Determinants of inter-state differences in Economic Development: Exploring the Role of Innovative Efforts

Savita Bhat
Assistant Professor,
Department of HSS & M, NITK, Surathkal,
Mangalore – 575025 Karnataka, India

The objective of the study is to understand the factors responsible for inter-state differences in economic development in India. The study specifically explores the role of innovative efforts, in terms of patent applications filed, in determining the differences in per capita gross state domestic product (GSDP) for the bigger states in India. Other state-level measures representing human capital (health and education based variables) and electricity consumption have also been included as control variables in the analysis. The panel data regression analysis uses data for two consecutive years, 2011 and 2012. Preliminary results indicate that differences in innovative efforts do explain inter-state differences in economic development. Variables representing human capital also turn out to be important in the study.

Introduction

Economic growth and development is a well researched topic in the area of economics. Theories have been proposed that have incorporated technology or innovation as one of the factors that can stimulate economic growth. According to Verspagen (2005), during 1980s and 1990s, there emerged two dominant approaches to the analysis of the relationship between technology and growth, namely, neoclassical (Eg. Solow 1956; Grossman and Helpman, 1994) and new-Schumpeterian or evolutionary theory (Eg. Nelson and Winter, 1982). In a recent work Howitt (2000) proposes a multicountry Schumpeterian growth model where productivity differences due to research and development (R&D) explain cross-country income differences.

These growth models have led to several empirical studies in the context of both developed and developing countries that have tried to understand the factors that affect economic growth (Akcomak and ter Weel, 2009; Banerjee and Roy, 2014). Many of these studies have specially considered the issue of convergence in economic growth (see Verspagen, 2005 for details). In the context of India, recent empirical studies on economic growth and development have invariably adopted variants of the standard growth model over time series data to study factors leading to convergence or divergence amongst states or districts (see Purohit, 2008 for details; Agarwalla and Pangotra, 2011). In a recent article, Bhat and Siddharthan (2013) observe that there is skill bias in the current technological revolution where employment and productivity grow faster in states that are better endowed in terms of human capital. However, in the presence of inter-state migration in India (Chandrasekhar and Sharma, 2014), there is a possibility that high skill labour move from one state to another and contribute to income generation in latter states.

In the light of the above facts, this paper attempts to investigate the factors that explain inter-state differences in economic development for India based on more recent panel data. In particular, the paper tries to understand the role of innovative efforts, defined in terms of patent applications filed, in explaining the income differences between states in India. For the purpose of this study, economic development is defined as gross state domestic product per capita and innovative efforts is defined as total patent applications filed per capita.

Literature Review

One of the indicators of economic development of a country is gross domestic product (GDP) per capita (UN, 2007). This indicator is a basic economic growth indicator and is defined as the sum of value-added of all production units divided by the population. It measures the average level and extent of total economic output. It is a powerful summary indicator of economic development, although it has some limitations. For example, it does not indicate the distribution of the income among the people and also does not account for social and environmental cost of production and consumption. Nevertheless, various studies have used GDP

per capita as an indicator of economic development. In the context of states within a country like India, data on gross state domestic product (GSDP) is available, which is similar to GDP at country level. Researchers like Basher and Lagerlof (2008) have considered GSDP per capita for state level income analysis.

Innovation and Economic Development

Economic theories have given importance to the role of innovation in explaining economic growth and development (Grossman and Helpman, 1994). The proponents of innovation systems approach attempt to understand how innovation affects economic development at national level (Lundvall, 1992; Nelson, 1993; Freeman, 1995) and regional level (Cooke *et. al.*, 1997). They emphasize the role of institutions and interactions in promoting innovation led development. Regional innovation networks lead to economic development as they make firms more competitive to provide higher wages and pay more taxes (Rutten and Boekema, 2007).

Empirical studies in the context of developed countries have suggested a strong influence of technology development or innovation on economic growth and development (Ogburn and Allen, 1959; Akcomak and ter Weel, 2009). Whether a similar relationship holds true for India needs to be explored.

Human Capital and Economic Development

Human capital is considered to be one of the important factors for economic growth and development (Barro, 1991, 2001) as it can directly increase labour efficiency (Banerjee and Roy, 2014). Education and health are considered to be important aspects of human capital formation (Maitra and Mukhopadhyay, 2012). While education can provide returns that could be both monetary and non-monetary (Oketch, 2006), health indicators like infant mortality rate can capture the general level of health, nutrition and wellbeing of the population (Bhat and Siddharthan, 2013). Higher education indicators can be used as a proxy for quality of labour or skill formation (Maiti and Mitra, 2010).

Empirical studies in the context of developing countries have found a positive relationship between education and income inequality (De Gregorio and Lee, 2002; Paweenawat and McNown, 2014). Studies have also found health expenditure (Maitra and Mukhopadhyay, 2012) and health capital (Knowles and Owen, 1995) to have positive effect on income.

Some recent studies have also explored the role of introduction of information and communication technology (ICT) in schools on residential adoption (Mo *et. al.*, 2013) and its spill-over effects outside schools (Tengtrakul and Peha, 2013). The studies did find favourable effects of ICT in schools on skills of the students and on spill-over effects outside the school in terms of adults in the household using ICT.

Electricity Consumption and Economic Development

The empirical studies dealing with the relationship between energy consumption, including electricity consumption and economic growth are indecisive with regards to the direction of causality (Ozturk, 2010). Nevertheless, the proponents of positive causality from energy consumption to economic growth suggest that energy can be considered to be another essential factor of production along with labour and capital. Hence, increase in availability or consumption of energy can contribute to economic growth both directly and indirectly.

Studies in the context of India have found that differences in infrastructure, including availability of electricity have resulted in differences in regional development (Ghosh and De, 2005). Infrastructure can affect economic growth both directly and indirectly. For the pre-liberalization period (1957-1991) in India, Datt and Ravallion (1998) found that states starting with better infrastructure had significantly higher long-term rates of poverty reduction. Electricity and other rural infrastructure have more direct impact on economic growth and development in a region. Electrification enables employment and income generating activities, where people build assets and production units to achieve better cash flows. It may also encourage rural entrepreneurship (Cook, 2011).

Data, Sample and Descriptive Statistics

For the purpose of analysis secondary data has been collected from various publicly available government documents. Data for two consecutive financial years, 2011 and 2012 has been collected for 18 bigger states of India (excluding Delhi).[1] The details on the sources of data are in Appendix I. Suitable measures have been constructed to capture innovation, education, health, infrastructure and economic activity. Table 1 gives the definitions of the variables. In this study human capital related variables, that is, education and health variables have been included in terms of input as well as outcome measures in different econometric models, since there could be differences in input and the actual outcome (Knowles and Owen, 1995).

Table 1: Definitions of the Variables

Sl.	Variable	Symbol	Definition
1.	Gross State Domestic Product Per Capita	GSDPPC	Ratio of Gross State Domestic Product at 2004-05 prices in Rs. Crore to the Projected Population of the State in Thousands
2.	Total Patents Per Capita	TPAT	Ratio of Total Patent Applications Filed in numbers in the given State to the Population of the State in Lakhs
3.	i) Schools with Computers	SCH_CMP	Percentage of Schools with Computers in the State
	ii) Higher Education	HEDU	Number of Colleges per Lakh Population of 18-23 Years in the State
	iii) General Education Investments Per Capita	GEDU	Ratio of Inflation Adjusted Revised Outlay on General Education by the State Government in Rs. Crore to the Projected Population of the State in Thousands
4.	i) Infant Mortality Rate	IMR	Number of deaths of infants below one year old per 1000 live births in a given year for the State
	ii) Medical and Public Health Investments Per Capita	MED	Ratio of Inflation Adjusted Revised Outlay on Medical and Public Health by the State Government in Rs. Crore to the Projected Population of the State in Thousands
5.	Electricity Consumption	ELEC	Consumption of Electricity in MWh per Capita

Table 2 gives the descriptive statistics for the sample. An interesting aspect to note is that on an average only around 25 percent of the schools in the big states have computers. The average IMR is also quite low at around 40. On an average the states seem to be investing higher amount on general education as compared to medical and public health.

Table 2: Descriptive Statistics (Number of Observations = 36)

Sl.	Variables	Mean	Standard Deviation	Sl.	Variables	Mean	Standard Deviation
1	GSDPPC	4.38	1.57	5	GEDU	2.47	2.06
2	TPAT	0.58	0.66	6	IMR	40	12.59
3	SCH_CMP	25.68	23.17	7	MED	0.98	0.62
4	HEDU	24.25	11.83	8	ELEC	0.945	0.454

Econometric Models and Results

The data is a balanced panel data consisting of 18 states and 2 years. Hence, panel data regression model has been used for the analysis. Following Baltagi (2005), the econometric model is specified as follows:

[1] The Bigger States are identified as per the classification given in Sample Registration System (SRS) Bulletin September 2013. The Bigger States considered are Andhra Pradesh, Assam, Bihar, Chhattisgarh, Gujarat, Haryana, Jammu and Kashmir, Jharkhand, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Odisha, Punjab, Rajasthan, Tamil Nadu, Uttar Pradesh and West Bengal. In this study, Delhi is not considered although it is classified under Bigger States in SRS Bulletin 2013.

$$y_{it} = \alpha + X'_{it}\beta + u_{it}$$

where y is the explained variable, namely, gross state domestic product per capita (GSDP_PC) and X is the vector of relevant explanatory variables from Table 1. The value of i ranges from 1,..., 18 (representing the states) and t takes the value 1 and 2 (for the years, 2011 and 2012, respectively). α is a scalar, β is coefficient on the explanatory variables and u is the stochastic error. Hausman specification test (Baltagi, 2005) is used to choose between fixed and random effects model. Statistical analysis has been carried out in STATA version 10 statistical package. The coefficients of the explanatory variables representing innovation (TPAT), education (SCH_CMP, HEDU, GEDU), investment on medical and public health by state (MED) and electricity consumption (ELEC) are expected to have positive sign. The coefficient on the variable IMR is expected to have a negative sign.

Table 3 presents the correlation matrix for the variables used in this study. All the variables expect the one representing higher education (HEDU) is correlated to economic development indicator, namely, per capita gross state domestic product (GSDPPC). Since IMR has high correlation even with some of the other explanatory variables like TPAT and SCH_CMP, hence the econometric models with IMR and these variables need to be interpreted with caution. The alternative for IMR is the input variable MED.

Table 3: Correlation Matrix

	GSDPPC	TPAT	SCH_CMP	HEDU	GEDU	IMR	MED	ELEC
GSDPPC	1.00							
TPAT	0.66*	1.00						
SCH_CMP	0.74*	0.54*	1.00					
HEDU	0.54*	0.57*	0.51*	1.00				
GEDU	0.08	-0.29*	-0.30*	-0.09	1.00			
IMR	-0.62*	-0.66*	-0.78*	-0.25	0.23	1.00		
MED	0.46*	0.12	0.12	0.17	0.52*	-0.05	1.00	
ELEC	0.70*	0.29*	0.43*	0.53*	0.28*	-0.25	0.43*	1.00

* indicates statistical significance at 10% level.

Table 4 presents the results for the econometric models where each of the above variables has been introduced individually into the model. All the variables including the variable representing innovative efforts (TPAT) are statistically significant with expected signs.

Table 4: Determinants of inter-state differences in Economic Development (GSDPPC)

Regressors	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**	**Model 7**
Constant	3.48 (9.53)[a]	3.23 (9.22)[a]	3.13 (4.92)[a]	3.60 (7.95)[a]	7.64 (9.29)[a]	3.61 (8.63)[a]	1.68 (3.63)[a]
TPAT	1.56 (3.90)[a]	-	-	-	-	-	-
SCH_CMP	-	0.04 (4.76)[a]	-	-	-	-	-
HEDU	-	-	0.05 (2.3)[b]	-	-	-	-
GEDU	-	-	-	0.31 (3.37)[a]	-	-	-
IMR	-	-	-	-	-0.08 (-4.26)[a]	-	-
MED	-	-	-	-	-	0.79 (3.12)[a]	-
ELEC	-	-	-	-	-	-	2.85 (7.23)[a]
Number of Observations	36	36	36	36	36	36	36
Wald Chi^2	15.20[a]	22.62[a]	5.27[b]	11.33[a]	18.11[a]	9.72[a]	52.25[a]
Fixed/Random Effects (Hausman Test Based)	Random Effects	Random Effects	Random Effects	Random Effects	Random Effects	Random Effects	Random Effects

[a], [b], [c] represent statistical significance at 1%, 5% and 10% respectively
z-statistics is in parenthesis

Table 5 presents the result for the econometric models which explore the relationship between innovative efforts and economic development in the presence of other variables representing human capital, that is, education and health, and electricity consumption for the large states in India. In each of the econometric models, innovative efforts are statistically significant with positive sign. Econometric model 11 has the highest Chi^2 value among all.

Table 5: Effect of Innovative Efforts (TPAT) on Economic Development (GSDPPC) in the presence of Education, Health and Electricity Consumption

Regressors	Model 8	Model 9	Model 10	Model 11	Model 12	Model 13
Constant	2.46 (2.29)[b]	2.98 (3.01)[a]	3.02 (3.26)[a]	1.57 (4.47)[a]	1.46 (3.05)[a]	1.43 (3.59)[a]
TPAT	0.80 (2.51)[b]	0.85 (2.41)[b]	0.82 (2.63)[a]	0.86 (3.21)[a]	1.01 (3.03)[a]	1.05 (3.57)[a]
SCH_CMP	0.01 (0.98)	-	-	0.02 (2.43)[b]	-	-
HEDU	-	-0.006 (-0.38)	-	-	0.003 (0.15)	-
GEDU	-	-	0.13 (2.08)[b]	-	-	0.10 (1.52)
IMR	-0.02 (-0.89)	-0.03 (-1.57)	-0.03 (-1.89)[c]	-	-	-
MED	-	-	-	0.36 (1.98)[b]	0.25 (1.25)	0.16 (0.91)
ELEC	2.01 (5.13)[a]	2.22 (5.68)[a]	1.86 (4.56)[a]	1.57 (3.81)[a]	2.15 (4.93)[a]	2.05 (4.92)[a]
Number of Observations	36	36	36	36	36	36
Wald Chi^2	82.66[a]	78.59[a]	92.41[a]	97.54[a]	75.58[a]	83.11[a]
Fixed / Random Effects (Hausman Test Based)	Random Effects	Random Effects	Random Effects	Random Effects	Random Effects	Random Effects

[a], [b], [c] represent statistical significance at 1%, 5% and 10% respectively
z-statistics is in parenthesis

Thus, higher innovative efforts by the firms and researchers in the state do imply higher economic development in the states. In this study, the large states with higher values on total patents as well as total patents per capita happen to be Maharashtra, Tamil Nadu and Karnataka. One needs to explore further as to the reasons behind these states having higher total patents as compared to other states.

The variable representing percentage of schools with computers is also determining inter-state differences in economic development. When the school children are exposed to latest technologies like computer, their skills improve. The households of these children also get exposed to computer and other latest technologies including information and communication technologies. This in turn may help them bring in efficiencies in their work. General education is also important as more educated the people in a state are more informed will be their decisions regarding economic activities. Furthermore, familiarity with internet makes children motivated for higher education and better employment.

The variables representing health aspect of human capital, IMR and MED, are statistically significant in the econometric models 10 and 11 respectively. A healthy population in general implies more productive labour and hence higher economic development in the state.

Higher electricity consumption is also turning out to be an important determinant of inter-state differences in economic development. Electricity is used for various economic activities in both rural and urban areas. Presence of electricity would imply that the firms can use more capital intensive techniques as compared to labour intensive, thereby increasing the productivity of the firm. Furthermore, availability of electricity can increase production activity late in the evening and sometimes beyond mid night.

Conclusion

This study tried to understand the factors responsible for inter-state differences in economic development in India. The study specifically explored the role of innovative efforts, in terms of patent applications filed, in determining the differences in per capita gross state domestic product (GSDP) for the bigger states in India. One of the important findings was that innovative efforts are an important determinant of inter-state differences in economic development. Electricity consumption per capita has also turned out to be an important factor in explaining inter-state difference in economic development.

One needs to understand the reasons behind higher innovative efforts in some states as compared to others. In the light of the innovation systems approach, there is evidence that state like Maharashtra does have institutions that are helping small and medium enterprises (SMEs) in terms of funding, helping in filing patents and even building intellectual property (FICCI, 2012). Thus, one can further explore the role of strong institutions and networks in promoting firms in the state, which ultimately would lead to economic development in the state.

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Appendix I

Sources of Data

Sl.	Measure	Source
1.	Gross State Domestic Product at 2004-05 prices in Rs. Crore	Planning Commission, Government of India.
2.	Projected Population of States	Central Bureau of Health Intelligence, Ministry of Health and Family Welfare, Government of India.
3.	State-wise Total Patent Applications Filed	Annual Reports of The Office of the Controller General of Patents, Designs, Trademarks and Geographical Indications, Department of Industrial Policy & Promotion, Ministry of Commerce & Industry, Government of India.
4.	State-wise Percentage of Schools with Computers	State Report Cards, District Information System for Education (DISE), National University of Educational Planning and Administration (NUEPA), New Delhi, India.
5.	State-wise Number of Colleges per Lakh Population of 18-23 years	Report on All India Survey on Higher Education, Department of Higher Education, Ministry of Human Resource and Development, Government of India.

6.	Revised Outlay on General Education by State Governments	State Plans, Planning Commission, Government of India.
7.	Infant Mortality Rate	Sample Registration System (SRS) Bulletins, Office of the Registrar General & Census Commissioner, Ministry of Home Affairs, Government of India.
8.	Revised Outlay on Medical and Public Health by State Governments	State Plans, Planning Commission, Government of India.
9.	State-wise Consumption of Electricity in MWh per Capita	Statistical Year Book, Ministry of Statistics & Program Implementation, Government of India.
10.	Whole Sale Price Index with 2004-05 =100 as base	Office of Economic Adviser, Department of Industrial Policy & Promotion (DIPP), Ministry of Commerce & Industry, Government of India.