDM, and SAC). The introduction of WX variables in the model when their coefficients are nil yields no bias in the estimates

of independent variables. Likewise, introducing a spatial dependence model in the disturbances, when the parameter of dependence is indeed "nil", has no negative influence on SAC estimates within any relatively larger sample. (LeSage & Pace, 2009)

- SAC model assumes that no variables are missing from the model, which is unlikely in highly complex econometric settings. Even in such an overly idealistic model setting of non-missing variables, using extended specification of SDM instead of SAC to generate estimates would result in inefficient yet consistent explanatory variable estimates. It should be noted that for large spatial samples, the estimates' efficiency has not always been a primary source of frustration. (LeSage & Pace, 2009)

- Using the SAC model incorrectly instead of the SDM model, on the other hand, would result in unacceptable econometric consequences. The independent variable coefficient estimates will unavoidably be distorted since the spatially-lagged independent variables (WX) were erroneously excluded from the model. To put it another way, when the extended SDM model is the true spatial model and independent variables from surrounding regions are relevant, employing the SAC model results in biased estimates due to the aforementioned excluded variable issues.

- Finally, if the SDM model were the true spatial, which includes both spatial lag dependency and independent variable spatial-lags, incorrectly chosen SAR, SAC, and SEM coefficients estimates would be influenced by omitted variables because they do not include WX variables. SEM would undergo extended biases owing to the absence of the dependent variable's spatial-lag. (LeSage & Fischer, 2008)

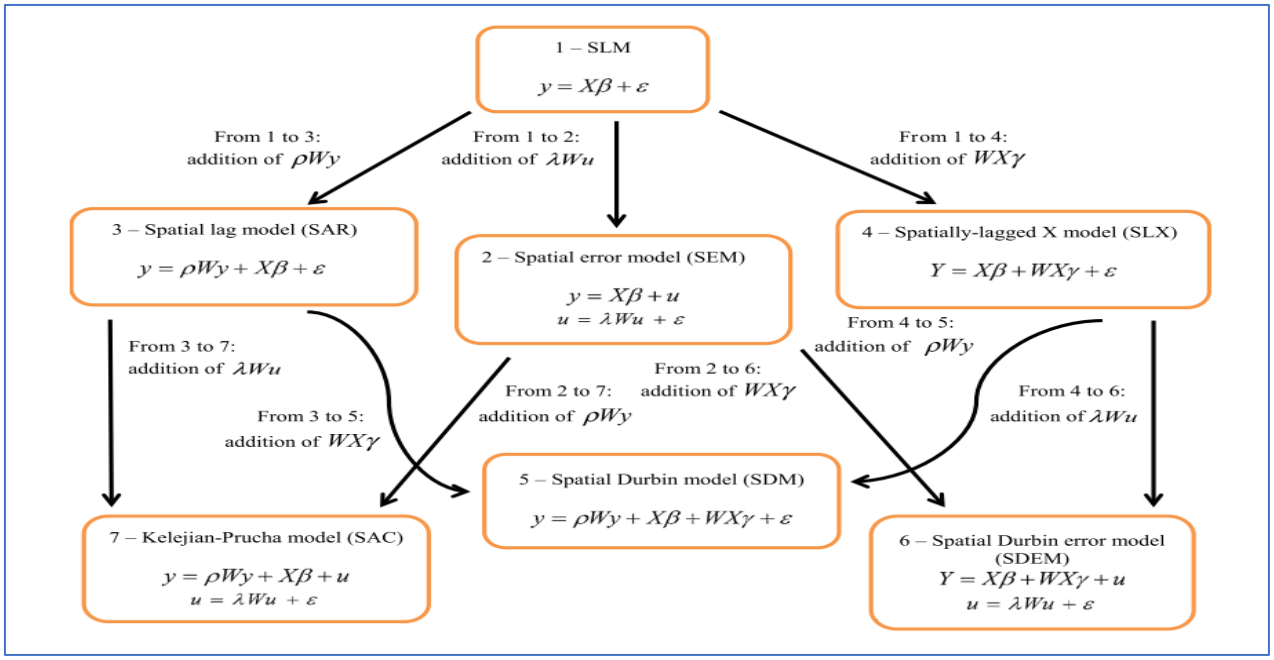
- The study of spatial econometrics is paying increasing attention to the spatial Durbin Model. SDM is a cross-sectional error-dependent simplified model that has been used as the nesting equation in a broad model selection approach.

- We conclude that under all five spatial modeling (SAR, SEM, SAC, GSPRE, and SDM) scenarios, only the SDM would produce unbiased coefficient estimates for spatial models.

4.3.4.2. Spatial Panel Data Model Selection (bottom-up)

Figure 2 depicts an alternative approach to the top-down (GNS), which is a bottom-up strategic approach to find out the most suitable spatial model and its relationships and in-between nuances.

Figure 2: Bottom-Up Approach for Spatial Panel Data Model Selection



Source: Golgher & Voss (2016)

4.4. SPATIAL MODEL SELECTION

Three comprehensive modules of spatial models are the basic cross-sectional model, static spatial panels, and dynamic spatial panels. We will go through the model selection process both empirically as well as in a solid theoretical way to conclude with the most adequate spatial model for our study.

In the previous sections, we have carried out some exploratory tests on which kind of model would best fit to explain the relationships in our study and presented the basic aspects of the spatial models. In this section, we will carry out the necessary tests in order to conclude with the most adequate spatial model empirically, alongside their theoretical backgrounds.

After concluding with the most adequate model for our study, to enhance the model, we will compare the possible pre-defined sub-effect options within the chosen model. We will try to discover whether any individual/time effects exist since these effects reflect unobservable heterogeneity and may have statistical implications that have yet to be explored.

Space-time panel models could also provide information that cross-sectional spatial regressions cannot. Thanks to the latest practical and theoretical advances, space-time data analysis has become

indispensable for the sake of a better spatial dynamics component, allowing some closer links between abstract conceptual frameworks and their evidence-based application.

We will look for further improvements in our model by applying “spatiotemporal” options provided by the statistical programs. We will introduce spatially-lagged variables to our model in line with our model assumption, and we will evaluate their contribution to the model empirically.

4.4.1. Testing for Spatial Panel Data Model Selection (top-down approach)

Fixed-effects Spatial Durbin Model estimation results are given in Appendix 4.7. Besides, a detailed explanation of the statistical operations is elaborated in Appendix 5.

1) Testing for SAR (Spatial Autoregressive Model):

We perform $\chi 2$ or F tests of linear restrictions on the model that is the most recently fit. The Wald test (or, $\chi 2$) evaluates the significance of independent variables. Significant variables contribute to model, while insignificant variables can be removed without affecting it.

The null hypothesis is H_0: some parameter = some value. As an example, one is investigating if some spatial interaction effects (dependable/explanatory/error) influence regional growth. Our parameter would be the spatial interaction effect (i.e., $WY_t/WX_t/Wu_t$). The value could be zero (suggesting that we do not believe the selected spatial interaction effect influences regional growth). If H_0 is rejected, then the model relevant to chosen spatial interaction effect in question is implied as invalid. The result is presented in Appendix 5.1.

Here, since p-value is less than 1%, H_0 is rejected strongly. The SDM is still the best spatial specification for our research.

2) Testing for SEM (Spatial Error Model):

Similar to the previous step of testing, we will continue comparing SEM results with the stored SDM results. The "testnl" command generates Wald-type hypothesis testing (linear/nonlinear) using the estimated model parameters from the most recent fit. The delta technique, which is a

decent approximation for large samples, is used to get the p-values. The result is presented in Appendix 5.2.

Here, since p-value (Prob > chi2 = 0.0000) is less than 1%, H_0 is strongly rejected. Therefore, the SDM still endures as the most adequate spatial model for our study.

3) SAC (Spatial Autoregressive Combined Model) vs. SDM:

We will use "AIC and BIC Information Criteria" to test the appropriate model: SAC vs. SDM

AIC and BIC are both methods for attempting to address model fit and overcomplication all at once. The criteria assess a collection of statistical models in order to meet these challenges, with the model having the lowest AIC/BIC quantification score being chosen as the best alternative.

The result is presented in Appendix 5.3. Given this, we choose SDM against SAC due to the lesser AIC and BIC values for the former. Therefore, the SDM still endures as the most adequate spatial model for our study.

4) SAC vs. GSPRE (Generalized Spatial Random-effects Model):

Finally, we would test SAC against GSPRE if SAC had prevailed against SDM in the previous step, which is not the case in our test. AIC and BIC values for SAC vs. GSPRE become non-relevant as the SAC model did not prevail in the third step.

Therefore, according to the top-down spatial model selection approach carried out by the various Stata tests above, at the end of the selection approach, the SDM is deemed to be the most adequate spatial model for our study.

Other spatial model options (SAR, SEM, SAC, and GSPRE) along with available sub-effects are also run in Stata for robustness checks, and the SDM model has turned out to be superior to the other models, as predicted by our empirical as well as theoretical analyses.

Having concluded the SDM to be most proper model for our study, to further enhance the model, we will investigate if there is any time/individual effect, as each of these effects embodies unobservable heterogeneity and may bear statistical implications yet to be explored.

In panel data models, both time effects and individual effects are frequently used to describe unobserved temporal or individual heterogeneity. Individual effects are unobservable abilities of individuals and are typically modeled like discrete intercepts for every individual. Since these effects are mostly unobservable by nature, it makes sense to run the model for the possible options and then reevaluate the results empirically. (Jeong & Lee, 2020)

Therefore, we run the SDM model using spatial fixed-effects (sdm_ind), time fixed-effects (sdm_time), and spatial and time fixed-effects (sdm_both) options. Respective outcomes per option are presented in the table below, accordingly.

Table 9: SDM Result with Various Effect Options

. estimates table sdm_ind sdm_time sdm_both, star(0.1, 0.05, 0.001) stats(R-sq)

Variable	sdm_ind	sdm_time	sdm_both
Main			
loggdp_r	0.32663836***	0.009	0.3281919***
ipa_funds	4.999e-10*	0.000	5.720e-10*
education	-0.001	-0.000	-0.001
emplymnrt	0.00082574**	0.000	0.0006529*
innovation	0.000	-0.000	0.000
roadperarea	-0.193	0.036	-0.151
export_pc	0.000	0.000	0.000
electric_pc	-0.000	-0.000	-0.000
gov_incentive	0.000	0.000	0.000
gov_investment	0.000	-0.000	0.000
Wx			
loggdp_r	-0.3037994***	-0.024	-0.163674***
ipa_funds	-1.050e-09*	-0.000	-0.000
education	0.00329513**	-0.000	0.000
emplymnrt	0.001	-0.000	0.000
innovation	-0.000	0.000	-0.000
roadperarea	0.852	-0.034	0.742
export_pc	-0.000	-0.000	-0.000
electric_pc	0.00001547*	0.000	0.000029***
gov_incentive	0.000	0.000	0.000
gov_investment	0.000	0.000	0.000
Spatial			
rho	0.68399003***	0.354096***	0.34611167***
Variance			
sigma2_e	0.00099949***	0.0012001***	0.00093567***

*** p<0.01, ** p<0.05, * p<0.1.

After analyzing results for these sub-effect options, we choose SDM with spatial fixed-effects individual [(type(ind)] option (i.e., 1st column), which has seemingly some empirical advantages over the other options. It is the sub-effect option with the highest number of significant variables.

(i.e., the (ind) option has 5 significant independent and 5 significant spatially-lagged independent variables, along with reasonable signs, i.e., an expected correlation with the dependent variable.)

The choice of individual fixed-effects is also coherent with the fact that Türkiye's cities may have some unexplainable longstanding differences for some regional variables among themselves.

4.4.2. Spatiotemporal Modeling

Magrini (2004) states that "If an extra temporal component exists, i.e., spatial data is gathered over time; that is spatiotemporality." In data analysis, the term "spatial temporal" or "spatiotemporal" should only be used when data has been gathered across both time and space.

Traditional temporal models for regional data make it possible for y_t for each city to be time-dependent on the previous (or present) period values y_{t-1} (or y_t) for its city. Using those "spatial-lags of the time-lags" Wy_{t-1} (or Wy_t) and WX_{t-1} (or WX_t), mainstream time-dependent models could justifiably be modified to account for spatial dependence on specific cities over the period. Those could be combined with traditional temporal lags, y_{t-1} (or y_t) and X_{t-1} (or X_t), giving rise to a spatiotemporal model. (LeSage & Pace, 2009)

Spatial interactions can be complex and dynamic as well. The value used in observation_i at t, a particular time, might be affected by past observations near i. Similarly, error terms can be treated in the same way. For the dynamic version of SDM, the value of the explained variable used for observation_i over time period t is determined by the value of the explained variable used for observation_i during the prior period (time-lag), the value of the explained variable for observations nearby i in period t (synchronous spatial-lag), and finally, the value of the explained variable for observations nearby i in period t-1 (delayed spatial offset).

Spatial spillover effects, which take place in city_i at time t and disperse to neighboring cities afterward (t+1,2,3…), are some possible paths for the latter term. Most of the time, this model can also involve an individual, fixed, or random effect, i.e., $\boldsymbol{\mu}$. (Okunlola & Kassouri, 2023)

Because higher temporal dependence levels elevate the functionality of the past and space due to spread, the temporal dependence parameter influences the model's general spatial dependence. An

intriguing consequence of this formation is that even when both types of models are selected properly, cross-sectional spatial regressions and spatiotemporal regressions can yield quite diverse estimates of dependence.

As an example, a cross-sectional spatial regression might yield significantly spatially-dependent estimates, whereas a spatiotemporal regression would yield estimates suggesting low spatial dependence but surprisingly high temporal dependence. (LeSage & Pace, 2009)

Equation (4.3) shows the dynamic specification in SDM (and SAR) model estimation:

$$y_t = \varphi y_{t-1} + \rho W_N y_t + \eta W_N y_{t-1} + x_{t-1}\beta + W_N X_{it-1}*\gamma + \boldsymbol{\mu} + \varepsilon_t, \quad (4.3)$$ where

the specification includes a dependent variable that could be time-lagged and/or time-space-lagged.

It is widely acknowledged in the economic growth literature that the explanatory variables and even the dependent variable possibly have spatiotemporal dimensions. In order to detect the likely spatiotemporal interactions that best fit our model, we will run the time-lagged dependent variable (φy_{it-1}), the time-space-lagged dependent variable ($\eta W y_{it-1}$), and finally, the former and the latter altogether in the model ($\varphi y_{it-1} + \eta W y_{it-1}$). Detailed explanation of the "space-time dependency types" is elaborated in Appendix 6.

4.4.2.1. Testing for Spatiotemporality

We first present the results of "non-spatiotemporal SDM FE (ind)" as a base point to explore whether a devised dynamic spatial panel data model improves our model's explanatory power.

Table 10: Non-spatiotemporal SDM FE (ind) i.e. ($y_t = \rho W_N y_t + x_{t-1}\beta + W_N X_{it-1}*\gamma + \boldsymbol{\mu} + \varepsilon_t$) Results

. xsmle gdpgrth_r loggdp_r ipa_funds education emplymnrt innovation roadperarea export_pc electric_pc gov_incentive gov_investment, fe model(sdm) wmat(W) type(ind)

gdpgrth_r	*Coeff.*	*Std. Err.*	*z*	*P>z*	*[95%Conf.*	*Interval]*
Main						
loggdp_r	0.3266384***	0.0249095	13.11	0.000	0.278	0.375
ipa_funds	5.00e-10**	2.46e-10	2.03	0.042	0.000	0.000
education	-0.000968	0.0008108	-1.19	0.233	-0.003	0.001
emplymnrt	0.0008257***	0.0003139	2.63	0.009	0.000	0.001
innovation	2.10e-07	2.48e-07	0.85	0.395	-0.000	0.000

roadperarea	-0.193482	0.2578141	-0.75	0.453	-0.699	0.312
export_pc	1.20e-08*	7.04e-09	1.70	0.089	-0.000	0.000
electric_pc	-6.5e-06*	3.82e-06	-1.70	0.089	-0.000	0.000
gov_incentive	9.88e-07	1.21e-06	0.82	0.413	-0.000	0.000
gov_investment	1.18e-08	9.34e-09	1.26	0.207	-0.000	0.000
Wx						
loggdp_r	-0.303799***	0.0276556	-10.99	0.000	-0.358	-0.250
ipa_funds	-1.1e-09**	4.11e-10	-2.56	0.011	-0.000	-0.000
education	0.0032951***	0.0010666	3.09	0.002	0.001	0.005
emplymnrt	0.0012567*	0.0006492	1.94	0.053	-0.000	0.003
innovation	-4.9e-07	5.24e-07	-0.94	0.348	-0.000	0.000
roadperarea	0.8523584	0.553419	1.54	0.124	-0.232	1.937
export_pc	-1.7e-08	1.22e-08	-1.38	0.166	-0.000	0.000
electric_pc	0.0000155**	6.88e-06	2.25	0.025	0.000	0.000
gov_incentive	4.03e-06	2.62e-06	1.54	0.123	-0.000	0.000
gov_investment	8.08e-09	1.75e-08	0.46	0.643	-0.000	0.000
Spatial						
rho	0.68399***	0.0240728	28.41	0.000	0.637	0.731
Variance						
sigma2_e	0.0009995***	0.0000468	21.36	0.000	0.001	0.001

*** p<0.01, ** p<0.05, * p<0.1.

Having analyzed the results for the different spatiotemporal options, we choose the space-time lagged and time-lagged dependent (i.e., dlag(3)) variable SDM FE (ind) which has seemingly some empirical advantages (higher R^2 value, higher number of significant variables, etc.) over the other spatiotemporal and non-spatiotemporal options. A detailed explanation for other spatiotemporal model options (i.e., dlag(1) and dlag(2)) is also elaborated in Appendix 6.1 and 6.2, respectively.

Table 11: Spatiotemporal SDM FE (ind) i.e. ($y_t = \varphi y_{t-1} + \rho W_N y_t + \eta W_N y_{t-1} + x_t\beta + W_N X_{it}\gamma + \boldsymbol{\mu} + \varepsilon_t$) Results

```
. xsmle gdpgrth_r loggdp_r ipa_funds education emplymnrt innovation roadperarea export_pc electric_pc
gov_incentive gov_investment, fe model(sdm) wmat(W) type(ind) dlag(3)
```

gdpgrth_r	*Coeff.*	*Std. Err.*	*z*	*P>z*	*[95%Conf.*	*Interval]*
Main						
gdpgrth_r L1.	-0.2206348***	0.0316191	-6.98	0.000	-0.2826072	-0.1586624
Wgdpgrth_r L1.	0.1438773***	0.0407695	3.53	0.000	0.0639705	0.2237841
loggdp_r	0.4268842***	0.0272498	15.67	0.000	0.3734756	0.4802928
ipa_funds	5.09e-10**	2.43e-10	2.10	0.036	3.33e-11	9.85e-10
education	-0.0010976	0.0009089	-1.21	0.227	-0.002879	0.0006837
emplymnrt	0.0007093**	0.0003258	2.18	0.029	0.0000708	0.0013478
innovation	3.71e-07	2.46e-07	1.51	0.131	-1.10e-07	8.53e-07
roadperarea	-0.2922544	0.2660396	-1.10	0.272	-0.8136825	0.2291738
export_pc	1.87e-08**	7.33e-09	2.55	0.011	4.30e-09	3.30e-08
electric_pc	-3.06e-06	3.85e-06	-0.80	0.427	-0.0000106	4.49e-06
gov_incentive	7.31e-07	1.19e-06	0.62	0.537	-1.59e-06	3.05e-06
gov_investment	7.84e-09	9.38e-09	0.84	0.403	-1.05e-08	2.62e-08
Wx						
loggdp_r	-0.3831566***	0.0307099	-12.48	0.000	-0.44335	-0.3229664
ipa_funds	-1.11e-09***	4.07e-10	-2.72	0.006	-1.9e-09	-3.11e-10
education	0.0045006***	0.0012347	3.65	0.000	0.0020807	0.0069204
emplymnrt	0.0014356**	0.000684	2.10	0.036	0.0000951	0.0027761
innovation	-8.28e-07	5.24e-07	-1.58	0.114	-1.9e-06	1.99e-07
roadperarea	0.995818*	0.5689403	1.75	0.080	-0.119284	2.11092
export_pc	-2.71e-08**	1.33e-08	-2.04	0.041	-5.3e-08	-1.10e-09
electric_pc	0.0000156**	7.14e-06	2.18	0.029	1.60e-06	0.0000296
gov_incentive	2.97e-06	2.59e-06	1.15	0.250	-2.1e-06	8.04e-06
gov_investment	1.07e-08	1.73e-08	0.62	0.537	-2.3e-08	4.47e-08
Spatial						
rho	0.687556***	0.0249099	27.60	0.000	0.6387335	0.736378
Variance						
sigma2_e	0.001012***	0.0000454	22.30	0.000	0.0009231	0.001101

*** p<0.01, ** p<0.05, * p<0.1.

Our model has become a "*first-order autoregressive lag model in both space and time, covering the first-order spatial autocorrelation model*". In full compliance with the results of the analyses, it is even more extended to incorporate both spatial and temporal dynamic effects.

At this point, our model description becomes:

$$y_t = \varphi y_{t-1} + \rho W_N y_t + \eta W_N y_{t-1} + x_{t-1}\beta + W_N X_{it-1}*\gamma + \boldsymbol{\mu} + \varepsilon_t, \quad (4.3), \text{ where}$$

φy_{it-1} represents for dependent (time-lagged) variable

$\eta W_N y_{t-1}$ represents for dependent (space-time lagged) variable

$\boldsymbol{\mu}$ represents for non-observable individual fixed effects

$\rho W_N y_t + x_{t-1}\beta + W_N X_{it-1}*\gamma + \varepsilon_t$ represents for the Spatial Durbin Model specification

4.4.3. Spatially-lagged Explanatory Variables

The model incorporates spatially-lagged explanatory variables to take into account likely city-to-city exchanges, making it feasible to explicitly model spatially mediated interregional spillovers and reducing the spatial autocorrelation concern.

To decide which (and how many) spatially-lagged explanatory variables (explanatory variables have been chosen according to their significance levels for each step) would best contribute to our model, we have run four different regressions with "no spatially-lagged explanatory variable", "with 2 explanatory (spatially-lagged) variables", "with 6 explanatory (spatially-lagged) variables", and a regression "with 10 spatially-lagged explanatory variables".

To decide on the most robust model, we have done post-estimation tests like the Likelihood Ratio Test (Appendix 7.1), Table of Fit Statistics (Bayesian Information Table) (Appendix 7.2), and R-square Statistics (Appendix 7.3) of the four above-mentioned options.

Since there are 4 options, we run 6 different nested LR tests. As seen in Appendix 7.1, between "six_sp_lg_vars" and "ten_sp_lg_vars", the situation is strongly in favor of the latter ($p = 0.0223$ significance level). Superior AIC/BIC (3425 vs. 3409) and R^2 values (0.4460 and 0.4617) also point to "ten_sp_lg_vars" as the best option.

In sum, after analyzing the results for the different number of spatially-lagged regression outputs in four options, we choose "*dlag(3) Spatiotemporal SDM FE(ind) regression with 10 spatially-lagged explanatory variables*", which has seemingly convincing empirical advantages (highest R^2 value and lowest BIC value, etc.) compared to the other three options.

4.4.4. Log-transformation of Dependent and Explanatory Variables

Finding the model's optimal fit, we have run regressions for the original non-log transformed model, the model with log-transformed 5 financial-based explanatory variables, and the model with log-transformed all dependent and explanatory variables.

After analyzing the above-mentioned regression outputs in three options (i.e., without log transformation, with 5 and with 10 log-transformed explanatory variables), we choose to continue with the model with log-transformed all dependent and explanatory variables, which has seemingly

some empirical (high R^2 and highest log-likelihood value and better explanation for the variables, etc.) advantages over the other two options. A detailed explanation of the logarithmic transformation is elaborated in Appendix 8.

4.4.5. Direct and Indirect Effects of Independent Variables

Spatial econometric models having lags both in space and time for independent and dependent variables enable the prediction of short- and long-run direct and indirect effects. Ability of spatial models to measure spatial spillovers accurately (or, in economic terms, positive/negative externalities) is one of their most important features. In Appendix 9, a thorough discussion of the direct and indirect impacts of independent variables is provided.

4.4.5.1. Direct Effect

"Direct effect" indicates the "average expected alteration" throughout all observations of our dependent variable for any specific city caused by a one-unit increase in a specific independent variable within the city. The indirect effect (spillover) represents variations in a specific city's dependent variable caused by a one-unit increase in another city's independent variable. That implies that variations in independent variables for city_i have an effect on the values of dependent variables in city $j \neq i$. (Golgher & Voss, 2016)

Direct effects could be used to verify if a specific variable imposes some significant influence on its dependent variable in the same spatial unit, whereas indirect effects could be used to determine if any spatial spillovers exist (Elhorst, 2014). The direct effect shows everything else is constant; if we change the value of x_k in city_i by one unit, we expect to observe direct marginal effects of x_k in the y_i variable. For instance, should city_i raise IPA funds reimbursements, what would be the average influence on the economic performance of city_i?

4.4.5.2. Indirect Effect

On the other hand, indirect effect shows some effects of x_k will spillover across other cities, $y_{j\neq i}$; the quantity would consider feedback effects that result from the alteration in the city_i IPA funds reimbursement on the economic growth of neighboring cities in the scheme of spatially dependent cities. This effect, for example, could be used to analyze the effects of all other cities elevating their IPA fund reimbursements on the economic growth of a single city, which would then be averaged across all provinces. (LeSage, 2008)

4.4.5.3. Feedback Effect

When a variable indirectly affects itself, this is referred to as a "feedback loop". Since city_i is assumed a neighbor to its neighbor, any effects that traverse across all bordering cities would have an effect on city_i. As a result, the direct effect for city_i contains feedback loop effects caused by the effects passing through bordering city_j and again to city_i.

For instance, observation_j influences observation_i, and observation_i also influences observation_j as well as throughout some extended routes, which may spill out from observation_j to i to k and from k again to j. When the model contains feedback loops, indirect effect interpretation should be done with caution. The sum for the indirect effect has an infinite number of terms when calculating the indirect effect; however, the individual indirect term values get lesser and lesser and thus habitually approach a limited outcome. (Debarsy et al., 2012)

Extensive variations or feedback effects on the given city results occur when changes to the city characteristics have some influence on results in the given city and neighboring cities. These feedback effects are commonly known as virtuous cycles or self-reinforcing effects and regional economic growth is often classified under this characteristic form. Exogenous technological innovations can kick-start growth by causing economies of scale and learning curve effects. As a result, costs can be reduced and production efficiencies could improve, resulting in lesser market average prices. Prices falling, aggregate output as well as consumption rise; as output rises, more scale effects and learning occur, triggering a new sequence. (LeSage & Pace, 2014)

The following factors will influence the feedback scale:

- position of the cities in the country,

- extend connectedness among cities, which are overseen by the model's weight matrix W,
- "ρ" calculating the "spatial dependence strength",
- "β" and "γ". (LeSage & Pace, 2009)

4.4.5.4. Total Effect

Total effect is summation of the two partial effects (i.e., direct and indirect). If all cities raised IPA reimbursements, what would be the average total influence on the typical city's economic growth? The average direct and indirect impact will be included in this total effect. Total effect also accounts for the total combined impact resulting from one city_j increasing its IPA funds reimbursement on the average economic growth of all other cities. (LeSage, 2008)

4.4.6. Local and Global Spatial Effects

As previously stated, "Spatiotemporal SDM with Individual Fixed-effects" version of the spatial model is figured out to be the most robust and useful model for our analysis because it embodies a "spatial-lag" specification, which also allows for control of Xs spatial dependence.

Any variation in the dependent variable within city_i imposes some direct effect on itself nonetheless; it also indirectly affects the remaining cities according to the SDM specification. Indirect effects of SDM could be separated into:

- *"γ" local effects coefficient, and*
- *global effects of the inverse matrix, including ρ.*

The very initial effects have been considered "local" since they solely affect the closest cities (assuming a weight matrix of first-order contiguity), whereas the "global" effect influences every other city throughout the (I-ρW)-1 matrix. (Golgher & Voss, 2016)

The common sense underneath local effects is that their spatial extent is limited to immediate (i.e., first-order) neighbors and local spillovers show insignificant feedback effects. Local spillovers portray a situation in which the impact is limited to immediate neighbors, diminishing before affecting second-order neighboring regions (LeSage & Pace, 2014). According to W, local

spillovers take place in some other regions only if they are closely linked to one another. This mandate necessitates that $\gamma \neq 0$.

When a variation in a given city characteristics affects the outcomes of all regions, this effect is called “global spillover”. This is true even for the given city because effects could spread to adjacent cities and then back to the given city as feedback. Global spillovers, in particular, affect neighbors, neighbors to neighbors, neighbors to neighbors to neighbors, and so on. They take place when some change in X_t within any city is spread to every other city, even if the cities are unrelated according to W. As a mandate, this imposes that $\rho \neq 0$.

SDM allows broader spillovers than those of SAR and SAC, which contain a spatially-lagged dependent variable like itself, due to both local and global indirect effects. In addition, SDM has broader spillovers than the SLX and SDEM models, which contain only spatially-lagged explanatory variables. (Golgher & Voss, 2016)

4.5. MODEL ESTIMATION RESULTS

4.5.1. Final Model Structure

We now come to the conclusion with the final model:

- ***Spatial Durbin Model (SDM)***
- ***Fixed-Effect (individual type)***
- ***Spatiotemporal (dlag3, i.e., time and space-time lagged dependent variables) dimension***
- ***with 10 spatially-lagged explanatory variables and***
- ***with log-transformed dependent and all explanatory variables***

$$y_t = \varphi y_{t-1} + \rho W_N y_t + \eta W_N y_{t-1} + x_{t-1}\beta + W_N X_{it-1}*\gamma + \boldsymbol{\mu} + \varepsilon_t, \qquad (4.4)$$

In our model,

– dependent variable, y, represents the city income growth (per capita),

– independent variables represent the city characteristics (industrial structure, physical and human capital, innovation, energy utilization),

– variation in city-level income growth is defined as a function of income growth rates from bordering cities acquired by Wy (spatial-lag vector) as well as the characteristics of bordering cities represented by WX.

SDM models can correlate direct effects (positive or negative) with indirect effects (negative or positive) for each k^{th} variable; therefore, effects of spillover could even function in reverse of direct effects caused by variations in each explanatory variable.

For our model (Eq. 4.4) with spatial-lags of the explained (economic growth rate) variable, city_i, y_i, economic growth rate depends on:

- levels from surrounding cities measured via $W_i y$ (i.e., the spatial-lag variable),
- city_i initial level of income ($\beta_0 \, Yi_0$),
- city_i regional characteristics represented via X_i,
- surrounding cities' initial income level, reflected via the spatial-lag variable,
- surrounding cities' characteristics measured via spatial-lag variables $W_i X$.

Any variation in city_i initial income level will have a direct impact on city_i growth rate, yet it will have some indirect effect as well since these changes will affect the growth rates of nearby cities ($j \neq i$). The changed initial growth rate will be embodied in the spatial-lag in surrounding cities, influencing their income, which influences city_i via the spatial-lag variable $W_i y$. One must remember that each city is a neighbor to the cities around it, so feedback effects are inherent in models of spatial regression.

Variations in city_j's initial growth rate will now directly affect city_j and thus indirectly affect the income of nearby cities. This is because any factor affecting city_j growth rate within any spatial-lag (Wy) model would affect surrounding cities' ($j \neq i$) growth rate as well.

We will proceed with our deliberation of the various effects of our concluded model based on the results shown below. As expected, the main effects of dependent and the lagged variables display notable disparities in their signs. This phenomenon is attributed to the inherent difficulty in discerning the effects when a model encompasses both endogenous and exogenous autocorrelations, as recognized in the econometric literature. (Agiropoulos, C., et al., 2021)

4.5.2. Estimation Results for the Final Model

We have run a regression with respect to the concluded final model (Eq. 4.4) along with our data set. The main section of the result is presented in the table below, and its elaborations will follow in due course. Unabridged regression results (short- and long-run results with direct, indirect, and total effects) are presented in Appendix 10.

Table 12: Estimation Results for the Final Main Model

gdpgrth_r	Coeff.	Std. Err.	z	P>z	[95%Conf.	Interval]
Main						
gdpgrth_r						
L1.	-0.22067***	0.03092	-7.14	0.000	-0.28127	-0.16007
Wgdpgrth_r						
L1.	0.13473***	0.03973	3.39	0.001	0.05686	0.21261
loggdp_r	0.40055***	0.02650	15.11	0.000	0.34860	0.45249
ipa_funds	-0.00008	0.00027	-0.29	0.769	-0.00062	0.00046
education	-0.00817	0.01436	-0.57	0.569	-0.03631	0.01997
emplymnrt	0.02831**	0.01148	2.47	0.014	0.00581	0.05081
innovation	0.00652***	0.00099	6.60	0.000	0.00459	0.00846
roadperarea	-0.30216	0.26058	-1.16	0.246	-0.81289	0.20858
export_pc	-0.00117	0.00229	-0.51	0.608	-0.00566	0.00331
electric_pc	-0.00401*	0.00234	-1.71	0.087	-0.00859	0.00058
gov_incentive	0.00214*	0.00116	1.85	0.064	-0.00013	0.00441
gov_investment	0.00059	0.00356	0.17	0.869	-0.00640	0.00757
w1x_loggdp_r	-0.00074	0.00939	-0.08	0.937	-0.01915	0.01767
w1x_ipa_funds	0.00022	0.00031	0.71	0.479	-0.00039	0.00084
w1x_education	-0.00188	0.00889	-0.21	0.833	-0.01931	0.01555
w1x_emplymnrt	0.01669	0.01726	0.97	0.334	-0.01714	0.05051
w1x_innovation	0.00021	0.00117	0.18	0.856	-0.00208	0.00251
w1x_roadperarea	-0.53839	0.38296	-1.41	0.160	-1.28896	0.21219
w1x_export_pc	0.00236	0.00291	0.81	0.417	-0.00334	0.00806
w1x_electric_pc	0.00177	0.00645	0.27	0.784	-0.01088	0.01442
w1x_gov_incentive	0.00103	0.00159	0.64	0.520	-0.00210	0.00415
w1x_gov_investment	-0.00967**	0.00489	-1.98	0.048	-0.01925	-0.00010
Wx						
loggdp_r	-0.34535***	0.05424	-6.37	0.000	-0.45166	-0.23903
ipa_funds	-0.00052	0.00158	-0.33	0.740	-0.00362	0.00257
education	0.07524*	0.04453	1.69	0.091	-0.01203	0.16251
emplymnrt	-0.03900	0.08019	-0.49	0.627	-0.19618	0.11818
innovation	-0.00206	0.00557	-0.37	0.711	-0.01299	0.00886
roadperarea	2.96273*	1.73003	1.71	0.087	-0.42806	6.35353
export_pc	-0.00443	0.01298	-0.34	0.733	-0.02988	0.02101
electric_pc	0.00214	0.03034	0.07	0.944	-0.05733	0.06161
gov_incentive	-0.00340	0.00807	-0.42	0.674	-0.01921	0.01242
gov_investment	0.04454*	0.02407	1.85	0.064	-0.00265	0.09172
Spatial						
rho	0.65620***	0.02695	24.35	0.000	0.60339	0.70902
Variance						
sigma2_e	0.00097***	0.00004	22.33	0.000	0.00088	0.00105

*** p<0.01, ** p<0.05, * p<0.1.

The inclusion of spatiotemporal coefficients in our model has provided evidence for the importance of considering the spatiotemporal dimension. The findings indicate that the regions' economic growth rates are supposed to be significantly influenced not only by their previous growth rates but also by the temporal growth rates of neighboring regions in Türkiye.

As far as the total effects are concerned, impacts of time and space-time lagged dependent variables [φy_{it-1} (i.e., gdpgrth_r LI.) and $\eta W y_{it-1}$ (i.e., Wgdpgrth_r LI.)] are highly (p-value = 0.000 and 0.001, respectively) significant (negative and positive, respectively). The implications for these and following spatiotemporal variable findings (i.e., η, ρ) are also elaborated in this section.

φy_{it-1} (i.e., gdpgrth_r LI.) has a negative value of (-0.2207), which is an indication of first-order negative serial autocorrelation for the dependent variable, i.e., per capita growth rate of city_i. Any positive per capita growth rate in city_i in the previous (t-1) period would have a restraining (reverse) marginal effect on the growth rate in the current (t) period in the very same observation unit, which defines the convergence of the growth rate in the observation units. The negative significant temporal-lag coefficient, $\varphi yit{-}1$ (i.e., gdpgrth_r LI.), indicates that a positive per capita growth rate in city_i during the previous period (t-1) has a dampening (reverse) marginal effect on the growth rate for current period (t) within city_i. This finding suggests that there is a tendency for the growth rates among the cities to converge over time.

$\eta W y_{it-1}$ (i.e., Wgdpgrth_r LI.) has a positive value of (0.1347), which is an indication of first-order positive serial autocorrelation of the spatial effects for the dependent variable. Any positive per capita growth rate in any adjacent neighbor city_j ($j \neq i$) in the previous (t-1) period has a boost effect on the growth rate for current (t) period in city_i, which suggests the presence of temporal spillover effects from neighboring units, where growth in neighboring cities ($j \neq i$) positively influences the growth in city_i. This implies that any positive per capita growth rate in any adjacent neighbor city_j ($j \neq i$) during the previous period (t-1) has some boosting effect on the growth rate for current period (t) in city_i.

$W_N y_t$, or 'spatial-lag vector' (in Eq. 4.4), is a sequential combination of neighboring cities' economic performances. $W_N y_t$ reflects spatial dependence in y via ρ (rho), a scalar parameter,

indicating the impact of attributable cities' growth rates on city_i's growth rate. The scalar parameter for spatial dependence, **ρ**WNyt, of the 'spatial-lag vector,' signifies the influence of the neighboring cities' growth rates on city_i growth rate. The spatial indicator ρ(rho) is positive (0.656) and decidedly significant, signaling that economic growth rates of cities have a strong positive spatial dependency.

Positive spatial (ρ) dependence is anticipated in spatial economic growth regressions, such as our model, revealing that city growth rates are positively linked to those of bordering cities. ρ could also be reflected as a rate of discount that causes a decline in growth impact for neighboring cities located further away. Because of our model's use of log-transformed values for both dependent and independent variables, the overall effect estimates show "elasticities." From this, we can conclude "any 1% rise in the neighboring cities output growth corresponds to some 0.656% increase in local economic growth".

The model suggests that the strength of the absolute convergence effect is 0.221% and that of the conditional convergence effect is 0.656%, respectively, based on the values for φ, the coefficient of the lagged dependent variable, and ρ, the coefficient of the spatial lag of the dependent variable. The EU convergence rates cited in various academic researches vary substantially. According to some research, there is a definite trend of convergence, with poorer areas catching up to wealthier areas at a pace of about 2% year. Other research has revealed that there is either no discernible pattern of convergence or that the pace of convergence is substantially slower.

Barro and Sala-i-Martin's (1991) study on EU member states convergence is one of the most often quoted ones. In the EU, they discovered a pronounced trend of -convergence, with poorer regions catching up to richer regions at a pace of about 2% per year. The convergence rate, however, has been shown to be substantially slower in other experiments. For instance, a research by Neven and Gouyette (1994) discovered that the EU's convergence rate was around 1% year. The time period analyzed, the methodology employed, and the concept of convergence are some of the probable causes of the variance in convergence rates identified in these research.

From Table 12, the results for the total effects are summarized as follows:

- X_1 (log_gdp, i.e., natural log for per capita GDP level at start of year) is positive and highly (p-value = 0.000) significant effect on output growth. So, this implies that higher initial level of GDP per capita in the city are linked to greater subsequent economic growth rates and suggests a pattern of conditional regional convergence, where regions with lower beginning GDP levels typically enjoy rapid economic progress, gradually catching up to regions with higher initial GDP levels. This aligns with the interpretation of temporal-lag coefficient φ, which signifies the regional convergence of growth. It suggests that policies aimed at fostering economic growth in regions with lower initial GDP levels can contribute to reducing regional disparities and promoting overall regional convergence.
- The coefficient of X_{2it-1} (ipa_funds, i.e., EU IPA funds reimbursements) is not statistically significant. Therefore, according to our empirical analysis, IPA funds does not have any significant effect on the incomes of the provinces and therefore on their local growth. The results of this research are consistent with a wide range of empirical investigations that explored the effects of EU structural funding in various regions of EU member countries and have yielded diverse results, as discussed in the literature review.

  There are several statistical as well as policy factors that can be attributed to the lack of any significant impact for EU IPA funds reimbursements, which are elaborated in the Conclusion. These constraints can undermine the efficient assessment and implementation of the policies and limit the potential positive effects they could have on economic growth.

There might be several reasons that can explain the infectiveness of IPA funds to stimulate the regional growth rate. The most likely explanation is the insufficiency of funds to stimulate the growth. Small-scale projects may have limited capacity to generate substantial employment opportunities and stimulate regional economies.

With IPA funds accounting for only 0.0225% of the cities' GDP, it is evident that the financial support was relatively weak and could not have had any noteworthy effect on regional progress. The highest utilization of IPA funds as a percentage of GDP, observed in Kars province at 0.2345%, is still relatively low in comparison. Besides, the selection of projects to be financed by the IPA funds may not have been strategic enough to maximize their impact on regional growth.

Secondly, the timeframe to evaluate the effects of IPA funds might be too short. The impact of these policies may take time to materialize as investments in infrastructure and labor market

reforms gradually translate into improved productivity, competitiveness, and overall economic performance. Therefore, observed lack of significant impact on growth could be attributed, at least in part, to the relatively short timeframe of the implementation of the IPA funds' policies as well as to the timeframe to discern their impacts on the regional growth more soundly. Therefore, there is a need for future studies to analyze the effects in the long term, especially as longer spans of data on EU IPA funds become available. Our study may provide a background for future studies both in terms of the methodology as well as in terms of the EU IPA funds data set that we constructed.

Furthermore, the allocation of IPA funds may not have been evenly distributed among regions, resulting in an uneven financial impact. Certain regions may have received a larger share of the funds, while others received relatively less, further contributing to the limited overall impact. It is crucial to assess whether the transfers were effectively targeted toward the most productive investments that have the potential to stimulate economic growth. If the allocation of funds was not optimally directed towards areas with the highest growth potential or strategic sectors, it could have limited their overall influences for regional progress.

It is crucial to keep in mind that the period under examination in Türkiye has been marked by significant changes in policy, politics, and regional economies. These dynamic and evolving conditions create a challenging environment for accurately assessing the precise impacts of IPA funds on regional economic progress. Their implementation may have coincided with various policy reforms, political transitions, or economic fluctuations, which can complicate the identification of the specific effects attributed solely to the funds.

It is crucial to acknowledge that the implementation of policies associated with the IPA funds can present substantial informational and technical challenges for government bureaucracies. The successful execution of these policies requires a thorough understanding of the targeted objectives, effective coordination among various government agencies, and the ability to navigate complex administrative processes. However, the requirements and complexities involved in executing these policies may overwhelm government agencies responsible for their implementation. Limited institutional capacity, insufficient resources, and bureaucratic inefficiencies can hinder the effective delivery of the IPA funds and the realization of their intended impacts.

Challenges in data collection, monitoring, and evaluation may also arise, making it difficult to track the utilization and effectiveness of the funds accurately. These constraints can undermine the efficient implementation of the policies and limit the potential positive effects they could have on economic growth. Thus, the challenges faced by government bureaucracies in effectively executing these policies should be considered when assessing the outcomes and effects of IPA funds over regional growth.

Additionally, statistical reasons like error dependence and omitted variable challenges faced in regional growth studies might be the reasons for the insignificant coefficient of the EU IPA funds variable. Error dependence in regional growth studies implies that conventional standard errors tend to overstate the information contained in the data. This can lead to inaccurate estimation of model parameters and misleading statistical significance, affecting the reliability of the results. However, it is very difficult to avoid omitted variable bias in regional growth studies in Türkiye due to the lack of comprehensive regional data set.

- The coefficients of X_{4it-1} (emplymnrt, i.e., employment rate) and X_{5it-1} (innovation, i.e., innovations) variables are statistically significant and positive that show positive influence of an increase in employment and innovation on regional economic growth. In line with theoretical expectations, employment and innovation are to be as important determinants of regional growth in Türkiye. The common understanding here is based on the notion that relative regional strengths in human capital (employment) and R&D expenditures (innovation) act as growth factors.
- Coefficients of X_{8it-1} (electric_pc, i.e., electricity consumption per capita) and X_{9it-1} (gov_incentive, i.e., governmental incentives) variables have significant (at 10% significance level) impacts (negative and positive, respectively) on output growth. The evaluation of the electricity per capita variable should be contextualized within Türkiye's regional electricity dynamics. It is important to consider that this proxy may not have performed as expected, possibly due to factors such as illegal use and unauthorized access to electricity power lines, particularly prevalent in the underdeveloped eastern cities. Also, it is noteworthy that the findings align with the consistent behavior of governmental incentives aimed at stimulating economic growth.

- The coefficients of X_{3it-1} (education, i.e., tertiary education), X_{6it-1} (roadperarea, i.e., stabilized roads per area), X_{7it-1} (export_pc, i.e., regional per capita export), and X_{10it-1} (gov_investment, i.e., governmental investments) variables are not statistically significant, namely these variables have no significant impact on output growth. Despite fact that our empirical test results for these variables provide little evidence of their effects on regional economic progress, one can highlight potential role of infrastructural disparities across Türkiye, looking at their influence on the economic activities' spatial location. Economic development will surely arise from improving transportation infrastructure and public spending on education, at least over the long term.
- The coefficient of [wlx_gov_investment] entails a significant negative influence on the growth. This shows that any public investment in the adjacent neighbor city_j ($i \neq j$) could affect the growth rate of city_i negatively, possibly by attracting the qualified labor force and would-be investment decisions away from city_i.
- Other stand-alone spatially-lag variables (wlx_X1, X2, X3…, X9) are insignificant and do not have any total impact on gdp per capita growth for city_i.
- When spatially-lagged variables are used in a spatiotemporal regression, previously insignificant infrastructure variables could show significant spillovers, or previously significant infrastructure variables could turn out to be ineffective. This is due to the inclusion of time and spatial dimensions not only for the individual variable but also for the whole independent variable set.
- Our model employs 10 spatially-lagged regional characteristics. Inclusion of the significant spatially-lagged variable [wlx_gov_investment] emphasizes the significance of taking into account spatial lags in our model for avoiding potential "omitted variable bias" in the non-spatial interaction specification.
- **Wx** part of Table 12 depicts the spatial dependency of our data set. It measures the average influence of the neighboring spatial units on our individual observation unit (i.e., city_i).
- The coefficients of $\boldsymbol{WX}_{1it-1}$ (log_gdp), $\boldsymbol{WX}_{3it-1}$ (education), $\boldsymbol{WX}_{6it-1}$ (roadperarea), and $\boldsymbol{WX}_{10it-1}$ (gov_investment) have significant spatial impact on output growth (log_gdp is negative and others are positive, respectively), which signifies "spillover effects" with respect to their signs. In this regard, initial gdp levels of the neighboring units entail some negative influence for city_i's gdp per capita growth, while tertiary education, road

infrastructure and government investment levels have some positive significant effects for the city_i gdp per capita growth.

Table 13: Interpretation of Short-run Total Effects

gdpgrth_r	Coeff.	Std. Err.	z	P>z	[95%Conf.	Interval]
SR_Total						
loggdp_r	0.16570	0.14230	1.16	0.244	-0.11321	0.44460
ipa_funds	-0.00203	0.00471	-0.43	0.666	-0.01127	0.00720
education	0.19968	0.12519	1.60	0.111	-0.04569	0.44504
emplymnrt	-0.03788	0.23642	-0.16	0.873	-0.50125	0.42549
innovation	0.01166	0.01564	0.75	0.456	-0.01900	0.04232
roadperarea	7.97049	5.15796	1.55	0.122	-2.13893	18.07992
export_pc	-0.01532	0.03870	-0.40	0.691	-0.09118	0.06053
electric_pc	-0.00472	0.09071	-0.05	0.959	-0.18250	0.17306
gov_incentive	-0.00333	0.02450	-0.14	0.892	-0.05135	0.04469
gov_investment	0.1313*****	0.07063	1.86	0.063	-0.00716	0.26970
w1x_loggdp_r	-0.00359	0.02686	-0.13	0.894	-0.05624	0.04905
w1x_ipa_funds	0.00069	0.00094	0.74	0.462	-0.00115	0.00252
w1x_education	-0.00704	0.02522	-0.28	0.780	-0.05646	0.04239
w1x_emplymnrt	0.05078	0.05163	0.98	0.325	-0.05042	0.15198
w1x_innovation	0.00094	0.00342	0.28	0.783	-0.00577	0.00766
w1x_roadperarea	-1.61482	1.14356	-1.41	0.158	-3.85617	0.62652
w1x_export_pc	0.00690	0.00878	0.79	0.432	-0.01030	0.02410
w1x_electric_pc	0.00570	0.01958	0.29	0.771	-0.03268	0.04408
w1x_gov_incentive	0.00279	0.00475	0.59	0.556	-0.00651	0.01209
w1x_gov_investment	-0.0282******	0.01397	-2.02	0.043	-0.05561	-0.00086

*** p<0.01, ** p<0.05, * p<0.1.

- X1 (log_gdp) is nonsignificant and positive (although positive and significant in direct effects). Therefore, the initial income level of GDP has no influence on income improvements and does not suggest a pattern of regional convergence in the near term.
- The coefficient of X_{2it-1} (ipa_funds) is not significant and negative (the same in direct effects). As it has no effect in the long-run, IPA funding has no impact on regional economic growth in Türkiye in the short-run, either. Since, by nature, the variable is a reimbursement payment for the investment, any short-run effect should not have been expected in the first place.
- X_{10it-1} (gov_investment) is significant and entails some positive influence on economic progress (both direct and indirect effects). This implies that, even in the short-run, public investments in the observation unit city_i could affect its growth rate positively, possibly by attracting the qualified labor force and would-be investment decisions to the observation

unit (i.e., city_i). The public investments are scheduled by the central government beforehand via officially announced multi-annual investment programs. This makes it possible to foresee future government investment decisions and take action accordingly for possible investors and other economic actors. Therefore, it makes sense to see its effect in the short-term, as well as in the long-term.

- The coefficients of X_{3it-1} (education), X_{4it-1} (employment rate), X_{5it-1} (innovation), X_{6it-1} (roadperarea), X_{7it-1} (export_pc), X_{8it-1} (electric_pc) and X_{9it-1} (gov_incentive) are insignificant. Hence, we settle that tertiary education, employment rate, innovations, stabilized roads per area, regional export, electricity consumption per capita and governmental incentives have no significant short-run effect on output growth.
- [wlx_gov_investment] is significant and entails some adverse near-term impact on economic growth (both direct and indirect effects). [wlx_gov_investment] is one of the stand-alone spatially-lag variables that are introduced to model spatially mediated interregional spillovers and reduce the issue of spatial autocorrelation. This shows that any public investment in the adjacent neighbor city_j ($i \neq j$) could affect the growth rate of city_i negatively, possibly by attracting the qualified labor force and would-be investment decisions away from the observation unit (i.e., city_i).
- Other stand-alone spatially-lag variables (wlx_X1, X2, X3,…, X9) are insignificant and do not have any short-run impact on the gdp per capita growth for city_i.

Table 14: Interpretation of Long-run Total Effects

gdpgrth_r	Coeff.	Std. Err.	z	P>z	[95%Conf.	Interval]
LR_Total						
loggdp_r	0.13251	0.11341	1.17	0.243	-0.08978	0.35479
ipa_funds	-0.00162	0.00375	-0.43	0.666	-0.00897	0.00574
education	0.15956	0.09982	1.60	0.110	-0.03608	0.35520
emplymnrt	-0.03014	0.18859	-0.16	0.873	-0.39976	0.33948
innovation	0.00933	0.01247	0.75	0.455	-0.01512	0.03377
roadperarea	6.36294	4.10714	1.55	0.121	-1.68691	14.41279
export_pc	-0.01225	0.03086	-0.40	0.690	-0.07274	0.04824
electric_pc	-0.00371	0.07224	-0.05	0.959	-0.14529	0.13788
gov_incentive	-0.00264	0.01953	-0.14	0.892	-0.04093	0.03564
gov_investment	0.1047*	0.05576	1.88	0.060	-0.00456	0.21402
w1x_loggdp_r	-0.00287	0.02141	-0.13	0.893	-0.04485	0.03910
w1x_ipa_funds	0.00055	0.00075	0.74	0.461	-0.00091	0.00201
w1x_education	-0.00561	0.02011	-0.28	0.780	-0.04503	0.03381
w1x_emplymnrt	0.04056	0.04115	0.99	0.324	-0.04010	0.12123
w1x_innovation	0.00076	0.00273	0.28	0.782	-0.00459	0.00611
w1x_roadperarea	-1.28956	0.91202	-1.41	0.157	-3.07709	0.49798
w1x_export_pc	0.00552	0.00699	0.79	0.430	-0.00819	0.01922
w1x_electric_pc	0.00454	0.01560	0.29	0.771	-0.02602	0.03511
w1x_gov_incentive	0.00223	0.00378	0.59	0.556	-0.00518	0.00963
w1x_gov_investment	-0.0225**	0.01104	-2.04	0.041	-0.04416	-0.00090

*** p<0.01, ** p<0.05, * p<0.1.

- X1 (log_gdp) does not seem to impose any significant long-term consequence on growth performance, as it does not any near term (Table 13). However, it is highly significant in the main regression (Table 12).
- X_{2it-1} (ipa_funds) is non-significant and negative. IPA funding has no long-term impact on regional growth across Türkiye, as it does not for the near term.
- X_{10it-1} (gov_investment) has a significant and positive effect on economic performance in the long-run. This suggests that public spending in the observation unit city_i could have a favorable impact on its growth rate, perhaps by luring qualified workers and potential investors to the observation unit (i.e., city_i).
- The coefficients of X_{3it-1} (education), X_{4it-1} (emplymnrt), X_{5it-1} (innovation), X_{6it-1} (roadperarea), X_{7it-1} (export_pc), X_{8it-1} (electric_pc) and X_{9it-1} (gov_incentive) are statistically insignificant. Hence, we settle that education, employment rate, innovations, stabilized roads per area, regional export, electricity consumption per capita and governmental incentives have no significant long-run influence for the regional growth.
- [wlx_gov_investment] has some significant negative effect on growth performance. It demonstrates how public investments in the neighboring city_j ($i \neq j$) may negatively affect

city_i's pace of growth, either by diverting skilled workers or potential investment decisions away from the observation unit (i.e., city_i).

- Other stand-alone spatially-lag variables (wlx_X1, X2, X3…, X9) are insignificant and have no long-term influence on the growth of city_i's gdp per capita.

In order to analyze the implications of the results, it is crucial to thoroughly explore the underlying statistical causes for the discrepancy between the main regression results and the short- and long-run outcomes as well as take into account the unique properties of the data and model being utilized. The statistical reasons for the contradiction could include:

Endogeneity: endogeneity problems might affect variables that are statistically significant in the main regression. In the short- or long-run analysis, these endogeneity problems might become more apparent and affect the variables' statistical significances.

Collinearity: Presence of collinearity among explanatory variables can affect their statistical significance. In the main regression, collinear variables might show significance, but in the short- or long-run analysis, when collinearity is more pronounced, statistical significance can diminish.

In the main regression results, the independent variables (loggdp_r, emplymnrt, innovation, electric_pc, gov_incentive and w1x_gov_investment) have significant effects and (loggdp_r, education, roadperarea and gov_investment) have significant spillover effects. On the other hand, in both short- and long-run regression results, only (gov_investment) and (w1x_gov_investment) variables have significant effects.

While we have pointed out the underlying reasons for the short- vs. long-run discrepancy in the previous paragraphs, one important implication of the above results is that government investments have important immediate as well as lasting impacts not only on the observation unit but also on its neighboring units. (w1x_gov_investment) variable is the only spatially-lagged independent variable which is significant in all term regressions implying that public investments have effective global spillover effects that permeate across the country, while other variables have limited regional spillover effects on their immediate neighbors.

CONCLUSION

Understanding the effects of EU pre-accession funding on regional growth in Türkiye is the major objective of this study. To achieve this, we employ the dynamic spatial panel data method to evaluate the impact of the Instrument for pre-Accession Assistance (IPA) funding on regional growth in Türkiye. Specifically, we attempted to address the issue of whether there is a causal link between the regional growth in Türkiye's 81 cities and the pre-accession assistance received from the EU.

It will be the first research, as far as we are aware, to use spatial econometrics to examine the effects of EU pre-accession funds on regional growth across Türkiye. Regarding evaluating the economic effects of IPA grants, there is a severe academic research gap in Türkiye. Due to the DIS structure, numerous national institutions recognized by the EU are responsible for utilizing IPA monies, which have been allocated to national resources through deductions from the EU central budget. The countrywide impact of IPA funds cannot be fully assessed because of this decentralization.

Another limitation is that IPA funds lack the data and history to adequately support econometric analysis, and the implementation process takes only a brief amount of time. One of the main challenges in academic research is the absence of sufficient local statistical resources to accurately measure economic growth. This constraint is seen as the third biggest barrier to carrying out such research. It was only after conquering the two significant challenges stated above that it was able to write this thesis.

It provides insights into the efficiency of IPA funding and regional development policy instruments in fostering regional growth. The study's findings have important policy implications for both counterparts, i.e., Türkiye and the EU, especially in light of their common goals of fostering sustainable economic growth and lowering regional inequality.

In our model, y, the dependent variable, denotes city_i per capita income growth, the independent variables represent the city characteristics (industrial structure, physical and human capital, innovation, energy utilization), and variation in city-level income growth is defined as a function of income growth rates from bordering cities acquired by Wy (spatial-lag vector) as well as characteristics of bordering cities represented by WX.

The dataset used in this study focuses on IPA funds and includes yearly reimbursements from 2007 to 2018 on a regional basis in Türkiye, covering 81 cities. Due to the challenges associated with

obtaining annual expenditure data per IPA program (RCOP, IPARD, and TAIB) in Türkiye, it would have been simpler to aggregate EU IPA funds commitment data based on budget cycles and programming periods (2007–2013 and 2014–2020).

However, to ensure accuracy, we have made efforts to compile annual reimbursement data at the provincial level for the IPA programs. One of the contributions of this study to the literature is the creation of the IPA funds data at the regional level.

Spatial panel data approaches are used to estimate the model. After conducting the required statistical selection processes, we apply the spatiotemporal fixed-effect Spatial Durbin Model with log-transformed spatially-lagged variables to estimate the model.

As far as our main explanatory variable is concerned, our estimation results point out that there is no statistically significant impact of IPA funds on the growth of the local economy. As we have analyzed in the last chapter, there might be several reasons that can explain the infectiveness of IPA funds to stimulate the regional growth rate. The most likely explanation is the insufficiency of funds to stimulate the growth. Small-scale projects may have limited capacity to generate substantial employment opportunities and stimulate regional economies. Secondly, the timeframe to evaluate the effects of IPA funds might be too short. The impact of these policies may take time to materialize as investments in infrastructure and labor market reforms gradually translate into improved productivity, competitiveness, and overall economic performance. Thirdly, the allocation of IPA funds may not have been evenly distributed among regions, resulting in an uneven financial impact. At the same time, it is crucial to keep in mind that the period under examination in Türkiye has been marked by significant changes in policy, politics, and regional economies. These dynamic and evolving conditions create a challenging environment for accurately assessing the precise impacts of IPA funds on regional economic progress.

It is crucial to acknowledge that the implementation of policies associated with the IPA funds can present substantial informational and technical challenges for government bureaucracies. The successful execution of these policies requires a thorough understanding of the targeted objectives, effective coordination among various government agencies, and the ability to navigate complex administrative processes. However, the requirements and complexities involved in executing these policies may overwhelm government agencies responsible for their implementation. Limited

institutional capacity, insufficient resources, and bureaucratic inefficiencies can hinder the effective delivery of the IPA funds and the realization of their intended impacts.

Challenges in data collection, monitoring, and evaluation may also arise, making it difficult to track the utilization and effectiveness of the funds accurately. These constraints can undermine the efficient implementation of the policies and limit the potential positive effects they could have on economic growth. Thus, the challenges faced by government bureaucracies in effectively executing these policies should be considered when assessing the outcomes and effects of IPA funds over regional growth.

Additionally, statistical reasons like error dependence and omitted variable challenges faced in regional growth studies might be the reasons for the insignificant coefficient of the EU IPA funds variable. Error dependence in regional growth studies implies that conventional standard errors tend to overstate the information contained in the data. This can lead to inaccurate estimation of model parameters and misleading statistical significance, affecting the reliability of the results. However, it is very difficult to avoid omitted variable bias in regional growth studies in Türkiye due to the lack of comprehensive regional data set.

Our estimation results also address the other important determinants of regional growth in Türkiye. Our results show that higher initial points of GDP per capita for the city are linked to greater subsequent economic growth rates. The findings suggest a pattern of conditional regional convergence, where regions having lower initial GDP points tend to experience more rapid economic growth, gradually catching up to regions with higher initial GDP levels.

This aligns with the interpretation of temporal-lag coefficient φ, which signifies the regional convergence of growth. It suggests that policies aimed at fostering economic growth in regions with lower initial GDP levels can contribute to reducing regional disparities and promoting overall regional convergence.

The coefficients of the employment as well as innovations variables are significantly positive in the model's main estimation part. This shows the positive influence of an increase in employment and innovation on regional economic growth. In line with theoretical expectations, employment and innovation are considered as two important regional growth determinants in Türkiye.

As opposed to that, tertiary education, stabilized roads per area, regional export, and public investment variables have no significant effect on output growth in the model's main estimation part. Only in the short- and long-run models can public investment have some significant positive effect on growth performance, which is elaborated in due course.

Despite the fact that our empirical test results for these variables provide little evidence of their effects on regional progress, one can highlight probable roles of infrastructural disparities across Türkiye, looking at their influence on the economic activities' spatial location. Strengthening transportation infrastructure, also investing public funds in education will undoubtedly result in economic growth, at least over the long term.

Any public investment in the adjacent neighboring city might have a negative impact on the city's growth rate in the long-run as well as short-run models, which is another significant finding of the study. This might be due to the possible attraction of the qualified labor force and would-be investment decisions away from the relevant city.

The inclusion of spatiotemporal coefficients in our model has provided evidence for the importance of considering the spatiotemporal dimension. The negative significant temporal-lag coefficient suggests that there is a tendency for the growth rates among the cities to converge over time. The positive spatial-lag coefficient shows the presence of temporal spillover effects from neighboring units, where growth in neighboring cities positively influences the growth in the relevant.

The findings indicate that regional growth rates in Türkiye are significantly influenced by their previous growth rates as well as by the temporal growth rates of neighboring regions. The scalar parameter for spatial dependence indicates a strong positive spatial dependency among the economic growth rates of cities. In spatial economic growth regressions, such as the model employed in our study, it is expected to observe positive spatial dependency, indicative of the positively correlated city growth rates with those of the neighboring cities.

In general, the findings of this thesis point to the validity and superiority of spatial econometric modeling techniques for the topic of regional growth and convergence in Türkiye. The findings are particularly significant because they demonstrate how ignoring spatiality can result in hidden economic connections between regions as well as biased inconsistent, and/or inefficient parameter

estimates that lead to false conclusions about the true nature of spatial relationships between regions.

Considering the inherent statistical challenges and policy factors that contribute to the limited impact of IPA funds on growth, it is crucial to implement some policy measures that can enhance the effectiveness of these funds and maximize their positive influence on local growth and development in Türkiye. In light of these, the following proposed measures are recommended:

Strategic Planning and Prioritization: Develop a comprehensive strategic plan that outlines the specific objectives, target sectors, and geographical areas where IPA funds will have the greatest impact. Prioritize investments that align with long-term development goals and have the potential to generate sustainable economic growth.

Efficient Resource Allocation: Ensure the efficient allocation of IPA funds by conducting thorough assessments of project proposals and rigorous cost-benefit analyses. Allocate resources to projects with the highest potential for economic impact, such as infrastructure development, innovation, entrepreneurship, and human capital development.

Strengthen Institutional Capacity: Invest in building the institutional capacity of relevant government agencies responsible for implementing IPA fund projects. This involves delivering instruction and technical support to enhance project management capabilities as well as monitoring, evaluation, and financial management systems. Therefore, to increase the effectiveness of IPA funds in Türkiye, institutional capacity as well as bureaucratic efficiency should be enhanced.

Enhance Transparency and Accountability: Promote transparency in the distribution and utilization of IPA funds by implementing robust monitoring and evaluation mechanisms. Establish clear accountability frameworks to track the progress and outcomes of funded projects. Publish regular reports on fund utilization and results achieved.

Encourage Public-Private Partnerships: Inspire teamwork between the public and private sectors to create additional capital and know-how. Foster partnerships that can enhance the effectiveness and sustainability of IPA-funded projects, particularly in areas such as infrastructure development and innovation.

Promote Regional Collaboration and Synergies: Foster collaboration among regions to capitalize on economies of scale and create synergies in regional development initiatives. Encourage knowledge sharing and joint projects that can amplify the impact of IPA funds across regions. The government institutions should collaborate and share their know-how to create public synergy.

Continuous Monitoring and Adaptation: Implement a robust monitoring and evaluation framework to continuously assess the impact of IPA funds and identify areas for improvement. Adapt policies and strategies, ensuring that the funds are continuously optimized for maximum effectiveness.

Long-term Perspective: Recognize that it frequently takes a long time for the effects of IPA funds to become visible. Maintain a long-term view throughout the design, execution, and assessment of sponsored initiatives, understanding that sustainable economic growth requires patience, consistency, and a comprehensive approach.

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APPENDIX 1: RCOP and IPARD Provinces in Türkiye

Code	Province	RCOP Provinces	IPARD Provinces	
01	Adana			
02	Adıyaman	Adıyaman		
03	Afyon		Afyon	
04	Ağrı	Ağrı	Ağrı	
05	Amasya	Amasya	Amasya	
06	Ankara		Ankara	
07	Antalya			
08	Artvin	Artvin		
09	Aydın		Aydın	
10	Balıkesir		Balıkesir	
11	Bilecik			
12	Bingöl	Bingöl		
13	Bitlis	Bitlis		
14	Bolu			
15	Burdur		Burdur	
16	Bursa		Bursa	
17	Çanakkale		Çanakkale	
18	Çankırı	Çankırı	Çankırı	
19	Çorum	Çorum	Çorum	
20	Denizli		Denizli	
21	Diyarbakır	Diyarbakır	Diyarbakır	
22	Edirne			
23	Elazığ	Elazığ	Elazığ	
24	Erzincan	Erzincan	Erzincan	
25	Erzurum	Erzurum	Erzurum	
26	Eskişehir			
27	Gaziantep	Gaziantep		
28	Giresun	Giresun	Giresun	
29	Gümüşhane	Gümüşhane		
30	Hakkari	Hakkari		
31	Hatay	Hatay	Hatay	
32	Isparta		Isparta	
33	İçel		İçel	
34	İstanbul			
35	İzmir			
36	Kars	Kars	Kars	
37	Kastamonu	Kastamonu	Kastamonu	
38	Kayseri	Kayseri		
39	Kırklareli			
40	Kırşehir			
41	Kocaeli			
42	Konya		Konya	
43	Kütahya		Kütahya	
44	Malatya	Malatya	Malatya	
45	Manisa		Manisa	
46	Kahramanmaraş	Kahramanmaraş	Kahramanmaraş	
47	Mardin	Mardin	Mardin	
48	Muğla	Muş	Muş	
49	Muş			
50	Nevşehir		Nevşehir	
51	Niğde			
52	Ordu	Ordu	Ordu	
53	Rize	Rize		
54	Sakarya			
55	Samsun	Samsun	Samsun	
56	Siirt	Siirt		
57	Sinop	Sinop		
58	Sivas	Sivas	Sivas	
59	Tekirdağ			
60	Tokat	Tokat	Tokat	
61	Trabzon	Trabzon	Trabzon	
62	Tunceli	Tunceli		
63	Şanlıurfa	Şanlıurfa	Şanlıurfa	
64	Uşak		Uşak	
65	Van	Van	Van	
66	Yozgat	Yozgat	Yozgat	
67	Zonguldak			
68	Aksaray		Aksaray	
69	Bayburt	Bayburt		
70	Karaman		Karaman	
71	Kırıkkale			
72	Batman	Batman		
73	Şırnak	Şırnak		
74	Bartın			
75	Ardahan	Ardahan	Ardahan	
76	Iğdır	Iğdır		
77	Yalova			
78	Karabük			
79	Kilis	Kilis		
80	Osmaniye	Osmaniye		
81	Düzce			
		43 Provinces	42 Provinces	

	Non-RCOP and non-IPARD Province	21 Provinces
	Only RCOP Province	18 Provinces
	Only IPARD Province	17 Provinces
	Both RCOP and IPARD Province	25 Provinces
	Total	81 Provinces

APPENDIX 2: Correlation Table of Independent Variables and Significance Levels

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. pwcorr gdpgrowth_r loggdp_r ipardandrcop_r_e vocationalhighscholls employmentrate_e road_per_area_e export_r_e electricity_per_p
> erson_e investment_incentives_r_e publicinvestment_r_e population_density, star(0.05) sig
```

	gdpgro~r	loggdp_r	iparda~e	vocati~s	employ~e	road_p~e	export~e	electr~e	invest~e	public~e	popula~y
gdpgrowth_r	1.0000										
loggdp_r	0.0126	1.0000									
	0.6953										
ipardandrc~e	0.0139	0.0269	1.0000								
	0.6652	0.4021									
vocational~s	0.1311*	-0.4347*	-0.1053*	1.0000							
	0.0000	0.0000	0.0010								
employment~e	0.0854*	0.0170	0.0817*	-0.1241*	1.0000						
	0.0077	0.5966	0.0109	0.0001							
road_per_a~e	0.0101	0.2055*	-0.1305*	-0.1224*	-0.0276	1.0000					
	0.7534	0.0000	0.0000	0.0001	0.3903						
export_r_e	-0.0058	0.3512*	0.0096	0.1606*	-0.0862*	0.0257	1.0000				
	0.8560	0.0000	0.7645	0.0000	0.0071	0.4234					
electricit~e	0.0015	0.6521*	-0.0689*	-0.1449*	-0.0021	0.2766*	0.0928*	1.0000			
	0.9632	0.0000	0.0316	0.0000	0.9485	0.0000	0.0038				
investment~e	0.0468	0.3431*	0.0794*	0.0793*	-0.0574	0.0231	0.4755*	0.2000*	1.0000		
	0.1448	0.0000	0.0133	0.0135	0.0738	0.4729	0.0000	0.0000			
publicinve~e	-0.0089	0.3549*	0.2080*	0.1192*	-0.0116	-0.0758*	0.8242*	0.0441	0.4766*	1.0000	
	0.7821	0.0000	0.0000	0.0002	0.7191	0.0180	0.0000	0.1697	0.0000		
population~y	-0.0040	0.3541*	-0.0129	0.1892*	-0.0754*	0.1117*	0.9687*	0.1433*	0.5009*	0.8108*	1.0000
	0.9014	0.0000	0.6871	0.0000	0.0187	0.0005	0.0000	0.0000	0.0000	0.0000	

*** p<0.01, ** p<0.05, * p<0.1.

APPENDIX 3: Testing Options in Stata

- In Stata, "test" command performs F or χ^2 tests of linear restrictions applied to the most recently fit model, which is (sdm_fe) in our case. "test" may be used after any estimation command, although for maximum likelihood techniques, "test" produces a Wald test that depends only on the estimate of the covariance matrix.
- The Wald test (also called the Wald Chi-Squared Test, χ^2) is a way to find out if explanatory variables in a model are significant. "Significant" means that they add something to the model; variables that add nothing can be deleted without affecting the model in any meaningful way. The test can be used for a multitude of different models including those with binary variables or continuous variables.
- The null hypothesis for the test is: some parameter = some value. For example, we are studying if some spatial interaction effects (dependable/explanatory/error) are affecting the provincial growth. The spatial interaction effect (i.e., $WY_t/W\mathrm{X}_t/W\mathrm{u}_t$) would be our parameter. The value could be zero (indicating that we don't think the chosen spatial interaction effect is affecting the provincial growth). If the null hypothesis is rejected, it suggests that the spatial model relevant to the chosen spatial interaction effect in question can be dismissed.
- The Wald test is a rough approximation of the Likelihood Ratio Test. However, you can run it with a single model (the LR test requires at least two). It is also more broadly applicable than the LR test: often, you can run a Wald in situations where no other test can be run. For large values of n, the Wald test is roughly equivalent to the t-test; both tests will reject the same values for large sample sizes. The Wald, LR test and Lagrange multiplier tests are all equivalent as sample sizes approach infinity (called "asymptotically equivalent"). However, samples of a finite size, especially smaller samples, are likely to give very different results.
- Agresti (1990) suggests that one should use the Wald test instead of the Likelihood Ratio Test for sample sizes that are above 30, which in our case is 972.

AIC (Akaike's Information Criteria) and BIC (Bayesian Information Criteria):

- AIC (Akaike's Information Criteria) and BIC (Bayesian Information Criteria) are widely used in model selection criteria. AIC can be termed as a measure of the goodness of fit of any estimated statistical model, while BIC is a type of model selection among a class of parametric models with different numbers of parameters. AIC will present the danger that the model would outfit, while BIC will present the danger that it would underfit.
- Both AIC and BIC are a way to find the balance between a good fit and over complexity in a model. If you were to start with few parameters and add more, your model will fit your sample data more accurately but also grow in complexity and risk overfitting. If you were to start with many parameters and systematically eliminate some, your model will grow in simplicity and thus avoid overfitting, but it will also explain your data less accurately and possibly risk under-fitting.
- To find this balance the criteria compare a set of statistical models to each other, and ***the model with the lowest measurement of AIC/BIC is the model that should be selected***, the best model will be the one that neither under fits nor overfits.

APPENDIX 4: Diagnostics Tests for Model Specification

Appendix_table_4.1: Breusch-Pagan Test for Panel (Random) Effects

Test: Var(u) = 0
chibar2(01) = 2033.75***
Prob > chibar2 = 0.0000

*** p<0.01, ** p<0.05, * p<0.1.

Appendix_table_4.2: Hausman's Specification Test

. hausman fixed random

	Coefficients			
	(b) fixed	**(B) random**	**(b-B) Difference**	**sqrt(diag(V_b-V_B)) S.E.**
loggdp_r	.1311399	.0354636	.0956763	.0117629
ipa_funds	-2.13e-10	3.47e-10	-5.60e-10	1.99e-10
education	.0077491	.0037755	.0039736	.0005985
emplymnrt	.0020291	.0008005	.0012286	.0004248
innovation	-5.68e-08	-2.77e-07	2.20e-07	3.62e-07
roadperarea	-.1001443	.0494589	-.1496032	.3810229
export_pc	1.32e-08	-6.14e-09	1.93e-08	9.81e-09
electric_pc	1.73e-06	-3.80e-06	5.53e-06	5.11e-06
gov_incentive	3.25e-06	2.26e-06	9.88e-07	8.08e-07
gov_investment	1.11e-08	-9.99e-10	1.21e-08	9.70e-09

b = consistent under H_o and H_a; obtained from xtreg
B = inconsistent under H_a, efficient under H_o; obtained from xtreg

Test: H_o: difference in coefficients not systematic
chi2(4) = (b-B)'[(V_b-V_B) ^ (-1)] (b-B)
= 109.73***
Prob>chi2 = 0.0000

*** p<0.01, ** p<0.05, * p<0.1.

Appendix_table_4.3: Wald Test for Groupwise Heteroskedasticity

. xttest3
Modified Wald test for groupwise heteroskedasticity in fixed effect regression model

H_0: sigma(i)^2 = sigma^2 for all i

chi2 (81) = 388.43***
Prob>chi2 = 0.0000

*** p<0.01, ** p<0.05, * p<0.1.

***Appendix_table_4.4*: Cross-Sectional Dependence (Pesaran's) Test**

. xtcsd, pesaran abs

Pesaran's test of cross-sectional independence = 91.892***, Pr = 0.0000

Average absolute value of the off-diagonal elements = 0.487

*** p<0.01, ** p<0.05, * p<0.1.

***Appendix_table_4.5:* Wooldridge (Wald-test) Test for Autocorrelation**

D.gdpgrth_r	Coef.	Robust Std. Err.	t	P>t	[95%Conf.	Interval]
loggdp_r						
D1.	0.777***	0.037	21.200	0.000	0.704	0.850
ipa_funds						
D1.	0.000	0.000	1.050	0.297	-0.000	0.000
education						
D1.	0.007***	0.001	4.950	0.000	0.004	0.010
emplymnrt						
D1.	0.001	0.001	1.540	0.128	-0.000	0.002
innovation						
D1.	-0.000	0.000	-0.460	0.645	-0.000	0.000
roadperarea						
D1.	0.060	0.629	0.100	0.924	-1.191	1.312
export_pc						
D1.	-0.000	0.000	-1.130	0.260	-0.000	0.000
electric_pc						
D1.	-0.000	0.000	-1.630	0.107	-0.000	0.000
gov_incentive						
D1.	0.000	0.000	1.550	0.124	-0.000	0.000
gov_investment						
D1.	0.000	0.000	1.510	0.135	-0.000	0.000

Wooldridge test for autocorrelation in panel data
H0: no first-order autocorrelation
F(1, 80) = 129.520***
Prob > F = 0.0000

*** p<0.01, ** p<0.05, * p<0.1.

***Appendix_table_4.6*: Moran's I Statistics Test for Spatial Diagnostics**

Diagnostic tests for spatial dependence in OLS regression

Fitted model

gdpgrowth_r = loggdp_r + ipa_funds + education + emplymnrt + innovation + roadperarea + export_pc + electric_pc + gov_incentive + gov_investment

Diagnostics

Test	Statistic	df	p-value
Spatial error:			
Moran's I	4.699***	1	0.000
Lagrange multiplier	3.843**	1	0.050
Robust Lagrange multiplier	1.836	1	0.175
Spatial lag:			
Lagrange multiplier	2.768*	1	0.096
Robust Lagrange multiplier	0.761	1	0.383

*** p<0.01, ** p<0.05, * p<0.1.

Appendix_table_4.7: **Spatial Durbin Model estimations (FE)**

SDM with spatial fixed-effects Number of obs = 972

gdpgrth_r	***Coeff.***	***Std.Err.***	***z***	***P>z***	***[95%Conf.***	***Interval]***
Main						
loggdp_r	0.32664***	0.0249095	13.11	0.000	0.277817	0.375460
ipa_funds	5.00e-10**	2.46e-10	2.03	0.042	1.75e-11	9.82e-10
education	-0.0009678	0.0008108	-1.19	0.233	-0.002557	0.000621
emplymnrt	0.00083***	0.0003139	2.63	0.009	0.000210	0.001441
innovation	2.10e-07	2.48e-07	0.85	0.395	-2.75e-07	6.96e-07
roadperarea	-0.1934823	0.2578141	-0.75	0.453	-0.698789	0.311824
export_pc	1.20e-08*	7.04e-09	1.70	0.089	-1.84e-09	2.57e-08
electric_pc	-6.50e-06*	3.82e-06	-1.70	0.089	-0.000014	9.96e-07
gov_incentive	9.88e-07	1.21e-06	0.82	0.413	-1.38e-06	3.35e-06
gov_investment	1.18e-08	9.34e-09	1.26	0.207	-6.53e-09	3.01e-08
Wx						
loggdp_r	-0.3038***	0.0276556	-10.99	0.000	-0.358003	-.2495954
ipa_funds	-1.05e-09**	4.11e-10	-2.56	0.011	-1.86e-09	-2.45e-10
education	0.00331***	0.0010666	3.09	0.002	0.001205	0.005386
emplymnrt	0.0012567*	0.0006492	1.94	0.053	-0.000016	0.002529
innovation	-4.92e-07	5.24e-07	-0.94	0.348	-1.52e-06	5.35e-07
roadperarea	0.8523584	0.553419	1.54	0.124	-0.232323	1.937040
export_pc	-1.68e-08	1.22e-08	-1.38	0.166	-4.07e-08	7.01e-09
electric_pc	0.000016**	6.88e-06	2.25	0.025	1.97e-06	0.000029
gov_incentive	4.03e-06	2.62e-06	1.54	0.123	-1.09e-06	9.16e-06
gov_investment	8.08e-09	1.75e-08	0.46	0.643	-2.61e-08	4.23e-08
Spatial						
rho	0.68399***	0.024073	28.41	0.000	0.636808	0.731172
Variance						
sigma2_e	0.00099***	0.0000468	21.36	0.000	0.000908	0.001091

*** p<0.01, ** p<0.05, * p<0.1.

APPENDIX 5: Testing for Spatial Panel Data Model Selection (top-down approach)

- In this study, we will employ "xsmle" in most of our statistical computations in Stata. "xsmle" is a Stata command for extensive spatial analysis. It's primarily designed to deal with balanced panel data in which *n* units are observed for exactly *T* periods.
- It employs the maximum likelihood (MLE) estimation of a wide set of both fixed and random effects spatial models for balanced panel data for a wide range of specifications: Spatial Autoregressive Model (SAR), Spatial Error Model (SEM), Spatial Durbin Model (SDM), Spatial Autoregressive Model with Autoregressive Disturbances (SAC), Generalized Spatial Random-effects Model (GSPRE).
- "xsmle" allows to handle unbalanced panels, to use spatial weight matrices in the form of both Stata matrices and spmat objects, to compute direct, indirect and total marginal effects and related standard errors for linear (in variables) specifications, and to exploit a wide range of postestimation features, extending to the panel data case.
- In the case of SDM, "xsmle" also allows users to specify a different set of spatially lagged explanatory variables through the "durbin(varlist)" option, where the default is to lag all independent variables in varlist.
- "xsmle" also allows dynamic specification in the estimation of SAR and SDM models like $y_t = \varphi y_{t-1} + \rho W_N y_t + \eta W_N y_{t-1} + x_t\beta + \boldsymbol{\mu} + \varepsilon_t$

  where the lagged (in time) dependent variable and/or the lagged (in both time and space) dependent variable can be included in the specification.
- "estimates store" stores the current (active) estimation results under the given name (sdm_fe).

Appendix_table_5.1: **Testing for SAR (Spatial Autoregressive Model)**

```
. test [Wx]loggdp_r = [Wx]ipa_funds = [Wx]education = [Wx]emplymnrt = [Wx]innovation =
[Wx]roadperarea = [Wx]export_pc = [Wx]electric_pc = [Wx]gov_incentive = [Wx]gov_investment = 0

( 1)  [Wx]loggdp_r - [Wx]ipa_funds     = 0
( 2)  [Wx]loggdp_r - [Wx]education     = 0
( 3)  [Wx]loggdp_r - [Wx]emplymnrt     = 0
( 4)  [Wx]loggdp_r - [Wx]innovation      = 0
( 5)  [Wx]loggdp_r - [Wx]roadperarea    = 0
( 6)  [Wx]loggdp_r - [Wx]export_pc      = 0
( 7)  [Wx]loggdp_r - [Wx]electric_pc     = 0
( 8)  [Wx]loggdp_r - [Wx]gov_incentive     = 0
( 9)  [Wx]loggdp_r - [Wx]gov_investment   = 0
(10)  [Wx]loggdp_r = 0

          chi2(6)       =  150.77***
        Prob > chi2  =  0.0000

*** p<0.01, ** p<0.05, * p<0.1.
```

Appendix_table_5.2: **Testing for SEM (Spatial Error Model)**

```
. testnl

 (1)  [Wx]loggdp_r          = -[Spatial]rho*[Main]loggdp_r
 (2)  [Wx]ipa_funds         = -[Spatial]rho*[Main]ipa_funds
 (3)  [Wx]education         = -[Spatial]rho*[Main]education
 (4)  [Wx]emplymnrt         = -[Spatial]rho*[Main]emplymnrt
 (5)  [Wx]innovation        = -[Spatial]rho*[Main]innovation
 (6)  [Wx]roadperarea       = -[Spatial]rho*[Main]roadperarea
 (7)  [Wx]export_pc         = -[Spatial]rho*[Main]export_pc
 (8)  [Wx]electric_pc       = -[Spatial]rho*[Main]electric_pc
 (9)  [Wx]gov_incentive     = -[Spatial]rho*[Main]gov_incentive
 (10) [Wx]gov_investment    = -[Spatial]rho*[Main]gov_investment

           chi2(10)  =      72.77***
         Prob > chi2 =       0.0000
```

*** p<0.01, ** p<0.05, * p<0.1.

Appendix_table_5.3: **SAC (Spatial Autoregressive Combined Model) vs SDM**

```
. estimates stats sac_fe sdm_fe

Akaike's (AIC) information criterion and Bayesian (BIC) information criterion
```

Model	N	ll(null)	ll(model)	df	AIC	BIC
sac_fe	972	.	1986.382	10	-3952.763	-3903.970
sdm_fe	972	.	1915.422	16	-3798.844	-3720.774

APPENDIX 6: Spatiotemporal Modelling: Space-time Dependency Types

Space–time dynamic models produce a situation where a change in the i^{th} observation of the k^{th} explanatory variable at time t will produce contemporaneous and future responses in all provinces' dependent variables $y_{it+T,}$ as well as other-province future responses y_{jt+T}. This is due to the presence of an individual time lag (capturing time dependence), a spatial lag (that accounts for spatial dependence) and a cross-product term reflecting the space–time diffusion. (Debarsy et al., 2012)

In spatiotemporal model literature, there are four common space-time dependency types, as follows:

Pure space recursive models, in which the dependence pertains only to neighbouring locations in a previous period:

$y_t = \eta W_N y_{t-1} + X_t\beta + \varepsilon_t$, "η" as the space-time autoregressive parameter. Note that this model can be readily extended with time and spatial lags of the explanatory variables, X_{t-1} or $W_N X_t$. However, since $W_N y_{t-1}$ already includes $W_N X_{t-1}$, adding a term of this form would create identification problems.

Time-space recursive models, in which the dependence relates to both the location itself as well as its neighbours in the previous period:

$y_t = \varphi y_{t-1} + \eta W_N y_{t-1} + X_t\beta + \varepsilon_t$, "φ" as the serial (time) autoregressive parameter. Spatially lagged contemporaneous explanatory variables ($W_N X_t$) may be included as well, but time lagged explanatory variables will result in identification problems.

Time-space simultaneous models, which include a time lag for the location itself together with a contemporaneous spatial lag:

$y_t = \varphi y_{t-1} + \rho W_N y_t + X_t\beta + \varepsilon_t$, "ρ" as the (contemporaneous) spatial autoregressive parameter. Inclusion of any spatially lagged X in the original specification will lead to identification problems.

Time-space dynamic models, where all three forms of lags for the dependent variable are included:

$y_t = \varphi y_{t-1} + \rho W_N y_t + \eta W_N y_{t-1} + X_t\beta + \varepsilon_t$. While this model is sometimes suggested as the "general space-time specification", it results in complex nonlinear constraints on the parameters, and, in practice, often suffers from identification problems.

The same types of space-time dependence processes can also be specified for the error terms in panel data models (e.g., Fazekas et al., 1994). However, combinations of both spatially lagged dependent variables and spatially lagged error terms may lead to identification problems unless the parameters of the explanatory variables are non-zero. (Anselin et al., 2008)

Spatiotemporal Model Options (dlag(1) and dlag(2) option results)

Appendix_table_6.1: **dlag(1) Spatiotemporal SDM FE (ind) i.e. ($y_t = \varphi y_{t-1} + \rho W_N y_t + x_t\beta + W_N X_{it}\gamma + \mu + \varepsilon_t$) Results**

. xsmle gdpgrth_r loggdp_r ipa_funds education emplymnrt innovation roadperarea export_pc electric_pc gov_incentive gov_investment, wmat(W) model(sdm) fe dlag(1) type(ind) nolog

Dynamic SDM with spatial fixed-effects — Number of obs = 891
Group variable : city — Number of groups = 81
Time variable : year — Panel length = 11
R-sq: within = 0.3869
between = 0.2033 — Mean of fixed-effects = -0.7026
overall = 0.0052 — Log-likelihood = 1775.0815

gdpgrth_r	Coef.	Std.Err.	z	P>z	[95%Conf.	Interval]
Main						
gdpgrth_r						
L1.	-0.1396112***	0.0224513	-6.22	0.000	-0.1836149	-0.0956075
loggdp_r	0.4017831***	0.0267898	15.00	0.000	0.3492761	0.4542901
ipa_funds	4.89e-10**	0.0000000	1.98	0.048	0.0000000	0.0000000
education	-0.0007491	0.0009192	-0.81	0.415	-0.0025506	0.0010524
emplymnrt	0.0007615**	0.0003311	2.30	0.021	0.0001127	0.0014104
innovation	0.0000003	0.0000002	1.24	0.216	-0.0000002	0.0000008
roadperarea	-0.2834641	0.2705815	-1.05	0.295	-0.8137940	0.2468659
export_pc	1.79e-08**	0.0000000	2.40	0.017	0.0000000	0.0000000
electric_pc	-0.0000032	0.0000039	-0.81	0.415	-0.0000109	0.0000045
gov_incentive	0.0000006	0.0000012	0.50	0.619	-0.0000018	0.0000030
gov_investment	0.0000000	0.0000000	0.85	0.396	-0.0000000	0.0000000
Wx						
loggdp_r	-0.3501411***	0.0298398	-11.73	0.000	-0.4086261	-0.2916562
ipa_funds	-1.17e-09***	0.0000000	-2.82	0.005	-0.0000000	-0.0000000
education	0.0045669***	0.0012563	3.64	0.000	0.0021046	0.0070292
emplymnrt	0.0017708***	0.0006897	2.57	0.010	0.0004191	0.0031225
innovation	-0.0000008	0.0000005	-1.57	0.117	-0.0000019	0.0000002
roadperarea	0.8100805	0.5763446	1.41	0.160	-0.3195342	1.9396950
export_pc	-2.35e-08*	0.0000000	-1.74	0.081	-0.0000000	0.0000000
electric_pc	0.0000195***	0.0000072	2.72	0.006	0.0000055	0.0000336
gov_incentive	0.0000030	0.0000026	1.15	0.248	-0.0000021	0.0000082
gov_investment	0.0000000	0.0000000	0.55	0.581	-0.0000000	0.0000000
Spatial						
rho	0.6676116***	0.0251642	26.53	0.000	0.6182906	0.7169327
Variance						
sigma2_e	0.0010455***	0.0000468	22.35	0.000	0.0009538	0.0011372

*** p<0.01, ** p<0.05, * p<0.1.

Appendix_table_6.2: **dlag(2) Spatiotemporal SDM FE (ind) i.e. ($y_t = \rho W_N y_t + \eta W_N y_{t-1} + x_t\beta + W_N X_{it}\gamma + \mu + \varepsilon_t$) Results**

. xsmle gdpgrth_r loggdp_r ipa_funds education emplymnrt innovation roadperarea export_pc electric_pc gov_incentive gov_investment, wmat(W) model(sdm) fe dlag(2) type(ind) nolog

Dynamic SDM with spatial fixed-effects — Number of obs = 891
Group variable : city — Number of groups = 81
Time variable : year — Panel length = 11
R-sq: within = 0.3652
between = 0.1961
overall = 0.0053
Mean of fixed-effects = -0.5825
Mean of fixed-effects = -0.7026
Log-likelihood = 1748.9882

gdpgrth_r	Coeff.	Std.Err.	z	P>z	[95%Conf.	Interval]
Main						
Wgdpgrth_r						
L1.	-0.0621432**	0.0297515	-2.09	0.037	-0.1204551	-0.0038312
loggdp_r	0.3678911***	0.0271284	13.56	0.000	0.3147205	0.4210618
ipa_funds	4.91e-10*	2.54e-10	1.93	0.053	-6.81e-12	9.89e-10
education	-0.0005286	0.0009472	-0.56	0.577	-0.0023851	0.0013279
emplymnrt	0.0006604*	0.0003407	1.94	0.053	-7.30e-06	0.0013281
innovation	2.50e-07	2.56e-07	0.97	0.330	-2.53e-07	7.53e-07
roadperarea	-0.2542215	0.2782580	-0.91	0.361	-0.7995972	0.2911543
export_pc	1.56e-08**	7.66e-09	2.04	0.042	5.82e-10	3.06e-08
electric_pc	-4.52e-06	4.02e-06	-1.12	0.261	-0.0000124	3.36e-06
gov_incentive	6.71e-07	1.24e-06	0.54	0.588	-1.76e-06	3.10e-06
gov_investment	8.58e-09	9.81e-09	0.88	0.382	-1.06e-08	2.78e-08
Wx						
loggdp_r	-0.327277***	0.0310998	-10.52	0.000	-0.3882320	-0.2663229
ipa_funds	-1.14e-09***	4.26e-10	-2.67	0.008	-1.97e-09	-3.03e-10
education	0.0038376***	0.0012859	2.98	0.003	0.0013173	0.0063580
emplymnrt	0.0014927**	0.0007153	2.09	0.037	0.0000907	0.0028947
innovation	-7.11e-07	5.47e-07	-1.30	0.194	-1.78e-06	3.62e-07
roadperarea	0.8524517	0.594865	1.43	0.152	-0.3134622	2.0183660
export_pc	-2.48e-08*	1.39e-08	-1.79	0.074	-5.20e-08	2.37e-09
electric_pc	0.0000188**	7.46e-06	2.52	0.012	4.17e-06	0.0000334
gov_incentive	4.02e-06	2.70e-06	1.49	0.137	-1.28e-06	9.31e-06
gov_investment	1.02e-08	1.81e-08	0.56	0.574	-2.54e-08	4.58e-08
Spatial						
rho	0.6757751***	0.0258587	26.13	0.000	0.6250930	0.7264573
Variance						
sigma2_e	0.0011072***	0.0000497	22.30	0.000	0.0010099	0.0012046

*** p<0.01, ** p<0.05, * p<0.1.

APPENDIX 7: Tests for Spatially-lagged Explanatory Variables

Appendix_table_7.1: Likelihood Ratio (LR) Test

. lrtest no_sp_lg_vars two_sp_lg_vars			
Likelihood-ratio test	LR chi2(2)	=	6.01**
(Assumption: no_sp_lg_vars nested in two_sp_lg_vars)	Prob > chi2	=	0.0494
. lrtest no_sp_lg_vars six_sp_lg_vars			
Likelihood-ratio test	LR chi2(8)	=	28.09***
(Assumption: no_sp_lg_vars nested in six_sp_lg_vars)	Prob > chi2	=	0.0005
. lrtest no_sp_lg_vars ten_sp_lg_vars			
Likelihood-ratio test	LR chi2(12)	=	39.50***
(Assumption: no_sp_lg_vars nested in ten_sp_lg_vars)	Prob > chi2	=	0.0001
. lrtest two_sp_lg_vars six_sp_lg_vars			
Likelihood-ratio test	LR chi2(6)	=	22.07***
(Assumption: two_sp_lg_vars nested in six_sp_lg_vars)	Prob > chi2	=	0.0012
. lrtest two_sp_lg_vars ten_sp_lg_vars			
Likelihood-ratio test	LR chi2(10)	=	33.48***
(Assumption: two_sp_lg_vars nested in ten_sp_lg_vars)	Prob > chi2	=	0.0002
. lrtest six_sp_lg_vars ten_sp_lg_vars			
Likelihood-ratio test	LR chi2(4)	=	11.41**
(Assumption: six_sp_lg_vars nested in ten_sp_lg_vars)	Prob > chi2	=	0.0223

*** p<0.01, ** p<0.05, * p<0.1.

Appendix_table_7.2: **Table of Fit Statistics (Bayesian (BIC) information criterion)**

. estimates stats no_sp_lg_vars two_sp_lg_vars six_sp_lg_vars ten_sp_lg_vars, n(972) bicdetail

Model	N	Type	ll(model)	df	BIC
no_sp_lg_v~s	972	user-specified	1788.239	18	-3452.649
two_sp_lg_~s	972	user-specified	1791.246	20	-3444.905
six_sp_lg_~s	972	user-specified	1802.282	26	-3425.700
ten_sp_lg_~s	972	user-specified	1807.987	30	-3409.594

Appendix_table_7.3: **R-square Statistics of the Models**

no_sp_lg_vars	two_sp_lg_vars	six_sp_lg_vars	ten_sp_lg_vars
R-sq: within = 0.3910	R-sq: within = 0.4030	R-sq: within = 0.4460	R-sq: within = 0.4617
between = 0.2005	between = 0.0156	between = 0.0205	between = 0.0110
overall = 0.004855	overall = 0.000872	overall = 0.000827	overall = 0.001590

APPENDIX 8: Logarithmic Transformation of Dependent and Explanatory Variables

The logarithmic transformation is one of the most commonly used in the econometric literature and Spanos (1986) lists three major reasons for its popularity. First of all, many random variables

characterized by a positive skew (like a gamma, a log-normal or a chi-square) are reduced to normality through this transformation. Secondly, the logarithmic transformation produces a stabilizing effect on the variance that helps in solving certain problems of heteroskedasticity. Finally, it has an intuitive appeal in that it quantifies concepts like elasticities and growth rates. (Arbia, 2006)

For strictly positive variables, we often use the natural log transformation, ln(y), and use a linear model in line with the above-mentioned reasons. The following financial-based explanatory variables in our model are large integer numbers in (TL):

- Augmented IPA (EU) funds imbursements to related provinces
- R&D Expenditures
- Exports
- Governmental Incentives
- Governmental Investments

Other non-financial explanatory variables could have negative values, however using Inverse Hyperbolic Sine Function (IHS) transformation we are able to log-transform non-financial variables, as well. IHS Transformation behaves similar to a log, and allows retaining zero-valued observations. In cases where it is useful, it even allows retaining negative-valued observations; in Bellemare et al. (2013). The IHS transformation (arsinh (x)) can be denoted as: IHS(x) = ln[x + √(x2 + 1)]. In Stata, we get IHS(x) by the command "gen IHS_x = ln(x + ((x^2 +1)^0.5))".

The followings are non-financial dependent and explanatory variables in our model:

- Provincial GDP growth rate per capita (dependent variable)
- Natural log of level of provincial GDP pc at beginning of each year
- Tertiary Education (students per vocational school teacher, #)
- Employment Statistics (percentage, %)
- Stabilized roads per area, (km/km2)
- Energy consumption (kWh per capita)

We have the options to use logarithmic transformation restricted to the 5 financial-based explanatory variables or to apply logarithmic transformation to all variables in our model. In order to conclude with the best option empirically, we implemented the first option (i.e., log-transformed with 5 variables) and then implemented the logarithmic transformation to all variables. We have utilised IHS transformation for both options. Afterwards, we compare the both options results.

In order to decide the best option statistically and comparisons, we have run regressions for:

- original non-log transformed model
- model with log-transformed 5 financial-based explanatory variables

- model with log-transformed all dependent and explanatory variables

As known, there are options for the logarithmic basis. The most common two options are; natural logarithm (i.e., ln) and 10_based logarithm. We try both types of logarithmic base options.

Appendix_table_8.1: **R-square Statistics of the Models**

Original model	5 vars log-transformed	All vars log-transformed
	Log. Transformation with natural base (ln_e)	
R-sq: within = 0.4254	R-sq: within = 0.4830	R-sq: within = 0.4822
between = 0.0239	between = 0.0235	between = 0.0754
overall = 0.0010	overall = 0.0025	overall = 0.0058
	Log. Transformation with 10_base (log_{10})	
	R-sq: within = 0.4821	R-sq: within = 0.4836
	between = 0.0292	between = 0.1237
	overall = 0.0053	overall = 0.0159

Appendix_table_8.2: **Log-likelihood Statistics of the Models**

Original model	5 vars log-transformed	All vars log-transformed
1792.7684	1810.6391 (ln)	1812.5769 (ln)
	2543.6390 (log_{10})	2545.4483 (log_{10})

With the log-transformation of the variables:

- We have seen a considerable improvement in R^2 values in the model.
- Some explanatory variables lose their significance (IPA funds and export), while some explanatory variables gain significance (electric consumption and governmental incentives) in line with the theoretical perspectives.

APPENDIX 9: Direct and Indirect Effects of Independent Variables

The model gives us the option to obtain direct and indirect effect in the short-run and long-run:

Short run (assuming $\tau = \psi = 0$,):

$$\left[\frac{\partial y}{\partial x_{1k}} \quad \cdots \quad \frac{\partial y}{\partial x_{nk}} \right]_t = (I_n - \rho W)^{-1} [\beta_k I_n + \gamma_k W] .$$

Long run (assuming $y_t = y_{t-1} = y^*$):

$$\left[\frac{\partial y}{\partial x_{1k}} \quad \cdots \quad \frac{\partial y}{\partial x_{nk}} \right]_t = [(1 - \tau) I_n - (\rho + \psi) W]^{-1} [\beta_k I_n + \gamma_k W] .$$

- the direct effect is the average of the diagonal elements of the matrices on the right-hand side
- the indirect effect is the average of either the row sums or the column sums of the non-diagonal elements of these matrices. (Values for the indirect effect depend on the magnitude of the Υ_k)

Also, there is,

- no spatial spillovers or indirect effects in the case of linear regression relationships where $\rho = 0$ and observations are independent
- no indirect short-term effect if $\rho = \Upsilon_k = 0$ and
- no indirect long-term effect if $\rho = -\psi$ and if $\Upsilon_k = 0$.

Different ranges for the spatial spillovers can be incorporated by applying the spatial lag operator (pre-multiplication by the spatial weight matrix W) to the y, X or ε terms in a regression specification. However, it is important to note that (Anselin, 2002):

- global forms of spillover are induced in models that include Wy,
- local forms of spillover are obtained from spatial lags for the explanatory variables (WX) and particular error covariances, such as those induced by a spatial moving average model and a spatial error components model.

APPENDIX 10: Estimation Results for the Final Model

The dependent variable y represents an N(81) by 1 vector of observed per capita income growth rates and the N(81) by k(10) matrix X contains k(10) explanatory variables excluding the intercept

vector, denoted by $\boldsymbol{\mu}$ and the matrix WX represents a linear combination of spatially lagged-explanatory variables:

$$y_t = \varphi y_{t-1} + \rho W_N y_t + \eta W_N y_{t-1} + x_t\beta + W_N X_{it}\gamma + \boldsymbol{\mu} + \varepsilon_t,$$

Appendix_table_10: **Main Estimation Result for Final Model (Unabridged Regression Result)**

. xsmle gdpgrth_r loggdp_r ipa_funds education emplymnrt innovation roadperarea export_pc electric_pc gov_incentive gov_investment w1x_loggdp_r w1x_ipa_funds w1x_education w1x_emplymnrt w1x_innovation w1x_roadperarea w1x_export_pc w1x_electric_pc w1x_gov_incentive w1x_gov_investment , durbin (loggdp_r ipa_funds education emplymnrt innovation roadperarea export_pc electric_pc gov_incentive gov_investment) wmat(W) model(sdm) dlag(3) fe type(ind) effects nsim(972) dec(5)

Dynamic SDM with spatial fixed-effects	Number of obs	=	891
Group variable: city	Number of groups	=	81
Time variable: year	Panel length	=	11

R-sq: within = 0.4822
between = 0.0754
overall = 0.0058
Mean of fixed-effects = -1.1177
Log-likelihood = 1812.5769

gdpgrth_r	Coef.	Std.Err.	z	P>z	[95%Conf.	Interval]
Main						
gdpgrth_r L1.	-0.2207***	0.03092	-7.14	0.000	-0.28127	-0.16007
Wgdpgrth_r L1.	0.1347***	0.03973	3.39	0.001	0.05686	0.21261
loggdp_r	0.4006***	0.02650	15.11	0.000	0.34860	0.45249
ipa_funds	-0.00008	0.00027	-0.29	0.769	-0.00062	0.00046
education	-0.00817	0.01436	-0.57	0.569	-0.03631	0.01997
emplymnrt	0.02831**	0.01148	2.47	0.014	0.00581	0.05081
innovation	0.0065***	0.00099	6.60	0.000	0.00459	0.00846
roadperarea	-0.30216	0.26058	-1.16	0.246	-0.81289	0.20858
export_pc	-0.00117	0.00229	-0.51	0.608	-0.00566	0.00331
electric_pc	-0.00401*	0.00234	-1.71	0.087	-0.00859	0.00058
gov_incentive	0.00214*	0.00116	1.85	0.064	-0.00013	0.00441
gov_investment	0.00059	0.00356	0.17	0.869	-0.00640	0.00757
w1x_loggdp_r	-0.00074	0.00939	-0.08	0.937	-0.01915	0.01767
w1x_ipa_funds	0.00022	0.00031	0.71	0.479	-0.00039	0.00084
w1x_education	-0.00188	0.00889	-0.21	0.833	-0.01931	0.01555
w1x_emplymnrt	0.01669	0.01726	0.97	0.334	-0.01714	0.05051
w1x_innovation	0.00021	0.00117	0.18	0.856	-0.00208	0.00251
w1x_roadperarea	-0.53839	0.38296	-1.41	0.160	-1.28896	0.21219
w1x_export_pc	0.00236	0.00291	0.81	0.417	-0.00334	0.00806
w1x_electric_pc	0.00177	0.00645	0.27	0.784	-0.01088	0.01442
w1x_gov_incentive	0.00103	0.00159	0.64	0.520	-0.00210	0.00415
w1x_gov_investment	-0.00967**	0.00489	-1.98	0.048	-0.01925	-0.00010
Wx						
loggdp_r	-0.3454***	0.05424	-6.37	0.000	-0.45166	-0.23903
ipa_funds	-0.00052	0.00158	-0.33	0.740	-0.00362	0.00257

education	0.07524*	0.04453	1.69	0.091	-0.01203	0.16251
emplymnrt	-0.03900	0.08019	-0.49	0.627	-0.19618	0.11818
innovation	-0.00206	0.00557	-0.37	0.711	-0.01299	0.00886
roadperarea	2.96273*	1.73003	1.71	0.087	-0.42806	6.35353
export_pc	-0.00443	0.01298	-0.34	0.733	-0.02988	0.02101
electric_pc	0.00214	0.03034	0.07	0.944	-0.05733	0.06161
gov_incentive	-0.00340	0.00807	-0.42	0.674	-0.01921	0.01242
gov_investment	0.04454*	0.02407	1.85	0.064	-0.00265	0.09172
Spatial						
rho	0.6562***	0.02695	24.35	0.000	0.60339	0.70902
Variance						
sigma2_e	0.001***	0.00004	22.33	0.000	0.00088	0.00105
SR_Direct						
loggdp_r	0.3848***	0.02722	14.14	0.000	0.33147	0.43817
ipa_funds	-0.00023	0.00046	-0.50	0.619	-0.00114	0.00068
education	0.00783	0.01659	0.47	0.637	-0.02468	0.04034
emplymnrt	0.02380	0.02102	1.13	0.258	-0.01740	0.06500
innovation	0.0069***	0.00147	4.68	0.000	0.00401	0.00979
roadperarea	0.31881	0.47855	0.67	0.505	-0.61913	1.25676
export_pc	-0.00208	0.00371	-0.56	0.575	-0.00935	0.00519
electric_pc	-0.00402	0.00722	-0.56	0.578	-0.01817	0.01013
gov_incentive	0.00167	0.00223	0.75	0.454	-0.00270	0.00603
gov_investment	0.01069	0.00677	1.58	0.114	-0.00257	0.02396
w1x_loggdp_r	-0.00142	0.01049	-0.14	0.892	-0.02198	0.01914
w1x_ipa_funds	0.00027	0.00036	0.74	0.460	-0.00045	0.00098
w1x_education	-0.00274	0.00986	-0.28	0.781	-0.02206	0.01658
w1x_emplymnrt	0.01994	0.02016	0.99	0.322	-0.01956	0.05945
w1x_innovation	0.00037	0.00134	0.28	0.780	-0.00224	0.00299
w1x_roadperarea	-0.63356	0.44812	-1.41	0.157	-1.51185	0.24474
w1x_export_pc	0.00272	0.00342	0.79	0.428	-0.00400	0.00943
w1x_electric_pc	0.00222	0.00762	0.29	0.770	-0.01271	0.01716
w1x_gov_incentive	0.00109	0.00185	0.59	0.556	-0.00253	0.00471
w1x_gov_investment	-0.01105**	0.00531	-2.08	0.037	-0.02145	-0.00065
SR_Indirect						
loggdp_r	-0.21912*	0.13068	-1.68	0.094	-0.47525	0.03701
ipa_funds	-0.00180	0.00432	-0.42	0.677	-0.01027	0.00667
education	0.19184*	0.11541	1.66	0.096	-0.03436	0.41804
emplymnrt	-0.06168	0.21844	-0.28	0.778	-0.48982	0.36646
innovation	0.00476	0.01455	0.33	0.744	-0.02375	0.03327
roadperarea	7.65168	4.74481	1.61	0.107	-1.64797	16.95133
export_pc	-0.01324	0.03568	-0.37	0.710	-0.08317	0.05668
electric_pc	-0.00070	0.08385	-0.01	0.993	-0.16504	0.16364
gov_incentive	-0.00500	0.02255	-0.22	0.825	-0.04920	0.03920
gov_investment	0.12058*	0.06489	1.86	0.063	-0.00660	0.24775
w1x_loggdp_r	-0.00217	0.01641	-0.13	0.895	-0.03433	0.02998
w1x_ipa_funds	0.00042	0.00057	0.73	0.464	-0.00070	0.00154
w1x_education	-0.00430	0.01539	-0.28	0.780	-0.03446	0.02587
w1x_emplymnrt	0.03084	0.03160	0.98	0.329	-0.03109	0.09277
w1x_innovation	0.00057	0.00209	0.27	0.785	-0.00353	0.00468
w1x_roadperarea	-0.98126	0.69963	-1.40	0.161	-2.35252	0.38999
w1x_export_pc	0.00419	0.00537	0.78	0.435	-0.00633	0.01471
w1x_electric_pc	0.00348	0.01199	0.29	0.772	-0.02003	0.02698
w1x_gov_incentive	0.00170	0.00291	0.59	0.558	-0.00399	0.00740
w1x_gov_investment	-0.01718**	0.00876	-1.96	0.050	-0.03435	-0.00002

SR_Total						
loggdp_r	0.16570	0.14230	1.16	0.244	-0.11321	0.44460
ipa_funds	-0.00203	0.00471	-0.43	0.666	-0.01127	0.00720
education	0.19968	0.12519	1.60	0.111	-0.04569	0.44504
emplymnrt	-0.03788	0.23642	-0.16	0.873	-0.50125	0.42549
innovation	0.01166	0.01564	0.75	0.456	-0.01900	0.04232
roadperarea	7.97049	5.15796	1.55	0.122	-2.13893	18.07992
export_pc	-0.01532	0.03870	-0.40	0.691	-0.09118	0.06053
electric_pc	-0.00472	0.09071	-0.05	0.959	-0.18250	0.17306
gov_incentive	-0.00333	0.02450	-0.14	0.892	-0.05135	0.04469
gov_investment	0.13127*	0.07063	1.86	0.063	-0.00716	0.26970
w1x_loggdp_r	-0.00359	0.02686	-0.13	0.894	-0.05624	0.04905
w1x_ipa_funds	0.00069	0.00094	0.74	0.462	-0.00115	0.00252
w1x_education	-0.00704	0.02522	-0.28	0.780	-0.05646	0.04239
w1x_emplymnrt	0.05078	0.05163	0.98	0.325	-0.05042	0.15198
w1x_innovation	0.00094	0.00342	0.28	0.783	-0.00577	0.00766
w1x_roadperarea	-1.61482	1.14356	-1.41	0.158	-3.85617	0.62652
w1x_export_pc	0.00690	0.00878	0.79	0.432	-0.01030	0.02410
w1x_electric_pc	0.00570	0.01958	0.29	0.771	-0.03268	0.04408
w1x_gov_incentive	0.00279	0.00475	0.59	0.556	-0.00651	0.01209
w1x_gov_investment	-0.02823**	0.01397	-2.02	0.043	-0.05561	-0.00086
LR_Direct						
loggdp_r	0.3150***	0.02218	14.20	0.000	0.27154	0.35849
ipa_funds	-0.00019	0.00037	-0.50	0.619	-0.00092	0.00055
education	0.00610	0.01347	0.45	0.651	-0.02030	0.03250
emplymnrt	0.01957	0.01688	1.16	0.246	-0.01351	0.05265
innovation	0.0056***	0.00119	4.75	0.000	0.00331	0.00796
roadperarea	0.24809	0.38367	0.65	0.518	-0.50390	1.00008
export_pc	-0.00168	0.00299	-0.56	0.574	-0.00753	0.00417
electric_pc	-0.00328	0.00576	-0.57	0.569	-0.01457	0.00801
gov_incentive	0.00137	0.00179	0.77	0.443	-0.00213	0.00488
gov_investment	0.00854	0.00541	1.58	0.114	-0.00206	0.01914
w1x_loggdp_r	-0.00116	0.00855	-0.14	0.892	-0.01791	0.01560
w1x_ipa_funds	0.00022	0.00030	0.74	0.460	-0.00036	0.00080
w1x_education	-0.00223	0.00803	-0.28	0.781	-0.01798	0.01351
w1x_emplymnrt	0.01626	0.01643	0.99	0.322	-0.01594	0.04846
w1x_innovation	0.00030	0.00109	0.28	0.780	-0.00183	0.00244
w1x_roadperarea	-0.51644	0.36537	-1.41	0.158	-1.23255	0.19968
w1x_export_pc	0.00221	0.00279	0.79	0.428	-0.00326	0.00769
w1x_electric_pc	0.00181	0.00621	0.29	0.770	-0.01036	0.01399
w1x_gov_incentive	0.00089	0.00151	0.59	0.556	-0.00206	0.00384
w1x_gov_investment	-0.0090**	0.00432	-2.08	0.037	-0.01747	-0.00053
LR_Indirect						
loggdp_r	-0.18251*	0.10417	-1.75	0.080	-0.38669	0.02166
ipa_funds	-0.00143	0.00344	-0.42	0.677	-0.00818	0.00531
education	0.15346*	0.09201	1.67	0.095	-0.02687	0.33380
emplymnrt	-0.04971	0.17426	-0.29	0.775	-0.39126	0.29184
innovation	0.00369	0.01160	0.32	0.750	-0.01904	0.02642
roadperarea	6.11485	3.77843	1.62	0.106	-1.29074	13.52043
export_pc	-0.01057	0.02845	-0.37	0.710	-0.06633	0.04519
electric_pc	-0.00042	0.06678	-0.01	0.995	-0.13131	0.13046
gov_incentive	-0.00402	0.01798	-0.22	0.823	-0.03925	0.03122
gov_investment	0.09619*	0.05122	1.88	0.060	-0.00420	0.19658
w1x_loggdp_r	-0.00172	0.01288	-0.13	0.894	-0.02697	0.02354
w1x_ipa_funds	0.00033	0.00045	0.73	0.463	-0.00055	0.00121

w1x_education	-0.00338	0.01209	-0.28	0.780	-0.02708	0.02033
w1x_emplymnrt	0.02431	0.02479	0.98	0.327	-0.02428	0.07289
w1x_innovation	0.00045	0.00164	0.27	0.784	-0.00277	0.00367
w1x_roadperarea	-0.77312	0.54887	-1.41	0.159	-1.84889	0.30265
w1x_export_pc	0.00330	0.00421	0.78	0.433	-0.00495	0.01156
w1x_electric_pc	0.00273	0.00940	0.29	0.771	-0.01569	0.02116
w1x_gov_incentive	0.00134	0.00228	0.59	0.557	-0.00313	0.00580
w1x_gov_investment	-0.01353**	0.00677	-2.00	0.046	-0.02679	-0.00026
LR_Total						
loggdp_r	0.13251	0.11341	1.17	0.243	-0.08978	0.35479
ipa_funds	-0.00162	0.00375	-0.43	0.666	-0.00897	0.00574
education	0.15956	0.09982	1.60	0.110	-0.03608	.3552
emplymnrt	-0.03014	0.18859	-0.16	0.873	-0.39976	0.33948
innovation	0.00933	0.01247	0.75	0.455	-0.01512	0.03377
roadperarea	6.36294	4.10714	1.55	0.121	-1.68691	14.41279
export_pc	-0.01225	0.03086	-0.40	0.690	-0.07274	0.04824
electric_pc	-0.00371	0.07224	-0.05	0.959	-0.14529	0.13788
gov_incentive	-0.00264	0.01953	-0.14	0.892	-0.04093	0.03564
gov_investment	0.10473*	0.05576	1.88	0.060	-0.00456	0.21402
w1x_loggdp_r	-0.00287	0.02141	-0.13	0.893	-0.04485	0.03910
w1x_ipa_funds	0.00055	0.00075	0.74	0.461	-0.00091	0.00201
w1x_education	-0.00561	0.02011	-0.28	0.780	-0.04503	0.03381
w1x_emplymnrt	0.04056	0.04115	0.99	0.324	-0.04010	0.12123
w1x_innovation	0.00076	0.00273	0.28	0.782	-0.00459	0.00611
w1x_roadperarea	-1.28956	0.91202	-1.41	0.157	-3.07709	0.49798
w1x_export_pc	0.00552	0.00699	0.79	0.430	-0.00819	0.01922
w1x_electric_pc	0.00454	0.01560	0.29	0.771	-0.02602	0.03511
w1x_gov_incentive	0.00223	0.00378	0.59	0.556	-0.00518	0.00963
w1x_gov_investment	-0.02253**	0.01104	-2.04	0.041	-0.04416	-0.00090

(*** p<0.01, ** p<0.05, * p<0.1)

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