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THE IMPACT OF RAILWAY INFRASTRUCTURE ON ECONOMIC GROWTH AND POPULATION IN TURKEY

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Danışman
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Mehmet Aldonat BEYZATLAR tarafından hazırlanmış ve sunulmuş **"The Impact of Railway İnfrostructure on Economic Growth and Population in Turkey"** başlıklı Tezi**( ) /** Projesi**( )** kabul edilmiştir.

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Yüksek Lisans Tezi olarak sunduğum "…The Impact of Railway Infrastructure on Economic Growth and Population in Turkey…" adlı çalışmanın, tarafımdan, bilimsel ahlak ve geleneklere aykırı düşecek bir yardıma başvurmaksızın yazıldığını ve yararlandığım eserlerin kaynakçada gösterilenlerden oluştuğunu, bunlara atıf yapılarak yararlanılmış olduğunu belirtir ve bunu onurumla doğrularım.

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Mehmet Aldonat BEYZATLAR

İmza

ÖZET

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(Mehmet Aldonat Beyzatlar)

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Bu çalışma ulaşım altyapısı ve iki önemli değişken; demografik ve ekonomik değişkenler arasındaki deneysel ilişkiyi araştırmaktadır. İl bazında demiryolu uzunlukları, nüfus yoğunluğu ve tarımsal üretim değişkenleri, sırasıyla ulaşım altyapısı, demografik ve ekonomik ölçümler için kullanılmıştır. Bu çalışmanın en önemli katkısı, yazarın bilgisi dâhilinde Türkiye'deki tek örneği olan veri setleridir. Türkiye için panel ekonometri veri analizi uygulanan il bazındaki bu veri setleri, zaman ve alan çerçevesinde ilişkileri araştırmak için kullanılmıştır. Değişkenler arasındaki ilişkiyi 1856 ve 2007 yılları arasında ortaya çıkarmak için panel regresyon, panel birim kök, panel eşbütünleşme ve panel nedensellik test metotları gerçekleştirilmiştir. Ulaşım altyapısı ve ekonomik gelişim değişkenleri arasındaki ilişki, farklı pek çok gelişmiş ve/veya endüstrileşmiş bölge için deneysel olarak analiz edilmiştir. Ayrıca, ulaşım altyapısı ve demografik değişkenler arasındaki ilişkiler de aynı şekilde analiz edilmiştir. Bu çalışma ise gelişmekte ve endüstrileşmekte olan Türkiye için deneysel analizler bulundurmaktadır. Bunun için, çalışmanın ikinci önemli katkısı bu analizlerdir. Üstelik ulaşım altyapısı değişkenlerinin, ekonomik ve demografik değişkenler üzerindeki etkilerini inceleyen deneysel çalışmalar geniş bir şekilde bu çalışmada sunulmuştur. Buna ilaveten, Osmanlı İmparatorluğu ve Türkiye Cumhuriyeti dönemlerindeki demiryolu ağının ve demiryolu yapım aşamalarının tarihsel gelişimleri de çalışmada sunulan diğer önemli bölümlerdir.

Anahtar Kelimeler: Ulaşım Altyapısı, Demir yolları, Nüfus Yoğunluğu, Panel Veri Analizi, Tarımsal Üretim

ABSTRACT

Graduate Thesis

(The Impact of Railway Infrastructure on Economic Growth and Population in Turkey)

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This study explores the empirical relationship between transportation infrastructure and two measures; demographic and economic activity. Railway lengths, population density and agricultural production at province level base used as datasets for transportation infrastructure, demographic and economic activity measures, respectively. The most important contribution of this study is related with the datasets, which should probably be the first example for the knowledge of the author in Turkey. Using province level panel data for Turkey, panel econometric methods are applied to investigate these relationships in time and space. Panel regression, panel unit root, panel cointegration and panel causality testing procedures are performed to sort out the linkage between measures for the sample period between 1856 and 2007. The relationship between transportation infrastructure and economic development measures is empirically analyzed for many different developed or industrialized regions. Besides, the relationship between transportation infrastructure and demographic measures is also investigated in the same way. This study provides an empirical process for Turkey as a developing and not industrialized country. Therefore, this is the second important contribution of this study. In addition, an extensive overview of the empirical literature, investigating the effects of transportation infrastructure on economic and demographic measures, is provided in this study. Furthermore, a brief history of the railway constructions and railway network expansion during the Ottoman Empire and Republic of Turkey is also presented.

Key Words: Transportation infrastructure, Railways, Population Density, Panel Data Analysis, Agricultural Production

THE IMPACT OF RAILWAY INFRASTRUCTURE ON ECONOMIC GROWTH AND POPULATION IN TURKEY

CHAPTER THREE
TRANSPORTATION AND ECONOMIC ACTIVITIES

CHAPTER FOUR
THEORETICAL FRAMEWORK

CHAPTER FIVE
DATA AND METHODOLOGY

CHAPTER SIX
EMPIRICAL RESULTS

ABBREVATIONS

ADF	Augmented Dickey-Fuller
AIC	Akaike Information Criteria
DF	Dickey-Fuller
ERP	Europe’s Reconstruction Program
FRG	Federal Republic of Germany
GAP	South-Eastern Anatolian Project
GDP	Gross Domestic Product
GIS	Geographic Information System
GNP	Gross National Product
GSP	Gross State Product
HST	High-speed Train
IPS	Im-Pesaran-Schmidt
Km	Kilometers
KPSS	Kwiatkowski-Phillips-Schmidt-Shin
LL	Levin-Lin
LLC	Levin-Lin-Chu
LM	Lagrange Multiplier
MSA	Metropolitan Statistical Areas
OLS	Ordinary Least Squares
PP	Phillips-Perron
SMSA	Standard Metropolitan Statistical Areas
TCDD	Turkish State Railways
TFP	Total Factor Productivity
TPV	Total Product Value
TUIK	Turkish Statistical Institute
UK	United Kingdom
USA	United States of America
WW	World War
WWII	Second World War
2SLS	Two Stage Least Squares

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INTRODUCTION[1]

The effects of transportation infrastructure on demographic and economic activity measures can be explained by many examples such as: expanded and/or extended transportation could increase population by adding employment opportunities; better transportation allow people to move to areas where they face reduced costs and higher quality of living; effective transportation increase the accessibility of people to travel daily or seasonally to other places for benefits, advantages and opportunities of these areas. Some studies state that, transportation infrastructure has served as an important function in transforming human society and affecting population change (Baum-Snow 2007; Vandenbroucke 2008).

Transportation infrastructure systems affect economic and social development directly or indirectly depending on their structure, type, quality and quantity. Improvements in transportation infrastructure have benefits to economic activities such as lowering costs, increasing productivity and output, creating new markets, reducing unemployment and supporting trade. Historically, each improvement in transportation systems had significant consequences for both the spatial organization of the landscape and the patterns of interaction among widely dispersed populations (Lichter and Fuguitt, 1980). As an example, the invention of the steam engine in the late eighteenth century and its application to transportation profoundly changed the way that people and goods were moved, both by water and land. During the nineteenth century, the newly developed technologies brought more speed, carrying capacity and safety. Steamships eliminated the wild unpredictability of voyaging by sail, where a typically week-long journey might take three months with contrary winds. Rather than technical and geographical advantages, the new technologies also meant new market opportunities, both around the port areas served by the new ships and in the regions accessed by railroads.

[1] The thesis is a part of a ESF Eurocores Research Programme "Inventing Europe" within Common Research Project (CRP) titled, "The European Road and Rail Infrastructure: A Geographical Information System for the History of the European Integration (1825-2010)". The financial support for the Turkish Individual Project was provided by TUBITAK SOBAG (Social Sciences and Humanities Research Group). We thank TUBITAK for financially supporting this research project under the 1011 programme with project number 106K392.

However, these innovations also meant that the producers, cultivators and companies should compete on the world market. The emergence of steam technology meant increased foreign involvement in the economies of countries. Easy access to raw materials to subcontractors and to the market (possible customers) encouraged foreign entrepreneurs to make investments in other countries and to share the market with local manufacturers. The expansion of railroads fostered the growth of heavy industries, such as iron and steel production in the United States, Great Britain and Russia. Railroads conquered vast interior spaces, sharply reduced transport costs and made the important linkages between related areas such as linked inland regions (raw materials) to the coast (harbors, airports etc.).

Thus, investments in transportation infrastructure have important contributions to economic development directly by lowering transportation costs and facilitating trade. Services provided by transport infrastructure are fundamental to economic activities due to enhanced mobility of goods and services. Lower costs and ease of access to markets causes a range of sectoral, spatial and regional developments from the private sector point of view (Aschauer, 1989; Munnell, 1990; Gramlich, 1994; Bougheas, et al. 2000). Improvements in transportation cause increased accessibility, specialization and market expansion thus causing increasing returns to scale and spatial agglomeration effects as well as innovation. As a result, total factor productivity and economic growth increases (Bougheas et al., 2000; Lakshmanan, 2007). The effects of transportation infrastructure to economic development are argued to be more interpretable in developing countries rather than developed countries (Zhou, Yang, Xu and Liu, 2007).

This study examines the interactions between transportation infrastructure and demographic measures; transportation infrastructure and economic activity measures. The objective and the scope of this study, with a particular focus on the province level, is exploring the effects of railway infrastructure (as transportation infrastructure measure) on population density (as demographic measure); and agricultural production (as economic activity measure). The study uses panel econometric methods to sort out these relationships for Turkey in time and space with, cointegration and causal linkage.

The aim of this study is to provide significant empirical evidence and hence some implications for railway infrastructure policy towards promoting economic development and population activities. These linkages' purpose is to analyze the long-term relationships as intangible and tangible (values of transportation infrastructure) effects of railways on population density and agricultural production, respectively. When transportation infrastructure has positive impacts on private sector output, productivity and economic activity related measures, people desire to be a part of that residential area (village, province, county, state, region or country), therefore the population (and population density) will increase and vice versa.

In addition to exploring the above linkages, econometric analysis conducted in this study matches significantly previous empirical studies addressing these relationships in terms of the measurement of datasets. This study uses different panel datasets from Turkey. The population data (population density) are collected from Turkish Statistical Institute (TUIK) for all population censuses on all 81 provinces of the Republic of Turkey from 1831 to 2007. The railway dataset (railway lengths in km) is acquired from Turkish State Railways (TCDD) as annual observations on 81 provinces from 1856 to 2007. Agriculture production (production in tons) data are taken from TUIK as annual observations on all 81 provinces from 1909 to 2007.

The importance of datasets used in this study is one of the main and significant contributions of this study. Datasets are compiled with great efforts especially population data, because of the village based population dataset. Besides, the existing literature includes developed country analysis but this study examined Turkey as a developing country in an historical perspective.

Empirical analyses, which are panel data regression, cointegration and causality analyses, are performed by using econometric software program. The results of panel data analyses are met with the expectations in the light of the literature. Studies, which analyzed the relationship between transportation infrastructure and demographic measures found positive connection. Panel regression results provided that railways positively affected population density as statistically significant. Panel cointegration is also found but the panel causality results showed that the direction of the statistically significant causality relationship is from population density to railways.

The empirical analyses investigating the relationship between railways and agricultural production provided parallel results. According to panel regression analyses, railways are found positively and statistically significant variable effecting the agricultural production. Panel cointegration is found at one percent significance level for all three panel cointegration tests. Panel causality results are found robust at one percent significance level but the direction is found from agricultural production to railways.

The framework of this study in the light of the objectives and scope is related with a project named as The European Road and Rail Infrastructure: A Geographical Information System for the History of the European Integration (1825-2010), Project No 106K392. This project is affiliated with European Science Foundation (ESF) Eurocores programme. The Turkish project is financed by TUBITAK.

This study is comprised of four chapters, excluding introduction and conclusion parts. Chapter one provides a background on the history of Turkish railway constructions. It includes a review of the beginning of the railway constructions in the Ottoman Empire between 1856 and 1923. This is followed by the railway network development after the establishment of the Republic of Turkey. The latter part is divided into two as railway intense period covering 1923-1950 and the highway intense period after 1950 to today.

Chapter two presents an overview of the existing literature on transportation infrastructure and demographic measures as the first part. Chapter Three extends the overview to the relationship between transportation infrastructure and economic activity measures, by examining both theoretical and empirical studies. The findings of empirical studies have several important implications on policies, variables and methodologies used to estimate the impacts of transportation infrastructure on dependent variables.

Chapter five is concerned with the data and methodology. The descriptions, characteristics and collection processes of each dataset (demographic, transportation infrastructure and economic activity) are explained in the light of the objective and scope of this study. Methodology part covers brief explanations and features of econometric tools (tests), which are used to test the hypotheses of this study. Chapter six is the empirical chapter of this study presenting the results of unit root, cointegration and causality tests in panel econometrics to investigate the effects of railways on province population density and province agricultural production in Turkey. Conclusion part provides a summary of the main findings from empirical analysis and discusses the research of this study by comparing these findings with the empirical results obtained in the literature. Also give suggestions for further research on the interaction between transportation and other issues. These are followed by the references and appendices.

CHAPTER ONE
THE HISTORY OF TURKISH RAILWAY CONSTRUCTION

In the 19^{th} century, the inventions in the field of transportation and communication had constituted a specific importance in the history of humanity. Development of trade brought about the shipping concept, and transportation of goods became a particular specialization field. Furthermore, the increase of the production and the rise of the world population enhanced transportation requirements. These developments also made "time" concept crucial and the distinctive types of transportation have been verified by competing against the others. These conditions caused the arousal of a new transportation system during the middle of 19^{th} century: the railway transportation system.

The Ottoman Empire came late to the railway age. The technology was totally new and thus initially had to be totally imported. Likewise, the introduction of railroads required workers to be familiar with the technology. This meant foreign, imported labor, at least for a while. In addition, railroad construction required vast investments to lay the tracks and to purchase the engines and cars before operations could be initiated. Foreign capital and workers played critical role in the construction and initial operation of almost all Ottoman railroads. Thus, the construction of railroads posed unusual financial and technological problems for the Ottoman Empire.

In the middle of the 19^{th} century, there were no railroad track laid anywhere in the area of Ottoman Empire. However, Italy had 620 km of track while Spain possessed less than 100 km. Austria-Hungary had already maintained 1,357 km while there were more than 2,000 km in Germany. Major railway nations such as Great Britain possessed 9,800 km and the United States 14,480 km of railway track until the 1950s.

During the second half of the 19^{th} century, mainly after 1890, Ottoman territories acquired 7,500 km of track. This relative burst of activity came several decades after the great explosion of railroad building in the United States, where the track laid rose almost tenfold between 1850 and 1880, more than twenty times the track that would be constructed in the Ottoman lands. As the American system reached maturity, railroad construction in many other lands quickened. The construction of railroads in the Ottoman Empire and in many European countries except Italy, Spain, Great Britain, Germany and Austria-Hungary was started in the middle of 1950s, but the construction progression was totally different. On one hand, railroad lines in the Germany extended nearly 23,000 km by 1913. On the other hand, former Ottoman territories in the Balkans (Rumania, Bulgaria, Serbia and Greece) built about 8,000 km of track more than in the Ottoman Empire.

The Turkish Railways, which dates back over 150 years, is not only a transportation system but also one of the top institutions, which played an important role in shaping the country's destiny. The railway adventure which has begun in 1856 with the construction of Izmir-Aydın railway line also signifies the mirror of the previous 150 years history of these lands.

During the first two decades of the 20th century the Turkish Railways witnessed the years of war with the turbulent period of the Ottoman Empire and became the first locomotive of the move towards the development period. The Ottoman Empire, with vast lands, considered the railway transportation as a way to solve the transportation problem such as integrating different parts of the Empire physically. The state, did not only consider the transportation of population and commodities by railway, but also aimed at reaching the farthest places out.

On one side, railways carried a lot of weight at assurance of country's security, opening of new lands to production as well as enhancing product variety, enabling market integration in the country with better tax collection and delivering raw materials to the larger markets with the products extracted from mines. On the other side, railways had a special place at the country's defense mechanism during wars (1897 War with Greece; the Balkan Wars in 1912-1913; World War I in 1914-1918 and Independence War in 1918-1919) between 1890 and 1920 by conveying soldier and ammunition to the front in a shorter time. All these made the railways inevitable for the Turkish people from all points of view.

The importance of railways for Turkey can really be understood when the cultural and social life resources such as; phones, doctors, cinema, theaters, garden decorations and many other social elements are considered. There are many folk-songs and stories where you can hear many words of “railway” and the Turkish cinema has been nourished from this source. There are many stories and novels whose subjects are the interaction of railways and life.

The railway construction history of Turkey should be considered as two main periods; Pre-Republic period (1856-1923) and Post-Republic period (1923-today). Furthermore Post-Republic period (1923-today) should also be analyzed under two periods: Railroad-Intense Period (1923-1950) and Land Route-Intense Period (1950-today). The distinctive characteristics of these periods could be summarized as follows: the railway lines were constructed by foreigners in return for the grant of privileges in the Pre-Republic period. Besides the railways transportation experienced its golden age during the Railroad-Intense Period, while the existence of railway transportation was ignored against the highway transportation in the Land Route-Intense Period.

1.1. PRE-REPUBLIC PERIOD (1856-1923)

Turkish Railway construction history starts in 1856 around the western part of Turkey with the foundation of the first railways line of 130 km between Izmir and Aydın. Izmir-Aydın line was laid by a British company – The Ottoman Railway Company – in this year under the privilege granted to this company (Talbot, 1981:6). The selection of this line was not incidental; it was an important decision with respect to all perspectives. The establishment of the railway network depended on the transportation of agricultural products. Izmir-Aydın region was more populated than other regions with a higher commercial potential, hosting different ethnic factors suitable for becoming a market for British products and had an easy access to raw materials. Besides, it had a strategic position for controlling Indian routes in terms of the domination of the Middle-East.

The British, French and Germans had separate zones of influence in the territory of Ottoman Empire as they were granted privileges. France created influence zones in Northern Greece, Western and Eastern Anatolia, and Syria; Britain in Romania, West Anatolia, Iraq, and the Persian Gulf; Germany in the Thrace, Central Anatolia and Mesopotamia. The western capital holders constructed the railways as the significant and strategic transportation means in order to transport the agricultural products that were the raw materials of textile industry to seaports and to their countries. Shipping tonnage entering main Ottoman ports between 1830 and 1913 can be seen from Table 1-1. Moreover, they generalized the railway constructions by obtaining privileges like profit guarantee per kilometer, exploiting the mines located 20 kilometers around the railways, etc.

Table 1-1: Shipping tonnage entering main Ottoman ports

Port	1830	1860	1890	1913
Basra	10	-	100	400
Beirut	40	400	600	1700
Istanbul	-	-	800	4000
Izmir	100	600	1600	2200
Trabzon	15	120	500	-

Source: Faroqui, McGowan, Quataert and Pamuk, 1997:801

Consequently, the railway lines that were constructed in the territory of Ottoman Empire and their routes were shaped according to the economical and political goals of these countries. Table 1-2 provides the British, German and French railway lines in the Ottoman Empire with respect to routes and railroad lengths. According to the distribution of railroad construction between three superpowers of the Western Europe in the Ottoman Empire by the year 1898, France was the leading constructer with 1,266 km of railways. These railways were constructed both on Eastern and Western parts of Anatolia. German and British railways were the second and third with 1,020 km and 440 km of railways respectively.

Table 1-2: British, French and German railroad lines until 1898

British		French		German	
Line	Length (km)	Line	Length (km)	Line	Length (km)
Smyrna – Aidin	373	Smyrna – Casaba	512	Haidar Pasha – Ismid	91
Mersina – Adana	67	Jaffa – Jerusalem	87	Ismid – Angora	485
		Beirut – Damascus	247	Eski Shehr – Konia	444
		Damascus – Aleppo	420		
Total	440	Total	1266	Total	1020

Source: Earle, 1966:53

German financiers received their first Ottoman railway concession in the year of the accession of William II and that the capture of Aleppo occurred just few days before his abdication. The plan was a German controlled railway from Berlin to Baghdad. The trade of Baghdad was valued at about £2,500,000 annually during the beginning of the twentieth century. The expansion of German economic interest and political prestige in the Ottoman Empire was also related with isolating France and avoiding commercial and colonial conflicts overseas (Earle, 1966:39).

Nationality, ethnicity and religion were important and distinctive marks of railway workforce. Among railroad employees, Europeans, European and/or Ottoman Christians and Ottoman Muslims (either Turks or Arabs) held the highest, middle and lowest ranked jobs respectively. Europeans filled the very highest levels of management positions virtually such as board memberships and crucial management positions. In the early years of the railway network development, because of the unfamiliarity of rail technology, the novel nature of railway work in Ottoman society naturally meant reliance on European personnel.

Sultan Abdulhamid the 2nd reined the Ottoman Empire for 33 years between 1876 and 1909, who narrated these facts in his memoirs: "I accelerated the construction of Anatolian Railways with all my might. The purpose of this railroad is to connect Mesopotamia and Baghdad to Anatolia and to reach the Persian Gulf. This has been achieved thanks to German aid. The grains that were running to waste before now finds market and our mines are exposed world market for sale. A good future for Anatolia has been prepared. The competition among the big states for the construction of the railways within the territory of our Empire is so weird and suspicious. Although the big states do not want to confess, these railways are important not only for economic reasons, but also for political reasons." (Sultan Abdulhamid, 1999:56)

In the early years of Ottoman railways, workers protested to improve working conditions and strikes occurred in the late 1870s to obtain higher wages. Railway employees and workers were powerfully influenced by developments in Europe while many of the engineers and more highly skilled employees were Europeans familiar with labor syndicates or unions. The direct physical links between the Ottoman and European railway systems promoted the easy flow of ideas among the engineers and workers.

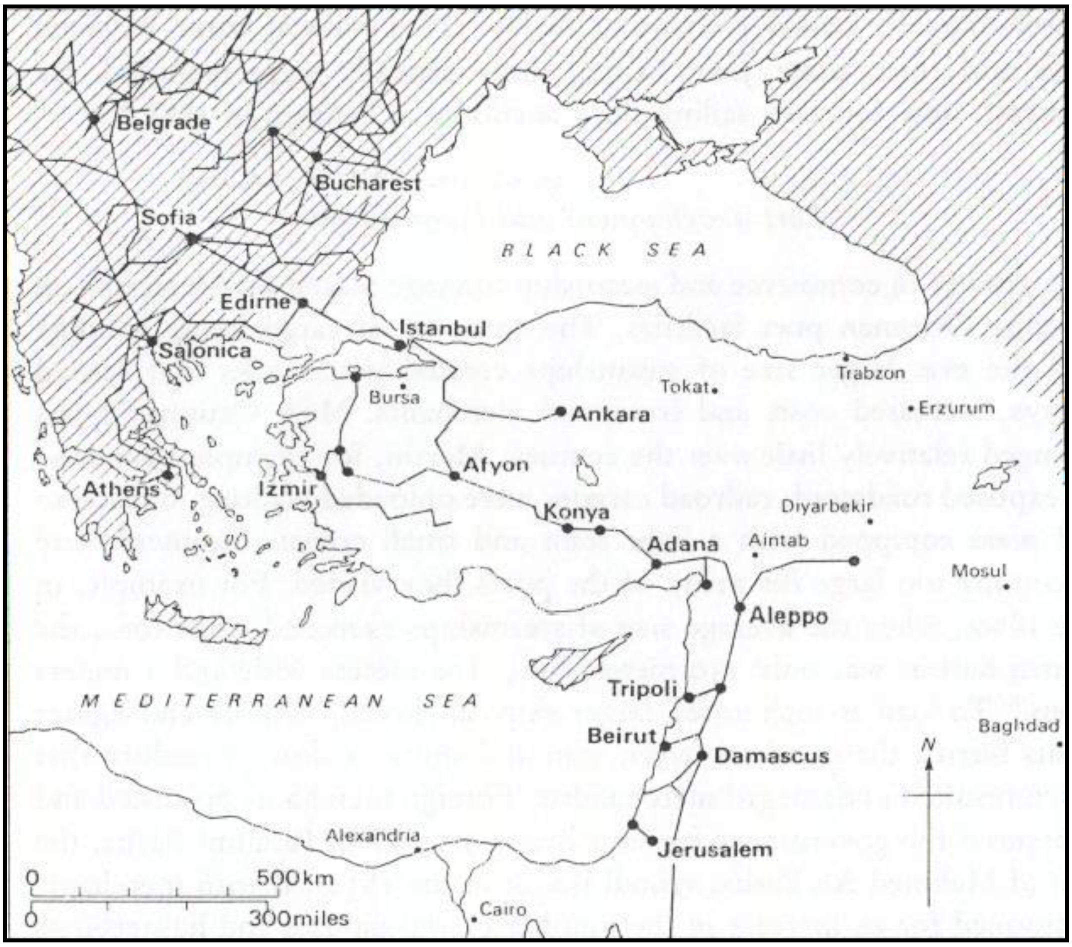
Ottoman workers formally organized surprisingly and workers on the Istanbul-Edirne-Salonica line formed the first Ottoman railway union in 1907. Their adoption to the European model continued while the Anatolian Railway Union emerged just weeks after the July 1908 Young Turk Revolution. Officers were mostly Ottoman Christians or foreigners and that was certainly a reflection of actual union membership. In 1908, strikes erupted among the railway workers in all regions of the empire. Thereafter, until 1914, railroads remained a center of labor agitation as workers regularly struck to promote their demands (Faroqui, McGowan, Quataert and Pamuk, 1997:811).

Although the railroad construction was an extremely expensive investment, the Ottoman Empire Railroads offered many advantages. These advantages were important from the perspectives of both the government and the public. In terms of economical, political, and military based advantages. The railroad network construction was started from the western part of the Anatolia, but the spread of the railroad network continued towards the inner parts of the Anatolia. The “remote” control of the government over the whole Anatolia became more efficient with railroad network developments. The shipment of Ottoman troops and ammunition became easier within the borders, during the 1897 War with Greece, the Balkan Wars (1912-1913), World War I (1914-1918) and Independence War (1918-1919).

Figure 1-1 shows the railway network of the Ottoman Empire and its former territories in year 1914. The connection between the western part of Anatolia and the inner parts of Anatolia can be seen from the map. Also that connection spanned to important but distant cities at the eastern part of the borders of the Empire such as Aleppo, Beirut and Jerusalem. The accuracy of the importance of railways became more crucial with regards to executive issues, in terms of the connection between Istanbul as the capital of the Empire and far but important cities. Railways connected Istanbul-Izmir-Bursa to inner parts Afyon-Konya-Ankara and to western parts Adana-Aleppo-Jerusalem. Those connections were important, crucial and strategic. Not only the administrative facts but also the economical issues were important.

Economically, transportation of the goods, animals and passengers by railroads became more convenient with the reduction of the transportation costs. By the first decade of the twentieth century, goods and passengers started to be carried from all railroad lines. Table 1-3 shows the goods transported on various railways in the Ottoman Empire. In 1890s almost 120,000 tons of goods carried by railroad increased to 600,000 tons in 1900 and to 18,000,000 tons by 1910. Nearly half of the goods transported in Anatolia and eastern parts of the Empire were transported by railroads. Raw materials, semi-finished goods, finished goods, mines and agricultural goods were carried in better conditions with larger amounts.

Figure 1-1: Railroads in the Ottoman Empire in 1914



Source: Faroqui, McGowan, Quataert and Pamuk, 1997:805

The positive effects of railroads on economic development can be seen from the passenger side as well. The movement of passengers also increased at that period all over the empire. Ottoman cities became more accessible and a decisive suburbanization occurred by the interaction between Ottoman Empire residents and railroads. Also, the population of railroad districts grew proportionately faster than in other areas (Faroqui, McGowan, Quataert and Pamuk, 1997:813). The number of passengers transported on various railways in the Ottoman Empire can be seen from Table 1-4.

Table 1-3: Goods transported on various Ottoman Railways (thousand tons)

Line	1891	1895	1900	1910
Ankara-Konya	-	118	357	585
Izmir-Kasaba	-	-	245	327
Aydın	-	-	-	342
Mersin-Adana	-	-	-	130
Damascus-Hama	-	-	-	309
Hejaz	-	-	-	66
Baghdad	-	-	-	28

Source: Faroqui, McGowan, Quataert and Pamuk, 1997:813

Table 1-4: Passengers transported on various Ottoman Railways (millions)

Line	1891	1895	1900	1910
Ankara-Konya	0,7	1,0	1,2	2,7
Izmir-Kasaba	-	1,5	1,7	2,4
Aydın	-	-	-	1,9
Mersin-Adana	-	-	-	0,3
Damascus-Hama	-	-	-	0,7
Hejaz	-	-	-	0,2
Baghdad	-	-	-	0,01

Source: Faroqui, McGowan, Quataert and Pamuk, 1997:812

During 1910s, approximately 14 million passengers were carried by all railroad lines. Oriental Railway in the Balkans accounted for a one-half of the total passengers carried at the first decade of the 20th century. The Anatolian Railway, Izmir-Kasaba Railway and Izmir-Aydın Railway were also important railway networks with respect to passenger and freight transportation at the same period. By the beginning of the 1910s, 1.9 million, 2.4 million and 1.4 million passengers were carried by the Anatolian Railway, Izmir-Kasaba Railway and Izmir-Aydın Railway respectively. On the other hand, the Baghdad Railway line carried less than 60,000 passengers until the end of the first decade of the 20th century. That was a reflection of the sparsely distributed population of the suburban area around that railroad line. By contrast, the Damascus-Hama line reported nearly 700,000 passengers and the Hejaz Railway line transported nearly 200,000 passengers until the end of 1910s.

Transportation of passengers and freight were not only affected by the development of railroad network but also other sectors were influenced from the railroad spread. As the most important sector, agriculture came under the influence of railroad network development.

The increase of the agricultural production went parallel with the spread of the railway network. The production amounts are provided in Table 1-5. Production of many agricultural products increased during the first decade of the 20th century. However, the effects of wars and the slowdown of the railway network development affected agricultural production negatively.

Table 1-5: Production of Agricultural Products (million kg)

Product	1897/98	1909/10	1913/14	1914/15
Wheat	126	140	169	232
Barley	79	113	106	111
Corn	13	20	19	19
Tobacco	15.3	21.4	49	41.3
Cotton	30	76	120	135
Raisin	36	54.6	69	60.8
Dried Fig	15.1	22	32	17.6

Source: Eldem, 1970:77

The flow of agricultural products became faster, cheaper and secure by the railways. The transportation of agricultural products from landward plantations to coastal cities, ports and Istanbul increased agricultural exports and imports. That reciprocal connection was advantageous for production, consumption and trade. Table 1-6 shows that, agricultural exports increased more than agricultural imports except the 1909/10 period. That gave rise to the increase of the net exports. The share of the exports in Total Product Value (TPV) also increased except the 1909/10 period.

Table 1-6: Agricultural Exports and Imports

Period	TPV	Agricultural Exports	Agricultural Imports	Net Exports	Exports /TPV
1899-1900	8103	1010	220	790	9.8
1900-1901	8991	1210	304	906	10.1
1907-1908	9803	1360	317	1043	10.6
1909-1910	11263	1430	571	859	7.6
1913-1914	11757	1620	359	1331	11.3

Source: Eldem, 1970:71

The relationship between agricultural sector and railways differed from time to time and varied according to the political, strategic or economical circumstances. When the potential impact of railways on agriculture decreased, the direction of the emphasis returned to strategic and military importance of railways. The decisions of constructing new railway lines were determined according to the current perspective on railways.

The expansion of Izmit-Ankara section in 1896 could be considered a didactic and suitable example for strategic and military based determination of administration. Izmit-Ankara section was expanded to Eskişehir-Konya section, which was less populated and in fertile. On the other hand, Izmit-Ankara section could be linked to Sivas region, which was fertile and densely populated, compared to Eskişehir-Konya section. These kinds of orientations mainly rose from executive power, and could not be interrogated from economical or social perspectives.

Railroads out of Anatolia also had some problems and were not economically efficient. The Beirut-Damascus Railway, for example, reportedly did not play an important role in the continuing development of the Beirut economy. Nor was the Hejaz railway line considered an economic success since, in the richer agricultural zones through which it passed, it duplicated existing lines. However its price wars to attract customers did improve the export potential of local growers by reducing rail charges for wheat around 16 percent. Similarly, it enhanced the purchasing power of local consumers as it reduced sugar freight charges by 50 percent (Faroqui, McGowan, Quataert and Pamuk, 1997:814).

The movement of imported and exported goods was elevated by the expansive trend of railroad lines. The promotion of raw materials, foods and agricultural goods' exports by railroad network development, reverberated over the import of finished goods, which were mostly manufactured goods, such as textiles, coffee, sugar and coal. Increased sales of imported goods were financed by rising exports from the railroad districts. The volume of railway exports exceeded railway imports, where railway exports were in the interval between 70 and 85 percent of all shipments on the Anatolian, Damascus-Hama and Izmir-Kasaba railway lines.

Despite the positive effects of railways on trade local producers around the Ankara region were negatively influenced. Besides that, manufacturing centers such as Amasya, Tokat, Arapkir and Diyarbakır were successful in the absence of railroad lines. These were unfavorable examples of the interaction between local producers and the rose of imported products. Nevermore, being close proximity to railways was in favor of local producers in manufacturing centers such as Aleppo, Damascus and Buldan.

Agricultural production and railroads inseparably formed an association, where all economic activities in agricultural production were directly or indirectly connected to that correlation. The reduction of transportation costs after the railroad network development helped cultivators compared to the period before railroads. Foods, cereals, raw materials and grains were not only transported and exported by railways. They also provided the requirements of big provinces such as Istanbul. In the absence of railroads, Anatolia could not be as reachable as the post railroad network construction for the coastal provinces with higher population density.

Previous to the Anatolian railroad development, wheat was shipped from Russia, Bulgaria and Romania to Istanbul. After the construction of railways, millers in Istanbul began buying wheat, which was shipped by railroads from interior parts of the Anatolia to Istanbul. Istanbul changed its provisioning patterns and Anatolia became an important factor in the city's grain supply by the railways. Istanbul was not only a capital, but also a large city with huge consumption compared to other cities. The Anatolian Railway provided over 90 percent of the wheat delivered to the capital city just for local consumption.

In addition to its positive effects on Istanbul, within a decade of its completion, the Anatolian Railway caused additional annual production of 400,000 tons of grain. That was also viable nearly for all railroad lines within the whole network. By substituting locally grown by imported grains, the railroads contributed important sums to the balance of payments. Around 75 percent of the domestic grain exported abroad. Thus, railroads offered import substitution benefits while reinforcing the role of the Ottoman economy as a supplier of grains, cereals, agricultural commodities and raw materials.

Figure 1-2: Railroad Network Development 1856-1919

(a) 1856-1879

(b) 1856-1899

(c) 1856-1919

Source: Inventory of the Project TUBITAK SOBAG No. 106K392

The highlights of the Pre-Republic period were the positive linkage between railways and agricultural production; strategic and military importance based decisions during the railway network expansion in Anatolia. While the map of the railway network in the Ottoman Empire in 1914 was given with Figure 1-1 the development of the railway network in the current borders of Turkey during the Pre-Republic period is given with Figure 1-2 in a detailed form because, the scope of this study is the development of the railways in the current borders of Turkey. Figure 1-2 provides the railway network development for the periods of 1856-1879, 1856-1899 and 1856-1919 in sections a, b and c respectively.

The railway network construction began around the cities with high trade volume and densely populated. Figure 1-2, section (a) shows the first railways in Anatolia. Izmir and Istanbul regions were the first to acquire railways. Throughout the twenty-year period between 1980 and 1900, the railways were constructed in the inner parts of the Anatolia and around the southern part of Turkey as seen in section (b). During the first two decades of the 20th century, the railways provided the accessibility between the northwestern and southeastern parts of Turkey (Section (c)).

In conclusion, 4,239 kilometers of the railways constructed by different foreign companies during the Pre-Republic period remained within the national borders that were determined with the proclamation of the Republic. Young Turkish Republic inherited a normal width line of 2,282 km and narrow line of 70 km owned by foreign companies and a normal width line of 1,378 km that was under the control of state. Table 1-7 shows the constructed railway lines between 1856 and 1922 in the territory of Ottoman Empire.

Table 1-7: Constructed railway lines between 1856 and 1922 in the territory of the Ottoman Empire

Railway line	Length in km	Type of the railway (meters)
Anatolia Railways	1032	normal lines (1.435)
Baghdad Railways	966	normal lines (1.435)
Adana-Mersin	68	normal lines (1.435)
Izmir-Kasaba	703	normal lines (1.435)
Izmir-Aydın	609	normal lines (1.435)
Orient Railways	337	normal lines (1.435)
Bursa-Mudanya	41	narrow lines (1.050)
Erzurum-Sarıkamış	232	narrow lines (0.750)
Sarıkamış-Sınır	124	wide lines (1.524)
Ankara-Yahşihan	127	narrow lines (1.050)
Total	4239	

Source: Atatürk Research Center[2]

1.2. POST-REPUBLIC PERIOD (1923-TODAY)

The modern history of Turkey and the golden age of railways in Turkey began with the foundation of the Republic on October 29, 1923. Mustafa Kemal Atatürk became the first President of the Republic of Turkey and subsequently introduced many radical reforms. Consequently, those radical reforms motivated solid developments with the aim of founding a new secular republic. Besides the economic and security effects of railways, social effects were also important according to Atatürk. Railways were a more important security issue than guns, arsenals and many other weapons. Atatürk mentioned in a convention of the Congress that railways were necessary factors of being a wealthy and a civilized country.

[2] http://www.atam.gov.tr

When the Republic of Turkey was established, the country's transportation facilities were in a very remote and poor condition to meet the needs of the country. Corruption and lack of transportation were important problems. One of the main components of the country's overall development objectives was seen to be the transport infrastructure, especially the railways. The State Railways of the Republic of Turkey was founded as a state organization in 1927 to take over the operation of the existing railways in Anatolia, which were left within the borders of the Republic of Turkey after the dissolution of the Ottoman Empire. The function of the organization was not only operating railways but also developing them in accordance with the needs of the country.

Contrary to the Pre-Republic Period railway construction policy was a national struggle aimed to realize the country's development and national defense needs without external pressure.

Post-Republic Period after the proclamation of the Republic includes both the golden age of the railway network development and the ignorance of the railway transportation. In the Railroad-Intense Period, which covers the period between 1923 and 1950, railway network constructions were accelerated all over the country. During that period, nearly 3,800 kilometers of railway lines, which corresponded to 250 railway routes in different parts of the country, were constructed and started to operate to transport passengers and goods.

By the year 1950, the highway network development came into existence and railway transportation was disregarded. After 1950, less than 1,000 kilometers of railroad lines were constructed and Turkish railways' golden-age ended with respect to railroad network development. Industries decided in favor of trucks, busses, commercial lorry and trucks. They chose more pollutant, waster and self-interested transportation. These two periods, golden-age and ignorance, follow with brief explanations and historical instantaneous' standing.

1.2.1. Railroad Intense Period (1923 – 1950) :

The railways were constructed by foreign companies with the privileges granted to them in a manner to serve foreign economies and political interests during the Pre-Republic period. On the contrary, they were structured to serve national interests during the Post-Republic period. Activating the national sources by means of the railways was targeted for the purpose of creating a self-sufficient national economy. The distinctive characteristic of this period is that the basic industries like iron and steel, coal, and machine were given priority with the 1st and 2nd Five-Year Industrialization Plans prepared between 1932 and 1936. Railway investments focused on transporting mass goods and freight in the cheapest way. For this reason, the railway lines were oriented towards motional resources and they became determining factors for establishing the locations during the process of national industrialization.

After WWI the borders of Turkey were partitioned by Allied forces (Great Britain, France and Greece) because Ottoman Empire was defeated in the war. Istanbul, Izmir and many provinces were occupied by the Allies. By September 1922, the occupying armies were expelled and the new Turkish state established after the establishment of the Turkish national movement. In spite of all of the negative conditions of this period, railway constructions and operations were succeeded with national strength.

Mustafa Kemal Ataturk mentioned about the importance of railways as: “The activity and energy of economic life is measured with the situation and level of transportation means, roads, railways, and ports. All of the central areas of our country will be connected to each other with railways. Important mine treasures will be opened. The foundation stones of our aim for transforming the ruined scene of our country at every corner into a developed country will shine the eyes with excitement.”

The opening ceremony of the Ankara-Sivas railway line was held on the August 30th, 1930. The prime minister of the Republic of Turkey Ismet Inönü, emphasized the following with reference to the first program of the Government formed under the leadership of Mustafa Kemal Ataturk in 1920: “While facing the biggest challenges, while its existence in the future was at risk, while the barefooted citizens were struggling against the invaders with sticks in their hands, while having lost all of his resources, and while he did not have even a penny in the treasure, he was saying in the first program that he would extend the railroad network from Ankara to Yahşihan.”

In the early years of the Republic, the interest and attention to railways was increasingly freshened. One of the impressive speeches, which were delivered by the distinguished figures of the Republic, belongs to Surgeon M. Necdet Bey on the ceremony of the railroad extension to Sivas province: “Congratulations! Here the train arrived. Railroad is the steel arm of our Republic. Sivas is not any more far from anywhere. Now Ankara is one day distance from our province. They laid these iron bars here to clean the rust of ground. They spliced them to turn yellow gleanings into gold. These iron bars decreased the travel between Ankara and Sivas from 10 days to 1 day. These iron bars bring richness and welfare to waste plateaus. A kilogram of grain that now amounts to 1 Lira will amount to 5 Liras after tomorrow. This is not iron, but gold road. The road is the vein of earth. The land that does not have pulse becomes gangrenous. The body of land needs road veins like the blood veins of our bodies to survive. The pulse of land must beat without stopping even for a minute just like a human being. Water feeds the crop until it grows and road feeds it after it has grown.”

The construction process of railways was increasingly progressed under destitution until the Second World War. In Railroad-Intense Period between 1923 and 1950, in 27 years almost 3,600 km of railroads were constructed but nearly 3,200 km of that amount tracks were finished before 1940. The decline of the railroad construction progress in the last decade could be due to slowdown because of the conjuncture, rather than a setback.

The railways intended to achieve following goals:

- To connect potential production centers with the natural resources. For example, the railroad reaching Ergani was called as copper line, the one reaching Ergani coal basin as iron line, and Adana and Çetinkaya lines were called as cotton and iron lines.

- To establish connections between production and consumption centers and especially seaports and rural areas. The number of seaports having railroad connections was increased from 6 to 8 with Kalin-Samsun and Irmak-Zonguldak lines. Sea connection of Central and Eastern Anatolia were reinforced with Samsun and Zonguldak lines.

- To reach especially underdeveloped areas for the purpose of generalizing the economic development throughout the country. Together with the establishment of Republic, the political center moved from the West to Central Anatolia and the accessibility was generalized from the West to Central Anatolia, Eastern and South-Eastern Anatolia. According to this policy, Kayseri was connected to railway network in 1927, Sivas in 1930, Malatya in 1931, Niğde in 1933, Elazığ in 1934, Diyarbakır in 1935, and Erzurum in 1939.

- To surround the country for the purpose of ensuring national security and integrity.

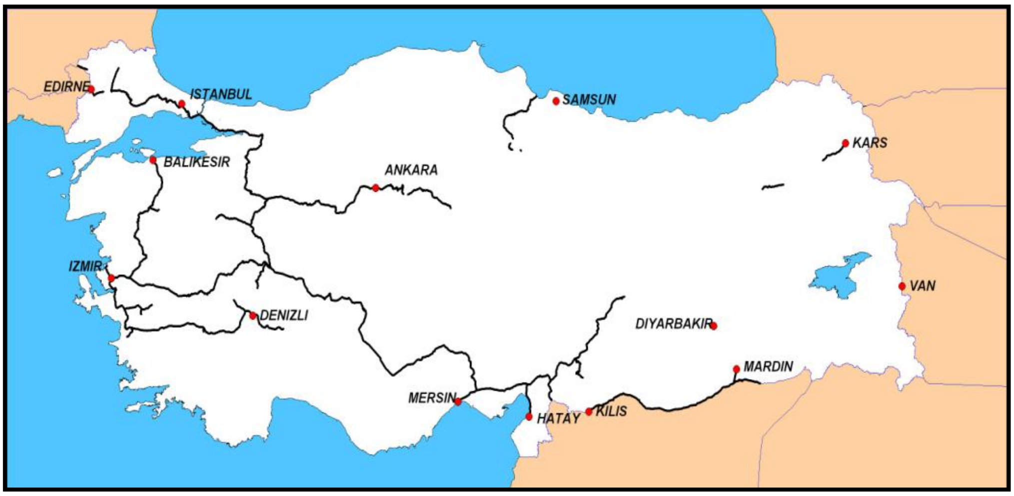
For achieving these aims, the railway transportation policy was handled in two phases. In spite of the serious financial challenges, the railway lines owned by foreign companies were procured and expropriated and some of them were taken over by agreements in the first phase. Railroad lines were mostly concentrated in the Western region of the country and thus in the second phase, the aim was connecting Eastern regions with Central regions of the country.

Main railway lines were mostly constructed by ensuring the direct connection of railroad lines with production centers. Main routes constructed at this period are: Ankara-Kayseri-Sivas, Sivas-Erzurum (Caucasus line), Samsun-Kalin (Sivas), Irmak-Filyos (Zonguldak coal line), Adana-Fevzipaşa-Diyarbakır (Copper line) and Sivas-Çetinkaya (Iron line). Before the establishment of Republic of Turkey, more than three fifth of the railroad lines were constructed in the western part of Anatolia. That scenario changed after the Republic and nearly four fifth of railroads were constructed in the eastern part of the country. Consequently, the balance of railroads (46% to 54%) was reached in the East and West at the end of the golden-age period.

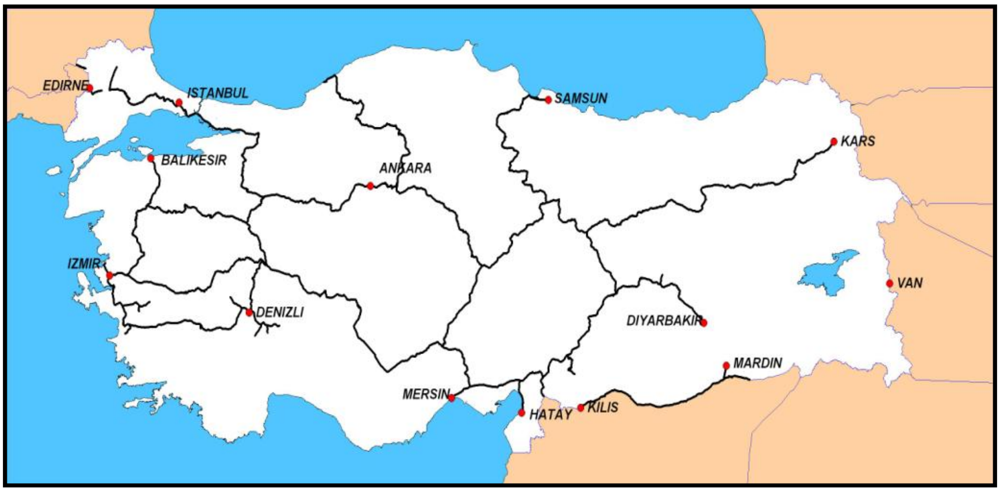
The railway network development after the establishment of the republic is shown in Figure 1-3. The construction of railways was in progress with an increasing speed until the 1929 world economic crisis. The slowdown period delayed the new railroad construction plans to 1933. In determining the route of the railway during the period 1923-1938, national defense concerns dominated, but also creating an integrated internal market was aimed as well. After 1938, the constructions were continued at the eastern part of Turkey as seen in part I. The railways made Van and Kars provinces accessible from the inner parts of Anatolia.

In addition, the importance was also given to construction of junction lines after 1933. Junction lines were significant about the widespread of railways throughout the country and in terms of national defense. Atatürk emphasized this point in his speech at the opening ceremony of Afyon-Karakuyu junction line: “We faced serious problems in defending our country due to lack of this line. It is almost impossible to perform the service of such a short line with 100,000 oxen. During the period of Ottoman Empire, the junction lines were attached slight importance. This was because of their lack of understanding rather than their financial weakness.”

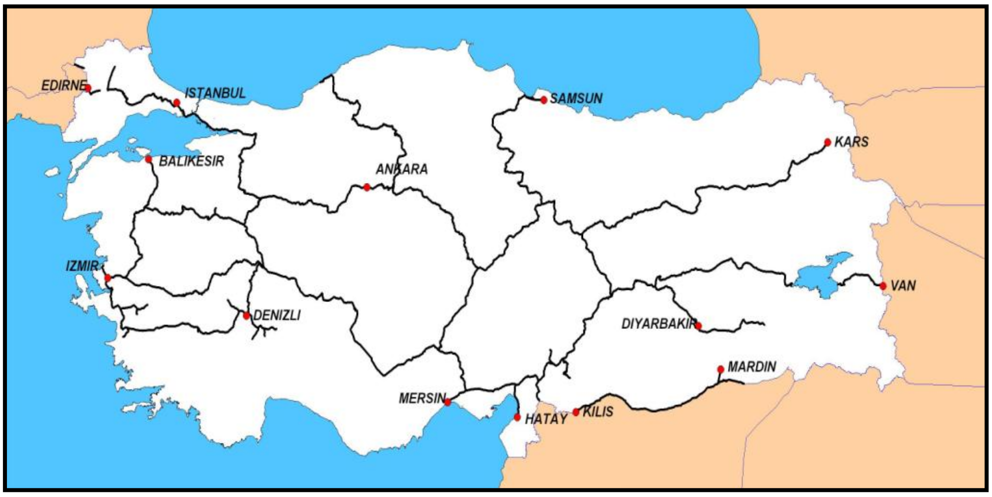
Figure 1-3: Railway Network Development 1920-1949



(a) 1920-1929



(b) 1920-1939



(c) 1920-1949

Source: Inventory of the Project TUBITAK SOBAG No. 106K392

Junction lines' construction was concentrated between 1935 and 1945. The tree shaped railways transformed into two loops in 1935: Manisa-Balıkesir-Kütahya-Afyon and Eskişehir-Ankara-Kayseri-Kardeşgediği-Afyon. The aim of that transformation was mostly economical and to this point Izmir-Denizli-Karakuyu-Afyon-Manisa and Kayseri- Kardeşgediği- Adana- Narlı- Malatya- Çetinkaya loops were obtained after the transformation of tree type railways to network type railways. Decreasing the physical and economic distance was also aimed by constructing these junction lines. For example, the distance between Ankara-Diyarbakır was 1,324 km and Çetinkaya-Malatya junction line decreased this distance to 1,116 km, therefore providing a decrease of 208 km. With these junctions, the tree shaped railroads that had been created by the semi-colonial economy in the 19th century were transformed into a looping network. Land route system was designed to support the railroads at this period.

February, 1937 issue of the Iron Ways magazine summarized the golden age period of 1923-1950 as: "A nation that was tired and without money after the interminable wars has laid brand new steel irons of 2,700 through a very steep and wide country with very difficult transportation possibilities within fifteen years, penetrated the mountains and tinged the deserted corners of its country, created a life and business source at every corner of the country, and succeeded to strengthen the national ideal and national unity monuments with a steel network of 3,300 km purchased from companies and all these are the unexampled subjects to be written in our history."

1.2.2. Land Route Intense Period (1950-today):

The land route heritage of Ottoman Empire consisted of 18,355 km roads, 13,885 km of which were damaged surface narrow paved roads and 4,450 km were unimproved roads and 94 bridges. The period following 1950 was almost the golden age of land routes (highways).[3]

[3] This period can be divided as: First Leap Term (1950-1963), Planned Leap Term (1963-1980), Transportation Main Plan Term (1983-1993), and Highways Term (1986-today)

Land routes were regarded as a system to support and integrate the railroads under the transportation policies that had been applied until 1950. However, the scenario changed after 1950s and the priorities shifted from railroad construction to land route construction. After the 2nd World War Turkey, who remained neutral, and many other European countries received financial support from United States of America, in the name of Marshall Aid. It was put into effect between 1948 and 1951. Under the umbrella of Marshall Aid, USA became dominant on Turkish economy.

Land route constructions were accelerated and commenced with Marshall Aid. Railroads were ignored after the latest advances in transportation policy decisions of the government. Highways and motorways became the first choice of transportation of passengers and goods. Busses and trucks were substituted with trains over the newly build roads. Besides, high priority was given to communications for its importance in providing transport facilities of raw materials from industrial centers to consumer markets within the country and abroad. The Turkish economic policy aimed at the rational exploitation of natural resources, intensification and improvement of agriculture, exploitation of power resources on a rational basis and the development of the means of communications (Üstün, 1997:42).

An industrialization process especially based on agriculture and consumer goods controlled the economic structure. Emphasis was given to agricultural production from many perspectives like concentrating efforts on the achievement of the agricultural mechanization. The mechanization programme aimed at the utilization of Turkey's vast arable spaces with the agricultural equipment and machinery that would be provided under the European Recovery Programme (ERP).During the planned development period after 1960, the goals envisaged for railroads were never achieved. The main aims were the coordination of transportation substructure systems. However, the characteristics of the previous period continued and the coordination between transportation substructure systems could not be created. It was always envisaged to focus on the new arrangements, modernization works and investments on the railroads to meet the increasing transportation needs of industry timely and appropriately. Those great expectations from the railroad perspective could not be realized and these policies remained only on papers as political dreams. Between 1950 and 1980, only 30 km of railroads were constructed annually.

In the middle of 1980s, a rapid highway construction mobilization was initiated in Turkey and the highways were accepted as the third biggest project after GAP (South-Eastern Anatolian Project) and Tourism. Within this framework, almost 2 billion dollars of investment was made annually for highways until the end of 1990s, while no project was implemented for the railroad substructure investments. A big part of the existing railroads was left within the geometric structure that was constructed at the beginning of the century. The resources allocated for maintenance investments were insufficient.

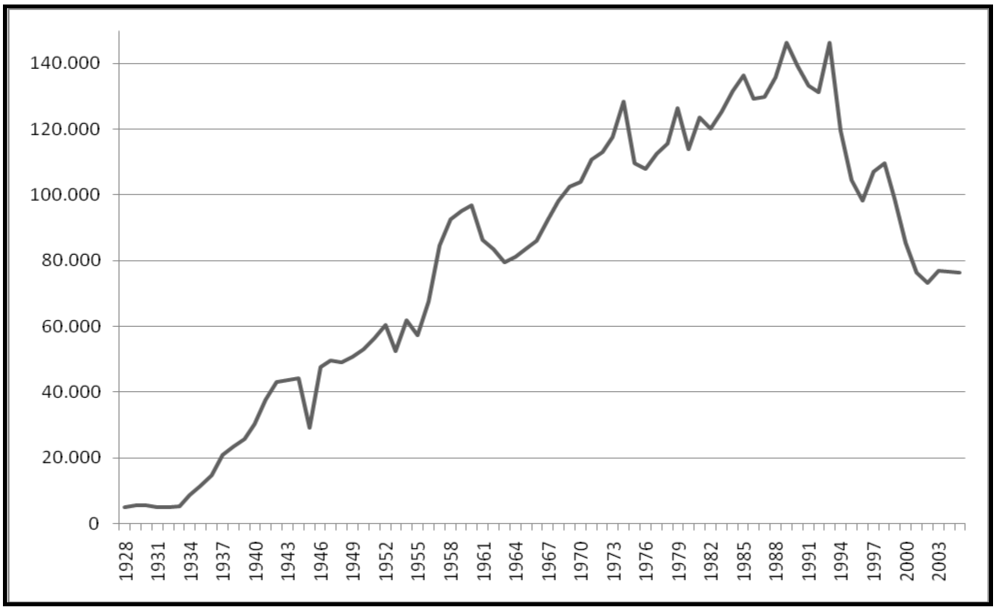
The “1983-1993 Transportation Interim Planning”, was the only national transportation plan prepared in Turkey for the purpose of improving transportation system. The share of highways in transportation was aimed to be reduced from 72% to 36%, which could not be implemented. Finally, the plan was abolished after the year 1986.

As a result of the land route-intense transportation policies, the length of land routes increased 80% between 1950 and 1997, but the railroad length increased only by 11%. When the investment shares among the transportation sectors are investigated, it could be monitored that while land routes got a share of 50%, railroads got only 30% before 1985. Afterwards the share of rail routes fell to below 10%, which decreased nearly by 70% when compared to the period before 1985.

As a result of these transportation policies, the transportation system of Turkey has been channeled to system. As far as the passenger transport shares of Turkey are concerned, the passenger transport share of land routes was 96% and the passenger transport share of railroads was only 2% per year between 1950 and 2000. Within the same period of time, the passenger transport share of railroads has been regressed 38% within last 50 years. Regrettably, the existing railway network, substructure and operating conditions of railroads were not rehabilitated.

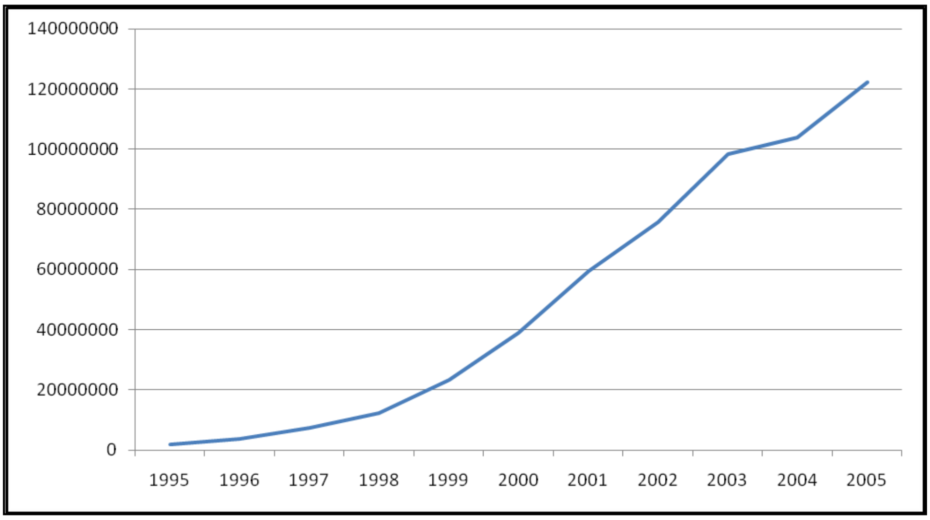
Railway passenger transportation statistics between 1928 and 2005 is graphed in Figure 1-4. The amount of passengers transported with railways posed increased until the end of 1980s; but in real terms the share of railways decreased with respect to huge rate of increase of the share of land routes. Since the beginning of the 1990s, the transportation of passengers with railways decreased from 143,000 passengers per year to 75,000 passengers per year in 2004, corresponding to a 50% reduction in one and half decade. Revenues from railway passenger transportation with that are graphed in Figure 1-5 provide that they increased although the number of passengers decreased between 1995 and 2005.

Figure 1-4: Passenger Transportation with Railways 1928-2005 (number of peoples)



Statistical Source: TCDD

Figure 1-5: Revenues of Passenger Transportation with Railways 1995-2005 (million TL)



Statistical Source: TCDD

After 2000, the amount of passenger transportation with railways stayed constant in an interval between 75,000 and 82,000 passengers per year. Table 1-8 provides the railway and land route passenger transportation per year between 2001 and 2008.

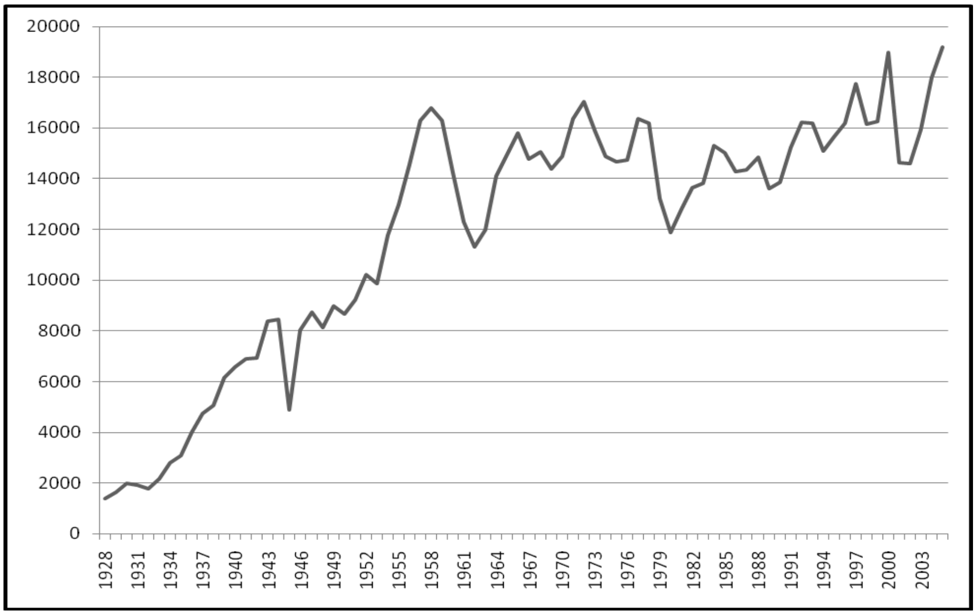
Table 1-8: Passenger Transportation with Railways and Land Routes (1000 peoples)

Year	Railways	Land Routes	Total
2001	76322	1682110	1758432
2002	73088	1633270	1706358
2003	76993	1643110	1720103
2004	76756	1743120	1819876
2005	76306	1821520	1897826
2006	77414	1875930	1953344
2007	81260	2091150	2172410
2008	79187	2060980	2140167

Statistical Source: TUIK

When the freight transportation shares of land routes and railways were examined, it can be seen that the share of railways was again beyond comparison with respect to land routes. While the freight transportation share of land routes was 94% per year at the end of 1990s, the freight transportation share of railroads was less than 5% per year at the same period of time. The freight transportation share of railways decreased nearly 60 percent within the last 50 years period between 1950 and 2000. The graphical representation of freight transportation amounts of railways between 1928 and 2005 can be seen in Figure 1-6.

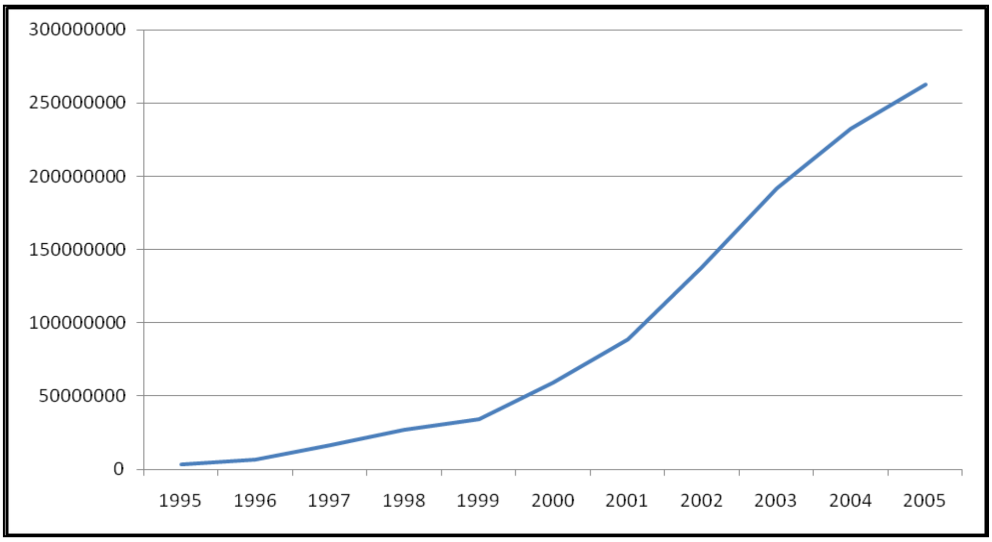
Figure 1-6: Freight Transportation with Railways 1928-2005 (thousand tons)



Statistical Source: TCDD

Revenues obtained from freight transportation, which has an increasing trend, with railways is provided in Figure 1-7. The relationship between revenues from freight transportation and freight transportation amounts in tons with respect to progressive trends is positive as can be seen from Figures 6 and 7.

Figure 1-7: Revenues of Freight Transportation with Railways 1995-2005 (million TL)



Statistical Source: TCDD

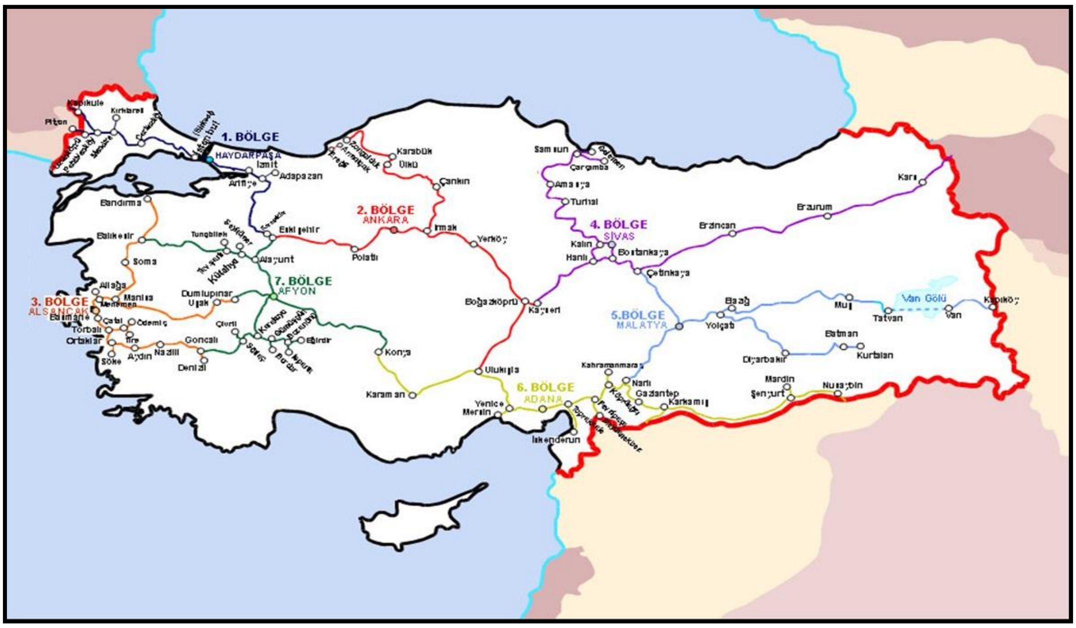
Increasing the share of railways in both freight and passenger transport has been the aims of the Ministry of Transport and Communication after 2003. Railway construction was 109 kilometers per year during the years 1923-1950 with lots of difficulties and shortages such as wars, poverty and transition from an Empire to a young Republic. However, the construction amount decreased to 11 kilometers per year between 1950 and 2003. Since 2003, railways became the most prior transport issue for the government and the budget share of railways exceeded the budget share of land routes in 2003 for the first time since 1950.

The incentives of Ministry of Transport and Communication thither to develop and increase railway transport. These incentives are based to provide the production and transportation of goods and passengers in a balanced, safely, environmental friendly, fair, feasible and cheap conditions within the country and abroad. Ministry of Transport and Communication aims to improve the railway network and to raise the amount of transport of goods by railways by %100 and passenger transport by % 50[4]. When compared to previous circumstances of railroad

[4] http://www.ubak.gov.tr/

transport shares with these aims, the importance given to railroads could be easily and apparently conceived. Today, the renewal of 2,500 km of the existing railway lines included to the plans with the construction of 4,984 kilometers of high standard new railway lines. The final stage of the railroad network of Turkey can be monitored from Figure 1-8.

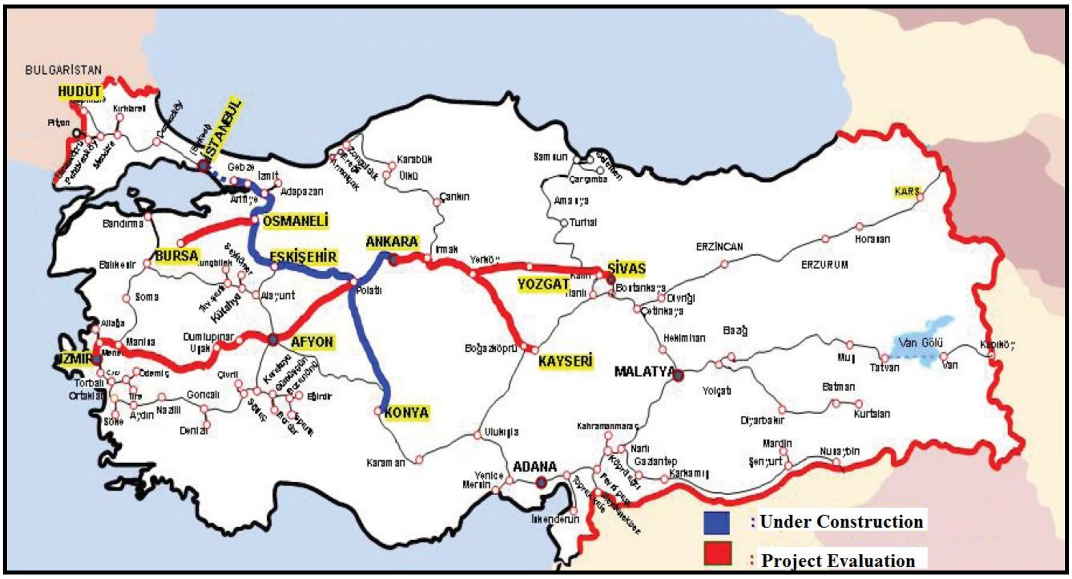
Figure 1-8: Turkish Railway Network Map



Source: Turkish State Railways

Increasing the share of railways in transportation of passengers and freight is aimed to be realized by the creation of faster, secure and comfortable railway transportation with the assistance of new projects. One of these outstanding projects about the railways in Turkey is the High Speed Train (HST) project. The main aim of that project is to decrease the travel time between large cities, which are densely populated and highly industrialized. Performing the connection between Ankara and Istanbul is the prime target. Actually that project is aimed to extend to other cities such as Eskişehir, Konya, Bursa, Kayseri, Sivas, Yozgat, Afyon and Izmir. The map of that project is provided in Figure 1-9.

Figure 1-9: Fast Train Project Routes



Source: Ministry of Transport and Communication

The constructions for the HST project started in 2003 and finished in March 2009 between Eskişehir and Ankara as the first section of Ankara-Istanbul route. The second step is finishing the second section between Istanbul and Eskişehir to reach the whole route between Ankara and Istanbul. The constructions of fast-train routes of 2,197 kilometers are estimated to be finished until 2023.

CHAPTER TWO
TRANSPORTATION AND DEMOGRAPHY

The aim of this study is to find the effects of railways as transportation infrastructure on population density as demographic measure and agricultural production as economic activity measure in Turkey. Thus, the relationship between the transportation infrastructure and demographic measures is explained in this chapter.

The evidence from empirical studies shows a positive relationship between transportation infrastructure (investment, infrastructure, spending) and demographic measures (population, migration, urbanization). The diverse body of the literature is nourished by several theories and streams of research. The existing literature on the relationship between transportation infrastructure and demographic measures is tabulated in Table 2-1. Table 2-1 includes empirical studies related with the relationship between infrastructure measures and demographic measures. This table includes the transportation measures, demographic measures, observed area, study period and results.

The effects of transportation infrastructure on demographic variables such as population, population density, population distribution, living standards, environment and migration are explained in this section. Actually, the effects of transportation on demographic variables and economic activities are inextricable. When the accessibility of producers and consumers to raw materials, employers, goods and services increase by developed transportation infrastructure systems, the transport costs will decrease, productivity will increase, economy will develop and the flow of population to those residential areas such as county, city, province or state will increase (Jenks, 1944; Taaffe, Morrill and Gould, 1963; Kuehn and West, 1971; Fernald, 1999; Glaeser and Kohlrase, 2003; Boopen, 2006; Keeling, 2009; Snow, 2010).

People desire to live in a better residential area, where their children can take better education and they can find jobs with higher wages. Just because of these economic and social reasons, people want to change their residential areas and move, but changing the home, job and school are complex and compulsive issues. Especially in developing countries rather than developed countries. Because, this is the effects of an advanced transportation infrastructure in developed countries may conduct to a decrease of the possibility to move away from one place to another. In developed countries, people mostly live around large cities and they take daily trips from home to work and go back home with railways and highways. The accessibility to large cities with better job and school opportunities is the most struggling issue of the people living in developing countries. Transportation infrastructure such as highways and railways can solve problems arising from accessibility issues between suburban and urban. Keeling (2009) stated that, theories and methodologies, which are aimed to explain the changing dynamics of accessibility and mobility, should contain economic, cultural and transportation impacts as a combined impact on population changes.

2.1. TRANSPORTATION AND POPULATION CHANGE

The relationship between transportation infrastructure and population change is investigated by many scholars in the third quarter of the twentieth century. These post 1950s studies are William (1958), Kanwit and Todd (1961), Thiel (1962), Taaffe, Morrill and Gould (1963), Gamble et al (1966), Hobbs and Campbell (1967), Bohm and Patterson (1971), Wisenbaker (1973) and Fuguitt and Beale (1976). These studies all used highways as transportation infrastructure variable and investigated the effects of transportation infrastructure on population changes and population change based variables such as population distribution, migration and urbanization. The results of these studies were impressive because they all found and presented positive interaction between transportation infrastructure and population change. Studies investigated the United States as the observed area after the Second World War until 1970s except Taaffe, Morrill and Gould (1963). They discussed the relationship between transportation and population, where that relationship was used as the basis for examination of such additional factors as the physical environment, rail competition, intermediate location and commercialization. Throughout the study, Ghana and Nigeria are used as examples for the period 1922-1958. Those countries from Africa were selected because the improvement of internal accessibility through the expansion of a transportation network was considered as a critical factor in the economic growth of underdeveloped countries. The sequence between transportation network and population shaped in African countries as: when population increases in an area, then the demand for transportation is intensified; new transport lines are built into the area; a greater population increase is encouraged and that calls for still more transportation.

In the last quarter of the 20th century scholars are continued to investigate the relationship between transportation infrastructure and population change as demographic measure. Humphrey (1980), Briggs (1981), Eyerly et al (1987), Moon (1988), Crane and Leatham (1990), Doeksen (1990), Fuguitt and Brown (1990), Gerardin (1991), and Boarnet and Haughwout (2000) found positive and statistically significant results including the connection between transportation measures and demographic measures. Highways were again one of the popular transportation infrastructure measures but there were newly established ideas looking for new transportation infrastructure measures.

After 1970s, the constructions of new highway systems were raised and the investments on transportation infrastructure became an important point for the scholars. Studies using highway investments, public capital investments and expenditures found positive effects on population changes. Humphrey (1980), Briggs (1981), Eyerly et al (1987), Crane and Leatham (1990), Doeksen (1990), and Boarnet and Haughwout (2000) examined the effects of highway investments on metropolitan development in the United States. According to these studies highways and highway investments could be an important factor in shaping and channeling the growth of urban areas. They found that, highways influenced land prices, population, and employment changes. Overall, they concluded that federal highway policy should be oriented toward more efficiently funding and managing the nation's road infrastructure. They recommended a shift in the federal role from being a major source of highway revenues to encouraging states and metropolitan areas to empower similar regional governments in transportation planning.

Schafer and Victor (2000), Cervero and Hansen (2002), Voss and Chi (2006), Chi, Voss and Deller (2006) and Chi (2010) investigated the effects of highways, highway expansions, investments on population change in the United States except Schafer and Victor (2000). They investigated that interaction for eleven countries from all over the world by using automobiles, aircrafts, busses and railroads. They used per capita values of travelling time, traffic volume, motorization rate, GDP and travelling budget as data for all regions and the world between 1960 and 1990. Schafer and Victor stated that, mobility rose in proportion with income because people devoted a predictable fraction of income to travel. Therefore, an increase in income led directly to an increase in demand for mobility. Results provided that, transportation infrastructure was built to accommodate particular patterns of urbanization, population density, land-use and the travel behavior affected from transportation infrastructure.

Cervero and Hansen (2002), Chi, Voss and Deller (2006) and Chi (2010) investigated the effects of highways on population change. Studies examined the role that highway expansion played in the process of population change from 1980 to 2000. Specifically, the impacts of highway expansion on population change in the 1980s and 1990s in Wisconsin at the minor civil division level in the United States were analyzed. It is pointed out that, it was essential to comprehend the impacts of highway expansion on population change as well as economic growth and development. The findings suggested that the impacts of highway expansion on population change differed across rural, suburban, and urban areas. There were only indirect effects in rural areas, both direct and indirect effects in suburban areas and no statistically significant effects in urban areas. Overall, highway expansion served as a facilitator of population change and as an important function in transforming human society.

The empirical studies dealing with the relationship between transportation infrastructure and population change; William (1958), Kanwit and Todd (1961), Thiel (1962), Taaffe, Morrill and Gould (1963), Gamble et al (1966), Hobbs and Campbell (1967), Bohm and Patterson (1971), Wisenbaker (1973) and Fuguitt and Beale (1976), Humphrey (1980), Briggs (1981), Eyerly et al (1987), Moon (1988), Crane and Leatham (1990), Doeksen (1990), Fuguitt and Brown (1990), Gerardin (1991), and Boarnet and Haughwout (2000), Schafer and Victor (2000), Cervero and Hansen (2002), Voss and Chi (2006), Chi, Voss and Deller (2006) and Chi (2010) provided positive and significant results.

2.2. TRANSPORTATION AND POPULATION GROWTH

The studies investigating the relationship between transportation and population growth began appearing in the 1970s. Humphrey and Sell (1975), Miller (1979), Wang (1987), Moore and Thorsnes (1994), Cervero and Hansen (2002) and Snow (2010) investigated the effects of highways and highways related measures as transportation infrastructure on population growth as demography measure. All studies took the states and counties in the United States over the period from 1960s to 2000.

Miller (1979), Wang (1987), Cervero and Hansen (2002) and Snow (2010) indicated the effects of highway construction on population growth for the counties in the United States. They all stated that, highway construction played a crucial role in the decentralization of the cities in the United States as the growth of the suburbs and decline of cities as employment and residential decentralization. Results implied that, highway constructions as new urban transportation infrastructure provided advantages for firms by declining transport costs and increased productivity. New highways benefited workers with higher wages and lower housing costs as well. Consequently, with the construction of new highways, firm and labor productivity became attainable to same productivity advantages from further distances.

Humphrey and Sell (1975), Moore and Thorsnes (1994) indicated the effects of highway access and new highway systems on population growth, income and mobility decisions in the United States. Humphrey and Sell (1975) investigated the relationship between 1970 and 1980 for the 138 counties in the United States while, Moore and Thorsnes (1994) investigated the interaction between transportation and population growth for the counties in Alabama in the United States for the same observation period. These studies provided statistically significant and positive results for the relationship between transportation and population growth.

Studies, which examined the interaction between transportation and population growth, reflected to a positive relationship (Humphrey and Sell, 1975; Miller, 1979; Wang, 1987; Moore and Thorsnes, 1994; Cervero and Hansen, 2002; Snow, 2010). All these studies proved a similar context like the population change and transportation provided. Population growth is positively affected from transportation infrastructure developments, improvements and investments.

2.3. TRANSPORTATION, POPULATION AND EMPLOYMENT

Transportation and population based demographic measures were investigated by many scholars from different perspectives but the effects of transportation on population and employment is first investigated by Allen and MaClennan (1970). This is followed by Zahavi (1976), Gaegler, James and Weiner (1979), Miller (1979), Botham (1980), Hilewick, Deak and Heinze (1980), Lichter and Fuguitt (1980), Carlino and Mills (1987), McHugh and Wilkinson (1988), Cervero and Hansen (2002) and Snow (2010).

Allen and MaClennan (1970) investigated the effects of public capital on population and employment for Italy and France. Zahavi (1976) analyzed the empirical relationship between transportation systems and the accumulation between the spatial distributions of population and jobs for ten states in the United States and 8 cities from all over the world between 1955 and 1970. Botham (1980) analyzed the impact of highways on population and employment for the Britain from 1960 to

1970. Zahavi provided the differential accumulation of population and jobs by proximity to (distance from) city center for the observed cities. The daily travel distance and travel speed were important criteria, which differ across cities and states, and affected the accumulation of population and jobs around city center. Zahavi considered travel money and travel time budgets as double constraints within travel behavior of households. It is stated that, the spatial distributions of population and jobs as the spatial structure of an area were linked to travel behavior and transportation infrastructure systems. Allen and MaClennan (1970), Zahavi (1976) and Botham (1980) found that population and employment were effected positively from transportation infrastructure during the observed period for the investigated countries.

Gaegler, James and Weiner (1979), Lichter and Fuguitt (1980) and Hilewick, Deak and Heinze (1980) investigated the relationships between interstate highways as transportation infrastructure measure and demographic measures such as changes in employment and population characteristics for nonmetropolitan counties. Gaegler, James and Weiner (1979), Lichter and Fuguitt (1980) investigated during the period 1950-1975 in the United States. Both studies' results provided that counties with interstate highways consistently maintained an advantage over other counties in net migration and employment growth. Population growth was also relatively high in interstate highway counties compared to other counties. The positive effects of highways on net migration were more noticeable and intensive in less remote areas. Lichter and Fuguitt stated that developed transportation infrastructure system contributed to manufacturing employment growth, population growth and enhanced accessibility. Gaegler, James and Weiner indicated that the level and distribution of population and economic activities as increases in population, increases in manufacturing employment, retail sales, and land values were related to increases in accessibility afforded by the modernization of transportation infrastructure. On the other hand Hilewick, Deak and Heinze (1980) investigated the relationships from 1970 to 1980 for counties in Pennsylvania and North Carolina states in the United States for 1970-1980. Investing in communication systems resulted in stronger short-term and long-term effects rather than transportation investments on demographic and economic measures such as population, jobs, income, gross regional product and overall economic structure.

Carlino and Mills (1987) and McHugh and Wilkinson (1988) investigated the factors affecting US county population and employment growth between 1970 and 1980. First study investigated the effects of economic, demographic, climatic and policy related variables on the growth of population and employment for 3,000 counties in the United States. Latter study argued out the former study and investigated the same relationship with considering state-level effects with the same dataset. Both studies used interstate highway density as transportation infrastructure measure and total population density, total employment density, manufacturing employment and population as demographic measures. Both studies found that, total employment, manufacturing employment and population density variables were positively affected from interstate highway density.

Allen and MaClennan (1970), Zahavi (1976), Gaegler, James and Weiner (1979), Miller (1979), Botham (1980), Hilewick, Deak and Heinze (1980), Lichter and Fuguitt (1980), Carlino and Mills (1987), McHugh and Wilkinson (1988), Cervero and Hansen (2002) and Snow (2010) showed that employment and population variables were positively affected from new highway systems, highway investments and expenditures in the United States and outside the United States.

2.4. TRANSPORTATION AND POPULATION DENSITY

The impact of transportation infrastructure on population density is found positive (Carlino and Mills, 1987; McHugh and Wilkinson, 1988; Forkenbrock and Foster, 1996; Schafer and Victor, 2000; Robinson and Kapo, 2004; Levinson, 2008, Atack et al, 2009). The difference between population density and other demography measures such as population change and population growth is acquiring the area variable of the observed place (city, state, country etc.). Population change and population growth variables are obtained from population data, which is not very unfamiliar to population density obtaining procedure. Population density is calculated by dividing the population of a place to the area of the same place.

Transportation can influence population change, growth and density at the same time by several paths: economic growth or decline, employment change, altered socio-demographic structure, and environmental change (Carlino and Mills, 1987; McHugh and Wilkinson, 1988; Forkenbrock and Foster, 1996; Schafer and Victor, 2000; Robinson and Kapo, 2004; Levinson, 2008, Atack et al, 2009). Carlino and Mills (1987) and McHugh and Wilkinson (1988) investigated the effects of highways and highway access on population change between 1970 and 1980 in the United States. They stated they that, population density variables were positively affected from highways. Forkenbrock and Foster (1996) examined the relationship for Missouri and Iowa states in the United States and they argued that access to highways generally had become a less important factor in location decisions but highways were considered as important factors affecting the potential of economic development and population density of the place.

Schafer and Victor (2000), Robinson and Kapo (2004), Levinson (2008) and Atack et al. (2009) expanded the content of transportation infrastructure by adding cars, busses, aircrafts, trains, transportation networks and waterways as transportation infrastructure. Schafer and Victor (2000) examined the effects of these transportation measures on population density. They revealed that transportation variables are positively correlated with population density in eleven regions and in world average for the period 1960-1990. Robinson and Kapo (2004) explored the interaction between transportation networks and population density distribution in Maryland, Washington DC and Virginia states in the United States from 1997 through 2001. According to Robinson and Kapo, population centers created high market demand for aggregate directly and indirectly as demand for infrastructure, development, maintenance and repair. Levinson (2008) examined the changes that occurred in the rail network and density of population in London from 1871 to 2001. Levinson focused on the question of whether railways were centralizing or decentralizing force. Levinson provided that railway network density is a positive factor effecting population density. Atack et al. (2009) examined the effects of transportation infrastructure on population density and urbanization as settlement in the United States for 278 counties of seven states between 1840 and 1860. Atack et al (2009) suggested that, the railroads were quantitatively significant cause of urbanization, which was measured as the increase in the fraction of population living in urban areas during the 1850s. Results were also implied that the effects were less important on the population density growth but according to Atack et al., the population density increase can be attributed to the coming of the railroads.

To sum up, demographers considered transportation infrastructure as a sufficient requirement for local economic growth and development and as a catalyst of change to influence population growth. Transportation infrastructure is regarded as one of the important factors effecting and/or affected from demographic measures such as population, population change, population density, urbanization and migration (Taaffe, Morrill and Gould, 1963; Lichter and Fuguitt, 1980; Atack et al., 2009; Chi, 2010; Snow, 2010). The effects of transportation infrastructure on demographic measures can be summarized by three important points. First, expanded highways could increase suburban populations by augmenting employment opportunities in or near the surrounding areas. Second, better highways allow urban families to move to suburban areas with lower real estate costs and the perception of a higher quality of life. Third, convenient highways can also encouraged suburban and rural people to travel to urban areas for employment opportunities and urban amenities.

Table 2-1: Literature Review about Infrastructure Measures and Demographic Measures

Author and Year	**Infrastructure Measure**	**Demographic Measure**	**Observed Area and Period**	**Results**
William 1958	Highways and highway expenditures	Population change	United States, Texas	+
Frey, Dansereau, Pashek and Markham 1960	Highways	Population	United States, Monroeville – Pennsylvania	+
Kanwit and Todd 1961	Highway transportation	Population change and migration	United States	+
Thiel 1962	Transportation investments	Population change	United States	+
Dansereau 1965	Public capital	Population components	United States, 1950-1960	+
Gamble, Raphael and Sauerlender 1966	Highway investments	Population change	United States	+
Hobbs and Campbell 1967	Highways	Population change	United States	+
Allen and MaClennan 1970	Public capital	Population and employment	Italy and France	+
Bohm and Patterson 1971	Highways	Population change	United States	+
Wisenbaker 1973	Highways and highway expansions	Population change and distribution	United States, 1960-1965	+
Humphrey and Sell 1975	Controlled highway access	Population growth	United States, 1970-1975	+
Fuguitt and Beale 1976	Transportation infrastructure	Population change	United States, 1970-1975	+

Table 2-1 continued

Author and Year	Infrastructure Measure	Demographic Measure	Observed Area and Period	Results
Miller 1979	Highway construction	Population and employment growth	United States	+
Botham 1980	Highways	Population and employment distributions	Britain, 1960-1970	+
Hilewick, Deak and Heinze 1980	Transportation infrastructure systems	Population, jobs and income	2 states in the United States, 1970-1980	+
Lichter and Fuguitt 1980	Interstate Highways	Population characteristics and employment	Counties in United States, 1950-1975	+
Humphrey 1980	Public capital	Population change	United States, 1970-1980	+
Briggs 1981	Transportation infrastructure	Population change	United States	+
Carlino and Mills 1987	Highways and highway access	Population density and employment	United States, 1970-1980	+
Eyerly, Twark and Downing 1987	Interstate Highway system	Population change	United States, Pennsylvania	+
Wang 1987	Interstate Highway system	Demographic growth	United States, Georgia, 1960-1980	+
McHugh and Wilkinson 1988	Highways and highway access	Population density and employment distribution	United States, 1970-1980	+
Moon 1988	Interstate highways	Population distribution	United States, 1970-1980	No effect
Cervero 1989	Transportation capital	Land distribution	United States	+
Crane and Leatham 1990	Highway expansion	Population change	United States	+

Table 2-1 continued

Author and Year	Infrastructure Measure	Demographic Measure	Observed Area and Period	Results
Doeksen 1990	Transportation investment	Population change	United States, 1980-1990	+
Fuguitt and Brown 1990	Public capital expenditures	Population distribution	United States, 1970-1980	+
Deller 1991	Hard types of infrastructure investments	Regional population components	United States, 1980-1990	No effect
Gerardin 1991	Transportation infrastructure investments	Population change	Britain	+
Vickerman 1991	Transportation infrastructure	Population and location distribution	Europe	+
Moore and Thorsnes 1994	Transportation capital	Population growth	United States, Alabama	+
Forkenbrock and Foster 1996	Highways and highway access	Population and firm location decisions	United States	+
Mikelbank 1996	Highways	Regional demographic measures	United States, Ohio	+
Halstead and Deller 1997	Transportation infrastructure mainly highways	Regional demographic measures	United States	+
Boarnet and Haughwout 2000	Highways and highway investments	Population change	United States	+
Guild 2000	Transportation infrastructure investment	Population and economic growth	United States	+
Schafer and Victor 2000	Automobiles, aircrafts, busses and railroads	Population Density and Population Mobility	11 regions and World average, 1960-1990	+
Cervero and Hansen 2002	Highways	Population change and growth	United States	+

Table 2-1 continued

Author and Year	Infrastructure Measure	Demographic Measure	Observed Area and Period	Results
Dilworth 2002	Public infrastructure capital	Population distribution	United States, New York	+
Pucher and Renne 2003	Transportation infrastructure	Population components change	9 states in United States	+
Robinson and Kapo 2004	Proximity to Highways	Population Density	3 States in United States, 1997-2001	+
Voss and Chi 2006	Highways and highway expansion	Population change	Wisconsin in United States, 1970-2000	+
Chi, Voss and Deller 2006	Highways	Population change	Wisconsin in United States	+
Garcia-Milà and Montalvo 2007	National roads and Highways	Firms located near highways	Spain, 1980-2000	+
Levinson 2008	Rail network	Population Density	33 boroughs of London, 1871-2001	+
Atack et al. 2009	Railways and Waterways	Population Density and Urbanization	278 counties in United States, 1940-1960	+
Chi 2010	Highways and Highway Expansion	Population Change	Wisconsin in United States, 1980-2000	+
Snow 2010	Highways	Population Growth, Employment	152 counties from United States, 1960-2000	+

CHAPTER THREE
TRANSPORTATION AND ECONOMIC ACTIVITIES

The relationship between transportation infrastructure and economic activities analysis is examined for different kinds of areas, such as industrial zones, tourism regions, countries, communities and continents. In these studies different kinds of approaches are used which are related with the area of the study, data, period and also the view of the researcher. This chapter presents empirical and theoretical studies to overview the historical development of the analysis investigating the relationship between transportation infrastructure and economic activities.

The evidence from empirical studies shows, in general, a positive relationship between all components of transportation (investment, infrastructure, spending) and economic activities (development, productivity, growth, quality). There is a vast amount of literature on the relationship between transportation infrastructure and economic development. Some seminal and important studies, which are theoretical but mostly empirical, are explained and visualized in Table 3-1, which provides studies dealing with the relationship between infrastructure measures and economic activity measures. This table includes the types of measures, observed area, study period and results.

The relationship between transportation infrastructure and economic activity, basically growth and development have been analyzed in many studies for regions, countries and continents by using production function or cost function approaches. The theoretical framework which argues that improvements in transportation infrastructure have positive effects on economic development is supported by many empirical studies where transportation infrastructure is measured by highway lengths, railway lengths, transportation spending per capita and transportation capital such as water and sewer, electricity and gas, hospitals and passenger rail stations. These measures are selected according to the observed area (local, county, state and/or national base) and data availability. The measures regarding economic activity are generally per capita income, growth, investments (e.g. foreign direct investment, manufacturing industry), manufacturing costs, productivity, and rate of return, output, employment, and labor force.

As one of the earliest studies Jenks (1944) investigated the contribution of railways on economic development in the United States between 1837 and 1937. Healy (1947) analyzed the contribution of transportation to economic growth in the United States. Leinbach (1975) concerned with the role of transportation in the development and modernization of Malaya by analyzing the road and rail network change from 1870s to 1970s and gave notice of the development, spread and interaction of transportation systems. Jenks (1944) stated that the advantages of railways were speed, flexibility of service and enhancing pioneering opportunities with respect to waterways and horses. Jenks (1944) illustrated railways as an idea, as a construction enterprise and as a producer of transportation services. According to Jenks (1944), the most striking contribution of railway transportation to economies was the reduction of shipping (transportation) costs. Healy (1947) mentioned that, transportation costs of passengers and goods sharply reduced after the improvements and transformation of transportation systems and energy sources of transportation. According to Healy (1947), the contribution of railways was more than just lowering the transportation costs and extending the range of service for all over the relevant area. Leinbach (1975) stated that, the growth of the railways generated considerable debate over the role of railways and roads that the railways could be effective during new developments with the support of an extensive network of feeder roads. According to Leinbach (1975), transportation systems increased accessibility and the growth of accessibility had a significant impact upon the spread of communication.

The relationship between infrastructure and economic activities is one of the perspectives as a natural consequence of investigating the nature of public-private relationship. That relationship is investigated by many scholars covering the effects of public sector infrastructure investments on private sector production, employment, productivity and many other economic activity measures. Most of them produce public policies, some modifies these policies and others give only some ideas. The intersection between public sector and private sector can be seen easily in daily-life activities of private sector such as export, import, shipping of goods and services and so on. These activities can be counted as the ingredients of economy. The development of infrastructure has an important impact on these activities with the largest share among all infrastructure types.

The literature review, which investigated the relationship between transportation infrastructure and economic activities, is explained by dividing into three headings at the following part of this chapter. Actually, that is hard to draw some borders and group the economic activity measures, which are connected by transportation infrastructure directly or indirectly. Anyway, the following sections provide the group of studies with respect to their main economic activity measures, to propose a more understandable and organized literature survey.

3.1. INCREASE AND GROWTH OF OUTPUT AND GROSS PRODUCT

The effects of transportation infrastructure on output and gross product is investigated by many scholars using almost the same methodology, observation period and observed area. Deno (1988), Hulten and Schwab (1991), Conrad and Seitz (1994), Boarnet (1996), Garcia-Mila, McGuire and Porter (1996), Haughwout (1996), Boarnet (1998), RESI (1998), Sanchez and Robles (1998), Fernald (1999), Felloni et al (2001) and Lakshmanan (2007) investigated the effects of highway capital as transportation infrastructure measure on the increase and growth of output. Deno (1988), Hulten and Schwab (1991), Boarnet (1996), Garcia-Mila, McGuire and Porter (1996), Haughwout (1996), Boarnet (1998), RESI (1998), Sanchez and Robles (1998) and Fernald (1999) observed cities, counties and states in United States and found positive connection between these variables.

Deno (1988) investigated the effects of public capital on manufacturing firms for the period 1970-1978. Deno provided that, public capital played an important role in manufacturing firms and according to empirical analysis, Deno suggested that, highway investment had significant effects on regional output, demand for private capital and labor. Hulten and Schwab (1991) investigated the linking between highways and manufacturing output for the United States between 1951 and 1986. They distinguished the role of infrastructure into two parts as a direct input to production and infrastructure as a source of externalities. Boarnet (1996) examined the redistribution of economic activities by road and highway investments for the data on over fifty California counties from 1969 to 1988. Results showed that street and highway capital were significantly positive coefficients in production function for observed counties when these coefficients were significantly negative on neighbor counties.

Garcia-Mila, McGuire and Porter (1996) investigated the effects of highways on private sector output between 1970 and 1983. They found that highways positively affected private sector output. Haughwout (1996), Boarnet (1998), RESI (1998), Sanchez and Robles (1998) and Fernald (1999) examined the impact of highways on private sector output in the United States for the period 1970-1990, 1969-1988, 1982-1996, 1970-1990 and 1953-1989, respectively. The results obtained by these studies were consistent as positive with each other. Boarnet (1998) examined the location impacts of public capital by modeling and testing for an existence of negative output spillover. That negative spillover was the migration of mobile factors of production to locations with the best infrastructure stocks, from public capital, as street and highway capital. The results suggested that street and highway capital was productive and associated with higher output in California counties. Sanchez-Robles (1998) argued that in types of public capital that follow distribution networks the payoff of the investment was related to the size and configuration of the network, being usually smaller in the case of larger networks. If public capital was considered as a public good, increases in it shifted the production function upward, raising the steady state level of output and also the growth rate of the economy in the transition to the steady state. Many services provided by the public capital stock may be subject to congestion and therefore the marginal increments of the public capital stock will not have an impact on output.

Conrad and Seitz (1994), Felloni et al (2001) and Lakshmanan (2007) investigated the connection between public capital including transportation infrastructure and private sector output for Germany from 1961 to 1988, for China from 1991 to 1996 and for seven countries between 1951 and 1987, respectively. Felloni, Wahl, Wandschneider and Gilbert (2001) used thirty Chinese provinces for the years 1991, 1993 and 1996 to assess the effects of transportation and electricity infrastructures on agricultural production and productivity. Infrastructure dataset contained roads per capita, roads per agricultural land, electricity consumption and production of electricity per capita. Economic activity measures were GNP per capita, the value of agricultural production per capita, gross agricultural output and gross output in the transportation, communication and energy sectors per capita. Their analysis provided that, transportation and electricity infrastructure were important and statistically significant issues for agriculture. Results of analysis on China showed that, roads and electricity had positive and significant effects on gross agricultural output, productivity of land and labor. Consequently, the availability of roads and electricity were key factors affecting the modernization of Chinese agriculture sector.

Munnell and Cook (1990), Eisner (1991), Garcia-Mila and McGuire (1992), Evans and Karras (1994), Holtz-Eakin (1994), Moonmaw et al (1995), Harmatuck (1996), Bougheas et al (2000), Berechman et al (2006), Boopen (2006), Wu and Hu (2007), Zhou et al (2007) and Banerjee et al (2009) investigated the relationship between transportation capital and the gross product. Results obtained in studies provided that, transportation measures positively and significantly affected gross product for the observed areas except Evans and Karras (1994) and Holtz-Eakin (1994). These two studies found no relationship between highways as transportation infrastructure and GSP as economic activity measures.

Munnell and Cook (1990), Eisner (1991), Garcia-Mila and McGuire (1992), Evans and Karras (1994), Holtz-Eakin (1994), Moonmaw et al (1995), Harmatuck (1996), Bougheas et al (2000) and Berechman et al (2006) investigated the relationship for the observed areas in the United States. Munnell and Cook (1990) studied the impact of highways on Gross State Product (GSP) for the period 1970-1986. Eisner (1991) investigated the connection between state local public capital and GSP over the period 1970-1986. Garcia-Mila and McGuire (1992) studied the effects of two publicly provided inputs as highways and education on regional gross product, labor and private capital by using production function approach by employing a panel data set consisting of annual observations on the 48 contiguous states from 1969 to 1983. Moonmaw et al (1995) revealed the connection between highways and GSP for the period 1970-1986. Berechman et al (2006) investigated the relationship between transportation infrastructure investment and economic development analytically and empirically to provide a plausible explanation covering the period 1990-2000 by using production-function approach.

Munnell and Cook (1990) found two-sided causality relationship between transportation infrastructure investment and GSP growth. In that case, the effects of investment on transportation infrastructure on GSP growth were found to be greater than the effect of GSP growth on transportation investments. Eisner (1991) found positively significant relationship between the measure of public transportation capital and the measure of economic benefit. The evidence showed that richer states bought more public capital or states with more public capital produced more output. Garcia-Mila and McGuire (1992) found that both of the publicly provided inputs had significant and positive effects on output. Moonmaw et al (1995) found that the effect of transportation infrastructure on output was investigated as state effect or in other words interregional effect of infrastructure capital and this matched with the aim of that paper. Berechman et al (2006) stated that, the effects of private and public capital stocks on output were found positive and statistically significant at the state and county levels.

Boopen (2006), Wu and Hu (2007), Zhou et al (2007) and Banerjee et al (2009) investigated places out of the United States. Boopen (2006) investigated countries in Africa and the last three examined China as an important country in the world wide. These studies investigating countries in Africa and China found robust and positive results like the studies dealing with the United States as a developed country. Boopen (2006) used a Cobb-Douglass production function and investigated the relationship between total output, labor, physical capital and transportation capital. The findings showed that investment in transportation capital was more productive than investment on average in Africa. Zhou et al (2007), Wu and Hu (2007) and Banerjee et al (2009) acclaimed transportation infrastructure as a key element in promoting growth and development in countries like China. These three studies examined the period 1997-2004, 1949-2003 and 1986-2003, respectively. Zhou et al (2007) stressed that the quality and the quantity of transportation infrastructure was crucial in terms of its contribution to economic development. Wu and Hu (2007) showed that the role of the relationship between transportation industry and economic development was important for the regional economic growth. Banerjee et al (2009) showed that the proximity of places to transportation networks had significant and positive causal effect on per capita GDP growth rates and that reflected increases in aggregate production.

The studies explained in that section revealed that, developed, expanded and improved public capital including transportation infrastructure tend to an increase in output and gross product. Output and gross product are related variables but gross product of a state, county or country covered all industries. Output of an industry or a couple of industries was investigated by many scholars and that benefited to research as comparing industries. Consequently, the importance of this section could be the comparison of places (county, city, state, country etc.) in industry level or the comparison of the industries. As a result, the effects of transportation on output and gross product are positive.

3.2. INCREASE AND GROWTH OF PRODUCTIVITY AND DECREASE IN COSTS

In the studies reviewed, the measures of economic benefit are increased productivity, productivity growth and cost reduction. Seven studies found a positive significant relationship between transportation infrastructure as public capital and productivity (Aschauer, 1989; Munnell, 1990; Lynde and Richmond, 1993; Seitz, 1993; Conrad and Seitz, 1994; Eberts, 1994; Fernald, 1999; Albala-Bertrand and

Mamatzakis, 2007). Two studies found no relationship between public capital and productivity (Tatom, 1993; Holtz-Eakin and Schwartz, 1995).

Studies performed the investigations for the United States (Aschauer, 1989; Munnell, 1990; Tatom, 1993; Eberts, 1994; Holtz-Eakin and Schwartz, 1995; Fernald, 1999), for the West Germany (Seitz, 1993; Conrad and Seitz, 1994), for Sweden (Lynde and Richmond, 1993) and for Chile (Albala-Bertrand and Mamatzakis, 2007). The public capital measure used ranges from all public capital (Tatom, 1993; Lynde and Richmond, 1993; Eberts, 1994) to core capital of transportation, water, sewer, gas and electricity (Aschauer, 1989; Munnell, 1990; Holtz-Eakin and Schwartz, 1995; Albala-Bertrand and Mamatzakis, 2007) to highway capital (Seitz, 1993; Conrad and Seitz, 1994; Fernald, 1999).

Aschauer (1989) indicated that the elasticity of private sector productivity with respect to public capital was positive. Munnell (1990) concluded that, public capital had a positive impact on several measures of state-level economic activities such as output, investment and employment growth. Lynde and Richmond (1993) presented strongly that the infrastructure services provided by the stock of public capital had played a significant role in production and costs in the U.K. manufacturing sector. Seitz (1993) suggested that the effects of transportation infrastructure varied in industries but the total effects were positive for the connection between transport infrastructure and manufacturing industry indicators. Conrad and Seitz (1994) suggested that infrastructure capital was labor saving and it enhanced total factor productivity. Conrad and Seitz (1994) stated that infrastructure capital was an important complement to private investment activities. Fernald (1999) focused on the road-vehicle relationship and he stated that expanded highways meant larger productivity changes in more vehicle intensive industries when compared to other industries. Albala-Bertrand and Mamatzakis (2007) indicated that transportation and electricity infrastructure systems enhanced the productivity of the Chilean economy.

The measure of economic benefit derived from public infrastructure investment in ten of the studies reviewed is reduction in costs of production. In all ten of those studies, the relationship between public capital and production cost is negative, which meant better and more public capital decreases the cost, as tabulated as a positive effect and it is statistically significant (Berndt and Hansson, 1992; Lynde and Richmond, 1993; Seitz, 1993; Nadiri and Mamuneas, 1994; Conrad and Seitz, 1994; Harmatuck, 1996; Holleyman, 1996; Morrison and Schwartz, 1996a; Morrison and Schwartz, 1996b; RESI, 1998). Three of those studies used highways as the measure of public capital (Seitz, 1993; Holleyman, 1996; RESI, 1998) but two used highways, water and sewer (Morrison and Schwartz, 1996a, 1996b). One used all transportation (Conrad and Seitz, 1994) and two used all public capital (Lynde and Richmond, 1993; Nadiri and Mamuneas, 1994).

Some studies used national data (Berndt and Hansson, 1992; Lynde and Richmond, 1993; Seitz, 1993; Nadiri and Mamuneas, 1994; Conrad and Seitz, 1994; Holleyman, 1996), two used state data (Morrison and Schwartz, 1996a, 1996b), and one used data for a single state as Maryland (RESI, 1998). One study covered the entire private sector (Berndt and Hansson, 1992), three focused on all manufacturing (Lynde and Richmond, 1993; Morrison and Schwartz, 1996a, 1996b), and five (Seitz, 1993; Nadiri and Mamuneas, 1994; Conrad and Seitz, 1994; Holleyman, 1996; RESI, 1998) divided the manufacturing sector into parts. Greater disaggregation reveals that the impact of public transportation infrastructure varies by type of industry. For example, the excellent article by Nadiri and Mamuneas (1994) develops production cost equations for twelve Manufacturing industries. The inference then is that the economic benefit of public transportation infrastructure investment is not the same for all industries.

A key advantage of the cost reduction models over the increased output models is that the cost models tend to yield more reliable estimates of the impact of public transportation infrastructure on production costs. Berndt and Hansson (1992) used cost function approach and found that the impact of transportation infrastructure on private sector productivity and costs were positive for Sweden between 1960 and

1988. Nadiri and Mamuneas (1994) suggested that there were positively significant and productive effects from two types of public capital, which were infrastructure capital services and public-financed R&D capital stock.

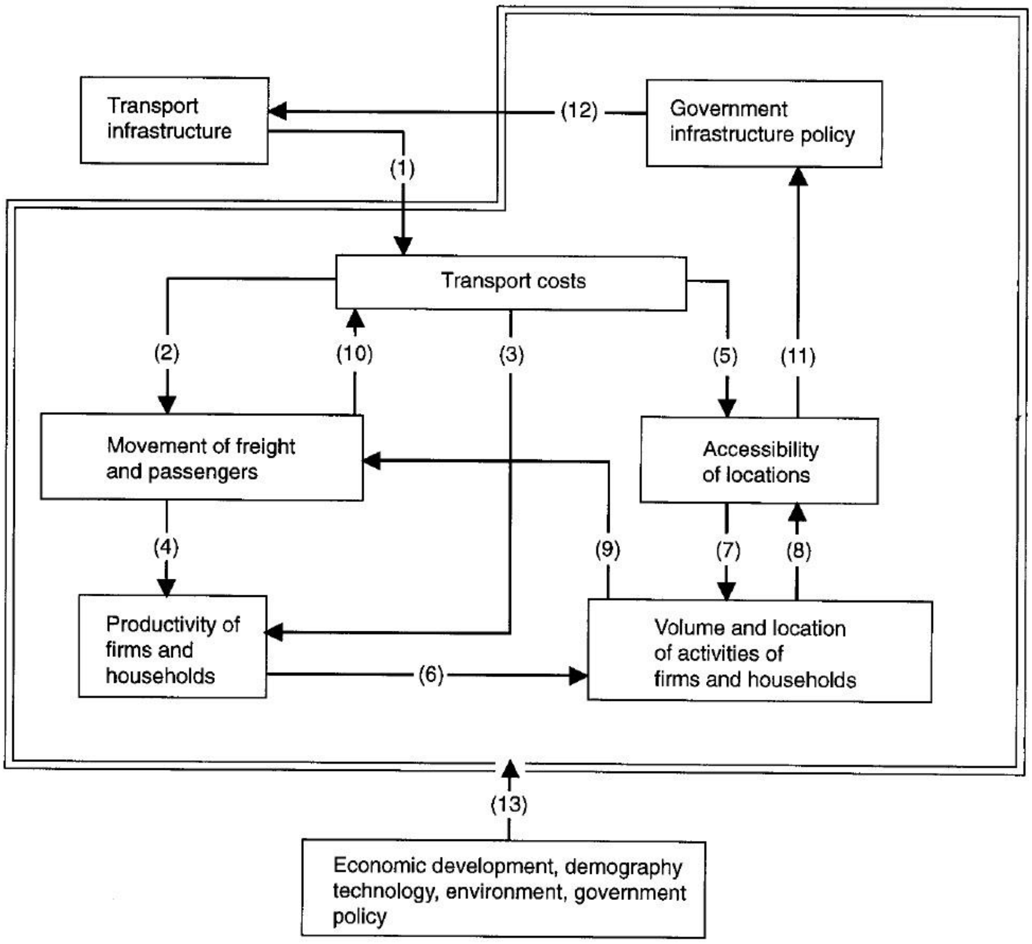
Investigating the productivity and costs of observed places and/or industries is the main theme of this section. Transportation infrastructure with other infrastructure capital issues effected productivity growth by reducing costs and vice versa. The results obtained from studies explained in this section presented positive connections from transportation side to productivity and cost sides. Improvements and investments to transportation (public) capital seemed an important policy on effecting industry (private) productivity by increasing and industry (private) costs by decreasing.

3.3. INCREASE AND GROWTH OF INCOME AND EMPLOYMENT

There are sixteen studies in this section and eleven of the sixteen found positive and significant connection between the measure of public transportation capital and the measure of economic benefit (Aschauer, 1990; Jones, 1990; Mofidi and Stone, 1990; Duffy-Deno and Eberts, 1991; Coughlin, Terza, and Aromdee, 1991; Luce, 1994; Singletary et al, 1995; Bruinsma, Rienstra, and Rietveld, 1997; Lobo and Rantisi, 1999; Özbay et al, 2002; Donaldson, 2008).

Aschauer (1990) found that, economic growth was directly affected from public capital or in other words infrastructure. The results of this study were positive and provided a significant relationship between the highway capacity and per capita income was obtained. Jones (1990) provided positive and valuable results only for some states of United States and stated that, these variations are emanated with respect to public policies of states. Mofidi and Stone (1990) found significant and positive relationship between highway spending per capita, manufacturing investments and employment. The studies, which considered income, property values, employment and real wages, mostly found a positive significant relationship between the measure of public transportation capital and the measure of economic benefit. Duffy-Deno and Eberts (1991) and Luce (1994) obtained positive relationships between transport infrastructure and economic development measures by using production function approach. Singletary et al (1995) and Grihfield and Panggabean (1995) showed that increases in highways rose manufacturing industry employment and productivity growth by using production function approach.

Figure 3-1: Conceptual model on the relation between transport infrastructure and the spatial pattern of economic activities



Source: Bruinsma, Rienstra and Rietveld, 1997:393

Bruinsma, Rienstra and Rietveld (1997) analyzed the effects of highway infrastructure construction on regional economic development and employment in Netherlands for the period 1970-1990. Their relationship between transportation infrastructure and economic activities were visualized in Figure 3-1. Results provided that, the impact of the highway construction was clearly positive for the level of corporate investments, the number of employees, the perceived accessibility, travel time and the accuracy in delivery times. The impact of constructing highways on regional employment growth was not significant except for the transport and communication sectors.

Özbay, Ertekin and Berechman (2002) tested the hypothesis that there existed a relationship between economic growth and accessibility. The main goal was to investigate the impact of accessibility changes as transportation system's performance on the level of economic development for 18 counties in the New Jersey/New York metropolitan area in the United States between 1990 and 2000. Özbay et al. used the changes in total earnings, changes in total income and employment as economic development measures and accessibility as transportation system's performance. The results showed that there were strong and significant relationships between accessibility changes and economic development. Regression analysis results provided that, improved accessibility had a positive impact on economic development in terms of changes in employment and earnings.

Donaldson (2008) evaluated the effects of large improvements in transportation infrastructure on real income and attempted to quantify the role of increased trade opportunities after improvements. Donaldson mentioned that, the penetration of the railroad network towards the inland regions brought them opportunities and connected them with the rest of India and the world. Estimations were performed according to the economic impact of the construction of colonial India's railroad network between 1861 and 1930. The data covered the same period as district level data on output, prices, rainfall, intratrade and international trade flows. Results provided that, railroads caused the reduction of transport costs and that reduction increased the India's interregional and international trade flows. Donaldson stated that, railroads raised the level of real agricultural income and welfare because they enabled regions to trade with one another.

Four studies (Kuehn and West, 1971; Reynolds and Maki, 1990; Crihfield and Panggabean, 1995; Bollinger and Ihlanfeldt, 1997) of the sixteen found either no relationship and in one (Dalenberg and Partridge, 1995) a negative relationship. Kuehn and West (1971) indicated that highways were not crucial factors in economic development and the construction of more and better highways was insufficient for economic development in addition to manufacturing employment differences within counties and the region's economy. Two of the four studies that found no relationship did not use a measure of the public transportation capital stock but rather some measure of highway spending (Reynolds and Maki, 1990; Dalenberg and Partridge, 1995). In most of those fourteen studies, the measure of economic benefit is highly aggregated, such as per capita personal income or total employment. The spatial units are either states, metropolitan areas, local governments, or small zones mostly in the United States except one study investigated Netherlands (Bruinsma, Rienstra, and Rietveld, 1997) and one India (Donaldson, 2008).

Although the role of transportation infrastructure was defined differently in the literature, in general transportation infrastructure is considered as an important key, promoting productivity, growth and development (Aschauer 1989 and 1990; Tatom, 1993; Holtz-Eakin, 1994; Dalenberg and Partridge, 1995; Mikelbank, 1996; Bougheas, Demetriades and Mamuneas, 2000; Özbay, Ertekin and Berechman, 2002; Robinson and Kapo, 2004; Atack et al., 2009; Banerjee, Duflo and Qian, 2009, Chi, 2010).

Transportation infrastructure investments have often been appraised as an effective strategy for policy makers in underdeveloped areas rather than developed ones (Zhou, Yang, Xu and Liu, 2007; Banerjee, Duflo and Qian, 2009). From that point of view, the development process should be investigated from the transportation perspective as a significant research procedure of the developing countries, as the construction of infrastructure such as railroads, which were considered as an input into the production process, occurred during the times of rapid economic growth of countries that are now rich, such as the United States, Western

Europe and Japan (Lichter and Fuguitt, 1980; Canning and Fay, 1993; Eberts, 1990; Felloni, Wahl, Wandschneider and Gilbert, 2001).

The studies investigated in this section broadened the perspective of the scholars examining the effects of transportation infrastructure and other infrastructure based public capital issues on economic activity measures such as income and employment. These variables are directly and indirectly affected with demography measures as population based issues. All sixteen studies investigated similar relationships but give different perspectives to researchers. That perspective is the social side of the relationship between transportation and economic activity measures. Consequently, the results provided from these studies showed that transportation infrastructure effected employment and income in a positive way.

Table 3-1: Literature Review about Infrastructure Measures and Development Measures

Author and Year	Infrastructure Measure	Development Measure	Observed Area and Period	Results
Jenks 1944	Railways	Economic Development, Costs	United States, 1837-1937	+
Healy 1947	Transportation capacity of canals, railways (locomotives)	Economic Growth, Costs, Services	United States, 1840-1930	+
Kuehn and West 1971	Interstate Highways	Employment	Ozarks Region in the United States, 1954-1963	+
Leinbach 1975	Railways and Roads	Rural Economic Growth	Malaya, 1878-1970	+
Deno 1988	Highway capital	Output	United States	+
Aschauer 1989	Transportation, water and sewer, gas and electricity	Productivity, private sector	United States, 1949-1985	+
Aschauer 1990	Highway miles	Per capita income	United States, 1960-1985	+
Jones 1990	Highway spending per capita	Employment, income, investment	United States	+
Mofidi and Stone 1990	Highway spending per capita	Manufacturing investment and employment	United States	+
Munnell 1990	Transportation, water and sewer, gas and electricity	Productivity, private sector	United States, 1949-1987	+
Munnell and Cook 1990	Highways	Gross state product (GSP)	United States, 1970-1986	+
Reynolds and Maki 1990	Highway spending per capita	New manufacturing plants	Labor market areas	No effect
Coughlin, Terza and Aromdee 1991	Highway miles per square mile	Foreign direct investment	United States	+

Table 3-1 continued

Author and Year	Infrastructure Measure	Development Measure	Observed Area and Period	Results
Duffy-Deno and Eberts 1991	Transportation, water and sewer, public hospitals	Per capita income	Twenty-eight metros, 1980-1984	+
Eisner 1991	All state and local public capital	GSP	United States, 1970-1986	+
Hulten and Schwab 1991	Highways	Manufacturing output	United States, 1951-1986	No effect
Berndt and Hansson 1992	Transportation, Water and sewer, Electricity	Private sector costs	Sweden, 1964-1988	+
Garcia-Mila and McGuire 1992	Highway Density	GSP	United States, 1970-1982	+
Lynde and Richmond 1993	Nonresidential public capital	Manufacturing costs and productivity	United Kingdom 1966-1990	+
Seitz 1993	Highways	Manufacturing costs and productivity	West Germany, 1970-1989	+
Tatom 1993	All public capital	Private sector Productivity	United States, 1949-1990	No effect
Conrad and Seitz 1994	Proxy for transportation infrastructure	Sector output and costs and production	West Germany, 1961-1988	+
Eberts 1994	Public infrastructure	Labor productivity growth	United States,	+
Evans and Karras 1994	Highways and highway spending	GSP	United States, 1970-1986	No effect
Holtz-Eakin 1994	All state and local government capital	Private GSP	United States,	No effect
Luce 1994	Highway and railroad access	Employment, labor force	Local governments	+

Table 3-1 continued

Author and Year	Infrastructure Measure	Development Measure	Observed Area and Period	Results
Nadiri and Mamuneas 1994	All public capital	Manufacturing costs, labor demand	Twelve manufacturing industries, 1955-1986	+
Crihfield and Panggabean 1995	Highways, lane miles	Per capita income growth	282 metro areas	No effect
Dalenberg and Partridge 1995	Highway spending / per income	Employment	Metro areas	-
Holtz-Eakin and Schwartz 1995	Highways, water and sewer, gas and electricity	Productivity growth	United States, 1971-1986	No effect
Moonmaw, Mullen and Martin 1995	Highways	GSP	United States, 1970-1985	+
Singletary et al. 1995	Highway and highway access and highway type	Durable and nondurable manufacturing employment growth	477 areas in South Carolina	+
Boarnet 1996	Highways	Private output	Fifty-five California counties, 1969-1988	+
Garcia-Mila, McGuire, and Porter 1996	Highways	Private sector output	United States, 1970-1983	+
Harmatuck 1996	All public capital	Gross national product	United States, 1949-1985	+
Haughwout 1996	Highway capital	Output	48 states in the United States,	+
Holleyman 1996	Highways	Manufacturing costs	369 four-digit industries, 1969-1986	-
Morrison and Schwartz 1996a	Highways, water and sewer	Manufacturing costs	Six New England states in the United States, 1970-1987	-
Morrison and Schwartz 1996b	Highways, water and sewer	Manufacturing costs	United States, 1970-1987	-

Table 3-1 continued

Author and Year	Infrastructure Measure	Development Measure	Observed Area and Period	Results
Bruinsma, Rienstra, and Rietveld 1997	One major new highway	Employment growth, Firm growth	Netherlands, 1970-1990	Emp. Growth: no effect, firm growth: +
Bollinger and Ihlanfeldt 1997	Passenger rail stations	Population and employment	Atlanta in United States	No effect
Boarnet 1998	Streets and highways	Output	California counties in United States, 1969-1988	+
RESI 1998	Highways	Industry costs, output	Maryland, United States, 1982-1996	+
Sanchez and Robles 1998	All public capital	Private sector output and growth	Eight industry countries	+
Fernald 1999	Highways	Industry productivity, industry output	Nine industry groups, United States, 1953-1989	+
Haughwout 1999	Highways and highway expenditure	Residential property values	Individual properties in metro areas	-
Lobo and Rantisi 1999	Local government capital spending	Wage growth	Metro areas	+
Boarnet and Haughwout 2000	Highways and highway investments	Metropolitan development: employment growth, urban dev.	United States	+
Bougheas, Demetriades and Mamuneas 2000	Transportation and communication infrastructure	GDP growth	United States, 1987-1992	+
Felloni et al. 2001	Electricity and Transportation	Agricultural production and productivity	83 countries, 1950-1988 China, 1991-1996	+
Boopen 2006	Transportation capital	GDP	38 Sub-Saharan countries and 13 SIDS, 1980-2000	+
Albala-Bertrand and Mamatzakis 2007	Transportation and electricity	Productivity and costs	Chile, 1960-2000	+

Table 3-1 continued

Author and Year	Infrastructure Measure	Development Measure	Observed Area and Period	Results
Garcia-Milà and Montalvo 2007	National roads and Highways	Firms located near highways	Spain, 1980-2000	+
Lakshmanan 2007	All public capital	Private sector productivity, output	7 countries, 1951-1987	+
Wu and Hu 2007	Entire society cargo volume	GDP	China, 1949-2003	+
Zhou, Yang, Xu and Liu 2007	All public capital	GDP, exports, investments	31 regions of China, 1997-2004	+
Donaldson 2008	Railways, roads, rivers	Agricultural Income, Exports	India, 1861-1930	+
Banerjee, Duflo and Qian 2009	Accessibility to Transportation Networks	Per capita GDP	353 counties in China, 1986-2003	+

CHAPTER FOUR
THEORETICAL FRAMEWORK

The existing literature, which is briefly explained in chapter two and three, included different perspectives for empirical analyses. These perspectives differ when measuring transportation infrastructure, demography and economic activity measures for different observed areas over different time periods. In line with theory and empirical studies investigating the relationship between transportation and economic activities, two important approaches are used as production function approach and cost function approach. The relationship between transportation and demography is investigated by using regression and Granger Causality analyses. These approaches are explained in this chapter in the light of the literature. The hypotheses used in this study are presented in the light of the harmonization of the existing literature and theoretical framework.

4.1. PRODUCTION FUNCTION APPROACH

Modern macro-econometric studies on the roles of public infrastructure investments in economic growth dates back to a series of studies undertook by Aschauer (1989, 1990). The pioneering paper of Aschauer (1989) employs aggregate time series data to investigate the relationship between public investment and economic growth by expanding the conventional production function to include the public capital or its components. The expanded function form is written as:

$$\mathrm{Q} = \mathrm{AF}(\mathrm{L}, \mathrm{K}, \mathrm{G})$$

Where Q is economic output, A is a measure of total factor productivity, L is the labor force, K is the stock of private capital and G is the public capital stock. Using Cobb-Douglas production function form and writing the above equation in logs gives:

$$\mathrm{lnQ} = \mathrm{lnA} + \mathrm{alnL} + \mathrm{blnK} + \mathrm{clnG}$$

Where a, b, c can be explained as the elasticity of output with respect to labor, private capital and public capital respectively. An assumption of constant return to scale across all factors leads to the summation of all coefficients are equal to one. Aschauer (1989) uses private business output and private capital ratio as the dependent variable and assumes the constant return to scale across all inputs. Using data for the period 1949 to 1985, he finds a strong positive relationship between output per unit of capital input, the private labor-capital ratio, and the ratio of the public capital stock to the private capital input. The estimated elasticity of output with respect to the public capital is found positive. Compared to the private capital, these figures in Aschauer (1990) show that, increases in GNP resulting from increased public infrastructure spending are estimated to exceed those from private investment by a factor of between two and five.

Munnell (1990) also uses aggregate time series data and a Cobb-Douglas production function with an assumption of constant return to scale across all inputs. Munnell confirms Aschauer’s finding that public capital does indeed belong in the production function. Both total public capital and core infrastructure enter with coefficients similar to those found by Aschauer and are generally statistically significant.

In order to determine the exact relationship between infrastructure and productivity, it was necessary to test the variables for stationarity and co-integration before econometric analyses. That was necessary to examine whether variables grow over time together and converge to their long-run relationship. After that examination variables should be adjusted before estimating the relationship by taking the first difference using the change in a variable from one time period to the next rather than the absolute level of the variables was necessary. The studies that follow this approach are Hulten and Schwab (1991), Tatom (1993), Harmatuck (1996). Besides Munnell (1992) argues that first-differencing destroys any long-term relationships, which was the whole point of studying infrastructure and economic growth. Munnell further points out that no one would expect the growth in the capital, whether private or public, on one year to be correlated with the growth in output in that the same year as called concurrent effect.

4.2. COST FUNCTION APPROACH

Some researchers have moved to a cost function approach in their studies and argue that the cost function was preferable to the production function for both conceptual advantages and econometric reasons. The production approach is a purely technical specification of the relationship between inputs and outputs and not a behavior one. In this approach, the firm's optimization decisions with respect to how much output to produce and what mix of inputs to use in the production process were not considered specifically. The cost function approach takes explicit account of the firm's optimization behavior by considering both inputs and outputs as endogenous variables, while some variables are beyond the immediate control of the firm, are the only exogenous variables. Exogenous variables, which do not enter the production function, are difficult to say whether efficient choices have been made concerning the various inputs, in particular public capital. Furthermore, a cost-function-based analysis facilitates the explicit exploration of cost efficiency. This allows researchers to determine the effects of public infrastructure capital through a measured rate of return specified in terms of cost-saving benefits at a given output level.

Cost function approach avoids the multicollinearity problem that may result in estimated coefficient biases because multicollinearity is usually more of a problem with input quantities than with factor prices. The causality problem, which is difficult to be overcome in the production function approach, does not arise in the cost function methodology as endogenous inputs rather than their quantities are exogenous. Also, using a cost function allows us to impose linear homogeneity in factor of prices on our models. Imposing such restrictions is the same as using additional information when making an estimate and, therefore, that reduces the variance of an estimator. Imposing linear homogeneity on the production function, unfortunately, is the same thing as assuming constant returns to scale.

It should be noted, however, that cost functions require the assumption of an optimal mixture of inputs (Oum, Waters and Yu, 1998). While debatable, this is more plausible for applications to individual firms (micro data) than to aggregate or even industry-level data. To examine the effects of public infrastructure on the cost of production in the private sector, a traditional cost function can be modified to include the public infrastructure service. Therefore the general form of the cost function can be written as:

$$C = C(w, Y, T; H)$$

Where C is total cost, w is the vector of prices of private inputs (usually labor, private capital, materials etc.), Y is the quantity of output, T is a measure of technical change and H represents public infrastructure service (the quantity of public capital stock).

Studies on the topic of the effects of public infrastructure investment using cost function approach (Berndt and Hansson, 1992; Lynde and Richmond, 1993; Seitz, 1993; Nadiri and Mamuneas, 1994; Conrad and Seitz, 1994; Holleyman, 1996; Morrison and Schwarz, 1996a, 1996b; Albala-Bertrand and Mamatzakis, 2007) focused on individual industry level investigation, particularly the manufacturing industry. Interestingly, unlike the ones using the production function approach, the studies using the cost function approach have largely been consistent in reaching a conclusion that the public infrastructure investment has significant effects on reducing the cost of production in the private sector. When empirically estimating the effects of public capital, a flexible cost function form is used by all researchers except Morrison and Schwarz (1996a and 1996b) and Seitz (1993) who instead use the Generalized Leontief cost function. This function is usually jointly estimated with cost share equations by the SUR method (Seemly Unrelated Regression), imposing theory-based constraints. In the case of using panel data, fixed effects models should be specified.

4.3. CAUSALITY APPROACH

Munnell (1990) can be regarded as a seminal study for making use of pooled time-series and cross-section data. Several subsequent articles made use of the private and public capital stock data created by Munnell, who specified both Cobb-Douglas and Translog functions. Munnell used data for 48 states over the years 1970 to 1986 by using the Cobb-Douglas function and elasticities of gross state product to public and highway capital stocks are reported as positive and significant. In her models estimation procedures appeared to be ordinary least squares (OLS) without taking the first difference estimates and using random or fixed effects.

Eisner (1991) raised the issue that the estimated effects may be running another way, and that increased private output raises the demand for public infrastructure capital. A number of studies have used the Granger test to examine the direction of causality between public infrastructure and output. Duffy-Deno and Eberts (1991) provide regional evidence suggesting that causality runs both ways. Holtz-Eakin (1994) finds some ambiguity in the direction of causation. But Tatom (1993) does a series of lead-lag tests that indicate causation may be more from output to infrastructure capital. If the causality runs both ways then single equation production function techniques for quantifying the influence of public capital may have yielded biased coefficients.

Causality relationship is used in many other studies to investigate the relationship between transportation and other issues such as economic activities and demographic measures. Whether, panel data or time series analyses, mostly Granger Causality procedure applied by scholars in their studies. The brief explanation of that procedure is given in the methodology section in chapter five.

4.4. HYPOTHESES OF THIS STUDY

The hypotheses of this study are determined in the light of the literature, structure and availability of the data. One of the most important characteristics of the data is being at province level. Another is that, the data should be historical to satisfy the objective of the study. These two characteristics were enough to eliminate all transportation infrastructure types except railways. Because historical railway data could be found at province level and railway lengths in provinces are selected as a historical transportation capital. Processing production function approach is eliminated because labor data or any data which could be a proxy for labor capital is impossible to find for a historical period and at province level. Cost function approach is also eliminated. Cost data is not available because of the same problems (historical data and province level). The decision was made by selecting Causality approach using population data as demography issue and agricultural production as economic activity measure.

The hypotheses are constructed as follows:

1. Hypothesis one: Railways positively affect and Granger Cause Population Density in Turkey
2. Hypothesis two: Railways positively affect and Granger Cause Agricultural Production in Turkey

Previous chapters are used to construct the hypotheses written above and the following chapters are constructed based on these two hypotheses. The data and methodology used during the testing process of these hypotheses are briefly explained in chapter five. Chapter six includes empirical results obtained in the light of the methodology and hypotheses are tested by using panel data econometric analyses.

CHAPTER FIVE
DATA AND METHODOLOGY

5.1. DATA

The data consists of three major data sets: demographic measure data, transportation infrastructure data and economic activity measure data. The acquisition process of these data is completed after a long and fatiguing work, which took more than two years to be completed. The acquisition, preparation, computation and the compatibility processes of these data sets are explained briefly in the further sections.

5.1.1. Demographic Measures Data

Data used for demographic measure is the population density data, which is the density (frequency) of the population living in an area. That area could be the world, continent, country or residential area like a state, region, province, borough, county or village. Population density is calculated by dividing the population of the area by the area in km^2, which is also known as population or people per kilometer square:

$$\text{Population density of an area} = \frac{\text{Population of the area}}{\text{Area (km}^2\text{)}}$$

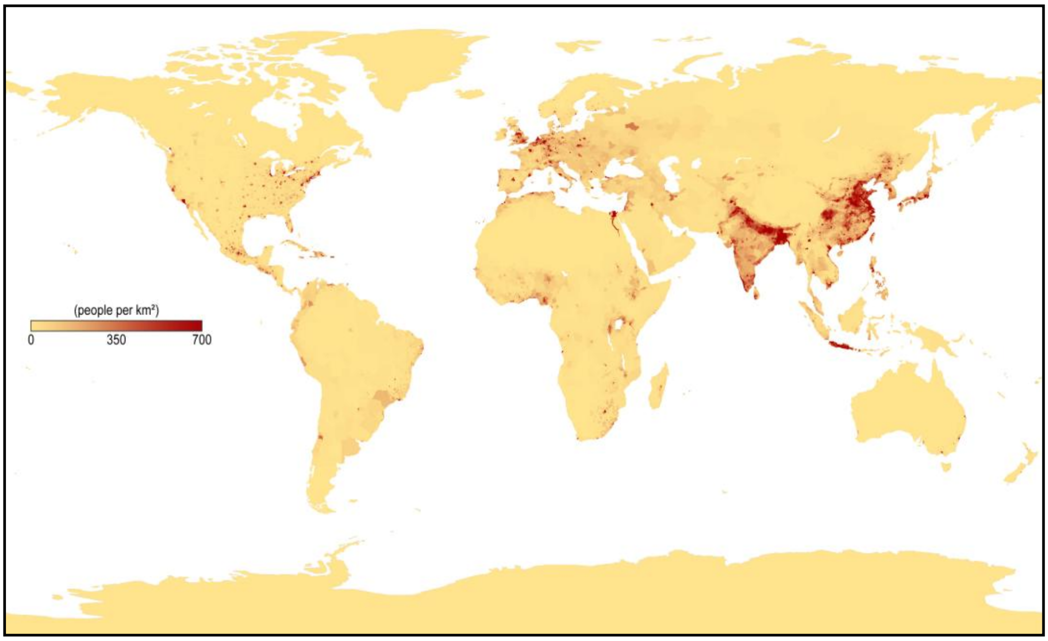
Thus, population density data consists of two different data sets, which are population data and area data (km^2). Population density data can easily be obtained from Turkish Statistical Institute (TUIK)[5] data bases. However, just obtaining and using the population density data has no meaning without explaining population data and/or area data according to the perspective of this study. The reason why the population density data is not taken directly from TUIK data sets into account, but computed from two data sets (population and area) is mainly the change of

[5] http://www.tuik.gov.tr/

residential areas' characteristics such as borders, names, areas, subdivisions, etc. Because of these changes, using the population density raw data could be inconsistent with respect to the aims of this study.

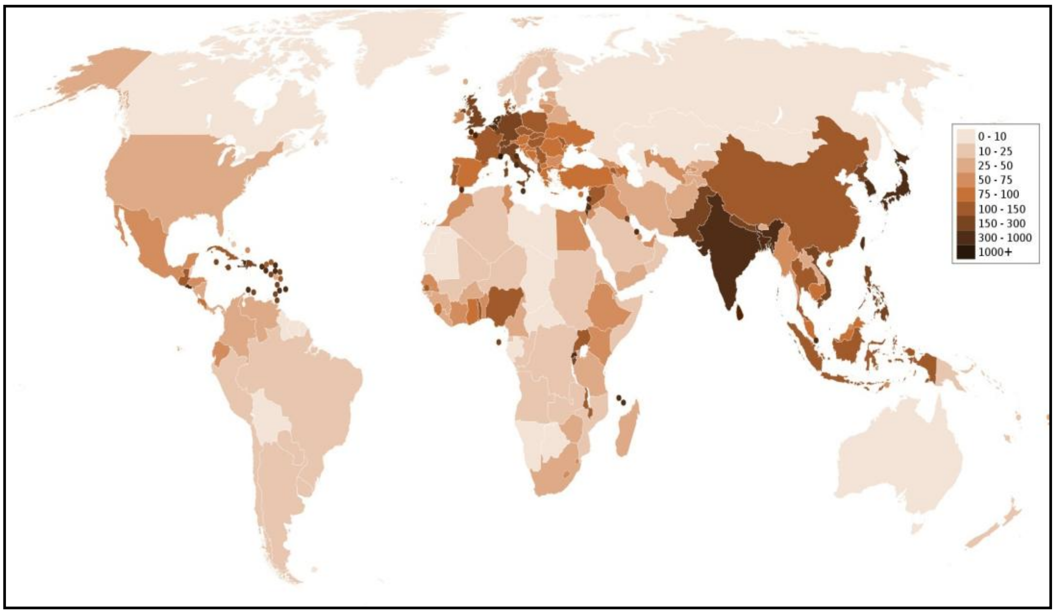
The best way of explaining and of course plumbing the population density data could be eventuated by the help of mapping of population density amounts of investigated areas. For example, Figures 11 and 12 show the population density of the whole world and the population densities country by country respectively. That mapping procedure helps substantially to show the results of population density measurements easily and makes the analysis meaningful even if the observed area is very large. The difference between two different residential areas' population densities at the same period of time can be understood better. Also the difference between two years of the residential area's population densities can be analyzed easily by using two different maps.

Figure 5-1: Population Density of the world in 1994[6]



[6] Source: http://en.wikipedia.org/wiki/Population_density

Figure 5-2: Population Density by country in 2004[7]



5.1.1.1. Population Data

Population data in this study takes villages as the major initial unit. Village populations are taken as the origin and the starting point of population data because the villages are the smallest unit of observations for population data in Turkey. Boroughs are composed of villages, provinces are composed of boroughs, regions are composed of provinces and countries are composed of regions. So the population of a residential area could be best computed by village populations for optimum results.

Population data is obtained from the censuses of population years from the Ottoman Empire Period and the Republic of Turkey Period. Each census of population contains all villages, boroughs and provinces of Turkey at that year but the classification of residential areas is totally different during the Ottoman Empire. Thus, population data is divided into two sections, which are Ottoman Empire Period and the Republic of Turkey Period.

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[7] Source: http://en.wikipedia.org/wiki/Population_density

The acquisition process of population data was completed after a long and fatiguing data collection progress because of some problems occurred during the collection and harmonization phases. On one hand, during the collection process, the difficulties mainly aroused from the non-existence of the soft versions of huge amount of data, which consists of more than 60,000 units, at the village level. On the other hand, during the harmonization process, the changes of the characteristics of villages, boroughs and provinces such as borders, areas, subdivisions and upper divisions were the main problems which detained the process. Besides, the classification difference between two periods (Ottoman and Turkish Republic) has been one of the main setbacks.

Village population data is mostly obtained from books, CDs and web pages published by Turkish Statistical Institute (TUIK)[8]. These books are statistical publications, which incorporate all village populations for the census of population year. That means; there are different books for each census of population. This is also viable for compact disk publications and web sources as well. Each census of population involves nearly 60,000 units, which covers village populations, borough populations and province populations.

The population data acquisition and harmonization processes for Ottoman Empire Period and the Republic of Turkey Period are explained in the next two parts respectively. To reach the population data, which consists of time series figures on censuses of population from Ottoman Empire Period to the Republic of Turkey Period, these two periods should be analyzed separately but harmonized together. Also in the latter part, the solution progress of problems and the terminal stage of population data are briefly illustrated. The harmonized population database should probably be the first example for the knowledge of the author in Turkey.

Before explaining these periods incisively, one important point should be mentioned. The base year for the population data is the census of population in year 2000 that entails the last residential area classification. That year is selected with

[8] http://www.turkstat.gov.tr/

respect to the last locations and characteristics of residential areas (villages, boroughs and provinces). In addition, this study considers only the current borders of Turkish Republic.

5.1.1.1.1. Ottoman Empire Period

During the Ottoman Empire Period, there have been several censuses of populations. The years for which there are available data are 1831, 1844, 1866/73, 1877/78, 1881/82-93, 1906/07 and 1914. However, census of population years 1844, 1866/73, 1877/78 and 1906/07 did not represent consistent and complete population figures. These censuses of populations mostly aimed to identify the number of men, who could be ready to participate in wars as soldiers and to designate the population to collect taxes. Not only most of the provinces were inadequate, but also the conjuncture during those years was unable to perform an exact and comprehensive census of population. Therefore, Ottoman census figures of only the years 1831, 1881/82-1893 and 1914 were used for Ottoman Empire period of time. (Karpat, 1985:149-258)

The population figures for the Ottoman Empire and census of population data of the Republic of Turkey were checked for geographical consistency according to the year 2000. In this case only the residential areas, which are in the borders of current Turkey map, were taken into account from the Ottoman Empire Period censuses of populations. This was necessary in order to get a consistent time series population data, which is based on identical geographical borders and administrative area for the base year.

Harmonization with respect to geographical consistency is important because there has been transfer of villages from one borough to another and boroughs from one province to another. These changes were due to population growth, changes in administrative definition and borders of villages, towns, boroughs and provinces, etc. Therefore, realignment of residential areas such as villages which belong to boroughs and boroughs which belong to provinces was necessary. In order to get robust results, the analysis of Ottoman Empire censuses of populations were checked for geographical consistency with respect to all census years including the years after the fall of the Ottoman Empire.

In this process, the importance of villages was evident because of the different classification of administrative borders of residential areas in the Ottoman Empire with respect to the Republic of Turkey borders. States, provinces, counties, towns and villages were differently assembled when compared to the classification in the Republic of Turkey period except villages. Province borders, county borders and others were totally different because of the state system. As a result, the only way to match the period before the Republic with the period after the Republic is village based harmonization.

5.1.1.1.2. The Republic of Turkey Period

After the establishment of the Republic of Turkey in 1923, the importance and the motivation of performing censuses of population were changed. Therefore, the classification of administrative borders and residential areas were effective on the changes of characteristics of population censuses. During the Ottoman Empire Period, the census of population included the population of all minorities, who were non-Muslims such as Jewish, Gypsies, Armenians etc. Also some census of population years had covered only the population of men not women with respect to being soldier or taxable people. Besides these characteristics, the number of settlements, which were approximately thousand units, was also small when compared to the Republic period examples, which were almost 60,000 units. These units of the Ottoman Empire included states, main provinces, big counties and some large-scale villages.

The Republic of Turkey period covers population data on all census years: 1927, 1935, 1940, 1945, 1950, 1955, 1960, 1965, 1970, 1975, 1980, 1985, 1990, 2000 and 2007. There were 15 general censuses after the establishment of the

Republic until year 2010. All of these censuses of population data except 1980, 1985, 1990, 2000 and 2007 were gathered from books, published by TUIK.

All data except that for year 2007 represent village and borough populations. In 2007, population data does not exist in village base. However, that is not a problem as the characteristics and ingredients of year 2007 were totally same with the base year 2000. Besides, the census of population in 2007 was performed according to the outcomes of 2000.

Acquired population data was entered year by year into Excel spreadsheet format covering all villages, boroughs and provinces as a time series data set from 1831 to 2007. Then, all Excel spreadsheets were joined together as one spreadsheet population data. The dataset was prepared to be imported into the GIS environment by using MapInfo software. Figure 5-3 shows the entry process of population data. However, that was not a robust dataset according to map representation because of the reasons mentioned above and the borders of a province (borough) could be changed because of newly established province (borough).

Due to the fact that many population centers have changed names, merged with others, dissolved or divided, the data set needed to be reworked through for a better geographical consistency on village base. Although, population data was acquired and harmonized seriously after a long and fatiguing process, it had to be rearranged thoroughly for a second time. Figure 5-3 represents the initially arranged and ID based population datasets as old and new styles. In order to have a consistent data set, a new data entry format, which was named and based on ID representation, was designed by MapInfo. Therefore, unique ID numbers were assigned to every village with the Boundary Select methodology.

Figure 5-3: Data Entry Formats

	A	B	C	D	E	F	I	L	O	R	U	X	AA	AD	AG	AJ	AM	AP
1	KÖY	İLÇE	İL	1831	1881/82-93	1914	1935T	1940T	1945T	1955T	1960T	1965T	1970T	1975T	1980T	1985T	1990T	2000T
2	ALTINTAŞ	MERKEZ	UŞAK	0	0	0	0	0	0	0	377	415	243	286	253	303	295	278
3	AKSE	MERKEZ	UŞAK	0	0	0	0	0	0	1223	1272	1312	0	0	0	0	0	0
4	BAĞBAŞI	MERKEZ	UŞAK	0	0	0	0	0	0	675	721	744	656	579	562	502	490	446
5	BELKAYA	MERKEZ	UŞAK	0	0	0	0	0	0	0	204	197	185	153	154	122	119	134
6	BOZKÖY	MERKEZ	UŞAK	0	0	0	0	0	0	0	388	406	376	354	298	304	302	283
7	BOZKUŞ	MERKEZ	UŞAK	0	0	0	0	0	0	1193	1185	1193	1274	1243	1399	1364	1357	1628
8	BÖLME	MERKEZ	UŞAK	0	0	0	0	0	0	1190	1352	1215	1293	1246	1252	1458	1506	2798
9	CİĞERDEDE	MERKEZ	UŞAK	0	0	0	0	0	0	484	526	513	496	500	497	537	527	559
10	ÇAMYUVA	MERKEZ	UŞAK	0	0	0	0	0	0	0	578	611	635	602	665	682	721	761
11	ÇARIK	MERKEZ	UŞAK	0	0	0	0	0	0	423	443	452	451	447	541	442	597	527
12	ÇEVREKÖY	MERKEZ	UŞAK	0	0	0	0	0	0	0	1285	0	1235	1183	1189	1149	1158	2000
13	ÇINARCIK	MERKEZ	UŞAK	0	0	0	0	0	0	226	228	238	211	206	152	166	120	82
14	BAĞBAŞI	UŞAK	KÜTAHYA	0	0	0	506	515	601	0	0	0	0	0	0	0	0	0
15	BAHADIR	UŞAK	KÜTAHYA	0	0	0	828	853	877	0	0	0	0	0	0	0	0	0
16	BAKDEMİR	UŞAK	KÜTAHYA	0	0	0	164	0	0	0	0	0	0	0	0	0	0	0
17	BANAZ	UŞAK	KÜTAHYA	0	0	0	662	733	803	0	0	0	0	0	0	0	0	0
18	BEKDEMİR	UŞAK	KÜTAHYA	0	0	0	0	0	225	0	0	0	0	0	0	0	0	0
19	BEKİ	UŞAK	KÜTAHYA	0	0	0	699	721	743	0	0	0	0	0	0	0	0	0
20	BEKMİŞ	UŞAK	KÜTAHYA	0	0	0	139	0	0	0	0	0	0	0	0	0	0	0
21	BOZKUŞ	UŞAK	KÜTAHYA	0	0	0	926	939	1024	0	0	0	0	0	0	0	0	0
22	BÖLME	UŞAK	KÜTAHYA	0	0	0	937	1002	1096	0	0	0	0	0	0	0	0	0

(a) Old Style

	A	B	D	E	F	G	J	K	L	M	N	O	P	Q	R	S	T	U	V
1	Koy	KoyAdi	Ilce	IlceAdi	Il	İlAdi	1914	1935	1940	1945	1955	1960	1965	1970	1975	1980	1985	1990	2000
2	6400005	ALTINTAS	6400	MERKEZ	64	UŞAK	0	487	578	523	702	798	993	1071	1159	1383	1511	1637	278
3	6400006	BAGBASI	6400	MERKEZ	64	UŞAK	0	506	515	601	675	721	744	656	579	562	502	490	446
4	6400007	BELKAYA	6400	MERKEZ	64	UŞAK	0	0	0	0	0	204	197	185	153	154	122	119	134
5	6400008	BEYLERHAN	6400	MERKEZ	64	UŞAK	0	0	0	0	726	730	661	510	400	301	304	267	289
6	6400009	BOLME	6400	MERKEZ	64	UŞAK	0	937	1002	1096	1190	1352	1215	1293	1246	1252	1458	1506	2798
7	6400010	BOZKOY	6400	MERKEZ	64	UŞAK	0	0	0	0	0	388	406	376	354	298	304	302	283
8	6400011	BOZKUS	6400	MERKEZ	64	UŞAK	0	926	939	1024	1193	1185	1193	1274	1243	1399	1364	1357	1628
9	6400012	BUGDAYLI	6400	MERKEZ	64	UŞAK	0	911	959,5	1008	194	234	269	277	225	237	235	200	132
10	6400013	CAM	6400	MERKEZ	64	UŞAK	0	0	0	0	0	0	0	0	0	0	0	0	0
11	6400014	CAMYAZI	6400	MERKEZ	64	UŞAK	0	0	0	0	0	370	0	0	0	323	321	309	213
12	6400015	CAMYUVA	6400	MERKEZ	64	UŞAK	0	0	0	0	0	578	611	635	602	665	682	721	761
13	6400016	CARIK	6400	MERKEZ	64	UŞAK	0	298	309	326	423	443	452	451	447	541	442	597	527
14	6400017	CATALBAYIR	6400	MERKEZ	64	UŞAK	0	0	0	0	0	243	0	0	269	296	303	284	212
15	6400018	CEVREKOY	6400	MERKEZ	64	UŞAK	0	0	0	0	0	1285	0	1235	1183	1189	1149	1158	2000

(b) New Style (ID Based)

Source: Inventory of the Project No. 106K392

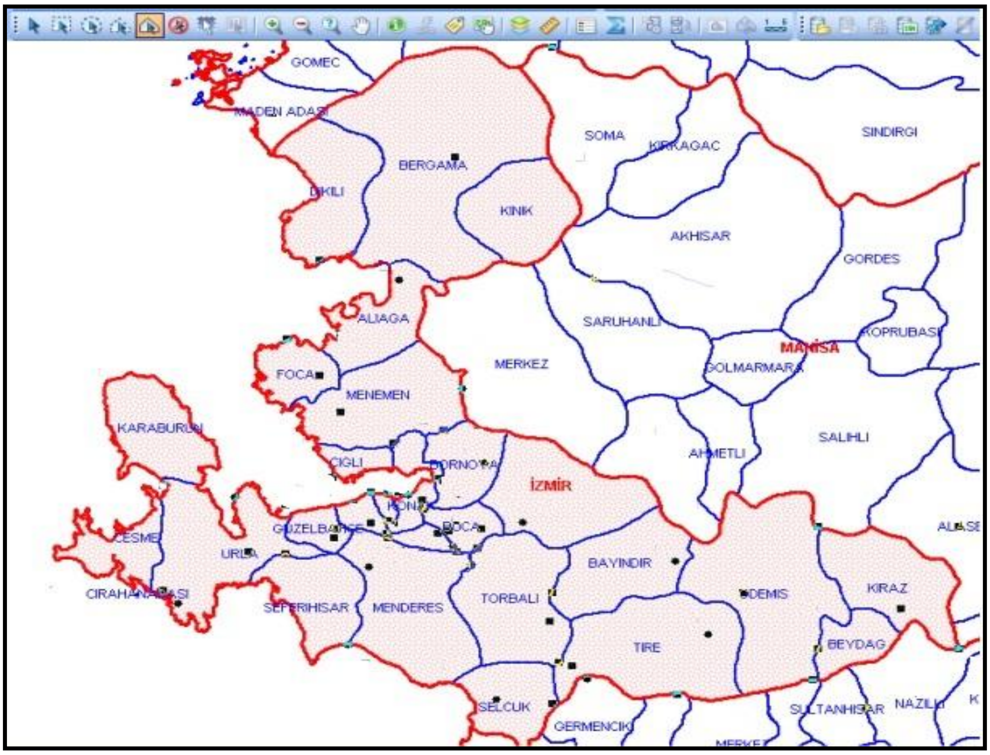
Boundary Select methodology is used with village based ID representation because each settlement considered as a village or based on villages has an exact and permanent place according to the coordinate system in the borders of Turkey. A village could be included as borough B1 in year 1970 but it could be merged with borough B2 in year 1975; however the coordinates of that village are the same. There can also be another village in another region of Turkey with the same name. There again the determining point is the coordinates of these two different villages. As an end, the importance and the accuracy of the village based perspective for population data came into existence.

At the beginning of the rearrangement process, unique ID numbers were assigned to all residential areas such as provinces, boroughs and villages by the MapInfo GIS software program. That means every point (coordinates of villages) on the map has a unique name, which is formed of just numbers. For example, ID name 35’00’000 is given for Izmir province. This procedure is applied for all provinces from 01st province to 81st province.

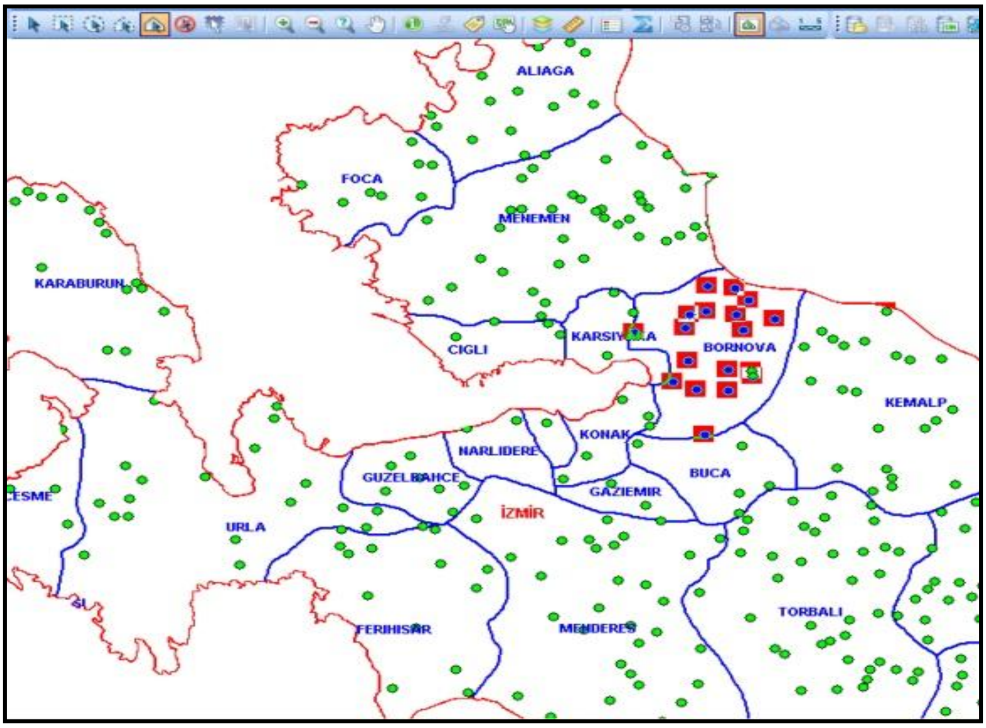
Considering Izmir, the 35th province, a unique ID name such as 35’01’000 is assigned for Konak borough or in other words a subdivision of Izmir. That represents the 01st borough of 35th province. After that, the same procedure was applied for each borough in Izmir province. Finally, similar procedure for ID assignment was applied for the villages. For example; ID name 35’01’010 represents and matches with the coordinate system of the 10th village of the 1st borough of the 35th province in the borders of Turkey. This was applied for every village in every borough of Izmir and for every village in the borders of Turkey.

Boundary selection method is provided in Figure 5-4. In section (a) boroughs were selected from province Izmir, which is the pink area. Bornova borough is selected from province Izmir and in section (b) villages are selected from borough Bornova. In section (b) each green dot represents villages and red boxes represent selected villages from borough Bornova. During the data entry process, it does not matter where these villages belong to. The most important issue is the ID representation of these villages (boxes).

Figure 5-4: Boundary Select Methodology



(a) Selecting boroughs from provinces



(b) Selecting villages from Boroughs

Source: Inventory of the Project No. 106K392

Different villages with the same name in the same borough were one of the most important problems, which were solved by ID representation. Other solved problems were the villages which were transferred to another borough or became a borough and boroughs which were transferred to another province or became a province. For example; Yalova was one of the boroughs of Istanbul until 1995 and it became a province after 1995. That was represented by two Excel rows in the first data composition, which was not efficient and robust, can be seen in Table 5-1. One of these lines included Yalova as the borough of Istanbul province and the second one included Yalova as a province.

Table 5-1: Initial Data Harmonization Process

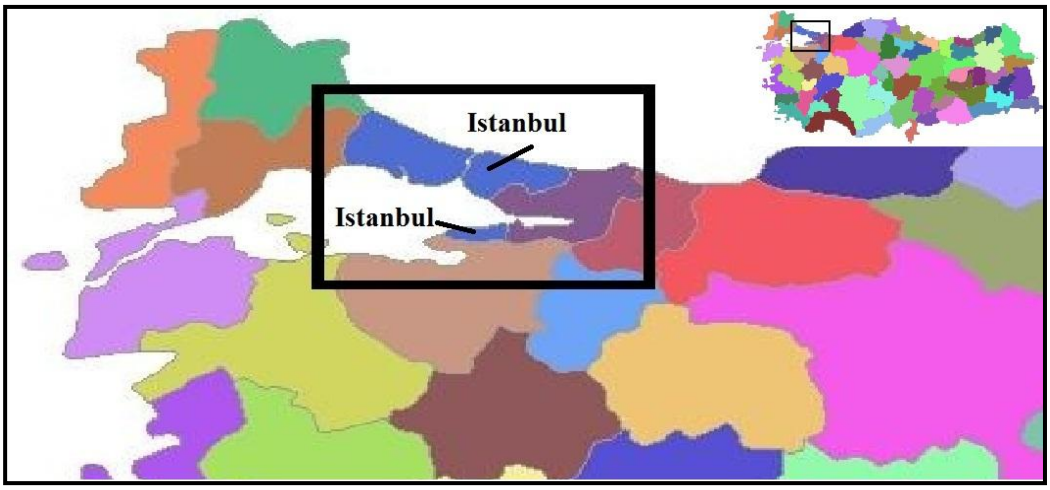
Village	Borough	Province	1985	1990	2000	2007
-	Yalova	Istanbul	106576	135385	0	0
-	-	Yalova	0	0	168593	181758

According to ID representation, one area must have one ID and one coordinate, so Yalova could not be represented by two different ID's in the data set or in other words by two different points on map. Therefore, two excel rows were joined together by the ID representation to arrange time series backwards from 2007 to 1831. Yalova as a borough before 1995 just covers villages. On the other hand, Yalova as a borough did not include boroughs and villages when compared to Yalova as a province in 2000 and after. That situation is also possible for many other new provinces and old provinces. For instance, the population of Istanbul could not be calculated correctly and properly because of Yalova. Istanbul covers Yalova as a borough and its villages before the year 1995, but does not include these villages and Yalova in 2000 and after. There exists two different Istanbul and two different Yalova's before and after year 1995 represented in Figure 5-5.

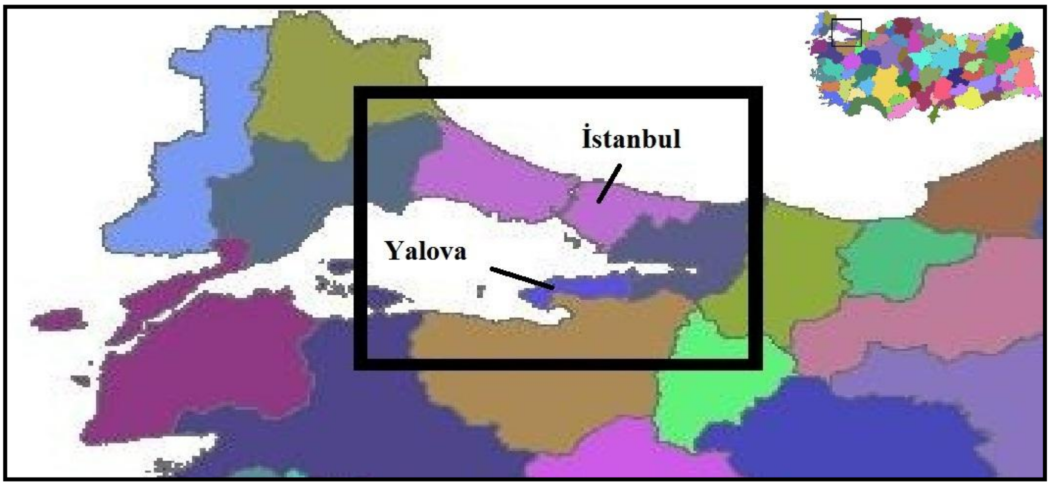
The harmonization process of the village based population dataset does not take into account what is the difference between Yalova in 2000, 1975 and 1927.

According to the base year 2000 Yalova covers boroughs and these boroughs covers villages. So the population of these villages in 1927, 1975 and 2000 are important for that harmonization process. The population of current Yalova in 1927 and 1975 could be calculated by the summation of the population of these villages in 1927 and 1975.

Figure 5-5: Yalova as a Borough and Province



(a) Yalova as a Borough of Istanbul before 1995



(b) Yalova as a Province after 1995

Source: Inventory of the Project No. 106K392

To sum up; villages which belong to boroughs and provinces, are localized according to year 2000. ID numbers are given to each village with respect to coordinate system. Therefore, the provinces and boroughs are not taken into consideration during the data entry process. The population of each village for every census of population year is entered to the dataset. As a result, a time series dataset is constructed backwards from 2007 to 1831. Consequently, this population dataset, which should probably be the first example as to the knowledge of the author in Turkey, are combined and visualized with maps by MapInfo GIS software program to visualize the analyses.

5.1.1.2. Area Data

The second component of population density is the area, which is the denominator of the population density equation. Like population data, area data (in kilometer square) is used to derive the population densities of boroughs and provinces. However, area data was easily acquired from the internet database of the Turkish Statistical Institute (TUIK)[9]. Areas of all boroughs and provinces are taken in km^2 based on the year 2000, which is also the base year of the population dataset. Therefore, area data is just taken for the year 2000, which represents the last and current situation of the classification of administrative borders. Consequently, areas of villages, boroughs and provinces are stable according to base year 2000 but the populations of these stable villages change during the observed period from 1831 to 2007.

5.1.2. Transportation Infrastructure Data

In the light of the literature, railway lengths are used as transportation infrastructure data from 1856 to 2007 in province-level, obtained as a result of the combination of railway network data in country-level and railway network maps. Railway network data and railway network maps were collected from the Turkish State Railways (TCDD). That railway network data was arranged and harmonized by

[9] http://www.turkstat.gov.tr/

MapInfo GIS software program. Harmonized railway network data includes variables such as line ID (given by MapInfo), line name, segment name, beginning station, ending station, establishment date, first operating date and railway length provided in Table 5-2.

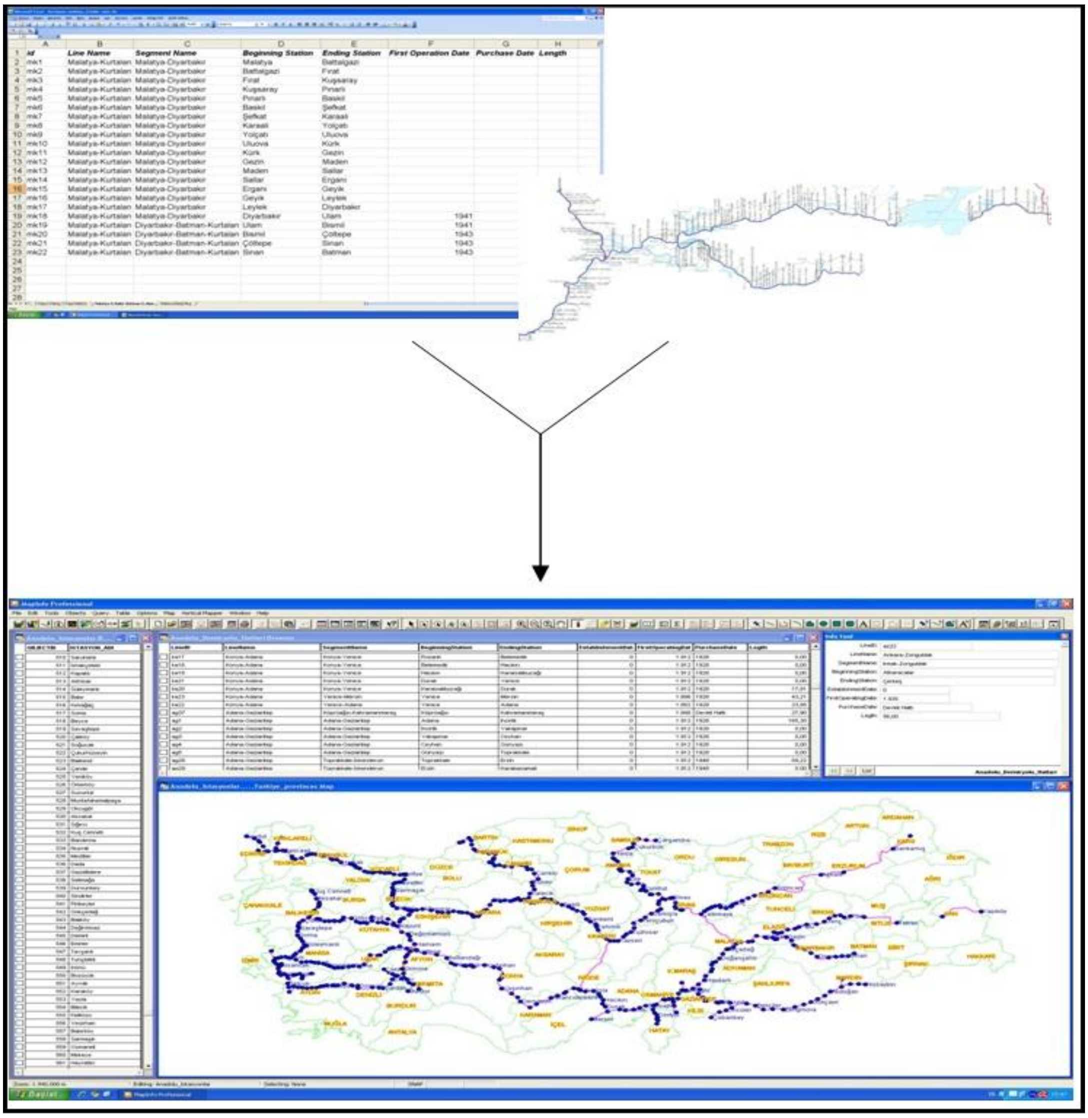
Table 5-2: Railway Network Data

Line ID	Line Name	Segment Name	Beginning Station	Ending Station	Establishment Date	First Operating Date	Length
id03	İzmir-Aydın-Denizli	İzmir-Aydın	Buca	Gaziemir	1856	1866	9,92
id04	İzmir-Aydın-Denizli	İzmir-Aydın	Gaziemir	Cumaovası	1856	1866	5,46
iu06	İzmir-Manisa-Uşak	İzmir-Manisa-Uşak	Halkapınar	Alsancak	1856	1866	2,77
id01	İzmir-Manisa-Uşak	İzmir-Manisa-Uşak	Alsancak	Basmane	1856	1866	2,46
id13	İzmir-Aydın-Denizli	İzmir-Ödemiş	Çatal	Ödemiş	1874	1882	22,51
id17	İzmir-Aydın-Denizli	İzmir-Söke	Ortaklar	Söke	1874	1882	21,49
ad02	Afyon-Dinar	Afyon-Dinar	Sehir	Tinaztepe	1902	1902	23,93
ad03	Afyon-Dinar	Afyon-Dinar	Tinaztepe	Kocatepe	1902	1902	13,13
ib14	İzmir-Manisa-Balıkesir	İzmir-Balıkesir	Soma	Beyce	1910	1912	15,82
ib13	İzmir-Manisa-Balıkesir	İzmir-Balıkesir	Beyce	Savaştepe	1910	1912	11,83

Railway network maps[10] were detailed maps including all stations, but these maps do not include any data about the railway network. Railway network data and railway network maps were entered to computer environment and joined together by using MapInfo GIS software program to create a detailed railway network map of Turkey. That data and map combination process is visualized in Figure 5-13.

[10] All maps are provided in appendix in Figures from 5-6 to 5-12

Figure 5-13: Railway Data and Maps are joined as a Group



Source: Inventory of the Project No. 106K392

During that joining process, railways' first operating dates were taken into account because railway network maps were constructed for parallel years with censuses of population. Railway network lines and the fixed borders of provinces in year 2000 were joined together. The borders of provinces are fixed but the railway network changed on maps through years. The development process of the railway network in Turkey could be visualized from these maps year by year and province by province. The length of railways in censuses of population years could be calculated by using these maps. For example, the length of railways in province Izmir in 1881, 1914 and 1927 until 2007 could be obtained by calculating the railway lengths in the borders of Izmir in 1881, 1914 and 1927 until 2007 by the help of newly established railway network maps. Consequently, country-level railway network data was transformed into province-level railway network data after that process by the help of railway network data and railway network map combination.

5.1.3. Economic Activity Measures Data

Economic activity measures are diversified and not specifically limited when the literature is overviewed. Agricultural production is used for this study's econometric analysis as economic activity measure to investigate the effects of railways on agricultural production as the second hypothesis of this thesis. Agricultural production at province based is acquired from 35 books published by Turkish Statistical Institute (TUIK) between 1909 and 2008. Agricultural production includes cotton, wheat, tobacco, grape, milk, pulse and citrus fruits, which are important goods for Turkey's agricultural production. These goods are selected according to data availability and freight transportation routes of railways in Turkey.

Agricultural production amounts of these seven goods were obtained from hardcopies published by TUIK and transferred to computer by entering to excel format. Agricultural production of these goods was entered in province level from 1909 to 2008 as two measurements; production in tons and plantation in hectares. Production in tons were taken for every good and summed as total agricultural production of each province. These calculations were obtained for every province and for each year between 1909 and 2008.

5.1.4. Data Summary

In this section, the dataset used for the econometrical analyses of this study is tabulated to show the characteristics and features of each data (population, transportation and economic activity) in Table 5-3.

Table 5-3: Data Summary

Analysis	Data	Period	Observed Units	Frequency	Source
The effects of Railways on Demographic Measures	Railway Length	1856-2007	55 provinces out of 81	Census of Population Years	TCDD
	Population Density	1856-2007	55 provinces out of 81	Census of Population Years	TUIK Karpat, 1985
The effects of Railways on Economic Activity	Railway Length	1909-2007	50 provinces out of 81	Census of Population Years	TCDD
	Agricultural Production	1909-2008	50 provinces out of 81	Census of Population Years	TUIK

The relationship between railways and population density constitutes the first hypothesis of this study. The time period included census of population years from 1831 to 2007 but the railway constructions started in 1856 so the observation period became the censuses of population years between 1856 and 2007. The provinces as observation units are only 55 provinces[11] out of 81 provinces, which have railways in their borders. 26 provinces do not include any railway tracks in their borders.

The second hypothesis is the relationship between railways and agricultural production. The time period included again the census of population years from 1831 to 2007 but the agricultural production dataset starts from 1909 so the observation period became the censuses of population years between 1909 and 2007. The provinces as observation units are only 50 provinces[12] out of 81 provinces, which have railways in their borders and agricultural production data is available.

[11] The list of provinces is displayed in Table 5-4 in appendix 8.
[12] The list of provinces is displayed in Table 5-5 in appendix 9.

5.2. METHODOLOGY

A large body of the literature during mid 20^{th} century has considered the impact of transportation infrastructure on economic activities and demographic measures. These relationships were investigated and analyzed by using econometrics in empirical studies. Time series and panel (pooled or longitudinal) data analyses were used as econometric techniques to obtain results to resolve the link between transportation infrastructure and other variable series. In the light of the literature and hypotheses of this study, cross-section and time series data were pooled to study the effects of railways as transportation infrastructure on population density as demographic measure and agricultural production as economic activity measures for Turkey in province base.

These hypotheses were tested by the order of cointegration and causality testing procedures. Before the conduction of cointegration and causality tests between those variables, it was necessary to perform unit root tests. Unit root, cointegration and causality tests in the time series dimension suffered of low power and size distortion. Additional cross-sectional dimension, however, brings an improvement to the power of testing procedures by acting as repeated draws from the same distribution. Unit root, cointegration and causality tests under panel framework are explained in the following parts respectively.

5.2.1. Panel Unit Root Test

Unit root testing is basically testing stationarity (or nonstationarity) of variables or series. At the beginning of an econometric analysis, both time series analysis and panel data analysis require information whether the variables are stationary or not. Actually, the main reason of performing unit root analysis is implementing a cointegration analysis to identify long-run and/or short-run relationships between variables, if any. Observed variables should be non-stationary and integrated of the same order during the cointegration processes. Otherwise, the test results may falsely give evidence of cointegration and problems can be associated with nonstationary time series like the spurious regression problem that may arise from the regression of a nonstationary time series on one or more nonstationary time series. The solution is transforming nonstationary time series data and panel data to stationary time series data and panel data.

The time series properties of variable series are determined by the use of Dickey-Fuller (DF), Augmented Dickey-Fuller (ADF), Phillips-Perron (PP) and Kwiatkowski, Phillips, Schmidt and Shin (KPSS) unit root tests, which are the most popular unit root tests in the econometric research literature. However, these tests are not used to check the stationarity and/or nonstationarity characteristics of the transportation infrastructure, agricultural production and population density variables. Hypotheses are analyzed with the panel data framework and unit root tests should be specialized on panel data unit root testing.

It has been emphasized that, panel data analyses have played an increasingly important role in economics and econometrics because small time dimension of most datasets rendered researchers to strike into cross-section issue (Levin and Lin, 1992 and 1993; Quah, 1992 and 1994; Pesaran and Smith, 1995; Pesaran et al., 1996; Kao, 1997 and 1999; McCoskey and Kao, 1998; Maddala and Wu, 1999; Pedroni, 2000 and 2004; Choi, 2001; Levin, Lin and Chu, 2002; Im, Pesaran and Shin, 1997 and 2003). These contributions to panel data analysis facilitated important aspects over investigations with panel data sets, covering different industries, regions, states or countries. Thus, the use of panel unit root tests may prove to be particularly useful in analyzing cross-province data of this study. The panel unit root tests, which are used for this thesis, are explained below.

Six panel unit root tests are considered in this study's econometric analysis: Im-Pesaran-Shin (IPS), Maddala-Wu (Fisher Type ADF test), Choi (Fisher Type PP test), Levin-Lin-Chu (LLC), Breitung and Hadri tests. The first three tests assume cross-sectional independence (individual unit root), while LLC and Breitung assume cross-sectional dependence (common unit root).

Im, Pesaran and Shin (2003) proposed a panel unit root test for dynamic heterogeneous panels based on the mean of individual unit root statistics, which standardized t-bar test statistic based on the ADF statistics. This testing procedure is an extensive and developed version of the panel unit root test constructed by Im, Pesaran and Shin (1997). The basic framework of Im, Pesaran and Shin (2003) panel unit root test considered N cross-sections (countries, cities, provinces etc.) observed over T time periods:

$$y_{it} = (1 - \emptyset_i)\mu_i + \emptyset_i y_{i,t-1} + \varepsilon_{it} \text{ , i = 1… N and t = 1… T}$$

where the null hypothesis of unit roots $\emptyset_i = 1$ for all i expressed by:

$$\Delta y_{it} = \propto_i + \beta_i y_{i,t-1} + \varepsilon_{it}$$

where $\propto_i = (1 - \emptyset)\mu_i$, $\beta_i = -(1 - \emptyset)$, $\Delta y_{it} = y_{it} - y_{i,t-1}$ and the ε_{it} errors are assumed to be auto-correlated with different serial correlation and variance properties across the cross-section units, but they are independent across the units of the sample. IPS unit root test tested the null that each series in the panel has a unit root for all cross-section units against the alternative that at least one of the series is stationary. Consequently, null and alternative hypotheses of IPS panel unit root test become:

$H_0: \beta_i = 0$, for all i

$H_1: \beta_i < 0$ i = 1… N1 where $\beta_i = 0$, i = $N_1 + 1, N_1 + 2 \dots N$

Maddala and Wu (1999) emphasized that, the commonly used unit root tests like the Dickey-Fuller (DF), augmented Dickey-Fuller (ADF), Kwiatkowski, Phillips, Schmidt-Shin (KPSS) and Phillips-Perron (PP) had insufficient power in distinguishing the unit root null from stationary alternatives. According to Maddala and Wu, using panel data unit root tests was one way of increasing the power of unit root tests based on a single time series. Maddala and Wu (1999) constructed a Fisher type panel unit root test with reference to the ADF unit root test. This Fisher type test does not require balanced panels, which use different lag lengths in the individual ADF regression, and it is an exact test when compared to asymptotic tests like IPS.

Maddala-Wu Fisher-Type panel unit root test considered the simple model:

$$\Delta y_{it} = \rho_i y_{i,t-1} + \varepsilon_{it}, i = 1, 2 \dots N \text{ and } t = 1, 2 \dots T$$

Maddala-Wu tests $\rho_1 = 0$ versus $\rho_1 < 0$ and they apply a single equation unit root test for the first time series. Then their unit root test tests the null and alternative hypothesis:

$$H_0: \rho_i = 0 \text{ and } H_1: \rho_i < 0, \text{for } i = 1, 2 \dots N$$

Choi (2001) also developed a Fisher-Type panel unit root test, which combined p-values of a univariate unit root test, devised under more general assumptions when compared to other panel unit root tests, such as the number of groups like finite or infinite, group components like stochastic or non-stochastic and the difference time series spans of groups. Choi (2001)'s model is proposed as:

$$y_{it} = d_{it} + x_{it} \quad \text{where; } i = 1 \dots N; t = 1 \dots T$$

$$d_{it} = \beta_{i0} + \beta_{i1} t + \cdots + \beta_{im_i} t^{m_i}$$

$$x_{it} = \propto_i x_{i(t-1)} + u_{it} \text{ and } u_{it} = I(0)$$

In that model y_{it} composes of both a non-stochastic process d_{it} and a stochastic process, x_{it}. Besides, y_{it} has also different sample size and specification of non-stochastic and stochastic components with respect to i. Null and alternative hypothesis of Choi are:

$H_0 : \propto_i = 1$ for all i , implies that all time series are unit-root nonstationary.

$H_A: |\propto_i| < 1$ for at least one i , some time series are nonstationary while the others are not for finite N.

$H_A: |\propto_i| < 1$ for some i , all time series are stationary for infinite N.

Levin, Lin and Chu (2002) stated that, panel data framework would provide dramatic improvements in power compared to performing a separate unit root test for each individual time series. Levin, Lin and Chu (LLC) panel unit root test is the extended version of Levin-Lin (LL) panel unit root test proposed by Levin and Lin (1993).

LLC test performs the ADF regression for every individual (i) by implementing three different models (m) respectively where -2 < δ ≤ 0 for all i = 1… N and t = 1…T:

$$\Delta y_{it} = \delta_i y_{it-1} + \sum_{L=1}^{P_i} \theta_{iL} \Delta y_{it-L} + \propto_{mi} d_{mt} + \varepsilon_{it} , \; m = 1, 2, 3.$$

Model 1: no intercepts or trends;

$$\Delta y_{it} = \delta y_{it-1} + \zeta_{it}$$

Null Hypothesis: $H_0: \delta = 0$

Alternative Hypothesis: $H_1: \delta < 0$

Model 2: individual-specific intercepts;

$$\Delta y_{it} = \alpha_{0i} + \delta y_{it-1} + \zeta_{it}$$

Null Hypothesis: $H_0: \delta = 0$ and $\alpha_{0i} = 0$

Alternative Hypothesis: $H_1: \delta < 0$ and $\alpha_{0i} \in R$

Model 3: individual-specific intercepts and trends;

$$\Delta y_{it} = \alpha_{0i} + \alpha_{1i}t + \delta y_{it-1} + \zeta_{it}$$

Null Hypothesis: $H_0: \delta = 0$ and $\alpha_{1i} = 0$

Alternative Hypothesis: $H_1: \delta < 0$ and $\alpha_{1i} \in R$

Breitung (2000) stated that panel unit root tests such as LL and IPS suffered from a severe loss of power if individual specific trends were included. Breitung tested the hypothesis of a difference stationary time series against trend stationary alternatives and mentioned the unobserved heterogeneity problem of panel data analysis. That rendered the separately analysis process of each cross-section data and the advantage of pooling the data became inefficient.

$$y_{it} = \mu_i + \beta_i t + x_{it} \quad \text{where; } t = 1, 2 \ldots T$$

$$x_{it} = \sum_{k=1}^{p+1} \alpha_{ik} x_{i,t-k} + \varepsilon_{it}$$

Where x_{it} is generated by the autoregressive process and the null hypothesis is the process of difference stationarity;

$$H_0: \rho_i \equiv \sum_{k=1}^{p+1} \alpha_{ik} - 1 = 0 \text{ for all } i = 1 \ldots N$$

Hadri (2000) proposed a residual based Lagrange Multiplier (LM) test for a null that the individual observed variable series were stationary around a deterministic level or trend against the alternative of a unit root in panel data. The testing procedure of Hadri (2000) is easy to apply to panel data models with fixed effects, individual deterministic trends and heterogeneous errors across cross-sections. According to Hadri, the power of the test could be increased with an increase in the number of cross-sections and his test is applicable to panel data with large T and moderate N.

The panel unit root test developed by Hadri (2000) tests both the unit root hypothesis and the stationarity hypothesis. Consequently, it could be distinguished series that appear to be stationary, series that appear to have a unit root and series whether stationary or integrated. The two models considered by Hadri are:

Model 1: $y_{it} = r_{it} + \epsilon_{it}$

Model 2: $y_{it} = r_{it} + \beta_i t + \epsilon_{it}$

There, r_{it} is the random walk as $r_{it} = r_{it-1} + u_{it}$ and y_{it}, t = 1 … T and i = 1 … N are the observed series to test stationarity for all i and t. Also ϵ_{it} and u_{it} are mutually independent for all i over t. The null and alternative hypothesis of Hadri panel unit root test is proposed as:

$$H_0: \lambda = 0 \quad against\ the\ alternative \quad H_1: \lambda > 0$$

Table 5-6: Panel Unit Root Tests

	Test	Hypothesis Test	Cross-Sectional
LLC	Levin-Lin, 1992 and 1993 Levin-Lin-Chu, 2002	Non-Stationarity	Dependence
Breitung	Breitung, 2000	Non-Stationarity	Dependence
IPS	Im-Pesaran-Shin, 1997 and 2003	Non-Stationarity	Independence
Fisher Type	Maddala-Wu, 1999	Non-Stationarity	Independence
	Choi, 2001	Non-Stationarity	Independence
Hadri	Hadri, 2000	Stationarity	Independence

All of the panel unit root tests, explained above are processed by using E-Views econometric analysis software program and their results are provided in the following chapter. Before explaining the panel cointegration and panel causality, Table 5-6 summarizes the characteristics and features of panel unit root tests used for econometric analysis.

5.2.2. Cointegration Test

Cointegration is a statistical property of two or more individually integrated variable series when their combination has lower order of integration. Testing the hypothesis that there is a statistically significant linkage between transportation infrastructure and population density could be analyzed by testing for the existence of a cointegrated combination of the two series. Assume that, the variable series are individually integrated of order one as I(1) and their combination has a lower order of integration of order zero as I(0). That can emphasize a cointegration relationship between the variables, which are then denoted as cointegrated variables (series). Consequently, cointegration is testing hypotheses concerning the relationship between variables integrated of at least order one. If variable series are integrated of order n as a nonstationarity degree, these could be made stationary by taking the difference n times.

Econometric literature before the contributions of Robert Engle and Clive Granger was teemed with the studies involving linear regression analysis of nonstationary variable series. Those analyses included spurious relationship (correlation, regression), which is the misleading correlation between two variables produced through the effect of third causal variable, between variable series. Engle and Granger (1987) formalized cointegrating vector approach and they introduced Engle-Granger two step method, which is used to test the cointegration relationship between two variable series. Another important cointegration testing process, which was formalized by Soren Johansen in 1991, is known as Johansen procedure. That procedure can be used for testing several variable series that does not require all variable series to be in the same order of integration. Since Johansen procedure, there has been a vast amount of contributions to cointegration issue for time series analysis.

5.2.2.1. Panel Cointegration Test

The most important difference of panel data when compared to time series is the existence of cross-section dimension. Panel data unit root and cointegration tests can provide more robust and powerful results rather than tests dealing with time series analysis. Time series analysis provide results with the information obtained from only time dimension, whereas panel data analysis combine the information obtained from time dimension in addition to the information obtained from cross-section dimension.

In the literature dealing with panel data analysis, economists pool data on similar countries, cities or regions in the hopes of adding cross-sectional variation to the data and thus to increase the power of unit root tests and/or panel cointegration tests. Consequently, panel cointegration tests and panel unit root tests require more powerful tests than time series cointegration tests, which are limited and have low power for time and cross-section together. That is valid especially for short time and short span of data (Baltagi, 2008:252). The literature that attempted to produce reliable and robust panel cointegration tests that divided into two broad directions. First type tests take the null hypothesis of no cointegration and second type tests take the null of cointegration. These two testing procedures are both residual-based tests and have their analogue in the time series (Banerjee, 1999:617).

The seminal and important contributions to panel cointegration analysis belong to Pedroni (1995, 1997, 2000, 2004), McCoskey and Kao (1998) and Kao (1997, 1999). McCoskey and Kao (1998) derive a residual-based test for the null of cointegration rather than the null of no cointegration in panels, which is an extension of Lagrange Multiplier (LM) and Locally Best Invariant (LBI) tests. Their model involves the assumptions that a varying intercept captures differences in behavior over cross-sectional units and that the slope coefficients may also vary across cross-sectional series. The model is presented as:

$$y_{it} = \propto_i + x'_{it}\beta_i + e_{it}$$

$$x_{it} = x_{it-1} + e_{it}$$

$$e_{it} = \gamma_{it} + u_{it}$$

$$\gamma_{it} = \gamma_{it-1} + \theta u_{it}$$

where u_{it} are IID $(0,\sigma_u^2)$ and null hypothesis of cointegration is equivalent to $\theta=0$, i=1… N and t=1…T.

Kao (1999) propose DF-type and ADF-type unit root tests for residuals as a test for the null of no cointegration. Kao's Panel regression model is as follows:

$$y_{it} = x'_{it}\beta + z'_{it}\gamma + e_{it}$$

DF-type tests can be regressed from the following equation:

$$\hat{e}_{it} = \rho\hat{e}_{it-1} + v_{it}$$

where $\hat{e}_{it} = \widetilde{y_{it}} - \tilde{x}'_{it}\hat{\beta}$, $\tilde{y}_{it} = y_{it} - \bar{y}_i$ and null hypothesis is H_0: $\rho=1$.

ADF-type test can be regressed from the following equation:

$$\hat{e}_{it} = \rho\hat{e}_{it-1} + \sum_{j=1}^{p} \vartheta_j \Delta\hat{e}_{it-j} + v_{itp}$$

Pedroni propose panel cointegration test for the null hypothesis of cointegration in a panel data model that allows for considerable heterogeneity, which can be classified into two categories. First testing category involves averaging test statistics for cointegration in the time series across cross-sections and second testing category considers averaging in pieces so that the limiting distributions are based on limits of piecewise numerator and denominator terms. The regression of cointegration equation is as follows:

$$y_{it} = \alpha_i + \delta_i t + \beta_i x_{it} + e_{it} \quad , i = 1 \ldots N \text{ and } t = 1 \ldots T$$

where $\beta_i = (\beta_{1i}, \beta_{2i}, \ldots, \beta_{Mi})$ and $x_{it} = (x_{1it}, x_{2it}, \ldots, x_{Mit})$.

Null hypothesis and alternative hypotheses of the first and second categories of Pedroni tests are the following hypotheses respectively:

H_0 : $\gamma_i = 1$ for all i means that, all of the variables of the panel are not cointegrated.

H_A : $\gamma_i = \gamma < 1$ for all i means that, all of the individuals are cointegrated.

H_A : $\gamma_i < 1$ for all i means that, a significant portion of the individuals are cointegrated.

5.2.3. Causality Test

The existence of a relationship between two or more variables does not prove the causality relationship and/or the direction of influence in regression analysis, which deals with the dependence of one variable on other variable(s). This is because regression analysis does not always include causation.

Granger (1969) proposed the Granger-Causality test to determine the usefulness of a variable (time series) within forecasting another variable (time series). Granger test provides that for example, railways cause population density (railways → population density) and/or population density cause railways (population density → railways), where the arrow shows the direction of causality. One of the important assumptions of Granger-test is the information relevant to the prediction of the respective variables (railways and population density) contained solely in the time series data on these variables.

The Granger-causality models implemented with respect to R as railways and PD as population density are follows:

$$PD_t = \sum_{i=1}^{n} \propto_i R_{t-i} + \sum_{j=1}^{n} \beta_j PD_{t-j} + u_{1t}$$

$$R_t = \sum_{i=1}^{n} \lambda_i R_{t-i} + \sum_{j=1}^{n} \delta_j PD_{t-j} + u_{2t}$$

where population density and railways are stationary, u_{1t} and u_{2t} are uncorrelated and the number of lagged terms introduced in the causality test are determined by Akaike or Schwarz information criterions. According to these models population density, is related to past values of railways and itself, railways are related to past values of population density, and itself, respectively. Consequently, the lagged values of railways have explanatory power in a regression of population density on lagged values of population density and railways, meaning railways Granger cause population density.

5.2.3.1. Panel Causality Test

Granger Causality test is implemented as two-stage procedure to obtain the causality relationship for panel data analysis. Several studies investigate panel causality, perform that testing procedure, where the first step is the estimation of the residual values from the long run relationship and the second step is incorporating the residual as a right hand side variable as the short run error correction model estimation (Chakraborty and Nandi, 2003; Lee and Chang, 2008; Lee, Chang and Chen, 2008).

At the first step the equation below is regressed, where PD and R denotes population density and railways, respectively:

$$PD_{it} = \propto_i + \beta_t + \delta_i R_{it} + \varepsilon_{it}$$

where $\propto_i$, β_t and ε_{it} are referred to cross-section effects (provinces), trend effects and the estimated residuals indicating deviations from the long run relationship, respectively. At the second step, the residual ε_{it}, estimated as the error correction term ϵ_{it} from the first step is used as an independent variable at the right-hand side of the normal Granger causality testing procedure with dynamic error correction as follows:

$$\Delta PD_{it} = \propto_{1i} + \lambda_{1i}\epsilon_{it-1} + \sum_{k=1}^{n} \emptyset_{11ik} R_{it-k} + u_{1it}$$

$$\Delta R_{it} = \propto_{2i} + \lambda_{2i}\epsilon_{it-1} + \sum_{i=1}^{n} \emptyset_{21ik} PD_{it-k} + u_{2it}$$

where k is the number of lags determined, which is necessary to satisfy the assumptions of error term, $\emptyset_{ik}$ is the parameter to be estimated, u_{it} is the serially uncorrected error term, λ_i is the long run effects of variables and $\emptyset_{ik}$ is the short run Granger Causality of variables. In our case, λ_{1i} is referred as the long run effect of railways (R) on population density (PD) and $\emptyset_{11ik}$ is referred as the short run Granger Causality obtained from R to PD.

CHAPTER SIX
EMPIRICAL RESULTS

The empirical analysis in this chapter investigates the effects of railways on province-level population density and agricultural production using panel data for Turkey. The methodology described in the previous chapter is applied to examine the relations between railways and each series: population density and agricultural production. All variables are studied in logarithms. First, panel data is used to perform panel regression analysis. Second, panel unit root tests are performed; this is followed by panel cointegration and panel causality testing procedures. These steps are performed for both the relationship between railways and population density, and railways and agricultural production. The equations of the two hypotheses are as follows:

$$\text{Population Density}_t = \propto_0 + \propto_1 \text{ Railways}_t + \varepsilon_t \qquad (4.1)$$

$$\text{Agricultural Production}_t = \beta_0 + \beta_1 \text{ Railways}_t + \epsilon_t \qquad (4.2)$$

6.1. PANEL REGRESSION RESULTS

In this first step, panel regression analysis is performed for equations 4.1 and 4.2, followed by Hausman testing procedure to determine the robustness of the random effects selection criteria for the panel regression analyses for both hypotheses. The results are reported in Table 6-1. First hypothesis one as in equation 4.1 is regressed with cross-section random effects; and the effect of railways on population density is found positively significant for 55 provinces in Turkey for the sample period between 1856 and 2007. Random effects criteria is used for cross-section because, population of provinces changed over during the time period and transiting from one province to another. Equation 4.2 is regressed with period random effects; the effect of railways on agricultural production is found positively significant for 50 provinces for the sample period from 1909 to 2007. The random-effects selection is used for period because of the nature of agricultural production.

Agricultural production is changed over the time but did not conduct from one province to another. Also agricultural goods are affected from period effects. Consequently, fixing the period is not consistent for agricultural production.

Table 6-1: Panel Regression Analysis and Hausman Test Results

Variable	Coefficient (t-stat)	Hausman Chi-Sq. Statistic Null Hypothesis: Random
Dependent Variable: Population Density		
Railways	0,199 (2,107**)	0,353569
Constant	26,869 (3,002***)	
Dependent Variable: Agricultural Production		
Railways	0,286 (2,908***)	0,000039
Constant	10,837 (15,241***)	

Note: *, ** and *** indicate the significance of the independent variable at the 0.10, 0.05 and 0.01 significance levels. Component variances are estimated by Swamy and Arora. Standard errors and covariance are corrected by Period SUR (PCSE). Estimations are undertaken with E-Views 6.0.

6.2. PANEL UNIT ROOT TEST RESULTS

Panel unit root tests' results are displayed in Tables 6-2 and 6-3, where the reported test results are organized for two hypotheses as the number of observation units (provinces) is different for both hypotheses. For the hypothesis investigating the relationship between railways and population density (equation 4.1) covers 55 provinces, but the second one investigates 50 provinces with respect to the relationship between railways and agricultural production (equation 4.2). Six types of panel unit root testing procedures are applied to all variables. Im-Pesaran-Shin, Fisher Type ADF, Fisher Type PP, Levin-Lin-Chu, Breitung and Hadri panel unit root tests are included in the following.

Table 6-2: Panel Unit Root Tests' Results for Railways and Population Density

Method	Statistics Type	Statistics Value	Conclusion
Variable: Railway Length			
Null Hypothesis: Individual Unit Root			
Im-Pesaran-Shin	W-stat	-3,358***	I(0)
Fisher-ADF	Fisher Chi-square Choi Z-stat	38,247*** -2,597***	I(0)
Fisher-PP	Fisher Chi-square Choi Z-stat	1844,07*** NA	I(0)
Null Hypothesis: Common Unit Root			
Levin-Lin-Chu	t-stat	-3,477***	I(0)
Breitung	t-stat	0,293	I(1)
Null Hypothesis: No Unit Root			
Hadri	Z-stat	11,112***	I(1)
Variable: Population Density			
Null Hypothesis: Individual Unit Root			
Im-Pesaran-Shin	W-stat	-7,222***	I(0)
Fisher-ADF	Fisher Chi-square Choi Z-stat	279,926*** -6,163***	I(0)
Fisher-PP	Fisher Chi-square Choi Z-stat	813,549*** -15,773***	I(0)
Null Hypothesis: Common Unit Root			
Levin-Lin-Chu	t-stat	-14,334***	I(0)
Breitung	t-stat	4,817	I(1)
Null Hypothesis: No Unit Root			
Hadri	Z-stat	15,320***	I(1)

Note: 55 provinces are used. Lags are determined by Modified Akaike Info criteria. *, ** and *** indicate the rejection of null hypothesis at the 0.10, 0.05 and 0.01 significance levels. Estimations are undertaken with E-Views 6.0.

Table 6-3: Panel Unit Root Tests' Results for Railways and Agricultural Production

Method	Statistics Type	Statistics Value	Conclusion
Variable: Railway Length			
Null Hypothesis: Individual Unit-Root			
Im-Pesaran-Shin	W-stat	3,679***	I(0)
Fisher-ADF	Fisher Chi-square Choi Z-stat	41,562*** -2,470***	I(0)
Fisher-PP	Fisher Chi-square Choi Z-stat	1834,80*** NA	I(0)
Null Hypothesis: Common Unit-Root			
Levin-Lin-Chu	t-stat	4,907***	I(0)
Breitung	t-stat	0,474	I(1)
Null Hypothesis: No Unit Root			
Hadri	Z-stat	10,565***	I(1)
Variable: Agricultural Production			
Null Hypothesis: Individual Unit-Root			
Im-Pesaran-Shin	W-stat	-6,175***	I(0)
Fisher-ADF	Fisher Chi-square Choi Z-stat	245,991*** -4,931***	I(0)
Fisher-PP	Fisher Chi-square Choi Z-stat	405,589*** -10,473***	I(0)
Null Hypothesis: Common Unit-Root			
Levin-Lin-Chu	t-stat	-12,558***	I(0)
Breitung	t-stat	1,088	I(1)
Null Hypothesis: No Unit Root			
Hadri	Z-stat	13,815***	I(1)

Note: 50 provinces are used. Lags are determined by Modified Akaike Info criteria. *, ** and *** indicate the rejection of null hypothesis at the 0.10, 0.05 and 0.01significance levels. Estimations are undertaken with E-Views 6.0.

Panel unit root test results in Table 6-2 and 6-3 do not provide strong and consistent evidence about the unit root characteristics of the series. Im-Pesaran-Shin, Fisher type ADF and Fisher type PP panel unit root tests' results report the rejection of the null hypothesis of individual unit root for all variables. Besides, Levin-Lin-Chu panel unit root test results provide the rejection of the null hypothesis of common unit root for all variables at 1% significance level. On the other hand, findings from Breitung and Hadri panel unit root tests are different. These two tests provide the existence of unit root. Breitung test results provide that null hypothesis of a common unit root is accepted. Hadri panel unit root test results denoted the rejection of null hypothesis of no unit root at 1% significance level.

All these tests are performed to obtain robust results rather than applying only one panel based unit root test for all variables. However, panel cointegration analysis is performed according to Breitung and Hadri panel unit root tests, which reported significantly strong evidence about the existence of a unit root. Breitung and Hadri tests are based on cointegration relationship because these two tests have different characteristics but they gave the same result. Null hypothesis of Breitung and Hadri tests are having a unit root and no unit root, respectively. Besides, Breitung uses lags as autocorrelation correction method but Hadri uses Kernel. Hadri test is based on the residuals from the individual OLS regressions of the variable on a constant or both with constant and trend. Breitung test differs from other tests with the removing process of autoregression portion by constructing the standardized proxies, which are transformed and detrended.

6.3. PANEL COINTEGRATION TEST RESULTS

Panel cointegration testing is the next step of this study after panel unit root testing. Three panel cointegration tests are applied as Pedroni, Kao and Johansen-Fisher. Cointegration findings are reported in the presence of stationarity of the variables in Tables 6-4, 6-5 and 6-6 for Pedroni, Kao and Johansen-Fisher panel cointegration testing procedures, respectively. Their statistics are displayed designating the variable pairs by dependence and independence criteria. All panel cointegration tests are performed for both hypotheses, once with the dependent variable being population density, then with dependent variable chosen to be agricultural production as the development measure.

The existence of a strong cointegration at the 1% significance level in Pedroni, Kao and Johansen-Fisher panel cointegration tests is found for both hypotheses. The findings for 55 provinces in Turkey provided a cointegration relationship between railways and population density, when the population density is the dependent variable, for the sample period between 1856 and 2007. The results are not different for 50 provinces in Turkey, for the sample from 1909 to 2007, and cointegration is found between railways and agricultural production, when the agricultural production is the dependent variable, in all three panel cointegration tests.

Table 6-4: Pedroni Panel Cointegration Test: Railways independent variable

	Panel Statistics	**Group Statistics**	**Cointegration**
Dependent variable: Population Density			
v-statistic	4,258***		Yes
rho-statistic	-5,542***	-3,671***	Yes
PP-statistic	-11,912***	-13,502***	Yes
ADF-statistic	-9,074***	-9,324***	Yes
Dependent variable: Agricultural Production			
v-statistic	2,883***		Yes
rho-statistic	-2,939***	-1,576**	Yes
PP-statistic	-7,054***	-8,612***	Yes
ADF-statistic	-5,171***	-4,760***	Yes

Note: All reported values are asymptotically distributed as standard normal. Lags are determined by Akaike Info criteria. *, ** and *** indicate the rejection of the null of unit root or no cointegration at the 0.10, 0.05 and 0.01 levels of significance. Newey-West bandwidth selection is performed with Quadratic Spectral kernel. Estimations are undertaken with E-views 6.0.

Table 6-5: Kao Panel Cointegration Test: Railways independent variable

Dependent variable: Population Density		Cointegration
ADF t-stat	-10,900***	Yes
Residual variance	0,0194	
HAC variance	0,0200	
Dependent variable: Agricultural Production		**Cointegration**
ADF t-stat	-12,026***	Yes
Residual variance	0,0137	
HAC variance	0,0144	

Note: Lags are determined by Akaike Info criteria. *, ** and *** indicate the rejection of the null of unit root or no cointegration at the 0.10, 0.05 and 0.01 levels of significance. Newey-West bandwidth selection is performed with Quadratic Spectral kernel. Estimations are undertaken with E-views 6.0.

Table 6-6: Johansen Fisher Panel Cointegration Test: Railways independent variable

Hypothesized No. of CE(s)	Fisher Statistics		Cointegration
	Trace Test	Max-Eigen test	
Dependent variable: Population Density			
None	125,2***	109,0***	Yes
At most 1	73,15***	73,15***	
Dependent variable: Agricultural Production			
None	118,6***	122,5***	Yes
At most 1	280,0***	280,0***	

Note: Lags are determined by Akaike Info criteria. *, ** and *** indicate the rejection of the null of unit root or no cointegration at the 0.10, 0.05 and 0.01 levels of significance. The probabilities of Fisher statistics are computed using asymptotic Chi-square distribution. Estimations are undertaken with E-views 6.0.

6.4. PANEL CAUSALITY TEST RESULTS

Following panel unit root and panel cointegration processes, panel causality procedure is examined. The empirical findings are displayed for the relationship between railways and other variables; population density and agricultural production for the relevant observation units and sample periods. The Granger Causality procedure is applied to examine the existence of causality for the relationships introduced above. Granger Causality tests' associated F statistics of causality tests are used at 1 and 2 lags according to Akaike Information Criteria (AIC). The results are reported and displayed in Table 6-7.

Table 6-7: Panel Granger Causality Test Results

Causality Relationship	**Lags**	**F-Stat**
Railways and Population Density		
Railways Granger Causes Population Density	1	0,408
	2	0,059
Population Density Granger Causes Railways	1	2,779*
	2	39,482***
Railways and Agricultural Production		
Railways Granger Causes Agricultural Production	1	6,106**
	2	0,761
Agricultural Production Granger Causes Railways	1	7,623***
	2	7,518***

Note: Lags are determined by Akaike Info criteria. *, ** and *** indicate the rejection of the null of no causality at the 0.10, 0.05 and 0.01 levels of significance. Estimations are undertaken with E-views 6.0.

The results show strong evidence that agricultural production causes railways for 50 provinces in Turkey for the period between 1909 and 2007 in both lagging conditions at 1% significance level. However, railways cause agricultural production for the same provinces and sample period only with 1 lag level at 5% significance level.

The empirical findings indicate that railways do not causes population density for 55 provinces from 1856 to 2007 at all lags. The results are not similar that, population density causes railways for the same observation units and sample period with 1 lag at 10% significance level, which is not robust as other causality relations between railways and agricultural production. However, population density causes railways at 1% significance level with one lag.

CONCLUSIONS

This study aimed to examine the relationship between transportation infrastructure and two important variables; demographic and economic activity measures. Transportation infrastructure is measured by railway lengths in kilometers. Demographic and economic activity variables are measured with population density and agricultural production. These analyses are aimed to enhance the empirical literature by investigating provinces in Turkey. Because the empirical literature on the link between transportation infrastructure and each measures; economic activity measures and demographic measures, has focused on econometric analyses using data for developed and industrialized observation units such as states, countries and regions. There, this study explored the evidence of transport infrastructure impacts on related measures in Turkey as a developing country case. As like all empirical analyses, there are various limitations and constraints imposed mostly by data availability.

Empirical analysis captured the attention to cointegration and causality issues from railways to population density and agricultural production. These are performed with using panel econometric techniques to allow cointegration and causality interpretations. This study examines econometric analyses using panel data at province level for both hypotheses. First hypothesis is tested by investigating the linkage between railways and population density for 55 provinces in Turkey for the period from 1856 to 2007. Second hypothesis is tested by investigating the effects of railways on agricultural production, which is regarded as a measure of economic impacts of transportation infrastructure, for 50 provinces in Turkey between 1909 and 2007.

The works presented in Chapter six estimates panel data econometrics to investigate the effect of railway infrastructure on population density and agricultural production in provinces in Turkey for the observed sample period. First, panel regression analyses are estimated to report the magnitude and the sign of railways as independent variable on population density and agricultural production as dependent variables. The sign of railways is found positive for both.

Second, panel unit root tests are applied to railways of 55 provinces, population density of 55 provinces, railways of 50 provinces and agricultural production of 50 provinces in logarithms. Im-Pesaran-Shin, Fisher Type ADF, Fisher Type PP and Levin-Lin-Chu panel unit root tests' results showed that, all variables are integrated of order zero. However, Breitung and Hadri panel unit root tests provided that, all variables are integrated of order one. Based on these results, panel regression analyses, panel cointegration tests and panel Granger causality testing procedures performed to series with data formation.

Third, three panel cointegration tests are performed to reach robust results. Pedroni, Kao and Johansen Fisher panel cointegration tests are applied to stationary series. All tests give strong evidence to cointegration relation at 1% significance level. Fourth, Granger causality testing procedure is used to analyze the direction and significance of the effects of railways on population density and agricultural production. The results suggest that causality relationship exists only from population density to railways. There is no evidence found to support that, railways cause population density. Besides, the causality is found with strong evidence from agricultural production to railways direction at 1% significance level. Also, railways cause agricultural production with only one lag at 5% significance level.

Consequently, these results emphasized the importance of railways as a need of the regional development from population and agriculture perspectives at province level in Turkey since, the beginning stages of railway constructions. The work presented in this study has shown that, transportation infrastructure does not underlie the population density and agricultural production at province level in Turkey. On the other hand, transportation infrastructure investments such as railways, highways, seaways, airports and harbors could be shaped based on population and/or economic activities. In conclusion, transportation infrastructure systems are unabated and important requirements of populations for the sustainability of economic activities conducting by populations. According to Figure 3-1, the arrow (8) from Volume and location of activities of firms and households to Accessibility of locations, arrow (11) from Accessibility of locations to Government infrastructure policy and arrow (12) from Government infrastructure policy to Transportation infrastructure could be matched to the empirical results obtained in this study.

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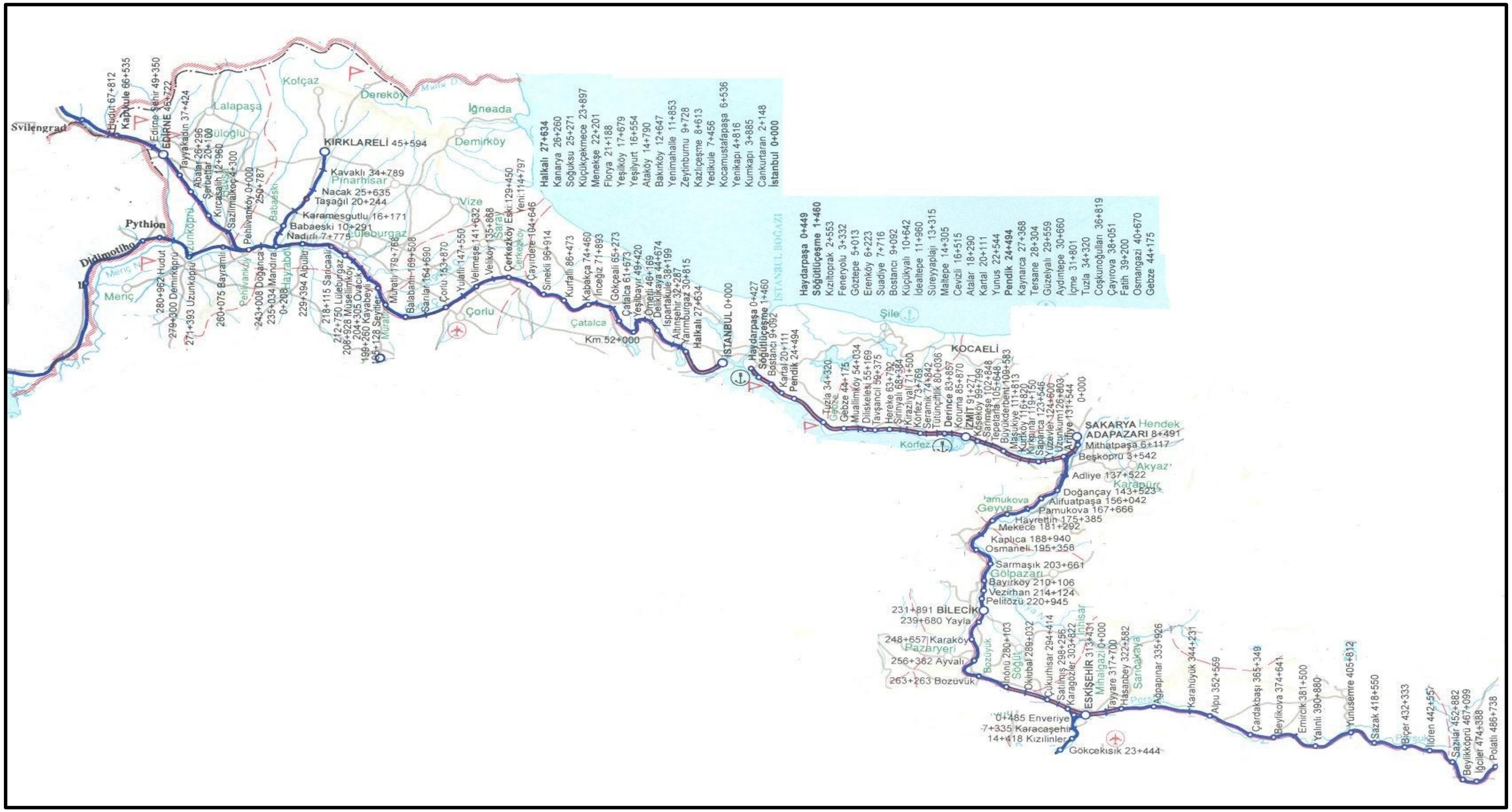
APPENDIX

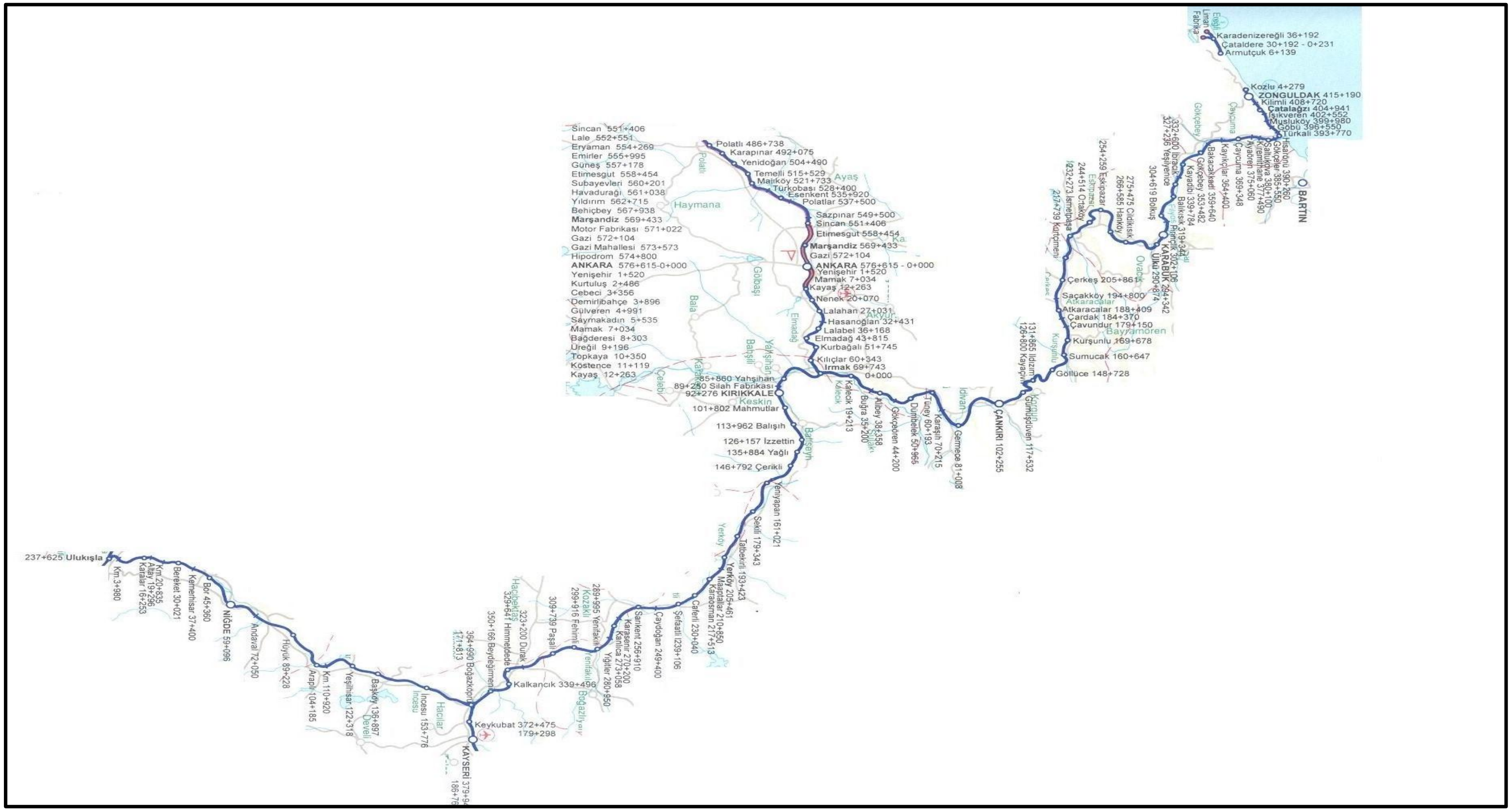
APPENDIX 1

Figure 5-6: Railway Network Map of the 1st Region (Istanbul as Regional Directorate)



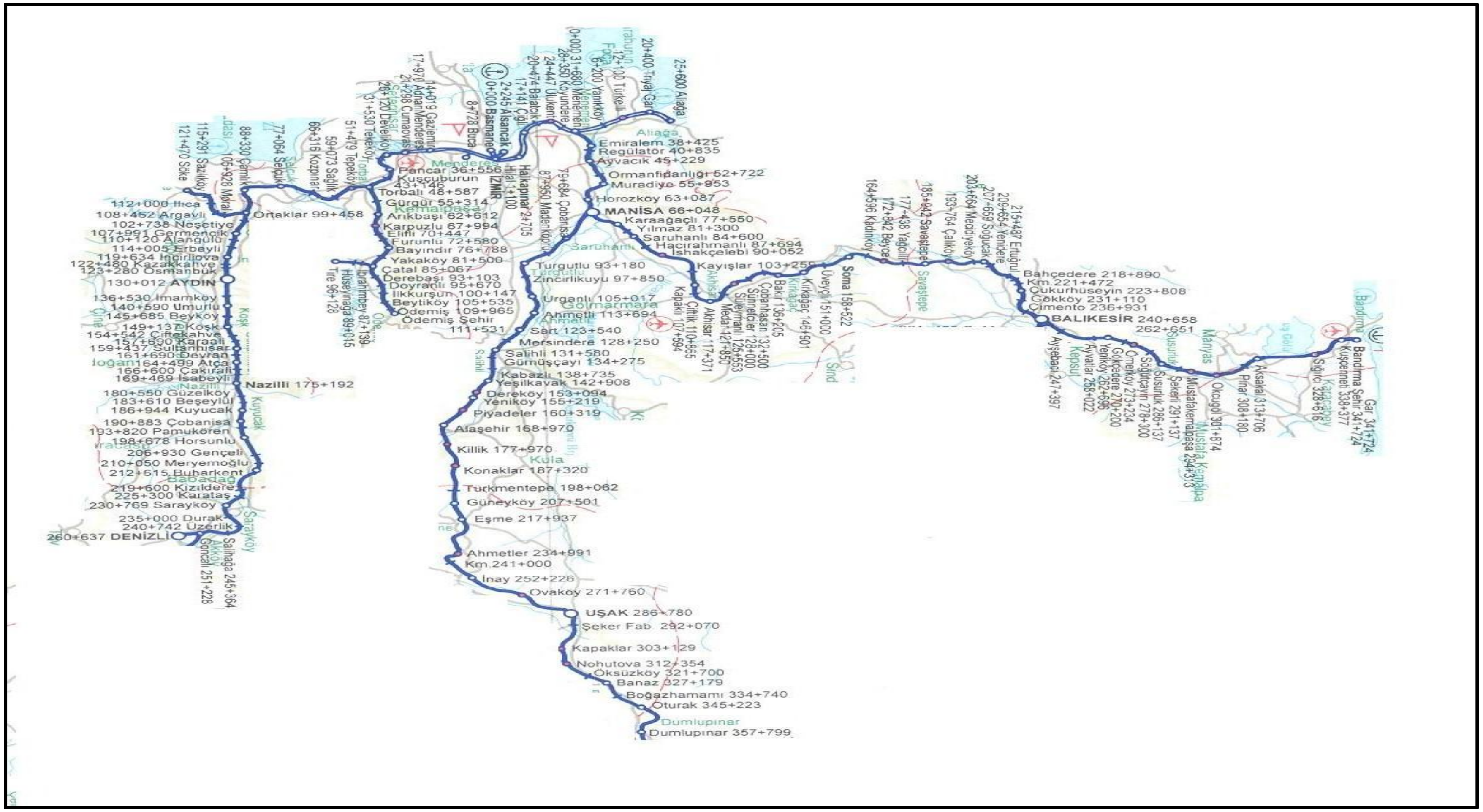
APPENDIX 2

Figure 5-7: Railway Network Map of the 2nd Region (Ankara as Regional Directorate)



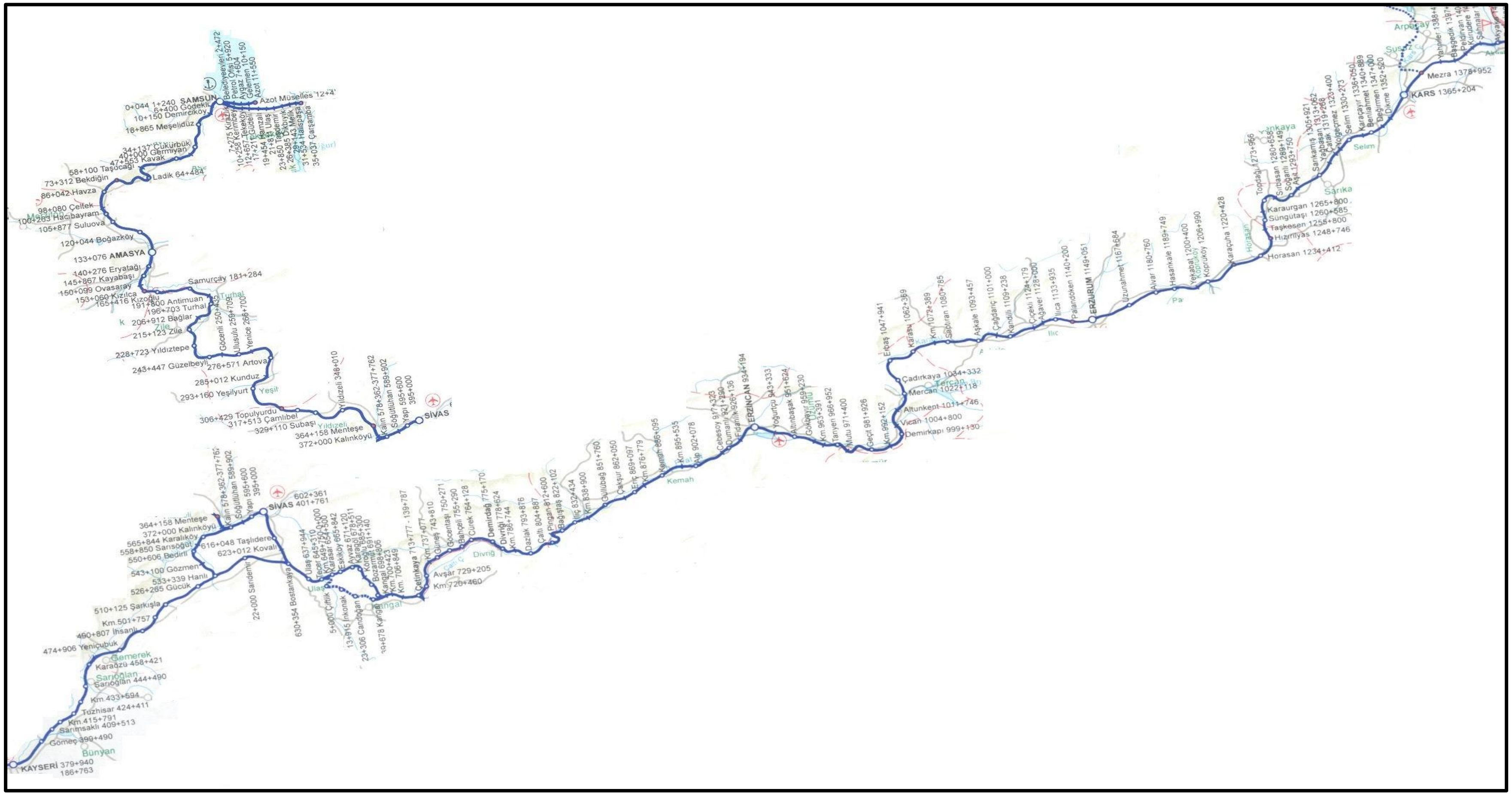
APPENDIX 3

Figure 5-8: Railway Network Map of the 3rd Region (Izmir as Regional Directorate)



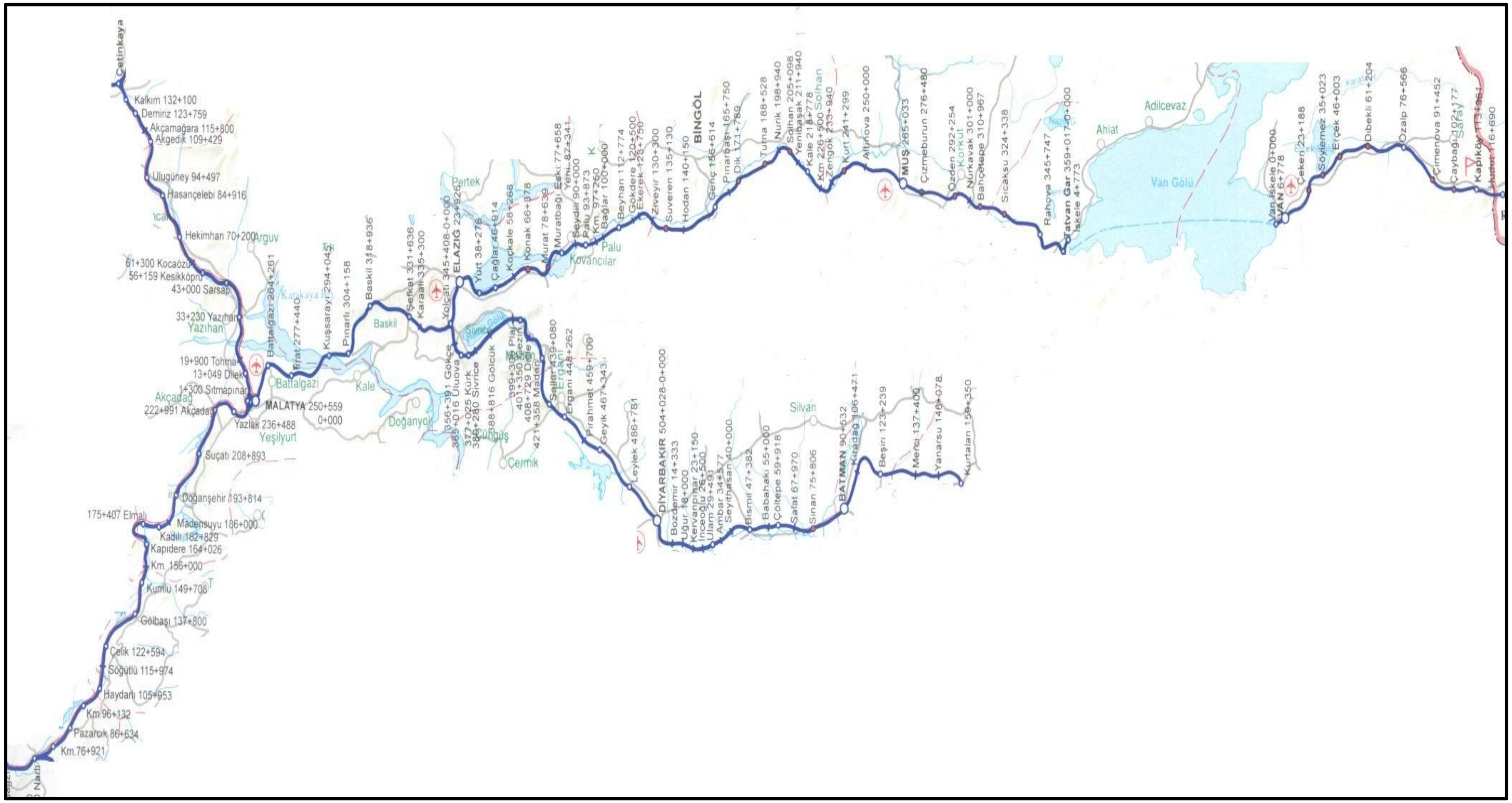
APPENDIX 4

Figure 5-9: Railway Network Map of the 4th Region (Sivas as Regional Directorate)



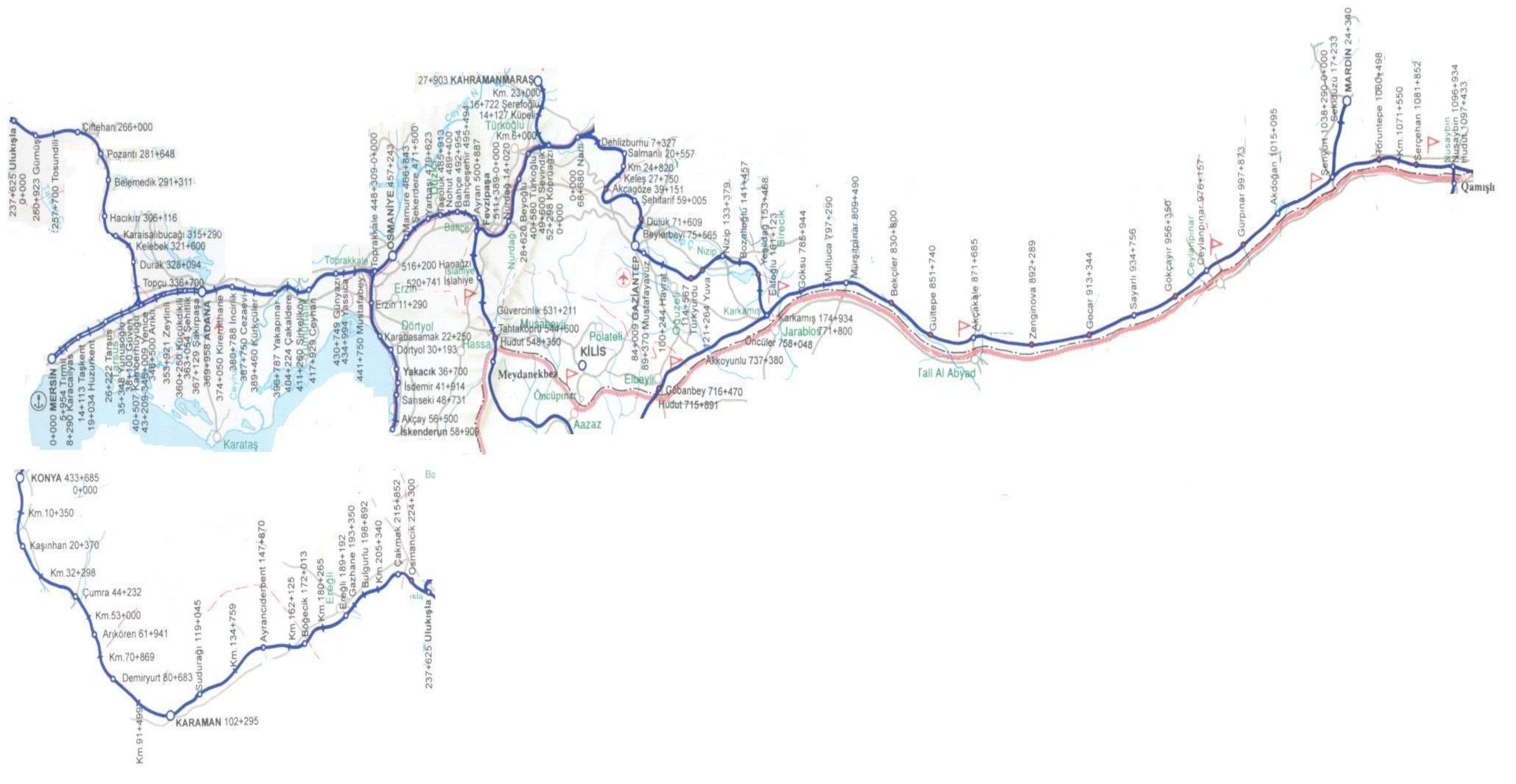
APPENDIX 5

Figure 5-10: Railway Network Map of the 5th Region (Malatya as Regional Directorate)



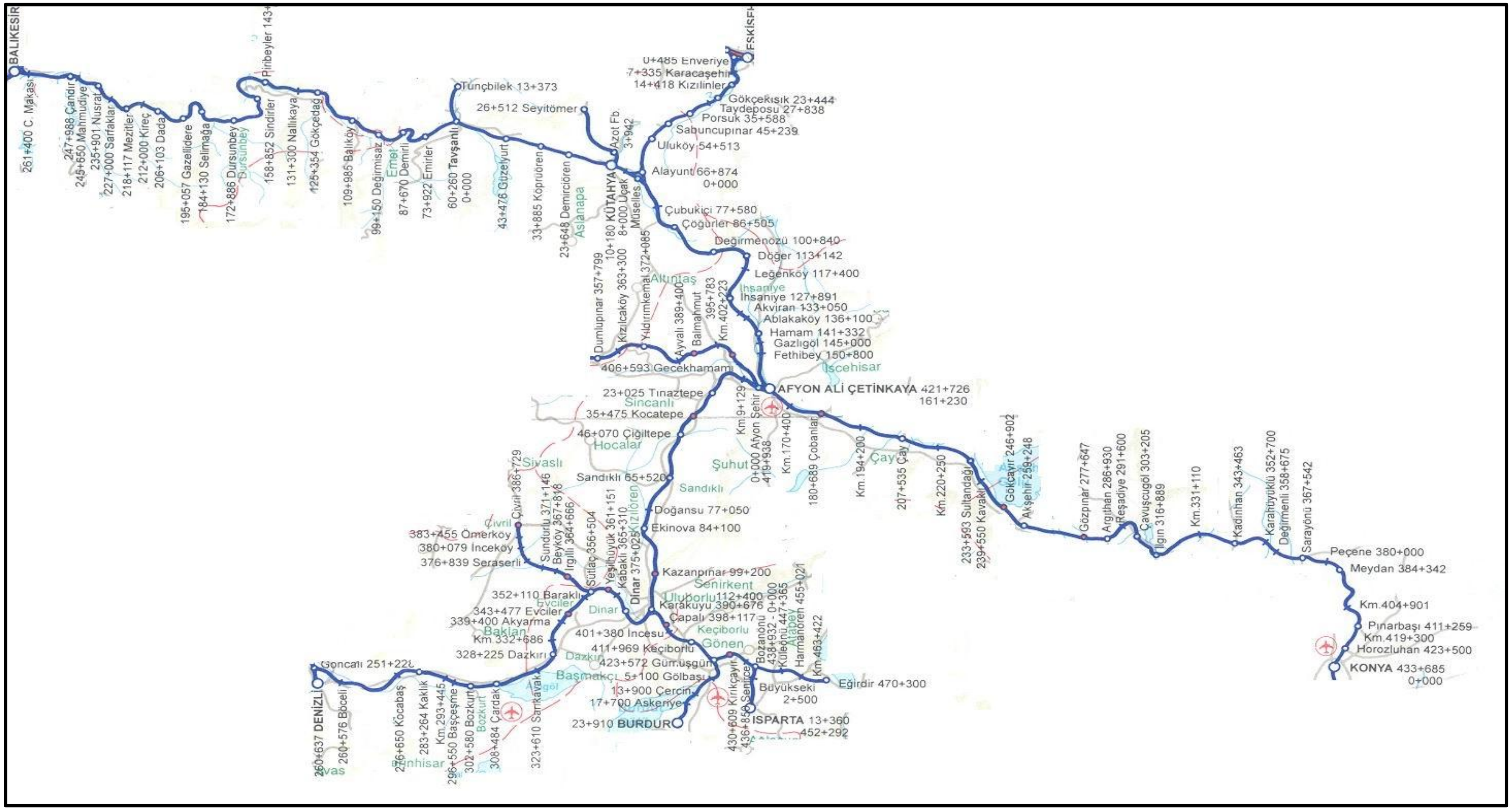
APPENDIX 6

Figure 5-11: Railway Network Map of the 6th Region (Adana as Regional Directorate)



APPENDIX 7

Figure 5-12: Railway Network Map of the 7th Region (Afyon as Regional Directorate)



APPENDIX 8

Table 5-4: Provinces used to examine the relationship between Railways and Population Density

Number	Province	Railways	Number	Province	Railways
1	Adana	Yes	29	Kars	Yes
2	Adıyaman	Yes	30	Kayseri	Yes
3	Afyon	Yes	31	Kırıkkale	Yes
4	Amasya	Yes	32	Kırklareli	Yes
5	Ankara	Yes	33	Kırşehir	Yes
6	Aydın	Yes	34	Kocaeli	Yes
7	Balıkesir	Yes	35	Konya	Yes
8	Batman	Yes	36	Kütahya	Yes
9	Bilecik	Yes	37	Malatya	Yes
10	Bingöl	Yes	38	Manisa	Yes
11	Bitlis	Yes	39	Mardin	Yes
12	Burdur	Yes	40	Mersin	Yes
13	Çankırı	Yes	41	Muş	Yes
14	Denizli	Yes	42	Nevşehir	Yes
15	Diyarbakir	Yes	43	Niğde	Yes
16	Edirne	Yes	44	Osmaniye	Yes
17	Elazığ	Yes	45	Sakarya	Yes
18	Erzincan	Yes	46	Samsun	Yes
19	Erzurum	Yes	47	Siirt	Yes
20	Eskişehir	Yes	48	Sivas	Yes
21	Gaziantep	Yes	49	Şanlıurfa	Yes
22	Hatay	Yes	50	Tekirdağ	Yes
23	Isparta	Yes	51	Tokat	Yes
24	Istanbul	Yes	52	Uşak	Yes
25	Izmir	Yes	53	Van	Yes
26	K.Maraş	Yes	54	Yozgat	Yes
27	Karabük	Yes	55	Zonguldak	Yes
28	Karaman	Yes			

APPENDIX 9

Table 5-5: Provinces used to examine the relationship between Railways and Agricultural Production

Number	Province	Railways	Number	Province	Railways
1	Adana	Yes	26	Kars	Yes
2	Adıyaman	Yes	27	Kayseri	Yes
3	Afyon	Yes	28	Kırklareli	Yes
4	Amasya	Yes	29	Kırşehir	Yes
5	Ankara	Yes	30	Kocaeli	Yes
6	Aydın	Yes	31	Konya	Yes
7	Balıkesir	Yes	32	Kütahya	Yes
8	Bilecik	Yes	33	Malatya	Yes
9	Bingöl	Yes	34	Manisa	Yes
10	Bitlis	Yes	35	Mardin	Yes
11	Burdur	Yes	36	Mersin	Yes
12	Çankırı	Yes	37	Muş	Yes
13	Denizli	Yes	38	Nevşehir	Yes
14	Diyarbakir	Yes	39	Niğde	Yes
15	Edirne	Yes	40	Sakarya	Yes
16	Elazığ	Yes	41	Samsun	Yes
17	Erzincan	Yes	42	Siirt	Yes
18	Erzurum	Yes	43	Sivas	Yes
19	Eskişehir	Yes	44	Şanlıurfa	Yes
20	Gaziantep	Yes	45	Tekirdağ	Yes
21	Hatay	Yes	46	Tokat	Yes
22	Isparta	Yes	47	Uşak	Yes
23	Istanbul	Yes	48	Van	Yes
24	Izmir	Yes	49	Yozgat	Yes
25	K.Maraş	Yes	50	Zonguldak	Yes