

**The Spillover Effects of Public Capital on the Turkish Private Manufacturing  
Industries in the Geographical Regions**

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**ABSTRACT**

This paper investigates the spillover effects of public capital formation on the Turkish private manufacturing industry at the regional level over the period 1980-2000. The aggregate effects of public capital cannot be captured entirely from the direct effects of public capital installed in the region itself. Therefore, we estimate vector autoregression models for the seven geographical regions of Turkey by including capital formation installed outside of the region. The results show that public capital affects private sector performance positively in all regions apart from Central Anatolia. Positive spillover effects of public capital can be seen in some regions, like Marmara.

**Key words:** Regional development, public capital, spillover effects, vector autoregression, Turkish manufacturing industry.

**JEL classification:** C32, L60, R00

## **1. Introduction**

Since the seminal work of Aschauer (1989a and 1989b), the role of public capital in the development process has attracted much interest. Recently, investigating the impact of public capital on private output has been an issue of considerable interest in the regional development literature. Regarding this, there have been several empirical studies investigating the effects of public capital on private sector output in many countries (see, for example, Munell and Cook, 1990; Pereira and Flores, 1999; Zugasti *et al.* 2001). The results of these studies generally point to the positive effects of public capital on private sector performance. However, some studies found no clear evidence of positive linkage between public capital formation and private sector output at the regional level for some countries (see, for instance, Holtz –Eakin 1994; Garcia-Milà *et al.* 1996; Pereira and Roca-Sagalés, 2001). The diversity of empirical results of the literature on the regional effects of public capital on private sector performance could, at least partially, be explained by the fact that they ignore spillover effects of public capital across regions. In fact, spillover effects should not be ignored when investigating the effects of public capital on private sector performance at the regional level, since public capital installed in one region may give benefit to the other regions. In spite of the fact that spillover effects of public capital are important at the regional level, there appear only a few studies in this area (see, for example, Holtz-Eakin and Schwartz, 1995; Boarnet, 1998; Pereira and Roca-Sagalés, 2003). However, the results of these empirical studies are inconclusive. Holtz-Eakin and Schwartz suggest that there is no quantitatively important spillover effect of public capital between the states in the USA. Boarnet (1998) finds negative

spillover effects of public infrastructure, while Pereira and Roca-Sagalés (2003) find positive spillover effects of public capital for almost all regions.

Despite the fact that interest in the effect of public capital formation on national and regional economies has generated a voluminous literature in other countries, there appears to be a lack of studies dealing with the impact of public capital in Turkey. To the authors' best knowledge, there appears only one study (Karadağ *et al.* 2002) that deals with the impact of public capital formation on private sector performance at the regional level. As far as we are aware, the present study is the first attempt to investigate the spillover effects of the public capital on the Turkish private manufacturing industries at the regional level<sup>1</sup>. Studying the spillover effects of public capital between the regions in Turkey gains importance, since there exists significant differences between regions of Turkey as far as economic development is concerned. Investigation of the spillover effects of public capital at the regional level will also be helpful in formulating economic policies for the reduction of regional inequalities.

Therefore, the main aim of this paper is to analyze the regional effects of public capital formation and the possible existence of spillover effects on the manufacturing industries in the seven regions in Turkey for the period 1980-2000. It is believed that public capital can motivate private sector performance directly as an additional input in private production and indirectly by having an impact on private production through dynamic feedback effects among the relevant variables, such as private inputs, capital, labor, and output (see also Wang, 2002). Therefore, following Pereira and Flores, 1999; and Pereira and Roca-Sagalés, 2003, we use Vector Autoregression (VAR) analysis by

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<sup>1</sup> In this study as the aggregate data are not available at the regional level, we are restricted to the manufacturing industry.

employing data over the period 1980-2000 for the aim of the study. The spillover effects of public capital formation at the regional level are based on the impulse response functions related with the estimated VAR models.

The remainder of this paper is organised as follows. Section two provides information about the data set used in the study. Section three is about the methodology used in the study and the estimation of the VAR models. Evaluation of the results are summarised and discussed in section four. The paper concludes with a summary analysis of the findings in section five.

## **2. Data**

We employed annual data on output, employment, and capital data related to private manufacturing industry and public capital data at regional levels for the aim of the study. The data set covers the time period of 1980 to 2000 for the seven regions.

The data for the private manufacturing industry of each region were obtained from several issues of Annual Manufacturing Industry Statistics published by State Institute of Statistics (SIS). Manufacturing industry wholesale price index was obtained from several issues of Monthly Bulletin of Wholesale Price Index, published by SIS. Investment deflators for public investments were taken from Main Economic Indicators published by State Planning Organization (SPO). The public investment series were obtained from Kutbay (1982) and SPO (see <http://www.dpt.gov.tr/kamuyat>) for the entire period.

The private output is calculated by subtracting the value of the stock at the beginning of a year from the total sales plus the value of the stock at the end of that year, and was measured in constant prices by taking 1994 as the base year. Inputs used in our model are labor and capital at the national and regional levels. The labor input is measured as total number of workers in production. The private capital input is measured as the total horsepower<sup>2</sup>. The public capital input was calculated through perpetual inventory method<sup>3</sup>. In order to calculate the public capital input at the regional level over the period 1980-2000, the real public investment series was obtained through deflating the nominal investment series by using the public investment deflator. All of the variables are used in the logarithmic forms in the following sections.

Table 1 presents some summary indicators for the Turkish geographical regions.

**Table 1: Average Percentage Share of Regional Manufacturing Value Added and Regional Public Capital**

Regions	Regional value added (% of Turkey)	Regional public capital (% of Turkey)
Aegean	15.73	19.37
Mediterranean	8.16	15.56
Marmara	59.60	20.24
Central Anatolia	9.38	19.24
Black Sea	4.65	10.53
South Eastern Anatolia	1.89	8.01
Eastern Anatolia	0.59	7.05

<sup>2</sup> Total horsepower of installed equipment can also be used as a proxy for capital. (see, Taymaz and Saatçi, 1997).

<sup>3</sup> See, for example, Önder et al. (2003) for more details on the method.

As the table indicates Marmara region has almost 60 %, while Eastern Anatolia has only 0.59 % of the total value added created in Turkish manufacturing industry. Marmara region also attracts the highest percentage public capital (20.24%), whereas Eastern Anatolia obtains the lowest percentage (7.05%).

### **3. Methodology and Estimation**

In this study, following Pereira and Flores (1999) we employed a multivariate dynamic approach, namely VAR modeling, to estimate the spillover effects of public capital on regional level. This approach allows us to consider dynamic feedback relations between private sector variables and public capital as well as among private sector variables, which is an important defect of single equation static production functions to estimate the elasticities (see Pereira and Flores, 1999; Karadağ *et al.*, 2002, for details).

#### *Estimation*

Before beginning the estimations, augmented Dickey-Fuller (ADF) test was used to specify the order of integration of the variables. ADF test statistics include a constant term. For the specification of the lag length, we used Akaike Information Criterion (AIC). In most of the cases the null hypothesis of a unit root could not be rejected at 5% significance level except for public capital series in some regions. But further experiments with other specifications suggested that the null hypothesis could be rejected at 5% significance level. By taking this into consideration, we have concluded the nonstationarity of the series. Unit root tests were further conducted related to the first

difference of the series. The output and private capital series were found to be I(1) both at national and disaggregated regional level. Some of the employment and public capital series were found to be I(2) while most of them are found to be I(1). As a further experiment, following Pereira and Flores (1999), we conducted unit root test to the logarithm of employment and public capital to output ratios at the national and regional levels. If these ratios are I(1) since the output series are found to be I(1), employment and public capital series should also be I(1). The results showed that all the ratios were I(1) except for public capital of Marmara, which is found to be I(1) with Phillips-Perron test at 1% significance level. Combining all of these results we have concluded that stationarity in first differences is a good approximation for the series at national and regional level<sup>4</sup>.

### *VAR Specification*

VAR models for the seven regions are specified separately seven times by using five variables: public capital installed in the region itself, public capital installed in the other regions, private capital, labor and output. As all of the series are found to be I(1), VAR in first difference model was used. Consequently, all the variables are in growth rates. For all estimations constant term and trend are included to the model. We used one lag of each variable to keep the model simple and to avoid the problem of overparameterization.

In order to explore the spillover effects of public capital formation at the regional level, we used impulse response function related with the estimated VAR models. In this context, we consider the impact of a one-time innovation of the growth rate of public

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<sup>4</sup> The results are available upon request.

capital installed in the region itself and of public capital installed outside the region on the private output at the regional level.

It should be noted that the errors were orthogonalised by standard Cholesky decomposition so that the covariance matrix of the residuals is diagonal. However the changing of the order of variables may change the results in this procedure. We assume that innovations in public capital lead innovations in private sector variables contemporaneously. Also we assume that innovations in public capital installed inside the region itself have a contemporaneous effect on public capital installed outside the region and *vice versa*. These are called as central case. In order to check the robustness of our results we also considered all the possible ordering of the variables.

#### **4. Results**

As it was mentioned earlier, the empirical results are based on impulse response function related with region specific VAR model. Table 2 presents the long-term accumulated elasticities related to public capital installed inside and outside the regions. It should be mentioned that long term is considered as the time horizon over which the growth effects of innovations disappear, i. e. impulse response functions converge. Accordingly, we have considered 20 years as the long term in our study. The long term accumulated elasticities show the total percentage change in private sector output for long term percentage change in public capital, which are calculated from the accumulated impulse response numbers. In the central case, it is assumed that innovations in public capital affect the private sector variables. Afterwards we checked the robustness of the results by

relaxing this assumption. In other words, we considered different ordering of variables in specification. The minimum and maximum values obtained from different specifications are given in parenthesis as ranges.

***Table2: Long-Term Accumulated Elasticities of Output with Respect to Public Capital Installed in the Region and Outside the Region***

Region	Public Capital Inside	Public Capital Outside
Aegean	0.029 (0.007/0.033)	-0.032 (-0.363/0.127)
Mediterranean	0.004 (-0.009/0.043)	-0.955 (-1.290/-0.061)
Marmara	0.080 (-0.295/0.107)	0.347 (0.011/1.444)
Central Anatolia	-0.027 (-0.031/0.001)	0.232 (-0.698/0.326)
Black Sea	0.040 (-0.136/0.234)	-1.180 (-7.346/-1.180)
South Eastern Anatolia	0.186 (-0.461/0.548)	0.423 (-0.484/0.692)
Eastern Anatolia	2.230 (-3.720/11.453)	-1.150 (-1.990/-1.147)

Note: The first figure in each case is the central case; ranges are shown in parentheses.

As can be seen from the table, the results show that the effects of public capital formation installed inside the region on the output of private manufacturing industries are positive for all regions except for Central Anatolia. Estimation results also suggest that only in three regions namely, Marmara, Central Anatolia, and South Eastern Anatolia, the regional output is positively affected by public capital installed outside of these regions. This implies the existence of positive spillover effects for the three regions.

As Table 2 indicates only in two regions, namely Marmara and South Eastern Anatolia, the effects of public capital installed inside and outside the region have positive effects. On the other hand, although public capital installed in Eastern Anatolia has a relatively high positive elasticity, the public capital installed outside of that region has a relatively high negative elasticity.

## **5. Conclusion**

In this study, we analyzed the spillover effects of public capital formation on private sector performance at the regional level in the Turkish manufacturing industries. Our empirical results are based on VAR estimates using private output, labor and capital and public capital installed inside and outside the region.

The results indicate that public capital installed in the region affects private sector performance positively in all regions except for Central Anatolia. On the other hand, the positive spillover effects of public capital only can be seen in three regions, namely, Marmara, Central Anatolia, and South Eastern Anatolia. Hence we can say that the positive effect of public capital mainly comes from capital installed inside the region in

the Turkish Regions as far as private manufacturing sector is concerned. However it is important to notice that Marmara, which has the highest share of output and Eastern Anatolia, which has the lowest share of output in Turkish Manufacturing sector regions have positive spillover effects.

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