Causal Relationship between Infrastructure Expenditures and Regional Income: The Case of Turkey

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Abstract

This research aims to demonstrate the regional role of the relationship between economic development and infrastructure expenditures that Turkey had lived in the growth process, arising as a result of the reforms implemented after the 2001 economic crisis. In this context, we investigate the Granger causal relationship between infrastructure expenditures and economic development in bidirectional framework. The analysis, using the panel data of 81 provinces, covers 2004-2014 period and is based on the three-stage analysis procedure, such as cross-section dependency, stationarity and causality investigation. To check robustness and investigate whether the causality varies between the geographical regions of Turkey we examine the causality both at national and at sub-national levels. The empirical findings show that on the national level there is one-way causality from GDP to Infrastructure expenditures. While on the regional level, the Granger causality test results vary considerably due to the geographical characteristics of these regions.

Keywords : Infrastructure Expenditures, Regional Economic Growth, Granger Causality, Turkey.

JEL Classification Codes : O18, P44, C23.

Introduction

Turkey has entered a period of rapid economic growth, arising as a result of the reforms implemented after the 2001 economic crisis. Public spending has made a significant contribution to this economic growth process. One of the most important expenditures that has increased rapidly during this period is the renewal of the transportation infrastructure. In this sense, significant investments have been made in areas such as highways, railways and airports. These expenditures have made important contributions to the economy by accelerating access to economic services, by providing access to the markets by saving time with the utilization of the transport facilities and by reducing operational costs (Farhadi, 2015: 73; Kuştepeli et al., 2012: 2619; Yu et al., 2012: 13).

One of the most important criticisms of these investments concerns the regional imbalances that the country has experienced. As it is shown in many studies there is East-west regional inequality in Turkey (Elburz & Gezici, 2012; Gezici, Walsh & Kacar, 2017; Karahasan, 2014; Yavan, 2010;

Yesilyurt & Elhorst, 2014). Specifically, economic activities in Turkey are mostly concentrated in western regions such as Istanbul, Kocaeli, Bursa, Ankara and Izmir.

The intention of this research is to demonstrate the regional role of the relationship between economic development and infrastructure expenditures that Turkey had lived in the growth process. This issue is frequently discussed in the international literature. In a pioneering work in this area (Aschauer, 1989) by using the standard production function it has been shown that the decline in infrastructure investments has resulted in a reduction in productivity in the United States. In other pioneering works like Munnell (1992) and Gramlich (1994), this method has been criticized and it is stated that the causality relationship is directed from GDP to infrastructure investments. According to this statement, regions with high income are also considered to have high infrastructural investments at the same time. In this study we looked over the causal relationship between regional income and infrastructure expenditures for Turkey.

When the literature is considered, it is seen that there are many studies using different approaches and analytical methods that overlook the relation between the transport infrastructure and the economies of the countries or regions. For example, Pereira and Andraz (2011) for Portugal and Blanchard and Perotti (2002) for the United States of America employed Vector Auto Regressive (VAR) Model, Tranos (2012) in provincial level for Europe, Yu et al. (2012) and Song and Mi (2016) for China, Sahoo and Dash (2009) and Maparu and Mazumder (2017) for India, Babatunde (2018) for Nigeria and Mohmand et al. (2017) for Pakistan used Panel Unit Root and Granger causality analysis. And finally, Yu et al. (2013) and Chen and Haynes (2015) for China and Arbués et al. (2015) for Spain used spatial data analysis methods in their estimations.

In the studies conducted for Turkey Kuştepeli et al. (2012) used Panel Unit Root and Granger causality analysis methods to analyze period between 1970 and 2005. Their estimates indicate a weak relationship in short term, while in the long run there is no correlation between transport infrastructures and the economic growth. Eruygur et al. (2012) used the vector error correction model to analyze period between 1963 and 2006. Communications and transportation spending has been shown to be a lagged impact on economic growth in this study. Kara et al. (2016) used panel fixed effect methods to analyze period of 2004-2008. Their analysis indicates that infrastructure spending, both nationally and regionally, increases economic growth. For a large literature review and meta-analysis on public infrastructure investments and regional revenue growth in both Turkey and the other countries, see Elburz et al. (2017).

In our study, the analysis method to be followed in the next section and the data set to be used in the third section will be introduced. The fourth chapter will contain the analysis made and the empirical results achieved. In the fifth section, we will sum up our main findings and draw some conclusions.

Methodology

According to the definition given by Granger (1969: 430) the causality is based completely on the foreseeability. Basically, Y_t is said to cause X_t in the Granger sense if lagged values of Y_t significantly improves the forecast of X_t . In this context, the Granger causal relationship can be both in the unilateral and in the bilateral direction. Bilateral causality is existing if two variables are Granger cause each other simultaneously.

We applied a three-stage analysis procedure to determine the existence and direction of Granger causality between government infrastructure investment and GDP for national and regional levels:

cross-section dependency, stationarity and causality investigation. The first stage of our analysis is, in principle, preliminary and provides information for appropriate generation selection for panel unit root tests. Since the Granger causality is assumed to be only between stationary series, on the second stage we investigate the stationarity of variables. The interpretation of the panel unit root tests results for eight different samples (a state and seven regions) is based on the existence of cross-section dependency. We tread carefully on this step, because first generation panel unit root tests, which don't deliberate over cross-sectional variation among units, may lead to spurious conclusions. On the other hand, the second-generation panel unit root tests consider cross-section dependency and therefore are more powerful than related first generation tests in the case of presence of cross-sectional dependency. After concluding that the variables meet the necessary assumptions we test the causality relationships.

Data Set

Due to data limitations, the analysis covers 2004-2014 period. In the full sample, which covers all country, the analysis is based on the panel data of 81 provinces. Along with this, we investigate whether the causality varies between the geographical regions of Turkey. In this context, all analysis procedures are also implemented for each seven regions: Mediterranean, Aegean, Marmara, Black Sea, Central Anatolia, Eastern Anatolia and South Eastern Anatolia regions. The public infrastructure investments are represented by public transportation and communication expenditures, expressed in thousands of Turkish Liras, and comes from the Strategy and Budget Ministry of Turkey. The economic development is proxied by GDP, expressed in thousands Turkish Liras, and comes from the Turkish Statistical Institute' Regional indicators database. In all specifications (in general sample and at regional levels) variables are transformed in the logarithmic term.

Empirical Findings

In this study we scrutinize the Granger causal relationship between infrastructure expenditures and economic development in bidirectional framework. In this regard our analysis is based on the following empirical models:

$$GDP_{it} = \beta_{0i} + \beta_{1i}InfrExp_{it} + \varepsilon_{it} \quad (1)$$

$$InfrExp_{it} = \alpha_{0i} + \alpha_{1i}GDp_{it} + \varepsilon_{it} \quad (2)$$

Here *GDP* denotes the real GDP, expressed in logarithms; *InfExp* is the public infrastructure expenditures in the log form; ε is the error term; while *i* and *t* symbolize province and year.

On the first stage of the analysis we investigate the cross-sectional dependency (CD) issue both on the state and on the regional levels. For this purpose we run the CD test proposed by Pesaran (2004) for all eight sample specifications. In compliance with the CD test results we strongly reject the null hypothesis of cross-section independence in GDP series on country level, as well as on all seven regional levels. At the same time, we also have similar results for Infrastructure expenditures with one exception for Mediterranean region, where the test result indicates existence of cross-sectional independency. Based on this result we should consider the CD issue to get unbiased results in the next steps of analysis. Therefore, we employ first and second-generation panel unit root tests to investigate stationarity.

The Granger causality is assumed to be only between stationary series. For this reason, on the second stage of our analysis we investigate the stationarity of variables. In order to bear the cross-section dependence issue in mind and to demonstrate the possible difference in the test results, we apply first and second-generation unit root tests. The tests assuming cross-section dependence and known as “first generation” tests are presented in our study by following standard tests: Levin, Lin and Chu (LLC) (2002); Im, Pesaran and Shin (IPS) (2003); Augmented Dickey Fuller (ADF) - Fisher test, suggested by Maddala and Wu (1999), and PP-Fisher test, developed by Choi (2001). The “second generation” panel unit test based on the covariate-augmented Dickey Fuller (CADF) statistics procedure (Pesaran, 2007) is also applied to investigate the stationarity of variables.

We conduct all stationarity tests for levels and for first differences of each variable, by including and excluding a trend. Even the results for mentioned above five different panel unit root tests are contradictory among themselves in some samples, we interpret stationarity in general based on the “second generation” CADF test results. According to the results of panel unit root tests each of two variables is stationary in levels for national, as well as for regional specifications. Thus, we can conclude that our variables are I(0).

In other words it means that variables, employed in our study, satisfy the main assumption of Granger causality assuming that only stationary series are embraced (Granger, 1969). Based on this, at the next stage of our analysis we conduct the Granger test on the country level and on the seven geographic regions. The main reason behind this analysis approach is the desire to check robustness of our results and to determine the possible differences among regions.

In the framework of the Granger causality, analysis is investigated the direction of causality relationship between two variables. As mentioned above, this relationship can be both one-way and two-way. The null hypothesis states that “*A* does not Granger-cause *B*”. In this regard it is very important to interpret the meaning of this statement correctly: “*A* is Granger-cause *B*” does not stand for “*A* is the effect or the result of *B*”.

The results of the Granger causality test are reported in Table 1. We investigate the causality between Infrastructure expenditures and GDP for the whole country and for regions as well. As it is seen from the test results, in general there is one-way causality from GDP to Infrastructure expenditures. When we evaluate the results in more detail, the empirical findings show that at the national level (full sample) there is a unilateral causality from GDP to Infrastructure expenditures at the 1% significance level. At the regional level, there are same results for Aegean, Black Sea, Central Anatolia and Eastern Anatolia regions. While for the Mediterranean region the direction of the causality is in the opposite way: In this region infrastructure expenditures Granger-causes GDP. For the Marmara region there is bidirectional Granger causality. Due to the development level of that region infrastructure expenditures and GDP growth are moving together interdependently. However, by reason of existence of geographical problems South Eastern Anatolia region cannot reach significant economic development and better infrastructure level as well.

Table 1. Granger Causality Test Results

Null Hypothesis	chi2	Prob > chi2	Conclusion
Full Sample (Turkey)			
GDP does not Granger-cause *InfrExp*	12.075	0.001	One-way causality from *GDP* to *InfrExp* (*GDP* does Granger-cause *InfrExp*)
InfrExp does not Granger-cause *GDP*	1.670	0.196	
Mediterranean Region (Geo1)			
GDP does not Granger-cause *InfrExp*	0.734	0.693	One-way causality from *InfrExp* to *GDP* (*InfrExp* does Granger-cause *GDP*)
InfrExp does not Granger-cause *GDP*	8.047	0.018	
Aegean Region (Geo2)			
GDP does not Granger-cause *InfrExp*	42.131	0.000	One-way causality from *GDP* to *InfrExp* (*GDP* does Granger-cause *InfrExp*)
InfrExp does not Granger-cause *GDP*	0.017	0.897	
Marmara Region (Geo3)			
GDP does not Granger-cause *InfrExp*	3.726	0.054	Bilateral causal relationship between *GDP* and *InfrExp*
InfrExp does not Granger-cause *GDP*	3.457	0.063	
Black Sea Region (Geo4)			
GDP does not Granger-cause *InfrExp*	2.963	0.085	One-way causality from *GDP* to *InfrExp* (*GDP* does Granger-cause *InfrExp*)
InfrExp does not Granger-cause *GDP*	0.434	0.510	
Central Anatolia Region (Geo5)			
GDP does not Granger-cause *InfrExp*	11.200	0.004	One-way causality from *GDP* to *InfrExp* (*GDP* does Granger-cause *InfrExp*)
InfrExp does not Granger-cause *GDP*	2.486	0.289	
Eastern Anatolia Region (Geo6)			
GDP does not Granger-cause *InfrExp*	2.938	0.087	One-way causality from *GDP* to *InfrExp* (*GDP* does Granger-cause *InfrExp*).
InfrExp does not Granger-cause *GDP*	0.273	0.601	
South Eastern Anatolia Region (Geo7)			
GDP does not Granger-cause InfrExp	2.607	0.106	No Granger causality between *GDP* and *InfrExp.*
InfrExp does not Granger-cause *GDP*	0.468	0.494	

Source: Authors' own calculations.

Concluding Remarks

In this study, we have investigated the causal relationship between infrastructure expenditures and GDP in the context of Granger causality for Turkey. In the framework of our analysis we utilized regional panels corresponding to Turkey's seven geographical regions. The aim of this approach is to examine causality both at national and at sub-national levels. In Turkey, as mentioned before, both economic activities and infrastructure expenditures are intensely intensified in the Western regions, especially in Istanbul and its neighborhood provinces. According to the analysis our test results varies across regions because of their geographical characteristics. One-way Granger causal relationship from GDP to Infrastructure expenditures can be found at the national level and also for Aegean, Black Sea, and Central Anatolia and Eastern Anatolia regions. It can be interpreted as economic development results in an increasing demand for infrastructure. At the same time for the Mediterranean region there is also unilateral causality, but from Infrastructure expenditures to GDP. For the South Eastern Anatolia region, being the least developed in country, there is no significant relationship in the context of Granger causality. When our results are evaluated together for the economic policy perspective, economic growth is based on other factors than infrastructure when it is considered geographically which we will analyze these spatial characteristics in our future research papers.

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