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Brief professional biography

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Structured Abstract

Purpose

This study explores the impact of transport infrastructure and services on foreign direct investment (FDI) flows to the Turkish provinces.

Design/methodology/approach

To get rid of any reverse causality when examining the linkage between transport infrastructure and services and FDI location decisions, we adopt an instrumental approach. To achieve this, we instrumented all of our four transport-related explanatory variables with their historical figures. To handle this system of simultaneous equations, we eventually employ a Three-Stage Least Squares (3SLS) estimation.

Main findings

Using data for the 2000-2010 period, our results suggest that provinces with larger air traffic and denser road network tend to attract more FDI. The adopted scenario analyses suggest that, holding other variables constant, a 10% increase in both air traffic and road network density is likely to attract almost 291 new FDI projects and $4,441 million of FDI stock and create around 33,173 new FDI jobs throughout a 10-year period in the 74 Turkish provinces analyzed.

Originality/value

The major contribution of our analyses is covering all of the four transport modes rather than employing one or two. In addition, we adopt traffic volumes for air and maritime transport to better reflect their economic impact rather than using dummy variables. Finally, yet importantly, our study differs from the majority of the previous literature in that it employs an instrumental approach when analyzing the effect of transport infrastructure and services on the location of FDI flows.

Keywords*:* FDI, Location Theory, Agglomeration, Labor Cost and Quality, Transport Infrastructure and Services, Turkey, 3SLS.

1. Introduction

The positive impact of transport infrastructure on economic development motivates governments to invest heavily in transport projects and Turkey is no exception. Turkish governments have been not only giving the lion share of the public investment budget to transport infrastructure projects for decades but also they provide substantial traffic and tariff guarantees to stimulate Build-Operate-Transfer type transport projects, especially in road and air transport sectors.

The significant funding allocated to such transport infrastructure projects requires precise project appraisals especially for a developing country like Turkey. The most challenging part of such appraisals is the evaluation of the social and economic impacts, which are difficult to quantify. The majority of the literature on this linkage focus more on income growth and job creation and generally overlook the impact of transport infrastructure and services on attracting foreign direct investment (FDI) if not several exceptions. In the relevant literature, transport infrastructure is rather used as one of the locational determinants of FDI such as market size (population), labor cost and quality, agglomeration, trade openness, economic performance, and political factors like transparency, corruption, the degree of freedom, and political stability. In addition, in such an attempt to analyze the locational determinants of FDI, the related studies tend to limit their focus to only one or two transport modes instead of covering all of the transport modes with a more centered approach to the transport effects.

To respond to the absence of such analyses, this study aims at predicting the impact of transport infrastructure and services on FDI flows in Turkey. More specifically, we will examine how individual transport modes contribute to the FDI location decisions in the Turkish provinces through Three-stage least squares (3SLS) method. The major contributions of our analyses are placing transport infrastructure and services to the focus as an FDI location determinant and covering all of the four transport modes rather than employing one or two. In addition, we adopt traffic volumes for air and maritime transport to better reflect their economic impact rather than using dummy variables. Finally, yet importantly, our study differs from the majority of the previous literature in that it employs an instrumental approach when analyzing the effect of transport infrastructure and services on the location of FDI flows. Using data from 74 Turkish provinces for the 2000-2010 period, our results reveal that provinces with higher air traffic and denser road network tend to attract higher FDI projects and FDI stock. Section 2 summarizes the literature and discusses the theoretical background. Section 3 explains the methodology and data. Section 4 provides the findings, and Section 5 presents the conclusions and policy implications.

2. Literature Review

The affordability, reliability, and speed of transportation systems have become a crucial competition tool because of several tendencies such as relocating the manufacturing plants abroad to enjoy lower labor costs, shortening products' lifespans, and decreasing or even perishing custom tariffs. Each transport mode contributes to this competitive advantage in its own way. Air transportation provides fast and reliable movement of both passengers and goods. Road network significantly enhances the accessibility by enabling door-to-door movements. Maritime transport offers the cheapest rates for long distance freight carriage when compared with other transport modes. Rail transportation combines the affordability of maritime transport and time savings of road transport and plays an important role in the multi-modal transport system. For such reasons, the quality of transport infrastructure has become a significant determinant of FDI location decisions.

The literature abounds in the studies examining the association between the level of transport infrastructure and the location decisions of FDI and we can classify these studies based on how they measure the quality and quantity of the transport infrastructure[1]. One group of studies used the expenditure figures to test how the transport infrastructure influenced FDI location decisions. In their study to model the factors determining the investment flows to Wales, Hill and Munday (1991) showed that road expenditure had a statistically significant and positive impact on both the nominal capital expenditure of the new projects and Welsh share of UK new jobs. In a similar study, Hill and Munday (1992) this time studied the UK data and documented that higher road expenditure per employee led to new FDI-related jobs and projects. Following a similar methodology, Billington (1999) employed two-level analyses on the location determinants of FDI. The first one was a country-level analysis including 7 countries and the transport expenditure was used to capture the impact of transport infrastructure on FDI. The second analysis, on the other hand, focused on eleven UK regions and adopted the road expenditure as a proxy for the effect of transportation on FDI. However, both transport-related variables did not get statistically significant coefficients.

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Please insert Table 1 here

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The second and bigger group of studies employed transport infrastructure variables, such as having an airport, a seaport or the densities of road and rail networks, rather than monetary figures. The majority of these studies either adopt a single infrastructure variable for only one transport mode or use a combination of variables representing various transport modes. Regarding road transport, the most common approach has been using the road network density. When examining the location determinants of FDI among Chinese regions, Cheng and Kwan (2000) employed two separate road transport measures such as road density and paved road density. They found that a 1% increase in road density was expected to raise the FDI in that region by 0.2% but the coefficient of paved road density was statistically insignificant. Using a sample of 29 Chinese provinces over the 1990-1997 period, Coughlin and Segev (2000A) employed paved highway density to model FDI flows but its positive coefficient was not statistically significant. Makabenta (2002) showed that a higher share of paved highways contributed to attracting FDI to Philippine regions. In his article covering the FDI distribution among Chinese cities, Hong (2007) documented that both urban road density and provincial density had a positive association with FDI location decisions. The findings of Khadaroo and Seetanah (2009) suggested that African

[1] Table 1 presents a comprehensive review of the literature.

countries could attract higher FDI by increasing their road density after testing a dataset coming from 33 African countries over the 1984-2002 period. Khadaroo and Seetanah (2010) analyzed the relationship between road density and FDI distribution in 20 African countries. Through a methodology similar to that of Khadaroo and Seetanah (2009), they documented that paved road network density was a strong determinant of FDI locations. In the relevant literature, one exception to using road density to measure the impact of road infrastructure on FDI location decisions is adopting a road dummy. In their analysis on the distribution of FDI among United States counties, Coughlin and Segev (2000B) used a dummy variable equal to 1 for counties having an interstate highway. They reported that counties with interstate highway increased the likelihood of attracting higher FDI.

Similar to the case of road transport, previous literature focusing on the linkage between FDI location decisions and rail transportation employed either rail network density or rail dummy that is equal to one when the examined geographic unit (city, province, etc) has direct access to rail network. Head and Ries (1996) used a railroad dummy to measure the effect of rail infrastructure on attracting Chinese cities. Their results showed having an access to rail network contributed to attracting FDI. The findings of Cheng and Kwan (2000) suggested that the coefficient of rail density was not statistically significant when analyzing the determinants of FDI flows. Sun et al. (2002) revealed that Chinese provinces with higher rail network density were more likely to attract higher FDI.

With respect to the effect of having a port on attracting FDI, relevant studies mostly adopted a port dummy. One exception is Head and Ries (1996), where the authors adopted the number of the deep-water berth, which has more explanatory power when compared with a port dummy variable. They documented that higher number of deep-water berths stimulated FDI attraction. Coughlin and Segev (2000A) reported that being a coastal province stimulated FDI flows using a dataset of 29 Chinese provinces. He (2002) showed that a Chinese port city was more likely to attract higher FDI than their non-port counterparts. Similarly, the results of Makabenta (2002) suggested that having an international port had a statistically significant and positive impact on attracting FDI to Philippine regions. Hong (2007) showed that being a coast city led to higher FDI flows in China.

On the linkage between air transport and FDI accumulation, there exists a variety regarding how the comparable studies measure the impact of air transport. Head and Ries (1996) showed that having an airport led to FDI growth in the Chinese cities. When analyzing the determinants of FDI flows in the Chinese cities, Hong (2007) revealed that having an airport stimulated FDI accumulation. Rather than using airport dummy, Coughlin and Segev (2000A) used per capita employment in airway transport to test how air transport affected FDI flows in China. However, they underlined that the coefficient of this variable was not statistically significant. Unlike the mainstream literature using econometric models, Bannò and Redondi (2014) explored the FDI impact of new air route developments at the catchments areas of the Italian airports through a unique methodology. While doing that, they established an experimental group consisting of airport catchments areas experiencing new air route developments and a control group made up of areas lacking such new air routes. In all of the 4 developed scenarios, the control group experienced a downward trend in FDI attraction unlike the upward trend of the experimental group. Their findings suggested that the total impact of the new air routes ranged from 36.1% to 50.3% implying that new air routes contributed to the FDI flows to their catchment areas.

Rather than using a single transport variable or a combination of several variables, a group of studies employed an aggregate measure or an index taking the effects of several transport modes into account. Wheeler and Mody (1992) documented that an infrastructure quality index made up of the quality of transport, communications, and energy infrastructures contributed to the FDI location decisions using data from 42 countries. Broadman and Sun (1997) employed an aggregate measure of transport route density that was equal to the sum of the railway, inland waterway, and highway densities. Their analyses documented that a 10% increase in transport route density might lead to 4.6% increase in FDI accumulation. In his study on the Central and Eastern European transition countries, Deichmann (2001) predicted that the transportation network density, which was the sum of paved highway and rail network densities, was a statistically significant and positive determinant of FDI location decisions. Khadaroo and Seetanah (2010) tried to estimate the effect of transport capital, which consisted of total capital in air, land, and water transport, on the FDI flows to the island state of Mauritius. They found that larger transport capital led to FDI accumulation. Blyde and Molina (2015) found that the quality of the logistics infrastructure index contributed significantly to the FDI location decisions using data from 230 countries and territories.

Last but not least, several studies took into account the transport infrastructure when modeling FDI location decisions in Turkey. After examining the distribution of FDI in Turkey, Deichmann et al. (2003) revealed that the percentage of paved roads in the total road network and having a sea access tended to increase the FDI that the Turkish provinces could attract. In his comprehensive analyses, Yavan (2010) examined the determinants of FDI among Turkish provinces His results suggested that larger road network would yield higher FDI but his findings did not reveal a similar association between having a seaport, an airport and FDI flows. Esiyok (2011) implemented a gravity model to estimate the FDI stock inflows to Turkey. He created an infrastructure index consisting of road network density, per capita commercial vehicle ownership, per capita telephones, and electricity production. He reported that this mostly transport-based infrastructure index had a positive and statistically significant coefficient in both of the estimations.

3. Methodology and Data

This study focuses on the impact of transport infrastructure and services on the location decisions of FDI among Turkish provinces. Our hypothesis is that, holding other explanatory variables constant, provinces with enhanced transport infrastructure and services should attract higher FDI. The specification used to test this hypothesis is as follows:

$$Y = \alpha + \beta X + \acute{\varepsilon}$$

where Y is the measure for FDI, X is a vector of explanatory variables, and έ is the error term.

Here, we use two separate variables for Y (FDI). The first one is the aggregate number of FDI projects (New, rehabilitation, or expansion) benefited from the investment incentives provided by Ministry of Economy throughout the 2001-2010 period whereas the second measure we use for Y (FDI) is the aggregate FDI stock (in 2015 US dollars, adjusted for inflation) of these of FDI projects. According to the related legislation, foreign direct investors can benefit from many government supports ranging from tax reductions/exemptions to site assignments. To use such incentives, foreign investors should complete the necessary paperwork at the Ministry of Economy. It is likely that some degree of leakage might occur from the FDI database of Ministry of Economy because some foreign direct investors may simply choose not to apply to Ministry of Economy for such supports. However, we can assert that the extent of such investors will be quite limited and only be confined to those small investments for which it is going to be costly, compared to the expected benefit, to prepare and apply for procedural work. Accordingly, we can use the FDI database of Ministry of Economy as a powerful tool to represent the whole FDI sample in Turkey.

We employ one explanatory variable for each of the four major transport modes. The first transport-related explanatory variable in X is air traffic. Air transportation provides superior services when compared to other transport modes in terms of speed, safety, and reliability. Air passenger services enable face-to-face business contact, which is essential especially for service industries, with the key stakeholders located remotely. In a world of lower inventories, shorter product life spans, rapidly changing customers' needs and preferences, and relocating manufacturing locations to the countries with lower labor costs, air cargo operations enhances fast movement of goods and provides firms a competitive advantage. For all these reasons, the enhanced air service should attract higher FDI. Regarding this linkage, Head and Ries (1996), Hong (2007), and Yavan (2010) adopted a dummy variable, which was equal to 1 for cities/provinces having an airport, whereas Coughlin and Segev (2000A) employed the number of airway employment in the state-owned enterprises. When compared to previous literature, we argue that using air traffic will be more effective to capture the impact of air transportation than either using airport dummies or adopting air transport employment. On the one hand, using a dummy variable for airports will fail to capture the magnitude of the airport size. To illustrate, the availability of an airport with a traffic of 10,000,000 passengers per year should be more attractive for foreign investors than that of an airport with 10,000 passengers per year. In addition, the dummy variable might not capture the extent of air cargo activities, which are not available or quite limited at the small regional airports. On the other hand, using employment figures in the state-owned enterprises might be questioned given the persistent labor redundancy problems associated with state-owned enterprises. To enhance our analyses, we employed an air traffic index to capture the aggregate combined impact of both passenger and freight movements. Air traffic index is the sum of airport workload units in 2000, in per capita terms, where one airport workload unit is equal to 1 air passenger or 100 kg of air cargo. Air traffic figure was extensively used by the relevant literature on the linkage between air transportation and its economic effects. The findings of Brueckner (2003) suggested that higher passenger enplanements led to employment growth in that in a metro area. Green (2007) documented that passenger boardings per capita and passenger originations per capita figures could explain the population growth and employment growth in the US largest metropolitan areas. Ozcan (2013) revealed that air passenger traffic contributed to job creation in the Turkish provinces. Using a sample of 66 airports in the State of Virginia, Button et al. (2010) presented that air traffic of the small community airports stimulated per capita income. Similarly, Ozcan (2014) showed that higher air traffic raised per capita income of Essential Air Service communities in the US.

The second transport-related explanatory variable in X is port traffic. In Turkey, there is a great dominance of ports in the movement of goods[2]. On the other hand, the extent of maritime passenger traffic remained quite limited with a 0.6% share of all domestic passenger movements in 2014 (Ministry of Transport, Maritime, and Communications, 2015). We can expect that having a sea-port with significant freight traffic can be a critical determinant of FDI location since such a factor can significantly reduce the logistics costs, both for inward and outward movements, of the firms. For the Turkish case where the role of maritime transport is negligible in passenger movements, the measure we employ to capture the effect of maritime transport should focus on freight traffic. To do that, we use per capita port freight traffic in each province in 2000. With respect to the linkage between maritime transport and FDI locations, Coughlin and Segev (2000A), He (2002), Makabenta (2002), Deichmann et al. (2003), Hong (2007), and Yavan (2010) used a dummy variable which was equal to 1 for cities having a port (coastal cities, cities accessible by sea) while Head and Ries (1996) employed the number of berths with a minimum capacity of 10,000 tons to capture the sea transport impact. As we tried to elaborate before, we assert that using traffic figures instead of a dummy variable can better depict the examined impact. Previous studies on the economic impact of seaports frequently employed port traffic. When modeling the linkage between seaports and employment levels in Italy, Ferrari et al. (2010) used port throughput. They documented that port traffic (measured in terms of aggregate, TEU, and bulk terms) had a positive association with job creation. In a similar study, Bottasso et al. (2013) showed that increasing port traffic led to employment increases in the port hinterlands using a sample of 166 European ports. Shan et al. (2014) documented that port cargo traffic stimulated growth rate of per capita GDP in the host Chinese cities. Likewise, the findings of Park and Seo (2016) revealed that port cargo traffic increased the growth rate of per capita GDP at the Korean seaport regions.

The remaining two transport-related explanatory variables are road density and rail density. Against several studies [(Head and Ries (1996) and Coughlin and Segev (2000B)] using dummy variables for road or rail networks and the two articles employing the percentage of the paved highways to the total road network [(Makabenta (2002) and Deichmann et al. (2003)], the rest of the literature adopted network densities for rail and road networks [(Coughlin and Segev, 2000A), (Cheng and Kwan, 2000), (Deichmann, 2001), (Sun et. al., 2002), (Hong, 2007), (Khadaroo and Seetanah, 2009), (Khadaroo and Seetanah, 2010), and (Yavan, 2010)]. In this study, we employed network density to capture the effect of road and rail infrastructure. Road density is the ratio of the total road network to the area of each province, (km road/km2) in 2000 whereas rail density is the total length of rail lines within the boundaries of each province divided by the area (km rail line/km2) as of the year 2000.

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[2] 57% of all Turkish foreign trade was achieved through seaports in 2014.

In addition to transport-related explanatory variables, which are the focus of our study, we use a couple of control variables, which might affect FDI location decisions. Our first control variable in X is agglomeration. Since agglomeration tends to provide positive externalities such as reduced supply costs, availability of wider range of labor at varying costs and qualifications, and higher specialization, competing firms are likely to form agglomerations. Accordingly, one can expect that a foreign firm might be tempted to select an investment site having a larger production/business base to enjoy such agglomeration benefits. Previous literature took the possible impact of agglomeration into account when modeling the FDI flows. Head and Ries (1996) found that the number of both foreign-funded equity joint ventures and domestic industry enterprises had a positive and statistically significant coefficient in predicting the FDI flow in the Chinese cities. He (2002) showed that the number of industrial enterprises, a proxy for agglomeration and clustering, contributed to FDI growth in Chinese cities. The analyses of Yavan (2010) suggested that the three agglomeration variables he adopted (foreign, domestic, and service agglomeration) had a positive and statistically significant coefficient in predicting the FDI flow in the Turkish provinces. In this paper, since statistics on the total number of firms are not available, the per capita number of manufacturing enterprises in each province captures the agglomeration effect in 2000, which is the most recent year with such statistics.

The second control variable in X is population. Location theory suggests that firms choose their locations to minimize the transport costs and the easiest way to reduce transport costs is obviously locating close to the big markets. Some studies used GDP/GNP figures to capture the effect of market size in FDI attraction (Broadman and Sun, 1997; Billington, 1999; Sun et al., 2002; Wheeler and Mody, 1992). Others (Coughlin and Segev, 2000A; Anyanwu, 2011) documented that higher population, as a proxy for market size, tended to increase FDI growth. In this study, we adopt the population of the provinces to capture the market size. Our expectation is that population, which equals to the natural logarithm of the population of each province in 2000, should get a positive coefficient.

Another regional determinant, which might affect FDI location decisions, is the labor cost. Especially for labor-intensive industries seeking low-cost labor, the impact of labor cost can be a significant factor. To illustrate, the shift of western manufacturing operations to Asia and Latin America is a typical outcome of the search for lower labor costs. Therefore, the logic says that lower labor costs should attract higher FDI. On the other hand, since more qualified and more productive labor force will demand higher wages and foreign investors will prefer locations with a higher number of the qualified labor force, higher labor costs induced by better education and accordingly higher productivity of labor force may stimulate higher FDI. The literature suggests contradicting evidence on this dilemma. Coughlin (1991), Coughlin and Segev (2000A), and Sun et al. (2002) showed that higher wages reduced FDI whereas Boudier-Bensebaa (2005) and Cheng (2006) reported that foreign investors preferred regions with higher wages. Therefore, labor cost, which corresponds to the natural logarithm of the average wage of labor in the manufacturing industry in each province as of 2000, can get both negative and positive coefficients.

Last regional factor, which might affect the location decisions of FDI, is the quality of the labor force. More qualified and better-educated labor force tends to be more productive and can move from one industry to another which will increase the labor market mobility. The literature includes various variables to capture this impact. Makabenta (2002) employed secondary school completion rate whereas Khadaroo and Seetanah (2010) used secondary education enrollment rate. Deichmann et al. (2003) adopted the student to teacher ratio. In this study, we use the percentage of the population with a bachelor degree or higher at each province in 2000 to measure the quality of the labor force.

Table 2 presents the key descriptive statistics, definitions, and data sources of all variables used in our analyses. The first two rows, which depict the statistics of the dependent variables, suggest that an average Turkish province attracted 23.9 FDI projects with an investment value of 393.5 million USD over the 2001-2010 period. The first two rows of Table 2 also reveal that the distribution of the FDI flows among Turkish provinces is not homogeneous. The standard deviation of both FDI projects and FDI stock are more than double of the average of these dependent variables implying that the FDI flows are concentrated in some provinces. This heterogeneous distribution of FDI flows among the Turkish provinces can be explained by the fluctuating patterns of some independent variables included into our estimations. When we compare the means and standard deviations of labor quality, air traffic, and port traffic, we see that standard deviations of these variables are almost equal or larger than their averages. The dataset was collected in May 2016 from various resources. For FDI statistics, we use the FDI incentive database of Ministry of Economy. Data on the provincial distribution of manufacturing enterprises, population, the average wage of labor in the manufacturing industry, and the educational attainment come from Turkish Statistical Institute (TSI). Both air passenger and air cargo figures come from the statistical report of General Directorate of State Airports Authority. Ministry of Transport, Maritime and Communications provides the annual port traffic handled within the borders of each province. Road and rail network statistics are gathered from General Directorate of Highways and Turkish State Railways, respectively. General Command of Mapping provides the area statistics of each province. We use data from the year 2000 since it is the most recent year providing statistics for agglomeration, the average wage of labor in the manufacturing industry, and educational attainment. In addition, since we use an aggregate approach, we need to pick an earlier cut-off year to examine the afterward-aggregate impact.

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Turkey has 81 provinces. However, 7 provinces lacked data on the average wage of labor in the manufacturing industry because of two major reasons. In Sirnak province, for example, there was no manufacturing firm. In Bitlis, Hakkari, Mus, Siirt, Ardahan, and Igdir, where there were only one or two manufacturing firms, TSI did not disclose the statistics on the average wage of labor in the manufacturing industry claiming the commercial privacy. As a result, our final dataset consisted of 74 provinces out of 81.

When examining the linkage between transport infrastructure and services and FDI location decisions, the regular ordinary least squares (OLS) approach might suffer from reverse causality. On the one hand, the enhanced transport infrastructure and improved transport services will likely foster FDI. On the other hand, higher FDI flows might trigger the public decision-makers to invest more in the transport infrastructure to ease the additional traffic stimulated by new FDI projects. Such a reverse causality, in turn, may create endogeneity bias leading to biased and inconsistent model coefficients. However, we can argue that the degree of endogeneity tends to be low for our analyses for three major reasons. First, the explanatory variables are coming from the year 2000 whereas the response variables, the aggregate number of FDI projects and aggregate FDI stock, come from the 2001-2010 period. In other words, earlier explanatory variables, including those transport-related variables, are used to model the afterward FDI impacts. This is also consistent with the explanation of Green (2007) where he used the air transport statistics from 1990 to model the growth impact occurred after 1990. Second, as Melo et al. (2010) pointed out in their similar study, the transport funding decisions are made at the central level instead of local level. Decision-making at the central level might reduce the effectiveness of the transport investment decisions and lead to significant delays to launch the necessary infrastructure projects to handle the capacity bottlenecks and enhance service improvements. This, in turn, lessens the impact of reverse causality. Third, Ozcan (2016) presented some preliminary evidence of pork-barrel politics in public investment funding in Turkey. His analyses suggested that the public investment funding allocated to each Turkish province by the central government in Ankara was influenced by the political support of each province to the political party governing Turkey. This means that political considerations affect the investment decisions, including transport investments, and accordingly the supposed rational linkage between infrastructure needs and corresponding funding allocations is broken to some extent.

Despite we believe that the degree of endogeneity is limited for our analysis, we still intend to adopt an instrumental approach to get rid of any possible reverse causality problem. To achieve this, we instrumented all of our four transport-related explanatory variables coming from the year 2000 with their historical figures coming from 1997. We use 1997 figures because the oldest public data for port traffic come from this year. Since we have four separate endogenous transport-related explanatory variables in X and since we adopt four separate instrumental variables, our estimation turns into a system of simultaneous equations. To handle this system of simultaneous equations, we can either use a Three-Stage Least Squares (3SLS) estimation, a Two-Stage Least Squares (2SLS) estimation, or a Structural Equations Model (SEM). We employed all three models (2SLS, 3SLS, and SEM) for our analyses. We should note that their results are very similar. Since 3SLS tends to give more efficient estimates than 2SLS, we use the results of 3SLS estimation to interpret and provide policy implications.

4. Empirical results

Table 3 reports the results of the OLS, 2SLS, 3SLS, and SEM estimations when the cumulative total of FDI projects is the dependent variable. Table 3 also presents the outputs of couple post-estimation tests regarding the validity of our models. For 3SLS estimation that we will focus on our analyses, the Breusch-Pagan test suggests that we fail to reject the null hypothesis of homoscedasticity implying that our model does not suffer from heteroskedasticity. In addition, Hansen-Sargan overidentification statistic and its p-value reported in Table 3 reveal that we cannot reject the null hypothesis that the overidentification restrictions are valid. Therefore, we can conclude that our 3SLS estimation (and 2SLS) is statistically valid.

We begin with the focus of this study; the effect of transport infrastructure and services on FDI. In all four estimations (OLS, 2SLS, 3SLS, and SEMs), air traffic has statistically significant and positive impact implying that higher per capita air traffic tends to attract more FDI. For the 3SLS estimation, the range of the expected impact is 17.06 with a standard deviation of 6.32 and this coefficient is statistically significant at the 1% level. Our results also indicate that similar to air traffic, higher road density tends to attract higher FDI. In all of the three estimations, road density has a positive and statistically significant coefficient. For the 3SLS estimation, the predicted coefficient is 416.65 with a standard deviation of 184.53 and it is statistically significant at the 5% level. The results presented in Table 3 also reveal that unlike air traffic and road density, both port traffic and rail density do not have a significant impact on FDI location decisions. In all of the OLS, 2SLS, and 3SLS estimations, port traffic and rail density do not get statistically significant coefficients.

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Table 4 reports the results of the estimations when the cumulative FDI stock is the dependent variable. As in the case of Table 3, our post-estimation tests show that our 2SLS and 3SLS models are free from heteroskedasticity and the instruments we employ are valid. Similar to the previous case, both air traffic and road density have statistically significant and positive impact in all of the three estimations. More concretely, the coefficient of air traffic and road density is 226.24 (significant at 5% level with a standard deviation of 100.59) and 6,954.02 (significant at 5% level with a standard deviation of 2,954.83), respectively in the 3SLS estimation for the aggregate FDI stock. Regarding port traffic and rail density, however, the coefficients are not statistically significant as is the case when the aggregate number of FDI projects is used as dependent variable.

These results support the expectation that enhanced transport infrastructure and services, at least in terms of air and road transport, play a positive role in attracting FDI. In addition to transport related variables, which are the focus of this study, we also obtain noteworthy results about our control variables. As expected, our results reveal that higher concentration of economic activities (agglomeration) and population tend to attract more FDI. With respect to the cost of labor, however, we failed to find a statistically significant estimate. Last, the labor quality, which was measured by the percentage of the population with a bachelor degree or higher, had statistically significant and negative coefficients in both of the 3SLS estimations

So far, we have talked about the impact of transport infrastructure and services in terms of percentages, densities and per capita values, which may seem a little abstract. To put our findings in a more concrete way, we also made a basic scenario analysis involving three scenarios. We simply tried to figure out, holding our control variables constant, how both the aggregate number of FDI projects and aggregate FDI stock would change if the air traffic per capita and road density would increase by 10% individually or at the same time. We also attempted to estimate the respective change in FDI jobs using the database of Ministry of Economy providing statistics on the new jobs that each FDI project is expected to create.

Table 5 presents the results of our basic scenario analysis. The third row depicts the case of 10% increase in air traffic and its impact on the number of FDI projects, FDI stock, and FDI jobs. The fourth row, on the other hand, reports the comparable impacts when the road network density is increased by 10%. Finally, the last row shows the aggregate impact when both the air traffic and road density increase by 10% at the same time.

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Please insert Table 5 here

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In the 74 provinces analyzed, 1,769 FDI projects benefited from investment incentives provided by the Turkish government throughout the 2001-2010 period. These 1,769 FDI projects were reported to create 201,132 new jobs that correspond to 113.70 new jobs per FDI project. According to the estimation for the 2001-2010 period presented in the last column of Table 3, holding all other variables constant, a 10% increase in air traffic is expected to attract 25.66 new FDI projects and $340.31 million of new FDI stock whereas the same amount of increase in road density is likely to attract 266.10 new FDI projects and $4,441.24 million of new FDI stock. If we assume that each FDI project will create 113.70 new jobs similar to the 2001-2010 averages, 25.66 FDI projects attracted by a 10% increase in air traffic can create 2,917.54 new jobs whereas 266.10 FDI projects attracted by a 10% increase in road density can create 30,255.57 new jobs (the last two columns of Table 5). In the case of combined effects, the total number of attracted FDI project will be almost 291, the increase in FDI stock will be $4,781.55 million, and the total number of new jobs created will be around 33,173.

5. Conclusion

This paper has focused on the impact of transport infrastructure and services on the FDI location decisions among the Turkish provinces. The major contribution of the methodology presented here is to include all of the transport modes into the analyses rather than covering only one or two transport modes like the great majority of the related literature did before. Further, using traffic figures instead of dummy variables help us better take the magnitude of transport factors into account. Last but not least, our instrumental estimation helps us handle reverse causality and its drawbacks like biased and inconsistent model coefficients. Our results reveal that both air traffic and road density have a positive and statistically significant impact on attracting FDI whereas port traffic and rail density do not have a comparable effect. Our basic scenario analyses using aggregate data from 2000-2010 period suggest that, holding all other variables constant, a 10% increase in air traffic is expected to create 25.66 FDI projects, $340.31 million FDI stock, and 2,917.54 new FDI jobs whereas the same percentage increase in road density can attract 266.10 FDI projects, $4,441.24 million FDI stock, and 30,255.57 FDI jobs.

Our results suggest crucial policy implications. First, they indicate that both air and road transportation are significant determinants of FDI location decisions among the Turkish provinces. This is important to analyze the dynamics of the location decisions of the foreign firms. In addition, future project appraisals can include such a positive externality into the analyses for enhanced evaluation.

Second, our findings are noteworthy in formulating policies aiming at increasing FDI accumulation. They suggest that a 10% increase in road density would attract more FDI than the same percentage increase in air traffic. However, we should acknowledge that increasing the road density by 10% will be a lot more capital intensive and requires significant investment whereas increasing air traffic by 10% can be both faster and more affordable through launching new air routes and increasing the frequency of the existing flights (assuming that the existing air transport infrastructure is utilized under capacity). Therefore, from the FDI point of view, provinces might give priority to supporting air routes to gain a competitive advantage over others. The adoption of revenue/passenger guarantees by the local trade and industry chambers, which was implemented before in several Turkish provinces such as Bursa and Isparta, can be a policy tool to increase air traffic by reducing the demand risks of the airlines. Other possible policy actions might include engaging promotion efforts towards airlines and travel agencies, launching market potential and feasibility studies for possible new entrant airlines, and providing subsidized services to the airlines.

Third, although the insignificance of the port traffic variable is quite surprising, such an insignificance for the coefficient of the rail density is expected given historically the poor state of the Turkish rail network and operations. The lower speed of the trains, the lack of signalization in certain routes, and the persistent inefficiency of the state-owned enterprise responsible for rail infrastructure provision and operation have all contributed to the failure to achieve the effective utilization of rail network. This might, in turn, erase the attractiveness of the rail infrastructure as a location determinant for foreign firms.

We should note that this study is not free from limitations. The lack of data does not let us employ a panel approach. The publication of the necessary data in the future can help overcome this barrier. In addition, after the accumulation of related data, further work may adopt the impact of the improved rail network and the launch of high-speed rail lines over the last couple years on FDI location decisions.

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TABLES

TABLE 1. The review of the literature on the impact of transport infrastructure on FDI

Authors	Transport Variable	Definition	Geographic Coverage	Period	Statistically significant and positive impact on FDI
Hill and Munday (1991)	Transport expenditure	Expenditure on new trunk roads and trunk road improvements	Wales	1983-1989	✓ (in 1 of the 3 estimations)
Hill and Munday (1992)	Road spending	The ratio of the regional share of spending on new trunk roads to the regional share of employees in employment	UK regions	1980-1989	✓ (in all of the 4 estimations)
Wheeler and Mody (1992)	Infrastructure quality	Quality in transport, communications, and energy infrastructure	42 countries	1982-1988	✓ (in both of the estimations)
Head and Ries (1996)	Deep-water berth	Number of berths with a minimum capacity of 10,000 tons	Chinese cities	1984-1991	✓ (in all of the 4 estimations)
	Railroad	1 for cities with a railroad but no deep-water berths, 0 otherwise			✓ (in 3 of the 4 estimations)
	Airport	1 for provinces having an airport, 0 otherwise			✓ (in 1 of the 4 estimations)
Broadman and Sun (1997)	Transportation route density	(length of railways + inland waterways + highways)/area	Chinese provinces	1992	✓ (in both of the estimations)
Billington (1999)	Transport expenditures	Central government expenditure on transport and communications	7 countries	1986-1993	-
	Road expenditure	Annual public expenditure on roads	UK regions	1984. 1986, 1990-1994	-
Coughlin and Segev (2000B)	Having an interstate highway	1 for counties with an interstate highway, 0 otherwise	Unites States Counties	1989-1994	✓ (in all of the 3 estimations)
Coughlin and Segev (2000A)	Highway density	Length of paved highway divided by area	Chinese provinces	1990-1997	-
	Employment in airway transport	Per capita employment in state-owned airway units			-
Cheng and Kwan (2000)	Road Density	Length of the road network divided by the area	Chinese regions	1985-1995	✓ (in all of the 3 estimations)
	Paved Road density	Length of the high-grade paved road network divided by the area			-
	Rail Density	Length of the rail network divided by the area			-

Deichmann (2001)	Transportation network density	Total paved road and rail network divided by area	17 Transition Countries in Central and Eastern Europe	1990-1999	✓ (in one of the 2 estimations)
He (2002)	Port city	1 for cities having ports, 0 otherwise	Chinese Cities	1995-1996	✓ (in both of the estimations)
Sun et al. (2002)	Railway	Railway length per square kilometer	Chinese provinces	1987-1998	✓ (in 10 of the 12 estimations)
Makabenta (2002)	Paved highways	The ratio of paved highways to the total road network	Philippine regions	1987-1998	✓ (in both of the estimations)
	International Port	1 for regions with international port, 0 otherwise			✓ (in both of the estimations)
Deichman et all. (2003)	Paved Roads	Percentage of paved roads in the total road network	Turkish provinces	1995	Has a statistically significant and positive impact in 2 of the 8 estimations
	Sea access	1 for provinces having sea access, 0 otherwise			Has a statistically significant and positive impact in 3 of the 8 estimations
Hong (2007)	Airport	1 for cities having an airport, 0 otherwise	Chinese cities	1992-2001	✓ (in 10 of the 14 estimations)
	Urban Road Density	Length of road network divided by the urban area			✓ (in 12 of the 14 estimations)
	Provincial Road Density	Length of road network divided by the provincial area			✓ (in 13 of the 14 estimations)
	Coast	1 for coastal cities, 0 otherwise			✓ (in all of the 14 estimations)
Khadaroo and Seetanah (2009)	Road Density	Paved road network divided by area	33 African countries	1984-2002	✓ (in all of 3 estimations)
Khadaroo and Seetanah (2010)	Transport Capital	Total capital in air, land, and water transport	Mauritius	1960-2004	✓ (in both of the estimations)
	Road Density	Paved road network divided by area	20 African countries	1986-2000	✓
Esiyok (2011)	Infrastructure Index	A combination of road network density, per capita commercial vehicle ownership, per capita telephones, and electricity production.	The FDIs of 19 home countries in Turkey	1982-2007	✓ (in both of the estimations)
Yavan (2010)	Road network	Length of asphalt roads divided by area	Turkish provinces	1996-2003	Road network has a statistically significant and positive impact in 3 of the 7 estimations
	Seaport	1 for provinces having seaports, 0 otherwise			No statistically significant impact
	Airway	1 for provinces having an airport, 0 otherwise			No statistically significant impact
Bannò and Redondi (2014)	Air Connectivity	New air route development	Catchment areas of Italian airports	2001-2010	✓ (in all of the 4 scenarios)
Blyde and Molina (2015)	Logistics infrastructure index	An index created using the port, airport, and ICT logistics indicators	230 countries and territories	2011	✓ (in one 4 the 7 2SLS estimations)

TABLE 2. The definitions and data sources of the variables used in the analyses

Variable	Definition	Mean	Std. Dev.	Minimum	Maximum	Data source
FDI project	The aggregate number of FDI projects (New, rehabilitation, or expansion) in the 2001-2010 period benefited from the investment incentives provided by Ministry of Economy (FDI projects: 2001-2010)	23.90541	55.61934	0	352	Ministry of Economy
FDI stock	The aggregate FDI stock (New, rehabilitation, or expansion) in the 2001-2010 period benefited from the investment incentives provided by Ministry of Economy (FDI stock: 2001-2010, million $ in 2015 values)	393.5212	873.5612	0	4770.192	Ministry of Economy
Agglomeration	The per capita number of manufacturing enterprises at each province (2000)	0.0001248	0.0001468	3.94e-06	0.0009457	TURKSTAT
Population	The natural logarithm of the population of each province (2000)	13.23858	0.934845	10.0991	16.11997	TURKSTAT
Labor cost	The natural logarithm of the average wage of labor in the manufacturing industry (2000)	8.387731	0.4574663	7.277488	9.735821	TURKSTAT
Labor quality	The percentage of population with a bachelor degree or higher (2000)	0.0384131	0.0365241	0.0003435	0.3119526	TURKSTAT
Air traffic	Air traffic is the sum of airport workload unit, in per capita terms, where 1 airport workload unit is equal to 1 air passenger or 100 kg of air cargo (2000)	0.2063663	0.7251824	0	4.357461	SAA, TURKSTAT
Port traffic	The per capita port freight traffic in each province (2000)	1.852187	4.853307	2.50e-07	26.21721	MOT, TURKSTAT
Road density	Road network is the density of road network at each province (2000)	0.0863052	0.0232803	0.0469385	0.1641604	GDH, GCM
Rail density	Rail density is the density of rail network at each province in (2000)	0.0110493	0.0097555	0	0.0373365	TSR, GCM

TURKSTAT: Turkish Statistical Institute
SAA: State Airports Authority
MOT: Ministry of Transport, Maritime, and Communications
GDH: General Directorate of Highways
TSR: Turkish State Railways
GCM: General Command of Mapping

TABLE 3. OLS, 2SLS, and 3SLS Regression results where the dependent variable is the aggregate number of FDI projects in the 2001-2010 period

	First Stage for FDI	First Stage for Air traffic	First Stage for port traffic	First Stage for Road density	First Stage for Rail density	OLS	2SLS	3SLS	Structural Equations Model
Agglomeration	226,387.4*** (4.75)	5.116 (0.06)	-3,489.992 (1.19)	-8.036 (2.05)	0.012* (1.70)	235,819.5*** (5.00)	234,386.4*** (4.96)	221,699.9*** (5.10)	235,819.5*** (5.35)
Population	26.218*** (4.98)	-0.001 (0.14)	0.386 (1.19)	0.000 (0.22)	-0.000 (1.32)	26.277*** (4.90)	25.674*** (4.76)	26.360*** (5.30)	26.277*** (5.23)
Labor cost	12.253 (1.25)	-0.014 (0.75)	-0.577 (0.96)	-0.001 (1.57)	0.000*** (2.74)	14.331 (1.47)	13.804 (1.41)	10.698 (1.19)	14.331 (1.57)
Labor quality	-296.481 (1.57)	-0.084 (0.24)	12.616 (1.08)	0.022 (1.44)	-0.000 (1.16)	-317.844* (1.68)	-321.497* (1.70)	-285.976 (1.64)	-317.844* (1.79)
Air traffic	-	-	-	-	-	16.662** (2.46)	17.417** (2.55)	17.060*** (2.70)	16.662*** (2.62)
Port traffic	-	-	-	-	-	1.077 (1.13)	1.369 (1.26)	1.300 (1.30)	1.077 (1.20)
Road density	-	-	-	-		414.880** (2.13)	411.727** (2.06)	416.650** (2.26)	414.880** (2.27)
Rail density	-	-	-	-	-	-95.552 (0.20)	-69.801 (0.15)	-115.255 (0.27)	-95.552 (0.22)
Air traffic 1997	17.904** (2.54)	1.046*** (79.16)	-0.218 (0.50)	-0.000 (0.06)	0.000 (0.05)	-	-	-	-
Port traffic 1997	1.482 (1.24)	-0.002 (0.74)	1.116*** (15.14)	-0.000 (0.44)	0.000 (1.05)	-	-	-	-
Road density 1997	411.062** (2.02)	0.109 (0.29)	-6.272 (0.50)	1.015*** (60.73)	0.000* (1.84)	-	-	-	-
Rail density 1997	-98.454 (0.21)	-0.178 (0.20)	-24.184 (0.85)	0.018 (0.48)	1.001 (15,000)	-	-		-
Constant	-482.797*** (4.48)	0.133 (0.66)	0.709 (0.11)	0.008 (0.95)	-0.000 (1.42)	-501.570*** (4.67)	-489.563*** (4.51)	-472.085*** (4.72)	-501.570*** (4.99)
F-value	15.03	1113.86	38.56	592.08	-	14.56	-	-	-
Adjusted R2	0.61	0.99	0.80	0.98	1.0000	0.60	-	-	-
Breusch-Pagan LM Test (P-Value > Chi2(10))	-	-	-	-	-	-	8.7927 (0.55)	8.7927 (0.55)	-
Hansen-Sargan overidentification statistic (Under H0, distributed as Chi-sq(31), pval)	-	-	-	-	-	-	32.896 (0.37)	33.293 (0.36)	-
Log likelihood	-	-	-	-	-	-	-	-	1432.9114
LR test of model vs. saturated (Prob > chi2)	-	-	-	-	-	-	-	-	48.70 (0.2896)

Notes: (1) Labor cost and population figures in natural logs. (2) t-statistics (z-statistics for 3SLS) in parenthesis. (3) ***, **, and * stand for significance levels at 1%, 5%, and 10%, respectively. (4) Number of observations: 74.

TABLE 4. OLS, 2SLS, and 3SLS Regression results where the dependent variable is the aggregate FDI stock in the 2001-2010 period

	First Stage for FDI	First Stage for Air traffic	First Stage for port traffic	First Stage for Road density	First Stage for Rail density	OLS	2SLS	3SLS	Structural Equations Model
Agglomeration	39,00,256*** (5.08)	5.116 (0.06)	-3,489.992 (1.19)	-8.036 (2.05)	0.012* (1.70)	4,074,032*** (5.43)	4,046,276*** (5.38)	3,789,263*** (5.44)	4,074,032*** (5.80)
Population	376.814*** (4.45)	-0.001 (0.14)	0.386 (1.19)	0.000 (0.22)	-0.000 (1.32)	366.696*** (4.29)	366.836*** (4.27)	382.114*** (4.80)	366.696*** (4.58)
Labor cost	188.263 (1.19)	-0.014 (0.75)	-0.577 (0.96)	-0.001 (1.57)	0.000*** (2.74)	218.954 (1.41)	215.2862 (1.38)	154.932 (1.07)	218.954 (1.51)
Labor quality	-7,247.003** (2.38)	-0.084 (0.24)	12.616 (1.08)	0.022 (1.44)	-0.000 (1.16)	-7,797.219*** (2.59)	-7,709.313** (2.55)	-6,970.844** (2.49)	-7,797.219 (2.76)
Air traffic	-	-	-	-	-	231.787** (2.15)	228.4155** (2.10)	226.242** (2.25)	231.787** (2.29)
Port traffic	-	-	-	-	-	23.805 (1.57)	24.782 (1.44)	22.926 (1.43)	23.805* (1.67)
Road density	-	-	-	-	-	7,375.433** (2.37)	7,547.655 (2.37)	6,954.019** (2.35)	7,375.433** (2.53)
Rail density	-	-	-	-	-	-4,230.48 (0.56)	-4,170.634 (0.55)	-3,541.076 (0.51)	-4,230.48 (0.60)
Air traffic 1997	233.229** (2.05)	1.046*** (79.16)	-0.218 (0.50)	-0.000 (0.06)	0.000 (0.05)	-	-	-	-
Port traffic 1997	26.95497 (1.40)	-0.002 (0.74)	1.116*** (15.14)	-0.000 (0.44)	0.000 (1.05)	-	-	-	-
Road density 1997	7,527.405** (2.30)	0.109 (0.29)	-6.272 (0.50)	1.015*** (60.73)	0.000* (1.84)	-	-	-	-
Rail density 1997	-4,673.595 (0.62)	-0.178 (0.20)	-24.184 (0.85)	0.018 (0.48)	1.001 (15,000)	-	-	-	-
Constant	-7,064.077*** (4.07)	0.133 (0.66)	0.709 (0.11)	0.008 (0.95)	-0.000 (1.42)	-7,188.19*** (4.20)	-7,175.83*** (4.15)	-6,819.986*** (4.25)	-7,188.19*** (4.48)
F-value	13.88	1113.86	38.56	592.08	-	13.91	-	-	-
Adjusted R2	0.59	0.99	0.80	0.98	1.0000	0.59	-	-	-
Breusch-Pagan LM Test (P-Value > Chi2(10))	-	-	-	-	-	-	8.3645 (0.59)	8.3645 (0.59)	-
Hansen-Sargan overidentification statistic (Under H0, distributed as Chi-sq(31), pval)	-	-	-	-	-	-	33.115 (0.51)	33.293 (0.50)	-
Log likelihood	-	-	-	-	-	-	-	-	1228.0229
LR test of model vs. saturated (Prob > chi2)	-	-	-	-	-	-	-	-	48.33 (0. 4191)

Notes: (1) Labor cost and population figures in natural logs. (2) t-statistics (z-statistics for 3SLS) in parenthesis. (3) ***, **, and * stand for significance levels at 1%, 5%, and 10%, respectively. (4) Number of observations: 74.

TABLE 5. Scenario analysis

		Aggregate FDI projects		Aggregate FDI (million $ in 2015 values)		Aggregate FDI jobs	
Air traffic	Road density	Air traffic	Road density	Air traffic	Road density	Air traffic	Road density
10% ↑	-	25.66	-	340.31	-	2,917.54	-
-	10% ↑	-	266.10	-	4,441.24	-	30,255.57
10% ↑	10% ↑	Total Effect: 291.76		Total Effect: 4,781.55		Total Effect: 33,173.11	