Hacettepe University Graduate School of Social Sciences

Department of Economics

THE ROLE OF AGGLOMERATION ECONOMIES AND SPATIAL SPILLOVERS ON PROVINCIAL EXPORT PERFORMANCE OF TURKEY

Tayyar DOĞAN

Ph.D. Dissertation

Ankara, 2022

THE ROLE OF AGGLOMERATION ECONOMIES AND SPATIAL SPILLOVERS ON PROVINCIAL EXPORT PERFORMANCE OF TURKEY

Tayyar DOĞAN

Hacettepe University Graduate School of Social Sciences

Department of Economics

Ph.D. Dissertation

Ankara, 2022

ACCEPTANCE AND APPROVAL

The jury finds that Tayyar Doğan has on the date of 09/06/2022 successfully passed the defense examination and approves his Ph.D. Dissertation titled “The Role of Agglomeration Economies and Spatial Spillovers on Provincial Export Performance of Turkey”.

Assoc. Prof. Dr. Itır İMER (Jury President)

Prof. Dr. Lütfi ERDEN (Main Adviser)

Assoc. Prof. Dr. Selcen ÖZTÜRK

Assoc. Prof. Dr. Halis KIRAL

Assoc. Prof. Dr. Fatih Hakan DİKMEN

I agree that the signatures above belong to the faculty members listed.

Prof. Dr. Uğur ÖMÜRGÖNÜLŞEN

Graduate School Director

YAYIMLAMA VE FİKRİ MÜLKİYET HAKLARI BEYANI

Enstitü tarafından onaylanan lisansüstü tezimin/raporumun tamamını veya herhangi bir kısmını, basılı (kağıt) ve elektronik formatta arşivleme ve aşağıda verilen koşullarla kullanıma açma iznini Hacettepe Üniversitesine verdiğimi bildiririm. Bu izinle Üniversiteye verilen kullanım hakları dışındaki tüm fikri mülkiyet haklarım bende kalacak, tezimin tamamının ya da bir bölümünün gelecekteki çalışmalarda (makale, kitap, lisans ve patent vb.) kullanım hakları bana ait olacaktır.

Tezin kendi orijinal çalışmam olduğunu, başkalarının haklarını ihlal etmediğimi ve tezimin tek yetkili sahibi olduğumu beyan ve taahhüt ederim. Tezimde yer alan telif hakkı bulunan ve sahiplerinden yazılı izin alınarak kullanılması zorunlu metinlerin yazılı izin alınarak kullandığımı ve istenildiğinde suretlerini Üniversiteye teslim etmeyi taahhüt ederim.

Yükseköğretim Kurulu tarafından yayınlanan ***"Lisansüstü Tezlerin Elektronik Ortamda Toplanması, Düzenlenmesi ve Erişime Açılmasına İlişkin Yönerge"*** kapsamında tezim aşağıda belirtilen koşullar haricince YÖK Ulusal Tez Merkezi / H.Ü. Kütüphaneleri Açık Erişim Sisteminde erişime açılır.

- o Enstitü / Fakülte yönetim kurulu kararı ile tezimin erişime açılması mezuniyet tarihimden itibaren 2 yıl ertelenmiştir. (1)
- o Enstitü / Fakülte yönetim kurulunun gerekçeli kararı ile tezimin erişime açılması mezuniyet tarihimden itibaren ... ay ertelenmiştir. (2)
- o Tezimle ilgili gizlilik kararı verilmiştir. (3)

09/06/2022

Tayyar DOĞAN

"Lisansüstü Tezlerin Elektronik Ortamda Toplanması, Düzenlenmesi ve Erişime Açılmasına İlişkin Yönerge"

(1) *Madde 6. 1. Lisansüstü tezle ilgili patent başvurusu yapılması veya patent alma sürecinin devam etmesi durumunda, tez* ***danışmanının*** *önerisi ve* ***enstitü anabilim dalının*** *uygun görüşü üzerine* **enstitü** *veya* **fakülte yönetim kurulu** *iki yıl süre ile tezin erişime açılmasının ertelenmesine karar verebilir.*

(2) *Madde 6. 2. Yeni teknik, materyal ve metotların kullanıldığı, henüz makaleye dönüşmemiş veya patent gibi yöntemlerle korunmamış ve internetten paylaşılması durumunda 3. şahıslara veya kurumlara haksız kazanç imkanı oluşturabilecek bilgi ve bulguları içeren tezler hakkında tez* ***danışmanının*** *önerisi ve* ***enstitü anabilim dalının*** *uygun görüşü üzerine* **enstitü** *veya* **fakülte yönetim kurulunun** *gerekçeli kararı ile altı ayı aşmamak üzere tezin erişime açılması engellenebilir.*

(3) *Madde 7. 1. Ulusal çıkarları veya güvenliği ilgilendiren, emniyet, istihbarat, savunma ve güvenlik, sağlık vb. konulara ilişkin lisansüstü tezlerle ilgili gizlilik kararı,* ***tezin yapıldığı kurum*** *tarafından verilir *. Kurum ve kuruluşlarla yapılan işbirliği protokolü çerçevesinde hazırlanan lisansüstü tezlere ilişkin gizlilik kararı ise,* **ilgili kurum ve kuruluşun önerisi** *ile* **enstitü** *veya* **fakültenin** *uygun görüşü üzerine* **üniversite yönetim kurulu** *tarafından verilir. Gizlilik kararı verilen tezler Yükseköğretim Kuruluna bildirilir.*
Madde 7.2. Gizlilik kararı verilen tezler gizlilik süresince enstitü veya fakülte tarafından gizlilik kuralları çerçevesinde muhafaza edilir, gizlilik kararının kaldırılması halinde Tez Otomasyon Sistemine yüklenir

**** Tez danışmanının** önerisi ve **enstitü anabilim dalının** uygun görüşü üzerine **enstitü** veya **fakülte yönetim kurulu tarafından karar verilir.***

ETİK BEYAN

Bu çalışmadaki bütün bilgi ve belgeleri akademik kurallar çerçevesinde elde ettiğimi, görsel, işitsel ve yazılı tüm bilgi ve sonuçları bilimsel ahlak kurallarına uygun olarak sunduğumu, kullandığım verilerde herhangi bir tahrifat yapmadığımı, yararlandığım kaynaklara bilimsel normlara uygun olarak atıfta bulunduğumu, tezimin kaynak gösterilen durumlar dışında özgün olduğunu, **Prof. Dr. Lütfi ERDEN** danışmanlığında tarafımdan üretildiğini ve Hacettepe Üniversitesi Sosyal Bilimler Enstitüsü Tez Yazım Yönergesine göre yazıldığını beyan ederim.

Tayyar DOĞAN

ACKNOWLEDGEMENTS

I would like to express my deepest gratitude to my supervisor Prof. Dr. Lütfi Erden who made this work possible. His constant enthusiasm and patience helped me throughout the process, and the direction he provided both on the method and interpretation of findings guided me to deepen the research which, otherwise, could not be where it is now.

I would like to thank the members of my Thesis Committee, Assoc. Prof. Dr. Selcen Öztürk, Assoc. Prof. Dr. Halis Kıral, Assoc. Prof. Dr. Itır İmer, and Assoc. Prof. Dr. Fatih Hakan Dikmen for their invaluable comments.

I would like to thank Dr. Murat Körs and Volkan İdris Sarı for their comments and suggestions.

I would like to thank my family for their encouragement and support.

Finally, I would like to thank my wife, Eda, for her understanding and support, and also for her detailed reviews and valuable feedback.

ABSTRACT

DOĞAN, Tayyar. *The Role of Agglomeration Economies and Spatial Spillovers on Provincial Export Performance of Turkey,* Ph.D. Dissertation, Ankara, 2022.

Global trade had a substantial surge in the first two decades of the 21st century. This increase is led by large urban centers and their hinterlands, and thus agglomeration economies and spatial spillovers become central to the sub-national geographic dimension of the increased global trade. The share of international trade in Turkish GDP has also been growing substantially since the early 2000s. This increase, however, has been highly heterogeneous across provinces. Using a spatial finite mixture model, this dissertation examines this spatial heterogeneity by estimating the determinants of the provincial export performance focusing on spatial spillovers, urbanization and localization economies.

The results indicate that both agglomeration economies and spatial spillovers are significantly associated with the provincial export performance under the assumption of homogenous subpopulations. These associations are, however, different across provinces. Low-performing provinces have negative spatial spillovers from their neighbors and benefit from urbanization economies, while high-performing provinces have positive spatial spillovers and benefit from localization economies. These findings indicate that low-performing provinces are negatively affected by the expansion in the exports of neighboring provinces but benefit from the expansion and diversity in their local economies. High-performing provinces, in contrast, benefit from the increased exports in their neighborhoods and from increased concentration of the manufacturing activities in their local economy.

Key words: agglomeration, exports, finite mixture, localization, spatial econometrics, spatial spillovers, urbanization

ÖZET

DOĞAN, Tayyar. *Türkiye'nin İl İhracat Performansında Yığılma Ekonomileri ve Mekânsal Yayılmaların Rolü*, Doktora Tezi, Ankara, 2022.

Küresel ticaret 21. yüzyılın ilk yirmi yılında önemli bir artış göstermiştir. Bu artışta büyük kentsel merkezler ve hinterlantları büyük ağırlığa sahiptir. Bu nedenle yığılma ekonomileri ve mekânsal yayılmalar artan küresel ticaretin ulus altı coğrafi boyutunun merkezinde yer almaktadır. Benzer şekilde, uluslararası ticaretin Türkiye GSYH'si içindeki payı da 2000'li yılların başından itibaren önemli ölçüde artış göstermektedir. Ancak bu artış iller arasında oldukça heterojen olmuştur. Bu tez mekânsal sınırlı karışım modeli kullanarak ve, mekânsal yayılmalar, kentleşme ve yerelleşme ekonomilerine odaklanarak il ihracat performansının belirleyicilerini tahmin etmekte ve iller arasındaki mekânsal heterojenliği incelemektedir.

Sonuçlar, alt popülasyonların homojen olduğu varsayımı altında, hem yığılma ekonomilerinin hem de mekânsal yayılmaların il ihracat performansı ile önemli ölçüde ilişkili olduğunu göstermektedir. Ancak, söz konusu ilişki iller arasında farklılık göstermektedir. Düşük performanslı iller için mekânsal yayılma etkisi negatif olup kentleşme ekonomilerinden faydalandıkları görülürken, yüksek performanslı iller pozitif mekânsal yayılmalara sahiptir ve yerelleşme ekonomilerinden yararlanmaktadır. Bu bulgular, düşük performans gösteren illerin komşu illerin ihracatındaki genişlemeden olumsuz etkilendiğini ancak yerel ekonomilerindeki genişleme ve çeşitlilikten yararlandığını göstermektedir. Yüksek performanslı iller ise çevre illerinde artan ihracattan ve yerel ekonomilerindeki imalat faaliyetlerinin artan konsantrasyonundan faydalanmaktadır.

Anahtar Sözcükler: ihracat, kentleşme, mekânsal ekonometri, mekânsal yayılma, sonlu karışım, yığılma ekonomileri, yerelleşme.

TABLE OF CONTENTS

ABBREVIATIONS

AIC	: Akaike Information Criteria
BIC	: Bayesian Information Criterion
CoV	: Coefficient of Variation
FEF	: Fixed Effect Filtered
FMM	: Finite Mixture Models
GDP	: Gross Domestic Product
HHI	: Herfindahl-Hirschman Index
OECD	: Organisation for Economic Cooperation and Development
OLS	: Ordinary Least Squares
SAR	: Spatial Autoregressive Model
SEM	: Spatial Error Model
SDM	: Spatial Durbin Model
TSI	: Turkish Statistical Institute
UN	: United Nations

LIST OF FIGURES

LIST OF TABLES

LIST OF MAPS

INTRODUCTION

The expansion of international trade and capital mobility across countries have reduced the economic dependence of sub-national units on national economies. Within countries, some regions have been forming stronger economic links with global economy, participating in global value chains and selling their products to larger markets. Others have been relying mostly on domestic demand and thus usually lagging behind in terms of growth and export performance (Combes et. at., 2008). Increased exports, in fact, benefit regions from various channels. Higher exports increase regional income (The World Bank, 2020), bring strong employment gains and lower regional unemployment (Dauth et al, 2012), lead to higher wages and draw workers from informal sector into formal sector (Artuc and Lopez-Acevedo, 2019). Therefore, the structural features of regions determining their export performances become important to assess the role of changing economic geography in national growth trajectories. This is reflected in the economic geography literature which has been focusing on sub-national spatial units since early 1990s (Coe and Hess, 2011).

The theoretical literature explaining the differences in cross-regional export performance dates back to Smith (1778), who observes that coastal areas and cities on rivers can transport their goods with lower costs and grow their exports faster than do landlocked areas. Subsequently, location theorists (Thünen, 1826; Weber, 1929; Christaller, 1933; Lösch, 1940; Hoover, 1949) put forward several other factors such as access to trade routes, labor cost and productivity as the determinants of cross-regional heterogeneity in export performance. Nevertheless, as the share of large urban centers and their hinterlands increase in global production and trade, agglomeration economies and spatial spillovers have become central to the sub-national geographic dimension of global trade (UN, 2019; Coe et al., 2019).

Theoretical and conceptual advancements in the economic geography and spatial econometrics have enabled empirical studies on regional export performance to integrate agglomeration economies and spatial spillovers into the assessments. In the empirical literature, the regions with large agglomeration economies are usually found to be better performers (Wu et al, 2010; Celbis et al, 2014; Márquez-Ramos, 2016; Tsekeris, 2017) while the effect of spatial spillovers on export performance is still ambiguous, with different studies finding positive (Koenig et al, 2010), negative (Stojčić et al, 2014) or insignificant (Bernard and Jensen, 2006) spatial dependence structures.

Motivated by these considerations, this study focuses on investigating the determinants of provincial export performance in an emerging market economy, Turkey, with a particular focus on agglomeration economies and spatial spillovers. Turkish economy presents an interesting case as it is one of the early economic success stories of this century (The World Bank, 2014a; 2014b) where the real average annual growth rate in Turkey's exports is around 6% between 2004-2018. This overall increase in the national exports, however, is extremely heterogeneous across Turkish provinces with average annual growth rate in provincial exports ranging between 0% to 25% in the same period. Nevertheless, the empirical literature on the regional export performance in Turkey is limited with few studies examining export performance at provincial level. Some studies analyze only the spatial distribution of exports by using univariate methods such as Lorenz curve and Gini coefficients (Karaoz and Govdere, 2004) or local indicators of spatial association (LISA) (Kara, 2018), while others such as Cosar and Demir (2016) and Celbis et al., (2015), use non-spatial regression models and focus mainly on the effect of the domestic transport infrastructure without considering the spatial spillovers in regional export performance. Nevertheless, the most common economic case for considering economic interactions between spatial units is the presence of spillovers. It is highly likely to have common input and output markets at a regional level as opposed to uniform distribution of markets across the regions of the country, as well-documented in the spatial economics literature (Krugman, 1991; Krugman and Venables, 1995) with reference to industrial location and trade leading to agglomeration. Similarly, the knowledge spillovers between nearby regions are a lot more likely than far away regions given relatively lower transaction and transportation costs. Moreover, the spillovers from neighboring socio-economic conditions may have an impact on the regional innovation capacity, and thus on export and overall economic performance (Moreno et al, 2005). Thus, ignoring spatial dependence might lead to biased estimates (Arbia, 2007; Anselin et al., 2004).

To this end, this study employs a novel empirical approach, a spatial finite mixture model, to examine the impacts of agglomeration economies and spatial spillovers on provincial export performance in Turkey. Along with the control variables such as connectivity, productivity, and public investment, we introduce proxies for the agglomeration economies (urbanization and localization) into the export model representing the effects of economic diversity and industrial concentration. To account for the spatial spillovers, we estimate several spatial models to correctly determine the spatial dependence structure.

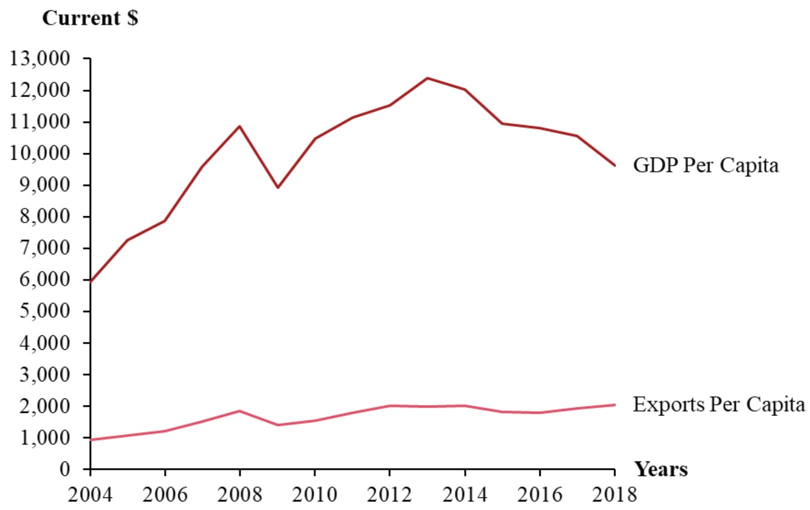
Subsequently, using a finite mixture model, we investigate the heterogeneity in the impact of the spatial dependence structures and agglomeration economies on the export performance across provinces. Spatial heterogeneity means variation in relationships over space indicating the fact that there can be different spatial relationships across different points in space (LeSage and Pace, 2009). These different relationships can result from various factors such as center-periphery relationships or existence of leading and lagging regions (Anselin, 1988a), institutional factors (Costa-Font and Moscone, 2009) and regional endowments (Kosfeld and Lauridsen, 2009) among many other possible spatial features. Similarly, urbanization and localization economies can arise differently based on the differing locational characteristics (The World Bank, 2009). Thus, application of finite mixture modelling allows for identifying different types of associations determined by various provincial characteristics.

The rest of the paper is organized as follows. Section 2 describes the spatial patterns of export performance in Turkey with descriptive statistics and figures. Section 3 discusses theoretical models and empirical findings on sub-national export performance with a focus on spatial dependence and agglomeration economies. Section 4 presents the economic case for export performance estimations and the empirical strategy including testing, and integrating spatial dependence into the model and the need for a finite mixture model. Section 5 describes variables and explains the estimation technique, presents and interprets the findings. Section 6 concludes and presents possible policy implications.

CHAPTER 1. REGIONAL EXPORT PERFORMANCE AND TURKEY

It is worthwhile to look at the overall pattern in regional exports over the last two decades. As seen in Figure 1, exports per capita follows a similar pattern as GDP per capita, with relatively smoother declines and slower pick-ups over the 2004-2018 period. In this period, GDP per capita grows by an annual 3.7%, while exports per capita grows by 4.4%[1].

Figure 1: GDP and Exports per capita in Turkey

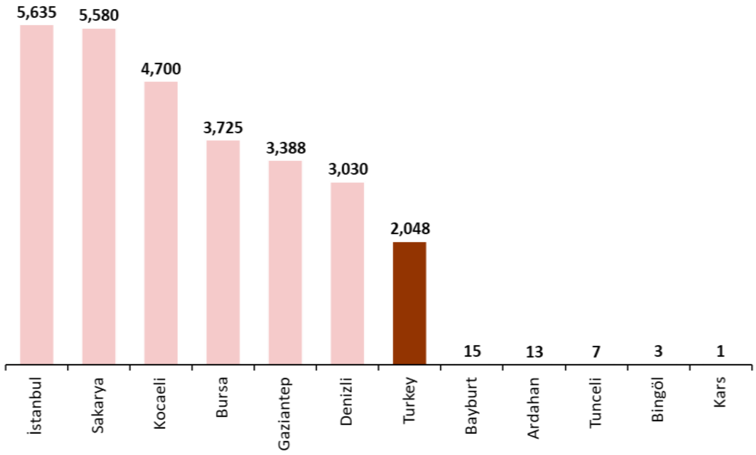


Source: Turkish Statistical Institute

However, as seen in Figure 2, exports per capita are highly diverse across 81 provinces of Turkey. In 2018, İstanbul, Sakarya, Kocaeli, Bursa, Gaziantep, and Denizli have exports values greater than USD 3,000 per capita (well above national average of USD 2,048) while other provinces such as Bayburt, Ardahan, Tunceli, Bingöl, and Kars have near-zero figures. Istanbul, with 18% of the country's population, exports 52% of all goods and services in 2018. When aggregated with other high export performers such as Bursa, Izmir, Kocaeli, and Ankara, the top 5 provinces, with around 36% of the total population, export 75% of all goods and services.

[1] In the same period imports per capita grows around 3%, indicating the import dependence of the exports.

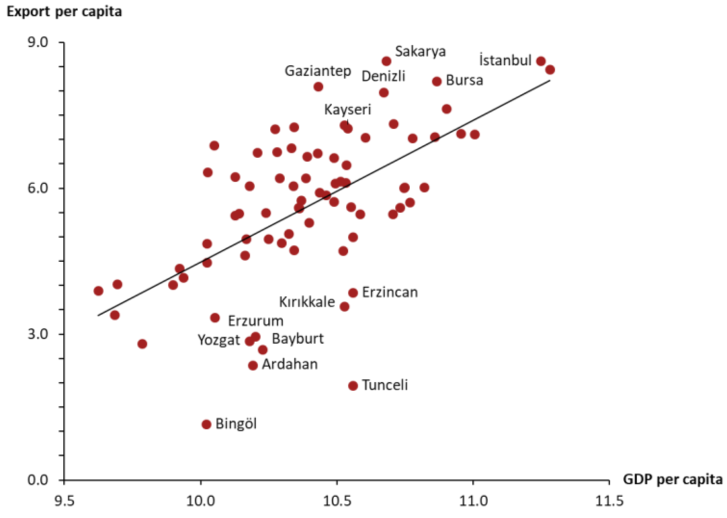
Figure 2: Exports Per Capita (current $, 2018, Top and Bottom Five Exporters)



Source: Turkish Statistical Institute

When we look at the association of provincial export performance with the overall economic performance, there seems to be high correlation as depicted in Figure 3. However, there are several provinces that deviate from their expected export performance given their GDP per capita values and vice versa.

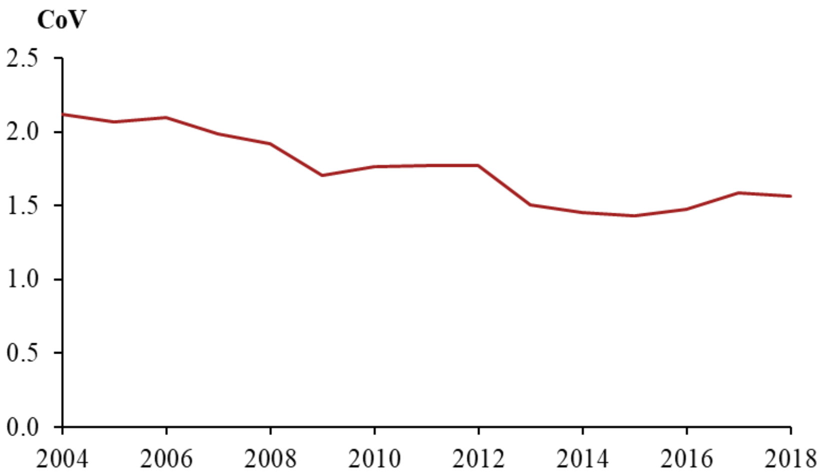
Figure 3: The Association between GDP and Export per Capita across Provinces



Source: Turkish Statistical Institute
Note: Logarithmic scale, 2018 values.

In order to observe cross provincial heterogeneity in exports, we calculate the coefficient of variation (CoV)[2]. Figure 4 shows the pattern in coefficient of variation (CoV) for the export per capita distribution across 81 provinces of Turkey between 2004 and 2018. As seen, cross-provincial heterogeneity in the export performances declines only slightly over the years with some reversals in 2009 and 2015. In general, the high dispersion of export performances across provinces appears persistent over time.

Figure 4: Coefficient of Variation for Export Performance Distribution



Source: Turkish Statistical Institute

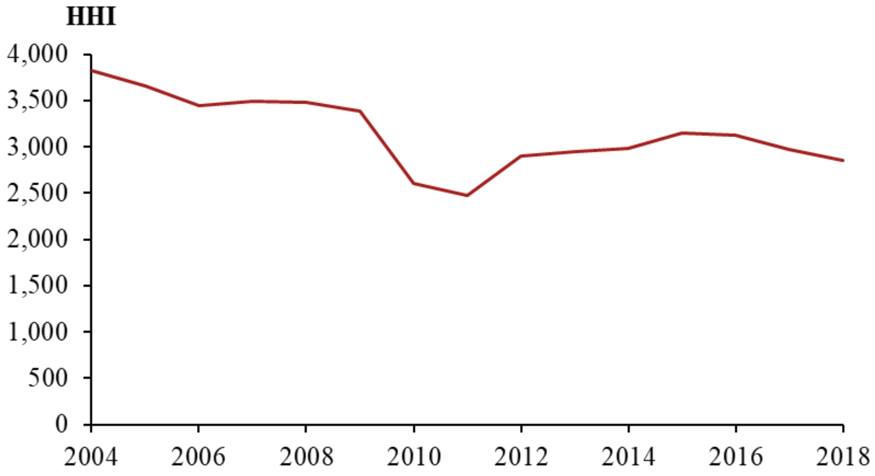
Further, we compute a Herfindahl-Hirschman Index (HHI) which is another measure of cross provincial heterogeneity in export values[3]. Figures 5 depicts the HHI pattern over the same period. Similarly, there seems a slight decline in export performance heterogeneity until 2011 but then a stable pattern with moderate rises and declines.

---

[2] CoV is calculated by: CoV= $\sigma/\ \mu$ where σ is the standard deviation and μ is the mean value of the distribution. It simply shows how the standard deviation of the export performance distribution changes over time taking into account the changing average performance.

[3] HHI is calculated by HHI= $\sum_{i=1}^{n}(S_i/S)^2$ where S is the market share of the each province. HHI simply shows how dispersed is the total export values across provinces.

Figure 5: Herfindahl-Hirschman Index of Export Performance Distribution

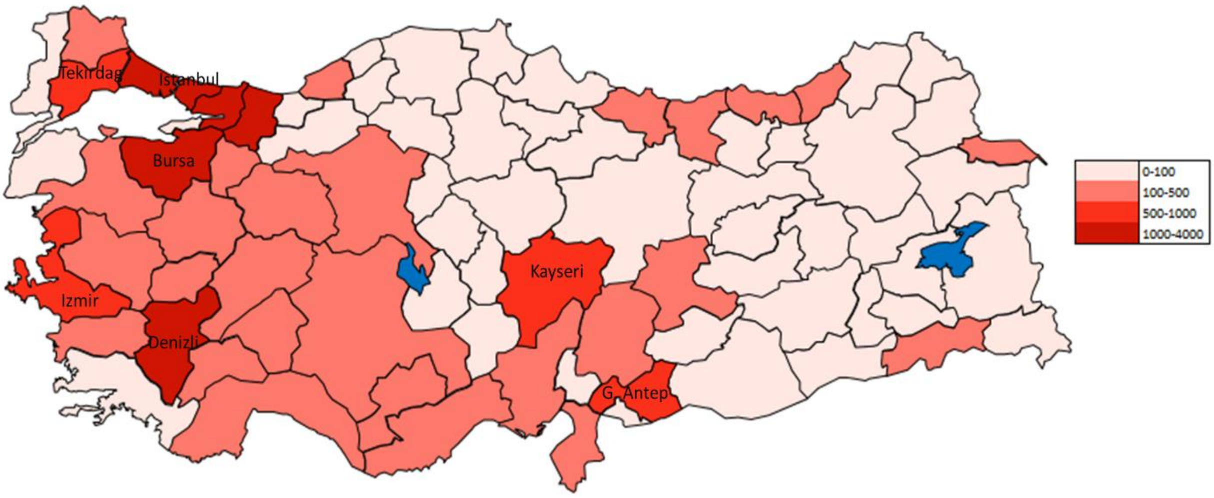


Source: Turkish Statistical Institute

In order to evaluate the geographical pattern in export per capita of the provinces, we made use of maps. Maps 1 and 2 show that an important feature of the geography of export performance is the differences between the provinces in the eastern and western part of the country. Istanbul and its hinterland stand out as the largest agglomeration of provinces with high-export performance. Izmir, Denizli and some other prominent industrialized provinces with high export performance, are also on the western part of the country.

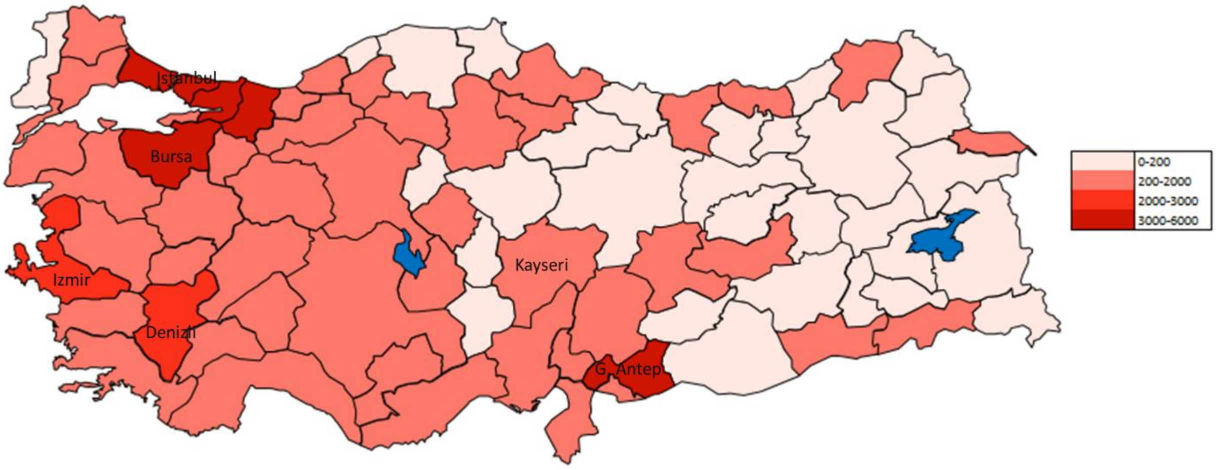
Overall, western provinces perform better than the eastern provinces. There are two notable exceptions to this general pattern. The first one is Gaziantep, which is landlocked and is located in one of the poorest geographic regions of the country, and yet achieved an extraordinary export growth producing 57% of all machine-made carpets globally (World Bank, 2015a). It has the 4th largest in export capita value. The second major exception is Kayseri, which is located in central Anatolia and is one of the fastest growing provinces employing a large share of new urban migrants in the 2000-2010 period (World Bank, 2015b).

Map 1: Exports per Capita (current USD, 2004)



Source: Turkish Statistical Institute

Map 2: Exports per Capita (current USD, 2018)



Source: Turkish Statistical Institute

These two maps also show that the geography of the high and low performing provinces did not experience any significant change in the 2004-2018 period. When the upper end of the export performance distribution is analyzed, the top performers remain almost the same. The 10 provinces with the highest export per capita figures in 2004 are still among the top performers in 2018 with few exceptions. For example, Ankara and Tekirdag, are replaced by Hatay and Manisa in top 10, but they are still in the top 15. Under this general pattern, there are few noticeable regional shifts. For example, some provinces in eastern black sea region such as Ordu, Rize, Giresun fell in the export performance rankings (losing 33, 25, and 17 ranks respectively), while some other provinces in Western Black Sea such as Cankiri, Karabuk, and Corum (gaining 53, 40, and 34 ranks respectively), in south Anatolia such as Osmaniye and Kilis (gaining 47 and 30 ranks respectively) had large gains in the rankings.

Another visible pattern in the export performance is that all the large cities perform well. For example, the most populous cities such as Istanbul, Ankara, Izmir, and Bursa are all among the top performers (i.e has the highest export per capita). The level and nature of agglomeration, however, are quite different across these cities. Istanbul, with the population of around 15 million, is almost five times larger than Bursa. Moreover, Istanbul has a large service economy (where services account for 70% and industry for 30% of the gross value-added) while Bursa's economy is characterized by industrial production (where services account for 47%, industry for 49% and agriculture for 4% of the gross value-added)[4]. A similar pattern exists for the lower end of the population distribution as well. The three smallest cities (Ardahan, Bayburt, and Tunceli) are, for example, all among the lowest performing group both in 2004 and in 2018. The cities with high export performance in Eastern and Central Anatolia such as Kayseri and Gaziantep also have larger populations and economies than their neighbors.

Overall, the assessments at different levels and scope indicate that there are large and persistent disparities in provincial export performance and these disparities have spatial characteristics. Moreover, larger cities have higher export per capita figures indicating potential gains from agglomeration economies. Therefore, in the assessment of the provincial export performance, the types of agglomeration economies and spatial spillovers should be taken into consideration. The latter is particularly important given the difficulties in measurement and inability of the non-spatial models to capture these effects (Anselin, 1988a; Anselin and Lozano-Gracia, 2009) as it will be explained more in the econometric modelling section.

[4] Turkish Statistical Institute, Regional Statistics, National Accounts.

CHAPTER 2. LITERATURE REVIEW

There is a rich theoretical literature on the sub-national export performance with international trade and spatial economics links dating back to Smith (1778). Empirical studies, however, are relatively limited, and inconclusive. This section provides a summary of the theoretical and empirical literature on the export performance. The theoretical literature review focuses on spatial heterogeneity created by spatial spillovers and agglomeration economies. The empirical literature review focuses on the assessments on sub-national export performance in different country contexts under certain categories of economic variables that are widely used in the recent literature.

2.1. THEORIES ON SPATIAL DEPENDENCE, CENTER-PERIPHERY RELATIONS AND AGGLOMERATION

In theoretical literature, Smith (1778) is the first to underline the importance of the sub-national spatial factors in export performance arguing that transportation of goods across water is much cheaper compared to land, and thus cities on rivers and coastal areas are the fastest to develop. Following Smith's observations on the locational characteristics and international trade, the advancements in the location theory and trade theory form the fundamentals of the regional export performance literature.

Location theorists (Thünen, 1826; Weber, 1929; Christaller, 1933) develop the first models addressing the question of which economic activities are located where and why. Among them, Thünen (1826) is considered the founder of spatial economics with his model on a monocentric city with agricultural rings. His theoretical model aims to solve the problem of optimal allocation of land across different agricultural activities. He shows that, in an optimal land-use setting, a city would be encircled by agricultural rings and each ring should have a specific crop associated with the highest bid rent. The bid rent is basically the agricultural revenue minus the cost of labor used in production and the cost of transporting the crops to the city. Therefore, perishable and heavy products, given the need and the cost to transport faster, would be produced close to the city while more durable and lighter goods would be produced easily on the city periphery. Even though the model is overly simplistic (e.g there exists only one city, there is only agricultural production, the transportation is only via land), it addresses the core issue of spatial economics of which economic activities are located in what type of locations, and develops an early land-use framework.

After the Thünen (1826) model of agricultural activities, Weber (1929) is the first to develop a general theory of location on industrial activities. He adopts a deductive approach to determine spatial factors which attract industries towards locating in different geographical regions. He classifies the factors affecting location of industries into two broad categories: the regional factors as the primary factor, and agglomerative and degglomerative costs as the secondary factors. The regional factors are mainly transportation and labor costs that vary from region to region and thus affect the location of industries. He argues that the weight to be transported and the distance to be covered are the factors that determine the transportation costs. He also examines how changes in labor costs leads industries to deviate from their optimal place using transportation costs. He argues that industries have a tendency to choose a place where material and fuel are not difficult to obtain and where labor costs are low. Beside considering manufacturing as opposed to agricultural activities as in Thünen (1826), the incorporation of labor costs as a differentiator in location choice is an important step in spatial economics. As for the secondary factors, Weber (1929) defines an agglomerative factor as a determinant which leads industries to centralize at a particular location. Such factors include banking and insurance facilities, gas and water sources. Deglomerative factors, on the other hand, decentralize the location of industries and include higher land prices, taxes and labor costs.

Although Thünen (1826) and Weber (1929) develop comprehensive theories of location respectively for agricultural and industrial activities, their theories have very extensive assumptions which are too abstract to reflect the true dynamics of a spatial economy. Moreover, they compare only economic characteristics across regions without considering spatial interactions.

Christaller (1933), examining the settlement patterns in southern Germany, introduces the central-place theory which brings spatial interactions into the location theory. He starts with the assumption that there are laws which determine the size, number and distribution of central places, and models the pattern of settlement locations using geometric shapes. Central-place theory suggests that the main function of a central settlement is to supply goods and services to the surrounding population. These central places are specialized in selling a variety of goods and services and attract consumers to their markets, which in turn determines the hierarchy between places. The places that provide more goods and services compared to others are called higher-order central places. Lower-order central places, on the other hand, have smaller and less valuable market areas and sell goods and services which are bought more frequently. The higher-order places are fewer in number, more widely distributed, and do not require frequent purchases given the nature of products and services they provide. However, this model has been subject to several criticisms. First, the model assumes a uniform distribution of such factors as population, purchasing power and agglomeration economies which is highly unlikely in real world (Berry and Garrison, 1958; Boventer, 1969). It is also simplistic in that the model assumes transportation costs increase linearly, and consumers act rationally and shop in the nearest center (Parr, 2017). Finally, the model does not include the effect of the horizontal trade (Ozturk et al, 2019). Nevertheless, despite all its limitations, this theory is unique in that it describes a hierarchical relationship considering spatial interactions among places with different economic characteristics.

These initial location theories are improved by subsequent theorists (Lösch, 1940; Hoover, 1937; Hoover, 1949) using the concepts developed by Marshall (1890) such as external economies and economy of skills. These studies lay the foundations of export performance as well as regional growth literature. Lösch (1940) builds his work on Christaller (1933) and applies general equilibrium theory to a spatially distributed economy. In contrast with Christaller (1933) who begins with the highest-order places when dealing with the system of central places, Lösch (1940) starts with the lowest-order of economic activity and derives partial equilibria for each network of market areas. Lösch (1940), by making as few simplifying assumptions as possible, works on the question of how the characteristics of production and trade drive certain spatial patterns of settlement. He finds that the pattern must have a hexagonal and hierarchical structure. This structure of central places allows for specialized places and shows how some central places grow to become richer areas compared to others. Being the first to illustrate a full general equilibrium system explaining the relationships of all locations, he made a seminal contribution not only to location theory but also to regional economics (Batey and Plane, 2020).

These theories for explaining and understanding production agglomeration have paved the way to the debate towards the concept of urbanization economies, which was mentioned for the first time by Hoover (1937). Hoover (1937, 1948), drawing upon the work of Marshall (1890), defines agglomeration economies as the benefits that firms accrue by locating with other spatial clusters of economic activities. He presents explanations for agglomeration economies, such as economies of scale and scope within the firm, varied labor markets and specialized skills, improved interaction between suppliers and buyers, savings on transport costs and shared infrastructure. Hoover (1948) also classifies agglomeration as large-scale economies, localization economies and urbanization economies. Large scale economies result from the expansion of the scale of the production of a firm at a given location, while localization economies are related to the same benefits but of all the firms in a given industry in a given location. Urbanization economies are related to the benefits gained by all firms in all industries in a given place, resulting from the enlargement of the economic size of that location. In other words, location economies are economies of scale that emerge from the size of the industry while urbanization economies result from the size of the local market.

Overall, the first group of location economists emphasizes the importance of transportation costs (Smith, 1776; Thünen, 1826; Weber, 1929, Hoover, 1937; Hoover, 1949), access to trade routes (Smith, 1776; Thünen, 1826), labor cost and productivity (Smith, 1776; Weber, 1929), and agglomeration economies (Marshall, 1890; Christaller, 1933; Lösch (1940). The agglomeration economies, however, have gained a special importance in theoretical literature in the last couple of decades as the global production and trade become more concentrated in the certain sub-national locations (Coe et al., 2019; UN, 2019).

Krugman (1980) acknowledges the importance of agglomeration in regional concentration of production and trade and creates the first links between the early theoretical studies and the upcoming new economic geography literature. His theoretical model shows how agglomeration economies turn some regions into locations of higher production and trade. In his model, firms take location decisions in order to maximize their profits. Once some firms select one location over others based on the gaps in the expected benefits from the agglomeration economies, the spatial differences in production and export performance across regions are amplified by the spatial clustering of firms and workers. Accordingly, Krugman (1991) explains the determinants of spatial economic differences by transportation costs and agglomeration economies in an open-economy context. Subsequently a vast literature on spatial development with international trade expansions emerges. This new literature, called new economic geography, brings spatial microeconomic explanations to regional economic disparities in production and trade (Feldman, 2000; Krugman, 2011). The focus in new economic geography is particularly on the economic benefits from agglomeration economies in certain locations created by links between firms, suppliers, and consumers (Krugman, 1998; Schmutzler, 1999).

The idea of the location with several firms bringing additional production and trade advantages in the form of agglomeration economies has been well-recognized by other prominent studies as well (Porter, 1990; Ellison and Glaeser, 1997). Agglomeration economies, in general terms, have been further formulated as the results of economic specialization (i.e. localization economies) (Marshall, 1890; Arrow, 1962; Romer, 1986) and urban economic diversity (i.e. urbanization economies) (Jacobs, 1969). The localization economies come from spatially concentrated groups of the firms, which are producing and/or trading similar goods. They operate in the same market and thus share similar suppliers and consumers which create larger scale and lead to cost reductions. They learn industry-specific know-how from each other due to knowledge spillovers resulting from proximity to one another. Moreover, they create a larger pool of employees with similar skills making hiring and training costs much lower. Urbanization economies, on the other hand, arise from economic diversity. The larger the local economy, the more opportunity arises from observing and adapting ideas from firms in other industries, allowing for cross-fertilization of ideas and innovation (Jacobs, 1969). Several firms locating nearby create a large, diversified labor market and attract workers with variety of skills. This, in turn, attracts more firms and further expands the market.

From a perspective of domestic interregional economic relations, new economic geography predicts that as some regions start to be the locations of production facilities more than others, a hierarchical system of regions emerges where some regions become the centers of production and trade benefiting from localization and urbanization economies while others loose competitiveness in attracting economic agents (Krugman, 1995; Fujita et al, 1999). Thus, being located in a peripheral area of a large competitive city can have an adverse effect on export and growth performance (Krugman and Venables, 1990; Porter, 1990; Overman et al., 2001). From the point of export performance, this structure means that some regions would attract exporting firms benefiting from agglomeration economies both in the form of urbanization and localization economies, and weaken the export performance of the surrounding regions with negative spillovers creating a center-periphery relationship that is not beneficial for the neighboring regions.

2.2. EMPIRICAL STUDIES ON REGIONAL EXPORT

This sub-section presents the empirical literature estimating export performance with spatial dependence, agglomeration economies, and other economic variables (i.e. connectivity, productivity, public investments) that are used to control for the remaining observable sub-national variation in export performance. Subsequently, literature on spatial heterogeneity is presented to indicate the need for a deeper look at export performance estimations when spatial dependence and agglomeration economies are used as explanatory variables.

2.2.1. Empirical Literature on Spatial Dependence and Regional Exports

In regional export literature panel data techniques have been widely used to account for spatial dependence. Fixed effects estimation technique, for example, has often been used for taking space-specific time-invariant information into account. Nevertheless, using fixed effects estimation technique (i.e. introducing dummy variables for spatial units) captures only spatial specific effects but not spatial interaction effects (LeSage and Pace, 2009; Elhorst, 2014). If the econometric models with spatial data are not corrected using spatial econometric techniques, the produced estimates become biased and/or inefficient (Arbia, 2007; Anselin et al. 2004). Therefore, spatial econometric techniques are needed to introduce spatial weight matrices that correct econometric models for spatial interactions across all spatial units with defined relationship weights (Corrado and Fingleton, 2012). Advancements of spatial econometrics with various tools and models developed by LeSage and Pace (2009), Anselin and Rey (2014), and Elhorts (2014) enabled empirical studies to analyze spatial determinants of export performance as well as regional development across regions using these relationship weights.

Due, at least partially, to the late development of the advanced spatial econometric tools and techniques, the literature on spatial determinants of export performance is limited and inconclusive. There are studies finding negative, positive, and insignificant spatial spillovers.

On the negative spatial spillovers side, aggregating firm data to Croatian sub-national spatial units, Stojčić et al (2014) finds significant negative spatial spillovers across counties and regions in their overall export performance. They conclude that the advantages that more developed counties and regions have (e.g. knowledge spillovers, skills, cooperation with other companies) help them attract exporting firms from their sub-national neighbors.

More recently, and as an opposing finding, Tsekeris (2017) finds an overall positive and significant spillovers from the improvements in the transport condition of the Greek prefectures to their neighbor’s export performance. This overall positive spillover, however, acts differently for agricultural and industrial exports. Some improvements in the highway infrastructure in the neighborhood create positive impact only for the agricultural exports.

Wu et al. (2010) and Alama-Sabater et al. (2013) study export performance in more detail and produce more nuanced findings. Wu et al. (2010) studies the manufacturing export performance of the states of the USA in Asian market and finds negative spatial spillovers in high-technology products and positive spillovers in low-technology products. Alama-Sabater et al. (2013) focuses on the spatial spillovers from the transport quality in Spanish regions. He argues that the spatial spillovers can be both positive and negative based on the magnitude of the diversion effects (i.e. exporting firms locate to neighboring regions with better infrastructure) and creation effects (i.e. firms from an origin region locate to a destination region creating similar flows to neighboring destinations). He also finds that the significance of the spatial spillovers varies by sector and sub-sectors within both agriculture and industry.

Other studies of Bernard and Jensen (2006) and Koenig et al (2010) do not find statistically significant spatial spillovers for the sub-national export performance, the former on the US and the latter on France. Studies on regional export performance in Turkey use either univariate spatial methods (Karaoz and Govdere, 2004; Kara, 2018) or non-spatial econometric models (Celbis et al 2014; Cosar and Demir, 2016). Karaoz and Govdere (2004) studies the change in provincial exports using Lorenz curve and Gini coefficients and find a moderate improvement in the export performance disparities across provinces over time. The other univariate spatial study on regional export performance is Kara (2018). He studies provincial export per capita levels using Local Indicators of Spatial Association (LISA) method and finds varying spatial interactions occurring positively for some provinces but negatively for others. Among the non-spatial econometric studies, Celbis et al (2014) develops an index from highway, road, and railroad lengths and finds positive but insignificant coefficient in the estimation of bilateral value of regional total exports. Another non-spatial study, Cosar and Demir (2016) estimates specifically the transportation infrastructure in moving goods, particularly the time-sensitive goods, from the gate of the factory to the ports and finds significant association.

2.2.2. Empirical Literature on Agglomeration Economies and Regional Exports

Unlike spatial spillovers, association between export performance and agglomeration economies is widely studied in empirical literature. Since early 2000s several empirical studies have been estimating this association for a varying level of sub-national units and at different country contexts.

Among the early studies on agglomeration and export performance, Nicolini (2003) finds that in European regions the size of the agglomeration is positively associated with export performance, Matthee and Naudé (2008) and Naudé and Gries (2009) report a similar association for South African districts. Similarly, Wu et al (2010) find a positive and statistically significant association between the size of the agglomeration and export performance for the states in the USA, Bensassi et al (2015) and Márquez-Ramos (2016) for Spanish regions.

Studies focusing on other dimensions of the home market have similar findings. Tsekeris (2017) find positive and statistically significant association between the export performance and GDP per capita of the local population in Greek regions, Stojčić et al (2014) for Croatian regions, and Grasjö (2008) for Swedish municipalities. Other studies focus on characteristics of the home market other than its size find similar results as well. Leichenko and Erickson (2002) find positive association between the growth in the size of the state level GDP and export performance in the USA; Nsiah et al (2012) also studying the export performance of the states in the USA find positive association between the employment density in the state labor market and export performance.

The advancement in the theoretical literature in decomposing the agglomeration economies into localization and urbanization economies is not well adopted in the empirical studies on export performance. Moreover, the estimation results of these variables are mixed. Among these few studies, Malmberg et al. (2000) finds positive localization and urbanization economies for Swedish firms. Their estimates show that urbanization economies, if industry effects are excluded, are the most important determinants of the export performance. They find that large urban agglomerations help firms export more.

Stojčić et al. (2014), however, finds insignificant urbanization economies for the export performance of the Croatian counties. They conclude that exporters in Croatia are not benefiting from the possible agglomeration externalities to build competitiveness. Their other finding is that export performance is negatively affected by the average company size and localization externalities. They interpret this finding as a sign of the relative success of the small companies in the export markets using their relatively flexible production methods. They argue that the association can actually be positive if the sample was restricted to high-tech exports, as they compete based on quality and would benefit from localization economies.

The already very limited number of studies on the regional export performance in Turkey do not include agglomeration economies as a determinant.

2.2.3. Connectivity, Productivity and Public Investment in Regional Exports Literature

Besides spatial spillovers and agglomeration economies, transport costs and labor productivity have been considered as the main determinants of the export performance differences across regions since the early studies on location theory. More recently, with the increased involvement of the government in regional development public investment has also started to be considered an important determinant of export performance.

Firstly, transport costs are considered to be the crucial elements for regional competitiveness for attracting manufacturing firms in many studies (Fujita and Mori, 1996; Fujita et al, 1999; Konishi, 2000) even before export performance literature emerges. Subsequently, both transport costs and transport quality have been widely used in assessing regional export performance as well. Given its easiness to be quantified, road length is the most common proxy for transport quality. The road length and regional export performance have positive association in very different county context. Nicolini (2003) proves this association for European regions, Wu (2007) and Zhang (2015) for Chinese regions, Nsiah et al. (2012) for the US states, and Artuc et al. (2014) for Croatian counties. Similarly, railway length has been found to positively impact the export performance by Zhang (2015) and Xu (2016) for Chinese regions and Donaldson (2010) on Indian districts.

Even though the effect of regional geography on export performance is partially captured by transport costs and quality, geographical location is also independently researched in the literature. Given the importance of the sea transportation in the global trade (in 2019 carrying around 57% of the global exports[5]), access to ports has been central to these studies. Distance to major or nearest ports has almost always been found negatively correlated with the export performance of the sub-national units (Matthee and Naudé, 2008; Ciżkowicz et al, 2013; Celbis et al, 2014; Márquez-Ramos, 2016; Abar and Tekmanli, 2018).

Secondly, labor productivity is considered to be an important element in export performance as well since the early thoughts of the Ricardo (1817) on international trade.

[5] World Trade Organization, 2020, World Trade Statistics Review.

In the Ricardian model of comparative advantages, labor productivity of the countries has been considered to provide cost advantages in any commercial good to help national economies export more (Ricardo, 1817; Krugman et al, 2018). Similarly, in Heckscher-Ohlin model, differences in productive factors, including labor, across economies have been considered as main determinants of what is being produced and exported (Feenstra and Taylor, 2017).

As it is difficult to estimate the labor productivity at regional level due to data limitations, education level is often used as a proxy in empirical literature. The positive association between education and productivity is well-established in theory as well. In his seminal human capital theory, Becker (1964) states that education increases market demand for workers' labor by developing skills that make them more productive.

Similarly, in spatial economics literature, labor productivity is considered to be a crucial element in a location's production and trade capacity, particularly when transportation costs are relatively low (Krugman and Venables, 1995; Fujita et al, 1999). Several empirical studies prove this association using both pre-university (Wu, 2007; Naudé and Gries, 2009) and university graduates (Grasjö, 2008; Ciżkowicz et al, 2013) shares in the local population as proxies. They all find positive association between education level and the regional export performance.

Thirdly, public investment has been found to be positively associated with the export performance of the sub-national units as well. Differences in public investment across regions can deepen or narrow the export performance from variety of channels. Investments in physical and human capital can increase the overall productivity in the region and can boost competitiveness of the exporting sectors. Similarly, investments related to quality of life can increase the attractiveness of the region for skilled labor or investments on environmental assets can support the sustainability and resilience of the provincial economy and exporting sectors (Royuela et al. 2010; Albouy et al. 2013). Moreover, investments in improving the efficiency of the government services such digitization of services or investments in the number and skills of the staff working in local bureaucracy can facilitate the ease of procedures for exporting and support export growth indirectly. In the empirical literature, Wu (2007) finds the expected positive association between government investments and the export performance for the Chinese regions, Leichenko and Erickson (2002) find a similar association for the states in the US.

2.2.4. Spatial Heterogeneity and Agglomeration Economies

In provincial export performance estimations, the differences in the characteristics of the neighbors (e.g geography, institutional structures, and technology endowment) and the differences in relationships with the neighbors (e.g core-periphery relationships, leading and lagging regions, and growth poles) can lead to non-uniformity of the spatial and agglomeration effects (i.e spatial heterogeneity). This, in return, requires models to include variation in the spatial dependence structures and agglomeration economies across subpopulations of provinces. With this approach, spatial spillovers from neighboring provinces belonging to different subpopulations can be allowed to exert different impacts (Cornwall and Parent, 2017). Similarly, by allowing for subpopulation heterogeneity, the differing impact of the urbanization and localization economies on different provinces can be estimated. In the estimation of these models, units of analyses are clustered to form homogeneous subpopulations (Frühwirth-Schnatter, 2006), and thus estimates are specific to sub-groups and are accurate.

In order to integrate heterogeneity into the estimation procedures, finite mixture modelling has long been applied in such fields as biology, medicine and engineering (McLachlan et al., 2018). Recently new estimation techniques have been developed to allow for application of the finite mixture modelling in spatial econometrics as well (Aquaro, 2015; Cornwall and Parent, 2017; LeSage and Chih, 2018).

Nevertheless, the econometric literature, in general, do not pay much attention neither to the location of the construed subpopulations nor to the potential impact of the existence of the subpopulations on the estimated association (Cornwall and Parent, 2017). On the other hand, different spatial relationships that are developed in spatial economics literature requires spatial mixture models to account for the heterogeneity in spatial dependence structures and varying impact of the agglomeration economies.

The empirical literature on the export performance, which is rather limited, becomes non-existent when it comes to investigating the different agglomeration affects and spatial dependence structures using the above-mentioned mixture models. Nevertheless, in other fields of economics, finite mixture models have been used to uncover subpopulation heterogeneity in estimations. Among the few application of the finite mixture models in economics, examples are Alfo et al. (2008) and Owen et al. (2009) who find subpopulation heterogeneity in economic growth across countries, Konte (2017) who finds subpopulation heterogeneity in the association of the remittances and country growth regimes, and more recently Ouédraogo et al (2020) who finds that the association between the level of public and private investments differs across subpopulations of countries.

CHAPTER 3. EMPIRICAL MODEL AND METHOD

Spatial econometric models require incorporation of the right spatial dependence structure in addition to the right economic variables. Thus, this section first introduces the economic determinants of the export performance that need to be operationalized in the empirical model, in line with the literature review. Then, different models are introduced that are likely to represent the spatial dependence structure in export performance estimation.

3.1. SPECIFICATION OF EMPIRICAL MODEL

Previous empirical studies employ various specifications for regional exports based on a mixture of traditional and new, trade and location theories. Accordingly, we specify a hybrid model for provincial exports, incorporating the major factors derived from trade and location theories. Thus, along with the productivity and agglomeration economies from traditional and new trade theories (Ricardian competitive advantage theory, Hecksher-Ohlin skilled labor endowment, New trade theory spatial agglomeration), we consider measures of connectivity and spatial spillovers from the location theory (Core-periphery relationships and the new economic geography). Finally, in order to account for the involvement of the governments in regional development, we also consider public investment. Thus, the empirical model in general form is specified as the following;

Exports = f (*Agglomeration, Connectivity, Productivity, Public Investment, Spatial Spillovers*)

where *Agglomeration* measures the effect of the home market characteristics. Each region has a unique size and economic composition that provide varying levels of locational benefits. These benefits emerge from the number and level of the purchasing power of customers, availability of local workforce, and the strength of the links with suppliers (Sullivian, 2012). Agglomeration economies can come both from concentration of similar economic activities (i.e localization economies) or diversity (i.e urbanization economies) of economic activities (Bernard and Jensen, 2006; Matthee and Naudé, 2008; Wu et al, 2010; Stojčić et al, 2014; Márquez-Ramos, 2016; Tsekeris, 2017).

Connectivity measures the opportunities of the links with the economic agents outside the region to facilitate flows of goods, services, people and knowledge. The level of connectivity of a region depends mostly on the ability of the transportation systems to handle high volumes of goods efficiently and the overall distance among the trading firms and customers (The World Bank, 2019).

Productivity measures the output per employee which determines the cost and quality of the products to be exported. Thus, increased productivity can lower the prices and/or increase the value-added of the products enabling higher competitive power in the markets.

Public Investment measures government's involvement in the local economy through capital formation. It includes government investments in areas that are critical for growth and well-being (OECD, 2018) and promotes favorable investment climate for foreign and local investors (Riain, 2011; Perrons, 2011).

Spatial spillovers measure the positive or negative impact of the neighboring regions to the export performance of the other regions. This contribution can come from latent unobservable characteristics of the neighboring regions as well as their export performance (LeSage and Pace, 2009).

In short, we represent the effects of agglomeration by urbanization and localization economies, connectivity by motorways, railroads and distance to port; productivity by education; and public involvement by public investment. Thus, econometric model can be written as,

$$\begin{aligned} EXPORTS = {} & \alpha + \beta_1 URB + \beta_2 LOCAL + \beta_3 MOTORWAY + \beta_4 RAILWAY \\ & + \beta_5 PORTDISTANCE + \beta_6 EDU + \beta_7 PINV + u \end{aligned}$$

where the dependent variable, *EXPORTS*, is the exports of the manufacturing sector from each province[6].

URB is the proxy for urbanization economies that arise from having a large number of diverse economic activities in close proximity in the local economy. This variable is measured by the provincial population size in line with the literature (Wheeler, 2001;

[6] The classification of export sectors follows United Nations Statistics Division's International Standard Industrial Classification of All Economic Activities (UNSD ISIC Rev. 3).

Yankow 2006; Di Addario and Patacchini 2008; Sarkar et al, 2020). In larger cities, firms and workers benefit from the large common resources including infrastructure (roads, buildings and power supply), gain access to a large and diverse labor supply and labor demand, and people can be more innovative from observing and adapting ideas from other people which leads to cross-fertilization of ideas and innovation. Therefore, the larger the number of people living in a region, the larger the benefits from urbanization economies are.

LOCAL is the proxy for localization economies that arise from having a large number of similar economic activities in close proximity in the local economy. It is calculated by the location quotient:

$$L_{jt} = \frac{M_{tj}}{T_{tj}} / \frac{M_{tN}}{T_{tN}}$$

in line with (Glaeser et al., 1992), where M is number of manufacturing firms, T is total number of firms, j is the province, t is the year, and N indicates national level. Thus, the formula measures share of manufacturing firms in the total number of firms in the province divided by the same ratio in the country. It simply shows the relative concentration of the manufacturing firms in each province. The higher the localization economies, the greater the share of manufacturing firms in the local economy relative to the national economy. In literature, several other methods, such as Gini coefficient and Ellison-Glaeser indices, are also used to measure concentration. When measuring sectorial concentration, however, this formula (i.e location quotient) is the most commonly used metric (Billings and Johnson, 2012). The criticism against the use of location quotients is mainly based on the argument that the groupings of areal units are arbitrary (Carrol et al, 2008). Nevertheless, in our study groupings are provincial units and are pre-determined by administrative borders which are not subject to frequent changes.

The variables *MOTORWAY*, *RAILWAY* and *PORTDISTANCE* accounts for connectivity in terms of land, railway and sea transport opportunities are considered to be region’s capacity to move its products easily when selling in international markets. The use of land and rail transport infrastructure is common in literature (Nicolini, 2003; Nsiah et al, 2012; Alama-Sabater et al, 2013; Cosar and Demir, 2016; Márquez-Ramos, 2016). Similarly, distance to nearest ports is considered a crucial component of connectivity in several studies (Matthee and Naudé, 2008; Ciżkowicz et al, 2013; Celbis et al, 2014; Márquez-Ramos, 2016; Abar and Tekmanli, 2018).

EDU is education, used as a proxy for (labor) productivity (i.e skilled labor endowment). The level of education is expected to increase the skills of workers to make them more productive, in both human capital theory (i.e Becker, 1964) and in the empirical export performance literature (Wu, 2007; Grasjö, 2008; Ciżkowicz et al, 2013).

PINV is the total government investment spending in the province. More investments are expected to increase the overall economic conditions in the region supporting production and trade capacity, which in return improves the export performance as found in other studies on export performance (Leichenko and Erickson, 2002; Wu 2007).

3.2. INTEGRATING SPATIAL DEPENDENCE INTO THE ECONOMETRIC MODEL

Tobler's First Law of Geography indicates that "everything is related to everything else, but near things are more related than distant things" (Tobler, 1970:3). In spatial economics this law can be interpreted as the dependence of economic values observed at one location on the values of neighboring observations at nearby locations (LeSage and Pace, 2009). There are variety of economic phenomena providing strong cases for integrating spatial dependence. The most common case for considering economic interactions between spatial units is the presence of externalities. It is highly likely to have common input and output markets at regional level as opposed to uniform distribution of markets across the regions of the country, as well-documented in the spatial economics literature (Krugman, 1991; Krugman and Venables, 1995), with reference to industrial location and trade leading to agglomeration. Similarly, knowledge spillovers between nearby regions are more likely than far away regions given relatively lower transaction and transportation costs, which in turn may have an impact on the regional innovation capacity and overall economic performance (Moreno et al, 2005). Furthermore, when estimating economic indicators at spatial units, unobservable factors may exert influence. These may include, among many others, location amenities and neighborhood prestige (LeSage and Pace, 2009). The unavailability of data on these latent influences or the difficulty of computing proxy variables that could effectively capture them can lead to omitted variable(s) in the estimating equation and thus biased estimates. Accordingly, spatial dependence needs to be considered in econometric models in order to capture the determinants of regional export performance in its full economic and spatial extent (Anselin, 1988a; Anselin and Lozano-Gracia, 2009). In so doing, one can incorporate the structure of spatial interaction effects that might be in the forms of within dependent variable, across independent variables, or across error terms (Manski, 1993), which can be expressed as a generic spatial nesting model as the following (Elhorts, 2014);

$$Y = \alpha + X\beta + WX\theta + \rho WY + \mu$$
$$\text{where } \mu = \lambda W\mu + \varepsilon$$

where Y is the dependent variable, X is independent variable(s), ε is independently and identically distributed error term, and W is the spatial weights matrix. WY represents the interaction effects within dependent variable, WX the interaction effects from independent variables, and Wμ the interaction effects across the disturbance terms of spatial units.

Using this nesting model, several types of spatial models can be defined by imposing restrictions on the parameters of θ, ρ, and λ. Spatial Autoregressive Model (SAR), Spatial Error Model (SEM), and Spatial Durbin Model (SDM) are, however, the ones that have been the most widely used, and provide the most relevant combinations of constraints to encompass the types of spatial dependence (Elhorst, 2014).

SAR introduces the association between export performance levels of the province with export performance levels of its neighboring provinces in the model. By imposing θ=0 and λ=0, this association can be expressed by:

$$Y = \alpha + X\beta + \rho WY + \mu$$

Intuitively, the model states that export performance (Y) in each province is associated with the average export performance of the neighboring provinces. However, it does not make any assumptions about the direction of this association. Provincial export performance can benefit from high performing neighbors from variety of channels including increased economic activity created by industry linkages, information spillovers, and ability to attract skilled workers from the labor markets developed in nearby areas. All these are expected to result in a positive association (i.e. a positive sign for ρ) between the individual province's export performance and the average export performance of the neighbors. Conversely, the provinces with high export performance can pull resources from the export sectors of the neighboring provinces. These can include the fact that high performing neighbors can attract exporting firms and skilled workforce which seek to benefit from being located or employed in these provinces. These regions can potentially hurt the local economy and export performance in their neighboring regions. The economic forces, however, do not all need to be in the same direction. For example, high performing provinces may hurt labor market in neighboring provinces by pulling the skilled workers, but they can also attract firms outside the region that would benefit the overall economy in the entire neighborhood with industry linkages. Thus, the overall economic impact from having high (or low) performing provinces will be a combination and interaction of these different forces. Additionally, the average export performance in the neighboring provinces can come from a heterogeneous distribution. Some neighboring provinces can be high performing while others performing below the average of the other neighbors. The overall economic association will be, again, a complex combination and interaction of the effects from the export performances of all neighboring provinces.

SEM also assumes a single source of spatial dependence similar to SAR, but instead of the spatial lag of the dependent variable, SEM introduces the existence of the spatial covariance of errors of spatial units. By imposing θ=0 and ρ=0, this association can be expressed by:

$$Y = \alpha + X\beta + \mu$$

$$\text{where } \mu = \lambda W\mu + \varepsilon$$

Thus, SEM captures the spatial dependence beyond what can be attributed to the significance of the spatial lag of the dependent variable in the neighboring spatial units. The spatial dependence is modeled to introduce the other factors in the neighboring units that can be associated with the dependent variable in a province. This specification assumes that spatial association between provinces is caused by unobserved characteristics which are assumed to follow a spatial pattern or to be spatially clustered. In addition, the spatial dependence structure in SEM assumes that there is no statistically significant association between the dependent variable and the spatial lags of the independent variables. This assumption ensures that the estimated spatial association is not the spatial lags of independent variables that are already in the model, but it is the impact expected to be created by unobservable characteristics. Thus, SEM aims at including the omitted information regarding the neighboring provinces into the econometric model to solve the potential endogeneity caused by the exclusion of the spatial information. Furthermore, SEM can introduce the information regarding several neighboring characteristics into the model. For example, the impact of the natural disasters or social unrest in the neighboring provinces on the provincial export performance are difficult to quantify and include in the model. SEM specification can allow the model to control for and estimate these characteristics. These are particularly important to be added in the model if these characteristics are densely clustered in certain sub-regions creating spatial heterogeneity.

SDM introduces the existence of both a spatially lagged dependent variable and spatially lagged independent variables, which can be expressed by imposing only λ =0 as:

$$Y = \alpha + X\beta + WX\theta + \rho WY + \mu$$

SDM incorporates the spatial lag of the dependent variable, WY, as well as the spatial lags of independent variables, WX. The motivation for SDM comes from the fact that omitted variables in spatial regression models result in data generating processes that involve the spatial lags of independent variables (LeSage and Pace, 2009). In export performance context, it assumes that the export performance is associated with the spatial lags of independent variables in the neighboring provinces as well as the average export performance of these neighboring provinces.

3.3. INCORPORATING THE POTENTIAL HETEROGENEITY IN THE IMPACTS OF SPATIAL SPILLOVERS AND AGGLOMERATION: SPATIAL REGRESSION WITH FINITE MIXTURE MODELLING

So far, spatial panel regression models assume homogenous impacts of spatial spillovers and the other regressors on exports. Particularly, the spatial dependence structure can be uniform across all the subpopulations (i.e in our sample provinces), but it can also be heterogeneous across subpopulations based on certain characteristics.

Finite mixture models (FMMs) are commonly used to model this type of heterogeneity and to provide a framework for clustering/classification. Based on the idea that the observed data may belong to unobserved subpopulations, called *latent classes*, FMMs are useful tools for capturing and modeling unobserved heterogeneity in addition to allowing for classifying observations and creating model-based clustering (Deb and Trivedi, 2011). They allow for estimating the parameters of interest for each subpopulation differently, as opposed to a single estimation for the overall mixed population. Thus, FMMs can be used to model mixtures containing a finite number of subpopulations and allow the inclusion of covariates with subpopulation-specific effects. They also allow for making inferences about each subpopulation (Deb and Trivedi, 2013).

The most general form of a mixture function is (Melnykov and Maitra, 2010):

$$f(x;\pi) = \sum_{k=1}^{K} \pi_k \, f_k(x)$$

where K represents the total number of components, π_k represents the probability for the observation x_i belonging to the k-th subpopulation with corresponding density $f_k(x)$ with $0 \leq \pi_k \leq 1$, k = 1, 2, . . . , K and $\sum_{k=1}^{K} \pi_k \; = 1$

In the FMM framework, it is assumed that each subpopulation has its own distribution and corresponding probability of representation. Following this assumption, k-th subpopulation have the density of $f_k(x;v_k)$ and the probability of inclusion in the sample as π_k. Under this setup, the observations π_i can be a sample from the following form:

$$f(x;v) = \sum_{k=1}^{K} \pi_k \, f_k(x;v_k) \qquad (1)$$

This model can be used to present a partition of the data into subpopulations of homogeneous observations by assigning each observation to different groups. In doing so, the model is assumed to use latent variables, which are not observable and can be interpreted as hidden values which the algorithm should compute (McLachlan and Peel, 2000). In the meantime, the parameter π may be further parameterized using other functions (e.g a logit function) or treated as a constant (Cameron and Trivedi, 2005).

While mixtures of different distributions have been used in estimations, Gaussian distributions have become by far the most preferred method (Melnykov and Maitra, 2010).[7] Non-Gaussian applications include using Poisson distributions to document classification in information retrieval (Li and Zha, 2006), and using the von Mises-Fisher distributions for analyzing text and gene expressions (Banerjee et al, 2005).

The estimation of the log likelihood of FMMs is burdensome and thus sometimes, the traditional Newton-Raphson algorithm works poorly when estimating them. Newton-Raphson algorithm is also sensitive to initial values and contains problems of local maxima (Cameron and Trivedi, 2005). Thus, for estimating FMMs, the method of maximum likelihood (ML) estimation is implemented via expectation-maximization (EM) algorithm (Melnykov and Maitra, 2010). For the implementation of the EM algorithm, the assumption is that there are some missing observations, namely the group identifiers. These missing observations will yield the so-called complete data, in conjunction with the observed data. The resulting complete likelihood function can be readily maximized; unlike the likelihood function for a sample from (1), whose form is complicated and more difficult to apply any analytical solutions or numerical optimization. Thus, EM procedure is used to find the ML estimate in FMMs and model-based clustering, as in other complicated multi-parameter situations (Melnykov and Maitra, 2010).

The EM algorithm consists of the expectation (E) and the maximization (M) steps and is an iterative procedure. The posterior probabilities are calculated at the E-step of the s-th iteration as follows (Melnykov and Maitra, 2010):

$$\pi_{ik}^{s} = Prob\,\{X_i \in k - th\ cluster | X_i;\ v^{s-1}\}$$

$$= \frac{\pi_k^{s-1}\, f(x_i; v_k^{s-1})}{\sum_{k'=1}^{K} \pi_k^{s-1} f(x_i; v_{k'}^{s-1})}$$

The expected conditional loglikelihood, which is denoted as Q-function, is maximized at the M-step with respect to the parameter vector v: $Q(v; v^{s-1}, x_1, x_2, \ldots, x_n)$. The ML

[7] Examples include, but not limited to, Fraley and Raftery (2006), Fruhwirth-Schnatter (2006), and McLachlan and Peel (2000).

estimate $\hat{v}$ for the original observed data is obtained with the iteration of the E- and M-steps until convergence.

The density function for the Gaussian mixtures, which is the most popular option in finite mixture models as indicated above, is as follows (Melnykov and Maitra, 2010):

$$f(x; v) = \sum_{k=1}^{K} \pi_k \, \emptyset(x; \mu_k, \Sigma_k)$$

where μ_k is the mean vector and Σ_k the dispersion matrix for the k-th component normal density, which is given by:

$$\emptyset(x; \mu_k, \Sigma_k) = (2\pi)^{-\frac{p}{2}} |\Sigma_k|^{-\frac{1}{2}} \, exp\left\{-\frac{1}{2}(x-\mu_k)' \Sigma_k^{-1} (x-\mu_k)\right\}$$

The Q-function is given by:

$$Q(v; x_1, x_2, \dots, x_n) = -\frac{1}{2} \sum_{i=1}^{n} \sum_{k=1}^{K} \pi_{ik} \left\{ \log|\Sigma_k| + (x-\mu_k)'^{\Sigma_k^{-1}} (x-\mu_k) \right\}$$

$$+\frac{1}{2} \textstyle\sum_{i=1}^{n} \sum_{k=1}^{K} \pi_{ik} \, log\pi_k - \frac{pn}{2} \log 2\pi$$

Updating the posterior probabilities π_{ik}^{s} is done at the E-step using the current parameter estimates v^{s-1}:

$$\pi_{ik}^{s} = \frac{\pi_k^{s-1} \, \emptyset(x_i; \mu_k^{s-1}, \Sigma_k^{s-1})}{\sum_{k'=1}^{K} \pi_{k'}^{s-1} \, \emptyset\left(x_i; \mu_{k'}^{s-1}, \Sigma_{k'}^{s-1}\right)}$$

The exact formula for the EM update of Σ_k can be different since the covariance matrix Σ_k can have various structures. As in Melnykov and Maitra (2010), assuming that Σ_k is a general unstructured dispersion matrix, the convenient closed-form solutions at the M-step can be given as follows:

$$\pi_k^{(s)} = \frac{1}{n} \sum_{i=1}^{n} \pi_{ik}^{(s)}$$

$$\mu_k^{(s)} = \frac{\sum_{i=1}^{n} \pi_{ik}^{(s)} \, x_i}{\sum_{i=1}^{n} \pi_{ik}^{(s)}}$$

$$\Sigma_k^{(s)} = \frac{\sum_{i=1}^{n} \pi_{ik}^{(s)} \, (x_i - \mu_k^{(s)})(x_i - \mu_k^{(s)})'}{\sum_{i=1}^{n} \pi_{ik}^{(s)}}$$

There are various methods to decide convergence, i.e. stopping EM iteration, but some of them, for example using the convergence of v^s, are too complex if the number of parameters is large. The most commonly used method is terminating the EM when the relative increase in the likelihood function becomes negligible (McLachlan and Peel, 2000). In this respect, Böhning et al (1994) use Aitken's acceleration to find the limiting value for the sequence of log likelihood values, which is named as the Aitken's rule. The stopping criterion they introduced is as follows:

$$|l_A^{s+1} - l_A^s| < \epsilon$$

where ϵ is the tolerance level and l_A^s is the Aitken accelerated estimate of the limiting value such that:

$$l_A^{s+1} = l_A^s + \frac{l_A^{s+1} - l_A^s}{1 - \frac{l_A^{s+1} - l_A^s}{l_A^s - l_A^{s-1}}}$$

The number of groups in the model, on the other hand, is not known a priori. This is the main advantage of FMMs over other clustering techniques since the number and elements of the groups are endogenously inferred from the data (De Graaff et al., 2009). One potential limitation is that simply the presence of outliers can lead to estimation of additional components. Nevertheless, this is not necessarily detrimental to the estimation quality as it reflects the true nature of the distribution (Cameron and Trivedi, 2005).

An important issue to note is that for estimating the number of groups, relying on maximum likelihood may result in overfitted solutions where the true distribution behind the data has fewer components than estimated (Celeux et al., 2018). For example, in some cases the procedure can estimate one component per each observation. Thus, a balance between fit versus generality is needed. The most commonly used methods for that purpose are the penalized likelihood approaches where the negative log likelihood function, augmented by some penalty function to reflect its complexity, is minimized. These include information-based criteria such as Akaike information criterion (AIC), Bayesian information criterion (BIC) and their modifications. AIC and BIC are the most well-known and most commonly used ones and they have been proved to perform well in simulation studies (McLachlan and Peel, 2000). Thus, using AIC and BIC, the selection of the number of subpopulations can simply be done by comparing the information criteria for FMMs with K and K+1 components until the values stop decreasing.

CHAPTER 4. VARIABLE DESCRIPTION, ECONOMETRIC STRATEGY, AND EMPIRICAL RESULTS

This section provides the details of the variables used in the operationalization of the economic determinants of the provincial export performance introduced in the previous section. This is followed by the step-by-step explanation of the empirical strategy and provides the estimation results.

4.1. VARIABLE DESCRIPTION

The dataset is extracted from three sources: Turkish Statistical Institute's (TSI) regional statistics database, Ministry of Development's provincial distribution of public investments yearbooks, and Port Operators Association of Turkey. The sample covers panel data from 81 provinces (NUT-3 regions of Republic of Turkey) over the 2004-2018 period. The description and sources of variables are presented in Table 1.

Table 1: Descriptions of Variable and Sources

Variable	**Description**	**Source**
EXPORTS	Total value of manufacturing exports in the province in real Turkish liras (2019 prices, billion, in logarithmic form)	TSI-Regional Statistics (Foreign Trade)
AGGLOMERATION		
URB	Total provincial population (million, in logarithmic form)	TSI- Regional Statistics (Population and Migration)
LOCAL	Share of manufacturing firms in the provincial economy as a ratio of its share in the national economy measured by $L_{jt} = (M_{tj}/T_{tj})/(M_{tN}/T_{tN})$ where M is the number of manufacturing firms, T is total number of firms, j is	Ministry of Industry and Technology (Entrepreneurs Information System)

	the province, and t is the year, and N indicates national level (in ratio form)	
CONNECTIVITY		
MOTORWAY	Total length of the inter-provincial motorways in the province (measured in kilometer and in logarithmic form)	TSI-Regional Statistics (Transportation)
RAILWAY	Total length of the railways in the province (measured in kilometer and in logarithmic form)	TSI-Regional Statistics/Transportation
PORTDISTANCE	The closest distance from city center to the nearest port (measured in kilometer and in logarithmic form)	MARLIM- The Port Operators Association of Turkey
PRODUCTIVITY		
EDUCATION (High School)	The provincial population (15 years old and above) who graduated from high school or vocational school as a share of the total provincial population, in percentage (in ratio form)	TSI-Regional Statistics/ Education
EDUCATION (Undergraduate)	The provincial population (15 years old and above) who hold an undergraduate degree as a share of the total provincial population, in percentage (in ratio form)	TSI-Regional Statistics/Education
PUBLIC INVESTMENT		
PINV	Total value of government capital expenditure in the province in real Turkish liras (2019 prices, billion, in logarithmic form)	Presidency of Strategy and Budget (Provincial Distribution of Public Investments Yearbooks)

Table 2 presents the summary statistics for the pooled variables. The average of export performance is TRY 6.5 billion and while its median is only TRY 0.4 billion. The mean being much greater than the median indicates that the number of provinces with below-average exports are larger than the number for provinces with above-average, showing that the distribution of the export performance is positively skewed. As explained earlier in Section 2, this is expected particularly given that top 5 provinces account for 3/4 of the total exports.

Table 2: Summary Statistics

Variables	Min	Mean	Median	Max
EXPORTS	21(x10^{-6})	6.5	0.4	474
URB	0.74	0.95	0.51	15.1
LOCAL	0.6 (x10^{-6})	0.9	1	1.07
MOTORWAY	33	110	81	513
RAILWAY	5	120	136	717
PORTDISTANCE	15	251	212	882
EDU(High School)	9	20	21	31
EDU(Undergraduate)	2	9	10	24
PINV	134	670	530	8,742

Source: Author's calculations

4.2. ECONOMETRIC STRATEGY

In this sub-section, several tests are performed for estimation purposes. First, spatial dependence is tested to decide if spatial econometric modelling is needed. This requires identifying the right weights matrix characterizing the neighborhood relationships among spatial units. Second, we perform the tests for the poolability of panel data, the test for the choice between fixed or random effects modelling and the test for the existence of time effects to employ suitable panel regression techniques. Finally, we check if the clustered structure is present across provinces in terms of the impacts on export of spatial spillovers and the other regressors.

4.2.1. Testing Spatial Dependence

The first step to decide whether to integrate the spatial dependence into any econometric models is to test its presence by a specification test. The most commonly used test for spatial dependence is derived from a statistic that Moran (1948) developed. In matrix notation, it can be shown as:

$$I = \frac{e'We}{S} * \frac{N}{e'e}$$

where *e* is the vector of OLS residuals, *N* is the sample size, *W* is spatial weights matrix where each spatial unit is represented in the matrix by a row *i* and a column *j* and i,j=1,…,N. $S=\sum i \sum j w_{ij}$ is the sum of spatial weights.

In order to further simplify the formula, rows of the weight matrix are very commonly standardized to add up to 1. In this case $S=\sum i \sum j w_{ij}$ becomes equal to N, and the statistic reduces to:

$$I = \frac{e'We}{e'e}$$

In this formula, the spatial weight matrix is constructed based on several choices that need to be made, including definition, structure and order.

First, in the spatial weights matrix, w_{ij} is an element indicating the neighbor structure between the observations as binary relationship taking the value 1 if the two provinces are neighboring and 0 if otherwise. This neighbor structure, developed by Moran (1948), relies on the simple concept of spatial contiguity and assumes the existence of clear-cut boundaries between spatial units. When spatial units are regions or provinces with pre-defined administrative borders, binary relationships can be easily derived from administrative border maps. However, when spatial units are irregularly located in space without clear-cut borders, contiguity can only be derived by using somewhat arbitrary networks and shortest paths across the defined spatial units (Anselin, 1988a). This study uses provincial data where the borders are pre-defined and did not change in the assessment period. Therefore, spatial contiguity is used in the weights matrix.

The second issue is the selection of the best-fitting neighborhood structure. Binary contiguity weights can be constructed using different neighborhood structures such as rook (i.e. vertical and horizontal neighboring), bishop (i.e diagonal neighboring), or queen (i.e vertical, horizontal and diagonal neighboring) (Anselin and Rey, 2014). As there is usually no theoretical justification to ignore either of the rook or bishop neighbor structure, the queen neighboring structure is the most commonly used one. Similarly, in this study, there is no spatial economic reason to assume any sort of difference between being horizontal, vertical, or diagonal neighborhood structures. Therefore, the queen neighborhood, which is the most comprehensive of all, has been adopted as the applicable structure.

The third issue is the order of contiguity in the spatial weights. In spatial models, by default, only the association between the first level neighbors is investigated. Nevertheless, certain special economic phenomena may, at least theoretically, require considering the spillovers from neighbor's neighbors. By incorporating a higher order of contiguity in the matrix this issue can be addressed. Nevertheless, there is no theoretical justification nor empirical evidence in export performance literature to introduce contiguity relationships higher than one. Therefore, the order of 1 is used in constructing the connectivity relationships.

With this framework, we calculated Moran's I statistic for the entire period using the 81x81 provincial queen contiguity first order weights matrix. According to the descriptive spatial statistics, the number of neighbors each province has widely varies. For example, being small and located in a border area, Kilis province has only one neighbor. On the other hand, some other provinces such as Konya and Erzurum being landlocked and large, have 9 neighbors. The average number of neighbors per province is approximately 5.

As seen in Table 3, there is a strong spatial dependence in export performance variable with statistically significant coefficients across all years. Moran's I values for the export performance are positive which indicate the fact that similar values tend to cluster spatially. In other words, high values (e.g provinces with higher export figures) are near other high values, while low values are near other low values. This is in line with the fact that western provinces, on average, perform better than the eastern provinces in most economic indicators, as visualized in Maps 1 and 2 for export performance, and the fact that Turkey has large regional disparities running along the east–west axis (World Bank, 2014b). Thus, there is a need for the spatial spillovers to be incorporated into the econometric model to control for the spatial dependence structure.

Table 3: Moran's I Calculations

Year	Value	Year	Value
2008	0.04**	2014	0.05***
2009	0.04***	2015	0.04***
2010	0.08***	2016	0.04**
2011	0.09***	2017	0.05**
2012	0.07***	2018	0.05***
2013	0.05***		

Source: Author's calculations

4.2.2. Testing the Poolability of Panel Data, the Choice of Fixed or Random Effects Modeling, and Fixed Effect Filtered Estimation Technique

As panel data cover multiple cross-sections (provinces) and years, the existence of the province-specific effects needs to be tested to assess the poolability of the data for estimation. For this purpose, an F-test is performed by comparing the following nesting spatial model:

$$Y_{it} = \alpha + X_{it}\beta + WX_{it}\theta + \rho WY_{it} + \lambda W\mu_{it} + \varepsilon_{it}$$

with the following fixed effects model,

$$Y_{it} = \alpha + X_{it}\beta + WX_{it}\theta + \rho WY_{it} + \lambda W\mu_{it} + \varepsilon_{it} + z_i$$

We test the null-hypothesis that H_0: $z_i = 0$, where z_i is the province-specific effects, and i=1,...81 is the index of provinces. F-statistics can be calculated by:

$$F = \frac{SSR_r - SSR_{ur}}{SSR_{ur}} * \frac{n-k-1}{q}$$

where SSR_r is the sum of squared residuals from the restricted (i.e the original/pooled) model, SSR_{ur} is the sum of squared residuals from the unrestricted model, and n-k-1 is the degrees of freedom with n is number of observations and k is the number of independent variables (Wooldridge, 2009). The calculated F statistics turns out to be $F(80, 724) = 61.98$ with a p-value close to zero and thus we reject the null, suggesting that province specific effects needs modeling.

The next question is whether to model province-specific effects as fixed or random. To this end, Hausman (1978)'s test is performed which compares the parameters with fixed (β_{FE}) and random (β_{RE}) effects models with the null hypothesis of:

$$H_0 = \beta_{FE} = \beta_{RE}$$

The estimators of fixed and random effects are both consistent if we do not reject H_0. In this case, since it is more efficient, we can choose the random effects estimator. If we reject H_0, on the other hand, the fixed effects estimator is consistent while random effects is not, and thus fixed effects estimator should be chosen. Based on this approach, a Chi-squared test following Wald criterion is undertaken (Greene, 2018):

$$W = \chi^2(k-1) = (\beta_{FE} - \beta_{RE})' \, \Psi^{-1} \, (\beta_{FE} - \beta_{RE})$$

where Ψ is the estimated covariance matrices of the slope estimator in fixed effects and the random effects models (i.e $[S_{\beta FE} - S_{\beta RE}]$). We calculate $Chi^2(5) = 91.40$ with a p-value of close to zero, suggesting that the fixed effects estimator is chosen over random effects estimator.

Finally, we perform an F-test on the existence of the time-fixed effects. We calculated $F(9, 715) = 4.56$ with a p-value of close to zero, which shows that time dummies should also be added in the model.

At this juncture, it is critical to note that all explanatory variables in the model are time-varying except for PORTDISTANCE. As there exists a perfect collinearity between (province) fixed effects and time-invariant variables (e.g PORTDISTANCE) the parameters cannot be estimated individually. To see the impact of PORTDISTANCE with fixed effects modeling, there is a recent estimation technique, fixed effect filtered

(FEF), suggested by Pesaran and Zhou (2014). Thus, to handle this issue, this study employs FEF estimation technique as well, which requires a two-step estimation process. In the first step, the spatial regression with fixed effects is estimated using only the time-varying variables, from which the residuals are obtained. In the second step, the time averages of the residuals are calculated, which are then regressed on time-invariant observable variable(s).

4.2.3. Testing the Presence of Clustered Impacts of Spatial Spillovers and Agglomeration

Once we decide on the right spatial and panel data technique, using FMM, we can investigate whether the observed distribution of export performance among provinces can be a mixture of more than one distribution with differing means and variances. If there are more than one subpopulation (i.e. cluster), we need to estimate the regression parameters for different classes. Thus, as a first step we test the existence of more than one class in an endogenous structure.

As mentioned before, the number of groups are estimated endogenously and not known a priori. Thus, we start with one class model and increase the number of classes one-by-one. We use the information criteria (AIC and BIC) to evaluate the models to identify the one fits the data the best.

Owen et al. (2009) points to the potential problem of results being spurious where we have singularities (or near-singularities) in the likelihood function. They indicate that in this case, the results would not be meaningful even though a maximum in the likelihood function can be identified by the maximization algorithm and a good fit is indicated by the fit statistics. They refer to McLachlan and Peel (2000) and indicate that one can analyze the error variances of the growth regressions in order to verify that the solution is not spurious. The error variances being close to zero would show that the result is spurious. Similarly, once we choose our preferred model, we check whether the estimated error variances are significantly different from zero.

Table 4 below shows the fit statistics from one to three classes. The information criteria suggest that a 2-Class model fits the data better than the 1-Class model does. We increase the class number to 3, but it does not reduce the AIC and BIC values, and thus it does not fit better than the 2-Class model does. Therefore, we conclude that 2-Class model fits the data better than do any other multiple class model. This shows that the parameter estimates of the export performance differs across two groups.

Table 4: Fit Statistics for the Models with Different number of Classes

Regression	AIC	BIC	Log Likelihood
1-Class	1,509	1,927	-665
2-Class	964	1,800	-304
3-Class	1,119	2,115	-347

Source: Author's calculations

In addition, when we run the 2-Class model, we do not get a spurious result since we find the estimated error variances to be significantly different from zero. Table 5 reports the findings on the residuals of the 2-Class model to be non-zero both in class-one and class-two.

Table 5: Error Variances from the two classes of the 2-Class model

	Mean	Min	Max
Class-1			
Residuals	11.66*** (3.99)	2.15	17.73
Class 2			
Residuals	13.51*** (5.38)	2.29	20.35

Source: Author's calculations
Note: t-values are in parenthesis and significance at 1% (***), 5% (**), and 10% (*) levels are indicated.

4.3. EMPIRICAL RESULTS AND DISCUSSION

We start the empirical analyses with the nested spatial regression with province and time specific effects using panel data from 81 provinces over 2008-2018 period. Since we have to exclude the time-invariant variable PORTDISTANCE for this first step of estimation;

as a second step, we apply FEF estimation to see the impact of PORTDISTANCE on export performance. Finally, in the third set of estimations we apply finite mixture modeling of the spatial regression to take a deeper look at the subpopulation characteristics of the spatial spillovers and agglomeration economies.

4.3.1. Estimation Results from Spatial Econometric Model

In order to assess the best-fitting spatial dependence structure, we make use of model selection criteria by Akaike (1974) (AIC)[8] and Schwarz (1978) (BIC)[9], which are reported at the bottom panel of the table. As seen, SAR, with smaller AIC and BIC values, fits the data better than does SEM or SDM. Additionally, the spatial autoregression coefficient (i.e ρ for WY) is consistently negative and significant in both SAR and SDM models. The spatial error coefficient (i.e λ for Wμ), however, is insignificant. Considering together with the model selection criteria, it is clear that spatial dependence structure is characterized by a spatial autoregressive process rather than a spatial error process. Nonetheless, it is worth looking at more specifics on the individual spatial models. The negative sign in the spatial coefficient in **SAR** indicates that negative spatial spillovers emanate from the high export performance itself given the spatial dependence structure introduced in the model considers only the spatial lag of the dependent variable. In **SEM**, the insignificant spatial error coefficient indicates that spatial dependence does not operate through a spatial error process. Thus, the negative spillovers from the neighboring provinces work through the high export performance in neighboring provinces and not from unobservable characteristics of the neighboring provinces. As mentioned earlier, **SDM** does not constrain the spatial dependence to a single source and thus captures spatial autoregressive structure in export performance and the effect of the spatial lags of the independent variables. The spatial lag of the export performance is significant and negative in SDM, which is consistent with the estimation result in SAR. This indicates that even when the spatial lags of the independent variables are controlled for, spatial autoregressive process is still significant and negative. From a practical point of view,

---

[8] AIC (i.e Akaike information criterion) is $-2 \ln L + 2k$; where lnL is the maximized log-likelihood of the model, and k is the number of parameters estimated.

[9] BIC (i.e Bayesian information criterion) is $-2 \ln L + k \ln N$; where lnL is the maximized log-likelihood of the model, and N is the sample size.

being surrounded by high performing provinces brings additional adverse impacts on the provincial export performance of regions compared to other provinces with similar neighbors in terms of agglomeration, connectivity, productivity, and public investment. However, as seen from the spatial lags of the independent variables in SDM reported in Table 7, the spatial dependence structure introduced by the spatial lags of the independent variables are all insignificant except for localization interaction. This is in line with the model selection results that the introducing the joint effects of the spatial lags of the independent variables do not make SDM a better fit than SAR. In short, SAR model turns out to be a preferred specification for spatial dependence structure and thus we focus on the SAR results to further interpret the findings.

Table 6: Estimations for Provincial Export Performance (EXPORTS)

(Productivity is measured by EDU (Highschool))

Main Variables	**SAR**[1]	**SEM**[2]	**SDM**[3]
URB	2.70***	2.62***	2.14**
	(3.49)	(3.83)	(2.59)
LOCAL	5.22**	3.99	1.78
	(1.97)	(1.36)	(0.05)
EDU(High School)	0.08***	0.15***	0.13***
	(5.32)	(2.92)	(2.23)
MOTORWAY	0.03	0.03	0.03
	(0.67)	(0.85)	(0.82)
RAILWAY	0.01	0.02	0.06
	(0.01)	(0.16)	(0.63)
PINV	0.16**	0.16**	0.14**
	(2.19)	(2.35)	(2.01)
Spatial Variables			
Spatial autoregressive (SPAUT) (WY)	-0.23**		-0.16***
	(-2.37)		(-2.53)
Spatial error (Wμ)		-0.15**	
		(-2.36)	
Coefficient of determination			
R-squared	0.56	0.61	0.62
within	0.27	0.26	0.26
between	0.58	0.63	0.64
Tests			
Model Significance, F-test	0.000	0.000	0.000
AIC	1193.565	1353.4	1346.6
BIC	1230.298	1433.3	1449.6

Notes:
1: Spatial autoregressive model using maximum likelihood estimator, with provincial and time fixed-effects.
2: Spatial error model using maximum likelihood estimator, with provincial and time fixed-effects.
3: Spatial Durbin model using maximum likelihood estimator with provincial and time fixed-effects.

- All regressions are with 891 observations.
- t-values are in parenthesis and significance at 1% (***), 5% (**), and 10% (*) levels are indicated.
- All the variables are in logarithmic forms except for the variables measured as ratio, i.e *LOCAL* and EDU(*Highschool*).

Table 7: Spatial Lag Coefficients from SDM

Variable	Value	Variable	Value
W URB*	1.40 (1.13)	*W* RAILWAY*	0.45 (1.57)
W LOCAL*	11.30** (2.26)	*W*EDU (Highschool)*	0.03 (0.32)
W MOTORWAY*	0.55 (0.69)	*W* PINV*	0.16 (1.08)

- Spatial Durbin model using maximum likelihood estimator with provincial and time fixed-effects.
- t-values are in parenthesis and significance at 1% (***), 5% (**), and 10% (*) levels are indicated.

Turning back to SAR results in Table 6, the finding of a negative association between the spatial autoregression coefficient and the export performance is in line with the hierarchical system of regions hypothesis (Krugman, 1995; Fujita et al, 1999) which posits negative spillovers from the high performing regions to their neighbors. As production and export centers pull skilled labor, firms, and investments from surrounding areas, being neighbors with high performing provinces has a negative impact on the provincial export performance. This finding indicates that even though peripheral provinces can offer lower productions costs (e.g lower rents and wages, tax deductions) that potentially attract exporting firms, this spatial advantage can be offset by the centripetal forces in the high-performing core regions generated by larger economies of scale. In their seminal works Kaldor (1970) and Dixon and Thirlwall (1975) explain the difference in central-periphery export performance by the cumulative causation where increasing returns give early developed regions advantages in exports with higher labor productivity. The growth pole theory supports this argument from the perspective that well-established industry linkages provide production and export advantages to clustered firms through supply chains (Hirschman, 1958). Moreover, localized industrial growth provides large firms with the higher innovation capacity with larger economies of scale supporting technically advanced industries (Perroux, 1950; Brulheart, 1998) contributing to their competitiveness in international markets. From the point of export-base theory, increase in the exports of the regions lead to a multiple effect by inducing increased investments in all other economic activities as well (North, 1955). Thus, growth in the exports help leading regions to maintain their positions as centers of capital, skills and specialized services at least until interregional transfer costs becomes less significant.

In the context of Turkey, long-lasting regional development disparities between western and eastern regions add an additional complexity to the traditional central-periphery relationships. In Turkey, there is a two-layered spatial dependence structure. At the upper layer, as evident from the mapping and the descriptive statistics of the export performance in previous section, the western provinces have higher export performances on average than the eastern provinces. At the bottom layer, regardless of their location within the country, provinces with higher-performing neighbors are disadvantaged in export performance due to center-periphery relationships, bringing negative spillovers.

On the agglomeration economies side, the coefficients of both *URB* and *LOCAL* are positive and significant which suggests i) the larger the provincial diversity the higher the export performance and ii) as the intensity of manufacturing firms relative to other sectors increases, so does the provincial export performance. Therefore, Turkish provinces seem to benefit both from having large diverse domestic markets (i.e urbanization economies) and spatially concentrated manufacturing firms (i.e localization economies). On the one hand, even when the effect of sectoral concentration is controlled for, the market size still matters for provincial exports. On the other hand, even when the market size is controlled for, the spatial concentration of manufacturing still has a significant association with export performance. Thus, there appear individual benefits from having larger markets and having sectoral concentration in provincial export performance. Moreover, the negative spatial spillovers along with positive agglomeration economies show that provinces benefit from their own economic size and concentration but are hurt by their neighbor's performance. This finding is in line with the World Bank's that within countries agglomeration and city-periphery integration give rise to leading areas of dense economic mass (World Bank, 2009), while other places lag behind, particularly in developing countries. Overall, these results complete the picture on the spatial determinants of the export performance in Turkey in favor of the center-periphery models. As some provinces become centers of export performance enabled by agglomeration economies, they pull resources from their neighbors and hurt the export performance of their neighboring provinces.

Two of the connectivity variables, *MOTORWAY* and *RAILWAY* are insignificant[10]. This finding can be resulting from the fact that the investments to expand the motorway and railway networks, and thus the eventual total motorway and railway lengths, are in association with other factors than the expected gains in economic growth or export performance. In fact, transport infrastructure investments have been an important tool in reducing large regional economic disparities in the country (World Bank, 2012) and particularly the quickly expanded road network has targeted to provide economic opportunities to the economically lagging regions (World Bank, 2015) as opposed to further accelerating the growth in regions that are already performing better. In literature there are not many studies on Turkey estimating export performance with road length to compare this finding. Among the few exceptions, Celbis et al (2014) develops an index from highway, road, and railroad lengths and finds positive but insignificant coefficient as well (in the estimation of bilateral value of regional total exports). Similarly, national level estimations of the Kustepeli (2012) finds no long-run relationships between highway infrastructure and the national export performance. Another study, Cosar and Demir (2016) estimates specifically the transportation infrastructure in moving goods, particularly the time-sensitive goods, from the factory gate to the ports and finds significant relationship. These initial findings suggest that the overall road transport infrastructure does not provide the expected export performance benefits, but specific elements in the infrastructure such as the focus on certain types of goods (e.g time-sensitive goods) or certain connections (e.g connections to port facilities) might do.

The coefficient of *PINV* is significantly positive, indicating the importance of government capital expenditure for the provincial export performance. This is expected given the fact that more investments in the provinces can support the productive capacity and better government services, contributing to the production and export performance.

Productivity variable, *EDU(Highschool)*, is positively and significantly related to export performance. However, when we measure productivity by *EDU(Undergraduate)*, the effect turns out insignificant as reported in Table 8. These results might suggest that the improvements in education level contribute to export performance up until undergraduate level. In other words, provincial exports do not seem to be sensitive to the level of labor

---

[10] When PINV is excluded from the regressions both MOTORWAY and RAILWAY are still insignificant, indicating that they are not insignificant due to fact that PINV is capturing their effect.

skills once high school level is exceeded. In fact, Turkey's high-technology exports as a share of total manufactured exports (which supposedly requires higher overall skills) is only 2%. In countries with comparable GDP per capita levels, this figure is much higher (Brazil: 13%, Bulgaria: 10%, China: 31%, Mexico: 21%, Russia: 11%)[11]. Thus, the reason why improvement in the local skills after a certain threshold does not support provincial exports may be due to the current technology use in the production of the exported goods and the subsequent skill requirements.

[11] The World Bank, World Development Indicators: United Nations, Comtrade database through the WITS platform. (accessed on September 26th, 2020) https://data.worldbank.org/indicator/TX.VAL.TECH.MF.ZS?most_recent_value_desc=false)

Table 8: Estimations for Provincial Export Performance (EXPORTS)

(Productivity is measured by EDU (Undergraduate))

Main Variables	SAR[1]	SEM[2]	SDM[3]
URB	3.69***	3.07**	2.41***
	(4.93)	(2.13)	(2.93)
LOCAL	5.40**	2.823***	0.03***
	(1.97)	(3.59)	(2.60)
EDU(Undergraduate)	0.07	0.03	0.04
	(0.02)	(0.98)	(1.13)
MOTORWAY	0.03	0.05	0.03
	(0.08)	(0.98)	(0.66)
RAILWAY	0.04	0.04	0.03
	(0.36)	(0.38)	(0.27)
PINV	0.22**	0.14**	0.13*
	(2.93)	(2.12)	(1.81)
Spatial Variables			
Spatial autoregressive (SPAUT) (WY)	-0.28***		-0.16***
	(3.14)		(-2.46)
Spatial error (Wμ)		-0.15**	
		(2.26)	
Coefficient of determination			
R-squared	0.59	0.67	0.70
within	0.26	0.26	0.28
between	0.62	0.69	0.67
Tests			
Model Significance, F-test	0.000	0.000	0.000
AIC	1214.002	1359.055	1347.745
BIC	1250.735	1438.905	1455.776

Notes:
1: Spatial autoregressive model using maximum likelihood estimator, with provincial and time fixed-effects.
2: Spatial error model using maximum likelihood estimator, with provincial and time fixed-effects.
3: Spatial Durbin model using maximum likelihood estimator with provincial and time fixed-effects.

- All regressions are with 891 observations.
- t-values are in parenthesis and significance at 1% (***), 5% (**), and 10% (*) levels are indicated.

- All the variables are in logarithmic forms except for the variables measured as ratio, i.e *LOCAL* and *EDU(Undergraduate).*

4.3.2. Estimation Results from Fixed Effects Filtered Model

Subsequently, to see the impact of the time-invariant connectivity variable, *PORTDISTANCE*, we apply fixed effects filtered (FEF) estimation technique. FEF estimator is calculated by regressing the time averages of the residuals from SAR in Table 6 on the *PORDISTANCE* variable, the results of which are reported in Table 9.

Table 9: FEF Estimation Results

Main Variables	
PORTDISTANCE	-0.003***
	(-5.64)
Constant	13.61***
	(77.87)
Coefficient of determination	
R-squared	0.19
Tests	
Model Significance, F-test	0.000

- Fixed effects filtered estimation with robust standard errors.
- 81 observations are used.
- Variables are in the logarithmic form.
- t-values are in parenthesis and significance at 1% (***), 5% (**), and 10% (*) levels are indicated.

PORTDISTANCE is significant and negatively associated with the export performance of the provinces in Turkey. This result is in line with empirical literature (Matthee and Naudé, 2008; Ciżkowicz et al, 2013; Celbis et al, 2014; Márquez-Ramos, 2016; Abar and Tekmanli, 2018). This indicates the natural advantage of the provinces with port as well as the hinterlands of the ports in selling their goods abroad with lower transport costs. This is in line with the fact 63% of the Turkish export goods (by value) are carried by sea and handled by ports[12], similar to global export goods (by value) at 70%[13]. In fact, all the

[12] Turkish Statistical Institute, Foreign Trade Statistics
[13] United Natıons Conference On Trade And Development, 2018, Review of Maritime Transport.

high performing provinces have at least one port in the nearby areas with the exceptions of Gaziantep and Kayseri, where exports to neighboring countries account for a significant share of total exports[14].

4.3.3. Estimation Results from Spatial Finite Mixture Model

The next step in the estimation process is to reexamine the estimation results in Table 6 in line with the findings in Table 4 that there are in fact two classes of provinces consisting of two homogenous subpopulations in terms of their association with the export performance. Table 10, below, shows the estimation results in the 1-Class versus 2-Class model.

First of all, we see that none of our control variables has differing relationship with the export performance based on subgroup characteristics. The significance and direction of these variables are the same in class-one and class-two. More specifically, EDU is positive and significant for both classes indicating the fact that upskilling labor force with formal education is strongly associated with the export performance in different local economic contexts. The same relationship pattern holds for PINV as well, PINV is positive and significant in both class-one and class-two. Our connectivity variables MOTORWAY and RAILWAY have a similar pattern as well. They are insignificant in the model assuming subpopulation homogeneity (i.e 1-Class model), and the same relationship holds both in the class-one and class-two of the model considering subpopulation heterogeneity in a two-class setting (i.e 2-Class model).

However, the spatial dependence coefficient, SPAUT, significantly differs across 1-Class versus 2-Class models with a p-value (testing coefficient homogeneity across two classes) near zero. This is reflected in the difference between the coefficients across class-one and class-two of the 2-Class model. SPAUT is negative and significant in the class-one model while it is positive and significant in the class-two. Thus, the overall negative spatial dependence structure found in the previous section does not apply to a certain subgroup of provinces. The finding of different spatial coefficients indicates that the export performance of the certain provinces is negatively associated with their neighbors' export

[14] Turkish Exporters Assembly, Export Figures, Exports per Province-Importer Country Pairs.

performance, which appears to dominate the estimation results when assumed homogeneity across all provinces as reported in Table 6 and Table 8. Nevertheless, there exists a subgroup of provinces which benefit from the higher export performance of their neighbors.

Table 10: Estimations for Provincial Export Performance (EXPORTS)

Main Variables	1-Class Model[1]	2-Class Model[2] Class-one	2-Class Model[2] Class-two	p-value[3]
SPAUT	-0.23**	-0.26**	0.09**	0.008
	(-2.37)	(2.01)	(2.25)	
URB	2.70***	5.78***	0.31	0.000
	(3.49)	(4.85)	(0.93)	
LOCAL	5.22**	0.19	0.02***	0.008
	(1.97)	(0.19)	(6.66)	
EDU(Highschool)	0.08***	0.07***	0.06***	0.576
	(5.32)	(3.5)	(8.57)	
MOTORWAY	0.03	-0.02	0.014	0.902
	(0.67)	(0.06)	(0.05)	
RAILWAY	0.01	-0.42	0.02	0.335
	(0.01)	(0.93)	(0.06)	
PINV	0.16**	0.14*	0.80**	0.627
	(2.19)	(1.66)	(2.66)	
Constant	-23.11***	-64.4***	7.17	0.000
	(-2.27)	(3.7)	(1.45)	
Class Size (% of observations)	100%	42%	58%	

Notes:
1: Spatial autoregressive model using maximum likelihood estimator, with provincial and time fixed-effects (same model as the SAR in Table 6)
2: Finite mixture model estimation using maximum likelihood estimator, with provincial and time fixed-effects.
3: Test for equality of coefficients across the two classes in the 2-Class model.
- All regressions are with 891 observations.
- t-values are in parenthesis and significance at 1% (***), 5% (**), and 10% (*) levels are indicated.
- All the variables are in logarithmic forms except for the variables measured as ratio, i.e *LOCAL* and *EDU(Highschool).*

Further, the effects of agglomeration variables, *URB* and *LOCAL*, differ across classes as well. These results are summarized in Table 11. For class-one provinces where SPAUT is negative, the coefficient of URB is significantly positive while that of LOCAL is insignificant. Put differently, the provinces that are negatively affected by the spatial spillovers from their neighbors benefit from urbanization economies, but not from localization economies. Whereas, for class-two provinces where SPAUT is positive, the coefficient of LOCAL is significantly positive while that of URB is insignificant. More specifically, the provinces that are positively affected by the spatial spillovers from their neighbors benefit from localization economies, but not from urbanization economies.

Table 11: Summary of Class Characteristics in estimating export performance

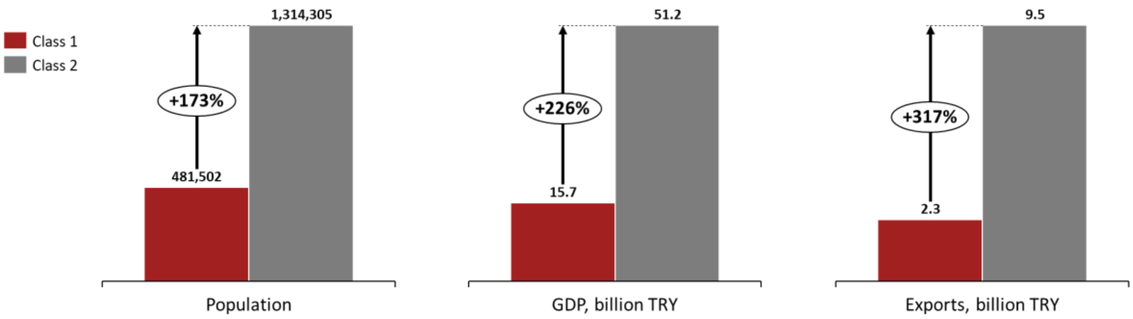
	Class-one	**Class-two**
SPAUT (Spatial spillovers)	**Negative**	**Positive**
URB (Urbanization economies)	**Positive**	*Insignificant*
LOCAL (Localization economies)	*Insignificant*	**Positive**

Source: Author's calculations

Taken as a whole, the negative spatial spillovers seem to co-emerge with the positive urbanization economies (class-one) while the positive spatial spillovers seem to co-emerge with the positive localization economies (class-two). In line with this finding, class-one may potentially consist of provincial economies where export performance is weaker compared to neighbors. This argument is supported by the two facets of the findings. First, the fact that class-one provinces are negatively affected by the export performance of the neighboring provinces can be result of relatively low level of exports that is not enough to retain exporting firms, skilled labor and investments against the resource pull factors from the neighboring provinces. Second, the fact that urbanization economies are positive indicate that there are benefits to be gained from the provincial size and diversity indicating a negative margin allowing to reach to a higher level of export performance in line with the level of the neighbors. Class-two provinces have the opposite spatial dependence structure with their neighbors. They benefit from positive export performance of the neighboring provinces and from the increase of the exporting firm concentration in their local economies. This finding indicates that class-two provinces may potentially be from the higher end of the export performance distribution. The fact that they benefit from higher export performance in their neighbors indicate that they are able to pull needed resources (e.g firms, skills, investments) as their neighbors accumulate resources to export.

Figure 6 confirms these arguments with the comparison of the difference in the mean values of the select variables in the two classes. Average population and GDP, as well as the average provincial value of exports is much larger in class-two provinces than that of class-one provinces. Average value is 174% higher in class-two than that of class-one in population, 214% in GDP and 314% in exports.

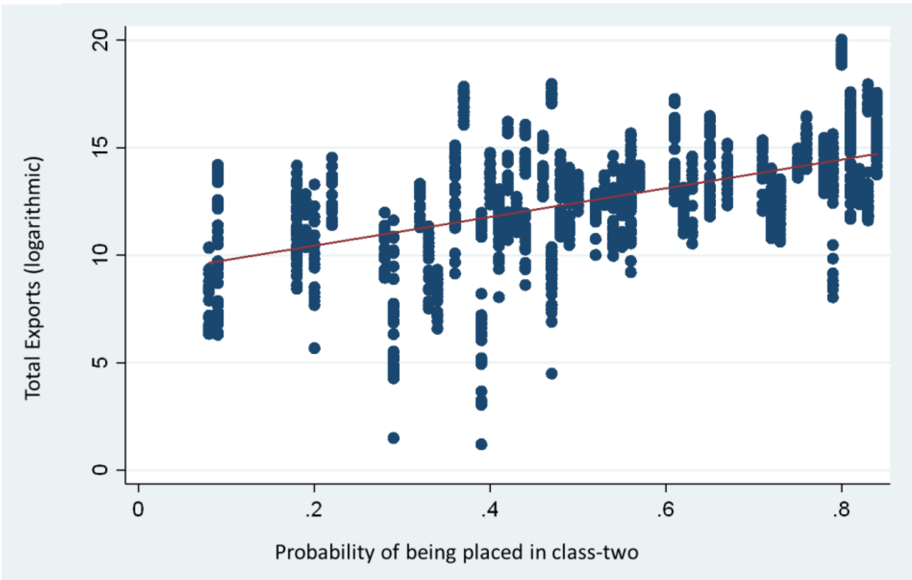
Figure 6: Difference between the classes in the mean values of key variables



Source: Author's calculations
Note: All figures are term averages, GDP and Exports data are with 2020 prices.

Figure 7 shows how the provincial exports incrementally increase with the increased probability of being placed in the class-two provinces.

Figure 7: Difference between the classes in the mean values



Source: Author's calculations

Additionally, Table 12 shows the likelihood of each province to be placed in class-one versus class-two. 37 of the provinces are more likely to be placed in class-one, while 44 of the provinces are more likely to be in the class-two (e.g probability>0.5). The provinces that are likely to be in class-two include major exporters such as Istanbul, Ankara, Izmir, Gaziantep, Denizli, Konya and Kayseri with a very high probability at above 80%.

Table 12: Class Probability of Provinces

	Probabilities			Probabilities	
Province	**Class1**	**Class 2**	**Province**	**Class1**	**Class 2**
Adana	0.18	0.81	Kahramanmaraş	0.21	0.78
Adıyaman	0.45	0.54	Karabük	0.36	0.63
Afyonkarahisar	0.21	0.78	Karaman	0.38	0.61
Ağrı	0.47	0.52	Kars	0.90	0.09
Aksaray	0.26	0.73	Kastamonu	0.63	0.36
Amasya	0.81	0.18	Kayseri	0.18	0.81
Ankara	0.18	0.81	Kilis	0.58	0.41
Antalya	0.43	0.56	Kırıkkale	0.71	0.28
Ardahan	0.65	0.34	Kırklareli	0.77	0.22
Artvin	0.37	0.62	Kırşehir	0.27	0.72
Aydın	0.24	0.75	Kocaeli	0.62	0.37
Balıkesir	0.20	0.79	Konya	0.15	0.84
Bartın	0.55	0.44	Kütahya	0.17	0.82
Batman	0.58	0.41	Malatya	0.42	0.57
Bayburt	0.91	0.08	Manisa	0.34	0.65
Bilecik	0.37	0.62	Mardin	0.28	0.71
Bingöl	0.52	0.47	Mersin	0.55	0.44
Bitlis	0.52	0.47	Muğla	0.18	0.81
Bolu	0.51	0.48	Muş	0.70	0.29
Burdur	0.67	0.32	Nevşehir	0.80	0.19
Bursa	0.52	0.47	Niğde	0.16	0.83
Çanakkale	0.49	0.50	Ordu	0.44	0.55
Çankırı	0.81	0.18	Osmaniye	0.20	0.79
Çorum	0.34	0.65	Rize	0.43	0.56
Denizli	0.18	0.81	Sakarya	0.38	0.61
Diyarbakır	0.26	0.73	Samsun	0.32	0.67
Düzce	0.16	0.83	Şanlıurfa	0.44	0.55
Edirne	0.56	0.43	Siirt	0.79	0.20
Elazığ	0.57	0.42	Sinop	0.81	0.18
Erzincan	0.66	0.33	Şırnak	0.63	0.36
Erzurum	0.60	0.39	Sivas	0.27	0.72
Eskişehir	0.20	0.79	Tekirdağ	0.57	0.42
Gaziantep	0.15	0.84	Tokat	0.50	0.49

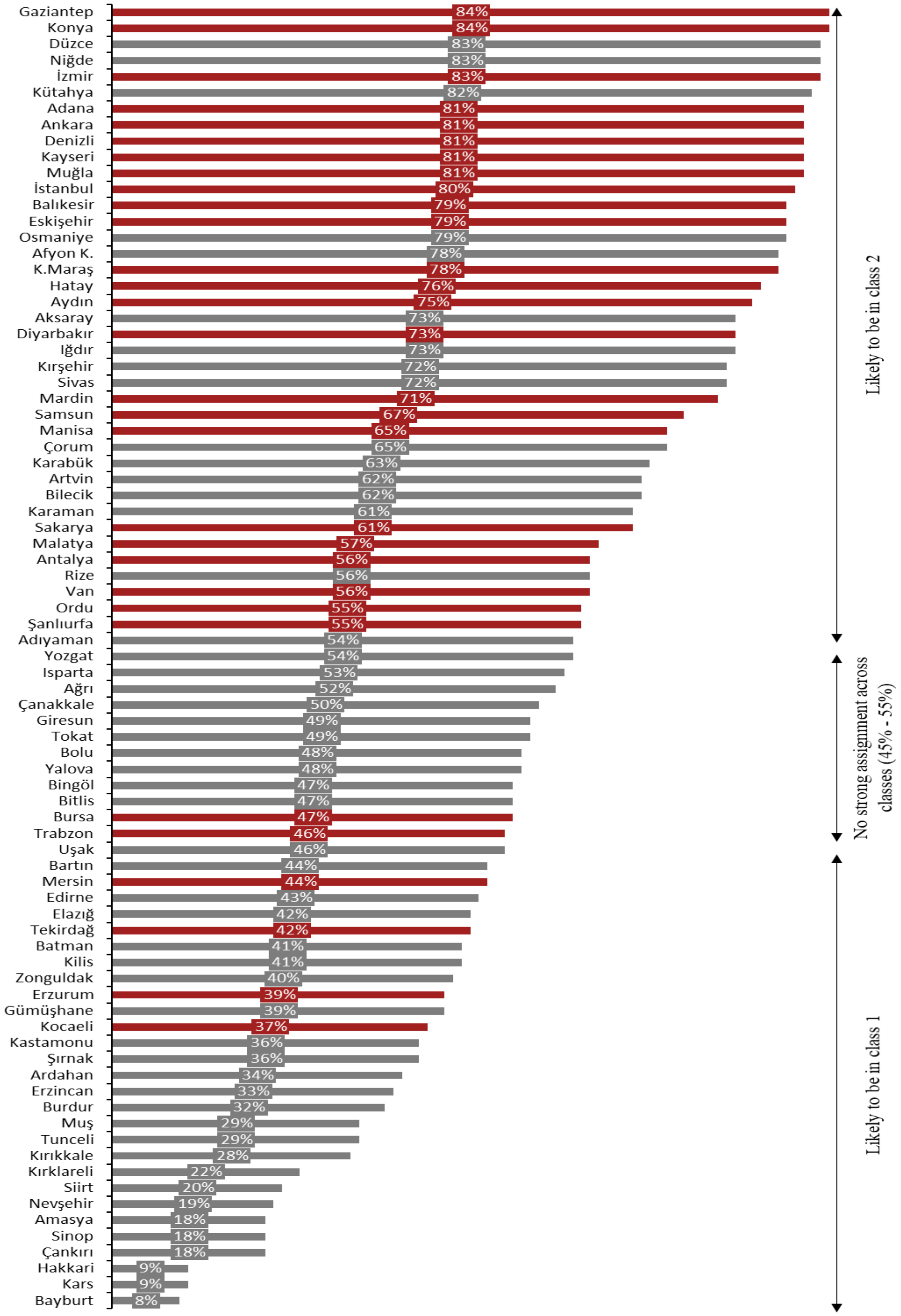
Giresun	0.50	0.49	Trabzon	0.53	0.46
Gümüşhane	0.60	0.39	Tunceli	0.70	0.29
Hakkari	0.90	0.09	Uşak	0.53	0.46
Hatay	0.23	0.76	Van	0.43	0.56
Iğdır	0.26	0.73	Yalova	0.51	0.48
Isparta	0.46	0.53	Yozgat	0.45	0.54
İstanbul	0.19	0.80	Zonguldak	0.59	0.40
İzmir	0.16	0.83			

Source: Author’s calculations

Figure 8 ranks the provinces as per their likelihood to be placed in class-two in descending order. Provinces with metropolitan municipalities are indicated in red color. This rank shows that provinces with metropolitan municipalities are, on average, more likely to be placed in class-two.

Once the provinces with likelihood to be place in either of the classes with less than 55% probability are excluded, Mersin, Erzurum, Kocaeli and Tekirdag are the only provinces with metropolitan municipalities that are more likely to be placed in class-one than they are to be placed in class-two. This is expected given the metropolitan municipalities are formed in provinces with more than 750,000 population, and population is positively correlated with the likelihood of being placed in class-two as shown in Figure 6.

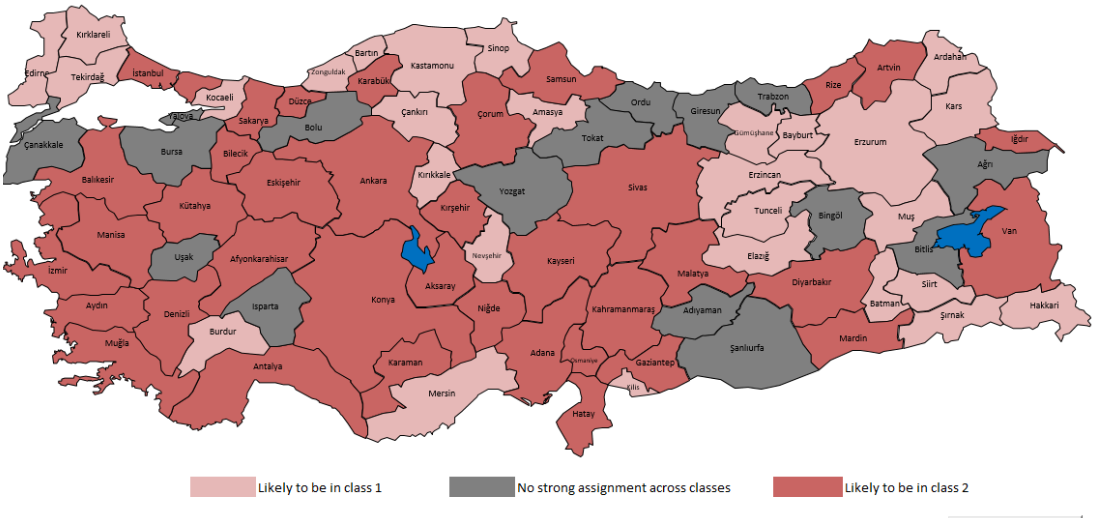
Figure 8: Probability of Provinces to be placed in Class 2



Source: Author's calculations
Note: Provinces with metropolitan municipalities are highlighted in red.

Map 3 provides an additional insight regarding the class assignment. The provinces neighboring Istanbul are all more likely to be in class-one indicating the fact that they are more likely to have negative spillovers.

Map 3: The Geography of Class Assignment



Source: Author’s calculations
Note: Provinces with likelihood of being assigned to either of the classes between 45%-55% are classified as “No strong assignment across classes”.

This indicates that the economic dynamism considered to be brought by Istanbul to its region was not observed during our assessment period in the form of positive export performance spillovers. The very high performing neighbors of Istanbul (e.g Kocaeli, Tekirdag, Kirklareli) are in fact hurt by the further expansion the exports in their region, unlike other high performing provinces in the country (e.g Ankara, Izmir, Kayseri. Gaziantep). It is likely that the extreme concentration of exports in Istanbul (i.e 52% of all goods and services exports) is too strong that it pulls resources from its neighbors albeit the neighbors are also strong performers in the estimation period.

CONCLUSION

As the share of large urban centers and their hinterlands increase in the global production and trade, agglomeration economies and spatial spillovers may come to play leading roles in explaining the sub-national export performance heterogeneity. In Turkey, some provinces experience high export growth rates in recent years while others are still at near-zero levels. Using a spatial finite mixture model, this study investigates highly heterogeneous export performances of Turkish provinces with a particular attention to agglomeration economies and spatial spillovers.

The findings on the connectivity variables indicate that neither of the length of motorways or railways is a significant determinant of the export performance. Thus, the transport infrastructure is not significantly associated with the export performance. This is in line with the relative underuse of the land and rail transport modes in exports and shows that expanding the land or rail networks may not necessarily foster export performance. The other connectivity indicator, distance to nearest port, however, is negative and highly statistically significant. This finding shows the natural advantage of the provinces with ports as well as the hinterlands of the ports in selling their goods abroad, suggesting that the policies targeting export performance might be efficient if they focus on the provinces closer to ports.

The results also show that the share of the high school graduates in the local population is positively associated with export performance, while the share of university graduates is insignificant. Interestingly, provincial export performance is not responsive to the knowledge or skills levels that correspond to university level. This is, however, in line with the fact that Turkey’s high-technology exports as a share of total manufactured exports is much lower than the comparable countries in terms of income per capital levels. Clearly, the policies that provide an incentive for high-tech production can increase the technology use in exports and thus create demand for the Turkey’s fast-growing number of university graduates to contribute to the export performance in their provinces.

The government investment is found to be positive and statistically significant. This is expected given the fact that higher capital spending may lead to better infrastructure or more efficient public services in the provinces can improve the overall doing business environment and support the international trade opportunities for local firms.

Regarding our two variables of interest, agglomeration economies and spatial spillovers, the findings show that Turkish provinces seem to benefit from agglomeration in their export performances in the form of both urbanization and localization economies. The provinces with larger domestic markets and spatially concentrated manufacturing industries have higher export performances. Thus, there are individual benefits from having diverse provincial markets and spatially concentrated manufacturing production. The strong and positive association between agglomeration economies and export performance suggests that export performance, typically, requires a certain economic size if not a large metropolitan economy. In fact, in Turkey, the highest performing cities either have relatively large local economies such as Istanbul, Ankara or Izmir, or they are part of a larger economic area such as Sakarya or Yalova as the part of larger Istanbul metropolitan area. This structure indicates that unless provinces reach to or connected with a certain size of economic activity that is conducive to export performance, government support programs aiming at increasing provincial export performance can be undermined by the limitations of the economies of scale. The results further indicate the presence of significant and negative spatial spillovers between provinces in export performance. The largest spatial adverse effect on the export performance comes from the high export performance of the neighboring provinces, as opposed to unobservable factors or spatial lags of the independent variables. This finding shows that being neighbors with high-performing provinces is, on average, detrimental to the export performance of the provinces.

When positive agglomeration economies and negative spatial spillovers are considered together, one can conclude that as certain provinces start to form stronger export relationships with the rest of the world, they gain economic advantage to expand their economic activities and improve their export performance disproportionately more than do their neighboring provinces. This is in line with the growth poles, center-periphery relationships and new economic geography theories for sub-national spatial units, which argue that as certain provinces become centers of production and export, they pull firms, skilled labor, suppliers, customers and investments from surrounding areas. The long-lasting regional economic disparities in Turkey, running along the east–west axis, brings additional complexity to this structure. On the one hand, the provinces on the western side of the country, on average, have higher export performance. This creates an upper-level duality across provinces. Under this general pattern, there exists a more complex pairwise center-periphery relationship structure with agglomeration economies supporting larger and more concentrated provinces to export more by pulling resources from their neighbors. Two-layered structure indicates an overall higher average export performance in provinces located in the western part of the country as well as the rise of the high-performing regions in the central and eastern Anatolia (e.g Gaziantep, Kayseri) pulling resources from surrounding areas and achieving higher export performance despite being located in a low-performing neighborhood. As in the case of regional economic growth, export performance should not be expected to be spatially balanced. However, the lagging areas can be supported to have more industrial concentration (i.e localization economies), which is an important determinant of the export performance even when the local economies are not diverse enough (i.e when urbanization economies are controlled for as in the case of our econometric model).

These discussions suggest that there might be distributional heterogeneity in responses of export performances of provinces to urbanization, localization and spatial spillovers. Thus, along with the application of the standard spatial regressions that assumes homogenous slopes, we adopt finite mixture modeling within spatial structure to see if provincial export performances are clustered in terms of their responses to agglomeration and spatial spillovers. This empirical endeavor uncovers that the association of the agglomeration economies and spatial spillovers with the export performance are not homogenous across provinces, and in fact there are two distinct clusters (i.e classes). In one group of provinces, there are negative spatial spillovers accompanied with positive urbanization economies (i.e class-one), and in the other group there are positive spatial spillovers accompanied with positive localization economies (i.e class-two). The class-one provinces are negatively affected by the export performance of the neighboring provinces. These provinces are with the low level of exports indicating the fact that they do not have enough exports to retain exporting firms, skilled labor and investments against the demand for these resource from the neighboring provinces. Also, the fact that urbanization economies are positive in these provinces confirm that there are benefits to be gained from urbanization economies (i.e provincial size and diversity) indicating a negative margin allowing to reach to a higher level of export performance without being affected by deglomerative forces which typically emerge at the high levels of agglomeration (The World Bank, 2009). Class-two provinces, in contrast, benefit from positive export performance of the neighboring provinces and from the increase of the exporting firm concentration in their local economies (i.e localization economies). Assessments show that provinces with higher export performance such as Istanbul, Ankara, Izmir, Konya, Gaziantep, Kayseri, Denizli are highly likely (i.e more than 80%) to be placed in this class. The fact that they benefit from higher export performance in their neighbors indicate that they are able to pull resources (e.g firms, skills, investments) as their neighbors accumulate these resources that are conducive to export. Moreover, insignificant urbanization economies, in this class, indicate that further expansion and diversity in the local economy do not benefit the export performance. This is also in line with the fact that the benefits of the urbanization economies might be offset by diseconomies in leading areas once a certain size is exceeded (OECD 2006; The World Bank, 2009; Grover et al., 2021). From the spatial spillovers perspective, as the relatively low-performing regions are hurt by the export performance of their neighbors via pull factors; policies for these provinces should focus on retaining firms, skills, and investments by incentives that compensate the losses from not moving to high-performing regions. But these policies should consider the global findings that trying to spread the economic growth (or in our case export growth) may discourage the overall regional performance (The World Bank, 2009) and thus specific needs of the places should be targeted (OECD, 2020) as opposed to developing policies to reduce regional performance disparities.

We believe that this research can be further enhanced by examining how some observable common shocks, such as exchange rate and demand on exported goods, would affect provincial export performances. In addition, the impact of regional incentive scheme and specific types of government investments such as on technology should be incorporated into the analyses as the data become available, in order to do further regional policy evaluations.

BIBLIOGRAPHY

Akaike, H. (1974). A new look at the statistical model identification. *IEEE Transactions on Automatic Control*, 19, 716-723.

Alama-Sabater, L., Marquez-Ramos, L., & Suarez-Burguet C. (2013). Trade and Transport Connectivity: A spatial approach. *Applied Economics*, 45(18), 2563-2566.

Albouy, D., Leibovici, F., & Warman C. (2013). Quality of Life, Firm Productivity, and the Value of Amenities across Canadian Cities. *Canadian Journal of Economics*, 46(2), 379-411.

Alfo, M., Trovato, G., & Waldmann, R. (2008). Testing for Country Heterogeneity in Growth Models using a Finite Mixture Approach. *Journal of Applied Econometrics*, 23(4), 487-514.

Anselin, L. (2001). *Spatial Econometrics*, in "A Companion to Theoretical Econometrics" edited by Badi H. Baltagi. Blackwell Publishing Ltd.

Anselin, L., Florax R., & Rey, S. J. (2004), Econometrics for Spatial Models: Recent Advances, edited by Anselin et al. (2004), *Advances in Spatial Econometrics*, Berlin and Heidelberg, Germany: Springer-Verlag.

Anselin, L. (1988a). *Spatial Econometrics: Methods and Models*, Dordrecht, The Netherlands: Kluwer Publishers.

Anselin, L. (1988b). Lagrange Multiplier Test Diagnostics for Spatial Dependence and Spatial Heterogeneity. *Geographical Analysis, 20(1),* 1-17.

Anselin, L. and Lozano-Gracia, N. (2009). Spatial Hedonic Models. In Palgrave Handbook of Econometrics: Volume 2: Applied Econometrics (pp. 1213-1250). Palgrave Macmillan.

Anselin, L. and Rey, S. (2014). *Modern Spatial Econometrics in Practice*. Chicago, IL, USA: GeoDa Press.

Aquaro, M., Bailey, N., & Pesaran H. (2015). Quasi Maximum Likelihood Estimation of Spatial Models with Heterogeneous Coefficients, USC Dornsife Institute for New Economic Thinking, Working Paper No. 15-17.

Arbia, G. (2007). *Spatial Econometrics - Statistical Foundations and Applications to Regional Convergence,* Berlin and Heidelberg, Germany: Springer-Verlag.

Arrow, K. J. (1962). The Economic Implications of Learning by Doing. *The Review of Economic Studies,* 29(3), 155-173.

Artuc, E., & Lopez-Acevedo G. (2019) “Exports to Jobs”. The World Bank Group, South Asia Development Forum.

Artuc, E., Iootty M., & Pirlea A. F. (2014). Export Performance and Geography in Croatia, *World Bank Policy Research Working Paper, 6999*.

Banerjee, A., Dhillon, I. S., Ghosh, J., & Sra, S. (2005). Clustering on the Unit Hypersphere using von Mises-Fisher distributions. *Journal of Machine Learning Research* 6, 1345–1382.

Batey, P., & Plane, D. (2020). *Great Minds and Regional Science,* Volume 1, Switzerland: Springer Nature and The Regional Science Academy.

Beard, T., Caudill, S., & Gropper, D. (1991). Finite Mixture Estimation of Multiproduct Cost Functions. *The Review of Economics and Statistics*, 73(4), 654-664.

Becker, G. (1964). Human Capital: A Theoretical and Empirical Analysis with Special Reference to Education, NBER Publishing.

Bernard, A. B., & Jensen, J. B. (2006). Why Some Firms Export, *National Bureau of Research. Working Paper, 8349*.

Berry, B. J. L & Garrison, W. L. (1958). Recent Developments of Central Place Theory. *Papers and Proceedings of the Regional Science Association*, Vol. 4.

Billings, S., & Johnson, E. B. (2012). The Location Quotient as an Estimator of Industrial Concentration. *Regional Science and Urban Economics,* 42, 642-647.

Böhning, D., Dietz, E., Schaub, R., Schlattmann, P., & Lindsay, B. (1994). The Distribution of the Likelihood Ratio for Mixtures of Densities from the One-Parameter Exponential Family. *Annals of the Institute of Statistical Mathematics* 46(2), 373-388.

Boventer, E. (1969). Walter Christaller’s Central Places and Peripheral Areas: The Central Place Theory in Retrospect, *Journal of Regional Science,* 9(1).

Brülhart, M. (1998). Trading Places: Industrial Specialization in the European Union. J*ournal of Common Market Studies*. 36 (3).

Cameron, A.C. & Trivedi, P.K. (2005). Microeconometrics: Methods and Applications, Cambridge University Press, Cambridge.

Carrol, M.C, Reid, N., & Smith, B. W. (2008). Location Quotients versus Spatial Autocorrelation in Identifying Potential Cluster Regions. *Annals of Regional Science 42,* 449-463.

Celbis, M. G., Nijkamp, P. & Poot, J. (2014). Infrastructure and the International Export Performance of Turkish regions, *UNU-MERIT Working Papers, 21*.

Celeux, G., Frühwirth-Schnatter, S., & Robert C. (2018), Model Selection for Mixture Models: Perspectives and Strategies. Handbook of Mixture Analysis, CRC Press.

Christaller, W. (1933). Central Places in Southern Germany. Englewood Cliffs: Prentice-Hall.

Cizkowicz, P., Rzonca, A., & Uminski, S. (2013). The Determinants of Regional Exports in Poland: A Panel Data Analysis. *Post-Communist Economies*, 25(2), 206-224.

Coe, N. M., & Hess, M. (2011). Local and Regional Development edited by Pike A. et al. (2011), *Handbook of Local and Regional Development*, New York City, NY, USA: Routledge.

Coe, N. M., Kelly P. F., & Yeung, H. W. C. (2019). *Economic Geography: A Contemporary Introduction*, Danvers, MA, USA: Wiley-Blackwell.

Combes, P. P., Mayer, T., & Thisse, J. F. (2008). Economic Geography: The Integration of the Regions and Nations, Princeton, NJ, USA: Princeton University Press.

Cornwall, Gary J., & Olivier Parent. (2017). Embracing Heterogeneity: the Spatial Autoregressive Mixture Model. *Regional Science and Urban Economics*, 64, 148-161.

Corrado, L., & Fingleton, B. (2012). Where is the Economics in Spatial Econometrics. *Journal of Regional Science*, 52(2), 210-239.

Coşar, A. K., & Demir, B. (2016). Domestic Road Infrastructure and International Trade: Evidence from Turkey. *Journal of Development Economics,* 118, 232-244.

Costa-Font, J., & Moscone, F. (2009). “The Impact of Decentralization and Inter-Territorial Interactions on Spanish Health Expenditure” edited by Arbia G. and baltagi B. (2009), *Spatial Econometrics: Methods and Applications*, Heidelberg, Germany: Springer

Dauth, W., Findeisen, S., & Suedekum, J. (2012). “The Rise of the East and the Far East: German Labor Markets and Trade Integration”. Institute of Labor Economics, IZA DP No. 6685.

Deb, P., & Trivedi, P. K. (2013). Finite Mixture for Panels with Fixed Effects. *Journal of Econometric Methods*, 2(1), 35-51.

Di Addario, S., & Patacchini, E. (2008). Wages and the City. Evidence from Italy. *Labour Economics,* 15(5), 1040-1061.

Donaldson, D. (2010). Railroads of the Raj: Estimating the Impact of Transportation Infrastructure. London School of Economic Asia Research Center Working Paper, 41.

Elhortst, J. P. (2014). *Spatial Econometrics: From Cross-Sectional Data to Spatial Panels*. Springer Briefs in Regional Science.

Ellison, G., & Glaeser E. L. (1997). Geographic Concentration in US Manufacturing Industries: A Dartboard Approach. *Journal of Political Economy*, 105(5), 889-927.

European Union. (2008). *Convergence of EU regions: Measures and evolution,* Report No. 1/2008.

Feenstra R. C., & Taylor A. M. (2017). *International Trade*. New York, USA: Worth Publishers.

Feldman, M. (2000). "Location and Innovation: The New Economic Geography of Innovation, Spillovers, and Agglomeration" edited by Clark, G., Feldman, M., and Gertler, M. in *The Oxford Handbook of Economic Geography*, Oxford, UK: Oxford University Press.

Fraley, C., & Raftery, A. E. (2006). MCLUST version 3 for R: Normal Mixture Modeling and Model-based Clustering. Technical Report 504, University of Washington, Department of Statistics, Seattle, WA. 2006.

Fruhwirth-Schnatter, S. (2006). *Finite Mixture and Markov Switching Models*. Springer, New York, USA.

Fujita, M., & Mori T. (1996), The Role of Ports in the Making of Major Cities: Self-Agglomeration and Hub-Effect, *Journal of Development Economics,* 49(1), 93-120.

Fujita, M., Krugman P., & Venables A. J. (1999). *The Spatial Economy: Cities, Regions and International Trade*. Cambridge, MA, USA: MIT Press.

Glaeser, E., Kallal, H. D., Scheinkman, J. A. & Shleifer, A. (1992). Growth in Cities. *Journal of Political Economy*, 100(6).

Grasjö, U. (2008). University-Educated Labor, R&D and Regional Export Performance. *International Regional Science Review*, 31(3), 211-256.

Greene, W. H. (2018). *Econometric Analysis*. New York USA: Pearson.

Grover, A., Lall S. V., & Timmis J. (2021). Agglomeration Economies in Developing Countries, The World Bank Policy Research Working Paper 9730.

Hausman, J. A. (1978). Specification Tests in Econometrics. *Econometrica*, 46, 1251-1271.

Hirschman, A. O. (1958). *The Strategy of Economic Development.* New Haven, CT: Yale University Press.

Hoover, E. M. (1937). *Location Theory and the Shoe and Leather Industries*. Cambridge, MA, USA: Harvard University Press.

Hoover, E. M. (1949). The Location of Economic Activity. *The Economic Journal*, 59 (234), 221-223

Jacobs, J. (1969). *The Economy of Cities*. New York City, NY, USA: Vintage.

Kara, M. A. (2018) Province Based Spatial Analysis of Foreign Trade in Turkey, *Journal of Yasar University*, 13(51), 293-304

Karaoz, M., & Govdere, B. (2004) An Analysis of Spatial Distribution of the Turkish Exports Lorenz Curve Approach, *Gazi Üniversitesi Ticaret Turizm Fakültesi Dergisi, 2004.*

Koenig, P., Mayneris, F. & Poncet, S. (2010). Local Export Spillovers in France. *European Economic Review*, *54*, 622-641.

Konishi, H. (2000). Formation of Hub Cities: Transportation Cost Advantage and Population Agglomeration. *Journal of Urban Economics, 48(1),* 1-28.

Konte, M. (2017). Do Remittances not Promote Growth? A Finite Mixture of Regressions Approach. *Empirical Economics*. United-Nations University, Maastricht, The Netherlands.

Kosfeld, R., & Lauridsen, J. (2009) "Dynamic Spatial Modelling of Regional Convergence Processes" edited by Arbia G. and baltagi B. (2009), *Spatial Econometrics: Methods and Applications,* Heidelberg, Germany: Springer

Krugman, P., & Venables, A. J. (1990), *Integration and the Competitiveness of the Peripheral Industry*. CEPR Discussion Papers, 363.

Krugman, P. (1980). Scale Economies, Product Differentiation and the Pattern of Trade. *American Economic Review*, 70, 950-959.

Krugman, P. (1991). Increasing returns and economic geography. *Journal of Political Economy, 99(3),* 483-499.

Krugman, P. (1995). *Development, Geography, and Economic Theory*, Cambridge, MA, USA: MIT Press.

Krugman, P. (1998). What's new about the new economic geography? *Oxford Review Of Economic Policy*, 14(2)

Krugman, P. (2011). The New Economic Geography, Now Middle-Aged, *Regional Studies*, 45(1), 1-7.

Krugman, P. (2018). *International Economics: Theory and Policy*. Harlow, UK: Pearson Publishing.

Krugman, P., & Venables, A. J. (1995). Globalization and the Inequality of Nations. *NBER Working Paper, 5098*.

Leichenko, R. M., & Erickson R. A. (2002). Foreign Direct Investment and State Export Performance. *Journal of Regional Science*, 37(2), 307-329.

LeSage, J., & Pace R. K. (2009). *Introduction to Spatial Econometrics*. Florida, USA: Chapman & Hall Publishing.

LeSage, P. J., & Chih Y. Y. (2018). A Bayesian Spatial Panel Model with Heterogeneous Coefficients, *Regional Science and Urban Economics*, 72, 58-73.

Li, J., & Zha, H. (2006). Two-way Poisson Mixture Models for Simultaneous Document Classification and Word Clustering. *Computational Statistics and Data Analysis* 50(1), 163-180.

Lösch, A. (1940). *The Economics of Location*. New Haven, USA: Yale University Press, 1954.

Manski, C. F. (1993). Identification of Endogenous Social Effects: The Reflection Problem. *The Review of Economic Studies*, 60(3), 531-542.

Marquez-Ramos, L. (2016). Port Facilities, Regional Spillovers and Exports: Empirical Evidence from Spain. *Papers in Regional Science*, 95(2), 329-351.

Marshall, A. (1890). *Principles of Economics*. London, UK: Macmillan.

McLachlan, G. J., Sharon, X. L., & Rathnayake S. I. (2019). Finite Mixture Models, *Annual Review of Statistics and Its Application*, 6(11), 1-24

McLachlan, G., & Peel, D. (2004). *Finite Mixture Models.* New York: John Wiley.

McLachlan, G., & Peel, D. (2000). Finite Mixture Models. John Wiley and Sons, Inc., New York. MR1789474

Melnykov, V., & Ranjan, M. (2010). Finite Mixture Models and Model-based Clustering. (2010). *Statistics Publications*, 67, https://lib.dr.iastate.edu/stat_las_pubs/67

Ministry of Development, Republic of Turkey (2019). Special Commission Report on Investment Policies and Priorities, Publication No: 2982.

Moran, P. (1948). The Interpretation of Statistical Maps. *Journal of the Royal Statistical Society*, 10, 243-25.

Moreno R., Paci, R., & Usai, S. (2005). Spatial Spillovers and Innovation Activity in European Regions. *Environment and Planning*, 37, 1793-1812.

Naudé, W., & Gries, T. (2009). Explaining Regional Export Performance in a Developing Country: The Role of Geography and Relative Factor Endowments. *Regional Studies*, 43(7), 967-979.

Nicolini, R. (2003). On the Determinants of Regional Trade Flows. *International Regional Science Review*, 26(4), 447-465.

Nsiah, C., Wu, C. & Mayer, W. (2012). An Analysis of US State's Export Performance in the Asian Market. *The Annals of Regional Science*, 49(2), 533-550.

OECD (2006). *OECD Territorial Reviews: Competitive Cities in the Global Economy*. Paris, France: OECD Publishing.

OECD (2018). *Rethinking Regional Development Policy-Making.* Paris, France: OECD Publishing.

OECD (2020). *Regions and Cities at a Glance*. Paris, France: OECD Publishing.

Ouédraogo, R., Relwendé, S., & Sawadogo, H. (2020). Private and Public Investment in Sub-Saharan Africa: The Role of Instability Risks, *Economic Systems*, 44(2).

Overman, H. G., Redding S., & Venables A. J. (2001). The Economic Geography of Trade, Production, and Income: A Survey of Empirics. *CEPR Paper, 465*.

Owen, A. L., Videras, J. & Davis, L. (2009). Do All Countries Follow the Same Growth Process? *Journal of Economic Growth*, 14, 265-286.

Öztürk, S., Başar, D., & Coşar, K. (2019). Determining Priority Regions to Nurture Economic Development: A Critical Approach, in *The Dynamics of Growth in Emerging Economies*, 98-125, Routledge.

Parr, J. B. (2017). Central Place Theory: An Evaluation. *Review of Urban and Regional Development Studies*, 29(3), 151-164.

Perrons, D. (2011). Regional Disparities and Equalities: Towards a Capabilities Perspective? edited by Pike A. et al. (2011), *Handbook of Local and Regional Development*, New York City, NY, USA: Routledge.

Perroux, F. (1950). Economic Space: Theory and Applications. The *Quarterly Journal of Economics*, 64 (1), 89-104

Porter, M., (1990). *The Competitive Advantage of Nations*. New York, USA: Macmillan.

Riain, S. (2011). Globalization and Regional Development edited by Pike A. et al. (2011), *Handbook of Local and Regional Development*, New York City, NY, USA: Routledge.

Ricardo, D. (1817). *On the Principles of Political Economy and Taxation*, Ontario, Canada: Batoche Books (2001)

Romer, P. M. (1986). Increasing Returns and Long-Run Growth. *Journal of Political Economy*, 94 (5), 1002-1037.

Royuela, V., Moreno, R., & Vaya, E. (2009). Influence of Quality of Life on Urban Growth: A Case Study of Barcelona, Spain. *Regional Studies*, 44(5), 551-567.

Sarkar, S., Arcaute, E., Hatna, E., Alizadeh, T., Searle, G., & Batty, M. (2020). Evidence for Localization and Urbanization Economies in Urban Scaling. *Royal Society Open Science*, 7(3).

Schmutzler, A. (1999). The New Economic Geography. *Journal of Economic Surveys*, 13(4).

Schwarz, G. (1978). Estimating the dimension of a model. *Annals of Statistics*, *6*, 461-464.

Smith, A. (1778). *An Inquiry into the Nature and Causes of the Wealth of Nations*, Wordsworth Editions Ltd.

Stojčić, N., Benić, D., & Karanikić, P. (2014). Regional Determinants of Export Competitiveness in Croatian Manufacturing Industry. *Journal of the Rijeka Faculty of Economics and Business*, 32(2), 193-212.

Sullivian, A. (2012). *Urban Economics* (8th Edition). New York, USA: McGraw-Hill/Irwin.

De Graaff T., Boter, J., & Rouwendal, J. (2009) On Spatial Differences in the Attractiveness of Dutch Museums. *Environment and Planning*, 41, 2778-2797.

The World Bank. (2009). *World Development Report 2009: Reshaping Economic Geography*. Washington, DC, USA: World Bank.

The World Bank. (2012). *Turkey Transport Sector Expenditure Review Synthesis Report*, Report No. 62581 -TR.

The World Bank. (2014a), *Trading Up to High Income, Country Economic Memorandum (Turkey)*, Report No. 82307-TR.

The World Bank. (2014b). *Turkey's Transitions: Integration, inclusion, Institutions*, Report No. 90509-TR.

The World Bank. (2015a). *Competitive Cities for Jobs and Growth*. Washington, DC: World Bank.

The World Bank (2015b). *Rise of the Anatolian Tigers: Turkey Urbanization Review*, Report No. 87180-TR.

The World Bank (2019). *Global Connectivity Outlook to 2030.* Washington, DC, USA: World Bank.

The World Bank (2020). *World Development Report 2020: Trading for Development in the Age of Global Value Chains.* Washington, DC, USA: World Bank.

Thünen von, J. H. (1826). *The Isolated State.* Germany: Rostock.

Tobler, W. R. (1970) A Computer Movie Simulating Urban Growth in the Detroit Region. *Economic Geography*, 46, 234-240.

Tsekeris, T. (2017). Domestic Transport Effects on Regional Export Trade in Greece. *Research in Transportation Economics*, 61, 2-14.

United Nations (2019). World Urbanization Prospects 2018, Report No. ST/ESA/SER.A/420.

United Nations Conference on Trade and Development. (2018), Review of Maritime Transport.

Weber, A. (1929). *Theory of the Location of Industries*. Chicago, IL, USA: University of Chicago Press.

Wheeler, C. H. (2001) Search, Sorting, and Urban Agglomeration. *Journal of Labor Economics*, 19, 879.

Wooldridge, J. M. (2009). Econometric Analysis of Cross-Section and Panel Data. Massachusetts, USA: The MIT Press.

World Trade Organization. (2020). World Trade Review.

Wu, C., Nsiah, C., & Mayer, W. J. (2010). The International Exports of U.S. States: An Investigation for Local Spatial Patterns. *The Review of Regional Studies*, 40(3), 287-301.

Wu, Y. (2007). Export Performance in China's Regional Economies. *Applied Economics*, 39, 1283-1293.

Xu, H. (2016). Domestic Railroad Infrastructure and Exports: Evidence from the Silk Route. *China Economic Review*, 41, 129-147.

Yankow, J. J. (2006). Why Do Cities Pay More? An Empirical Examination of some Competing Theories of the Urban Wage Premium. *Journal of Urban Economics*, 60, 139-161.

Zhang, K. H. (2015). What Drives Export Competitiveness? The Role of FDI in Chinese Manufacturing. *Contemporary Economic Policy*, 33(3), 499-512.

APPENDIX A. ETHICS BOARD FORM

HACETTEPE UNIVERSITY
GRADUATE SCHOOL OF SOCIAL SCIENCES
ETHICS COMMISSION FORM FOR THESIS

HACETTEPE UNIVERSITY
GRADUATE SCHOOL OF SOCIAL SCIENCES
ECONOMICS DEPARTMENT

Date: 26/04/2022

Thesis Title: The Role of Agglomeration Economies and Spatial Spillovers in Provincial Export Performance of Turkey

My thesis work related to the title above:

1. Does not perform experimentation on animals or people.
2. Does not necessitate the use of biological material (blood, urine, biological fluids and samples, etc.).
3. Does not involve any interference of the body's integrity.
4. Is not based on observational and descriptive research (survey, interview, measures/scales, data scanning, system-model development).

I declare, I have carefully read Hacettepe University's Ethics Regulations and the Commission's Guidelines, and in order to proceed with my thesis according to these regulations I do not have to get permission from the Ethics Board/Commission for anything; in any infringement of the regulations I accept all legal responsibility and I declare that all the information I have provided is true.

I respectfully submit this for approval.

Date and Signature

Name Surname:	Tayyar Doğan
Student No:	N11242298
Department:	Economics
Program:	Economics (Eng)
Status:	☐ MA ☒ Ph.D. ☐ Combined MA/ Ph.D.

ADVISER COMMENTS AND APPROVAL

Prof. Dr. Lütfi ERDEN
(Title, Name Surname, Signature)

APPENDIX B. ORIGINALITY REPORT

HACETTEPE UNIVERSITY
GRADUATE SCHOOL OF SOCIAL SCIENCES
Ph.D. DISSERTATION ORIGINALITY REPORT

HACETTEPE UNIVERSITY
GRADUATE SCHOOL OF SOCIAL SCIENCES
ECONOMICS DEPARTMENT

Date: 24/06/2022

Thesis Title: The Role of Agglomeration Economies and Spatial Spillovers on Provincial Export Performance of Turkey

According to the originality report obtained by my thesis advisor by using the Turnitin plagiarism detection software and by applying the filtering options checked below on 24/06/2022 for the total of 77 pages including the a) Title Page, b) Introduction, c) Main Chapters, and d) Conclusion sections of my thesis entitled as above, the similarity index of my thesis is 20 %.

Filtering options applied:

1. ☒ Approval and Decleration sections excluded
2. ☐ Bibliography/Works Cited excluded
3. ☐ Quotes excluded
4. ☒ Quotes included
5. ☒ Match size up to 5 words excluded

I declare that I have carefully read Hacettepe University Graduate School of Social Sciences Guidelines for Obtaining and Using Thesis Originality Reports; that according to the maximum similarity index values specified in the Guidelines, my thesis does not include any form of plagiarism; that in any future detection of possible infringement of the regulations I accept all legal responsibility; and that all the information I have provided is correct to the best of my knowledge.

I respectfully submit this for approval.

24/06/2022

Name Surname:	Tayyar Doğan
Student No:	N11242298
Department:	Economics
Program:	Economics (Eng)
Status:	☒ Ph.D. ☐ Combined MA/ Ph.D.

ADVISOR APPROVAL

APPROVED.

Prof. Dr. Lütfi ERDEN

(Title, Name Surname, Signature)