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Federalism, fiscal asymmetries and economic convergence: evidence from Indian States

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Abstract This paper tests economic convergence across States in India by incorporating federal fiscal asymmetries and differentials in gross fixed capital formation at the state level. Using dynamic panel models, it is observed that there is no unconditional convergence of economic growth. Controlling for state-wise asymmetries in fiscal policy variables, financial parameters, capital formation and human development outcomes using Arellano and Bond (JAMA 58: 277–297, 1991) panel data methodology, no strong evidence for conditional convergence is observed. It is observed from the GMM estimations that public capital spending has positive and significant relationship with economic growth. It is also observed that the quality of human capital formation is a pre-requisite for economic growth, both for club and (aggregate) conditional convergence.

Keywords Economic convergence · Asymmetric federalism · Dynamic panel estimation · GMM · Fiscal policy

JEL Classification C33 · E62 · H77 · R11 · R58

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1 Evidence from Indian States

India is a federal country with 29 States and seven centrally administered Union Territories. These States are at asymmetric levels of economic and social development. In a federal setup, asymmetries can be vertical (between Centre and the States) and horizontal (among the States). Theoretically, federations are seen as 'indestructible union of indestructible states'. However, empirical evidences show that such federations are rare. In a federal system, fiscal asymmetries are a complex outcome of constitutional division of resources and responsibilities across levels of governments. From fiscal federalism perspective, we try to analyse whether there is economic convergence across States in India over the years controlling for asymmetries in fiscal and social outcomes.

Economic convergence means that a state that starts off at low-growth performance levels should see a "catching-up" growth process with the states which had better starting points. Empirical evidences are inconclusive about economic convergence and these mixed results depended on the sample of countries, methodology, time period and type of convergence (conditional or unconditional convergence) at country level (Barro 1991; Barro and Sala-i-Martin 1992; Pesaran 2007; Rodrik 2011; Rodrik 2013). The unconditional convergence implies that poorer states will grow, on average, faster than richer ones; and the conditional convergence implies that this will only be true if account is taken of other factors such as human capital attainment, and other such attributes of an economy because they determine the steady-state equilibrium level of per capita GDP towards which countries converge (Roy et al. 2016). In Indian context, studies observed lack of unconditional convergence but some evidence of weak conditional convergence (Ahluwalia 2000; DeLong 2001; Rodrik and Subramanian 2004; Williamson and Zagha 2002; Ghosh et al. 1998) depending on the structure of econometric model.

In this paper, we make contributions to the existing literature on economic convergence on India in three ways. One, we have incorporated variables relating to federal fiscal asymmetries in the convergence model. Two, we have econometrically tested spatial convergence for coastal and inland states[1] separately incorporating macro-fiscal and financial variables along with human capital formation. Three, previous studies in India have not examined the impact of spatial factors such as State-level gross fixed capital formation on State-level growth convergence. We fill this gap in the literature.

[1] Empirical studies have highlighted the crucial role of geographical locations, a way of analysing the club convergence, in the development of a country and historically it has been found that the coastal regions experience faster economic convergence compared to inland areas due to their exposure to international trade (Lemoine et al. 2015; Krugman 1991).

The State-level investment data are obtained from the Reserve Bank of India Publication titled *Handbook of Statistics on Indian States* (2017).[2] As mentioned above, we have undertaken convergence analysis at the disaggregated levels for coastal and inland states, apart from the all-state analysis of conditional convergence. There are nine coastal states in India, viz., Andhra Pradesh, Goa, Gujarat, Karnataka, Kerala, Maharashtra, Odisha, Tamil Nadu and West Bengal. In this study, we test for convergence in per capita Gross State Domestic product (GSDP) for all India, coastal states and inland states, controlling for fiscal asymmetries and level of investment at the state level. The social sector asymmetries or the differences in human development outcome are also incorporated to test for spatial and conditional convergence in social and human development achievements across states.

The paper is organised in four sections. Section 1 reviews the literature relating to political and economic asymmetries and convergence in India. Section 2 undertakes an exploratory data analysis of social, fiscal and economic asymmetries across states in India. This section also discusses the methodology. Section 3 interprets the data and provides analysis of unconditional convergence. Section 4 econometrically analyses the conditional convergence controlling for asymmetric federal structure, clubbing Indian States into inland and coastal States. In Sect. 5, we draw conclusions.

2 Review of literature on asymmetric federalism and convergence

Globally, there is a renewed interest in analysing political and economic rationale of asymmetric federalism as an optimal eco-political area. Why nations federate? Why various jurisdictions "come together" to form a federation? Alsenia (2017) has analysed the extent of economic convergence, controlling for cultural and institutional heterogeneity within the European Union and how this has changed intertemporally. The main challenge posing further political integration in Europe may be "national identities". Such cleavages have started appearing even in the well-functioning federations such as USA very recently with Trump's protectionist policies. In India, quite contrary to European Union, it was not the benefits of a large market with free trade and integration in terms of economies of scale that motivated the units to federate, amidst the heterogeneities of preferences, but the political considerations. Such political considerations for nations to federate, which could be the benefits related to climate change commitments, defense against terrorism, foreign policy, research and innovation, securing energy supplies, a common army against external aggression and promoting peace, democracy and security (European Commission 2016). In India, it was on the basis of 'linguistic' considerations that jurisdictions in

[2] The first edition of the Handbook of Statistics on Indian States was published in 2015–2016. The second edition of Handbook of Statistics on Indian States 2016–2017 (2017) was released in June 2017 with a view to providing State-wise statistics on a wide range of features of the regional economy of India, viz., social and demographic characteristics, state domestic product, agriculture, industry, infrastructure, banking and fiscal developments. The second edition has further updated of the existing data series and improved the coverage of infrastructure. This publication has also started providing data on state-level gross capital formation and gross fixed capital formation.

an asymmetric federation were formed. Rao and Singh (2004) noted that symmetry in intergovernmental relations may not be possible in such processes as each federating unit will try to bargain terms advantageous to it to join the federation irrespective of the fact that the federation will try to attract entry and control exit.

2.1 Political asymmetry

The asymmetry can arise from unequal federal arrangements that are "discretionary" and "rule-based". The former relates to the administrative and political discretion in decision making and expediency. The differentials in the bargaining power of jurisdictions during the process of federation can be a source of political asymmetry (Rao and Singh 2004). If such asymmetry is established by institutions, the Constitution or by tradition, it is referred to as de-jure asymmetric federalism. On the other hand, if asymmetries are build-in at the practical levels, it is referred to as de-facto asymmetric federalism. If such de-facto asymmetries are evolved from short-term political expediency, political arbitrage and administrative discretion, it can lead to secular decline in the intergovernmental fiscal transfer (IGFT) institutions in the long term (Rao and Singh 2004).

The Cabinet Mission (1946) recommended that undivided India should be governed by a federal Constitution with national government dealing with foreign affairs, defense and communications and the remaining functions at the subnational government levels. The Cabinet Mission (1946) saw no virtue in partitioning undivided India into two independent country based on religion (Rao and Singh 2004). To "hold together" a nation with cultural and linguistic diversity, it was identified that a strong central government was necessary and to avoid centripetal tendencies to form confederation. While forming an independent nation, it was relatively easy for the territories ruled directly by the British to be integrated into the Union than the integration of the "Princely States" (the treaties of accession signed by the individual rules).

The de-jure asymmetry in Indian federalism can be traced to the Constitution that was adopted in 1951, classified the states into four categories; (i) provinces directly ruled by the British (Part A states), (ii) the princely States which had a relationship with the Government of India based on individual treaties (Part B States) which included the States of Hyderabad, Mysore, Jammu and Kashmir and five newly joined unions of princely states, and Jammu and Kashmir, special powers were given in the terms of accession; (iii) the remaining princely States acceding to the Union were grouped (Part C states) and (iv) the territories ruled by other foreign powers gaining independence (French and Portuguese) and areas not covered in the above three categories were brought under the direct control of the Union (Part D states or Union Territories) (Rao and Singh 2004). The political symmetry in Indian federalism can be traced back to this classification, where the terms of accession differed depending on the bargaining strength. It is also to be noted that the "Princely States" surrendered their "notional sovereignty" in exchange of "privy purse" (a guaranteed revenue stream). This asymmetric bargain of the princely States to join Indian federation was for security and finance in exchange of freedom and the residual control

rights. Only one exception to the voluntary accession was Hyderabad where military force ensured integration into the new Union (Rao and Singh 2004; Chanda 1965).

Jammu and Kashmir is an exception, as per the Article 370 of the Constitution which provided the State with a unique position in the Indian Union. Contrary to the process of administrative re-organisation of India based on the principle of language, north eastern part of India (Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim and Tripura) is an exception due to its distinct differences in ethnicity from rest of India. The upgradation of these States from the status of Union Territories gave them political status equivalent to that of larger States such as Bihar, Madhya Pradesh and Uttar Pradesh, providing equal weight in mustering the 50% of States required to ratify an amendment to the Constitution (Rao and Singh 2004; Arora and Gangopadhyay 1995).

2.2 Economic asymmetry

Whether federalism per se leads to economic integration among the subnational units is a matter of debate. However, in India, federal transfer system played a critical role in reducing fiscal inequality among the States (Chakraborty et al. 2018). Although the transfer system remained progressive, the large fiscal asymmetry among the States continues to remain a major challenge. We argue in this paper that any analysis of growth convergence should take these fiscal asymmetries across States into consideration.

2.2.1 Unconditional convergence

As mentioned above, if the growth rate of low-income states and high-income states tend to converge over a period of time, then it is said to have convergence. If the level of income converges without any control factors, then there is unconditional convergence. One of the earliest attempts to analyse the economic convergence empirically was by Barro (1991) and Barro and Sala-i-Martin (1992). Analysing the data for 98 countries for the period 1960–1985, Barro (1991) found no relationship between per capita growth and initial level of per capita GDP implying there was absence of unconditional convergence.[3] Rodrik (2013) showed that unconditional convergence does exist but it exists only in modern parts of the economy rather than economy as a whole. He found the occurrence of convergence of labour productivity in manufacturing activities irrespective of spatial location and country level influences.[4] In contrast to findings of Rodrik (2013), Barro (2016) observed the absence

[3] However, a strong negative correlation was found between the two when it was controlled for initial level of human capital (proxied by school enrollment rates at secondary and primary levels). Furthermore, he found inverse relationship between growth and share of government in consumption and positive relationship between growth and political stability.

[4] To analyse the industry-wise convergence across countries, he utilised United Nations Industrial Development Organisation (UNIDO) Industrial Statistics database 4 (INDSTAT4) for the period 1990–2011. He utilised the data either for 10-year time horizons and 5-year time horizons. Depending on the time horizon, the unconditional convergence is estimated to be in the range of 3–5.6% per year. The findings showed the existence of strong convergence for labour productivity in manufacturing even in the absence

of unconditional convergence.[5] Challenging the findings of Barro and Sala-i-Martin (1992) and Barro (2016), Roy et al. (2016) tested the existence of unconditional convergence and the notion of middle income trap. In their study, they examined two types of convergence: a classic Solow model where poorer countries catch up by growing faster (S-convergence); and Wilde model in which poorer countries grow faster than the frontier country (the US in their study) (W-convergence).[6] All the aforementioned studies have examined beta-convergence, which refers to the speed at which output growth of a country converges over time.

Barro and Sala-i-Martin (1992) analysed the neo-classical model of convergence, i.e. whether there is an inverse relationship between per capita growth rate and initial level of per capita income in the context of US States for the period 1840–1988 and the results demonstrated the existence of unconditional convergence. However, for the 98 countries under study, the study found only conditional convergence, i.e. after controlling for initial school enrollment rates and the ratio of government consumption to GDP.

Distinguishing between σ convergence (which is fall in the dispersion of real per capita income across countries) and β convergence (when the growth of per capita income of poor countries is higher than that of rich countries), Young et al. (2013) demonstrated that β-convergence is necessary but not sufficient condition for σ-convergence. Based on 3058 county level data for the US for the period 1970–1998, their results indicated the presence of β-convergence and σ-divergence at the same time.

Footnote 4 (continued)
of any control variables. The convergence was found to be even stronger when the model was controlled for country-specific determinants such as policies and institutions. Further, he concluded that the lack of convergence in economic growth was not due so much to economy-wide mis-governance or endogenous technological change, but due to the circumstances that influence the speed of structural reallocation from non-convergence to convergence activities and, therefore, policies should focus on the speed of reallocation.

[5] Based on two data sets (first for the period 1960–2010 and the other for much longer period of 1870–2010), he assessed China's past and future prospective growth. The control variables taken in the model were life expectancy at birth, total fertility rate, indicators of law and order and democracy, ratios to GDP of investment and government consumption, female and male average years of school attainment, the openness ratio (exports plus imports relative to GDP), a measure of changes in the terms of trade and the inflation rate. His findings showed that while initial life expectancy, the law and order indicator, the investment ratio, international openness and improvements in terms of trade have positive effects on growth, initial fertility rate and inflation rate had negative impact on growth. Further, he found that China's growth since 1990 has been quite impressive. Nonetheless, it cannot escape the 'iron law of convergence'; the results showed significant negative convergence coefficient for China.

[6] Utilising the Penn World Tables (version 8), the World Bank Development Indicators and the Maddison data, they examined the S-convergence and W-convergence at the country level. They investigated this issue based on three types of inequality as defined by Milanovic: between countries, between people assuming that income distribution within a country remains unchanged, and between people accounting for changing income distribution with countries. Their findings refuted the earlier findings that there existed only conditional convergence; the results showed that there was enough evidence of unconditional convergence for both S-convergence and W-convergence. The countries have started to converge since 1995 and it is stronger since 2005. Further, they found that people converge and the process of convergence is faster when it is weighted for population.

2.2.2 *Conditional convergence*

A wide array of studies has noted the existence of conditional convergence, which essentially implied that economies would have different levels of economic growth in the long run (Acemoglu and Robinson 2009; Durlauf et al. 2005). Pesaran (2007) noted that beta-convergence is not a useful criterion for the analysis of output convergence within a given economy or cross-country output convergence once the stochastic nature of the technological process is taken into account. To overcome this problem, he suggested the use of pair-wise output gaps for testing the cross-country convergence. He proposed the probabilistic version of output convergence, for which the converging economies need not be identical in all respects (saving rates, population growths and initial endowments. He suggested the use of log per capita output gap (which is useful in stochastic Solow-type growth models) rather than per capita output gap (which is more useful in studying cross-country income inequality). According to him, log per capita output gap should be a stationary process for two countries to be convergent. His findings showed no evidence of log per capita output convergence at a global level. However, there was some evidence of club convergence, which referred to countries with pair-wise output gaps that were stationary with a constant mean.

Following the pair-wise approach of Pesaran (2007), Le Pen (2011) also analysed the convergence for 195 European regions for the period 1980–2006. His findings showed that shocks to output gap have only a transitory effect and there is persistence in the relative positions of countries. Therefore, policy to counter these shocks is not quite necessary. Further, his findings did not suggest the presence of any convergence.

Extending the pair-wise approach, Beylunioglu et al. (2016) argued that the convergence hypothesis, which states that the income differences are transitory and the developing economies will catch up the developed ones in the long run, holds true only for a group of countries that share some common characteristics. To overcome this problem, they defined groups on the basis of geographic or economic developmental status and data availability. They used pair-wise approach of Pesaran with a maximal clique algorithm to establish a set of statistical criteria for cluster formation. The results indicated the same pattern as in the single club simulations. Further, his findings showed that KPSS method with the maximal clique extension demonstrated large over-forecasting tendencies. One of the problems of conventional convergence studies is that all of them implicitly assume identical growth processes among all the countries/regions, which is often not the case. Therefore, it is important to examine heterogeneity in convergence.

Using the county level data for 22 US states, Young et al. (2013) investigated the heterogeneity in convergence rates after controlling for a large number of demographic and socio-economic variables. He found an average convergence rate of 9.2% for 22 individual states and convergence rate above 5% was found for 15 states. Thus, the result highlighted substantial heterogeneity in individual state convergence rates suggesting proper policies to encourage balanced growth.

2.2.3 Club convergence and spatial effects

One of the key dimensions often missed in the convergence analysis is spatial imbalances, which is one of the major determinants of economic growth. Therefore, as suggested by Lemoine et al. (2015), spatial conditions need to be taken into account while carrying out convergence analysis. They carried out the convergence analysis for industrial performance of inland and coastal regions of China. The findings revealed the flying geese model is at work for China. The economic growth in inland areas is catching up the economic growth of coastal areas. The convergence process in manufacturing between the two has started since late 1990s and the process has been faster post 2005 period. The result supports Rodrik (2013) findings of unconditional convergence in manufacturing industry. In Indian context, Chikte (2011) tested σ-convergence for 15 major states for the period 1991–2005. A time trend was fit to standard deviation of per capita state domestic product for convergence analysis. The results indicated σ-divergence for the whole period and among input variables, only literacy rate showed evidence of convergence.

Utilising non-stationary panel data techniques, Kalra and Sodsriwiboon (2010) also examined the convergence and spillovers across Indian States. Their study also found evidence of divergence for the period from 1960 to 2003. However, convergence was found for the sub-period related to structural breaks. Further, they also examined club convergence and they found strong evidence of club convergence among the high-income and low-income states. Nayyar (2008) also examined economic growth for major Indian States for the period from 1978–1979 to 2002–2003. He found that states are not converging to identical levels of per capita income in the steady state. Once the factors affecting steady state are controlled for, the poor states grow faster than the rich. There is paucity of literature on convergence analysis at the state level in India. Chikte (2011) used standard deviation to test convergence across states. However, as the literature suggest, this method fails to control for the time effect. At the same time, it cannot be applied to test for conditional convergence, i.e. controlling for other factors which might affect the per capita state domestic product.

Cherodian and Thirlwall (2015) examined the regional disparities in per capita income, measured as gross state domestic product per capita in India for the period 1999–00–2010–2011 by estimating cross-section equations for unconditional and conditional beta (β)-convergence across 28 states and four union territories. Mishra and Mishra (2017) analysed the conditional income convergence hypothesis for 17 major states in India for the period of 1960–2012 using univariate stationarity tests. Their findings of stationarity tests without structural breaks confirm convergence hypothesis. However, when multiple structural breaks are incorporated in unit root tests of in per capita income series, the incomes of only around 11–13 states are found to stochastically converge to the national average, supporting the convergence hypothesis. Ghosh (2012) examines the economic convergence of 15 major states

in India, and examines during the period 1960–1961 to 2006–2007. Their results revealed that in the post-reform period, since 1991, the states have diverged in per capita income. The existing literature has not explored the economic convergence within a federal fiscal framework, clubbed the units into coastal and inland states. Our paper takes this literature forward by incorporating economic and fiscal asymmetries, in addition to the financial and socio-demographic variables at disaggregate level based on the economic geography of the states.

3 Data and methodology

Since we are dealing with state level macro aggregates in this study, it is important to mention about the regional accounting framework in India. Our review of the accounting framework shows that "The State Accounts statistics are an extension of the system of National Accounts to the regional level. These comprise of various accounts indicating the flows of all transactions within a time period between the economic agents constituting the State economy and their stocks. These accounts include various items such as total output of the economy, the intermediate expenditure, State domestic product, factor incomes, consumption expenditure, capital formation, capital stocks and CFC."[7] The most important aggregate of the State accounts is the Gross States domestic product (GSDP) or the State income. As mentioned, compilation of other aggregates and State accounts is also problematic, due to the absence of requisite data, particularly on the inter-State flows of incomes.[8] Regional accounting framework below the regions smaller than States, such as districts, is not available. The data for the paper are organised from various data sources (Table 1) including the regional accounts provided by the Ministry of Statistics and Programme Implementation.

The time span of the study is 2001–2014 after adjusting for the data gaps in all the variables. It is an unbalanced panel data analysis. The unit of analysis is 28 States of India, excluding Telangana, a newly formed State.[9] We have used Central Statistics Office (CSO) 2004–2005 series data for State's Gross State Domestic Product (GSDP). The data on social indicators such as Literacy Rate, Total Fertility Rate (TFR) and Infant Mortality Rate (IMR) are taken from Census 2011. The fiscal variables are organised from the Finance Accounts of various States for the period under study. The public investment-related variables and credit variables are also collated from CSO and the Reserve Bank of India.

Following Sala-i-Martin's (1996) methodology, we have used β-convergence as in Eq. (1).

$$\ln(\mathrm{yit}) = \alpha + (1-\beta)\ln(\mathrm{yi},\ \mathrm{t}-1) + \mu\mathrm{it} \tag{1}$$

[7] http://mospi.nic.in/137-regional-accounts.

[8] http://mospi.nic.in/137-regional-accounts.

[9] The Telangana State was carved out of the erstwhile State of Andhra Pradesh on 2nd June 2014.

Table 1 Database, 2001–2014. *Source* Author's compilations

Variable	Details	Database
Lnpci	Log (initial per capita income)	National Income Accounts, State-level GSDP data, Central Statistical Office, Government of India
lnpc CAPEX	Log (public capital spending)	State Finance Accounts data, Comptroller and Auditor General's Office
ln GFCF	Log (Gross fixed capital formation)	Handbook of Indian Economy on State Finances published by Reserve bank of India, Mumbai
CDR	Credit–deposit ratio	Handbook of Indian Economy on State Finances published by Reserve bank of India, Mumbai
ln COMMCREDIT	Log (Commercial credit by the banking sector)	Handbook of Indian Economy on State Finances published by Reserve bank of India, Mumbai
LIT	Literacy Rate	Census data, Government of India
IMR	Infant mortality rate	Census data, Government of India
TFR	Total fertility rate	Census data, Government of India

where $0 < \beta < 1$ and μ_{it} has mean zero, finite variance, σ^2 μ, and is independent over t and i.Manipulating Eq. (1) yields,

$$\ln yit/yi,\ t-1 = \alpha - \beta \ln (yi, t-1) + \mu it \tag{2}$$

Thus, $\beta > 0$ implies a negative correlation between growth and initial log income.

4 Interpreting data

As mentioned earlier, economic convergence implies that a state that starts off at low-performance levels on income should achieve faster growth on that outcome over time, improving its performance so that it catches up with states which had better starting points. Convergence is thus a metric of absolute and relative performance (Roy et al. 2016). We have analysed income convergence and demographic convergence in terms of social indicators in this section. Through an exploratory analysis, the idea is also to present the level of socio-economic and fiscal asymmetries across States in India.

In Table 2, per capita NSDP at constant prices (at 2004–2005) price for the year 2014–2015 is presented. As evident from Table 1, the highest per capita income state is Goa with a per capita of Rs. 2,41,081 and the state with lowest per capita income is Bihar with a per capita income of Rs. 23,223. The ratio of Goa's per capita income to Bihar's is 10.38. Figure 1 captures unconditional convergence in economic performance of Indian States over the last two decades. On the *X*-axis, initial level of per capita income is plotted and the growth of per capita GDP is plotted in *Y*-axis. If the relationship between these two variables is negative, there is convergence or catch up in growth among the Indian States. The trend line in Fig. 1, however, suggests divergence among Indian States, that is, states that had higher level of initial level of per capita income were experiencing higher growth rates. The graphical plot is adjusted for outliers.

The reason for no unconditional convergence is largely economic. Despite a progressive fiscal transfer system, where the poor States received much higher per capita transfers than richer regions, these transfers only partially offset fiscal disabilities leading to lower investment in social and economic infrastructure in poorer regions in the country. Also with the economic liberalisation and reforms of 1991 contributed to larger private investment inflow to the richer regions of the country resulting in further increase in inequality between the leading and lagging States (Ahluwalia 2000).

We also explore the movement of various health and education-related indicators and their relative position across States. These indicators are IMR and TFR for health, and literacy rates for education. Infant mortality rate (IMR) is defined as the number of infants dying before reaching one year of age, per 1000 live births in a given year. Total fertility rate (TFR) is defined as the number of children that would be born to a woman if she were to live to the end of her childbearing years and bear children in accordance with age-specific fertility rates in a given year (Economic Survey, 2016–2017). In Fig. 2, it can be observed that the state with the highest IMR is Madhya Pradesh with an IMR of 69 per thousand births and the state with

Table 2 Per capita income and growth rates: 2014–2015. *Source:* (Basic data), Central Statistics Office (hereafter CSO), Ministry of Statistics and Programme Implementation, Government of India

	Per capita income (at constant 2004–2005 prices) (in Rs.)	Growth (%) over previous year
Andhra Pradesh	78039	8.0
Arunachal Pradesh	88110	14.4
Assam	44809	4.2
Bihar	23223	2.0
Chhattisgarh	64841	5.8
Goa	241081	28.0
Gujarat	111370	8.6
Haryana	124302	4.0
Himachal Pradesh	105146	6.2
Jammu & Kashmir	52576	−2.8
Jharkhand	48781	11.4
Karnataka	106245	4.2
Kerala	112444	4.3
Madhya Pradesh	44357	3.7
Maharashtra	113629	3.9
Manipur	44101	6.4
Meghalaya	55936	−4.7
Mizoram	85056	25.8
Nagaland	60372	3.0
Odisha	54211	0.2
Punjab	95546	2.5
Rajasthan	64522	5.7
Sikkim	180675	7.0
Tamil Nadu	106186	4.5
Telangana	101119	5.7
Tripura	58033	6.6
Uttar Pradesh	34583	1.6
Uttarakhand	118788	5.3

the lowest IMR is Goa and Manipur, both states having an IMR of 11 per thousand births. The Total Fertility Rate (TFR) is the highest in Bihar, while the TFR is the lowest in Goa (Fig. 3). The highest literacy rate among the Indian States is Kerala with a literacy rate of 94 while the state with the lowest literacy rate is Bihar with a literacy rate of 61.8 (Fig. 4).

Figure 5 shows that there is convergence among states in health indicator for which the proxy variable is Infant Mortality Rate (IMR). The rate of decline in IMR is faster among states whose initial IMR was higher. We have also found convergence in case of education indicator, for which the proxy variable is literacy rate (Fig. 6). These scatterplots revealed that though there is no economic convergence among Indian States, there is convergence in education and health indicators.

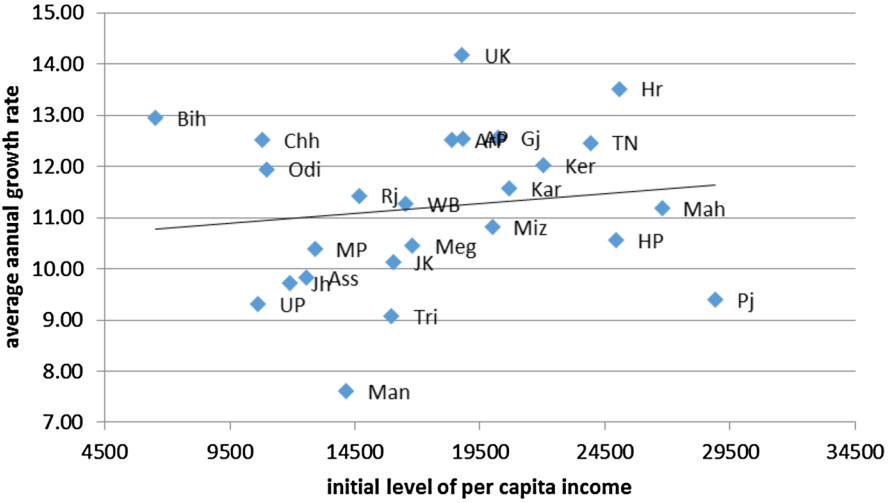

Fig. 1 Income convergence for Indian States. Trend line is $y = 2E-05 + 11.165$ *Source* (Basic data), CSO (various issues)

The fiscal asymmetry is captured through variables relating to revenue expenditure (Fig. 7) and capital outlay. The disaggregated components of revenue expenditure are given in Table 7 in Appendix. The two significant components of revenue expenditure—interest payments and pensions—to GSDP ratio at State level are around 1–3% of GSDP across most of the States in India (Table 7). In Table 8, it can be seen that developmental revenue expenditure is highest in Mizoram (33.8% of GSDP) and lowest in Punjab (6.2% of GSDP).

Figure 8 shows the capital outlay to GSDP ratio across Indian States. The capital outlay to GSDP ratio was highest in Tripura (9.5%) and lowest in Haryana and Punjab (0.8%). Table 8 shows that development expenditure (both revenue and capital) to GSDP ratio ranges from 38.5% in Arunachal Pradesh to 7.1% of GSDP in Punjab. The credit–deposit ratio across Indian States is plotted in Fig. 9. It shows that credit–deposit ratio in India ranges from 23.7 in Arunachal Pradesh to 121 in Tamil Nadu (Table 9). The credit given by the banks to commercial sector is highest in Maharashtra (Rs 18,212 billion) and lowest in Sikkim (Rs 14 billion) (Table 9).

The gross fixed capital formation in India ranged from Rs 46 billion in Nagaland to Rs 742,140.2 billion in Gujarat. The capital formation in North Eastern states is comparatively lower than other mainland states. Though the base was low, the annual average growth rate during 2001 to 2013 showed an increase in the capital formation in North Eastern states, especially Tripura (76%) and Meghalaya (81%). In Gujarat, capital formation picked up in this period at a growth rate of 54.68% (Table 10). The descriptive statistics of all variables under analysis are shown in Table 3. The variables are checked for multicollinearity by applying a pair-wise correlation analysis. Table 4 presents the correlation coefficients of the variables.

Having observed the movement of crucial variables under consideration across States during the last one and a half decade, we can conclude that the level of social

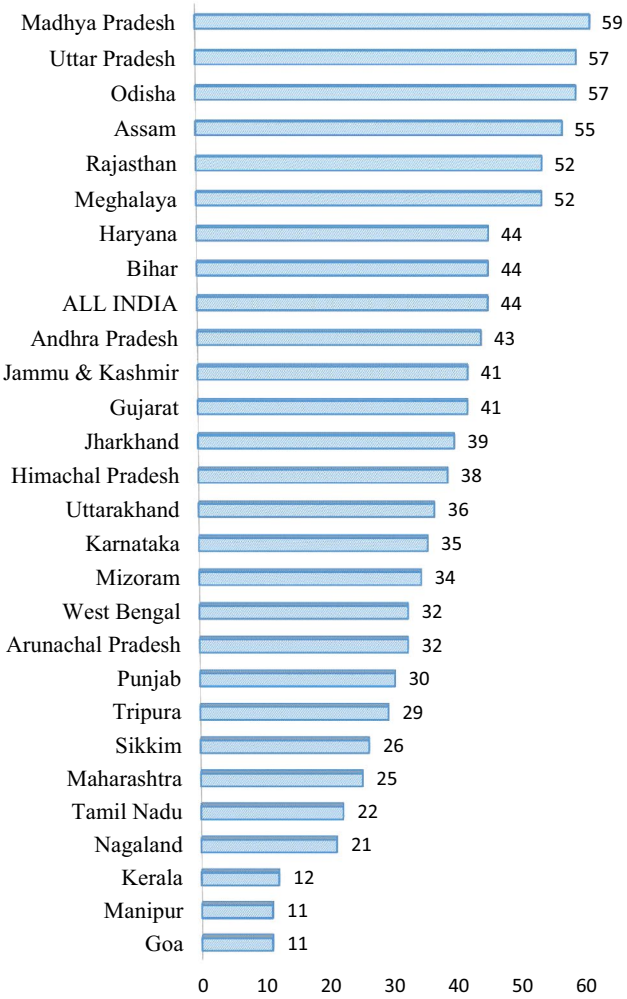

Fig. 2 Infant mortality rate in Indian States, 2011. *Source* (Basic data), Census, Government of India, 2011

and economic asymmetries is huge in India. Any analysis of economic convergence thus should take these asymmetries into account. Now we turn to econometric estimation of the model.

5 Econometric estimation of economic convergence

In terms of income convergence, the model we used is specified as follows:

$$\mathrm{GRW}_{it} = a + b1\ \ln\ \mathrm{PCI}_{it} + b2\ln X_{it} + \mathrm{u}_{it} \tag{3}$$

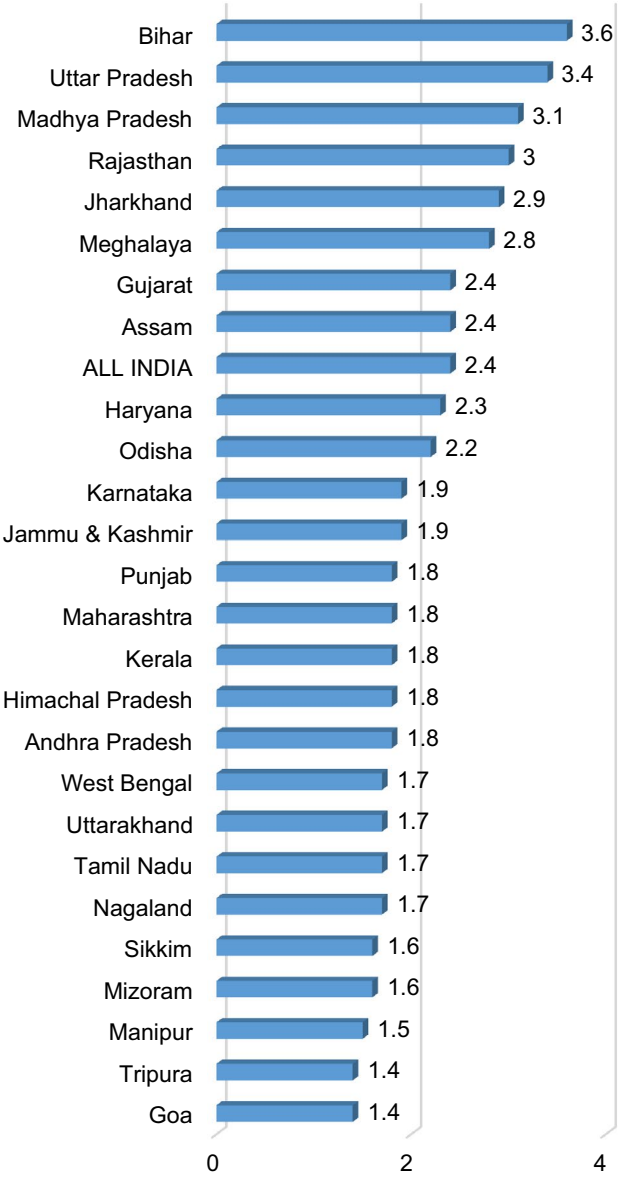

Fig. 3 Total fertility rate in Indian States, 2011. *Source* (Basic data), Census, Government of India, 2011

where GRW_{it} is the growth rate of per capita GDP, $\ln \mathrm{PCI}_{it}$ is the initial level of per capita income, X_{it} is the control variables, and U_{it} is the error terms

$$\mathrm{GRW}_{it} = a + b1\ \ln \mathrm{PCI}_{it} + b2\,\mathrm{ECON}_{it} + b3\,\mathrm{FIN}_{it} + b4\,\mathrm{SOCDEMO}_{it} + \mathrm{u}_{it} \quad (4)$$

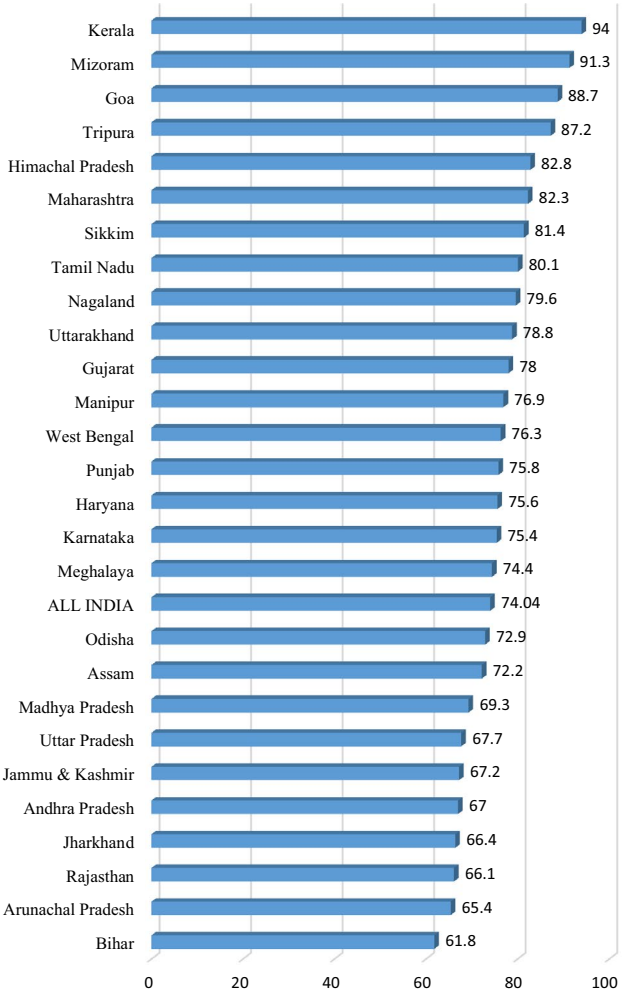

Fig. 4 Literacy rate in Indian States, 2011. *Source* (Basic data), Census, Government of India, 2011

where group variables ECON is the economic variables, FIN is the financial variables and SOCDEMO is the social and demographic variables for human capital formation.

After expanding the group variables ECON, FIN and SOCDEMO, equation can be rewritten as follows.

$$\begin{aligned} \mathrm{GRW}it = {} & a + b1\ \ln\ \mathrm{PCI}it + b2\ \ln\ pc\,\mathrm{PUBCAPEXP}it \\ & + b3\ \ln\ \mathrm{GFCF}it + b4\,\mathrm{CDR}it \\ & + b5\ \ln\ \mathrm{COMMCREDIT}it + b6\,\mathrm{LIT}it \\ & + b7\,\mathrm{IMR}it + b8\,\mathrm{TFR}it + uit \end{aligned} \tag{5}$$

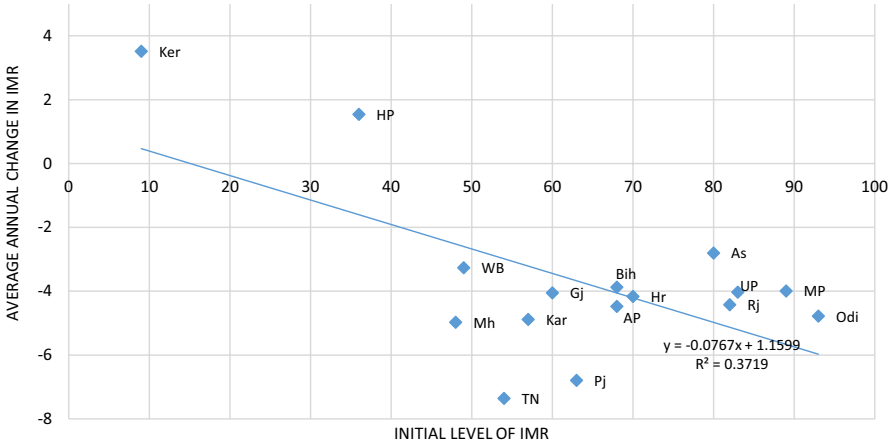

Fig. 5 Convergence in infant mortality rate. *Source* (Basic data), Census, Government of India (various issues)

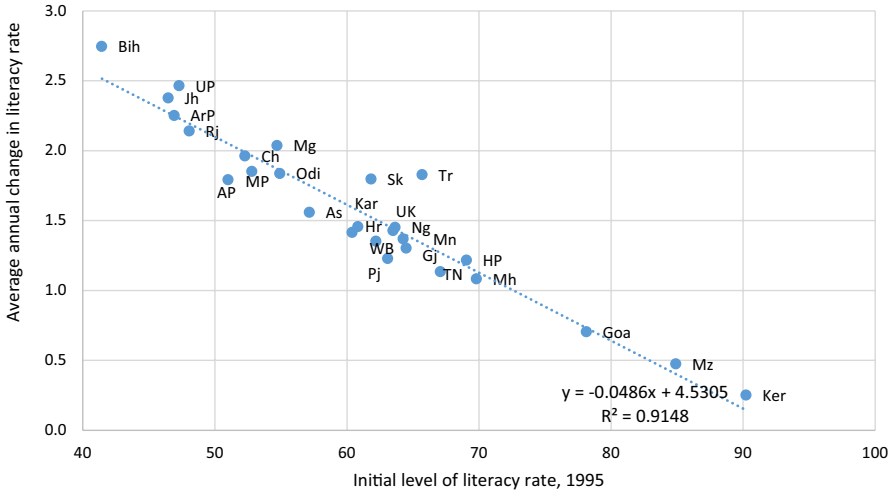

Fig. 6 Convergence in literacy rate. *Source* (Basic data), CSO (various issues)

where ln PCI is the log of initial level of per capita income.Group A ECON variables:

$$\ln \text{pc PUBCAPEXP} = \text{log of public (capital) expenditure per capita}$$

$$\ln \text{GFCF/GSDP} = \text{log of gross fixed capital formation to GSDP ratio}$$

Group B FIN variables:

$$\text{CDR} = \text{credit} - \text{deposit ratio}$$

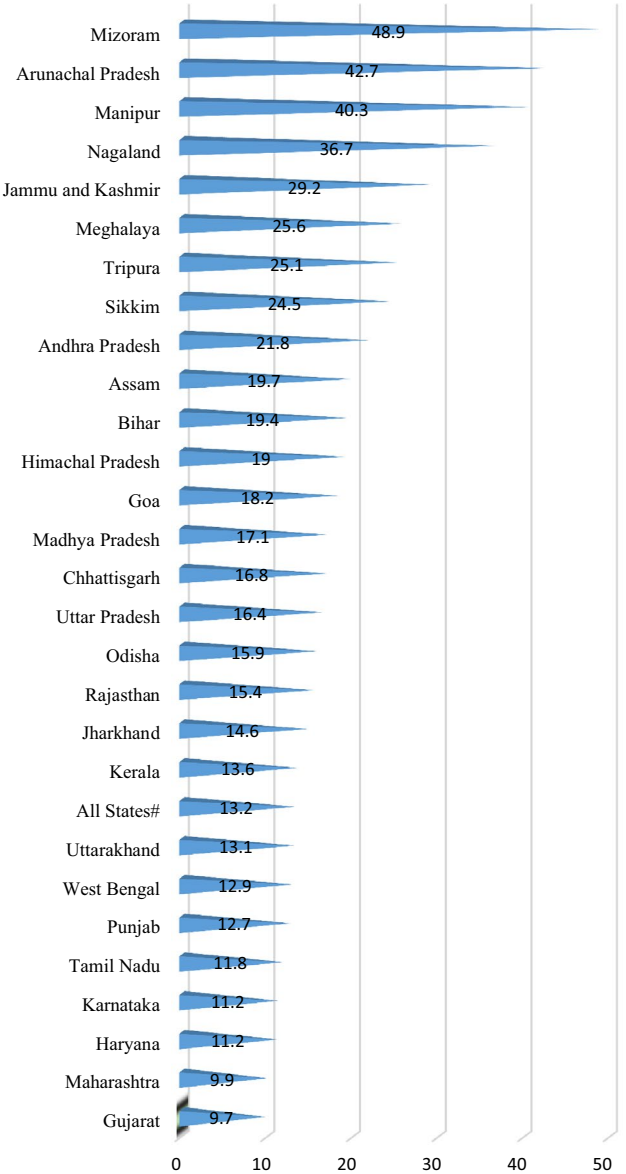

Fig. 7 Revenue expenditure to GSDP ratio across Indian States, 2014–2015 *Source* RBI State Finances, 2017

$$\ln \text{COMMCREDIT} = \text{log of commercial credit}$$

Group C SOCDEMO variables:

$$\text{LIT} = \text{literacy rate}$$

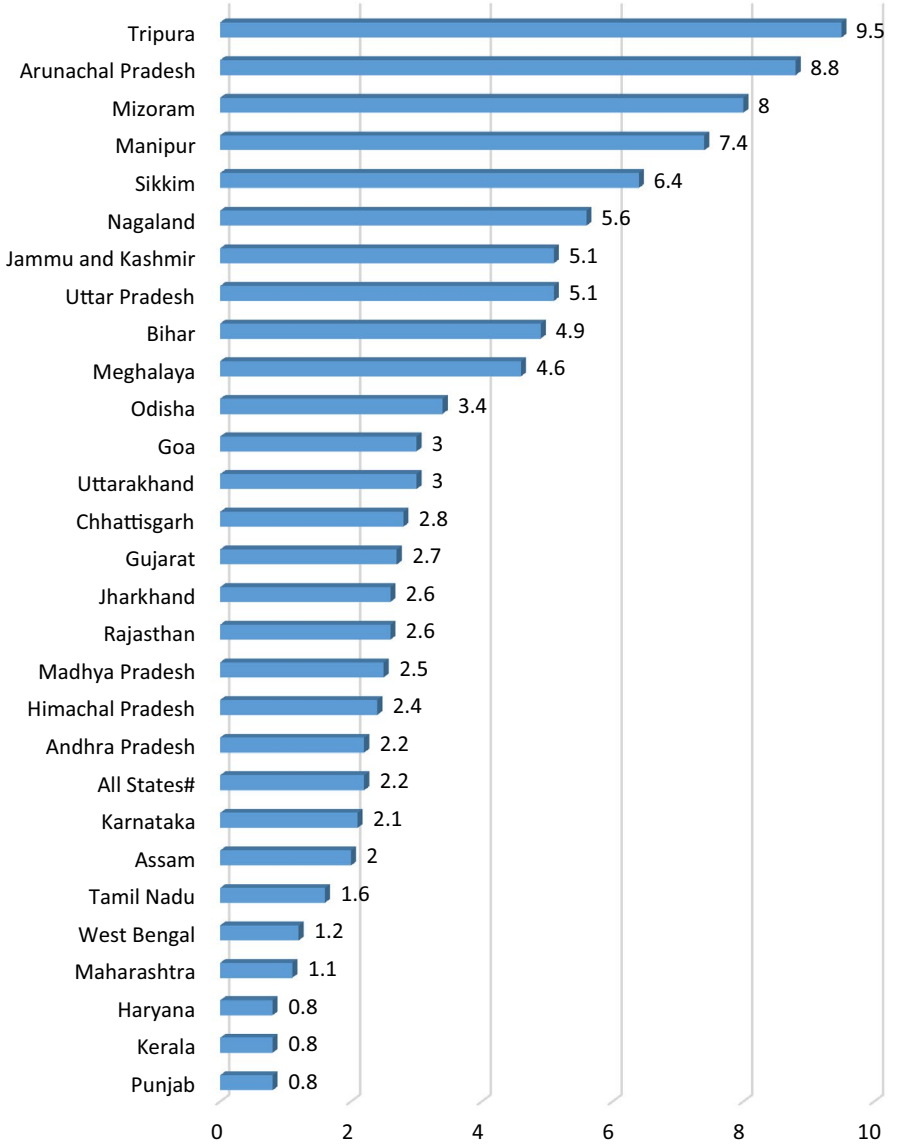

Fig. 8 Capital outlay to GSDP ratio across Indian States, 2014–2015. *Source* RBI State Finances, 2017

TFR = total fertility rate

IMR = infant mortality rate

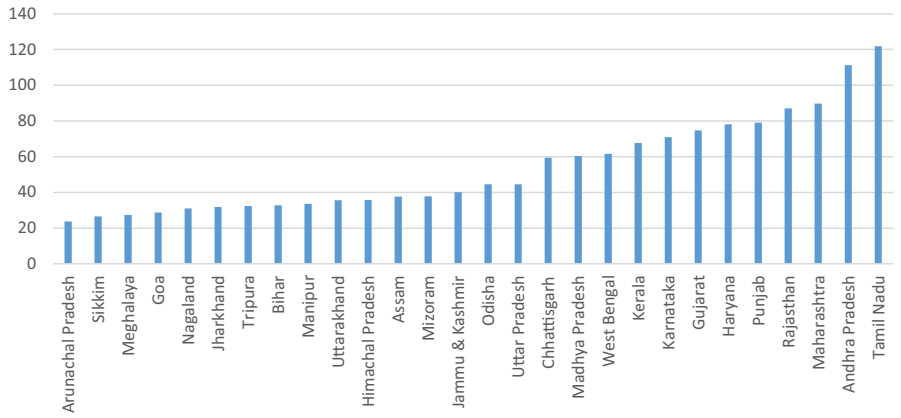

Fig. 9 Credit–deposit ratio across Indian States, 2014. *Source* RBI (various issues)

Table 3 Descriptive statistics of variables, 2001–2014. Source: Author's computations

Variable	Observations	Mean	Standard deviation	Minimum	Maximum
Lnpci	392	9.78	0.39	8.78	10.75
lnpc CAPEX	391	7.07	1.05	4.51	9.59
lnpc REVEXP	391	8.89	0.73	6.65	10.78
ln GFCF	325	7.66	2.57	− 1.17	11.25
CDR	392	48.87	23.58	12.40	123.30
ln COMCREDIT	392	9.49	2.15	4.61	14.42
LIT	392	73.71	9.26	47.00	94.86
IMR	264	48.35	16.80	9.95	91.20
TFR	250	2.56	0.74	1.60	4.50

The variables in our economic convergence models are kept in nominal terms due to the data issues highlighted below. As highlighted by Ghosh et al. (1998),

> "one of the most serious problems of studying the issue of inter-state convergence in the context of an LDC like India is the non-availability of a consistent set of data for a reasonably long period for the variables under considerations. The general convention is to deflate the nominal Per Capita Net State Domestic Product (PCNSDP) by some all-India level deflator. Although consistent data sets like as deflators Wholesale Prices in India (WPI) and Consumer Prices in India (CPI) are available at the all-India level state-wise data for these prices are absolutely lacking. Moreover, there are so much variations of actual prices, whether WPI or CPI types, across the stales that use of a single price for all the states cannot be justified on any ground whatsoever. The problem of using such deflator is that they are available only at the all-India level, and hence fail to capture inter-state variations in prices."

Table 4 Correlation coefficients matrix. *Source* Authors computations

Variable	Lnpci	lnpc CAPEX	lnpc REVEXP	Ln GFCF/GSDP	CDR	ln COMM CREDIT	LIT	IMR	TFR
Lnpci	1.00								
lnpc CAPEX	0.31*	1.00							
lnpc REVEXP	0.49*	0.66*	1.00						
ln GFCF/GSDP	0.12	0.09	0.08	1.00					
CDR	0.18*	−0.16*	−0.07*	0.58	1.00				
ln COMMCREDIT	−0.007	−0.34	−0.23	0.67*	0.74*	1.00			
LIT	0.56*	0.42*	0.62*	0.02*	0.13	0.05	1.00		
IMR	−0.53*	−0.34*	−0.65*	−0.28	−0.37*	−0.54*	−0.77*	1.00	
TFR	−0.72	−0.32*	−0.68	−0.29*	−0.55*	−0.43*	−0.43*	0.71*	1.00

*Denotes 5% significance level

We use panel data of 28 Indian States over the period 2001–2014. We use dynamic panel data (DPD) models to deal with unobserved heterogeneity by applying the within (demeaning) transformation, as in static panel models[10] (fixed vs random effects). DPD has the ability of first differencing to remove unobserved heterogeneity and these DPD models contain lagged dependent variables, allowing for the modeling of a partial adjustment mechanism. The first difference transformation removes both the constant term and the individual effects. But if there is still correlation between the error term and the differenced lagged dependent variables, the DPD approach is Arellano and Bond (1991) which is based on a generalized method of moments (GMM) context, which can construct more efficient estimates of the DPD Instrumental Variables approach.

We used Arellano and Bond (1991) methodology in this paper as this approach is better than the Instrumental Variable panel regression models suggested by Anderson and Hsiao (1982). Arellano and Bond (1991) argue that the Anderson–Hsiao estimator, while consistent, fails to take all of the potential orthogonality conditions into account. The significant strategy of Arellano and Bond (1991) methodology is the assumption that the necessary instruments are internal based on lagged values of the instrumented variable(s). However, the methodology allows the inclusion of external instruments as well. The Arellano and Bond (1991) methodology thus sets up a GMM in which the model is specified as a "system of equations", one per time period, where the instruments applicable to each equation differ with the additional lagged values of the instruments and the time periods.

5.1 Testing for unconditional club convergence

Using Arellano and Bond (1991) methodology, we have examined the unconditional convergence for Indian States, clubbed as coastal states and inland states. Econometrically, the positive sign indicates the divergence among Indian States as observed in the bivariate scatter plot in Fig. 1. Similar patterns were observed even after clubbing the states into coastal and inland states. The dynamic panel model estimates show that there is no unconditional convergence among Indian States; i.e. States with lower initial level of income are not catching up the advanced states (Table 5).

[10] For examining the economic convergence in static panel models, the studies prefer random effect model as the crucial variable in the equation is "time-invariant", and the coefficients get omitted in the Fixed Effects model. Though Hausman test is used in general to choose between Fixed Effects and Random Effects in the panel data analysis, in such cases, it is compelling to use Random Effects model due to the crucial time invariant properties of initial per capita income used in the model. As suggested by Greene (2011), though the value of the Hausman test statistic can suggest whether fixed effects or random effects to be favoured in the cases of variables with time-invariant properties, it will be highly misleading if the null hypothesis of random effects model is rejected in such cases. In such cases, Plumper and Troeger (2007) and Beck (2011) emphasised that only within effects can be estimated in such cases and a variable's between effects or a general effect cannot be estimated; and such effects coefficients of fixed effects models are over-interpreting their results (Hausman and Taylor 1981; Breusch et al. 1989; Baltagi and Bresson, 2012). However, we have used dynamic panel models with GMM estimation as an advancement over static random models.

Table 5 GMM estimates: testing for unconditional convergence in Inland and coastal Indian States. *Source* (Basic data), CSO (various issues)

	All States	Coastal	Inland
*L*1 (lag of dependent variable)	0.044 (0.062)	− 0.0044 (0.1005)	0.052 (0.064)
Ln PCI	1.178* (0.082)	1.278* (0.131)	1.167* (0.083)
N	336	108	312

The figures in the parentheses denote standard error. If Wald(Prob > X^2) value is less than 0.05, for all three models

The Economic Survey 2016–2017 published by Ministry of Finance, Government of India, also noted lack of convergence in economic outcomes among the Indian States. The survey noted that *"there continued to be divergence within India or an aggravation of regional inequality"*. From this inference, one could conclude that income may correspond to a conditional convergence, which we will analyse next, incorporating a few control variables. These estimations are highly relevant from the perspective of widening regional inequality among states in various economic outcomes (divergence).

5.2 Conditional convergence

As evident from Table 4, lnpc CAPEX has quite high correlation with ln pc REVEXP. There are other pairs of control variables having high correlations as well between them. This may create spurious regression. It may be better to drop some variables with high correlation and get models which are closed to the true regression. For example, lnpc REVEXP has shown high correlation with lnpc CAPEX. As mentioned, we have collapsed variables into sub-group as group A = economic variables such as public revenue, gross fixed capital formation; group B = financial variables such as CDR, and COMMCREDIT; group C = social and demographic variables such as LIT, TFR, IMR. Each group has strong relations among them and may create over identification problem for the model. We have also dropped variables from each group to arrive at the most appropriate model of convergence for aggregate, coastal and inland regions in Table 6, based on the inferences of pair-wise correlation coefficients from the matrix in Table 4. For instance, models were estimated by eliminating three variables, state-wise commercial credit by the banking sector as the financial proxy, along with two socio-demographic variables, viz., literacy rate and total fertility rate. However, the estimations of full model as in Eq. 5 for All India, inland and coastal states are provided in Table 11.

Using the control variables given in groups A (economic variables), B (financial variables) and C (social and demographic variables), the estimates of conditional convergence are reported in Table 6. The coefficient of initial per capita income is

Table 6 GMM panel estimates for conditional convergence in India. *Source* (Basic data), CSO and RBI (various issues)

Variables	Model 1 (All India)	Model 2 (Inland)	Model 3 (Coastal)
L1 (lag of dependent variable)	**−0.293***	**−0.299***	**−0.792***
	(0.078)	(0.0798)	(0.116)
Ln PCI	−2.125	−1.729	−1.792
	(1.416)	(1.463)	(1.534)
Group A : ECON variables			
ln pc CAPEX	**2.501***	**2.511***	**2.49***
	(1.375)	(1.386)	(1.709)
ln GFCF	**1.497***	1.263	**2.72***
	(0.833)	(0.861)	(0.466)
Group B: FIN variables			
CDR	**0.119***	0.117	**0.151***
	(0.068)	(0.775)	(0.287)
Group C: SOC_DEMO variables			
IMR	**−0.013***	**−0.039***	**−0.111***
	(0.104)	(0.108)	(0.191)
Constant	0 (omitted)	0 (omitted)	0 (omitted)
N	202	191	96

The models presented in this Table 6 are Eq. (5) deducted for TFR, LIT and lnCOMCREDIT, as inferences from pair-wise correlation matrices suggest high correlation of these variables with other variables. The estimation of Eq. (5) without deducting the variables is presented in Table 11

found to be negative and insignificant, indicates that there is no strong evidence for conditional convergence (Model 1, 2 and 3 in Table 6). The fiscal policy variable captured through the state-wise public spending on capital (ln pc_capex) is found to be positive and significant.[11] The state-wise gross fixed capital formation is also found to be positive and significantly related to economic growth rate across Indian States. GMM estimates show that increasing capital formation by 1% can strengthen the economic growth by 1.6% (Table 6, Model 1). We observe that there is no strong conditional convergence among Indian States while controlling for asymmetry in economic, fiscal, financial and social outcomes across States in India (models 1–3) at the aggregate level and at disaggregated levels across inland and coastal India (Table 6).

The GMM estimates revealed that public capital expenditure and gross fixed capital formation are the significant and positive variables determining the economic growth in India (Table 6). The financial sector, proxied through credit–deposit ratio is also significant for economic growth. The reduction in infant mortality rate is positively associated with economic growth.

[11] The model was also re-estimated using total public spending, though the coefficients were found insignificant, hence those estimations are not reported.

6 Conclusion

We have examined in this paper, economic convergence among Indian States, taking into account federal asymmetries in terms of capital availability, social and demographic outcomes, and differentials in public capital budgeting. The tests for unconditional convergence failed to show evidence of poorer states "catching up" with the richer states. Conditional convergence tests also show no evidences of strong economic convergence among Indian States. A separate analysis of coastal and inland states is also undertaken to analyse economic convergence as it has been observed in literature that economic geography plays a crucial role in the development of a region. Literature on convergence in the context of China has also documented that a large part of economic growth in coastal provinces comes from their deeper implementation of industrial and foreign trade reforms (D´emurger 2001). Our results show that public capital expenditure has positive and significant effect on growth, for both the coastal and inland regions. Health outcome proxied by Infant Mortality Rate shows that improvement in health outcome results in higher economic growth. These results have two important policy implications. One, if the path to fiscal consolidation is achieved through curtailing public capital spending by the States, it would have negative consequences on economic growth in the long run. Two, the quality of human capital formation is a pre-requisite for economic growth. Our results shows that health-related variables matter for economic convergence among States in India and, therefore, public investment in health can be growth-enhancing, both for club and (aggregate) conditional convergence.

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Appendix

See Tables 7, 8, 9 10, 11.

Table 7 Fiscal variables: major components of revenue expenditure across states. *Source* RBI State Finances, 2017

States	2014–2015			
	DRE/GSDP	NDRE/GSDP	IP/GSDP	PN/GSDP
1	3	4	5	6
Andhra Pradesh	16.4	5.4	1.9	1.9
Bihar	12.3	7.1	1.6	3.0
Chhattisgarh	12.5	3.8	0.7	1.4
Goa	12.4	5.8	2.5	1.6
Gujarat	6.3	3.4	1.7	1.0
Haryana	7.4	3.8	1.6	1.1
Jharkhand	9.8	4.9	1.3	1.6
Karnataka	7.5	3.1	1.0	1.1
Kerala	6.4	6.0	1.9	2.1
Madhya Pradesh	11.6	4.6	1.5	1.4
Maharashtra	6.4	3.4	1.3	0.8
Odisha	11.1	4.5	0.9	2.0
Punjab	6.2	6.3	2.4	2.0
Rajasthan	10.9	4.6	1.7	1.6
Tamil Nadu	7.1	3.8	1.3	1.6
Uttar Pradesh	9.2	6.2	1.8	2.1
West Bengal	7.5	5.3	2.7	1.5
Arunachal Pradesh	30.4	12.3	2.1	2.9
Assam	12.7	6.5	1.2	2.6
Himachal Pradesh	11.7	7.3	2.7	2.8
Jammu and Kashmir	17.2	12.0	3.5	3.7
Manipur	22.4	15.2	2.6	5.2
Meghalaya	17.3	8.3	1.7	2.1
Mizoram	33.8	15.1	2.6	4.7
Nagaland	19.7	17.0	3.0	4.9
Sikkim	13.8	10.4	1.6	2.2
Tripura	15.5	9.0	2.3	2.8
Uttarakhand	8.1	4.6	1.5	1.5
All States*	8.4	4.4	1.5	1.5

NDRE non-development revenue expenditure, *IP* interest payment, *RE* revenue expenditure, *PN* pension, *DRE* development revenue expenditure, *GSDP* gross state domestic product

*Data for all states are as% to GDP

Table 8 Developmental expenditure and social sector expenditure/GSDP ratio across States. *Source* RBI State Finances, 2017

State	2014–2015	
	Developmental expenditure/GSDP	Social sector expenditure/GSDP
Andhra Pradesh	18.7	10.4
Bihar	16.8	11.3
Chhattisgarh	15.3	10.1
Goa	14.7	7.8
Gujarat	8.9	5.3
Haryana	8.3	5.0
Jharkhand	12.5	8.2
Karnataka	9.6	5.6
Kerala	7.4	5.4
Madhya Pradesh	16.6	9.2
Maharashtra	7.5	4.9
Odisha	14.5	9.1
Punjab	7.1	4.2
Rajasthan	13.5	9.0
Tamil Nadu	9.0	5.7
Uttar Pradesh	14.1	8.3
West Bengal	8.8	7.2
Arunachal Pradesh	38.5	18.2
Assam	14.9	10.3
Himachal Pradesh	14.4	8.7
Jammu and Kashmir	21.8	11.5
Manipur	28.6	17.3
Meghalaya	21.7	13.5
Mizoram	41.2	25.1
Nagaland	24.4	13.6
Sikkim	19.7	11.7
Tripura	23.9	17.1
Uttarakhand	11.1	8.0
All States#	10.7	6.7

Table 9 Commercial credit and gross fixed capital formation across states. *Source* RBI (various issues)

State	Commercial credit given by banks, 2014 (Billion)	Credit–deposit ratio, 2014 (%)
Andhra Pradesh	1509	111.3
Arunachal Pradesh	18	23.7
Assam	316	37.7
Bihar	625	32.8
Chhattisgarh	526	59.5
Goa	129	28.7
Gujarat	3098	74.7
Haryana	1509	78.1
Himachal Pradesh	186	35.8
Jammu & Kashmir	267	40.1
Jharkhand	382	31.8
Karnataka	3814	71
Kerala	1906	67.7
Madhya Pradesh	1358	60.4
Maharashtra	18212	89.8
Manipur	17	33.6
Meghalaya	40	27.4
Mizoram	18	37.8
Nagaland	20	31
Odisha	733	44.6
Punjab	1820	79.1
Rajasthan	1753	87.1
Sikkim	14	26.5
Tamil Nadu	6087	121.8
Tripura	44	32.4
Uttar Pradesh	2666	44.6
Uttarakhand	271	35.6
West Bengal	2959	61.6

Table 10 Annual growth rate of gross fixed capital formation across states. *Source* RBI Handbook of Statistics on Indian States (2017). https://rbi.org.in/Scripts/AnnualPublications.aspx?head=Handbook%20of%20Statistics%20on%20Indian%20States

	Average annual growth rate, 2001–2013
Andhra Pradesh	19.17
Assam	17.56
Bihar	0.74
Goa	14.32
Gujarat	54.68
Haryana	21.20
Himachal Pradesh	42.04
Jammu and Kashmir	36.18
Jharkhand	21.88
Karnataka	21.34
Kerala	30.97
Madhya Pradesh	23.18
Maharashtra	17.85
Manipur	–
Meghalaya	81.14
Nagaland	–
Odisha	49.27
Punjab	25.22
Rajasthan	26.56
Sikkim	–
Tamil Nadu	17.30
Tripura	76.85
Uttar Pradesh	17.90
Uttarakhand	46.02
West Bengal	31.89
Total	19.25

Sikkim and Manipur have missing values in GFCF data, hence average growth rate is not calculated. In Meghalaya and Tripura, the variations in GFCF across years are very huge

Table 11 GMM estimation for economic convergence (estimating Eq. (5), with all variables). *Source* (Basic data), CSO and RBI (various issues)

Variables	Model A (All India)	Model B (Inland)	Model C (Coastal)
L1	**−0.282***	**−0.296***	−0.007
	(0.079)	(0.081)	(0.0443)
Ln PCI	**10.899***	**10.867***	**10.015***
	(5.031)	(5.047)	(0.003)
Group A: ECON variables			
ln pc CAPEX	**5.273***	**5.352***	**2.401***
	(1.711)	(1.703)	(1.159)
ln GFCF	**1.603***	**1.373***	**3.486***
	(0.968)	(1.01)	(1.224)
Group B: FIN variables			
CDR	**0.296***	**0.317***	**0.160***
	(0.111)	(0.120)	(0.052)
ln COMMCREDIT	**−9.95***	**−10.372***	**−7.05***
	(4.11)	(4.129)	(2.889)
Group C: SOCDEMO variables			
LIT	−0.119	−0.046	−2.770
	(0.565)	(0.558)	(0.744)
IMR	**−0.440***	**−0.504***	**−0.385***
	(0.199)	(0.209)	(0.192)
TFR	−7.767	−6.169	−14.839
	(6.166)	(6.591)	(9.72)
constant	0 (omitted)	0 (omitted)	0 (omitted)
N	192	181	86

The significant coefficients are marked in bold. The figures in the parenthesis are standard error

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