

**The Effects of Public Infrastructure on Private Sector Performances in the Turkish  
Regional Manufacturing Industries**

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**ABSTRACT**

This paper investigates the impact of public capital formation on private manufacturing sector performance at national and regional level in Turkey. We employ vector autoregression (VAR) model for the time period 1980-2000. The results show that public capital affects private output positively in many regions and in aggregate. The results also reveal that the public capital crowds in private sector inputs in some regions.

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

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

## 1. Introduction

Investigating the impact of public capital on private sector performance has received great attention either at national or at regional levels in recent years. 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 regional output of private sector 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 both at national and regional level in many countries (see, for example, Kim and Lee, 2002; Pereira and Roca-Sagalés, 2001; Pereira and Flores, 1999; Zugasti *et al.*, 2001; Rovolis and Spence 2001).

This issue is important regarding Turkey since there exists significant differences between regions of Turkey as far as economic development is concerned. One can say that public capital has significant positive effects on private sector performance. Public investments specifically on infrastructure might well be used as a tool in reducing regional disparities by the governments. In this context, the Turkish government has followed specific economic policies, such as spending more on infrastructure in relatively less developed regions and giving more investment incentives to those regions in order to be able reduce the development gap between regions since 1960s. In spite of the fact that the manufacturing sector is not the whole economy, it has continued to expand its output and make a positive contribution to total economic growth<sup>1</sup>. Therefore, investigating the effects of public capital on private sector performance at the national and regional level gains importance.

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<sup>1</sup> See section 2 for the details.

Regarding Turkey, there have been few numbers of studies dealing with the manufacturing sector at national and regional level (see, for example, Uygur, 1990; Aydoğuş, 1993; Kruger and Tuncer, 1982; Gökcekuş 1997, Karadağ *et al.* 2002). Despite a relatively extensive literature on Turkish manufacturing sector, there appears to be a lack of studies dealing with the impact of public capital on manufacturing industries. To the authors' best knowledge, this study is the first attempt to investigate the impact of the public capital on the Turkish manufacturing industries at the national and regional level. Investigation of the impact of public capital on private sector performance at the regional level will be helpful in formulating economic policies for the reduction of regional inequalities. The elimination of regional disparities is an important dimension of integration process and various initiatives have been undertaken towards this end in the European Union (EU). In this context, as Turkey is a candidate member of the EU, investigating the impact of public capital on regional private manufacturing sector performance becomes an important concept.

Therefore, the main aim of this paper is to analyse the impact of public capital formation on the manufacturing industries in the seven regions in Turkey for the period 1980-2000. Most of the studies in this area follow in one way or another the terms of debate and methodological approach used in Aschauer's works (1989a and 1989b). However, the methodological approach employed in Aschauer's studies has been criticized in terms of econometrics (See Munell, 1992; Pereira and Flores, 1999; and Pereira and Roca-Sagalés, 1999). 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, output. (see also Wang, 2002). Therefore, following Pereira and Roca-Sagalés, 2001; and Pereira and Flores, 1999, we use Vector Autoregression (VAR) analysis by employing data for the period 1980-2000 for the seven regions in order to investigate dynamic feedbacks. The impact of public capital formation on private manufacturing sector performance is based on the impulse response functions related with the estimated VAR models.

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

## **2. Brief Information About Regional Economics of Turkey**

The Turkish economy has performed well in the developing world over the past 30 years until the onset of the 1994 currency crisis. It grew at an average rate of around 5 % in the 1970s and of around 4 % during the 1980s and of 5 % between 1990-2000. Also, the share of manufacturing industry in the Turkish economy has increased from 15% in 1968 to 20% in 2000 and the growth rate of this industry has been around 6 % on average over these years.<sup>2</sup> This rapid economic growth has resulted from considerable changes in the structure of the economy. However, Turkey is still a country with inequalities across the regions in terms of economic activity within the country. There is an excessive

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<sup>2</sup> See State Planning Organization (SPO), Main Economic Indicators, (<http://www.dpt.gov.tr>)

agglomeration of people and industry in the western part. The western part is more developed compared to the eastern part in economic terms. Thus, relatively developed regions in the western part of the country enhance inequalities between the regions. The regional disparities in the country have been an important issue in terms of regional economic policies.

The following figure shows the geographical division of seven regions in Turkey.



**Figure 1. Geographical Regions of Turkey**

Table 1 sheds a light on economical development of the geographical regions by providing some basic recent data for the seven regions.

**Table 1: Basic Data for Turkish Geographical Regions**

<i>Regions</i>	<i>Share of Total Population in 1997 (%)</i>	<i>GDP Per Capita (000 TL in 1987 Prices)</i>	<i>Share of Total GDP on Average (1991-1997) (%)</i>	<i>Share of Total Value-added in the Manufacturing Industry on Average (%) (1980-2000)</i>	<i>Share of Total Public Investment on Average (%) (1980-2000)</i>	<i>Share of Total Private Investment Incentives on Average (%) (1991-1997)</i>
Aegean	13.44	2172	15.61	15.72	14.04	11.68
Mediterranean	12.82	1657	12.18	8.15	14.08	11.67
Marmara	25.75	2618	36.56	59.60	28.76	46.27
Central						
Anatolia	16.83	1616	16.57	9.37	21.61	13.99
Black Sea	12.48	1271	9.55	4.64	7.07	5.33
South Eastern						
Anatolia	9.75	952	5.43	1.88	7.96	8.29
Eastern						
Anatolia	8.93	683	4.09	0.59	6.58	2.77

As can be seen from the Table, there is a clear existence of regional disparities in population, income distribution, and GDP per capita in Turkey. The table also indicates that the public resources and private investment incentives implemented by the government are not used in the right direction to reduce regional inequalities in the country. As the table shows, Marmara region, as the dominant region in Turkey, has 59.60 % of output of Turkish manufacturing industry, 36.56 % of GDP on average, and 25.75 % of the total population in 1997. Also, GDP per capita in Marmara region is almost four times higher than that of the lowest region (Eastern Anatolia). In spite of the fact that the share of Eastern Anatolia has around 9 % in total Turkish population, it has only 0.59 % share in total manufacturing output. The dominant position of Marmara is also reflected in the share of public investment (28.66 % on average). These disparities

are even more dramatic regarding the private investment incentives, as the Marmara region obtains almost half of the incentives (46.27 % on average).

Reducing regional disparities between the regions of Turkey gains importance in the context of EU membership as well, since the regional development policies in the EU suggest that the regional disparities within the countries should be eliminated. In this context, Turkey needs to implement a consistent regional economic policy to reduce the large inequalities between the regions by increasing public investments especially in the relatively less developed regions before her membership is realised.

In this context, the performance of the manufacturing industry will have a positive contribution to reduce regional disparities, since the share of manufacturing industry in the Turkish economy is considerably high, and has increased in recent years.

### **3. Data**

In this study, we used output, employment, and capital data related to private manufacturing industry and public capital data at the national and regional levels for the aim of the study. The data covers the time period of 1980 to 2000 for Turkey and the seven regions.

The data set related to private manufacturing industry of each region was 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.

#### **4. Methodology**

In this study, following Pereira and Flores (1999) we employed a multivariate dynamic approach, namely VAR modeling, to estimate the effect of public capital on private sector performance in Turkey at national and regional level. This approach helps 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, for details).

A VAR model in a generalized form can be defined as;

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<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.

$$X_t = A_1 + A_2(L)X_t + E_t \quad (1)$$

where  $X$  is a vector of endogenous variables,  $A_1$  is a vector of constants,  $A_2$  is a polynomial in the lag operator  $L$ , and  $E$  is vector of error terms (see Sims, 1980). For the nonstationary series we may also use VAR in differences. A VAR in first difference has the following form:

$$\Delta X_t = B_1 + B_2(L)\Delta X_t + E_t \quad (2)$$

where  $\Delta$  denotes the first difference of the vectors.

## 5. Estimation

Before beginning the estimations, augmented Dickey-Fuller (ADF) test was used to specify the order of integration of the variables<sup>4</sup>. 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 public capital series in Central Anatolia, Aegean and Black Sea regions. But further experiments with other specifications suggested that the null hypothesis could be rejected at 5% significance level. Given this result 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

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<sup>4</sup> All of the variables used in this study are in logarithmic form.

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>5</sup>.

#### *VAR Specification*

VAR models for Turkey and seven regions are specified separately eight times by using four variables: public capital, private capital, labor and output. Since all of the series are found to be I(1), VAR in first difference model was used. Hence all the variables are in growth rates. For all estimations constant term and trend are included to the model. The order of VAR is determined by AIC and Schwarz criterion and the number of significant second order coefficients. A second order VAR specification was selected at national level and for all regions except for Eastern Anatolia and South Eastern Anatolia. For the remaining regions a first order VAR specification was selected.

In order to investigate the impact of public capital formation on regional private manufacturing industries we used impulse response function related with the estimated

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<sup>5</sup> The results are available upon request.

VAR models. In this context we consider the impact of a one time innovation on the growth rate of public capital, on the private variables at the national and regional level.

It should be noted that the errors were orthogonalised by a 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. Following Pereira and Roca-Sagalés (2003), we assume innovations in public capital lead innovations in private sector variables. This is called as central case. In order to check the robustness of our results we also considered all the possible ordering of the variables.

## **6. Results**

As it was mentioned earlier the empirical results are based on impulse response function related with VAR estimates. We conducted the analysis at the national and regional level for the aim of the study. Table 2 presents the long term accumulated elasticities related to public capital. 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 variables 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 affects 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 with Respect to Public Capital**

Region	$Y_t$	$L_t$	$K_t$
Turkey	1.450 (0.905/2.058)	-1.611 (-2.300/-1.483)	-0.696 (-0.889/-0.633)
Aegean	0.027 (-0.037/0.029)	-0.019 (-0.044/0.017)	-0.026 (-0.083/-0.004)
Mediterranean	-0.171 (-0.117/-0.007)	-0.458 (-0.471/-0.065)	-0.072 (-0.110/-0.002)
Marmara	0.116 (0.116/0.378)	0.211 (0.056/0.227)	0.121 (0.116/0.205)
Central Anatolia	0.063 (0.025/0.098)	-0.008 (-0.086/-0.008)	0.124 (0.058/0.124)
Black Sea	-0.250 (-1.826/0.058)	-0.335 (-3.844/-0.009)	-0.372 (-1.04/-0.034)
South Eastern Anatolia	0.264 (-0.036/0.356)	0.050 (-0.316/0.134)	-1.583 (-1.816/-1.421)
Eastern Anatolia	0.297 (6.27E-05/0.30)	0.896 (-0.248/0.948)	-0.887 (-1.775/2.918)

Note: The first figure in each case is the central case; ranges are shown in parentheses.  
 $Y_t$ ,  $L_t$ ,  $K_t$  are the private variables, namely output, employment and capital for regional manufacturing industries.

The results show that the public capital formation affects the private output positively at the national level in the manufacturing sector. This suggests that public capital can be an important tool to promote output growth in Turkish manufacturing industry. On the other hand, it has negative effect on private sector inputs, namely labor and capital. Regarding to the Turkish regions, the effects of public capital formation on the output of private manufacturing industries are positive for many regions, namely, Marmara, Aegean, Central Anatolia, South Eastern Anatolia and Eastern Anatolia. Among those regions, only in Marmara the elasticity values are positive for all inputs. That means the public capital affects private manufacturing positively with respect to both the inputs and the output. In other words, public capital crowds in private capital, i.e. they are complements in that region in the long run. This is not surprising, as Marmara constitutes 60% of private manufacturing output in Turkey and attracts the biggest share of the

public investment (28.66%) as mentioned before. This shows us that provision of public infrastructure can be an effective means by which the Turkish government can promote economic growth. The crowding in effect can also be seen in Central Anatolia as this region attracts the second biggest share of the public capital (21.61%). Regarding other regions, only in Eastern and South Eastern Anatolia regions the labor elasticity is positive. That means public capital creates employment in private sector in the long run. The positive effects of public capital on labor input for the last two regions is also important to decrease the high unemployment problem in these two least developed regions.

On the other hand, as the table shows, the impact of public capital formation is negative on Black Sea and Mediterranean regions regarding both inputs and outputs. The negative signs in Mediterranean region may be due to the fact that the government promotes mainly the tourism sector in that region<sup>6</sup>.

## **7. Conclusion**

In this paper we analyzed the effects of public capital formation on private sector performance both at national and regional level in the Turkish manufacturing industries. Our empirical results are based on VAR estimates using private output, labor and capital and public capital.

The results indicated that public capital has a positive effect on private sector output, while it has a crowding out effect regarding inputs at the national level. The positive impact of public capital formation on private output can also be seen at many

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<sup>6</sup> The Mediterranean region is the most popular tourism area among the seven regions in Turkey.

regions. The results also reveal that only in Marmara region the impact is positive both in inputs and output while in Black Sea and Mediterranean region the impact on all variables is negative.

Policy implications derivable from this study suggest that specific guidance is required to promote private sector production in each region. The Turkish government should implement consistent regional economic development policies to reduce the regional disparities between the regions of the country. Regarding this, more infrastructure expenditures should be made by the government in the relatively less developed regions particularly in the South Eastern and Eastern Anatolia to increase the private sector output. In this context, although the manufacturing sector is not the whole economy, the public policies to narrow the gap between the regions of Turkey regarding this sector will make a positive contribution to reduce regional disparities.

This issue is also important in the context of Turkey's accession to the EU, as the regional development policies in the EU suggest that the regional disparities within the countries should be eliminated.

One can say that the public investment in one region may also have some positive effect on the production process of other regions (spill over effect). Therefore, it could also be interesting to investigate the spill over effect of public capital formation at the regional level as a further research.

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