Impact of hard and soft infrastructure on economic growth of Tamil Nadu

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Abstract

Economic Growth is an increase in an economy's output in the short run and an increase in its productive potential in the long run. Hard and soft infrastructure are both key contributors to economic growth. It has been found in literature that there is an interlink between infrastructure and economic growth of a country. In line with the findings of previous research, an attempt has been made to analyse the effects of hard and soft infrastructure on economic growth in Tamil Nadu, for the time period 2012 to 2022. The findings of the paper show a positive relationship between the two variables using regression analysis. It is concluded that government spending on infrastructure should be continued to stimulate economic growth of Tamil Nadu in future too.

Keywords: Hard infrastructure, soft infrastructure, economic growth, employment,productivity

Introduction

For the last few years, India has been able to rank among the top five fastest growing economies in the world. To maintain this growth momentum, it is essential to strengthen infrastructural facilities. There are two types of infrastructure, one is soft and another is hard infrastructure. Soft infrastructure is the non-physical structures which are required for economic growth. Examples of soft infrastructure are education, healthcare, government laws and financial institutions. Hard infrastructure is the physical structures which are required for economic growth. This could involve roads, seaports, airports, telecommunication and railway systems. The effects of hard infrastructure are realised in the short run. On the other hand, the effects of soft infrastructure are not seen in the short run but are plentiful in the long run. When we consider certain soft infrastructures, we can see how they impact economic growth. For example, we can look at education. If more educational institutions are built the accessibility of education would rise across the economy. There would hence be an increase in productivity of labour as they are gaining skill through education. Moving on to healthcare, availability of hospitals, doctors and different health care facilities would help to control diseases. Moreover, in the case of government laws, if proper law and order is maintained and people get security the non-economic welfare of the state will improve. An example is the Payment of Wages Act 1936. This act ensured equitable distribution of wages and prevented any sort of income inequality as people could purchase a wider range of goods and services allowing high living standards. This helps contribute to economic growth from increased access to education, availability of wider range of healthcare services to income equality. Looking at the other side, we found how hard infrastructure impacts economic growth. The use of roads,tunnels,bridges and railway systems allow more efficient transportations of products to the market. The time taken for travel decreases, the safety of the product increases and more locations can be accessed. The use of airports is one of the major reasons for economic growth. They allow international markets to be explored and allow countries to have trading partners. Lastly, they also bolster the tourism and hospitality of a country. All of these will help increase economic growth.

Provision of proper infrastructural facilities in Tamil Nadu not only attracts flows of investment from domestic and international sources, but also raises the productivity of other

factors (labour, capital) and profitability of production units. In this context there is a need to study the relationship between economic growth of the state with its infrastructural facilities. For this paper, the data for the time period 2012-13 to 2021-2022 has been collected. As per the data collected, we can see the state domestic product (SDP, henceforth) of Tamil Nadu has been constantly increasing. Moreover, the length of railways and national highways and number of seaports have all shown an upward trend which signifies improvements in hard infrastructure. Along with this the public expenditure on health, schools and no. of scheduled commercial banks and regional rural banks have also been rising showing improvements in soft infrastructure. In our paper we will study how far this improvement in infrastructure contributes to economic growth of the state.

Literature Review

Huang(2006) in his paper compared the infrastructural facilities of India with that of China. He confirmed that India only has the upper hand on the key soft infrastructure that affects growth. When it comes to financial markets, China has more constraints than India. Moving on to property rights security, Huang conveys that tax compliance is greater in India than China because the complicative tax structure causes people to evade tax. In corporate governance he said India is better than China. He found India has much stricter regulations which leads to greater inefficiencies when compared with China. These inefficiencies could be overcome with good financing and property rights security. Huang concludes this paper by saying the effect of soft infrastructure is better realised in the long run than in the short run.

Sahoo and Dash (2009), investigated the role of infrastructure in economic growth in India for the period 1970-2006. They mentioned that infrastructure development is one of the major factors contributing to overall economic development in many ways such as: direct investment in infrastructure creates production facilities and stimulates economic activities, it reduces transaction cost and trade cost by improving competitiveness. They also found that govt expenditure in public infrastructure is an important input in the production process of private sector stimulating both output and productivity.

Dwivedi(2017) aimed to create a physical infrastructure index for India as well as analysing the impact of infrastructure on economic growth, mainly focused on the manufacturing sector. Dwivedi also found out that 1% improvement in the infrastructure index results in a 4.5% increase in per capita GDP and a 2.65% increase in the Gross Value Added(GVA) of manufacturing. He concludes by stating that improvement in infrastructure leads to positive outcomes for an economy.

Babu and Murugesan(2018) had a few objectives which were to find the relationship between basic rural infrastructure and livelihood of rural areas and suggested policies for successful operations and development of livelihood in rural areas. Hypothesis testing showed that there is a relationship between education and level of income in rural areas. At the end it was observed that infrastructural development reduces rural poverty and improves livelihood of rural areas.

Chan etal. (2023) aimed to inform people about perceived destination competitiveness and infrastructure. The findings showed that improving transportation and accommodation infrastructure lead to positive development of the tourism industry.

Research gap

The literature surveyed above is based on how hard and soft infrastructure affect economic growth on a country level while this paper aims to do the same at the state level, for Tamil Nadu.

Objective of the paper

- The objective of this paper is to check how development of soft infrastructure and hard infrastructure affect economic growth of Tamil Nadu.

Methodology and Data source

To find the objective of the paper we undertake quantitative analysis by collecting secondary data for the time period 2012-13 to 2021-22. Public expenditure on health, no. of schools, colleges, universities and banking institutions are taken as the indicators of soft infrastructure. Due to unavailability of data on no. of Government Hospitals, we have considered public expenditure on health as an indicator of health infrastructure. The data for public expenditure on health and banking institutions are taken from the Handbook of Statistics, Reserve Bank of India. The data on schools and colleges are collected from Unified District Information System for Education (UDISE) and All India Survey on Higher Education (AISHE) reports, respectively. For hard infrastructure length of national highways, railway routes, seaports, availability of power and Telephones per 100 population are taken as the indicators. Except seaports the data on other variables are collected from the Statistical Handbook of RBI for Indian states. The data on the number of seaports in TamilNadu has been taken from Basic port statistics of India.

Under soft and hard infrastructure since all the variables have different units of measurement, index for different variables is constructed by using the formula:

$$\frac{actual\ value\ -\ min\ value}{max\ value - min\ value}$$

After converting each variable into an index, average of them has been calculated to construct a hard and soft infrastructure index. Hard infrastructure index is the average of railway index, highway index, power index, seaport index and telephone per 100 population. On the other hand, soft infrastructure index is the average of public expenditure on health, total educational institutes and total banking institutes.These hard and soft infrastructure indexes are regressed individually on the SDP index.In appendix, calculation for soft infrastructure index and hard infrastructure index is shown in Table-3 and Table-4, respectively. Value of index ranges from 0 to 1.The closer the value of index to 1 the better is the quality of infrastructure.

Regression analysis

To analyse the proposed relationship between hard and soft infrastructure with economic growth of Tamil Nadu two separate simple linear regression equations are formulated. Noteworthy to mention that, the hard infrastructure also influences the productivity of soft infrastructure. So, there could be multicollinearity between hard and soft infrastructure. To avoid this problem, two separate regression equations are made. The regression equations are as follows:

$Y_t = \alpha + \beta H_t + \varepsilon_1$ _____1)

$Y_t = \alpha_1 + bS_t + \varepsilon_2$ _____2)

t= time period i.e. 2012-13 to 2021-22. No of observation (n)= 10

In equations 1) and 2) α, β, α_1, b are the parameters to be estimatedε_1 and ε_2 are residual terms.

Y_t= SDP_index

H_t= Hard_infra_index

S_t= soft_infra_index

By using the ordinary least square method the values of parameters are estimated. The estimated value of β and b determine the changein hard infrastructure on SDP and change in soft infrastructure on SDP in equation 1) and 2) respectively.

Process of estimating the parameters

After minimizing the sum square of residual in equation 1), we get two normal equations-

$\Sigma Y_t = n\alpha + \beta \Sigma H_t$ _____ 3)

$\Sigma Y_t \times H_t = \alpha \Sigma H_t + \Sigma H^2_t$ _____4)

Solving these two equations we get the value of α hat and β hat.

We have $\hat{\beta} = \frac{\Sigma(Ht - \bar{H})(Yt - \bar{Y})}{\Sigma(Yt - \bar{Y})^2}$

$\hat{\alpha} = \bar{Y} - \hat{\beta}\bar{H}$

$\hat{Y} = \hat{\alpha} + \hat{\beta} H_t$

In terms of Sample Regression Function the observed Y can be expressed as

$Y_t = \hat{\alpha} + \hat{\beta} H_t + \varepsilon_{1t}$

Estimated value of the variance of error term ε_1

$\widehat{\sigma^2} = \frac{\Sigma\, \varepsilon 1t\hat{}2 - RSS}{n-2}$ where RSS = Y_t - $\hat{Y}$and n-2 is the degree of freedom as there are two parameters in this model.

$Var\hat{\beta} = \frac{\sigma^2}{\Sigma(Ht - \bar{H})\hat{}2}$ $SE(\beta) = \sqrt{(Var(\hat{\beta})}$ he goodness of fit is measured by $R^2 = \frac{ESS}{TSS} = \Sigma\hat{\beta}^2 \frac{\Sigma(Ht - \bar{H})^2}{\Sigma(Yt - \bar{Y})^2}$

Following the same process value of α_1 and b can be estimated.

Testing for β

Here the null hypothesis is

β= 0 (it means there is no relation between hard infrastructure and SDP of Tamil Nadu)

Alternative hypothesis is

β1>0 (it means there is a positive relation between hard infrastructure and SDP of Tamil Nadu)

In this case test statistics is given by "t" $= \frac{\hat{\beta}}{SE\ OF\ \hat{\beta}}$ here we use "t" statistics as the standard deviation of population is unknown.)

The null hypothesis will be rejected for the given observation if the observed value of t is greater than the tabulated value of t at 95% confidence interval i.e.

t_obs>t_(α,n-2) here α is the level of significance

t_obs>t_(0.05,)8

Similarly for equation 2) null hypothesis is,

b= 0 (it means there is no relation between soft infrastructure and SDP of Tamil Nadu)

Alternative hypothesis is

b1>0 (it means there is a positive relation between soft infrastructure and SDP of Tamil Nadu)

The reason for rejecting the null hypothesis is the same as above.

ANALYSIS OF DATA:

Table- 1.1: Regression statistics for hard infrastructure

Regression Statistics	***Column1***
Multiple R	0.732526089
R Square	0.53659447
Adjusted R Square	0.478668779
Standard Error	0.212101401
Observations	10

Table-1.2

ANOVA	**Column1**	**Column2**	**Column3**	**Column4**	**Column5**
	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0.416736983	0.416737	9.263497067	0.015975651

Residual	8	0.359896035	0.044987		
Total	9	0.776633018			

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	Coefficient	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.29794501	0.135741922	2.194937	0.059461	-0.0150	0.6109	-0.0150	0.61096
hard infra index	0.8797926	0.2890632	3.043599	0.015976	0.2132	1.5463	0.2132	1.54637

179 **Table- 1.3**

180

181 Using the above methodology, we get a statistically significant relation between hard
182 infrastructure and SDP. The value of the coefficient (β) is 0.8797. Now, as the observed value
183 of 't' 3.04359 is greater than its tabulated value we will reject the null hypothesis with 95%
184 confidence and accept the alternative hypothesis. In other words, it is proved that there is a
185 positive and significant relation between hard infrastructure and SDP. In fact, the value
186 of $R^2$is 0.537 which implies 53.7% of the variance in SDP is explained by the model. Overall,
187 the model is statistically significant.

188 **Table-2.1: Regression statistics for soft infrastructure**

Regression Statistics	
Multiple R	0.943745597
R Square	0.890655751
Adjusted R Square	0.87698772
Standard Error	0.103029337
Observations	10

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190 **Table-2.2**

ANOVA					
	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0.691712664	0.6917127	65.163427	4.0924E-05
Residual	8	0.084920354	0.010615		
Total	9	0.776633018			

191

192 **Table-2.3**

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.212922	0.063950	3.329516	0.010392	0.065454	0.360391	0.065454	0.360391
soft infra index	0.798121	0.098871	8.072387	0.000041	0.570125	1.026117	0.570125	1.026117

In case of soft infrastructure, the value of the coefficient (b) is 0.798. The observed value of 't' statistics 8.072 is greater than the tabulated value and P-value is also less than 0.05. So, we can reject the null hypothesis with 95% confidence. Hence it is proved that there is a positive and statistically significant relationship between soft infrastructure and SDP. Moreover, the value of R^2 is 0.8906 implies that 89.06% of the variance in SDP is explained by the model and therefore the model is statistically significant.

Thus, it is empirically proved that both hard and soft infrastructure have a positive impact on economic growth of Tamil Nadu.

Conclusion

The causal relationship shows that there is a positive relationship between hard infrastructure and SDP as well as soft infrastructure and SDP. The finding of this research is that hard and soft infrastructure both have beneficial effects on the economic growth of Tamil Nadu. To promote economic growth, government expenditure in hard and soft infrastructure is necessary. Improvement in infrastructure will create more job opportunities, enhance the competitiveness of the state and productivity of different economic resources, which in turn raises the SDP of the state.

Here it is noteworthy to mention that our result is based on the data collected for just 10 years.Due to lack of availability of data, growth in no. of airports across the mentioned time period couldn't be traced. Moreover, short run and long run effects cannot be traced separately for both types of infrastructure because the time period is too short to analyse that. For this reason, the degree of association with hard infrastructure and SDP is quite low. In further analysis with increment in time period the strength of relationship between them will increase. Yet, the empirical evidence of our paper suggests that better facilitation of hard and soft infrastructure improves the economic wellbeing of the state.

A few policies to improve infrastructure that have already been taken are the Integrated Urban Development Mission, Tamil Nadu Urban Road Infrastructure Development Programme and Tourism Development. Likewise, some more schemes or policies to develop soft infrastructure can be taken, in future, by the state government for economic growth of the state.

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Appendix

Table1: Data on hard infrastructure

YEAR Col.1	SDP Col.2	RAILWAYS Col.3	NATIONAL HIGHWAYS Col.4	AVAILABILITY OF POWER Col.5	SEAPORTS[1] Col.6	TELEPHONES PER 100 population Col. 7
2012-13	44794362.00	3,943	4,943	7,616	18	116.61
2013-14	8,51,97,558	4,027	4943	8,798	18	108.17
2014-15	8,93,91,507	4,027	4,975	9,275	18	111.14
2015-16	9,67,56,246	4,027	5,006	9,659	19	117.52
2016-17	10,36,76,212	4,027	4,946	10,449	19	118.13
2017-18	11,25,79,344	4,028	5,918	10,584	19	128.41
2018-19	12,04,66,736	4,030	5,918	10,938	19	136.36

2019-20	12,43,83,550	4,031	6,742	10,881	18	116.94
2020-21	12,44,65,002	4,036	6,858	10,119	18	115.45
2021-22	13,42,81,685	4,033	6,858	10,980	18	108.22

Source:Reserve Bank of India, Handbook of Statistics on Indian States, 2023-24 (for col.2-5 & 7)

[1]Ministry of Road Transport and Highways, Basic Port Statistics of India, col.6

Table-2: Data on Soft infrastructure

YEAR col.1	public expenditure on health col.2	COLLEGES & UNIVERSITIES Col.3	SCHOOLS Col.4	total educational institutes col.5 (col.3+col.4)	SCB Col.6	RRB Col. 7	total no. of banks col. 8 (col.6+col.7)
2012-13	5484	2428	56572	59000	8,245	346	8,591
2013-14	6202.0	2518	56828	59346	9,090	372	9,462
2014-15	7696.0	2535	57192	59727	9,847	448	10,295
2015-16	8525.0	2426	57583	60009	10,164	485	10,649
2016-17	8848.1	2426	58033	60459	10,487	558	11,045
2017-18	10864.7	2530	58474	61004	10,851	617	11,468
2018-19	13157.8	2525	59,152	61677	11,206	636	11,842
2019-20	13012.4	2669	58,897	61566	11,829	646	12,475

2020-21	17394.0	2726	58,904	61630	12,028	652	12,680
2021-22	18632.0	2891	58,801	61692	12,094	657	12,751

Source: Reserve Bank of India, Handbook of Statistics on Indian States, 2023-24 (for col.2, 6,7)

All India Survey on Higher Education report 2012-13 to 2021-22 (col.3)

Report on Unified District Information System for Education Plus (col.4)

col.5 & col. 8 author's calculation

Table-3: Soft infrastructure index

YEAR	health index	education index	financial index	soft infra index	SDP INDEX
2012-13	0	0	0	0	**0.00**
2013-14	0.05	0.128528975	0.209375	0.1308377	0.45
2014-15	0.17	0.270059435	0.409615385	0.2826378	0.50
2015-16	0.23	0.374814264	0.494711538	0.3669386	0.58
2016-17	0.26	0.980013616	0.589903846	0.6085938	0.66
2017-18	0.41	0.744427935	0.691586538	0.6150851	0.76
2018-19	0.58	0.994427935	0.781490385	0.786522	0.85
2019-20	0.57	0.953194651	0.933653846	0.8198125	0.89
2020-21	0.91	0.976968796	0.982932692	0.9552476	0.89
2021-22	1.00	1	1	1	1.00

Source: Author's calculation

Table -4: Hard infrastructure index

YEAR	SDP INDEX	RAILWAY_INDEX	HIGHWAY INDEX	POWER INDEX	SEAPORT INDEX	COMMUNICATION INDEX	hard infra index

2012-13	**0.00**	**0**	**0**	**0.00**	**0.00**	**0.299396949**	**0.05987939**
2013-14	0.45	0.021	0.00	0.35	0.00	0	0.074
2014-15	0.50	0.021	0.02	0.49	0.00	0.105356509	0.127208456
2015-16	0.58	0.021	0.03	0.61	1.00	0.3316779	0.398540296
2016-17	0.66	0.998	0.002	0.84	1.00	0.353316779	0.638961126
2017-18	0.76	0.021	0.51	0.88	1.00	0.717985101	0.626093387
2018-19	0.85	0.022	0.51	0.99	1.00	1	0.703641848
2019-20	0.89	0.022	0.94	0.97	0.00	0.311103228	0.448580666
2020-21	0.89	1.000	1.00	0.74	0.00	0.258247606	0.60046046
2021-22	1.00	0.022	1.00	1.00	0.00	0.001773679	0.404814597

312 Source: Author's calculation

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