IMPACT OF INFRASTRUCTURE ON MANUFACTURING

Impact of Infrastructure on Manufacturing Sector of Pakistan

Komal Soneta, Niaz Ahmed Bhutto, Falahuddin Butt, Noorudin Mahar, Sajid Ali Sheikh

Sukkur Institute of Business Administration, Sukkur
ABSTRACT

Infrastructure is basic physical and organizational structures needed for the operation of a society or enterprise or the services and facilities necessary for an economy to function. It can be generally defined as the set of interrelated structural elements that provide framework supporting an entire structure of development. Public infrastructure is one of the foundations and key factor for economic growth of any country. The aim of this paper is to find out the impact of public infrastructure (i.e. transportation and communication, electricity and gas distribution and per capita income) on the growth of manufacturing sector of Pakistan. To analyze this relationship, time series regression model has been used and the data was collected from 1981-2009. The results have revealed that in Pakistan investment in public infrastructure has insignificant effect on manufacturing sector.

Key words: Infrastructure, Manufacturing Sector, Pakistan.
1. INTRODUCTION

In this era of cut-throat competition, every country is trying hard to get as much growth as possible to go ahead in the race of development. Many factors are involved in driving the growth of any economy. Significantly, one of them is the well-developed infrastructure. Infrastructure is a fixed capital investment by government and firm that make possible all its economic activities. Infrastructure includes broad categories such as telecommunication, transportation, utilities, waste removal, education, health care, research and development and training facilities. Further transportation includes roads, ports, railway and airplane and utilities (includes electricity and water). Infrastructure is the medium that facilitates reliability of services, low-cost, reduction in the delivery time of goods and ultimately joined effect of these factors results in increased productivity and profitability of the organization in any country. Whenever anyone ponders on a developed country many questions arise in one’s mind about its development process such as, what is the main cause of their development? Which factors are necessary for development? What are the main reasons of lagging behind in this cut throat competition?

There are many reasons for growth and development of any country and one of them is growth in manufacturing sector. These countries shifted from agriculture towards industrialization and developed such an environment that attracted investors to invest in making of new companies and increased productivity of existing ones. Manufacturing means production of consumer goods, industrial goods and machineries that is used for production of other goods by physically, chemically and mechanically transformation of different components and substances. Before industrial revolution most manufacturing industries were in rural areas of countries. They were not producing so much advanced products but they were known as a supplement for agricultural substances. But after industrial revolution entrepreneurs shifted their household manufacturing
from rural to large cities and became giants in economies and produced large amount of manufacturing goods. Some economists state that manufacturing sector is a wealth producing sector for an economy. Now some people consider manufacturing sector includes only production of large goods such as machineries, automobiles, textile etc, but it includes each and every thing which is produced by large firms as well as small medium enterprises. In developing countries because of fewer facilities provided by government to manufacturing sector, its growth is less as compared to developed countries. Many researchers conducted research on the impact of investment in infrastructure on economic growth and found the significant impact of infrastructure on manufacturing growth as well as on overall economic growth of any economy. Some of these researchers found the causal relationship between investment in infrastructure and economic growth of country. Some researchers found that there is a bidirectional causal relationship between these two variables, infrastructure impact on growth and vice versa, while others found that there is a unidirectional causal relationship between these two factors but they remained in dilemma either infrastructure effects growth or growth affects infrastructure. They found that either due to investment by the government in infrastructural development cause manufacturing sector to grow or the growth of economy generates more revenues for government encourages them to invest in infrastructural development. Castañeda, Cotler and Gutiérrez (2000) conducted research on impact of infrastructure on Mexican manufacturing growth. They used two measures of infrastructure highway and electricity; regardless of using estimation method they found significant impact of both variables on Mexican manufacturing growth. They found for the manufacturing sector, 10% growth in investment of assets of highways contributes to an increase in manufacturing output that lies in the range between .62% and .96%. An increase of 10% in the stock of capital in electricity leads to an increase of
manufacturing output in the range of 1.92% to 2.88%. Investment in infrastructure by government side offer services to manufacturing sector in terms of their reduction in cost, demand for private input of any industry and productivity performance of manufacturing growth. Mamatzakis (1999) examined the impact of infrastructure on cost, private input demand and productivity performance on Greek manufacturing sector and found the result that there is a productive impact of public infrastructure on cost of manufacturing industry because when government invests in transportation sector, it will cut the cost of transportation of companies and infrastructure will affect private input demand by owners so over all infrastructure affects manufacturing industry. The cost saving impact of improvement in public infrastructure ranges from 0.02% in food industry to 0.78% in wood industry. So it’s evident from previous researches that public infrastructure is an input for manufacturing industries and it is beneficial and helpful for any economy’s manufacturing sector growth. These studies attract the attention of policy makers that they should make policies as friendly as possible for growth of manufacturing sector and encourage government to invest in infrastructure for development of economy.

Manufacturing sector is the second largest sector of economy of Pakistan and its contribution in GDP is 18.4% (Economic Survey of Pakistan, 2008-09). Results of previous studies are country specific and cannot be generalized therefore we are going to conduct research on relationship between investment in infrastructure and growth of manufacturing sector in Pakistan.

2. LITERATURE REVIEW

The public investment in infrastructure plays an important role in growth of manufacturing sector of any economy. There are many studies conducted to analyze the impact of public infrastructure on economic growth, so it is theoretically as well as empirically proved that an
economy cannot grow until its sectors (i.e.; agriculture, manufacturing and service) do not improve.

Rietveld, Kameo, Schipper and Vlaanderen (1994) studied the impact of infrastructure (i.e.; roads, telecommunication and electricity) in the development of manufacturing industries and found the positive and significant impact of infrastructure on manufacturing sector. Researcher Seitz and Licht (1995) conducted their research to see the impact of public infrastructure on regional manufacturing production cost in 11 west Germany states and found that public infrastructure do improve competitiveness by reducing production and transport cost. The research, “contribution of transportation in economy” was conducted by Kim (1998) to show the impact of investment in transportation on Korean economy and found that investment in infrastructure has the advantage of economic growth but this caused the inflation. This is one of the disadvantages of the study. The growth in the investment of transportation can be maximized if regulation on foreign inflow to private sector lifted; and on the other hand effect on inflation through investment in transportation can be minimized if expenditures of transportation investment could completely by financed by tax revenue. The research on the relationship between aggregate productivity and government spending variables was conducted by Aschauer (1989) and founded that the non-military public capital stock is severely more important in determining productivity than the flow of nonmilitary or military spending, and a core infrastructure of streets, highways, airports, mass transit, sewers, water systems, etc. has most clarifying power for productivity. Whereas researchers Benvenuti and Marangoni (1999) studied the impact of infrastructure on performance of Italian economic system particularly construction sector production and they founded that investment in infrastructure improves the production of construction sector in short run and consequently it trigger income and employment multipliers.
The impact of investment in transport system was examined by the researcher Holl (2000) by using the time series data from 1980-2000 based on the Spanish road building program. The theoretical and empirical results proved that selection of firms’ location is not so easy process it takes time because firm select location that provides it expected profits. Author used the Market Potential Function (MPF). The empirical results of this paper support the hypothesis that there is an importance of transport infrastructure for industrial location. Two other researchers Khan and Sasaki (2001) conducted study on almost the same issue and analyzed the role of public capital stock by estimating the production functions both at national and sectoral levels including public capital as an input and Investment behavior of the private sector and the issue of substitutability and complementarily between public and private capital was also analyzed and found public capital-labor ratio and private capital have a significantly positive effect on output and private capital, public capital ratio and bank credit play important roles in explaining the private sector’s investment behavior. The coefficient of growth rate of public capital ratio is negative, indicating that public capital works act as a substitute for private capital. On the other hand Puga (2002) says infrastructure is an intermediate public good with an active part in the production process. Thus, increasing the stock of infrastructure in lagging regions, like increasing any other stock of capital will improve productivity of existing firms and attract new firms, thereby helping these regions grow closer to more developed ones. The effect of public infrastructure on cost structure and productivity in private sector in Australia was examined by Paul (2003) by using the annual time series data for 1968/69–1995/96. The author mentioned that the effects of public infrastructure on productivity are measured in terms of both cost saving and output augmenting measures and found that public infrastructure has a strong, positive and significant impact on productivity in private sector industries and Public capital serves as a substitute for both private
capital and labor. The impact of infrastructure of three sectors of the economy (Services, Agriculture & Manufacturing) was studied by Rioja (2004) by using panel data of seven Latin American countries in 1960s and 1990s and found that the countries that are in developing phase have the greatest gain if investment in infrastructure is raised in 1960s and in 1990s service sector benefited more from additional investment in infrastructure. The study about infrastructure investment on Canadian manufacturing productivity was examined by Brox and Fader (2005) by using Constant elasticity and substitution translog cost model they also describe interaction of public and private sector and found that public capital is substitute for private capital in Canadian manufacturing sector and services of public capital increases the productivity of private capital. Heintz (2010) studied the impact of public capital on productivity of private sector of US. By using public infrastructure as factor of production he found long term relationship between these two variables. The results show that decrease in the public capital growth in US decreases the productivity of private sector and ultimately decline in the GDP growth of private sector. Another researcher Lall (2006) investigated the role of infrastructure in the economic growth and told it has been the subject of considerable research in the fields of public policy, economics, and planning. The main findings which the author found in the paper are; transport and communications infrastructure expenditures are significant determinants of regional growth, and the positive benefits which occur from these expenditures come not only from investments made by individual states, but there are positive externalities from cumulative expenditures made by neighboring states. Whereas Yeaple and Golub (2007) studied the effect of infrastructure on industrial growth and international specialization. They used production equation, specialization equation, infrastructure equation and panel data of 18 developed and developing countries and 10 manufacturing industries from 1979-97 and the result shows the significant effect of
infrastructure on industrial productivity and it plays a vital role in explaining international disparities in comparative advantage among nations. The role of infrastructure on competitiveness of Greek manufacturing sector was examined by Mamatzakis (2008) he conducted research by using 20 two-digit Greek industries over the period 1959-1995 and examined by using dual cost function and found that public infrastructure is cost saving input for manufacturing industries. Other researchers like Arnold, Javorcik, Lipscomb, Mattoo (2008) studied the impact of service reform on productivity of manufacturing industries they used main service sectors “banking, telecom, transport and insurance” in their model and they found that there is significant impact of service reform on manufacturing productivity; it benefited the both domestic as well as foreign firms but foreign firms were benefited more as compare to domestic firms. The impact of public capital investment on individual sector of the Japanese economy was examined by Annala, Batina, Feehans (2008) by using time-series data for the period of 1970–1998 and found public capital investment does not affect all sectors of the Japanese economy in the same manner. There are differences in the employment effects, output effects and private investment effects across sectors in response to new public capital investment. Public capital can have a variety of effects on the economy. It can improve the efficiency of production of the firm and alter the mix of inputs. For example, a reliable supply of electricity can make manufacturing more efficient and possibly shift production from labor toward private capital. Research on impact of investment in road on productivity was done by Montolio and Solé-Ollé (2008) because road is an important determinant of total factor productivity (TFP). And the empirical result shows the significant impact of investment in road on the provincial productivity performance in Spain. The study about impact of national and local infrastructure investment on investment decision was conducted by Lall, Wang and Deichmann (2010) authors who have
taken “highway and port” in national infrastructure and municipal “roads, street light and drainage system” in local infrastructure and they found the results that national infrastructure has significant impact on investment decision than local infrastructure. Another researcher Bottasso and Conti (2010) estimated the impact of investment in roads on manufacturing and service sector productivity. Authors have used the production function model on industry level and the overall results exhibit the significant impact of investment in roads on manufacturing productivity when there will be less transport barriers from government side it means there will be liberalization in transport sector because of this transportation cost will decrease so overall productivity will increase. On the other hand Sahoo, Dash and Nataraj (2010) studied the effect of investment in public infrastructure on economic growth of china. The authors have taken electricity, energy power, telephone, road, railway and port as measures of infrastructure and found that there is significant impact of public infrastructure on manufacturing productivity growth because it attracts the investors for investment in that areas where infrastructure is well designed. The research on the impact of infrastructure on output of some south Asian countries was done by Sahoo and Dash (2011) to find this relationship they used variables like gross domestic capital formation, labor force, international trade and human capital and found that development in infrastructure has positive and significant impact on output of South Asian countries. Along with physical infrastructure social infrastructure also contributes to growth.

3. DATA AND METHODOLOGY

3.1 Data Sources and Econometric Procedure

Data is obtained from State Bank of Pakistan and The World Bank “World Development Indicators”. World Development Indicators (WDI) is the primary World Bank database for
development data from officially-recognized international sources. Data is collected for the period 1981 to 2009. Data of all the variables is taken annually for all 30 years. The variables of interest are transport and communication, gas and electricity distribution which are major part of infrastructure. Infrastructure is the basic physical and organizational structures needed for the operation of a society or enterprise, or the services and facilities necessary for an economy to function. The term typically refers to the technical structures that support a society, such as roads, water supply, sewers, electrical grids, telecommunications, and so forth. For this paper we have collected data on electricity and gas distribution and transport and communication as mean of infrastructure separately. In addition to these variables we have also focused on per capita income. Per capita income or income per person is the numerical quotient of income divided by population, in monetary terms. It is a measure of all sources of income in an economic aggregate, such as a country or city. It does not measure income distribution or wealth. Last variable which is the dependent variable is manufacturing growth.

3.2 Model Specification

Based on variables discussed above the following form of function has been structured:

\[
\ln M_t = \beta_0 + \beta_1 \ln TC_t + \beta_2 \ln EG_t + \beta_3 \ln YP_t + u_t
\]  

\( \ln M_t \) = Log of growth of manufacturing sector

\( \ln TC_t \) = Log of transportation and communication

\( \ln EG_t \) = Log of electricity and gas distribution

\( \ln YP_t \) = Log of per capita income
Transportation and communication, electricity and gas distribution and per capita income are the explanatory variable. Main variable under consideration are transportation and communication, electricity and gas distribution and control variable is per capita income. The research shows the positive impact of Transportation and communication and electricity and gas distribution on manufacturing sector. Because of Investment in transportation and communication and electricity and gas distribution by government will reduce the cost and improve the efficiency of firms. Increase in per capita income will cause the demand to rise because of increase consumption that will result in manufacturing growth.

As paper uses time series data so in order to avoid unreliable and spurious results due to non-stationarity in data the first step is augmented dickey fuller test for unit roots. Table 1 shows augmented dickey fuller test. The Null hypothesis would be “variables have unit root” that is checked against the alternative hypothesis of stationarity. The Unit root test suggest that manufacturing growth, transport and communication, electricity and gas and per capita income all have unit root and none of them is stationary when checked at intercept only on level. ADF test that includes trend along with intercept also provide evidence that all the variables have unit root except transport and communication which is stationary at 10%.

<table>
<thead>
<tr>
<th>Variables (1981-2009)</th>
<th>Intercept only</th>
<th>Intercept and trend</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Level</td>
<td>Level</td>
</tr>
<tr>
<td>lnM</td>
<td>0.3152</td>
<td>-1.9155</td>
</tr>
<tr>
<td>lnTC</td>
<td>1.1703</td>
<td>-3.4275*</td>
</tr>
<tr>
<td>lnEG</td>
<td>-1.1528</td>
<td>-1.2674</td>
</tr>
<tr>
<td>lnYP</td>
<td>1.4283</td>
<td>-1.4308</td>
</tr>
</tbody>
</table>

The individual coefficient is statistically significant at the *10% level, **5% level or ***1% significance level.
The results in Table 1 imply that all series exhibit non-stationarity in levels. In order to transform it into stationary we will check all the variables by taking their first difference. Table 2 shows its result. We conclude that by taking first difference of all variables at intercept only and at intercept and trend, all the variables are stationary, and hence does not have unit root. This suggests that these series are integrated of order one i.e. (1).

\[ \Delta \ln M_t = \beta_0 + \beta_1 \Delta \ln TC_t + \beta_2 \Delta \ln EG_t + \beta_3 \Delta \ln YP_t + \mu_t \]  \hspace{1cm} (2)

\[ \Delta \ln M_t = \text{First difference of log of growth of manufacturing sector.} \]

\[ \Delta \ln TC_t = \text{First difference of log of transportation and communication.} \]

\[ \Delta \ln EG_t = \text{First difference of log of electricity and gas distribution.} \]

\[ \Delta \ln YP_t = \text{First difference of log of per capita income} \]

**Table 2: Unit root test, Augmented Dickey Fuller**

<table>
<thead>
<tr>
<th>Variables (1981-2009)</th>
<th>Intercept only Level</th>
<th>Intercept and trend Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \Delta \ln M )</td>
<td>-4.8804***</td>
<td>-4.8837***</td>
</tr>
<tr>
<td>( \Delta \ln TC )</td>
<td>-3.2750**</td>
<td>-3.4313*</td>
</tr>
<tr>
<td>( \Delta \ln EG )</td>
<td>-5.2889***</td>
<td>-5.4856***</td>
</tr>
<tr>
<td>( \Delta \ln YP )</td>
<td>-5.1371***</td>
<td>-5.6491***</td>
</tr>
</tbody>
</table>

The individual coefficient is statistically significant at the *10% level, **5% level or ***1% significance level.

\[ \Delta \ln M_t = \beta_0 + \beta_1 \Delta \ln TC_{t-2} + \beta_2 \Delta \ln EG_t + \beta_3 \Delta \ln YP_t + \mu_t \]  \hspace{1cm} (3)

\[ \Delta \ln M_t = \text{First difference of log of growth of manufacturing sector.} \]

\[ \Delta \ln TC_{t-2} = \text{Second difference of log of transportation and communication.} \]
\[ \Delta \ln EG_t \quad = \quad \text{First difference of log of electricity and gas distribution.} \]
\[ \Delta \ln YP_t \quad = \quad \text{First difference of log of per capita income.} \]

In model (1) there was stationarity that’s why first difference was taken in order to eliminate stationarity in model (2); the other variables except transportation and communication were significant at 1% and 5% in model (2). Transport and communication was significant at 10% which time-series doesn’t allow to include a main variable at 10% so second difference of variable transport and communication was taken as to eliminate stationarity in model (3).

4. RESULTS AND DISCUSSIONS

In order to have a better understanding of the impact that public infrastructure has on manufacturing growth in Pakistan, we use time series data for the year 1981 to 2009. First step is to find out the impact of transport and communication on manufacturing growth and then we further add other infrastructure variables to see their impact as well. As discussed in literature in Italy, United States and many other countries that roads, ports, airports and railways are the infrastructure systems having greatest impact on transport cost for industries. Telecom services like other infrastructure needed for rapid growth and modernization of different sectors of economy. Public infrastructure asserts cost saving effect in most of the industries and enhance productivity growth as well. Different authors have found almost same results that public infrastructure has positive and significant impact not only on manufacturing but agriculture and service sector as well. But there is no any evidence of the same impact on manufacturing sector of Pakistan; this is why we specifically take Pakistan for this research to see whether infrastructure has also same impact in Pakistan manufacturing sector or not.

Table 3: Estimate the impact of investment in infrastructure in the manufacturing sector
In table 3, we examined the impact of public infrastructure (transport and communication, electricity and gas distribution and per capita income) on manufacturing growth. In column 1 only one regressor transport and communication has been taken to see its individual impact on the dependent variable that is manufacturing growth. Electricity and gas distribution included in column (2) and in column (3) per capita income is included as well along with former two variables. It is seen that in column (1) where only transport and communication has been taken, this variable is significant at 10%. But when we use electricity and gas distribution in column (2) it is significant at 5% and in column (3) with the inclusion of per capita income it become significant at 1%. As discussed in literature public infrastructure is cost saving input for most manufacturing industries so the expected sign for this variable is positive for most of the countries but our findings for Pakistan shows different results in table 3. Transport and communication has negative sign which shows that 23.575% negative change occurred in this
facility or it can be said that transport and communication is decreased by 23.575% in last two years.

According to this regression result there is little bit fluctuations in intercept but as the change is minor so it can be concluded that it remained constant and statistically significant at 1%. But R-square in model 1 is only 12.75% and adjusted R-square is 9.11% which implies that independent variable does not explain well the dependent variable.

To avoid the omitted variable bias another variable electricity and gas distribution is included which somewhat improves the result. In model 2 R-square is 23.325% and Adjusted R-square is 16.66%. In model 1 transport and communication was significant at 10% and now it is significant at 5%. Electricity and gas distribution is significant at 10%.

In third model another variable is included to see the impact on dependent variable manufacturing growth. It resulted in improved r- square and also the significance of the previous variables have improved that caused model3 to be more reliable than previous two models. R-square increased from 23.325% to 39.456% with the addition of a variable per capita income that has a significant impact on manufacturing growth and excluding it would have resulted in an omitted variable bias.

5. CONCLUSION

In this research paper we attempted to estimate the impact of public infrastructure on manufacturing sector of Pakistan. Some selected infrastructural variables like telecommunication, electricity and gas distribution and per capita income are evaluated and their contributions to the growth of manufacturing sector are examined. To sum up our results we find evidence that investment in infrastructure is inversely proportional to productivity and growth of
manufacturing sector in Pakistan. But in literature of other papers in which same relation is studied out of Pakistan results are different. Our new findings do not confirm the findings of earlier research. This paper provides empirical evidence that does not justify the infrastructure investment as key component of growth for manufacturing sector in case of Pakistan. This difference in Pakistan and other countries results is due to various reasons. Political instability and economic conditions of the country are the main reasons for such results. Because due to these conditions new investors do not want to invest in Pakistan and also existing investors move their businesses to abroad. Government expenditure is increasing every year on infrastructure in spite of it effect is negative on growth of manufacturing sector, other control variables such as corruption, bad governance, government structure and mismanagement which we have not included in our research also have direct or indirect impact on manufacturing growth.
REFERENCES


Lall S.V., Wang H.G. and Deichmann U. (2010). "Infrastructure and City Competitiveness in India".


Montolio D. and Solé-Ollé A. (2007). "Road investment and regional productivity growth: the effects of vehicle intensity and congestion."


