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BEHIND THE CRISES: HISTORIES OF KNOWLEDGE PRODUCTION FOR INDIAN AGRICULTURE[1]

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Abstract: In this paper, using the case of knowledge for agriculture, the benefits of pluralism in the study of institutions are laid out. The last century of development of institutions essential to new agricultural technologies are organised into two historiographical streams, each with intellectual eddies. The first set of histories of formal and informal agricultural research for development is reinterpreted as the product of an institutional synergy, now unravelling but whose path-dependence still constrains the application of technologies resulting from a second set of histories. The latter are currently needed to resolve the social-environmental crises of agriculture generated by the former.

Keywords: Agricultural research, Agro-ecology, Green revolution, India, Innovation system, Institutions, Organic agriculture

Introduction: Retrieving Agriculture

When the concept of the contemporary period has shallowed to five or ten years and the pace of social life is experienced as having accelerated, the idea that the present is the product of a long historical tap-root is regarded as outdated, nowhere more so than in the study of the economy. This essay is an attempt to test this outdated notion for part of the economy that has been progressively neglected over recent decades: agriculture.

In a slightly displaced 20th century that starts with the end of the first world war and ends with the start of the pandemic, India's agriculture has been vital both for her achievements and for her problems. Yet agriculture has shifted from being a primary productive sector to a welfare sector (Krishamurthy, 2021). In 'retrieving agriculture' four dimensions need introducing at the outset. First, its importance for growth and employment. While agriculture has declined as a share of GDP from over 60% in the 1930s to 18-14% by 2020, production—measured by the real value

[1] This paper is reworked from the Bhabatosh Dutta lecture which I delivered (remotely) in Presidency University in October 2022 to whose organisers I am very grateful. It is also background research for my entry: "Agriculture—Before, during and after the Green Revolution" for the Cambridge History of Modern India 2024.

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of output—has increased over five times. In both physical output and value terms, it continues to grow (NSO, 2021).[2] It has kept pace with consumption pressures from people and animals that have also intensified by a factor of 5 (Grigg, 1992; Patnaik, 2004). On the land of what became India, agriculture has directly supported a rural population that has grown from 183 million in 1911 to 833 million a century later and rural people are able to live on average some three times longer (Bagchi, 2014). While provisioning this transformation and given that the non-agricultural economy was unable to absorb surplus labour except into unregistered activity, agriculture has acted throughout as a labour sponge. Agricultural labour was 73% of the total workforce in 1921, this proportion scarcely changed until the 1980s and neither did its real wage (Jose, 1988; Roy, 2005). It was still 43% in 2020.[3] The productivity of labour and the absolute size of the agricultural workforce both rose over the century.[4]

Second, the links of agriculture to the rest of the economy are extensive. As the 20th century progressed, its conditions of existence expanded in scale and scope upstream and downstream: upstream to global chemicals and energy inputs, to national and international institutions of research and policy and downstream to family business and finance, to the state's trading and distribution corporations, to agri-corporate infrastructure and industry using agricultural raw materials and to their exports. Meanwhile the agrarian household, India's basic demographic unit, has been bound throughout to other economic sectors through differentiated portfolios, some consisting of more or less bonded labour activity, migrant wage-work, army-work and animal 'husbandry' dominated by women, others consisting of investments using savings, loans, remittances, rents and profits from agriculture, many involving miniaturised part-time, seasonal or independent self-employment (Harriss-White, 2012).

Third, over this century the contribution of agriculture to the earth's ecological emergency has been established beyond all initial doubt. In India, multiple cropping has starved soils of nutrients. Mechanisation together with chemical fertilisers, especially phosphate have mineralised and compacted the structure or soil, weakened its capacities to hold water, air and carbon, and its physical-chemical properties and shrunk the decomposing organic matter and the diversity of its vital biota. Most of the reactive nitrogen in urea is not absorbed by crops, exacerbates nitrous oxide and ammonia emissions and pollutes run-off.[5] Worldwide, the economic costs of reactive nitrogen inefficiencies and pollution have been estimated at 1.5 times those due to agricultural GHGs (Schulte-Uebbing et al., 2022).[6] The burning of agricultural waste to minimise unproductive periods between cultivation seasons has toxified the air, adding to its charge of greenhouse gases (GHGs). The over-use of chemicals has led to their ingestion by humans, terrestrial and marine animals, insects and microbes and to the contamination of water and the toxification of soil. Predictions of water table depletion due to the three times greater consumption of water by HYVs overlooked the further costs of increased soil damage in water polluted by heavy metals (cadmium, lead, arsenic), by alkalinisation, waterlogging and salination (Singh, 2000; Kloppenburg, 2005).

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[2] See also https://www.statista.com/statistics/805180/india-real-gva-in-agriculture-forestry-and-fishing-sector/

[3] https://www.statista.com/statistics/271320/distribution-of-the-workforce-across-economic-sectors-in-india/

[4] With a short period between 2004-12 when employment in agriculture fell slightly (Mehrotra, 2023). The real wage is the most highly neglected macro-economic variable.

[5] Up to 85% is lost according to Moring et al. (2021). See also Jones et al. (2022) and Yadav et al. (2023).

[6] Steven Lord, 2023 (Personal Communication)

Fourth, the social relations through which the tension between output and environment has developed are the manifestations of inequalities in production and contradictions between production and consumption. While agricultural growth is well-established to reduce poverty and while extreme poverty has dropped from 70% to 10%, it is ever more concentrated in the agrarian economy.[7] Over the century, holdings have miniaturised such that land is but part of diverse agrarian 'micro portfolios' of labour, tenancy and self-employment in crop and livestock production and the non-farm economy. While incomes from crops average about 40% of household income, net household incomes now approach that of earnings from the minimum wage (NSO, 2021). Agrarian distress is not only a problem of welfare and justice it has economic implications, enfeebling demand for goods from other economic sectors and constraining wages. Calorie availability in India has declined in a volatile way and widespread under- and mal-nutrition preserve the country in the bottom decile of the world hunger league tables.[8] Nutritional pathologies are not confined to humans but are also reflected in the poor nutritional condition of the livestock herd which has expanded by a factor of three this century (George, 1996; Ramdas and Ghotge, 2006).

To account for this contradictory and controversial story means acknowledging the co-existence of many histories of twentieth century agriculture. These have been written within disciplines, some using paradigms which cross them. While a systematic review is impossible, this 'first-cut' review navigates the shifting balance between institutional and science-biographical histories to contribute to the understanding of one of the necessary preconditions for the fluctuating growth and contradictory transformations of agriculture. This is technological research and knowledge, particularly for food for subsistence and for food as cash crops.[9] In searching for the histories of the innovative knowledge enabling the green revolution,[10] we trace the concatenation of national and international institutions in state, market and civil society that have evolved throughout the last century and persist into the present one. We argue that this path-dependent institutional complex is one of the constraints on technologies and practices which are currently invoked to resolve the agro-ecological crisis caused by the first set of histories of knowledge. Their 'second' set of histories runs parallel to that of the first and orthodox set. These histories on which this paper focusses are not exhaustive: they do not preclude other histories. They can be developed in at least three further directions outside the scope of the current essay. First, a rigorous comparison of the development of the two streams of research institutions; second, histories of the interactions between them; and third, a synthesis of the knowledge politics together with the politics of historiographical knowledge in orthodox and counter-orthodox research (Borras, 2023).

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[7] See Parikh et al. (2013). Extreme poverty line is $1.9/person/day. This definition and proportion have been contested. "A volatile period between 1884 and the late 1920s brings extreme poverty to a minimum of 54%. The upward trend that follows takes the poverty rate back up to 71% in 1953, a higher level than the one recorded in the 1820s. Despite a temporary surge in 1998 to 46%, extreme poverty declined to a low of 10%, in 2018" (Moatsos, 2021).

[8] https://admin.concern.org.uk/sites/default/files/documents/2021-10/2021%2 GHI%20EN_0.pdf?_gl=1*1juksel*_ga*MTExNDA4MTYxNy4xNjU3MjA3MjUy*_ga_3R30KL4S9R*MTY1NzIwNzI1Mi4xLjAuMTY1NzIwNzI1Mi4w

[9] Generally regarded as part of the superstructure. Other neglected preconditions include infrastructure, energy, cement, and the agricultural bureaucracy

[10] See Patel (2013) for its history.

A Century of Agricultural Knowledge and New Agricultural Strategy/Green Revolution

At the start of the 20th century, agriculture was practised by an uneducated workforce. In the current era half the agricultural labour force remains illiterate and further burdened with low levels of financial and debt literacy (which does not require formal education (Gaurav and Singh, 2012)). By contrast the histories of agriculture are written, and research on agriculture carried out, by highly educated scholars. For all the talk of democratising science, and with few and notable exceptions, authoritative statements and innovative practices have been socially distanced from close and active engagement with their living, working 'objects' and the intended 'destinations' of their scientific and technological accomplishments. Their effects shape what is to be done in the 21st century.

By 1918, India's colonial government had already created institutions for agricultural research in a characteristically complex bureaucratic architecture that was to be reproduced widely later on in other Ministries and sectors and in which, regardless of the post-Independence division of constitutional responsibilities, provinces competed with central government for resources.

The new scientific institutions had developed in response to both domestic and global forces. Inside India, Commissions of Inquiry into three late 19th century famines had formed a political pincer with Imperial commercial demands for improved supplies of staples and export crops: wheat, tea, jute and cotton. Outside India, from the mid19th century onwards, agricultural sciences in Europe and the USA had developed knowledge of soil chemistry, crop agronomy, the roles of superphosphate and later of ammonia and its synthetic Haber-Bosch production, together with testable theories of the evolution and genetics of animals and plants (Ramakumar, 2021). Drawing on foreign experience, between 1889 and the mid-1920s, the colonial government had created a research 'ecosystem' which sliced agricultural knowledge in many different ways. Starting with research for soil and plant bacteria, it spread to cover a range of crops, agricultural subsectors and commodity committees. By 1905, a co-ordinating role started to be supplied by an Agricultural Research Institute, originally financed through American philanthropy with a view to rehabilitating the indigo producers of Bihar who had been threatened by German synthetic dyes.[11] The late-colonial period also saw experiments with anti-elitist science and technology propagation through agriculture departments and a range of associated front-line institutions working in in local languages. But, as Bakshi and Kamble (2016) emphasise from their study of Marathi bulletins from 1910 to 1951, the implications of unequal agrarian caste-class structure for the adoption of new practices was studiously ignored.

The colonial institutional 'eco-system', directed by Indian scientists from 1935 onwards, has been criticised for its underfunding. Until Independence an exiguous 0.07% of agricultural GDP was invested in research (Mohan et al., 1973). It has also been criticised because concrete achievements, recorded by the evolving sciences of rural sociology and agricultural economics, were slow to materialise, disrupted by the Depression, limited substantially to export crops rather than food grains, and to basic research rather than to the generation of adaptive knowledge exchanges between laboratories and the land—a disconnect deplored by Malcolm Darling as early as 1925. By Independence, huge regional variations in the generally low productivity of seeds and of animals had opened up (Maddison, 1973). Agricultural stagnation and deterioration had been mitigated by technological progress that was confined to irrigated enclaves and to soils whose fertility was

[11] Renamed Imperial Institute of Agricultural Research in 2011 and the Imperial Agricultural Research Institute in 1919, moved from Pusa in Bihar to Delhi after the 1934 earthquake and relabelled Indian Agricultural Research Institute after Independence.

maintained only with long fallows.

Independent India wasted no time in transforming the institutional architecture to strengthen both the status and the domestic usefulness of agricultural research. From 1952, the Ford and Rockefeller foundations contributed to expanding India's institutional system from 17 to 67 Indian agricultural universities using the template of the US Land Grant model in which research, teaching and extension were integrated to increase the quantity, quality and status of agricultural research and outreach throughout the country. A decade later under C. Subramanian's secretary-ship, a bureaucratic cadre of trained agricultural scientists could be resourced. Krishi Vigyan Kendras (KVKs)—hybrid organisations of NGO volunteers and staff from state agricultural universities—supplied front line extension experts, growing in the 21st century to number 700 (Pal et al., 2012).

By the mid-1960s, investment in agricultural research and development had doubled to 0.18% of agricultural GDP (ibid) while remaining persistently low by global standards.[12] Another wave of research institutions complexified the ecosystem for research. Better balanced between centre and states, over 100 institutions had to be co-ordinated by the ICAR for agriculture alone (ibid). Formally re-focussed towards food-grains, crop resilience, agro-ecological environments and their stresses, and resource-scarce producers, they also added an expanded remit for all biological resources. Some thirty research institutes for forests, 38 for livestock and 8 for fisheries science came into being. Horticulture and agricultural engineering followed later. In 1965, the ICAR initiated the first of—eventually—65 All-India Co-ordinated Projects for subsets of crops and regions. It lent support to farming systems research. It also co-ordinated higher education in the proliferating multi-disciplines of agriculture (ibid).

In the 1930s, agronomist and renaissance man B.P. Pal had pioneered gene pyramiding and breeding of wheat for hybrid vigour, for resistance to biotic and abiotic stresses, especially rust. He had established a systematic register of varieties and had started crossing dwarf Japanese varieties with rust resistant wheat (Swaminathan, 1996). Meanwhile India's own Central Rice Research Institute (CRRI), established in 1946, had capitalised on decades of research into pure lines to develop resistance to deep water and flood, lodging, drought, to shedding, to diseases together with responsiveness to manure. By the 1960s, plant breeder R.H. Richcharia had developed clonal propagation techniques for hybrid vigour in rice, trialled Taiwanese dwarf varieties for disease-resistance and collected a germplasm bank with some 19,000 rice accessions (Menon, 2001).

Yet Field-yields Remained a Third of Lab-yields

At the same time US oil and agri-business gave support to agricultural research in the form of Rockefeller Foundation grants to Norman Borlaug, working in CYMMYT in Mexico. Borlaug's work triggered the development of dwarf, disease-resistant high yielding variety (HYV) wheat whose properties could then be transferred rapidly to land races elsewhere (Swaminathan, 1996).

Other bi- and multi-lateral donor agencies, notably the CGIAR's international network of research stations[13] then grafted other HYV technology for wheat and for rice—originating from the USA, Central America, China, Taiwan and East Asia—onto India's own robustly growing research into what the plant geneticist and agricultural administrator M.S. Swaminathan in 1968 called the 'genetic destruction of yield barriers'.

[12] In 2009, it reached 0.4% of agricultural domestic product (Pal et al., 2012).

[13] CYMMYT for wheat and maize; IRRI for rice and ICRISAT established in India in 1972 for millets legumes, pulses and beans.

What happened in detail remains subject to controversy, however. Indian scientists crossed local Indica with East Asian Japonica rice. They succeeded in breeding photo-insensitive, shorter-duration, non-lodging / dwarf varieties adapted to the high temperatures of South Asian environments, and responsive to rain and irrigation water and to inputs of synthetic agro-chemicals. The latter augmented soil fertility by mineralising soil, but agrochemicals also poisoned weeds and protected crops from insect pests, fungal moulds, viral and bacterial diseases. It is argued by critics that imported varieties were inadequately quarantined or tested for pest and disease-resistance in Indian conditions and that this practice also led to the import of viral diseases along with non-native germplasm (Alvares 1986; Menon 2001). High yields from declining genetic diversity further increased vulnerability to pests and diseases such that in subsequent decades plant-breeders have needed to bring new supplies of resistant varieties regularly to the conveyor belt on which seed is commercialised.

The practical 'D' of R&D is well-known. In 1960-61 the Ford Foundation had advised the Indian government to focus on intensive agricultural development through loan-seed-fertiliser-pesticide 'packages' in 28 districts selected for endowments of canal and lift irrigation, with proven histories of adapting new technology and with functioning co-operatives. The approach was expanded by the Planning Commission in 1964-65 to cover 114-150 'intensive areas'—regions with physical and social capacities for agricultural import substitution—with an additional nationalist objective of reducing dependence on the subsidised American PL480 food imports. The latter had required India to use its Rupee payments for US military and other projects (Wilder, 1963).

Out of the wide variety of coarse and fine grains that constituted subsistence staples, wheat and rice rapidly emerged as the high status and politically sensitive food-cash-crops—easiest to process, preferred by the wealthy, vital for the provisioning of burgeoning towns and cities and justified as sufficient in protein to counter mal-nutrition if consumed in sufficient calories to counter under-nutrition (Ryan, 1977). From 1965, the cusp of 20th century industrial agriculture, the high yielding varieties programmes started diffusing unevenly, aided by selective subsidies to inputs, credit, infrastructure and products that were all selectively targeted to regions, crops and agrarian classes (Ramakumar, 2012). Whether labour-displacing (tractors) or labour-enhancing (pumpsets) mechanisation dealt inroads into soil-enriching, pastoral-arable synergies. Across the country, diverse seasonally and inter-cropped systems producing 'coarse' millets and sorghums, fine grains, pulses, medicinal herbs and vegetables simplified. Physical losses in agriculture due to pests alone trebled from 1970 to the end of the century (Dhaliwal et al., 2015). But, demonstrating elastic responses to fertiliser and water, Indian wheat yields quadrupled and production increased tenfold to 112 million tonnes in 2020. From the 1960s, rice yields also trebled and production quadrupled, reaching 122 million tonnes in 2020 (Government of India, 2021). North-west doabs and Eastern deltas became India's food 'bowls'.

While the costs of production per unit of output did not decline in a revolutionary way (Farmer, 1986), the capitalisation of agriculture was unprecedented. It was claimed as triumphs either for the state or for private enterprise.[14] Retrospectively what was called the Green Revolution (GR) in the world at large and the New Agricultural Strategy inside India can be recognised as an unusual concatenation model of institutional synergy. Agricultural research infrastructure with knowledge extension services had to join forces with R and D in public and private agro-industries for inputs

[14] Debated in Anderson et al. (1982).

and products, with short-term agricultural credit and medium-term finance.[15] However, while the HYV packages have been subjects for social sciences, many of these linkages are the product of knowledge in agricultural engineering. And yet the technological research needed in these linked sectors took strikingly different forms from that for the agriculture to which they were essential.

The history of tractors for instance focusses on their effects: compressed land preparations, double and treble cropping, reduced risk, raised crop productivity, traded-off against the displacement of labour (Binswanger, 1978; Verma 2006). But tractors also exemplify the counterintuitive idea that inappropriate foreign technology can be a powerful stimulus to indigenous technology generation in both public (Hindustan Motors) and private sectors (Punjab Tractors) (Morehouse, 1980). After Independence, tractor imports were cleverly encouraged from a wide range of countries—not only the UK and USA but also the USSR, Czechoslovakia, Poland and Romania. So were joint ventures with Polish (Estcorts), German (Eicher), Czech, Japanese, British and North American corporate capital. The technological variety on display enabled engineers trained in state universities and employed in the private sector to learn from doing, evaluate and—from 1961—experiment, reverse-engineer and compete with the design of appropriate tractors. From the 1970s Indian tractor businesses invested modestly in private R and D. Technological responses to local conditions of use—such as long lives, hydraulics and axle loadings and multi-functionality (haulage, tilth preparation and harvesting)—all tended to favour 4 wheelers with 30-40 HP engines (Bhattarai et al., 2017). When in the 1980s Indian tractor production soared, private research, then $10 million a year, doubled in a decade and has doubled again reaching $40 million by 2010, roughly evenly divided between MNCs and Indian companies (Pray and Natarajan, 2014).

Despite the existence of the All India Coordinated Research Project on Farm Implements and Machinery and the various university departments of agricultural engineering, other essential inputs, which have been largely ignored in green revolution narratives, were rapidly mobilised from the 1970s onwards by inventive and adaptive entrepreneurs with little education. Organised in spatial clusters of partly informal/unregistered workshops they were the manufacturing source of comparatively labour-intensive pump-sets, tillers, well-drills, mills and other small machinery with single-cylinder diesel engines.[16] In response to demand from these workshop industries, upstream machine tools manufacture also surged in the 1970s and 80s (Chand and Sen, 2002). And downstream (though still mostly upstream of agriculture) there multiplied more or less skilled informal repair and maintenance services (Harriss, 1988; Biggs and Justice, 2015). Markets for second hand machinery also proliferated. In these sectors, competence and innovative capacities were acquired through learning-by-doing and informal apprenticeships, usually through caste-kin (Harriss-White, 2017). Nevertheless, small-scale mechanisation has spread slowly in Indian agriculture compared with other South and South East Asian countries probably because of its neglect by the large, foreign corporations which dominate agri-mechanisation (Chand and Sen, 2002).

R&D in other agricultural inputs have different, idiosyncratic histories. From 1971 to 1991, Pray and Nagarajan (2014: 146) have calculated that the distribution of 'certified and truthfully

[15] Inputs and outputs depend on roads, energy, repair industries–all of which are the product of knowledge industries rarely associated with agriculture. Exceptional new knowledge industries include AI and IT satellite data and E-nam But the justification of their appropriateness to small farmers requires the precondition of grouping them in collective producers' organisations of which at the time of writing there is only selective evidence (Chand et al., 2022).

[16] The history of rural markets for diesel and for cement awaits writing.

labelled seeds increased 10-fold, fertilizer consumption increased from 2 to 12 million MTs,[17] consumption of pesticides almost tripled', trends which continued into the 21st century. In the early years of the new agricultural strategy, state corporations and agriculture departments dominated the production of seeds, fertiliser and agro-chemicals, used economic levers such as subsidies and protective tariffs and from 1972 disincentivised patents. After 1991 private national and foreign capital grew to dominate the provision of inputs. Their changing industrial structure affected both the size and content of R&D.

In fertiliser, an industry second in size only to steel, R&D has been very low by global standards. And, despite decades of incentives from state subsidies to massive private/multinational corporates (Parrys-Coromandel-Murugappa, Shaw Wallace, Chambal and Deepak) and public corporations (SPIC and National Fertilisers) under the retention price scheme,[18] India is still not quite self-sufficient in urea. Its volatile imports of urea, phosphorus and potassium complexes have come from China, UAE, Saudi Arabia and Iraq, the USA and Russia where R&D is sited.[19] Post green revolution Indian R&D has been adaptive of state developed technology or that of imports. State R&D into the construction of fertiliser factories directly supported later private ventures (Pray and Nagarahan, 2014).[20]

Private pesticide production was also incentivised by public research from the National Chemical Laboratory in Pune. Private R&D took off after intellectual property rights (IPRs) were granted for chemical products in 2005. It took the form of low cost adaptations of imported pesticides, production technology for generic agro-chemicals and knowledge about export markets. Although pesticides research doubled between 1990 and 2009, at 1% of gross output it compared unfavourably with 6% globally. By then it also revealed a paradox: with one third of R&D controlled by multi-national corporations and half by a single Indian firm (UPL), industrial structure was nevertheless deconcentrating and competitiveness increasing.

At under 1% of the Rs value of turnover however, private R&D in agricultural inputs has remained relatively low, mostly adaptive and mostly dependent on the expert educational institutions, the infrastructure and the regulatory frameworks of the state.

The post 1991 era of neoliberal reforms has seen a sea-change in the control of seed research with the reclassification of seed and biotech as core industries and the introduction of IPRs in plant breeding in 2007—all of which eased the entry of private capital and foreign equity. The latter ranged in form from small specialised inputs firms vulnerable to acquisition by national agri-business capital (UPL-Advanta) or companies unrelated to agriculture (such as JK Tyres) to large foreign agri-business corporates (Bayes, Dupont, Monsanto and Syngenta). Private R&D expanded from $19 million in 1990 (3% of output) to $90 million in 2009 (and 7% of output) (Pray and Nagarajan, 2014). Since the 1980s, while research institutions have advanced the breeding of hybrid seeds,

[17] Metric tonnes

[18] In which manufacturers are paid the difference between production costs and a capped administered maximum retail price.

[19] https://tradingeconomics.com/india/imports/russia/fertilizers#:~:text=India%20Imports%20from%20Russia%20of%20Fertilizers%20was%20US%24609.73%20Million,updated%20on%20July%20of%202022.

[20] Fertiliser has been manufactured domestically as superphosphate from 1906, and as phosphatic pentoxide from 1933, as urea from 1959 and as complexes from 1961. India's capacity for nitrogen and phosphate ballooned from 17000 and 21000 tonnes in 1950-51 to 12.2 billion and 5.5 billion tonnes in 2004-05 (https://www.fao.org/3/a0257e/A0257E03.htm). The relations between fertiliser science, soil research, agricultural planning and subsidies are outside the scope of this essay.

attention has been captured by the spread of unregulated genetically modified seeds, accompanied by hype about their quite limited potential.

It is common for innovations to predate their regulation. The introduction to India in the late 1990s of Monsanto's GM cotton genetically incorporating a bacterium, Bacillus Thuringiensis, whose insecticidal properties had been known for a century, to protect it from bollworm attacks, preceded its official approval in 2002. Illegal production competed with sales by the Monsanto-Mahyco joint venture to cover 11 million ha with Bt cotton by 2011. The polarised debates fomented by Bt are paradigmatic: spanning controversies over biosafety protocols, monopoly property rights, insect resistance, yield advantages and market dependence leading to debt and even to farmer suicide. The critique of BT cotton is itself criticised for unauthenticated evaluations while peer-reviewed corroborations face condemnation for research design plagued by selection biases (Stone, 2013). Less acutely controversial state-of-the-art CRISPR Cas9 gene-editing techniques are being developed for biotech applications in institutions under the IARI. While exempted from GM regulation, this research is effectively protected by only a draft regulatory framework for biosafety (Shukla et al., 2018).

Private research also has projects for breeding, biotechnology, animal health, plant protection, agricultural machinery, not to mention bio-chemical processes in post-harvest food and beverage industries—all biased away from basic staples. While 21st century farmers are widely discredited as facing 'deskilling due to inconsistency, unrecognizability, and accelerated technological change' (Stone and Flachs, 2014) expert research-based knowledge itself has become segmented by patents and intellectual property rights (and attacked by technological pirates). From the mid-1980s to 2010, private R&D in the agro-food system leapt 6 times to $700 million (in 2005 ppp $) (Pray and Nagarajan, 2014). By 2010-11, public research in agriculture amounted to only 0.5% of the national GDP with the rest (2.1%) coming from the private sector. Yet "[p]rivate sector research is held back on account of policy uncertainties and a sclerotic regulatory regime, besides weak enforcement of intellectual property rights (IPR)," according to Gulati et al. (2022: 288).

The complex 21st century ecosystem for agricultural research faces several contradictions. While it remains path-dependent, it is officially accepted as no longer being a state-coordinated innovation system (Ramakumar, 2012). Private research is carried out for public markets, but for private profit rather than the public good. Returns to investment in agricultural research—and public extension services—that have for decades been consistently reported as high (Fan et al., 2008; Ramakumar, 2009) face declining research staff in public institutions, segmented and 'projectized' research with discontinuities in research successions,[21] rising incidences of inputs adulteration and declining rates of agricultural growth. Given the lack of state direction, the globalised CGIAR's increasingly underfunded, constantly reorganised plant-breeding system under sustained attack from private interests for its public good research and progressively deprived of core funds, has received a mandate to co-ordinate public and private research. But in 2022, India's station, ICRISAT, dedicated to rainfed crops in the semi-arid tropics and established in 1972, peeled off from the new 'One-CGIAR'[22] and the co-ordination role drifts listlessly in the institutional doldrums.

What are the effects of the historiographical distance reflective of the social distance between research and practice? In a nutshell, throughout the 20th century and accelerating after independence,

[21] Global Nitrogen Campaign discussion, personal communication, July 2022.

[22] https://www.icrisat.org/icrisat-strengthens-partnership-with-nars-assures-commitment-for-avisa-project-in-africa/

agricultural science in India, Indian agricultural science and diasporic Indian agricultural science saw the replacement of producers as breeders of crops by specialised research and changed the direction of agriculture from extensive to intensive production technologies relying on water and chemical inputs (Ramakumar, 2021). In at first replacing the adaptive precision of crop-environment interactions by input-dependent varieties that were designed to be comparatively robust to physical environments and in then attempting to reduce the effects of uncertainty and risk that emerged, new varieties have faced new risks together with the local uncertainties of climate change. The regionally and socially uneven trajectories that resulted have increasingly been constrained by deteriorating agro-ecological conditions.

Meanwhile throughout the century a separate stream of agricultural research had flowed alongside the main current. This marginalised parallel history calls for a lifebuoy.

Counter-orthodox Histories of Organic Agricultural Knowledge

Despite far less attention being paid to the historiography of organic agriculture and its institutions, at least two histories together with their international trajectories can be distinguished.

In his historiography of organic agriculture worldwide, Gregory Barton shows how in the first phase, Indian field research initiated in 1905 was fused with research results from Europe, China and Japan by Albert Howard and his two sister-wives (botanist Gabrielle and science communicator and biographer Louise, who remain unsung women in colonial science). With an original philosophy combining lab-land and systems approaches, they researched bacteriology, starting with mycological-pedological reactions to pesticides for wantonly imported exotic pests and diseases (Barton, 2018). They studied soil aeration, root growth and erodibility, crop-animal and weed-tree relations, and even post-harvest packing technology for perishable fruit. Presciently sensible to yields as dependent on temperature as well as water, they helped to breed tobacco, cotton and Pusa wheat—the latter which by 1925 had spread to 7.5 million acres of land.

But Howard locked horns with Justus von Liebig over chemical fertiliser; he also opposed the burning of plant wastes—championing their composting instead. As a science communicator and knowledge-extension activist, Howard was also an early critic not only of the 'bloated', 'heavy-handed' science categories of the new agricultural bureaucracies but also, controversially, of the principles of market exchange. For, where principles of profit and soil sustainability clashed, he argued that sustainability should prevail (Hershey, 1992). World-wide, the science and practice of organic agriculture is now attributed to the Howards.[23] The term covers fields encompassing practices with "a complex but necessary interrelationship of parts, similar to that in living things" (Heckmann, 2006).[24]

Between 1924-30 the Howards piloted and finessed the 'Indore process'. In response to the absence or unaffordability of nitrogenous fertiliser, this was a scientific protocol of accelerated composting and mycorrhizal processes using plants and animal wastes,[25] ash, lime and water—along with ammonium sulphate ('chemical dope') supplemented by pesticides where possible (Barton, 2017). Above all, organic agriculture was a solution to the problem of maintaining soil fertility without recourse to markets and commodified inputs. Howard recognised that 'his' crop rotations,

[23] Two books have stood the test of time: 1928-1931 *The Waste Products of Agriculture* and what Barton calls his popular and 'romantic' 1940-1976 *Agricultural Testament*.

[24] Quoting Howard (1976).

[25] Also acknowledged to compete with use as fuel.

animal-crop exchanges and worm management had been necessities for most farmers throughout most of India's history. Through the 20th century this has held true for a significant proportion of producers who were forced by poverty and environment to practise organic agriculture.

In the 1940s, the ideas of organic agriculture took hold internationally, politicised by both right and left (Bennet and Hodge, 2011).[26] In India, Gandhian environmentalists Mira Ben and Kumarappa were already critiquing 'technological desolation' and championing composting.[27] But, even if it resonated with Gandhians, Howard's legacy of 'romantic science' jarred with the post-Imperial turn to agricultural specialization and the promotion of artificial chemicals described in part one. In India, the colonial 'quest for agricultural and nutritional wholeness' (Barton, 2011: 182) lost institutional support, withered and lay dormant for decades.

Meanwhile, ricocheting from India through Britain to the Imperial dominions and settler colonies, amateurs carried on the work of imperial doyens of organic agriculture. Between 1946 and 1954, the 'Organic Farming Digest' started in Sydney with Howard as honorary patron propagating knowledge to a set of farmers, gardeners, and amateur 'health food' enthusiasts. They tended to favour an "imperial science" over a suspect "capitalist science…motivated by agri-business profits" (Barton, 2011: 163). While organic agricultural research in civil society evolved and diffused slowly, this post Second World War environmental movement drifted from a centre of gravity on the political right into a movement largely on the political left (Foster and Clark, 2004)—jolted in the early 1960s by Rachel Carson's *Silent Spring*.

After the period of international bloom, the Howards' legacy was to return to India in a set of ideas based not on Howard's science so much as on his popularisation as the prophet of the idea that soil health affected human and animal health through plant health.[28] From its colonial gestation, organic agricultural knowledge, has re-emerged in a cultural movement reconceiving relations between society and nature in forms which some call indigenous technical knowledge while others call peasant wisdom, and yet others peasant romanticism or peasant mysticism (Barton, 2017). Organic agriculture is one component of a socio-technological package involving local knowledge and capacity to experiment, self-sufficiency, peasant revivalism/small-holder farmerism, social economies of collective action, decentralised distribution/dedicated market segments and eco-feminism.[29] Rather than by yield maximisation or cost efficiencies in production, it has been driven by health-conscious consumerism and the politics of social and environmental justice.

Organic agriculture has had a second geneaological thread. While Howardian agricultural principles diffused fitfully and the orientalist origin myth of their being the repackaged product of ancient peasant wisdom miscegenated worldwide, in 1968 at the peak of phase one of the Green Revolution, its Indian champion M.S. Swaminathan provided a science-based warning which triggered and re-justified agro-ecology and organic agriculture in India:

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[26] The political right because the notion of environmental purity and the purity of organic food merged with the politics of racial purity. The left because organic food expressed resistance to chemicalised agriculture and its degrading environmental effects - already explained as the product of the capitalist food-system/'chemical combine' (Barton, 2011).

[27] Mandal (2019: 103)

[28] Termed 'soil fascism' by some scholars according to Barton (2018) The argument was unsolidly referenced from the health of Hunza people in NWFP (Barton, 2017).

[29] From exhaustive archival research on organic agricultural history, Barton (2017: 80) concludes that the "myth of peasant wisdom has proved, and still proves, a powerful tool in attempts to resist globalization and dominant consumerist culture by organic activists and their allies in the health food and slow food movements."

> "[i]ntensive cultivation of land without conservation of soil fertility and soil structure, would lead ultimately, to the springing of deserts. Irrigation without arrangements for drainage would result in soils getting alkaline or saline. Indiscriminate use of pesticides etc could cause adverse changes in biological balance as well as lead to an increase in incidence of cancer and other diseases. Unscientific tapping of underground water will lead to the rapid exhaustion of this wonderful capital resource left to us through ages of natural farming…..Therefore, the initiation of exploitative agriculture without a proper understanding of the various consequences…, and without first building up a proper scientific and training base to sustain it, … may only lead us, in the long run, to agricultural disaster rather than agricultural prosperity" (Swaminathan, 2010: 28-29).

At this stage the concept of agricultural disaster did not include green-house gases generated by the agri-food system, now thought to contribute a third of global GHGs, let alone Steven Lord's discovery, being confirmed, that the social costs of pollution and environmental damage caused by reactive nitrogen from agro-chemicals exceed those caused by GHGs, land-use change (from forests to crops/grazing) and water pollution combined.[30]

From Latin America, in the face of the validation of predictions such as Swaminathan's, came farmer-driven low tillage practices which, once they had expanded to 125 million ha worldwide and were backed by their own technical organisations, could not but be endorsed by UN agencies (Barton, 2017). Since 2011, FAO has supported conservation agriculture. Low or zero tillage (ploughing) has developed into sets of management practices for soil-crop-nutrient-water-landscape systems which lowered fossil energy, improved soil nutrients and soil stability, carbon sequestration and greater biodiversity, reduced costs and (controversially) sustained yields.[31] 'Ever-green' agricultural practices have proliferated encompassing "botanical and bio-pesticides, bio-fertilisers, vermiculture, nitrogen-fixing trees" (and legumes) "and pharmaceuticals of biological origin" (Swaminathan 2010: 116-117) sustainable nitrogen management (Raghuram et al., 2021), soil rejuvenation and biodiverse polyculture (Shah et al., 2022). While the status of conservation / organic agriculture and agroecology have been enhanced by their endorsement in the IPCC special report *Climate Change and Land*, 2019,[32] the field of agricultural alternatives to chemicalised technology is full of other phrases for cultivation practices. These mimic nature in diversity, interdependence and resilience or apply processes of sustainable development (Broman and Robert, 2017). In no special order, they include: regenerative, 'nature positive', holistic, 'real', 'genuine', nature-based, natural, farming systems revolution, agro-ecology, permaculture, zero tillage, 'zero budget natural farming', evergreen, restoration ecology, nitrogen stewardship, millets-centred, 'Cuban model', Systems of Rice Intensification', Sikkim and Kerala initiatives—even climate-smartness.

Despite its contributions to these discursive blossoms, India has slipped far behind the 20 vanguard countries in conservation and organic agriculture and, by 2012, its adoption was evaluated as 'marginal' (Friedrich et al., 2012). Despite progress in some state such as Andhra Pradesh (Dorin, 2021), the new wave is at best a wavelet on the All-India level, and at worst dismissed as appropriate only for hobby plots.

So, why bother to insist that this counter-narrative be inserted into India's agricultural histories? Because as science and as technological practices, organic agriculture / agro-ecology represent

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[30] Steven Lord, 2022, (personal communication) about an as yet unpublished paper.

[31] https://www.fao.org/conservation-agriculture/overview/why-we-do-it/en/

[32] Also, see IPCC's Sixth Assessment for 2022.

trajectories for agriculture which are unavoidably necessary responses to environmental degradation and agrarian social distress. They are not being given official scientific recognition. They are not being followed to scale despite UN approval and despite the Indian government's and NITI Aayog's combination of endorsement and failure to resource one of them: Zero Budget Natural Farming (Dorin, 2022). As a new 'hybrid' social movement that integrates agronomy with NGOs, farmer organisations, individual bureaucratic support and shards of state finance, agro-ecology enters the struggles of eco-feminist movements and NGOs reacting to damage caused by the GR. Its micro-politics is forced to be antagonistic.[33] Its selective official legitimacy results from parallel and divergent institutional path-dependencies in agricultural science and its politics. The formal system finds renewed legitimation in the science-based implication from India's small contribution to cumulative GHG emissions that fossil-fuel based agriculture is India's right to develop. Further, claimed yields and profits at present rest on evidence not considered valid by many scientists.[34] Jayaraman and Change for example conclude from a review of key research that the current evidence for high yields from 'agro-ecology' consists of a 'package of (sustainable) practices, otherwise well-known or recognised individually as having been developed in the very contexts that the (agro-ecological advocate) disparages, such as "industrial agriculture" or laboratory science' (Jayaraman and Change, 2021).

What is at play? Systems of Rice Intensification (SRI) which originated in Madagascar in the 1980s can be taken to represent the family of problems faced by one transitional higher-yielding, water-economising technique (Reddy et al., 2013; Taylor and Bhasme, 2019; Deb, 2020). First, as this essay shows, knowledge no longer diffuses in a lab to land mode mediated by extension staff (if it ever did). Experiments and land-land exchanges of techniques confront economic interests from powerful inputs companies (Aga, 2018), and—less frequently—socio-politically inflected advice from NGOs and social movements (Stone, 2016). A counter-culture of valid evidence has evolved from claims and counterclaims about practices and yields from micro-studies not grounded in 'abstract farmers' and RCT design. This discourages recognition and support in agricultural and policy bureaucracies, the science-policy establishment and most media and communications outlets.[35] Second, problems of agrarian social structure arise in which yield increases are traded off against the need for precision-timed access to knowledge, cash transfers, water, labour and new tools, all of which have been shown to be specific to gendered agrarian class positions and are found hard of access to small-holders (Taylor and Bhasme, 2019). Third, the paradigm shift is hostile to powerful agro-chemical lobbies, to their innovations in hybrid, GM and genetically edited seeds, to their new bulk machinery for storage and processing and to the new crowd of big data digital start-ups and private applications of drones, satellites, AI and machine learning, lubricated with block-chain finance that characterise the 21st century agro-industrial socio-technical regime (Dorin, 2021).[36] Last, organic/ecological agriculture confronts the macro-economic and political imperative to 'feed cities'. Pathways towards transformation have staggered time-frames. Processes of ecological restoration vary: pest-resistant seeds, rotations, intercropping—with bio-pesticides for emergencies—may require a few seasons, but the restoration of the organic life and fertility of

[33] Dorin (2022); Mandal (2019); see also Dantwala (1966) on credit and subsistence. The Report of the Committee of Direction of the All-India Rural Credit Survey (1954) summed up the position by observing: "Co-operation has failed, but co-operation must succeed." The same holds for agro-ecology.

[34] See High Level Panel of Experts (HLPE) (2019) and its critique by Jayaraman and Change (2021).

[35] See Gulati et al. (2022) where agro-ecology does not appear and organic agriculture receives fleeting mention.

[36] See also FICCI: https://ficci.in/past-event-page.asp?evid=25999.

mineralised and degraded soil takes longer. New trajectories are specific and localised, subject to risk and uncertainties. The introduction at scale of current non-chemicalised crop technologies would jeopardise food supplies, not simply in towns and cities, but to all net purchasing households throughout the countryside. While yields dip and recover (if they do), food security has no alternative to buffer-stocks and public distribution channels which, even if practice does not always follow preaching, require an interventionist state antithetical to the received neoliberal policy order.

Confined in practice to small acreages, to fruit and vegetables, organic agricultural produce lacks support prices to producers yet requires price premia to consumers to cover costs and diseconomies of small-scale marketing, costly dedicated supply lines (farmers' markets), and 'health' certification against adulteration. If dependent on well-irrigation, organic agriculture produces as much GHG as chemicalised agriculture due to the coal embedded in the electricity necessary for water-lifting. Though India has 40% installed capacity in the form of solar energy, solar pumps, already discussed in the 3rd Five-year Plan for the 1960s, are stuck in their infancy due to up-front capital costs (Gathorne-Hardy et al., 2019).

What are the combined effects of historiographical neglect and the lesser social distance between research and practice in counter-orthodox agricultural sciences? It seems as though alternative agricultural technology is re-creating itself similarly to how it began a century earlier—this time as a synthesis of science and counter orthodox developmentalism. This is faced with a complex formal innovation system rebalancing itself from public to private research, institutional elements of which still retain path-dependence and have demonstrated resistance to organic agriculture. The concatenation manifest in the first set of histories is missing in the second.

In Sum

Not only do institutions matter to the agricultural economy but so do their histories. The record of their development benefits from a pluralist genealogical approach which recognises knowledge-creation outside formal institutions, whether these be of state, market or academy. Innovation systems require institutional synergies: the science and technology for India's new agricultural strategy (or the green revolution) was a concatenation event which to date has been missing from technologies being developed to address the ecological crisis in agriculture. From the colonial period to the present, both streams of technical knowledge—orthodoxy and counter orthodoxy each with historical eddies, debates and critiques—have required continual engagements between Indian science and science worldwide. The institutions of agricultural research are also closely intertwined with public action and yet they set limits to it. As stressed by many analysts, both streams of histories pursue technology and neglect reform to an agrarian structure characterised throughout the century by miniaturisation.

Policy for agricultural technology is shaped not only by technical evidence and research but also by economic interests outside research institutions, by existing laws and procedure in ministries and departments over and above those dedicated to agriculture, and by macro-economic trends in public investment and expenditure. It is far from the 'policy implication' that pervades development economics. Counter-orthodox policy will need counter-orthodox economic forces. These it currently lacks.

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RELATIONSHIP BETWEEN BORROWING COST AND FARM SIZE: TEST RESULTS FROM PARAMETRIC AND NON-PARAMETRIC METHODS

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Abstract: Agriculture land conversion is becoming a severe threat to the sustainability of the agrarian systems in countries where farm activities are predominantly performed on marginal landholdings. The relationship between borrowing cost and farm size is a concern for many marginal farmers as some of the components in the borrowing cost are not scalable. The present study evaluates the relationship between borrowing cost and farm size based on a primary survey conducted among the paddy farmers of Kerala. MANOVA and PERMANOVA are used to test the hypothesis. The results from the study show that there exists a significant difference in the average cost bared by different categories of farmers, and the burden of borrowing costs is more on the smaller farmers.

Keywords: Borrowing cost, Transaction cost, Farm size, Cooperatives, MANOVA, PERMANOVA

1. Introduction

Agricultural land conversion and its impact on the environment and sustainability are important issues in many parts of the world. However, the problem is more seriously discussed in Asian countries mainly because of escalating pressure on land and the lack of alternatives (Gardi et al., 2015; Jiang and Zhang, 2016). Researchers identify many issues that act as a pushing factor for these conversions. Urban sprawl activities threaten to maintain agricultural land in urban zones (Sudirman, 2012; Meiyappan et al., 2017) provide evidence for converting a large portion of the very active agricultural land to fallow, reducing farm production using data based on satellite images and supporting surveys. Their study shows that the scarcity of labor, land fragmentation, shortages of supporting facilities, and capital are vital factors behind the land alterations. It is evident from these

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studies that production relations in agriculture have changed significantly over the period because of changes in technology, the average size of land holdings, relative cost, availability of labor, changes in agricultural prices, government policies, etc.

The size of agricultural landholdings is becoming a critical factor in determining the sustainability of farming activities. It affects many other factors, like the cost of production and technical efficiency. For example, Jha et al. (2005) show that an expansion in farm size augments technical efficiency, and an essential positive association exists between farm size and productivity. On the other hand, small holdings have minimal technical efficiency and face the danger of soil erosion at a higher level (Meiyappan et al., 2017). Moreover, studies show that small holdings are likely to face soil erosion, especially in semiarid areas, as small holdings are inefficiently mechanized (Yadav, 1996; Reddy, 2003; Singh, 2013). One of the significant factors identified in many studies behind the inefficiencies and conversion of the land is the size and nature of the existing landholdings. As per the latest agriculture census report (Government of India, 2020), marginal and small landholdings (below 2 hectares) constitute around 86% of the total land holdings in India. It indicates the severity of the problems faced by the country in this regard. The situation is similar in many other South Asian countries (Niroula and Dhapa, 2005).

Land fragmentation is a critical impediment to enhancing the productivity and sustainability of agricultural land in many Asian countries like India and Nepal (Blaikie and Sadeque, 2000). Niroula and Dhapa (2005) addressed how fragmentation and shrinkage of landholding size affect agricultural production and conditions of land and eventually determine the yield rate. The current scenario in South Asian countries is significantly different from the past, and the importance of the factors affecting productivity and efficiency has changed dramatically. While Schultz developed his theoretical framework, farming in the region was labor-intensive, and people used local inputs and mainly depended on their household resources. The employment of family members was mostly confined to these agricultural activities. However, with new technologies and scientific practices, many local inputs have got replaced by alternatives like inorganic fertilizers and hybrid seeds. New methods also require better irrigation facilities. It has been reported (Rosset et al., 2000; and IDEAs, 2003) that the credit requirements for arranging these inputs are generally not very easy for small farmers.

The migration of laborers from rural areas became intense as the return to labor from other sectors like services and industries is much better than agricultural activities. As a result, farmers face severe labor shortages for farming operations in many parts of South Asia (Niroula and Dhapa, 2005). In hastily urbanizing places, small households feel the pressure of the opportunity cost of labor. Many of them tend to shift from agrarian to non-agrarian activities gradually. On the other hand, large farmers systematically reduced the dependency on manual laborers by replacing them with mechanization (tractors and other equipment). These technologies are cost-effective, and by adopting these technologies, large farmers get the benefits of economies of scale (Jian-Ming, 1997).

Some studies show that the association between farm size and productivity envisaged by Schultz (1964) has been reversed, especially if we consider net farm income as a mark of production efficiency (Saravanakuma et al., 2020; Wattanutchariya and Jitsanguan, 1992). The production scale efficiency has been sited mainly because of the substantial changes in the production environment. Differing from the subsistence nature of farming, small farm holders have to compete with large farm holders to sell products in the market. Naturally, their capacity to compete in the market rest on the cost of production, apart from deciding their net farm income. Because of these changes, van Dijk (2003) points out that instead of productivity, net financial surplus per marginal unit (land) has to be considered as the standard for evaluating the efficiency of farmland usage.

The association between productivity and farm size is well explored in the literature (Jha et al., 2005; Foster and Rosenzweig, 2011). Similarly, the role of land size on technical efficiency was also evaluated by many authors. However, the literature does not explore the relationship between land size and other factors like borrowing cost, especially at a segregated level. The association has significant implications if we consider net financial gain per unit of farmland as the benchmark for evaluating efficiency and sustainability. The present study addresses this gap by exploring the relationship between farm size and the cost of borrowing for paddy farmers at a disaggregate level.

The rest of the paper is arranged as follows. The following section briefly reviews the issues related to borrowing costs. The third section describes the borrowing cost structure (definitions) used in the present study. The fourth section describes the data and the econometric model used in the study. The following section presents the results and discussions, and the final section concludes the paper.

2. A Brief Review

Adams and Nehman (1979) studied the issues related to the borrowing cost incurred by farmers in Bangladesh, Brazil, and Colombia. The study assesses that the high transaction cost is a significant factor that discourages small farmers from applying for formal institutional loans. Because of high transaction costs, farmers sometimes reject offers from credit institutions (Amanullah et al., 2020). Moreover, they observed that the transaction cost constituted a significant portion of borrowing costs for small and medium-sized farmers and a less critical part for large and experienced borrowers. The heavier impact of borrowing costs on small farmers is observed by Llanto and Chua (1996) in the Philippines and Ahmed (1989) in Bangladesh. Many studies conducted in India also reported similar results. The inverse relationship between borrowing cost and farm size is cited by George et al. (1985) in Andhra Pradesh and Sarap (1990) in Odisha. George et al. (1985) and Ahmed (1989) also observed an asymmetry in the effective cost of loans by size, and it favors large loans from formal institutions compared to informal ones.

Many authors observed that cooperatives worked not only for agricultural development but also for the overall development of farmers (Pantulu, 1994; Shivamaggi,1994; Anandaram and Medha, 1999; and Devi, 2012). However, some of the studies that evaluated the performance of the cooperatives in agriculture finance noticed the problems faced by the institutions and identified the reasons behind their failures. Satyasai and Badatya (2000) and Igwe and Egbuson (2013) examined that high transaction cost is one of the reasons which cramped the growth of lending by cooperatives. Patra and Agasty (2013) studied the role of cooperatives in financing agriculture in the Balasore district in Odisha, India. The study reveals that cooperatives provide loans for most farmers at a cheaper rate. However, the credit delivery system of cooperatives creates discontent among many farmers because of the demand for high collateral security, complex lending procedures, longer time gap for getting a loan, the incurrence of high transaction costs, etc. They observed that the adverse factors force many farmers to approach non-institutional agencies for loans.

3. The Structure of Borrowing Cost

Borrowing cost for agriculture includes not just the rate of interest on the loan but also includes other expenses such as application fees, charges for stationery items, payment of crop insurance, cost of risk fund, a service charge of the bank, payment for court fee stamp, personal insurance, travel towards the bank, loss of labor hours while visiting banks and, other expenses.

Some authors have tried to detail the cost structure associated with obtaining a loan (Ladman,

1984; Jugale, 1991). A farmer has to go through some procedures prescribed by the lender to get a loan, resulting in borrowing costs. The borrowing cost includes interest payment, transaction costs incurred by the borrowers, etc. Ladman (1984) provides a framework for explaining the demand for credit based on the relationship between average borrowing costs and the average revenue generated from the investment of the loan. Here average borrowing costs are the summation of total fixed and other transaction costs divided by the loan size. Total fixed transaction cost represents the amount of outlay the farmers incurred while applying for a loan, such as the payment of application fees, service fees, documents, and other paperwork. Another transaction cost involves the cost incurred by the farmers in charge of commission and bribes to bank staff and the opportunity cost of time spent. The transaction cost appears smaller for large and experienced borrowers, whereas it makes up a significant portion of the borrowing costs of small borrowers (Adams and Nehman, 1979; Sahu and Rajasekhar, 2005).

Jugale (1991) classifies agricultural borrowing costs into two types based on occurrences: (1) the costs incurred by the farmer before receiving the loan amount, and (2) the direct or indirect costs which a farmer has to bear after receiving the credit. For availing of credit, the farmer has to prepare documents such as no dues certificates, ownership copies, copies of photographs, etc., for which fees must be paid. Further, the farmer has to incur travel costs towards banking units, waste of labor hours while visiting the banks, expenses on photocopy and other charges, and refreshments during the visits to banks. These costs are involved in getting credit to continue up to the final repayment of the loan. The items like interest rate, storage charges, costs arising from uncertainty, marketing costs, period of waiting for selling the agricultural goods, etc., are those costs incurred after receiving the credit.

In the present study, the interest rate is not included as a borrowing cost component because Primary Agricultural Credit Societies (PACS) supply interest-free loans to paddy farmers. Interest is charged only in those situations where farmers make defaults. The total cost can be classified into indirect cost and direct cost. According to Chatterjee (2011), the total cost is divided into two: 1) transaction cost (indirect cost), which includes the number of visits to bank branches, and 2) costs of credit (direct cost) which includes the cost of stamp duty, processing fees, photographs, transport cost for visiting the bank premises, bribes, etc. Here, we made a few changes by including more items in costs of credit (direct cost) as these costs are particular to cooperatives. The direct cost includes four items such as crop insurance, cost of risk fund, service charge, and personal accident insurance. All other costs, such as stamp duty, photographs, and transport costs for visiting the bank premises, are included in the miscellaneous group. Items like money spent on bribes are excluded because farmers are reluctant to give such information.

4. Methodology

The present study is based on a primary survey conducted among paddy farmers from the Palakkad district of Kerala. Palakkad district is called the "rice bowl" of Kerala. A multi-stage stratified random sampling method is employed to collect data systematically from the Palakkad district of Kerala. From the district, three taluks are selected, namely Palakkad, Alathur, and Chittur, based on production levels and cultivation area. Three standard PACS from each taluk have been determined using the lottery method. The sample farmers are selected from the list of borrowers in the ledgers of the nine chosen PACS. According to the size of their operational holdings (small, medium, and large), an adequate representation of all groups is made in the sample using stratification. Out of the 2821 farmers, information is collected from 282 farmers using a structured questionnaire.

One of the primary objectives of this study is to explore the relationship between borrowing cost and farm size. The hypothesis for this objective can be stated as follows; no difference exists across the three groups of farms (small, medium, and large) concerning the borrowing cost. A common and straightforward framework for testing this hypothesis is the Analysis of the Various (ANOVA) and its multivariate generalization (MANOVA). Following Rencher and Christensen (2012: 176), briefly describe ANOVA and its multivariate extension (MANOVA).

We have n observations from k groups (samples) in a balanced one-way ANOVA. We assume k samples are from populations normally distributed with equal variances. The model can be represented as

$$y_{ij} = \mu + \alpha_i + \varepsilon_{ij}$$

$$y_{ij} = \mu_i + \varepsilon_{ij} \qquad i = 1,2,3..k;\ j = 1,2,3 \ldots n$$

where μ_i is the mean of the i^{th} group, and in ANOVA, we compare the means across the groups. The hypothesis is H_0: $\mu_1=\mu_{2=}\ \mu_3\ldots.=\mu_k$. We assume all y_{ij} are taken from the same population if the null hypothesis is true, $N(0, \sigma^2)$. So, one can get two estimates of σ^2 from the sample variances and sample means.

The pooled estimator ("within-sample") of σ^2 can be computed as $s_1^2 = \frac{\sum_{j=1}^{k}\sum_{i=1}^{n}(y_{ij}-\bar{y}_{i.})^2}{k(n-1)}$

The "between-sample" estimate of σ^2, from the variance of the sample-means, can be calculated as $s_2^2 = \frac{\sum_{i=1}^{k}(\bar{y}_{i.}-\bar{y}_{..})^2}{k-1}$ where $\bar{y}$ is the grand mean. If we accept the hypothesis, the ratio of the two estimates will be equal ($s_1^2 = s_2^2$). The ratio of the estimates forms the F statistic.

The multivariate extension is the MANOVA. We maintain the assumptions of normality and equal covariance matrices for the populations from which the samples are taken.

The relationship for the r^{th} variable (r =1, 2, …, p) in a vector y_{ij} can be represented as

$$y_{ijr} = \mu_r + \alpha_{ir} + \varepsilon_{ijr} = \mu_{ir} + \varepsilon_{ijr}$$

We can check the mean vectors of the k samples for substantial differences. The alternative hypothesis is H_1: at least two μ's are unequal.

The "between" (H) and "within" (E) matrices are defined as

$$H = n\sum_{i=1}^{k}(\bar{y}_{i.} - \bar{y}_{..})(\bar{y}_{i.} - \bar{y}_{..})'$$

$$E = \sum_{i=1}^{k}\sum_{j=1}^{n}(y_{ij} - \bar{y}_{i.})$$

The likelihood ratio test is given by, H_0: $\mu_1=\mu_2=\ldots.=\mu_k$

$$\Lambda = \frac{|E|}{|E + H|'}$$

Which is known as Wilks' Λ. It checks the equivalence of the "within" sum of squares (E) and the "total" sum of squares (E + H). This is like the univariate F-statistic. We can transform Wilks' Λ to F statistic for a given degree of freedom.

A review of the literature shows that MANOVA results can be sensitive to the violations of the assumptions. It is generally tough to fulfill all the test assumptions on practical grounds,

especially the multivariate normality assumption. To improve the robustness of the results, we followed additional procedures that are more resilient to violating these assumptions. Examining the variables (components of the borrowing cost) shows that they are highly correlated. We run MANOVA on the principal comments extracted from the variable scores. We also employ a non-parametric alternative called the permutation test for homogeneity of multivariate dispersions (PERMANOVA), which is robust against violation of most of the assumptions of MANOVA.

Referring to Rencher and Christensen (2012: 405), a brief description of the principal components' method can be given as follows. Let $a_1, a_2, \ldots, a_p$ be constants and the linear combination of the elements of the vector y, can be represented as $z = a_1y_1+a_2y_2+\ldots\ldots\ldots+a_py_p = a'y$, where $a' = (a_1, a_2, \ldots, a_p)$. For the multivariate cases with the same coefficient vector, we have $z_i = a'y_i$. The mean vector $\bar{z} = \frac{1}{n}\sum_{i=1}^{n} z_i = a'\bar{z}$. The sample variance of z_i can be found as, $a'Sa$, where S is the variance-covariance matrix.

We look for a linear combination of the variables with the maximal variance in the principal components approach. We seek the maximum variance of $\lambda = \frac{a'Sa}{a'a}$. The highest value of λ is associated with the largest eigenvalue in the expression $(S - \lambda I)a = 0$. The eigenvector a_1 consistent with the largest eigenvalue λ_1, is the coefficient vector in $z_1 = a'y$, which provides the linear combination with maximum variance.

Because of high correlation among the borrowing cost components we can use few principal components ($z_{1i} = a_1'yi$, $z_{2i} = a_2'y_i, \ldots\ldots, z_{ki} = a_k'y_i$, for i = 1,2,3,……, n) instead of raw variables. In vector form, the component scores can be rewritten as $z_i = A_k y_i$. We can use $z_1, z_2, \ldots, z_n$ as the dependent variables for estimating the MANOVA model.

Like other similar test statistics, PERMANOVA can segregate variation like in an ANOVA design. It can use distance measures and generate a *P*-value following suitable permutation methods. Because of employing permutations, the test does not rely on specific assumptions about the number of variables, type of distributions, or correlations. The test statistic is similar to *F*-ratio and is computed from sums of squared distances within and between groups. Following Anderson M J (2001), the method can be summarized as follows.

Create a distance matrix for N (N = an) observations by taking each pair of observations. Let d_{ij} is the distance between point $i = 1, \ldots, N$ and point $j = 1, \ldots, N$. We can compute the total sum of squares for the matrix as

$$SS_T = \frac{1}{N}\sum_{i=1}^{N-1}\sum_{j=i+1}^{N} d_{ij}^2$$

It is mostly equivalent to the sum of squares of the half of the distance matrix without diagonal and divided by the number of observations. Similarly, the residual sum of squares (within-group) can be expressed as

$$SS_w = \frac{1}{n}\sum_{i=1}^{N-1}\sum_{j=i+1}^{N} d_{ij}^2 \in_{ij}$$

The value of ϵ_{ij} will be one if point *i* and point *j* are from the homogenous group. In other cases, it will have a value of zero. $SSA = SST - SSW$ and a pseudo-F-ratio to test the hypothesis is

$$F = \frac{SS_A(a-1)}{SS_w(N-a)}.$$

For the true hypothesis (the groups are homogenous), the rows would be transferrable among the groups. So, the labels on the rows could be randomly assigned (permuted), and a new value of *F* can be computed (*F**). The P-value can be calculated by comparing the value of *F* from the initial ordering of the rows concerning the permuted one as

$$P = \frac{(No.\ of\ F^* > F)}{(Total\ no.\ of\ F^*)}.$$

5. Result and Discussion

The survey results show that, on average, the farmers incur Rupees 4944 as the borrowing cost for obtaining the loan (see Table 1). While small farmers incur Rupees 7059, large farmers face only around Rupees 972.

The ANOVA test results reject the null hypothesis (no difference exists across the three groups of farms (small, medium, and large) concerning the borrowing cost). Assuming the non-constant variance, the Games-Howell post hoc test is used. Results from the test are given in Table 2. It shows that the average difference in cost between small and large farmers is higher (Rupees 6087) than between medium and large farmers (Rupees 1353). Therefore, we can conclude that the average borrowing cost is higher for small and relatively lower for large farmers.

Table 1: Comparison of Total Borrowing Costs among the Different Categories of Farmers

Category of Farmers	Total	Borrowing cost per hectare (Rs) -Mean	Std. Deviation	F
Small	164	7059.08	4619.76	70.946***
Medium	90	2324.87	709.736	
Large	28	972.00	239.480	
Total	282	4943.77	4350.301	

Note: *** Significant at 0.01 level

Table 2: Post Hoc Test (Games-Howell) Results

Farm Size	Farm Size	Mean Difference
Small	Medium	4734.213**
	Large	6087.079**
Medium	Small	-4734.213**
	Large	1352.867**
Large	Small	-6087.079**
	Medium	-1352867**

Dependent Variable: Total Borrowing Cost
Note: ** Significant at the 0.05 level.

Next, we will analyze the relationship between borrowing cost and farm size at a disaggregated level by splitting the total cost into direct and indirect costs.

5.1 Indirect Cost

Each visit of a farmer to the PACS involves waiting for long hours. Working hours loss may be an essential component of borrowing costs (Hosseini et al., 2012). It has been observed that small farmers must spend more hours in PACS to access credit. If you look at the total number of hours spent and longer hours waited for, small farmers are in the first place (see Table 3). Spending these hours affects their farming activity, creating a disturbance and loss of their work. This lost work is viewed as an opportunity cost, and this opportunity cost for borrowers is relatively huge (Sahu and Rajasekhar, 2005; Sarap, 1990; Adams and Vogel, 1986; Adams and Nehman, 1979).

Table 3: Total Hours Spent for Getting Loan by Farmers

Hours Spent for Accessing Credit	Size Group			Total
	Small	Medium	Large	
1-2 hours	25	24	16	65
%	*15.24*	*26.67*	*57.14*	*23.05*
3-4 hours	63	42	10	115
%	*38.42*	*46.67*	*35.71*	*40.78*
5-6 hours	76	24	2	102
%	*46.34*	*26.67*	*7.14*	*36.17*
Total	164	90	28	282
%	*100*	*100*	*100*	*100*

Note: The figures in italics are the percentages of the total.

Following earlier studies (Chatterjee, 2011), we have also considered the number of visits to the banks required for getting a loan as the proxy variable for indirect cost. Table 4 clearly shows that out of the total number of farmers, only 15.6 percent of farmers had visited twice to get a loan from PACS. Of those, 57.1 percent are large farmers, 14.4 percent are medium farmers, and 9.2 percent are small farmers. Alternatively, out of 49 percent of farmers who have visited PACS more than thrice to get the loan, 65.2 percent were small farmers, 32.2 percent are medium farmers, and only 7.1 percent are large farmers.

Table 4: Number of Visits (Indirect Cost) to the Banks by Category of Farmers

Number of Visits	Size Group						Total	
	Small (Up to 1 hectare)		Medium (1-2 hectare)		Large (Above 2 hectares)			
	Number	%	Number	%	Number	%	Number	%
Two times	15	9.2	13	14.4	16	57.1	44	15.6
Three times	42	25.6	48	53.3	10	35.7	100	35.5
More than three times	107	65.2	29	32.2	2	7.1	138	48.9
Total	164	100	90	100	28	100	282	100

This highlights the inverse relationship between the number of visits to the bank and the holding size. Fisher's Exact Test tests the association between the number of visits to PACS and land holding size. Table 5 shows the results from the Chi-square tests. The test statistics are significant at a one percent level. Hence reject the null hypothesis that visits are similar for farmers across different categories and conclude that there is a significant association between the size of land holding and the number of visits to PACS.

Table 5: Fisher's Exact Test results

Tests Statistic	Value	df	p-value
Pearson Chi-Square	72.065	4	0
Likelihood Ratio	65.111	4	0
Fisher's Exact Test	63.966	4	0
Linear-by-Linear Association	54.3	1	0
N of Valid Cases	282		

As the size of the holding increases, the number of visits to the bank decreases. Chatterjee (2011) also reported similar findings and showed that a large percentage (about 60 percent) of the marginal farmers (Up to 1 hectare) are required to visit more than five times to avail of credit from the bank. This could be attributed to the backwardness of education of small farmers, hindering the free flow of information. Besides, as already mentioned, small farmers faced difficulty obtaining those sureties, as mandated by the PACS. Many small farmers also face the challenge of getting their loan applications rejected due to the overdue problems of sureties. In such cases, they have to produce new sureties that necessitate additional visits to the bank.

5.2 Direct Cost

In addition to the indirect cost of borrowing, the farmers also incur direct costs. Direct cost includes crop insurance, cost of risk fund, service charge, personal accident insurance, and other miscellaneous items, including application fees, photocopy charges, additional stationary charges, etc. Table 6 shows the component-wise average direct cost incurred by the farmers. A farmer has spend rupees 1900 as a direct cost to obtain the loan. The most oversized single item in it is the expense for crop insurance (average expense is around rupees 1158). Most direct costs are uniformly distributed across the farmers, and the cost per unit area could be significantly different concerning the category of the farmers. Next, we will examine the relationship between an average direct cost and farm size across different types of farmers.

Table 6: Components of the Direct Cost (Rs)

Cost Items	Minimum	Maximum	Mean	Std. Deviation
Crop insurance	464	2016	1158	361
Cost of risk fund	64	333	176	58
Service charge	124	833	383	150
Personal accident insurance	100	100	100	0
Cost of making a trip	20	200	82	36
Total direct cost	784	3036	1899	525

One-way MANOVA is used to examine whether any significant difference exists in the average direct cost for different categories of farmers or not. Table 7 shows the MANOVA results. The table shows that the test results are significant at a one percent level. Wilks' Λ is 0.21, $F(10,518) = 62.61$, $p < 0.001$. Multivariate $\eta^2 = 0.55$ shows that 55 percent of the variance of the dependent variable is associated with the group factor. The significant F indicates a significant difference in the direct cost across various sizes of holdings.

Table 7: Multivariate Test

Statistic	Value	F	η2
Pillai's Trace	0.82	35.79***	0.408
Wilks' Lambda	0.21	62.61***	0.547
Hotelling's Trace	3.6	97.49***	0.654
Roy's Largest Root	3.6	195.12***	0.790

Note: *** Significant at 0.01 level

Tests for between-subjects effects (see Table 8) indicate that crop insurance, cost of risk fund, service charge, personal accident insurance and miscellaneous items are significantly different among various size of holdings and, F (2,263) = 112.47, p < 0.001, η^2 = .461, F (2,263) = 91.49, P < 0.001, η^2 = .410, F (2,263) = 80.20, P < 0.001, η^2 =0.379,F(2,263) = 158.40, P < 0.001, η^2 = 0.546, F(2,263)= 61.07, p < 0.001, η^2 = .317 respectively.

Games-Howell post hoc test (without the assumption of equal variance) results of the pairwise comparison shows that the mean difference of each category of direct cost with different types of farmers is significantly different (p < 0.001). As per the results, the average difference in cost between small and large farmers is higher than the difference between medium and large farmers.

Table 8: Tests of Between-Subjects Effects

Source	Dependent Variable	F	η2
Corrected Model	Crop insurance	112.5***	0.461
	Cost of risk fund	91.5***	0.410
	service charge	80.2***	0.379
	Personal accident insurance	158.4***	0.546
	Miscellaneous items	61.1***	0.317

Note: *** Significant at 0.01 level

Sometimes MANOVA could be very sensitive to the basic assumptions, and it is pretty common to see deviations from the normality of the multivariate distribution. The result from a post hoc analysis shows some level of departure from the normality. To improve the robustness of our results, we have done a Permutation test for homogeneity of multivariate dispersions (PERMANOVA test), which is a robust alternative to parametric MANOVA. Moreover, PERMANOVA assumes no distribution. We can test the hypothesis in the presence of nonconstant variance across groups, correlated variables, and many zero values, as the test are not very sensitive to these issues. The results show that the average direct cost per hectare at disaggregate levels also significantly differs for farmers with different categories of farm holdings (see Table 9). Because both types of tests (parametric and non-parametric) give similar results, we can accept them more confidently.

Table 9: PERMANOVA Test Results

	Df	Sum Sq	Mean Sq	F	N.Perm	Pr (>F)
Size	2	0.16089	0.080445	10.086	999	0.001
Residuals	274	2.18543				

Using Principal Component Analysis, we explored the data and showed that the first two principal components could explain 92 percent variation in the data (cost categories). A plot based

on the two main components can clearly distinguish the farmers of different types (see Figure 1). We use scaled data for the estimation, and principal components are orthogonal; we could ignore some assumptions like multicollinearity. We attempted a one-way MANOVA using the first two principal components to test the hypothesis of independence of samples.

The Pillai's Trace test statistic (0.49081) and approximate F statistic (132.06) are statistically significant at a one percent level. It indicates that farm size has a statistically significant association with both principal components of direct costs (see Table 10). The measure of effect size (Partial Eta Squared; η^2) is around 0.5 and suggests a significant effect of size on both principal components of direct costs.

Table 10: MANOVA using the First Two Principal Components

	Df	Pillai	Approx. F	n DF	den DF	Pr (>F)
Size	1	0.49081	132.06	2	274	< 2.2e-16
Residuals	275					

A linear discriminant analysis (LDA) can distinguish the groups using information from the dependent variables. So here, LDA is used to depict the differences between each group. Figure 2 the LDA-based scatter plot discriminates farmers concerning their farm size based on the two principal components. Leaving very few cases, we can see that most observations are very clearly discriminated. These supplementary results also support the findings that direct costs are not independent of the farm size.

An evaluation of the components of direct costs (crop insurance, cost of risk fund, service charge, personal accident insurance, and other miscellaneous items) shows that most of them could be exempted for marginal and small farmers. In the case of the difficulties faced by farmers in finding sureties in getting loans, ward/council members of the local self-governments could play an active role. We think governments should consider these issues seriously and take the necessary steps to reduce the burden the small and marginal farmers face at the earliest. Either the non-scalable costs should be removed or compensated by advances. Otherwise, they may prefer to stay out of agricultural activities or will be forced to convert their land to shallow or other activities.

6. Conclusion

Fragmentation and conversion of farmlands raise a serious question about its sustainability and implications on the environment around the world. A literature review shows that the size of agricultural landholdings is becoming a critical factor in determining the sustainability of farming activities. Agriculture is the primary livelihood activity for many people in India, and most are small and marginal farmers. Low levels of income and very minimal savings make them depend on borrowings for conducting agricultural activities. There are many costs associated with lending, and some of the borrowing costs are not scalable according to the size of the landholdings. The inequitable distribution of costs creates more burdens on marginal farmers, and the availability of institutional credit facilities alone cannot reduce these burdens. In this context present study explores the relationship between borrowing costs and the size of land holdings at a disaggregated level with particular reference to the paddy farmers of Kerala, India. The results show a significant association between the cost of borrowing and the size of land holdings, and it is not in favor of marginal and small farmers. As the size of agricultural landholdings is becoming a critical factor in determining the sustainability of farming activities and findings show that non-scalable cost components hurt

the competitiveness of the small and marginal farmers, the study suggests that governments should act in favor of the small and medium farmers by removing the nonsalable cost components or compensate them in the form of advances. Otherwise, the adverse situation can push the marginal and small farmers from agricultural activities and opt for land conversion.

Figure 1: A Plot of the Categories of Farmers across the First Two Dimensions from PCA

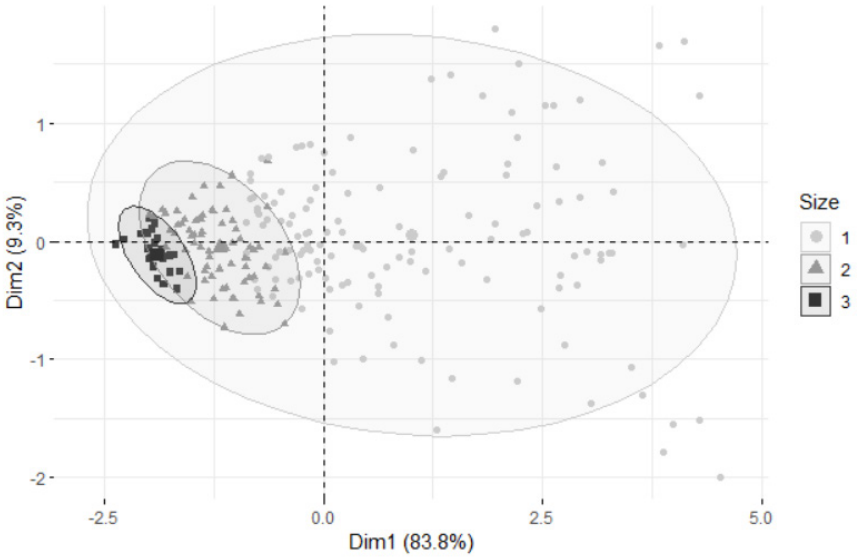
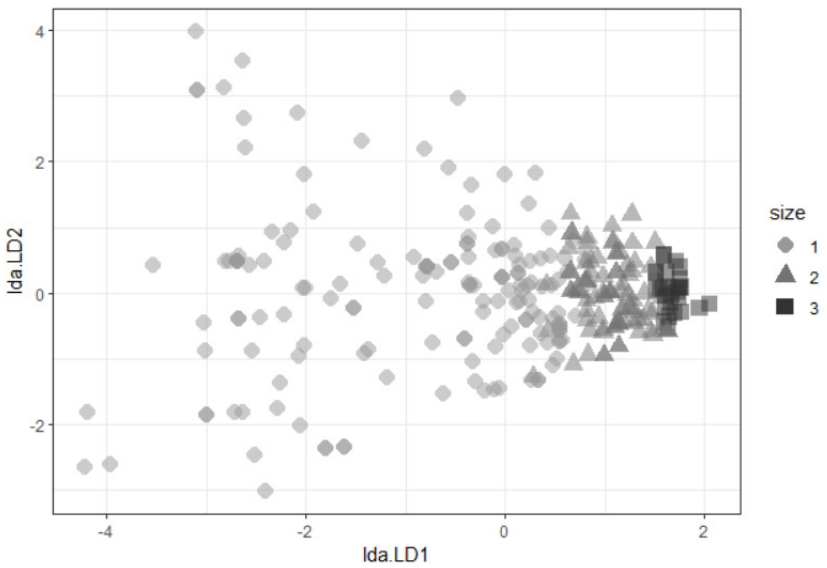


Figure 2: Linear Discriminant Analysis (LDA) Plot



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REGIONAL CATCH-UP OF INCOME IN INDIAN STATES: EVIDENCE FROM STATIC AND DYNAMIC MODELLING

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Abstract: The purpose of the paper is to examine the role of infrastructure in the process of regional convergence in India for the period 1991-2017 and also identify which infrastructure matters in ensuring convergence. The exercise of conditional convergence is carried out using Fixed effects and Generalized Method of Moments (GMM). The results estimated find out convergence rate of 0.133 percent per annum over a 4 year period taking almost 5 years to fill the half way gap with only physical infrastructure impacting the state income positively. Furthermore, not only infrastructure affects steady growth paths but even state incomes influence infrastructure. The results from Fixed effects instrumental regression pinpoint to the importance of physical infrastructure for the Indian states. The policy imperative from this suggests that more government expenditure is likely to foster better physical as well as social infrastructure.

Keywords: Infrastructure, India, Growth, GMM

1. Introduction

India seems to be diverging into almost two different countries: prosperous socially stable, rapidly modernizing southern and western regions and poor and politically volatile northern and eastern regions—Financial Times Survey, 1998. Even after years of independence and policy planning, India has not been able to correct this imbalance. The concept of Regional and Balanced development appeared as a radical issue in 12th Fiver Year Plan document which defined the scope of inclusiveness as referring to more coverage of regions and people who have remained bereft of advantages of growth. The Structural Adjustment Programme (SAP) of 1991 is often labelled as the culprit behind increasing disparities of income across Indian States but the truth to the fact is that these disparities are not of neoteric origin (Trivedi, 2002; Ghosh, 2012) though the volume of disparities has revved up post reforms (Ahluwalia, 2000). Why some states have been at the gaining side while others have been at the losing side has something to do with the nature of the state economies. Not all states are characterised by homogenous importance of sectors (Sachs et al., 2002).

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A set of Indian studies that deal with the convergence issue for Indian states is presented in the adjoining table (Table 1). The table highlights not just the conclusion of convergence issue but at the same time also provides us with an insight into the control variables that largely affect the steady growth path of states. The table succinctly supports the role of infrastructure in deciding the steady path of each state with infrastructure variables iteratively appearing in number of researches.

The table succeeds in conveying to us that absolute convergence is not what Indian states have witnessed but rather it is the conditional convergence hypothesis that stands accepted in the Indian scenario.

Table 1: Indian Studies on Convergence

Author	Conditioning Variables	Convergence	
		Absolute	Conditional
Cashin and Sahay (1996)	Migration, Centre State transfers	Yes	NW
Nagaraj et al. (2000)	Physical, Social and Financial infrastructure	No	Yes
Akkina (1999)	Per capita power consumption, Power shortages, Literacy rate, Per cent of income arising from industry and services, and Railroad per thousand square kilometres.	NW	Yes
Rao et al. (1999)	Primary sector, Sectoral share index,	No	Yes
Aiyar (2001)	Literacy rate, private investment	No	Yes
Sachs et al. (2002)	Urbanisation	No	No
Trivedi (2002)	IMR, High school enrolment, Physical capital	No	Yes
Adabar (2004)	Per capita investment, Population growth rate, Human capital	NW	Yes
Nayyar (2008)	IMR, Literacy rate, Public investment and Private investment	No	Yes
Purfield (2008)	Economic structure, Investment, Infrastructure, Human capital, Size of Govt., Industrial relations climate, Labour laws regulations	Yes	Yes
Ghosh (2012)	Infrastructure, FDI, Human capital	No	Yes
Kumar and Subramanian (2012)	Percent of Working Age Population	No	No
Cherodian and Thirlwall (2013)	Population growth, Bank Credit, Male Literacy Rate, Agricultures' share, State Expenditure as a percent of GDP	No	Yes
Pandya and Maind (2017)	Infrastructure Index, Population growth	NW	Yes
Lolayekar and Mukopadhyay (2020)	Political stability, Political alliance and social distribution	NW	No

Source: Authors' Compilation; *Note:* NW = not worked

The major objective of the research is to find out if infrastructure amenities can play a major role in speeding up the convergence process and if so, which infrastructure is important in deciding the convergence path. The major motivation to carry out the following research was drawn form the previous works as mentioned in Table 1. While most of the studies took into account one variable or the other but no separate attempt was made to differentiate the role of different indices in facilitating the process of convergence. Also, no study tried to look into the aspect of dynamism which is at the core of convergence exercise. So, the present effort tries to work along both these lines.

The present research can be differentiated from already existing ones in several domains. Firstly, the previous studies have picked up a particular infrastructure instead of segregating them into physical, social and financial indices. Secondly, the earlier studies have restricted themselves to simple panel regression analysis while not differentiating static and dynamic aspects of it but the present research addresses that too. Lastly and most important of all is the time sub division of our overall panel time that helps us to achieve more desirable results than the aggregated analysis.

The present paper is segregated into four sections including the present introductory one. Section 2 entails the database and methodology adopted for the present research. Empirical results are presented in Section 3. Conclusions and relevant policy implications are made in the final section i.e., Section 4.

2. Database and Econometric Model of Beta Convergence

A set of 17 Indian states form part of the present study.[1] The list of variables and their source of data is provided in Appendix A-1. Infrastructure variable is represented by index and the procedure followed to prepare the index is provided in Appendix A-2.

The Solow model (1956) in its augmented form was presented by Mankiw, Romer and Weil (1992) popularly known as MRW model wherein they explicitly accounted for human capital in explaining the growth convergence exercise. Similarly, Levine and Renelt (1992) took into account rate of investment, secondary school enrolment and rate of population growth as conditioning variables apart from initial level of income in his growth model. The general representation of the regression model is given as follows:

$$\ln(y_{it}) - \ln(y_{it-\tau}) = \beta \ln(y_{it-\tau}) + \psi X_{it} + \eta_i + \mu_\tau + \varepsilon_{it} \quad (1)$$

Where y represents the real income of the state i.e., per capita net state domestic product, *i* represent the state, τ stands for the number of years between every successive observation, η is state specific fixed effect and μ is on the other hand a year specific effect. X is nothing but a vector comprising of list of conditioning variables or explanatory variables whose effect is likely to be studied which in the present case are share of agriculture sector, investment, population growth and infrastructure indices.

The estimation of equation 1 using Ordinary Least Squares tends to provide biased results in upward direction thereby generating inconsistent estimates. This inconsistency is on account of positive correlation that is suspected between the lagged dependent variable and the error term (Roodman, 2007). An alternative to this is fixed effects model. The fixed effect model takes into account the unobservable region specific differences between the steady state of regions. These are represented by η in equation 1. The fixed effects model is more practical to use than a random effect model because there are justified reasons to expect that unobserved region specific effects are correlated with the some or at least one of the explanatory variables in the regression model. Even though fixed effect model outclasses the OLS modelling and random effect modelling but it is still subject to strict critique. The most widely used alternative to fixed effect estimation is the GMM estimation procedure which makes use of first difference estimation form. The basic idea in GMM is to use lags of regressors and regressand as instruments for the lagged dependent variable.

[1] Andhra Pradesh, Assam, Bihar, Gujarat, Haryana, Himachal Pradesh, Jammu & Kashmir, Madhya Pradesh, Maharashtra, Odisha, Rajasthan, Punjab, Tamil Nadu, Uttar Pradesh and West Bengal. The newly formed states of Jharkhand, Chhattisgarh, Uttarakhand (in 2000) and Telangana (in 2014) have been included in the parent state so as to maintain coherence in the dataset.

This lagged exercise helps to correct the problem of heteroscedasticity and autocorrelation within individuals, and the endogeneity problem explicitly.

The present convergence attempt will be based on Fixed effect estimation coupled with Generalised Method of Moments.

2.1 Fixed Effects Model

The equation specified in (1) is rewritten in dynamic form wherein the current output is regressed on lagged value of output along with other set of control variables. Statistically speaking the two equations are very much equivalent with the only difference in the interpretation of the convergence coefficient. While in equation 1 it was β which is now transformed into 1+β:

$$\log(y_{it}) = (1+\beta)\log(y_{it-\tau}) + \psi X_{it} + \eta_i + \mu_\tau + \varepsilon_{it} \tag{2}$$

The fixed effect modelling enables us to control for unobserved state differences. While dealing with the long period annual data on cross section of regions crops two major problems in the analysis: serial correlation problem tends to multiply due to business cycle phenomenon and shrouding of the changes in the growth pattern over the entire period As an alternative to using long period data averages in one go we split our data into sub panels of four-year spans (τ = 4). Thus for the entire study period we form six panels running from 1991-2017. Even though the time span of four years may not be an appropriate option but increasing the time period of lags to much bigger value is likely to intensify the problem of "Nickell Bias (1981)" in a dynamic panel data models with fixed effects.

In line with the dimension of our panel (τ = 4), we use an average value of the variable over the past four years and then use it as a regressor. The set of equations that we get under fixed effect modelling will look like the following:

$$Log(PCNSDP)_{1994} = \gamma\ (income)_{1991} + \frac{\sum_{i=1991}^{1994} Xi}{4} + \mu_i + \varepsilon_{it} \tag{3}$$

$$Log(PCNSDP)_{1998} = \gamma\ (income)_{1995} + \frac{\sum_{i=1995}^{1998} Xi}{4} + \mu_i + \varepsilon_{it} \tag{4}$$

$$Log(PCNSDP)_{2002} = \gamma\ (income)_{1999} + \frac{\sum_{i=1999}^{2002} Xi}{4} + \mu_i + \varepsilon_{it} \tag{5}$$

$$Log(PCNSDP)_{2006} = \gamma\ (income)_{2003} + \frac{\sum_{i=2003}^{2006} Xi}{4} + \mu_i + \varepsilon_{it} \tag{6}$$

$$Log(PCNSDP)_{2010} = \gamma\ (income)_{2007} + \frac{\sum_{i=2007}^{2010} Xi}{4} + \mu_i + \varepsilon_{it} \tag{7}$$

$$Log(PCNSDP)_{2014} = \gamma\ (income)_{2011} + \frac{\sum_{i=2011}^{2014} Xi}{4} + \mu_i + \varepsilon_{it} \tag{8}$$

$$Log(PCNSDP)_{2017} = \gamma\ (income)_{2015} + \frac{\sum_{i=2015}^{2017} Xi}{3} + \mu_i + \varepsilon_{it} \tag{9}$$

2.2 Generalised Method of Moments

Given the model specification of our regression that implicitly is a dynamic one (involving the lag of dependent variable as one of the regressor); the fixed effects estimation is likely to produce inconsistent estimates. To overcome econometric problem of endogeneity Holtz-Eakin et al (1988) and Arellano and Bond (1991) suggest estimating dynamic panel data models using the generalized method of moments (GMM) wherein endogenous variable is instrumented using lagged values. The equation after first differencing becomes:

$$\Delta\log(y_{it}) = (1+\beta)\Delta\log(y_{it-4}) + \psi\Delta X_{it} + \Delta\mu + \varepsilon_{it} + \varepsilon_{it-4} \tag{10}$$

Arellano-Bond (1991) shows that first difference GMM estimator can be applied in a panel data regression with fixed effects and a lagged dependent variable. The GMM approach is based on using lagged levels of series as instruments for lagged first differences. To illustrate, $\Delta\log(y_{it-4})$ in our case can be instrumented using the $\log(y_{it-8})$, $\log(y_{it-12})$ and $\log(y_{it-16})$ for our endogenous regressor of the dependent variable while other explanatory variables are treated as exogenous.

The consistency of the estimation depends on whether lagged values of the endogenous variables are valid instruments in our regression. As a result, certain diagnostic checks are performed to ensure the consistency of our GMM estimates. The two diagnostic tests that are reported alongside GMM estimates are Sargan/Hansen[2] test of over identifying restrictions and the absence of second-order autocorrelation (AR2)[3] in residuals (see Appendix A-3).

3. Empirical Results and Discussion

To begin with, the convergence exercise is carried out without using any of the mentioned control variables. Such an exercise is termed as unconditional convergence in the economic parlance.

Table 2: Unconditional Convergence or Divergence?

Dependent Variables / Independent Variables	Log $PCNSDP_t$ OLS (Pooled Regression) (1)	Log $PCNSDP_{16\text{-}17}$ OLS (Cross Section Regression) (2)
Constant	-0.657	-1.934
	(0.212)	(2.098)
	[0.003]	[0.370]
Log per capita $NSDP_{t-4}$ (1)	1.072	1.298
	(0.020)	(0.206)
Log per capita $NSDP_{90\text{-}91}$ (2)	[0.000]	[0.000]
R squared (adjusted)	0.966	0.695
Implied λ (rate of convergence)	-0.018	-0.074

Note: The values in the round brackets refer to the standard errors and those in the square parenthesis refer to the p-values

By eliminating all the state-fixed effects and other conditioning variables, we find out that (Table 2) the coefficient on the lagged income term from the second column of the above table is 1.072. This value pertains to the estimate of 1+β. But the coefficient of our interest is β whose value is ascertained at 0.072. This value is statistically significant. But being a positive value for β implies divergence rather than convergence in the present context. The rate of divergence is found to be 0.072. To be more specific, we can say that the rate of unconditional divergence is 1.8 percent per annum over a four year period. This is estimated as implied rate of convergence or better represented as λ. To estimate the value of λ, we divide the estimate of β by 4 which represents panel of 4-year time span in the present analysis. Besides pooled regression we additionally estimate a cross-section regression for the whole period between 1990-91 and 2016-17 by regressing the level of PCNSDP in the final year (2016-17) on the base year (1990-91). Here too the value of β coefficient is positive and statistically significant thus suggesting a tendency towards divergence. Thus, there is ample evidence to support unconditional non convergence for Indian states. These findings are in line with those of Trivedi (2002), Nayyar (2008) and Cherodian et al. (2013). In the

[2] The choice between Sargan and Hansen test is guided by the reporting of our standard errors. Hansen test is implemented instead of the Sargan test when the estimations are adjusted for heteroscedasticity. Te null ypoyesis in case of tis test is tat tere is no invalid over identifyin restrictions.

[3] Auto Correlation Test suggests that there is no Autocorrelation of second order in our analysis

absence of control variables what we get is unconditional divergence so that takes us to the next step to testify whether the inclusion of control variables have any significant impact on the convergence tendencies of the Indian states. Following this, the convergence exercise is carried out using the already mentioned control variables. The conditional convergence activity is performed using static as well as dynamic estimation technique. The static estimation technique results are presented in the Table 3 which is performed by using Fixed effects regression while the dynamic exercise is carried out using Generalised Method of Moments (GMM), the results of which are presented in Table 4. Both the regressions have been performed using stata 15 software.

The fixed effects estimation as well as the GMM estimation is run on two versions: one without infrastructure indices and second with infrastructure indices along with other selected control variables. The purpose of running two models is to see how inclusion of infrastructure indices alters the pace of convergence of Indian states toward steady state growth paths. Thus we can arrive at a notion that running two versions of equations will help in identifying the change in pace of convergence attributed to the inclusion of infrastructure indices in our model. Alongside this, two different methodologies (within-estimation and GMM estimation) have been adopted to carry out this exercise to help in checking the robustness of our regression estimates and at the same time observe the change in the convergence coefficient with the expectation that convergence coefficient of GMM will likely be higher than that obtained under Fixed effects estimation.

The fixed effects regression results where the dependent variable is Log Per Capita $NSDP_t$ are given in Table 3. The second column of the Table presents the estimation model with only three explanatory variables namely share of agriculture, investment and growth rate of population alongside the lagged value of our dependent variable, the coefficient of which will yield the convergence value. The third column gives the results with added infrastructure indices.

Table 3: Fixed Effects Estimation

Dependent Variable → **Explanatory Variables ↓**	**Log Per Capita NSDPt**	
	Model 1	**Model 2**
Log per capita $NSDP_{t-4}$	0.746***	0.465**
	(0.049)	(0.164)
Share of Agriculture	-0.014***	-0.007
	(0.004)	(0.005)
Investment	9.80e-10**	1.25e-09***
	(3.83e-10)	(6.84e-10)
Population Growth	-0.124***	-0.087
	(0.059)	(0.057)
Physical Infrastructure Index		0.038**
		(0.013)
Social Infrastructure Index		-0.024*
		(0.015)
Financial Infrastructure Index		-0.007
		(0.015)
R- squared	0.946	0.9556
Implied λ Rate of Convergence	0.063	0.133
Expected Half-life (inyears)[4]	10.95	5.18
F-statistic	280.11***	210.69***

Notes: ***, ** and * mean significant at 1, 5 and 10 percent levels, respectively. The figures in parentheses represent standard errors. The number of observations used is 107 for 17 states.

[4] Half-life of convergence is the time that it takes for half the initial gap between steady state (potential level of GDP per capita) and actual GDP per capita to be eliminated.

Looking at the above table (Table 3) we find that the coefficient on share of agriculture sector is negative and significant at 1 percent level in both the models. This means that heavy dependence on agriculture sector is likely to impact the pace of convergence negatively. Thus, regions with more structure being biased towards agriculture are likely to grow slowly than the case if the economy is driven by other two sectors. These results are very much similar to findings of Purfield (2008), Ghosh (2012) and Cherodian and Thirlwall (2013). Moving on to the other explanatory variable of investment, we find that the coefficient of investment is positive and statistically significant at 5 percent level in model 1 and at 1 percent level in model 2. What matters here is the sign of investment on growth which is positive meaning thereby that more investment activity will enable the economy to grow more rapidly and enjoy a flourishing phase. Lastly, population growth exerts a significant negative effect on State per capita income growth. Similar were the findings of Adabar (2004), Cherodian and Thirlwall (2013) and Pandya and Maind (2017). The key result we find is that the coefficient on lagged per capita SDP is 0.746 in Model 1. This is not the convergence coefficient given the nature in which our equation is specified. This is actually the value of $1+\beta$. From here the value of β is worked out which stands at -0.254. This implies that convergence is observed given the negative and statistically significant value of our coefficient regressor. But this value pertains to 4-year coefficient of convergence. The value of yearly convergence rate is estimated at 0.063[5] . This is nothing but the implied rate of convergence. The overall explanatory power of the model is good with R-squared value of 0.946. Half-life is estimated at 10.95[6] (or approx. 11 years). Even though the selected explanatory variables account for 94 percent of the variations in the model but an important variable of infrastructure stands omitted from the analysis. The literature is super abounding to attach a prime importance to this very variable. Column 3 of Table 3 investigates the contribution of this variable to convergence exercise. Besides this, it also convincingly provides evidence regarding which infrastructure index is important for growth. Taking a dekko at the column 3 of table 3 we find that the explanatory variables of the agriculture share, investment and population growth retain their sign and significance as well except for population growth. Even though the growth of population loses its significance but it continues to influence growth negatively. Coming to the variables of our interest namely the infrastructure indices we find that physical infrastructure index influences the income of the state income positively, the coefficient being significant at 5 percent level. Interestingly financial infrastructure index has an insignificant impact. Lastly, the most engrossing conclusion comes for the social infrastructure index. The coefficient value for regression estimate is negative in magnitude. That asks the readers to contemplate on the reasons behind such negative impact of social infrastructure on the state incomes. Aiyar (2001) provides with an explanation that can serve as a tip of the iceberg. According to him there exists a mismatch between the education imparted and skill set needed to generate social returns. Similar were the findings of Benhabib and Spiegel (1994) and Islam (1995) wherein the human capital always entered the regression equation either with insignificant value or with opposite sign. Scrutinizing the logic behind negative impact of social infrastructure index on steady state income growth, we look at the literature evidence regarding individual impact of literacy rate and Infant Mortality Rate on economic growth. We know that IMR and economic growth will bear a negative relationship. Such results are validated in economic literature and needs no elaboration (Zakir and Wunnava, 1999; Trivedi, 2002; Nayyar, 2008; Erdogan et al., 2013). Talking of literacy rate we expect its impact on growth rate to be positive by way of

[5] The implied rate of convergence, λ, is computed by dividing the estimate of β by 4, which represents our panel of four-year span.

[6] $e^{-\lambda t} = 0.5$ and taking log on both sides gives $-\lambda t = \log 0.5$. Therefore, $t = 0.69/\lambda$.

increasing the earning capacity of individuals. Thus we can say that literacy rate and economic growth have endless companionship but there does also exist a twist in the tale because research also suggests a negative kind of relationship (Islam, 1995; Barro and Martin, 1999; Kalaitzidakis *et al*, 2001 and Purfield, 2008). Nayyar (2008) reasoned that negative coefficient on literacy rate could be attributed to lags in the effect of education on growth. Now since the constituent components of social infrastructure index affect growth negatively, such negative relationship stands justified with the sign of Social Infrastructure index. Adding to this explanation there can be another dimension to this negative relationship which can be viewed from the spectrum of migration. This happens because the state that is providing the social infrastructure to generate human capital may not be its beneficiary when the time comes. Probably because of extensive migration that takes place in search of better living opportunities and livelihoods. Lastly, the coefficient on lagged SDP regressor is changed to 0.465 thereby arriving at the rate of convergence of 0.133. We find that the convergence rate has improved in the model with the inclusion of infrastructure indices. Talking about the time needed to cover half the gap between the initial level and the steady state we find that approximately 5 years will be needed to cover that gap.

After assessing the pace of convergence and the importance of infrastructure in attaining convergence using fixed effects regression we now move on to estimating the same under dynamic model of GMM (Table 4). Having controlled for endogeneity, heteroskedasticity and omitted variables bias, the results from the above table pinpoint to a similar conclusion. With regards to magnitude and significance of all the explanatory variables we see a high degree of coherence in the results estimated. The only difference that comes here is the coefficient of convergence. With the regression coefficient of 0.617, the estimate of β is worked out at -0.383 and the implied rate of convergence is 0.095 which is higher than that obtained under the model 1 of fixed effects estimation. When the same regression is carried out for Model 2, i.e., with infrastructure indices, the pace of convergence increases from 0.095 (without infrastructure indices) to 0.159. The convergence pace is higher under the GMM model than under the fixed effect model.

Regarding the model's goodness-of-fit, there is no evidence of second-order serial correlation given the p-values of the AR(2) statistics, while the null hypothesis of instruments validity cannot be rejected at the 5% significance level given the p-values of the Sargan statistics.

Now since the infrastructure indices (variable of interest) influences the steady state growth paths in both fixed effect and GMM framework, it would be quite interesting to see what factors are influencing the levels of infrastructure which in turn is influencing the steady income levels of the state. For this, we will try regressing physical infrastructure index and social infrastructure index on levels of income (PCNSDP) and share of agriculture in the overall Gross Domestic Product. The results presented in Tables 5 and 6 speak strongly for income as a determinant of infrastructure (especially physical infrastructure).

From Table 5 it is clear that distribution of physical infrastructure as well as social infrastructure is lopsided with affluent states enjoying better infrastructure amenities and leading to divergence of income levels of these states.

Why and how does income affect the physical infrastructure could be attributed to many reasons but the most prominent ones are explained under. Firstly physical infrastructure amenities are going to be better in states with good foreign investment, more shares of industry, good governance, literate population and better health amenities. All these are actually the attributes of high-income states. So, the high income states are rich because of the above mentioned factors which in turn requires better infrastructure more specifically physical infrastructure. Secondly, the process of liberalisation has

unequivocally favoured certain states as compared to others. The reform process that commenced in 1991 has actually widened the gap between the growth prospects of certain states with some states enjoying bright prospects and for others these prospects are funereal. Lastly, because the infrastructure requires lump sum investment with no immediate benefit the state's ability to invest in such lumpy investment avenues is majorly guided by their fiscal position. More capital expenditure and higher tax collection strengthen the ability to provide infrastructure. Better fiscal prudence is yet another attribute associated with the high income states (Nayyar, 2008). Thus, we can say that: A state is rich because it has better infrastructure and because it has better infrastructure it supports economic activities in a better way causing it to grow more and earn higher incomes and retain the status of rich.

Table 4: Dynamic Panel Data Estimation (First Step Difference GMM Estimator)

Dependent Variable → **Explanatory Variables** ↓	**Δ(Log Per Capita NSDPt)**	
	Model 1	**Model 2**
Δ(Log per capita $NSDP_{t-4}$)	0.617***	0.361***
	(0.069)	(0.093)
Δ(Share of Agriculture)	-0.016***	-0.025***
	(0.006)	(0.010)
Δ(Investment)	1.39e-09*	1.87e-09***
	(7.40e-10)	(6.65e-10)
Δ(Population Growth)	-0.199***	-0.004
	(0.078)	(0.123)
Δ(Physical Infrastructure Index)		0.412*
		(0.233)
Δ(Social Infrastructure Index)		-2.838**
		(1.325)
Δ(Financial Infrastructure Index)		0.544
		(0.591)
No. of observations	85	85
No. of individuals	17	17
No. of instruments	15	18
Diagnostic Tests		
Hansen test of over identifying restrictions	15.35	13.52
	(0.167)	0.261
Arellano-Bond test for AR(1)	-2.64	-1.85
	(0.008)	0.064
Arellano-Bond test for AR(2)	-1.60	-0.86
	(0.110)	0.388
Wald test	1259.82***	805.77 ***
Implied λ Rate of Convergence	0.095	0.159

Notes: Heteroskedastic-consistent standard errors in parentheses for the explanatory variables and the p-values for diagnostic tests, with ***, ** and * denoting significance at the 1, 5 and 10 per cent levels, respectively. The number of observations used is 107 for 17 states.

Table 5: Determinants of Infrastructure (Fixed Effects Estimation)

Dependent Variables →	Physical Infrastructure Index	Social Infrastructure Index
Explanatory Variables ↓	Fixed Effects Estimation (Ordinary Least Squares)	Fixed Effects Estimation (Ordinary Least Squares)
Per Capita NSDP	7.000***	1.860***
	{0 .794}	{0.566}
Average share of agriculture	-0.020	-0.144***
	{0.067}	{0 .036}
R Squared	0.8989	0.7664

Note: Curly brackets show robust standard errors

As far as the results for social infrastructure is concerned, we see that income influences our regressor positively with lower magnitude and share of agriculture influence our regressor negatively.

The regression estimated through simple FE model suffers from an econometric problem of reverse causality because higher infrastructure will lead to higher levels of per capita income. Thus, the OLS estimates would be highly biased and inconsistent. Hence, to correct this econometric problem we use infant mortality rate to instrument for our endogenous variable of Per Capita SDP as given by Nayyar (2008). The results from instrumental regression reinstate the importance of Income for Physical infrastructure but as far as social infrastructure is concerned we do not see significant impact of income. The impact of income on social infrastructure is insignificant probably because the improvement in social infrastructure is actually a matter of choice because government prefers physical infrastructure over social infrastructure. Additionally the expenditure on Social infrastructure comes under the purview of State governments wherein the state has to spend on social infrastructure from its own kitty but unfortunately given the nature of fiscal federalism in our country the states are bound to keep the social sector expenditure in the backburner.

Thus, we see that physical infrastructure is guided by levels of income which is why steady paths of income depend on physical infrastructure while the same cannot be said for social infrastructure.

Table 6: Determinants of Infrastructure (Fixed Effects Instrumental Regression)

Dependent Variables →	Physical Infrastructure Index	Social Infrastructure Index
Explanatory Variables ↓	Fixed Effects Estimation (Instrumental Variables Estimation)	Fixed Effects Estimation (Instrumental Variables Estimation)
Per Capita NSDP	7.0867***	6.853
	{1.401}	{3.041}
Average share of Agriculture	-0.014	0.164
	{0.098}	{0.203}
R Squared	0.8989	0.4760
	Instrumented: Per capita NSDP Instrument: Infant Mortality Rate	Instrumented: Per capita NSDP Instrument: Infant Mortality Rate

Notes: Curly brackets show standard errors. ***, ** and * denote significance at the 1, 5 and 10 per cent levels, respectively.

Given the importance of income for infrastructure and of infrastructure for steady state of income, it becomes important to assess how the government actions can facilitate better infrastructure to shift the steady path of income of different Indian states. In this vein, we see that if government actions or policy can help in improving the infrastructure in the economy (Table 7). To address this we see if government per capita expenditure is important in deciding physical as

well as social infrastructure. The need to incorporate per capita government capital expenditure as a government policy parameter is important because policy makers exert a fair degree of control on it.

Table 7: Impact of Government Expenditure on Infrastructure

Dependent Variable → Independent Variables ↓	Physical Infrastructure Index	Social Infrastructure Index
Per Capita Government Capital Expenditure	9.529*** {1.952}	1.094* {0.681}
Population growth	1.185 {0.733}	-2.265*** {0.422}
Share of Agriculture	-0.276*** {0.086}	-0.086* {0.041}
Constant	7.531*** {1.320}	9.777*** {0.500}
R-squared	0.8529	0.8351
F-ratio	64.49***	87.84***

Notes: The values in the curly brackets refer to clustered standard errors. The number of observations used is 119 for 17 states.

Regressing infrastructure indices on per capita government capital expenditure, population growth and other variables of our fixed effects framework,[7] we find a positive and significant impact of per capita government expenditure on both indices. The impact of government expenditure on physical infrastructure is very high. As far as the channel of impact is concerned we can postulate that government expenditure or investment stimulates private investment as suggested from the complementarity nature between the two. Because both public as well as private investment will get a push from expenditure activities of the government the need to invest in physical infrastructure will be felt even more urgently.

Also, the amount of capital expenditure incurred by the government facilitates improvement in social infrastructure thus strongly supporting human development in the economy. In fact Reserve Bank of India (RBI, 1993) clearly documented the importance of social expenditure for enhancing the social infrastructure in the states of India. More expenditure on social sector helps to improve the quality variables by empowering people to be employed productively. But a caveat to be kept in mind is that Indian government is not investing adequately in social infrastructure. Also the social sector expenditure is more of a state's responsibility and as such a state with already low levels of revenue collection won't be in a sound position to incur expenditure on social infrastructure.

In yet other simple words we can say that more is the capital expenditure, better is the infrastructure, greater will be the investment and the result will be differing growth paths of state income. Thus, in a nutshell we can say that income determines infrastructure; infrastructure decides the steady growth path; government expenditure pushes the infrastructure levels of the economy.

[7] Level of investment is not included as an explanatory variable for determining policy relevance because it would have led to duplication of variable because level of investment already includes per capita government capital expenditure.

4. Conclusions and Policy Implications

The present paper does not fall short in providing certain important conclusions based on empirical analysis of convergence carried out using 17 Indian states for the period covering 1990/91 to 2016/17. Firstly there is no evidence of unconditional convergence (both in the cross section and panel estimation) thereby implying that Indian states inherently are not converging to identical steady state paths. Secondly, conditional convergence seems to be holding true in our case. The results from both fixed effects estimation and first difference GMM estimation point to robust existence of conditional convergence after controlling for population growth rate, investment, share of agriculture sector and different infrastructure indices. From among the different explanatory variables we see that physical infrastructure and investment levels impact the state income growth positively while population growth, share of agriculture sector in the overall NSDP and social infrastructure influence the steady state levels of income negatively. It is only the financial infrastructure that does not impact the steady growth path.

The major policy suggestions arriving from our analysis can be pointed as follows:

1. Poor states are likely to converge or move rapidly towards their steady growth paths if they try controlling their population; remove the sectoral biases towards agriculture; increase investment in general and physical infrastructure in particular.
2. Investment will yield positive results only if it is in the physical sector that is mainly on account of improved activity and increased productivity of the industrial units. These two policy implications try to reinstate each other. Lesser is the dependence on agriculture sector implies that other sectors of the economy are going strong; the strength of the other two sectors (more specifically industrial one) largely depends on infrastructure more so of the physical one. Thus, physical infrastructure is the main buttress of the industrial sector and thereby will facilitate transition towards non-agrarian economy.
3. Infrastructure of the other form i.e., Social infrastructure does not have the potential to lessen the gap between the rich and the poor states but that would not make it nugatory. Rather an additional role for the government is suggested wherein duty of the government is not limited to providing only the social amenities but it also extends to providing better economic environment for employment that would thwart large scale migration.
4. Additionally the results also suggest that both social as well as physical infrastructure can be very much influenced by the policy planners thus suggesting that state governments at their individual level can play a really important role in furthering their own growth prospects. But a caveat here is that state government finances are already marred by rising deficits on account of stagnant revenue and at the same time unproductive expenditures in the form of interest payment and subsidies. Given the present financial crunch of state governments the extent of centre state transfers will be of utmost importance to the states for improving their steady state incomes. With financial crunch experienced by the state governments, the choice of choosing between physical and social infrastructure arises and fortunately or unfortunately that goes in favour physical infrastructure (as is represented by our analysis) thus the social infrastructure remains overlooked.

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Appendix

Appendix A-1: List of Variables of the Study

Variables	Data Source
Growth Rate of Population	Computed on the basis of interpolation figures
Share of Agriculture in the Sectoral NSDP	$\frac{\text{(Sectoral NSDP Of Agriculture (2011-12) Prices,}}{\text{NSDP AT (2011-12) PRICES}} *100$
Investment	
• Outstanding credits extended by All Scheduled Commercial Banks	Handbook of Statistics on Indian States
• Government Capital Expenditure	
Physical Infrastructure Index	
• Road density (per 1000 sq km of geographical area)	
• Rail density (per 1000 sq km of geographical area)	CMIE
• Surfaced road density (per 1000 sq km of geographical area)	EPWRF Database Statistical Abstract of India
• Annual per capita consumption of electricity (in KWh)	Handbook of Statistics on Indian States
• Installed capacity per one thousands of population (in MW)	
• Tele density (per 100 population)	
Social Infrastructure Index	
• Infant Mortality Rate	SRS bulletins
• Literacy Rate	NSSO surveys and Census Data. (Literacy rates are derived from various rounds of the National Sample Survey with intervening survey years constructed by linear interpolation)
• Gross Enrolment Ratio in upper primary	
Financial Infrastructure Index	
• Bank branches per one thousand population	
• Bank branches per 1000 sq km of geographical area	Handbook of Statistics on Indian States
• Bank credit per one thousand population	
• Bank deposits per one thousand population	

Appendix A-2: Infrastructure Index Construction

The separate infrastructure indices (physical, social and financial) are constructed using Principal Component Analysis. But before we apply PCA we need to ensure that the variables are represented in a single unit or are unit free. After making the variables unit free (normalising them) thereafter PCA will be applied. The method of PCA is based on eigen values and subsequent extraction of the factor that explains maximum variance. In this context, Sarker (1994) provides with a useful insight. He holds that that if first principal component is sufficient enough to explain 50 percent variation then the index would be based on that very component but in the event when this condition is not met then combined component scores are used. The number of variables that make up to 65 to 73 percent of the variation will be eventually used. In the present analysis, only for physical

infrastructure index, combined component scores are used, while for others, simple index based on first principal component is constructed.

Combined component scores (CCS) = $W_1S_1+W_2S_2$

where $W_1=V_1/V_1+V_2$; $W_2=V_2/V_1+V_2$.

W_1 is the proportion of variance explained by the first component with a variance value V_1 and W_2 is the proportion of variance explained by the second principal component with variance value V_2.

After identifying the weights of different variables constituting physical infrastructure, the index is constructed using the following formula:

PII/SII/FII = $\sum W_i X_i$

where PII is the Physical Infrastructure Index; SII is social infrastructure index; FII is the financial infrastructure index; and $\sum W_i X_i$ is the sum of multiplication of weights and X_i of each variable of infrastructure.

For Physical infrastructure, two components have been extracted; thus we have used combined component scores while for social and financial infrastructure the index is constructed using only single component which is extracted.

Physical Infrastructure Index

KMO Measure of Sampling Adequacy and Bartlett's Test of Sphericity (At State Level): 1990-91 to 2016-17

Kaiser-Meyer-Olkin Measure of Sampling Adequacy	**0.658**
Bartlett's Test of Sphericity	
Approx. Chi-Square	1924.064
df	15
Sig	0.000

Source: Own calculations using IBM SPSS statistics 21.

Eigenvalues and Variance Explained by the Selected Components after PCA

Component	**Eigen Value**	**Variance**	**Cumulative**
1	2.900	48.333	48.333
2	1.792	29.865	78.197
3	.798	13.294	91.491
4	.273	4.542	96.033
5	.154	2.571	98.604
6	.084	1.396	100.00

Source: Own calculations using IBM SPSS statistics 21.

Rotated Component Matrix

Variables	Comp 1	Comp 2
Road Density		.920
Rail Density		.630
Surfaced Road density		.857
Installed capacity per one thousands of population	.958	
Annual per capita consumption of electricity	.942	
Teledensity	.807	

Note: Here only values greater than 0.45 are reported and used for index construction. Rotated Method: Varimax with Kaiser Normalization. Rotations converged in 3 iterations

Details of Social Infrastructure Index

KMO Measure of Sampling Adequacy and Bartlett's Test of Sphericity (At State Level): 1990-91 to 2016-17

Kaiser-Meyer-Olkin Measure of Sampling Adequacy	0.724
Bartlett's Test of Sphericity	
Approx. Chi-Square	622.819
df	3
Sig	0.000

Source: Own calculations using IBM SPSS statistics 21.

Principal Components & Total Variance Explained (At State Level): 1990-91 to 2016-17

Component	Eigen Value	Variance	Cumulative
1	2.328	77.600	77.600
2	0.393	13.094	90.695
3	0.279	9.305	100.000

Source: Own calculations using IBM SPSS statistics 21.

The Values of Factor Loadings after Rotation for Variable Importance (At State Level): 1990-91 to 2016-17

Variables	Comp 1
Infant Mortality Rate	-0.883
Gross Enrolment Ratio	0.858
Literacy rate	0.902

Note: Here only one component is extracted.
Source: Own calculations using IBM SPSS statistics 21.

Financial Infrastructure Index

KMO Measure of Sampling Adequacy and Bartlett's Test of Sphericity (At State Level): 1990-91 to 2016-17

Kaiser-Meyer-Olkin Measure of Sampling Adequacy	0.595
Bartlett's Test of Sphericity	
Approx. Chi-Square	1387.415
df	6
Sig	0.000

Source: Own calculations using IBM SPSS statistics 21.

Principal Components and Total Variance Explained (At State Level): 1990-91 to 2016-17

Component	Eigen Value	Variance	Cumulative
1	2.630	65.746	65.746
2	0.781	19.526	85.272
3	0.547	13.667	98.939
4	0.042	1.061	100.000

Source: Own calculations using IBM SPSS statistics 21.

The Values of Factor Loadings after Rotation for Variable Importance (At State Level): 1990-91 to 2016-17

Variables	Comp 1
Bank branches per one thousand population	0.735
Bank branches per 1000 sq km of geographical area	0.647
Bank credit per one thousand population	0.889
Bank deposits per one thousand population	0.938

Note: Here only one component is extracted. *Source:* Own calculations using IBM SPSS statistics 21.

Appendix A-3: Methodological Details

If the disturbances ε_{it} are not serially correlated, then first-order serial correlation should be significant and negative in differenced residuals and there should be no evidence of second-order serial correlation in the first-differenced residuals. Significant second-order serial correlation of the first differenced residual indicates that the original error term is serially correlated and thus that the instruments are misspecified. Alternatively, if the test fails to reject the null hypothesis of no second-order serial correlation, we conclude that ε_{it} is serially uncorrelated and the moment conditions are well specified. Failure to reject both the null hypotheses gives support to a correct model specification. Note that first differencing of the variables naturally generates first-order autocorrelation; hence, we test for second order autocorrelation in the error term.

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ENVIRONMENTAL KUZNETS CURVE FOR CO_2 IN INDIA: 1960 TO 2020

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Abstract: This paper examines how CO_2 emission responds to the growth of per capita GDP, changing share of manufacturing and international trade in GDP in India for the period 1960 to 2020. ARDL and Cointegration methods are employed to examine the short and long run quadratic relationships of the time series data. The results reveal a long run relation among CO_2 emission, economic growth, manufacturing output and export as a percentage of GDP. The existence of EKC in India is however associated with a short run insignificant relation of CO_2 emissions with manufacturing output and export share of GDP. The existence of long-run EKC relation in India, proves that economic growth itself is an antidote to the environmental degradation problem in the long run. However, the positive relation of manufacturing share in GDP with CO_2 emissions alerts for taking care of manufacturing growth but with serious environmental management and control of overall pollution.

Keywords: EKC, ARDL, Cointegration, CO_2 emission, Income

Background

Environmental Kuznets Curve (EKC) is a widely researched topic and researchers have been trying to establish or refute the inverted U hypothesis relating degradation of environmental quality with the level of development or economic progress by using cross country level data (Andreoni and Levinson, 2001). It is hypothesized that in the early stages of economic growth, pollution emissions increase and environmental quality declines, but beyond some level of per capita income (which varies for different indicators) economic growth leads to environmental improvement. In line with this argument, it has been accepted that the very poor economies, representing early stages of development use environmental deteriorating technology in various production units for the progress of the nation (Grossman and Krueger, 1991, 1995). Hence with rising per capita income (GDP) these nations experience higher concentration of pollutants, green-house gasses, carbon footprints (Shafik and Bandyopadhyay, 1992). In line with this argument, the middle-developed countries (like Saudi Arabia, Egypt) are mostly exhibiting greater deterioration of environmental quality. While the highly developed nations are in general found to use mostly environment friendly technologies for sustaining their growth process with the realization of higher social cost associated with environmental damage. Also, the demand for environmental quality rises with growth after

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a certain stage of development (Deacon and Norman, 2004). Thus, growing investment and innovation in less pollution intensive production technology with knowledge expansion and research are observed at higher level of development (Bo, 2011).

In comparison to using cross country level data and panel analysis, limited studies are found to examine the process of temporal changes in environmental quality with the development of a single country over time (Aung et al., 2017). It is highly likely that at the early stages of global development only a few nations (in Western Europe) led the economic progress, by registering rapid industrial revolutions and the realization of environmental degradation comes much later (Martinez, 1952). The reason would be their control over global socio-political space and a competition among a few in their grid for faster development in earning. Also, there remained less international pressure for maintaining environmental standard from large number of less developed countries, who lagged far behind in industrial progress and record lesser environmental damage. When these lesser developed nations try to catch up the progress of advanced nations through agricultural and industrial progresses, trade etc, on several occasions they face the opposition from the erstwhile developed nations citing rapid global environmental damage. Further, with progress of knowledge, information, these nations would realize the adverse environmental consequences of development activities at much earlier stage than the formerly developed countries. Thus, quality of environment starts improving in these nations even at middle level of development with comparatively smaller pollution peak.

It may be likely that middle or lower-middle income countries despite late starter and yet large dependence on traditional technology, take necessary steps towards adopting environment friendly technology and control emission of pollutants early. Since the pattern of EKC varies across countries, a time series analysis in respect of a single country would yield a better understanding of the income environmental quality relationship (Jalil et al., 2010).

Objective

This paper, instead of considering a cross country level or longitudinal data only followed the data on pollution (CO_2 emission) per unit of GDP and the per capita GDP, share of manufacturing etc in India since 1960. Using the data, we tried to examine how emission of CO_2 responds to the growth of per capita GDP (i.e., development), rising share of manufacturing (though it is still low in India), international trade (export as percentage of GDP) and urbanization (Shukla and Parikh, 1992; Stern et al., 1996; Aung et al., 2017). The research question to be answered here if the positive externality through experience of earlier development elsewhere and progress of knowledge in recent decades caused faster realization and it is possible to maintain the tempo of growth despite adopting environment friendly technologies. Here, the ARDL and Cointegration methods are employed to examine the short and long run quadratic relationships of the time series data.

In the next section of the paper, reviews of relevant literature related to EKC and the variables of analysis are incorporated. Thereafter, theoretical and econometric model for estimation is described, which is followed by empirical findings and discussion. The final section provides conclusion and policy implications.

Studies on Environmental Quality and Economic Growth

Theoretical Review

The waste sink capacity of the nature is not unlimited and that may limit the growth process (Brock and Taylor, 2004). Environmental deterioration is a by-product of economic activity and the possible

relationship between environmental degradation (pollution) and economic growth (income) may take several forms of which the most widely supported is the inverted U form of EKC (Shafic and Bandyopadhyay, 1992; Grossman and Krueger, 1995; and Selden and Song, 1994, Turner and Hanley, 2011). However, this general hypothesis is distorted depending on the nature of pollutants and the activities leading to growth process (Dinda, 2004). The EKC literature shifts the main issue of exhaustion of natural resources and environmental degradation to issues concerning the necessity of economic growth to overcome environmental degradation.

The theoretical arguments stem from the evidence that, although economic growth usually leads to environmental deterioration in the early stages of the process, in the end, the best and probably the only-way to attain a decent environment in most countries is to become rich (Beckerman, 1992). The learning effects of the growth process ultimately allows the system to control pollution. Also, the people with higher income have a tendency to demand clean environment or have a preference for better environment as the people start valuing environment more than the merely material output.

Empirical Studies

Plethora of studies are there on environmental quality and economic development trade. There are studies (Selden and Song, 1994; Grossman and Krueger, 1995; Shafik and Bandyopadhyay, 1992; Jalil et al., 2010; Bo, 2011) that reflect the direct consequence of economic growth on the environmental quality due to anthropogenic growth-related activities. Also, studies are there on development activities which create conditions and necessitate some policy and activity changes ushering adverse environmental consequences (Jalil et al., 2010; Narayan and Narayan, 2010; Zambrano-Monserrate et al., 2016).

After the Club of Rome, a series of events drew serious attention of people and governments across the countries for saving the environment and simultaneously maintain the tempo of economic growth (Meadows et al., 1972).[1] Multiple studies on cross country level data, demonstrated inverted U relation between environmental pollution and economic growth (Shafik and Bandyopadhyay, 1992; Panayotou, 1993; Selden and Song, 1994; Grossman and Krueger, 1995; Galeotti and Lanza, 1999; Millimet and Stengos, 1999; Bradford et al., 2000; Halkos, 2003; Hilton, 2013; Kasman and Duman, 2015; Neequaye and Oladi, 2015; Gökmenoğlu and Taspinar, 2016; Narayan et al., 2016; Javid and Sharif, 2016; Haq et al., 2016; Esso and Keho, 2016; Ahmad et al., 2017; Katircioğlu and Taşpinar, 2017; Abdouli and Hammami, 2017; Shahzad et al., 2017; Antonakakis et al., 2017; Sapkota and Bastola, 2017; Sinha and Shahbaz, 2018). Most of these studies have confirmed inverted-U relation of carbon dioxide emission with per capita income. In other words, CO_2 emission increases first with the growth of per capita income and it reaches a peak level and then declines with further growth of per capita income.

Amidst there have been some counterarguments and empirical results of non-existence of the EKC relation between economic growth and environmental quality either in the short run or long run (Dasgupta and Heal, 1979; Simon, 1981; Mayers, 1991; Repetto, 1989; Harbaugh et al., 2002; Haq et al., 2016; De Bruyn et al., 1998). It brought about controls at different levels irrespective of the level and stages of development across the world.

The US Environmental Protection Agency (US EPA) reported that the global net GHG

[1] The Club of Rome is a platform of diverse thought leaders who identify holistic solutions to complex global issues and promote policy initiatives and action to enable humanity to emerge from multiple planetary emergencies. Founded in 1968 at Accademia dei Lincei in Rome, Italy it is a global think tank that deals with a variety of international political issues.

emissions associated with various anthropogenic activities increased by about 35% between 1990 and 2000, with about 46 billion metric tons (US EPA 2014). Organization for Economic Cooperation and Development (OECD) also projected an increase of around 52% in GHG emissions by 2050 if further measures are not taken to mitigate climate change (Sohag et al., 2017). CO_2 is one of the major green-house gases that contributes substantially to the global warming (Tang et al., 2015). A few studies in recent past also examined the EKC hypothesis by using ARDL method (Narayan and Narayan, 2010; Al-Mulali et al., 2015).

In various empirical studies on EKC, interlinkage of different environmental indicators with the indicator of development (say per capita income or GDP) are examined across the countries that reflected varied outcomes. There is study investigating the existence of EKC for water pollution in some 30 countries sharing major rivers by using pooled mean group (PMG) estimation method (Thompson, 2014). Also, a study reveals non-existence of EKC relation between water pollution and per capita income (Barua and Hubacek, 2009). Further, the EKC relationship for deforestation differs in studies across the regions (Choumert et al., 2013). Studies on relationship between various atmospheric pollutants and economic growth observed mixed results. The relations between energy consumption, trade openness, emission or concentration of CO_2, SO_2, CH_4, etc. have been examined by Zambrano-Monserrate et al. (2016), Ang (2007), Pao and Tsai (2011), Ali et al. (2015), Davalos (2016), Jacint and Manuel (2016), Zambrano-Monserrate et al. (2016a, b), Al-Mulali et al. (2016), Saboori and Sulaiman (2013a, b), Alabdulrazag and Alrajhi (2016), Jungho (2015), Lachehed et al. (2015), Mazzanti et al. (2008), Cho et al. (2014), Parlow (2014), Aung et al. (2017), and Zambrono-Monserrate and Fernandez (2017).

Overall, a large number of studies have investigated the EKC hypothesis in both the developed and developing countries, by using different econometric methods, tools and variables. In most of these studies, relation between the emission of CO_2 or fossil fuel consumption with GDP growth per capita got prominent attraction assuming the importance of fossil fuel use and greenhouse emissions on the climate change scenario and its possible impacts. In order to examine the EKC hypothesis in the long or short run, researchers applied simple quadratic regression, cointegration, ARDL, ECM, VECM, panel error correction methods depending upon the nature of data (time series, longitudinal) and suitability of the method. Several studies found inverted U type EKC relation, and against these a few analyses observed relation like N or linear rejecting the hypothetical EKC relation. However, very few studies are there in India examining the existence of EKC despite significant structural changes in economic growth and policy evolutions in the last few decades. The climate change scenario has also been reflected in erratic rainfall and spatio-temporal temperature variations.

Materials and Methods

In order to examine the relationship between CO_2 emissions and economic growth in India for the period 1960 to 2020, data on yearly CO_2 emissions (per unit of GDP at 2010 USD), GDP and per capita GDP (at 2010 USD), manufacturing output share of GDP, share of export, import to GDP, percentage of urban population to total population have been extracted from the World Bank website (World Bank, 2021). Thereafter, CO_2 has been plotted against various variables like time, per-capita GDP, manufacturing share of GDP, export, urbanization. All the bi-variate relations appear to fit a quadratic function of inverse U type. Further, the rate at which the CO_2 is observed to rise with the growth of per-capita GDP, export or urbanization; after reaching its peak the speed of decline with further growth of per capita GDP, export or urbanization is found to be slower. Results of bi-variate simple and log-linear regressions with respect to various variables before and

after the peak point are presented in Tables 2 and 3.

Looking at the scattered diagram we tried to fit the quadratic relation of theoretical EKC type. The inverted U graphical relation of CO_2 emission per unit of GDP with per capita GDP apparently implies that intensity of CO_2 emission rises first with growing per capita income; and then after reaching a peak at certain level of per capita income CO_2 emission per unit of GDP declines with further growth of per capita GDP. It is some sort of similar theoretical relationship that is theoretically explained as, at the initial level of development (indicated by low per capita income) pollution level rises with increasing per capita income (i.e., economic growth). The country is constrained by pollution intensive production technology, lack of innovation and knowledge and capital for adopting environment friendly measures. But at high level of per capita GDP (that may vary across countries) due to both internal forces (availability of environment friendly technology, availability of human resource and capital) and external pressure (public demand, embargo of other trade partners) to control pollution, CO_2 emission start declining with further economic growth. This relation when translated into a mathematical form it yields a quadratic relationship where the sign of coefficient of the explanatory variable (per capita GDP here) is expected to have a negative sign.

In this analysis, logarithms of the variables are considered as it reduces the fluctuations and improve consistency as well as to obtain the elasticity directly in the form of demand for environmental quality with the rise in relevant explanatory variables (equation 1).

$$Ln(CO_2)_t = \beta_1 + \beta_2 LnY_t + \beta_3 (LnY_t)^2 + \beta_4 LnManu_t + \beta_5 (LnManu_t)^2 + \beta_6 LnExp_t + \beta_7 (LnExp_t)^2 + U_t \ldots \ldots \ldots (1)$$

where $(CO_2)_t$ is the emission of CO_2 in India during year t; Y_t is the per capita GDP (at 2020 USD) in the year t; $Manu_t$ is the percentage share of manufacturing in t^{th} year; Exp_t represents total export as a percentage of GDP in t^{th} year; Urb_t is the urbanization in t^{th} year and U_t is the random disturbance term. With rising per capita income, demand for environmental quality may rise and hence the coefficient of $(LnY_t)^2$ is expected to be negative. Similarly, in the initial years, growing manufacturing activities is expected to enhance CO_2 emissions with more and more fossil fuel consumption. But after a certain stage demand for clean energy is expected to rise and thus coefficient of $(LnManu_t)^2$ is hypothesized to be negative. Some studies have considered energy consumption as an explanatory variable for explaining changes in CO_2 emission (Aung et al., 2017; Muhammad et al., 2010). Assuming manufacturing consumption is highly energy intensive, here in the absence of energy consumption data, we used manufacturing share of GDP as an explanatory variable. More share of export means production and rise in pollution intensive goods in the early years, which comes down with the growing international pressure on demanding pollution free goods and availability of such technology. In the same way, with urbanization first CO_2 emission is expected to and then decline after reaching a peak. Hence, the coefficients of all squared variables on the right-hand side of equation 1 are expected to have negative sign. Table 1 describes the abbreviated variables.

Table 1: Description of Variables Used in the Analysis

Variables	Abbreviated Term Used in Equations
Per capita Gross Domestic Product (GDP)	Y
Carbon Dioxide Emission	CO_2
Percentage Share of Manufacturing to GDP	Manu
Export as a percentage of GDP	Exp
Urbanization	Urb

Further, both the short and long-term relations have been examined by ARDL bound test model developed by (Pesaran and Pesaran, 1997; Pesaran et al., 2001) and cointegration (Johensen, 1988). We applied augmented Dickey-Fuller (ADF) (Dickey and Fuller, 1979) and Phillips and Perron (PP) test (1988) to detect stationarity of data series. Depending on the order of integration, Johansen cointegration test (1988) is applied to test long run relationship between variables.

Of course, the autoregressive distributive lag model can be applied without investigating the order of integration (Pesaran and Pesaran, 1997). The ARDL approach to cointegration is expected to provide better outcome (Haug, 2002) for small sample as compared to the traditional approach of cointegration developed by Engle and Granger (1987), Johansen and Juselius (1990) and Philips and Hansen (1990). Another advantage of ARDL bounds testing is that the unrestricted model of ECM has sufficient flexibility to accommodate lags that captures the data generating process in a general-to-specific framework of specification ((Laurenceson and Chai, 2003). Further, appropriate modification of the ARDL model may simultaneously correct the residual serial correlation and problem of endogeneity (Pesaran and Shin, 1999).

The unrestricted ADRL model is written as equation 2 below :

$$\Delta \text{LnCO}_2 = \alpha_1 + \alpha_2 \text{LnY}_{t-1} + \alpha_3 (\text{LnY}_{t-1})^2 + \alpha_4 \text{LnManu}_{t-1} + \alpha_5 \text{LnExp}_{t-1} + \alpha_6 \text{LnUrb}_{t-1} + \sum_{i=1}^{p} \alpha_i \, \Delta \text{Ln}CO_{2,\ t-i} + \sum_{j=0}^{q} \alpha_j \, \Delta \text{Ln}Y_{t-j} + \sum_{k=0}^{r} \alpha_k \, \Delta (LnY_{t-k})^2 + \sum_{l=0}^{s} \alpha_l \, \Delta \text{Ln}Manu_{t-l} + \sum_{m=0}^{u} \alpha_m \, \Delta \text{Ln}Exp_{t-m} + \sum_{n=0}^{v} \alpha_j \, \Delta \text{Ln}Urb_{t-n} + \mu_t \quad \ldots\ldots\ldots (2)$$

Here, the ARDL bounds testing approach to cointegration is based on the tabulated critical values by Pesaran et al. (2001) to make a decision about cointegration among the variables. The null hypothesis is that $\alpha_2 = \alpha_3 = \alpha_4 = \alpha_5 = \alpha_6 = 0$. Cointegration among the chosen variables exist if the computed F value is greater than the tabular upper critical bound. If the long run relationship among the variables exists, the short run behavior of variables is examined by the following ECM model (equation 3).

$$\Delta \text{LnCO}_2 = \delta_1 + \eta ECM_{t-1} + \sum_{j=0}^{q} \delta_2 \, \Delta \text{Ln}Y_{t-j} + \sum_{k=0}^{r} \delta_3 \, \Delta (LnY_{t-k})^2 + \sum_{l=0}^{s} \delta_4 \, \Delta \text{Ln}Manu_{t-l} + \sum_{m=0}^{u} \delta_5 \, \Delta \text{Ln}Exp_{t-m} + \sum_{n=0}^{v} \delta_{j6} \, \Delta \text{Ln}Urb_{t-n} + €_t \quad \ldots\ldots\ldots (3)$$

The error correction term represents the short run changes in dependent variable towards long-run equilibrium path (Masih and Masih, 1997). The relevance of the ARDL model is checked through stability tests such as cumulative sum of recursive residuals (CUSUM) and cumulative sum of squares of recursive residuals (CUSUMSQ).

Observations and Findings

Figure 1 reveals that there was steady rise in emission of CO_2 in India from 1960 till 1992. At the global level also, overall CO_2 emission per PPP USD of GDP decreased steadily since 1993 (World Bank).[2] The pattern of change fits a quadratic equation against time (equation 4); after reaching a peak emission level of 1.29 kg per unit of GDP at 2010 USD, it started declining. Simple linear regression of emission level per unit of GDP on t (time) and t^2 is found to be:

$$Y_t = 0.752 + 0.024\ t - 0.000352\ t^2 \quad \ldots\ldots\ldots (4)$$

$$R^2 = .751$$

[2] https://data.worldbank.org/indicator/EN.ATM.CO2E.PP.GD

Figure 1: Scatter Diagram of CO_2 Emission in India during 1960 to 2020 (Kg per Unit of GDP at 2010 USD)

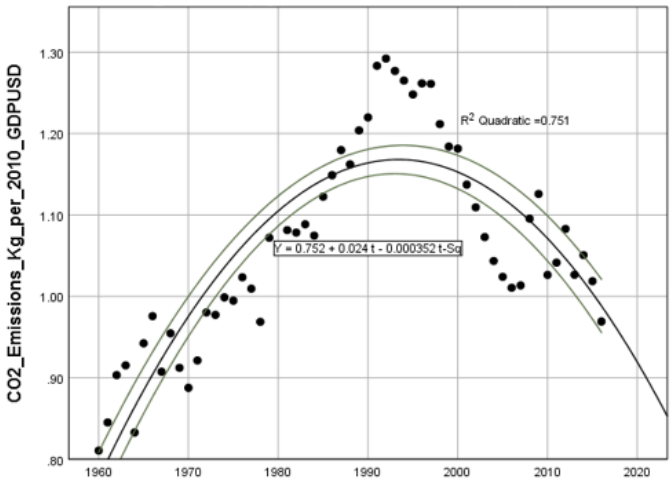


Figure 2: Changes in CO_2 Emission against Per Capita GDP in India during 1960 to 2020 (Kg per Unit of GDP at 2010 USD)

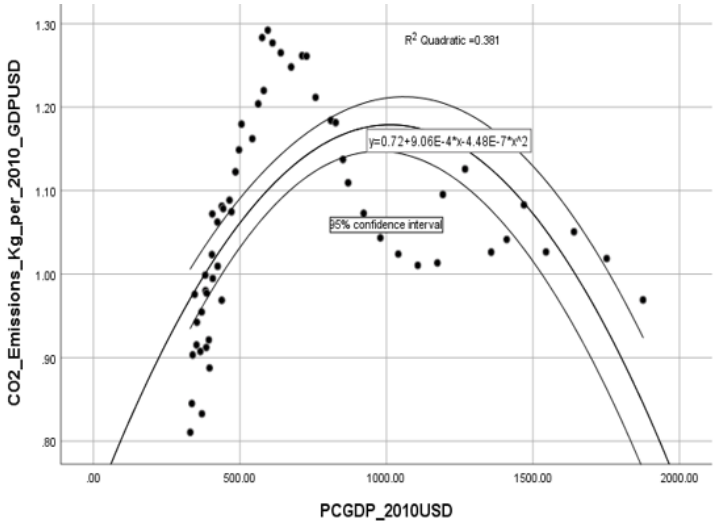


Figure 2 reveals inverted U relation between CO_2 emission per unit of GDP with per capita GDP (in 2010 USD) in India which reached its peak (1.29 kg per unit GDP) at per capita GDP (520 USD) and then declined till 2020. The diagram fits much better when the emission and per capita GDP is log transformed, as shown in Figure 3. The fitted line displays inflection (2nd order derivative equation 5) value of -0.4 with R^2 value of 0.69. The estimated simple linear regression (OLS) is:

$$LnCO_2 = -17.544 + 5.306\ LnPCGDP - .397\ (LnPCGDP)^2 \quad \ldots\ldots (5)$$

$R^2 = .692$

Figure 3: Changes in LogCO_2 against Log Per Capita GDP at Constant 2010 USD

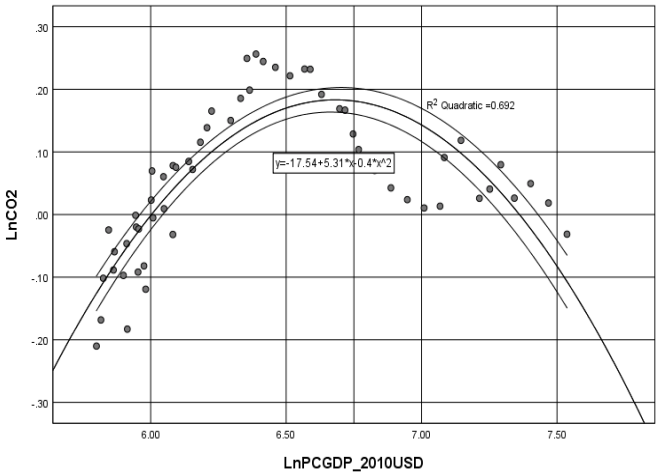


Figure 4 reveals a similar inverse U relation of CO_2 emission per unit of GDP with urbanization in India, where emission reached its maximum at around 27 percent urbanization. A similar relation is observed for CO_2 emission per unit of GDP with export as percentage of GDP (Figure 4). However, the relation of CO_2 emission per unit of GDP with share of manufacturing output in GDP is not found to be very strong (Figure 5). It is due to the fact that share of manufacturing to GDP in India has not increased significantly over the years. It is the tertiary sector growth that has been taking place exponentially and economic growth in India registered a direct shift from primary to tertiary sector, bypassing the secondary sector.

Figure 4(a): Scatter Diagram of CO_2 Emission (Kg per Unit of GDP at 2010 USD) against Urbanisation in India (1960 to 2020)

Figure 4(b): Changes in CO_2 Emission (Kg per Unit of GDP at 2010 USD) with Export (% of GDP) in India (1960 to 2020)

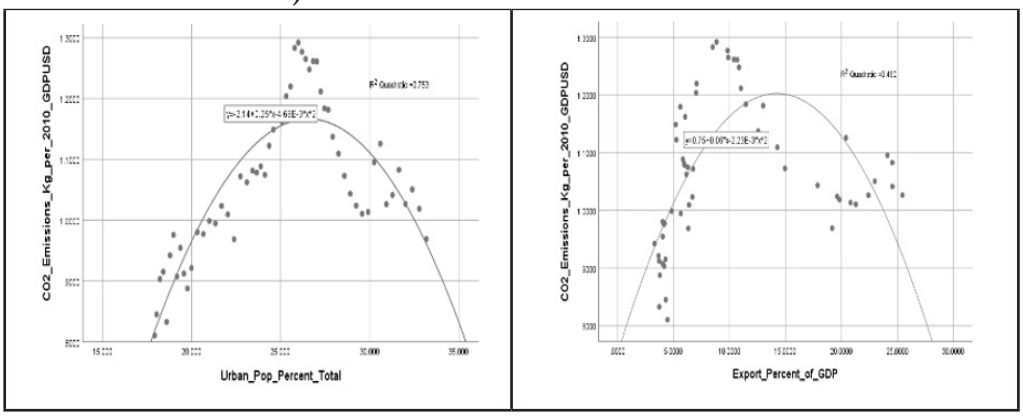
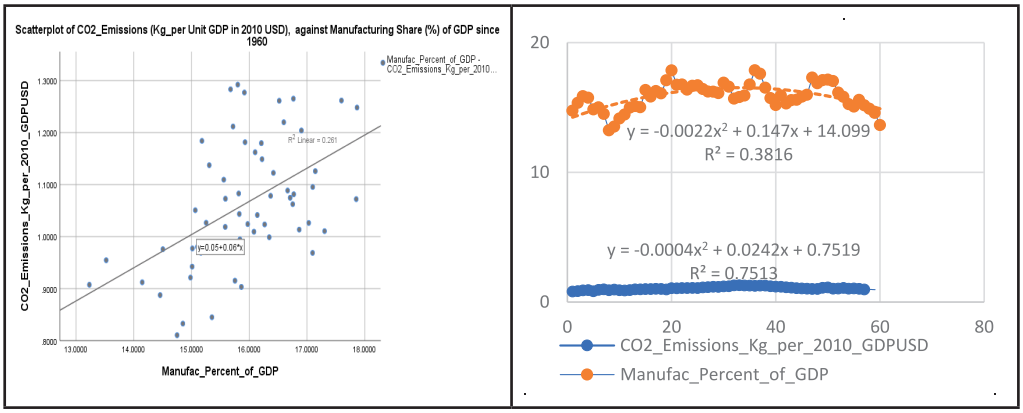


Figure 5: Relation between CO_2 Emission and Manufacturing Output in India since 1960



The semi-log linear and log-log linear relation between CO_2 emission and share of manufacturing output to GDP over the years can also be expressed by ordinary linear regression (equations 6 and 7) in quadratic form. The coefficient of square term on the right-hand side is however observed to be negative.

$$LnCO_2 = -4.476 + 0.159\ LnManufact\_Output - 1.28E^{-27}\ Manufact\_Output^2 \quad \ldots\ldots (6)$$

$R^2 = .60$

$$LnCO_2 = -96.50 + 6.61\ LnManufact\_Output - 0.113\ (LnManufact\_Output)^2 \quad \ldots\ldots (7)$$

$R^2 = .79$

Linear and semi-linear regressions of CO_2 against time (t) presented in Tables 2 and 3 reveal that emission level increased till 1992 and declined thereafter.

Table 2: Regression of CO_2 on Various Explanatory Variables before and after 1992

1960-1992 (N = 33)		1993-2018 (N = 26)	
CO_2 = .813 + .012 t (59.15) (17.73)	R^2 = .91, $\bar{R}^2$ = .907, F = 314.25***	CO_2 = 1.67 - .012 t (25.72) (-8.66)	R^2 = .773, , F = 74.97***
CO_2 = .364 + .002 PCGDP (7.94) (14.67)	R^2 = .874, $\bar{R}^2$ = .87, F = 215.10***	CO_2 = 1.347 - .000213 PCGDP (35.75) (-6.52)	R^2 = .66, , F = 42.48***
CO_2 = -.026 + .067 Manufacturing (-.092) (3.71)	R^2 = .31,$\bar{R}^2$ = .29,, F = 13.76***	CO_2 = .56 + .034 Manufacturing (1.45) (1.432)	R^2 = .09, , F = 2.052
CO_2 = .628 + .074 Export (12.73) (8.32)	R^2 = .691, $\bar{R}^2$ =.681, F = 69.213***	CO_2 = 1.368 - .015 Export (36.15) (-7.04)	R^2 = .693, , F = 49.55***
CO_2 = .64 + .058 Import (9.44) (5.83)	R^2 = .523, $\bar{R}^2$ =.507, F = 33.94***	CO_2 = 1.322 - .011 Import (34.45) (-5.762)	R^2 = .601, , F = 33.20***
CO_2 = .030 + .046 UrbanPop (.524) (17.27)	R^2 = .91, $\bar{R}^2$ =.903, F = 298.26***	CO_2 = 2.232 - .038 UrbanPop (14.97) (-7.52)	R^2 = .72, , F = 56.5***

Table 3: Estimation of Logarithmic Models by Least Square before and after 1992

1960-1992 (N = 33)		1993-2018 (N = 26)	
$InCO_2$ = -.188 + .012 t	R^2 = .92, $\overline{R}^2$ = .913,	$InCO_2$ = .596 - .011 t	R^2 = .77, $\overline{R}^2$ = .76,
(-14.69) (18.40)	F = 338.60***	(10.30) (-8.59)	F = 73.77***
$InCO_2$ = -3.98 + .661 *ln*PCGDP	R^2 = .86, $\overline{R}^2$ = .851,	$InCO_2$ = 1.647 - .222 *ln*PCGDP	R^2 = .745, $\overline{R}^2$ = .733,
(-13.50) (13.57)	F = 184.11***	(8.544) (-8.012)	F = 64.19***
$InCO_2$ = -2.802 + 1.024 *ln*Manufac	R^2 = .33, $\overline{R}^2$ = .31,	$InCO_2$ = -1.244 + .49 *ln*Manufac	R^2 = .082, $\overline{R}^2$ = .04,
(-3.85) (3.88)	F = 15.04***	(-1.29) (1.40)	F = 1.96
$InCO_2$ = -.614 + .384 *ln*Export	R^2 = .67, $\overline{R}^2$ = .66,	$InCO_2$ = .725 - .222 *ln*Export	R^2 = .76, $\overline{R}^2$ = .75,
(-7.55) (7.86)	F = 61.80***	(9.62) (-8.29)	F = 68.75***
$InCO_2$ = -.58 + .321 *ln*Import	R^2 = .451, $\overline{R}^2$ = .434,	$InCO_2$ = .651 - .188 *ln*Import	R^2 = .69, $\overline{R}^2$ = .676,
(-4.86) (5.05)	F = 25.50***	(8.27) (-7.002)	F =49.03***
CO_2 = -2.914 + .954 *ln*UrbanPop	R^2 = .901, $\overline{R}^2$ = .898,	$InCO_2$ = 3.51 - 1.008 UrbanPop	R^2 = .74, $\overline{R}^2$ = .726,
(-16.70) (16.81)	F = 282.61***	(8.12) (-7.87)	F = 61.86***

Table 4: Descriptive Statistics

Variable	N	Min	Max	Mean	Std. Dev
CO2 Emission (Kg/GDP 2010 USD)	57	.81	1.29	1.0626	.1229
Per Cap GDP (2010 USD)	60	330.21	2151.73	776.326	501.9
Manufacturing % of GDP	60	13.23	17.87	15.842	1.024
Export % of GDP	60	3.31	25.43	10.749	7.038
Urban Population (%)	60	17.924	34.472	25.389	4.788

Table 5: Result of Regression of $LnCO_2$ on LnPCGDP, LnManufacturing, LnExport and Their Square Terms

Variable	B	t	Sig.
Constant	-9.481	-.934	.355
LnPCGDP_2010USD	3.674	5.536	.000
LnManuf_Percent_GDP	-2.874	-.399	.692
LnExport_Percent_GDP	.509	3.123	.003
Sq_LnPCGDP	-.261	-5.300	.000
Sq_LnManuf_Percent_GDP	.567	.433	.667
Sq_LnExport	-.143	-4.157	.000
R2 = 0.80, Adj R2 = 0.78, F = 33.76			

The descriptive statistics presented in Table 4 reveal wide variation in GDP; and standard deviation of year-wise CO_2 is much lower than the other variables. It is observed from simple OLS regression that emission level has significant positive relation PCGDP and export as a percentage of GDP; while it has negative elasticity with respect to squares of PCGDP and export as a percentage of GDP (Table 5). That means CO_2 follows the inverted U hypothesis with respect to per capita GDP and export intensity, while its relation with manufacturing is insignificant. Urbanization is excluded for the collinearity problem.

Table 6: Unit Root Test Results

	ADF			PP		
	Level	1st Diff		Level	1st Diff	
Variable	T	T	Info	T	T	Info
$LnCO_2$	-2.299	-8.411	I(1)	-2.281	-8.468	I(1)
LnPCGDP_2010USD	4.126	-6.356	I(1)	6.731	-6.485	I(1)
LnManuf_Percent_GDP	-1.873	-6.920	I(1)	-2.026	-6.908	I(1)
LnExport_Percent_GDP	-0.412	-4.141	I(1)	-0.495	-7.369	I(1)

Notes: Critical values: -3.55(1%), -2.92(5%), -2.59(10%)

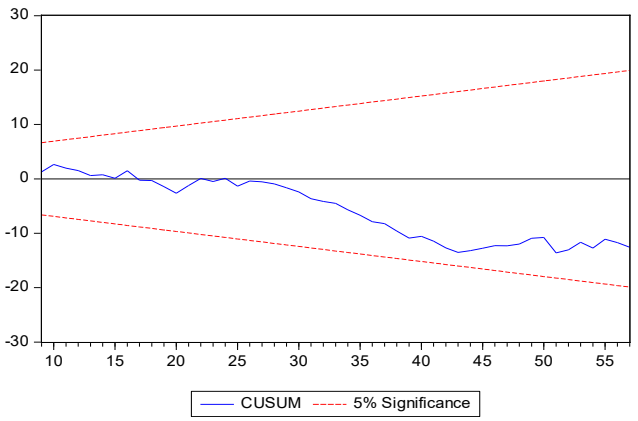
All the variables in logarithmic form are found to be integrated of order one (Table 6). Hence, a long run relationship among them is expected. The bound test also reveals existence of cointegration among those chosen variables (Table 7).

Table 7: The Results of Cointegration Test

	Bounds Testing of Cointegration	
Estimated Equations	**$LnCO_2$ = f(LnPCGDP, SQLnPCGDP, lNManufac_Percent_GDP, LnExport_ Percent_GDP)**	**CO_2 = f(PCGDP, SQPCGDP Manufac_Percent_GDP, Export_Percent_GDP)**
Optimal lag structure	2	1
F-statistics	7.9087	8.5871
Diagnostic check		
Adjusted-R^2	0.9312	0.9409
F-statistics (Prob.)	124.99 (0.000)	108.56 (0.000)
J-B Normality test	2.16	1.21
Breusch-Pagan-Godfrey Test [2]	0.637	1.351
ARCH Test [1]	0.002	0.311
Ramsey RESET	1.184	1.132
CUSUM	Stable	Stable
CUSUMSQ	Stable	Stable

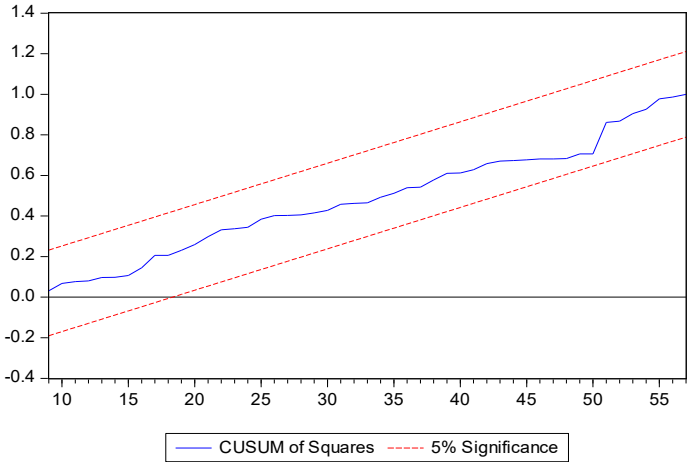
Notes: Lag length is determined by AIC. 1% and 5% critical values are 3.738 and 2.763 for I(0); and 4.947 and 3.813 for I(1).

Figure 6: Plot of Cumulative Sum of Recursive Residuals



Note: The straight lines represent critical bounds at 5% significance level.

Figure 7: Plot of Cumulative Sum of Squares of Recursive Residuals



Note: The straight lines represent critical bounds at 5% significance level.

Table 8: Estimated ARDL Equation

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNCO2(-1)	0.8672	0.0686	12.635	0.0000
LNPCGDP_2010USD	0.5044	0.4966	1.016	0.3148
SQLNPCGDP	-0.115	0.0384	-2.992	0.0043
SQLNPCGDP(-1)	0.0814	0.0129	6.275	0.0000
LNMANUFAC_PERCENT_GDP	0.2078	0.0803	2.5867	0.0127
LNEXPORT_PERCENT_GDP	-0.0321	0.0304	-1.056	0.2961
C	-2.3096	1.6821	-1.373	0.1760
R-squared	0.9387	Mean dependent var		0.0588
Adjusted R-squared	0.9312	S.D. dependent var		0.1117
S.E. of regression	0.0293	Akaike info criterion		-4.1051
Sum squared resid	0.0421	Schwarz criterion		-3.8519
Log likelihood	121.9432	Hannan-Quinn criter.		-4.007
F-statistic (Prob)	124.99 (.000)	Durbin-Watson stat		2.249

Table 9: Long-term Relation of $LnCO_2$ with Other Variables

Variable	Coefficient	Std. Error
LNPCGDP_2010USD	11.875**	4.276
SQLNPCGDP	-0.128**	0.331
LNMANUFAC_PERCENT_GDP	2.196*	1.150
LNEXPORT_PERCENT_GDP	0.558	0.444

Note: ** and * indicate that the coefficients are significant at 1% and 10% levels of significance respectively.

Table 10: ECM: Short-term Relation of $LnCO_2$

Variable	Coef.	Std. Error	t-Statistic	Prob.
C	0.0316	0.006	4.985	0.0000
ECM(-1)	-0.1316	0.075	-1.754	0.0856
D(LNPCGDP_2010USD-1)	-1.4574	1.207	-1.2074	0.2331
D(SQLNPCGDP-1)	0.0433	0.090	0.479	0.6341
D(LNMANUFAC_PERCENT_GDP-1)	0.1088	0.110	0.984	0.3299
D(LNEXPORT_PERCENT_GDP-1)	-0.0476	0.045	-1.059	0.2948
R-squared	0.5468	AIC		-4.0704
Adjusted R-squared	0.5015	SIC		-3.8534
Log likelihood	119.97	Hannan-Quinn criter.		-3.9862
F-statistic (Prob)	12.067(.000)	JB Normality Test		2.070
Durbin-Watson stat	2.002	Breusch-Pagan-		1.163
Serial Correlation LM	0.0165	Godfrey Test		
Ramsey Reset Test	0.010	ARCH Test		.0319

The ARDL model reveals strong inverse impact of current and previous years value of squared log per-capita GDP (Table 8). Also, it further displays a significant positive relation of log manufacturing output as a percentage of GDP which is later on supported by the long run cointegrating relationship.

The long run relationship reveals a significant positive impact of per capita GDP on the CO_2 emission, while it is inversely related to the square of per capita GDP (Table 9). The elasticity of CO_2 with respect to per capita GDP is 11.88 indicating very high intensity of CO_2 emission with the economic activity. It means, for one percent increase in income per capita, CO_2 emission is increased by about 11.88 percent, which indicates intensive use of fossil fuel. But the elasticity is not highly significant with respect to manufacturing and export intensity per unit of GDP. It is because of low contribution of manufacturing to GDP and export of more non-pollution intensive goods. The elasticity of CO_2 with respect to square per capita GDP is -.128, which is significant at one percent level. It strongly validates the existence of EKC hypothesis in the longer term. The CUSUM and CUSUM of Square tests (Figure 6 and Figure 7) are found to be stable and in support of stability of the model with a long run relationship.

Table 10 reveals the short-term adjustment by 13.16 percent rate towards long run equilibrium. Apart from the ECM term other variables are not found to be significant in the short run. The evidence is in line with the outcome of studies by Zhang and Cheng (2009) and Jalil and Mahmud (2009) on China, Ghosh (2010) on India, and Shahbaz et al. (2010) on Pakistan. The results of test for cointegration is provided in Table A-1 in the Appendix.

Conclusion

In this paper, we investigated the relationship among CO_2 emissions, economic growth, over the period of 1960 to 2020. The Environmental Kuznets Curve's (EKC) hypothesis has been tested by applying ARDL cointegration model. The results suggest that a long run relation exists among CO_2 emission, economic growth, manufacturing output and export as a percentage of GDP. The existence of an EKC in India is however associated with short run insignificant relation of CO_2 emissions with manufacturing output and export in proportion to GDP. Since the EKC hypothesis holds in India, the warning that economic growth itself is the means for environmental improvement holds in the long run (Stern et. al., 1996). The present findings are in line with the results obtained

by Shahbaz et al. (2010) in Portugal, Pao and Tsai (2011) in Brazil, Ali et al. (2015) in Pakistan, Alabdulrazag and Alrajhi (2016) in Saudi Arabia. Saboori et al. (2012a; 2012b) however found the presence of EKC for CO2 emissions and GDP for both long and short run in Malaysia.

The policy implication of the outcome of above findings is that continuous growth in economy is the primary source of pollution control and better environmental management. In India much of the recent past growth has been due to the structural change of the economy and development of tertiary sector with information, services etc. took leading position in growth of GDP. Though industrial sector in many cases is still based on pollution intensive technology like coal based thermal power, diesel engine-based railway (though move towards electric vehicle, non-conventional energy use has been initiated) etc, the share of manufacturing is very low. For sustained and rapid growth, it requires to take care of progress of manufacturing but with care for environmental management and control of emission standard and overall pollution.

The findings further opened up the scope of separate studies on time-series data for countries with different level of development, instead of considering a panel data to consider a pool of countries. It will help in comparison of CO_2 emission and economic growth relationship of different countries in connection with differences in policies and other factors that may be identified as the leading forces for such differences.

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Appendix

Table A-1: Test for Cointegration

Trend Assumption: Linear Deterministic Trend

Series: LNCO2 LNPCGDP_2010USD SQLNPCGDP LNMANUFAC_PERCENT_GDP LNEXPORT_PERCENT_GDP

Lags interval (in first differences): 1 to 1

Unrestricted Cointegration Rank Test (Trace)

Hypothesized		Trace	0.05	
No. of CE(s)	**Eigenvalue**	**Statistic**	**Critical Value**	**Prob.****
None *	0.554552	98.87747	69.81889	0.0001
At most 1 *	0.443226	54.40040	47.85613	0.0107
At most 2	0.206041	22.19262	29.79707	0.2879
At most 3	0.142162	9.502860	15.49471	0.3209
At most 4	0.019251	1.069149	3.841466	0.3011

Notes: Trace test indicates two cointegrating equations at the 0.05 level;

* denotes rejection of the hypothesis at the 0.05 level;

**MacKinnon-Haug-Michelis (1999) p-values.

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	**Eigenvalue**	**Max-Eigen Statistic**	**0.05 Critical Value**	**Prob.****
None *	0.554552	44.47707	33.87687	0.0019
At most 1 *	0.443226	32.20779	27.58434	0.0118
At most 2	0.206041	12.68976	21.13162	0.4812

Notes: Max-eigenvalue test indicates 2 cointegrating eqn(s) at the 0.05 level;

* denotes rejection of the hypothesis at the 0.05 level;

**MacKinnon-Haug-Michelis (1999) p-values.

Unrestricted Cointegrating Coefficients (Normalized by b'*S11*b = I)

LNCO2	**LNPCGDP_ 2010USD**	**SQLNPCGDP**	**LNMANUFAC_ PERCENT_GDP**	**LNEXPORT_ PERCENT_GDP**
2.632958	31.26618	-2.970496	-5.781860	1.468669
-9.085945	36.48105	-2.270090	23.40462	-5.962863
-8.646768	112.8441	-8.035310	-3.878734	-4.178214
-13.67519	46.43540	-3.595342	-3.549834	0.906365
-4.516593	39.30985	-3.498751	1.431905	5.837018

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STRUCTURAL CHANGE IN TRADE AND FINANCE IN INDIA DURING 1950-2019: IMPLICATIONS FOR DISPROPORTIONAL RISE IN OUTPUT AND EMPLOYMENT ACROSS THE SECTORS

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Abstract: In the last four decades, it was the tertiary sector which has brought the growth of the economy at higher trajectory. However, the sector is quite heterogeneous and diverse in its nature. The role of various sub-sectors is not the same in output and employment. Modern sector has contributed in output growth, while traditional sectors have generated employment. Therefore, a classic case of disproportionality in output and employment has been palpable in India's service sector—i.e., more rise in output share than employment. In this paper, the phenomenon has been discussed in the context of trade and finance. The result is quite startling. Trade has exhibited modest growth in output, and the proportionate generation of employment is observed. The role of finance is diametrically opposite. However, in post-2003-04, there is a clear rise in capital intensity of trade. This increase in capital intensity has reduced employment share despite the fact that no or little change in output share of trade is observed.

Keywords: Structural change, Service sector, Trade, Finance, Output, Employment

Introduction

India has registered an emphatic growth in the post-1990 attributed largely to the high growth in the service sector (Bhattacharya and Mitra, 1990). The economic growth in India was first driven by the primary-sector and then by the tertiary sector, bypassing the secondary or manufacturing sector (Mukherjee, 2013). However, the robust growth of service sector in India, does not transformed into concomitant higher employment generation in the sector (Bosworth and Maertens, 2010), and it was the major concern.

India, as we shall see, does not conform to the classical pattern. Understanding the sources of this 'deviation' from the classical pattern is important. Is it a measurement related issue? Are the reasons specific to the Indian economic structure, or do they merely reflect the fact that the

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Indian transition to services-led growth has taken place in the global context where the nature of services and of technological change is also being modified? How has government policy influenced the pattern of growth? How does the phenomenon of rising inequality accompanying per capita income growth matter? These are some of the important questions that need investigation. To further study the above-mentioned disproportionality, we zeroed in on trade and finance. They may be categorized as labour-intensive and traditional, and capital-intensive and modern, respectively.

A Brief Review of Literature

Initially, the services were not taken seriously as they were intangible, perishable and non-storable by nature. The distinction between manufacturing and service is highly exaggerated. Bhagwati (1984) argues that services can be divided into two categories; first, those that necessarily require the physical proximity of the user and the provider; and second, those that do not essentially require it.

Since service sector is variegated and heterogeneous,[1] and is evolving sector, the sector, broadly may be categories in two types on the basis of evolution- primitive services and specialized services. By primitive services[2] we mean those services which came into being right from the beginning of the civilization, and these services were very essential for the survival of the humankind. Specialized services are those services,[3] for generation of which specialized stock of knowledge is required. These services are mostly supplied by professionals and hence their supply is highly inelastic in nature and therefore costly.

Adam Smith called services as 'unproductive' activities. Fisher coined the term "tertiary" in 1935 for service sector. It is referred to as third position after "primary" and "secondary". Hence, Fisher positioned services in people'st minds as economic activities of lesser importance (Riddle, 1986). Similarly, Clark (1940) downplayed the significance of the sector as "residual". Bell popularised the term "post-industrial" in 1973, referring service sector which comes after "industrialisation".

According to Simon Kuznets, economic growth is defined as sustained increase in per capita income, generally followed by rise in population, and also sweeping structural transformation. Industrialization was the key factor behind economic growth and the shift away from agriculture to non-agriculture. Development economics has propounded a theory of growth based on the assumption that there is a linear progression of the economy. In this growth trajectory, primary sector takes a lead in the beginning, and then industrial revolution rules the roost. According to Lewis, surplus labour and other resources from primary sector help to spur industrialization. The rate of growth of the economy is highly correlated with faster rate of growth of manufacturing. This phenomenon is explained through higher productivity of manufacturing sector. Higher productivity of manufacturing sector is associated with increasing returns, arising from economies of scale, internal and external. To spur growth, division of labour, spillover of knowledge, availability of specialized labour and supply of raw materials cause increasing returns to the sector (Kaldor, 1978). The faster the rate of growth of investment, the faster the rate of growth of productivity owing to

[1] The service sector comprises a variety of economic activities, ranging from professional pursuits demanding high skills and large investments in training to domestic service and other unskilled personal services; from activities with large capital investment, such as residential housing, to those requiring no material capital; from pursuits closely connected with private market, such as trade, banking, and related financial and business services, to government activities, including defense, in which market considerations are limited Kuznets (1966).

[2] Early services required for the survival of the human beings (Kuznets, 1966).

[3] Capital-embodied services.

the phenomenon of 'learning by doing'. Hence, industrialization has played an important role in the rapid growth of an economy; and service sector comes in the end as post-industry. Fisher (1935), Fuchs (1968) and Clark (1940) conceived that services sector dominates over primary as well as secondary after a certain level of economic development of an economy.

According to a typical classical theory of linear progression of economic growth, fall in the share of the primary sector in output and employment takes places along with an increase in the secondary sectors' share in output and employment and gradually the share of tertiary sector increases in both employment and output. Such a growth path is witnessed in many developed as well as developing countries (Banga and Goldar, 2004). Unlike the secondary sector where rise in employment share tends to lag behind the output share, tertiarization of activities exhibits the opposite trend, rate of employment generation being higher than the rate of output increase. Most of the industrialized countries in the twenty-first century have transformed into 'service economies' in terms of the share of the service sector in the total employment in the economy. To illustrate, in 2017, 74 per cent of the US workforce were engaged in services compared to 72 per cent in the Netherlands, 71 per cent in the UK and France, 62 per cent in Germany, 63 per cent in Spain, and only 24 per cent in India (OECD, 2000).

Fisher argued that the scope of technological progress directly in services is limited. He believed that technology was not as readily applicable in tertiary sector as is the case in manufacturing. It comes indirectly through other two sectors. His argument is based upon the forward and backward linkages of the sectors. Baumol and Fourastise concurred with him. However, in the present time, technological breakthroughs are more service sector friendly. Low productivity of services sector may be the outcome of flawed measurement of the output of the sector, which has not been captured properly in the basic statistics. The evolution of IT related technology is immensely increasing the productivity of the service sector. Health, finance, business and sundry others have benefited at large extent. In addition, increasing investment has been done in new technology (especially, IT) with the objective of increasing the productivity of services sector.

High Employment in Service Sector: The Demand Side Explanations

Structural transformation according to Fourastié, which is based on the allocation of the workforce among the three sectors, as summed up in Table 1. Traditional civilizations phase describes a society in which people primarily earn a living from the primary sector. The transitional period (from primary to secondary) endows people with scientific temper and harbingers new phenomenon called industrialization based on innovation and invention. In the last stage (i.e., tertiary civilization which is characterized by service-led growth), the other two sectors contribute less in GDP. Tertiary sector accounts for major contribution in GDP.

Table 1: Percentage Share of Workforce in Three Major Sectors for Developed Economy

Sector / Stage	Percentage Share in Workforce		
	Traditional Civilization	Transitional Period	Tertiary Civilization
Primary	70	20	10
Secondary	20	50	20
Tertiary	10	30	70

Source: Excerpts from Fourastié (1949).

There is a general belief that income elasticity of demand for services is greater than unity which means that proportionate demand for services with growth in income is higher than that of

primary and secondary sectors. The demand for services and manufactured products is more elastic than that for primary products as per Engel's Law. In the course of development, this induces a shift away from primary products to manufactured goods and services (Clark, 1940). At higher levels of income, demand for services is always higher. Clark based on his analysis on the so-called 'hierarchy of needs' hypothesis argues that as income increases, a higher proportion would be spent on services. As per this hypothesis, the share of services must rise in employment, as labour will be reallocated from manufacturing industries, which experience high rates of productivity growth but stagnating demand, to services, which experience lower rates of productivity growth but rising demand. This is argued to be the reason why in western economies more employment is generated in service sector than the other two sectors (Schettkat, 2002). The above trends broadly hold true even in case of countries with very low per capita consumption (Sabolo, 1975). Early empirical studies have also conformed to the theoretical exposition. However, some recent studies have contradicted this exposition and have rejected the income-elastic demand for services (Falvey and Gemmel, 1996). Gershuny (1978) has argued that increased use of consumer durables automatically enhances the demand for intermediate services such as servicing and repair of household equipment. It is again based on 'dependency' argument of services. Empirical studies also support this hypothesis.

Another explanation of the rising share of employment in the service sector is the higher level of development and growing specialization of works leading to outsourcing of activities. Splintering and outsourcing of services have created a huge demand for various services (Bhagwati, 1984). The use of services as input is growing fast in industry and agriculture. With the expansion of secondary sector, it becomes cost effective to outsource non-core activities—i.e., feasibility study, advertisement, consultancy, financing, marketing, transport, insurance, storage, communications, security, etc.—to firms specialising in the provisioning of these services. Further, the consumption pattern of households as well as the Government final consumption expenditure is shifting in favour of services (Rakshit, 2007). As a result, intermediate and final services demand has risen to induce the growth of the sector. The demand for services does not just come from other two sectors. Conversely, the growth of service sector induces demand for non-services sectors.

High Employment in Service Sector: Supply Side Explanations

The above 'demand-side' explanation of output and employment trends of the service sector has been criticised by Baumol (1967). He opined that it is the supply-side effect rather than a demand-side effect. According to him, the structural shift of employment from industry to service does not result due to the changing composition of final demand, but because of differential productivity growth. He broadly divides services in two segments—one, where productivity of labour-force is rising (i.e., technologically progressive activities); and, two, where productivity of labour force remains stagnant. He further differentiated between manufacturing and services. In manufacturing, labour is an instrument for final product while, in services sector, it is an end product. Further, provisioning of services differs from provider to provider as the quality of service may change. In the consumption of services, the quality is always an active determinant of its demand. In the supply of and demand for services, a 'direct relationship' is made between the two, unlike the manufacturing where separation of demander and supplier is a traditional character (Urry, 1990). Each service product is unique in its quality. Flemish also worked on this theory and agreed with Baumol.

Baumol and Bowen, however, have failed to identify the role of human capital in service sector. Lower productivity argument of Baumol is probably based on the fact that the sector was emerging at that time, and penetration of technology was limited. Secondly, low productivity argument of service sector is based on data of earlier US economy. Labour-intensive service sector

is now becoming skill- or technology-intensive. Hence, question of productivity lagging may no more be a valid point. Greater education, healthcare, skill, work experience, R&D, etc. result in higher productivity of labour. Most likely, in service sector, providers of the services are skilled and enabled with technology; thus productivity is not low in long run, rather higher than other sectors. The recent technological breakthrough in the field of ICT is more enabling to tertiary sector.

In view of the productivity differentials, according to Triplett and Bosworth (2000), there was a reduction in productivity in the US during the post-1973 period that could be attributed to the rising share of the tertiary sector in the US economy. However, Griliches (1992) has questioned the lower productivity of tertiary sector. Rather, he argued that the low productivity is the result of flaws in measurement of services productivity, as its production is intangible in nature. Maclean (1997) observed that technological advancement, deregulation, growing competition are likely to raise the productivity of tertiary sector.

To conclude, we can say that conceptualization of services and service sector as a whole is based on its perishability, intangibility, heterogeneity, and its inseparability from producer. These unique features differentiate services from non-service sectors. A specific understanding of the nature of technological change, and demand and supply side factors have played an important role in conceptualizing what has been seen as the universally valid classical pattern of structural change, according to which services become prominent after industrialization and leads to employment creation. However, the Fisher-Clark theorization of linear stages of economic development view has been questioned even in the western countries; and its continuing validity in the face of more recent trends in technology development is also under doubt.

Services in Indian Growth Process

After 1980-81, the pace of growth of the Indian economy increased on account of faster growth of services; and its acceleration, outpacing that of industry, depicts the overall performance of various major sectors of the economy in various periods.

Table 2: Compound Annual Growth Rate (CAGR) for Selected Sectors of Indian Economy (Constant Price, 2011-12)

Sector	1950-51 to 1979-80	1980-81 to 2002-03	2003-04 to 2019-20
Agriculture	2.2	3.1	3.6
Industry	5	6.6	7.2
Services	4.1	7	6.7
GDP	3.6	6.1	7.8
Trade	4.8	7	8.6
Finance	7	9	7

Source: CAGR calculated based on data extracted from National Accounts Statistics (NAS).

The three broad periods—1950-51 to 1979-80, 1980-81 to 2002-03, and 2003-04 to 2019-20 as shown in Table 2—have broadly agreed upon to be distinct in terms of growth trends (Mazumdar, 2010). In the first period, the growth rate was hovering around 3 to 3.5 per cent, popularly called as 'Hindu growth' rate. Second period is a turning point for the economy, as the overall growth of the economy has remarkably shot up from around 3 per cent to 5.5 or 6 per cent. It was a switch from 'Hindu growth' to 'productivity surge' (Rodrik and Subramanian, 2005). The thrust in growth was primarily guided by the tertiary sector; and the secondary sector played a very little role in it.

Economic reforms of 1990s were a watershed in the history of Indian economy—a stride towards privatization, liberalization, and globalization (Srinivasan and Tendulkar, 2003). However, policy overhaul in 1990s has not directly and swiftly transformed into higher growth; rather it was more or less similar to 1980s growth. The post-reform period has exhibited a transformation from public to private, and from unorganized to organized sector (Papola, 2008). In the third period, which starts from 2003-04, the Indian economy experienced a jump in growth rate. The period exhibited a high growth till 2008-09. It is also regarded as 'golden period' of growth of the Indian economy, and hence set new normal for the economy in terms of growth.

Table 2 shows that while industry may have been the leading sector before 1980, the services since 1980 led the growth in the Indian economy. Services made the transition from a sector showing moderate growth before 1980, lower than that of industry and manufacturing, to becoming the fastest growing sector.

The prominence of services rather than industrialization in Indian growth and the structural change in output mark one important deviation from the classical pattern of growth. This includes the correlation between higher growth and the transition to greater importance of services, even as the share of industry, and especially manufacturing, stopped rising despite the fact that the economy, in general, and service sector, in particular, exhibited high trajectory of growth in 1980s (Papola and Sahu, 2012). It was remarkable that India exhibited a 'service revolution' at a very low per capita income, and the secondary sector never ruled the roost in generating higher growth of output and employment (Mazumdar, 2010).

Table 3: Share (%) of Different Services in GDP (Constant Price, 2011-12)

Services	1950-51	1960-61	1970-71	1980-81	1990-91	1995-96	2000-01	2005-06	2010-11	2015-16	2019-20
Trade, repair, hotels and restaurants	5.51	6.27	6.96	7.77	8.19	9.18	9.62	10.76	10.84	12.02	13.77
Transport, storage, communication & services related to broadcasting	1.92	2.28	2.71	3.63	3.80	4.21	5.15	6.17	6.41	6.97	6.57
Financial services	0.93	1.26	1.63	2.26	3.68	4.53	5.20	5.66	6.03	6.41	5.99
Real estate, ownership of dwellings & professional services	11.65	9.99	9.08	9.18	12.03	12.91	13.88	13.92	12.99	15.46	15.99
Public administration and defence	2.76	3.11	4.60	5.52	6.21	5.73	6.45	5.60	6.11	5.39	5.83
Other services	4.76	4.37	4.46	4.35	4.39	4.42	4.86	5.12	6.30	6.78	7.42
All services	27.55	27.27	29.44	32.71	38.31	40.99	45.15	46.86	48.67	53.04	55.57

Source: National Accounts Statistics (NAS), Central Statistics Office (CSO).

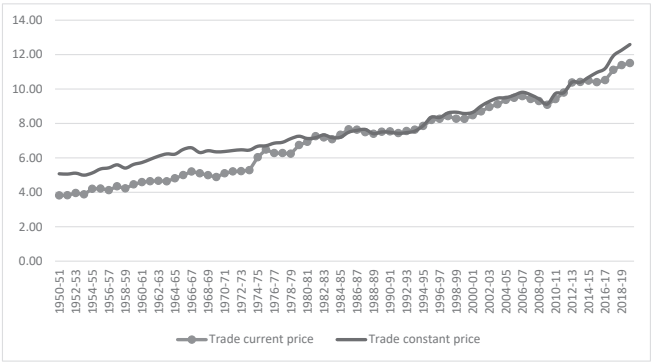
Table 3 gives an overview of the changing share of the services and their sub-sectors over the past six decades. In this long period (1950 to 2020), service sector's overall share in GDP almost doubled from 27.55 per cent to 55.57 per cent. The increase however has been uneven across the sub-sectors of services. The share of 'trade, hotel and restaurant' also doubled, particularly after the 1980s. The greatest order of increase, however, was in 'transport, storage and communication', share of which in GDP has risen from 1.92 to 6.57 per cent during this period. The share of 'financing, insurance, real estate & business services' also increased, entirely after 1980. Thus, unlike between 1950-51 and 1980-81, when 'trade, hotels and restaurants' and 'community social and personal

services' accounted for most of the increase in the share of services in GDP, after 1980-81 it was the other two sub-sectors which were more prominent.

Output Trends of Trade and Finance

Trade is one of the oldest services and has always had a significant share in GDP. Over the period, the share of trade in GDP has increased steadily (Figure 1) at both the current and the constant prices. The only difference is that for several years before 1980, the trade share in GDP at current prices remained below that at 2004-05 constant prices, but this gap was eliminated in the 1980s.

Figure 1: Percentage Share of Trade in Indian GDP (Constant and Current Prices)



Source: Based on National Accounts Statistics (NAS), Central Statistics Office (CSO).

Within the services sector GDP, trade accounted for 18.42 percent in 1950-51 at constant price and a slightly higher to 22.71 percent in 2018-19 (Figure 2). In 1978-79, it achieved the highest share. What is remarkable to note here is that increase in the trade share within services was not much significant at constant price than current price throughout the period, barring initial period. Even during 1980s and 1990s, despite the reforms, there is no remarkable change in share in service GDP.

Finance

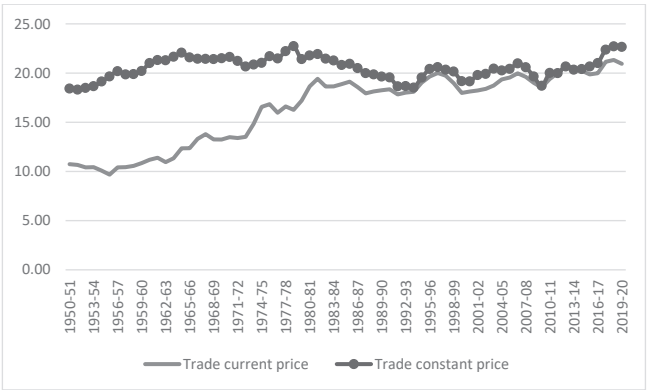
Finance helps mobilise resources for furthering credits for all other sectors, thereby playing the role of an enabler in promoting output and employment. The share of finance in GDP was barely 1% in 1950-51. However, its share has not only steadily grown thereafter (Figure 3), by 2011-12, finance had also significantly closed the gap with trade that it initially had.

Within services sector also, the relative importance of finance has increased relative to its position in 1950-51, when it accounted for just 0.8 per cent of services GDP at current prices and 0.93 per cent at 2011-12 prices (Figure 4). Stagnation in share was noticed after 2008-09.

Trade and Finance: Growth and Relative Situation

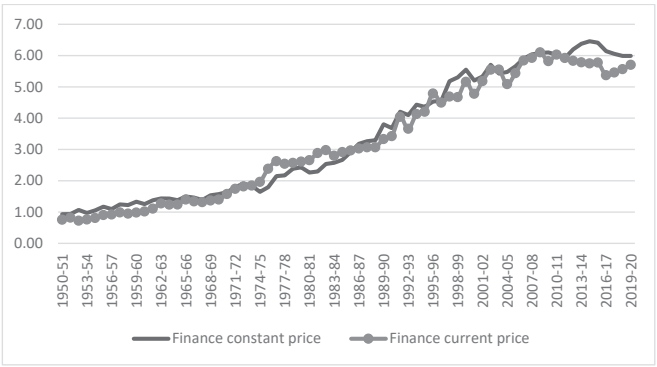
Till 1990s, the ratio of trade GDP to finance GDP has exhibited a steady downward trend at the current and the constant prices (Figure 5). This implies that while both sectors have shown a long-term growth at a rate higher than that of overall GDP, the financial sector was growing faster than trade. However, after liberalization, the trend is horizontal which suggests relative stability in the ratio at current and constant prices. From 2009-10 onwards, an upward trend is noticed, which betokens relative performance of trade is better than that of finance.

Figure 2: Share of Trade in Service GDP in India (Constant and Current Price)



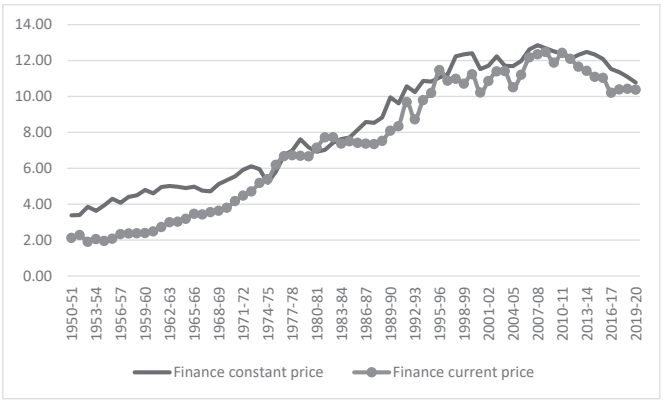
Source: Based on National Accounts Statistics (NAS), Central Statistics Office (CSO).

Figure 3: Percentage Share of Finance in GDP (at Current and Constant Price)



Source: Based on National Accounts Statistics (NAS), Central Statistics Office (CSO).

Figure 4: Share of Finance in service GDP (Current and Constant Price, 2011-12)



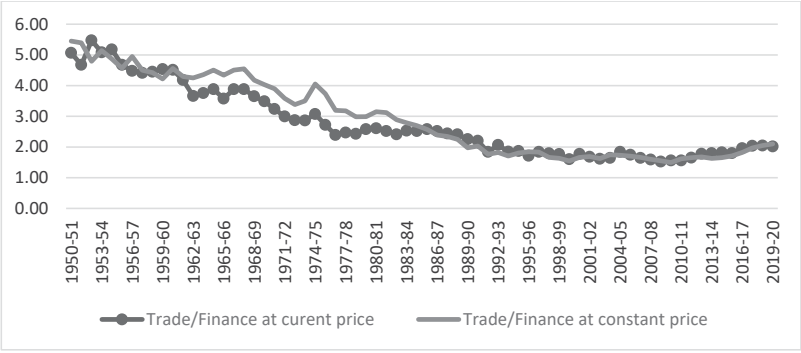
Source: Based on National Accounts Statistics (NAS), Central Statistics Office (CSO).

Organized and Unorganized Segments in Trade and Finance

Data for this division is not available in the back-series with 2011-12 series. Therefore, the 1999-00 base year series data on factor incomes for the period 1980-81 to 2010-11 has been used here to look at the relative shares of these two components in trade and finance, and changes in them over time. It shows that the levels of the unorganized and organized sector shares in trade and finance have not only been vastly different, the trends of change in the organized-unorganized distribution are also not in sync with each other.

As Figures 6 and 7 show, trade has always been dominated by the unorganized sector while it has been the exact opposite with finance. However, reversing a slow trend of decline in the 1980s, after liberalization there was steady trend of increase in the organized sector's share in Trade NDP that continued for a decade and a half. This carried the organized sector's share from less than 5 percent at the beginning of the 1990s to nearly 33 percent by 2006-07, subsequent to which there was a dip in this. However, 2005-06 and 2006-07 were somewhat exceptional years when this share was much higher than the years immediately before or after. If we take them out of the frame, a steady process of trade becoming more organized is perceptible through the 1990s and till the beginning of the high growth phase from 2003-04, after which the distribution that had emerged, of about four-fifths of the NDP coming from the unorganized sector and one-fifth from the organized sector. In the case of finance, an opposite kind of structural shift took place between the mid-1980s and the end of the 1990s, with the unorganized sector increasing its share from 3.5 percent to around 10 percent. In the subsequent years, it increased but without any clear trend.

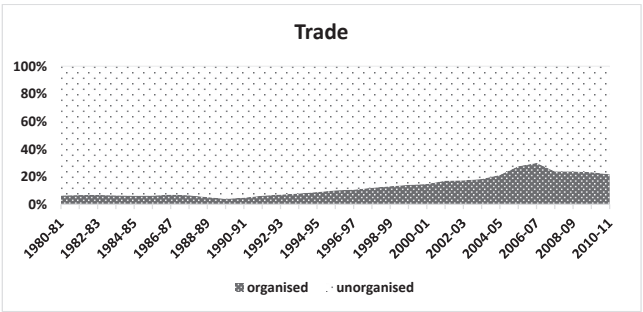
Figure 5: Ratio of Trade GDP to Finance GDP, 1950-51 to 2018-19 (Current and Constant Prices, 2011-12)



Source: Based on National Accounts Statistics (NAS), Central Statistics Office (CSO).

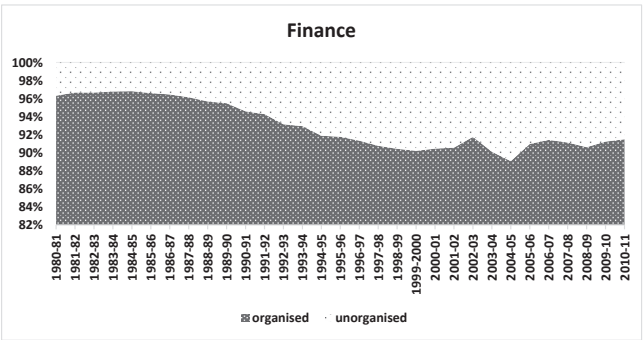
"Retailing in India, even of products produced by the organized sector, has always been dominated by unorganised sectors, most of which belong to the unorganized component. According to the study of ICRIER (2008), the unorganised sector dominates in food and grocery business, and the proportion of organised sector in this segment is very low. In India, unorganised sector may have dominated the trade sector, in contrast to Europe where the share of organized retail is as high as 80 percent in the United Kingdom, Germany and 85 per cent in the USA. Even among the emerging economies, the share of organised retail is well above India. They are as follows: Brazil - 36%, China - 20%, Indonesia - 30%, Korea -15 % and Malaysia - 55% (Hoda, 2008). The scope for expansion of organised retail in India is therefore immense (Prakash, 2022).

Figure 6: Distribution of NDP of Trade between Organized and Unorganized Sectors in India, 1980-81 to 2010-11



Source: Based on National Accounts Statistics (NAS), Central Statistics Office (CSO).

Figure 7: Distribution of NDP of Finance between Organized and Unorganized Sectors in India, 1980-81 to 2010-11



Source: Based on National Accounts Statistics (NAS), Central Statistics Office (CSO).

With liberalization, trade began exhibiting an inclination towards formalisation—i.e., a rise in the share of organised sector in output that happened mainly because of an expanding middle class and a fast growth of corporate-backed retail sectors. With the opening of the economy, inflow-outflow of goods and services rose manifold. Trade GVA also includes both new and old products. The second-hand goods market has also grown by leaps and bounds in the past. Government has also been encouraging recycling/reuse of products for environmental purposes. Repairing services has also added to GVA of trade. Gradually, the trading services— both wholesale and retail—have grown more difficult and complex with rising competition. The professionals are engaging in trade activities in supermarket or organised sectors. Marketing has become a potent tool for promoting products. Foreign capital investment has risen in this sector, which brings sophisticated technology. Government has relaxed the norms for promoting investment in this sector. By 2006, FDI was allowed in single-brand up to 51 per cent. The pace of construction of shopping malls also picked up in the 2000s. In 1999, India had just 3 shopping malls. By end of 2006, the number had gone up to whopping 137 (ICICI, 2007). Subsequently, digital technologies also came into the picture. The unprecedented rise of ICT created the possibilities for trade services through online platforms,

i.e., e-commerce. For instance, in China, the way Alibaba progressed in short span of time, India's trade sector could also benefit from similar activities (Mehrotra, 2019), though the penetration of technology is quite low in India.

Retail trade is heavily dependent on logistic support, and the logistic cost was as high as 15% of our GDP in 2005-06. India's rank has declined from 44th in 2016 to 35th in 2018 in the Logistics Performance Index rankings. Though the government has started a slew of measures to boost credit facilities, the end result is not very encouraging. Organised retail covers only 10% and e-commerce accounts for 3% only (Ramalingegowda, 2018). The organized sector is also more affected by archaic laws and acts and red-tapeism. The retail trade industry has to secure a total of 45 licenses, clearances, registration certificates or notification requirements for each outlet (Government of India, 2008). One of the important State Level Acts which regulates retail trade, i.e., the 'Shops and Establishment Act', was originally enacted in the 1950s. All these impetuses produced a trend that may be termed as formalisation of the trade sector in the post-reform period.

In the case of finance, organized sector dominance went along with low financial inclusion. Liberalization here in part could have contributed to an initial increase in such exclusion, as reforms pushed the credit institutions towards greater commercialization of operations. This might have led to some growth of unorganized finance as people turned to that alternative. However, the initial growth in the unorganized share in the finance sector was not entirely independent of what was happening in the organized sector. It coincided with the rising importance of FDIs. Non-banking Financial Institutions (NBFIs) have been doing remarkable job in mobilising resources for the economy.

A slightly longer and more continuous picture is presented in Figure 8 making use of the India KLEMS data (Reserve Bank of India) with 2011-12 base year. This shows the trends in GDP (both at current as well as constant prices) and employment shares in trade and finance for the period. In addition to highlighting the tremendous gap between trade and finance shares in employment and between the finance share in GDP and employment, it also shows that there have been some variations in how these different shares have moved relatively over time. Thus, in the case of trade, the decade of the 1980s saw its employment share increasing faster than its share in GDP, but the exactly the opposite situation marked the last decade of the period till 2018-19. In that last decade, the share of finance in employment increased without a real change in its share in GDP. The sector's share has changed significantly in post-1980s.

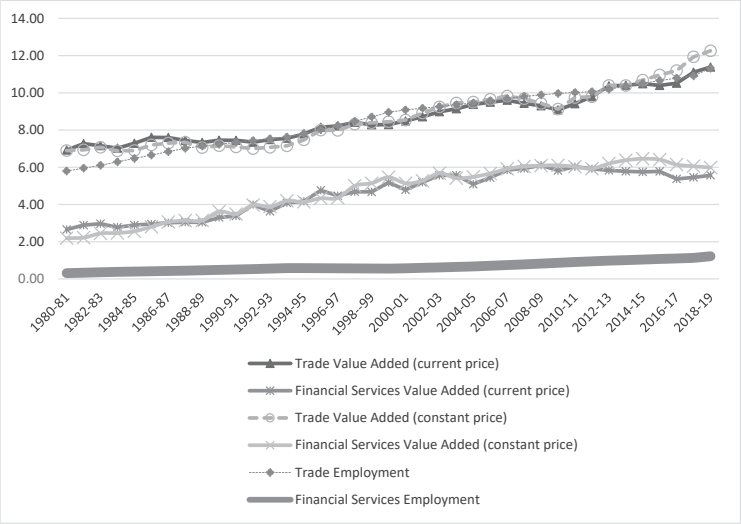
Thus, the movements in shares in output and employment of the two sectors have not exhibited a consistent pattern throughout the period after 1980. Table 4 reveals important turning points. For the entire period from 1980-81 to 2018-19, the share of trade in both output as well as employment increased more than that of finance, though the finance grew faster from a lower base. Further, trade witnessed a higher increase in employment than the output, while the opposite was the case for finance. Majority of the increase in employment share of trade has taken place till 2003-04, despite the fact that the sector grew with same pace in output. On the contrary, for finance, the major part of its increase in output share has taken place between 1980 and 2003-04. From 2003-04, the increase in finance's employment share was more than that of output. The further break-up of the periods before and after 2003-04 into two sub-periods also shows how the process of change gathered strength.

Structure of Employment by Type

The structure of employment for the two sectors has been quite non-identical. Self-employment

dominates trade, while regular salaried employment dominates finance. Casual employment on the other hand has been a relatively small portion of employment in both trade and finance. Trade and finance thus illustrate the heterogeneity in employment structures that make up the 'average' picture for services which is also shown in Table 5.

Figure 8: Shares of Trade and Finance in GDP of India (Current and 2011-12 prices) and Employment, 1980-81 to 2018-19



Source: India KLEMS, Reserve Bank of India.

Table 4: Changes in Shares of Trade and Finance in Value Added (VA) and Employment

Item	1980-81 to 2018-19	1980-81 to 1987-88	1987-88 to 2003-04	2003-04 to 2011-12	2011-12 to 2018-19
Trade VA Current	4.46	0.52	1.70	0.65	1.60
Trade VA Constant	5.36	0.45	2.11	0.34	2.47
Trade Employment	5.52	1.22	2.34	0.70	1.26
Finance VA Current	2.91	0.40	2.52	0.35	-0.36
Finance VA Constant	3.80	0.94	2.28	0.51	0.06
Finance Employment	0.91	0.13	0.20	0.30	0.27

Note: VA stands for value added
Source: India KLEMS, Reserve Bank of India.

Over the long term, a trend of a shift from self-employment towards regular employment can be seen in the case of trade in post-1980s. An exactly opposite shift, from regular to self-employment, has been noticed in finance till 2011-12, after which the rising trend of self-employment is reversed in the finance sub-sector.

Generally, regular employment is created in organized sector, and unorganized sector generates self-employment and casual employment. Thus, the dominance of self-employment in trade is in consonance with the sector's output composition as unorganized sector has a dominant share in the output. As organized sector's share in output has risen, the share of regular salaried employment has

also risen. The identical trend is found in finance. However, structural changes in employment have been slower than that of output for trade, while finance reflects the opposite trend, the rise in share of unorganized output being less than the rise in self-employed and casual employed.

Table 5: Structure of Employment by Type (%)

NSSO Survey Rounds	Trade			Finance			Services		
	SE	RE	CE	SE	RE	CE	SE	RE	CE
38th round (1983)	84.19	11.47	4.34	9.93	88.16	1.91	46.39	44.13	9.48
43rd round (1987-88)	84.62	11.25	4.13	9.91	88.86	1.23	48.01	42.3	9.69
50th round (1993-94)	83.71	12.22	4.07	14.26	84.5	1.24	49.81	40.86	9.34
55th round (1999-2000)	75.73	16.55	7.72	15.92	83.2	0.88	48.18	40.97	10.85
61th round (2004-05)	78.16	16.57	5.27	25.29	73.39	1.32	52.04	39.89	8.07
66th round (2009-10)	78.31	16.64	5.05	25.03	73.16	1.81	49.6	42.11	8.29
68th round (2011-12)	75.49	19.06	5.44	27.34	71.92	0.74	49.52	43.57	6.9
PLFS 2017-18	70.64	24.93	4.43	17.32	81.48	1.2	45.84	48.66	5.5
PLFS 2018-19	70.15	25.53	4.32	18.62	81.05	0.33	44.96	49.6	5.44

Notes: SE - Self-employed; RE - Regular employed; CE - Casual employed; PLFS - Periodic Labour Force Survey.
Source: National Sample Survey Office (NSSO).

Employment and Output Growth: Employment Elasticity Trend

We looked at the relative trends of the *shares* of trade and finance in output and employment. However, it is also important to keep in mind that work-participation rates have been falling in India in the 21st century, beginning precisely when growth rates of GDP accelerated. Therefore, it is important to not only to compare the shares of these sub-sectors in employment and output but also the rates of growth of employment vis-a-vis those of output.

Employment Elasticity

Employment intensity of the service sector is determined primarily by structural characteristics—technological change, policy intervention, productivity growth, international competition, labour market reforms, economic structure, etc. (Pattanaik and Nayak, 2010). A general downward drift of employment elasticity of Indian growth is noticeable in Table 6. It declined from 0.57 in the period 1972-73 to 1977-78 to as low as 0.15 during the period between 1993-94 and 1999-2000. However, CAGR of GDP was roughly 4 per cent during 1972-73 and 1987-88. During 1993-94 to 1999-2000, the CAGR of GDP was quite handsome, which was as high as 6.8 per cent, but performance on employment front was tepid. This is why this period is called 'jobless growth'. In the very next period, i.e. from 1999-2000 to 2004-05, the employment elasticity was very high because of a high employment growth. Mehrotra et al. (2014) has termed this phenomenon as progressive structural change, as large number of jobs, for the first time, were created in the non-agriculture sector. During 1999-2000 to 2004-05, non-farm employment grew, on average, by 7.5 million per year. On the other hand, nearly 12 million people were joining labour-force every year during the same period.

The decline in elasticity of employment was followed by a concomitant decline in unemployment rate between 1999-2000 and 2009-10. It may be attributed to secular fall in labour-force participation rate (LFPR). The decline in LFPR was mainly due to its decline in rural areas and particularly among rural females, probably because of high enrolment in educational institutions and skill enhancement programme. Recent trends in rising Gross Enrolment Ratio (GER) also support this hypothesis. GER rose from 20.5 per cent (1993-94) to 24.3 per cent (2004-05), and further to 26.6 per cent in

2009-10 (Himanshu, 2011). The rise was much faster in rural areas, and especially among females. As a result, the unemployment rate went down. However, compared to these numbers, the number of available jobs into which such an educated workforce could be absorbed have not grown anywhere close to the desired levels.

Table 6: Employment Elasticity of Indian Economy (CAGR Approach)

Year	Employment Growth	GDP Growth	Employment Elasticity
1972-73 to 1977-78	2.6	4.6	0.57
1977-78 to 1983	2.1	3.9	0.54
1983 to 1987-88	1.7	4	0.42
1993-94 to 1999-2000	1	6.8	0.15
1999-2000 to 2004-05	2.8	5.7	0.50
2004-05 to 2009-10	0.1	8.7	0.01
2009-10 to 2011-12	1.4	7.4	0.18
1999-00 to 2011-12	1.5	7.3	0.20
1993-94 to 2011-12	1.1	6	0.18

Source: Misra and Suresh (2014).

Table 7: Employment Elasticity of Trade in India

Sector	1983 to 1987-88	1987-88 to 1993-94	1993-94 to 1999-00	1999-00 to 2004-05	2004-05 to 2009-10	2009-10 to 2011-12	1993-94 to 2011-12	1983 to 2011-12
Trade (All)	0.13	0.31	0.26	-0.02	0.00	-3.78	2.72	1.55
Organized sector	-0.36	0.24	-0.71	0.04	0.01	-4.09	2.38	1.42
Unorganized sector	0.21	0.31	0.40	-0.02	0.00	-3.77	2.76	1.57

Source: Calculated based on data taken from National Sample Survey Office (NSSO) and National Accounts Statistics (NAS).

Table 7 shows that the employment elasticity of trade has not been very encouraging since 1980s. However, before economic reforms, employability of the sector was much greater. In the post-1990s, it declined consistently. During 2009-10 and 2011-12, it became even negative. Not just the organized sector, even the unorganized sector's employment elasticity has remained low in the 21st century. Employment elasticity in both trade and finance has remained very low (Tables 7 and 8). The post-reform worsening is seen here too with nothing to distinguish the employment elasticities of the organized and unorganized sectors. Over the long-run, the employment elasticities of trade and finance have not been very different from each other. Between 1999-2000 and 2004-05, when a progressive structural change was taking place, trade and finance still exhibited poor or negative employment elasticities.

Table 8: Employment Elasticity of Finance in India

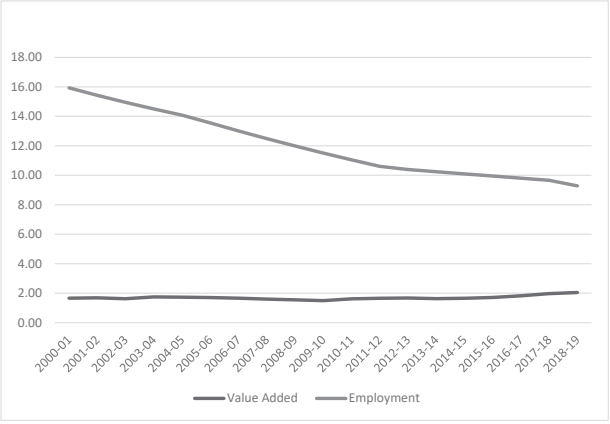
Sector	1983 to 1987-88	1987-88 to 1993-94	1993-94 to 1999-00	199-00 to 2004-05	2004-05 to 2009-10	2009-10 to 2011-12	1993-94 to 2011-12	1983 to 2011-12
Finance (All)	0.21	0.33	-0.03	-0.05	0.01	-4.20	2.79	1.57
Organized sector	0.23	0.30	-0.75	-0.06	0.01	-4.05	2.69	1.53
Unorganized sector	0.08	0.39	1.02	-0.05	0.00	-4.31	2.93	1.60

Source: Calculated based on data taken from National Sample Survey Office (NSSO) and National Accounts Statistics (NAS).

The Transitions in Trade and Finance

The essence of the transition in capital intensity is captured in Figures 9 and 10. Figure 9 shows that, since 2000-01, the relative importance of the trade and finance sectors in regard to value addition has not moved in favour of trade (a labour-intensive and low-productivity sector). However, there has been a consistent relative decline of trade as far as employment is concerned. This is just another way of saying that the growth of employment in the labour-intensive sector among the two has been lower but this is not explained by slower growth of trade output but instead by faster growth of productivity in that sector. This faster growth of productivity in trade compared to finance after 2000 is shown in Figure 10.

Figure 9: Value Added and Employment in Trade Relative to Finance, 2000-01 to 2018-19



Source: India KLEMS, Reserve Bank of India.

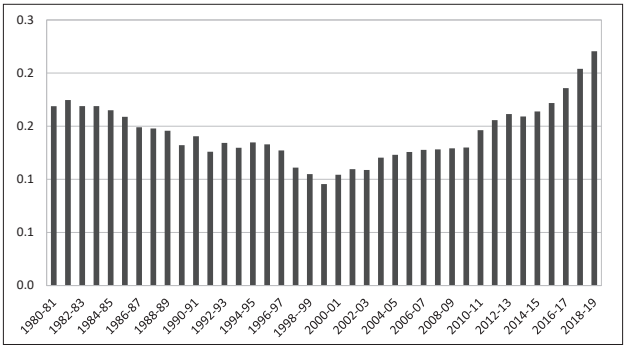
Figure 12 shows that value added per unit of capital in finance has increased. However, for trade, the overall trend of the ratio is roughly flat till 2003-04, but thereafter a clear decline is observed. It suggests that capital per unit of output has risen in trade. This rise appears to come from organized sector of the trade, as the share of organized sector within trade has risen in post-1990. Figure 13 also concurs with this result, depicting that capital stock ratio for trade relative to finance shows no sign of consistent change till 2003-04. However, 2003-04 onwards, the ratio is rising with exceptional rate, which again establishes the fact that the capital intensity of trade has risen compared to finance.

Figure 11 shows again rising capital intensity. Since the middle of 1990s, finance has experienced a consistent increase in capital-intensity. This process, however, ceased at the beginning of 2000s. However, trade has witnessed rise in capital intensity.

Conclusion

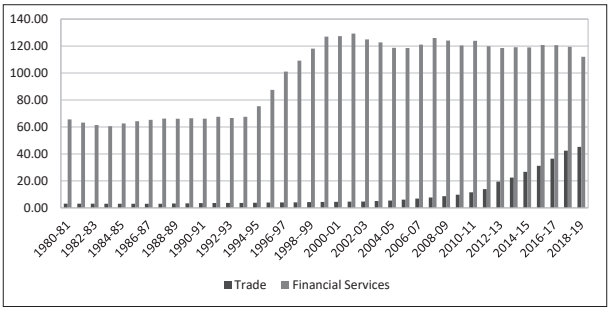
India has witnessed a service-dominated growth since 1990s, though the foundation was laid way back in 1980s. The 'great economic reform' of 1990s did not pay attention to the tertiary sector, though some reforms in service sector were proclaimed by the then government. However, service-led economy could not generate employment vis-à-vis output. This phenomenon of jobless growth perplexed the experts in India. On the contrary, tertiary sector's contribution in employment in the developed countries is much larger than that in the other sectors.

Figure 10: Labour Productivity in Trade Relative to Finance (2011-12 Constant Price), 1980-81 to 2018-19



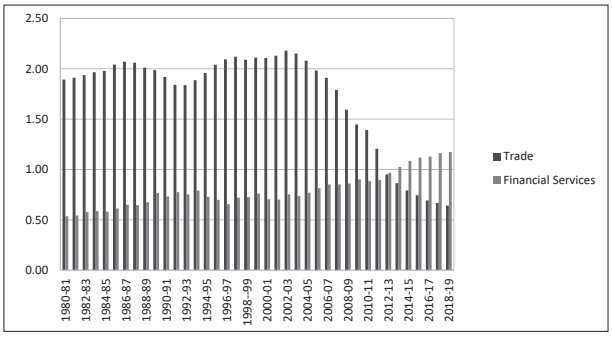
Source: India KLEMS, Reserve Bank India.

Figure 11: Capital Intensity (Capital Stock at 2011-12 Prices Per Employed Person) of Trade and Finance, 1980-81 to 2018-19



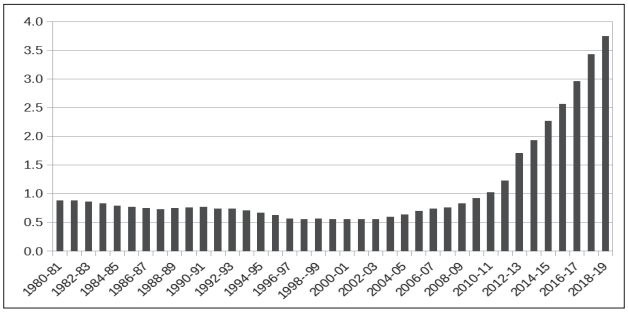
Source: India KLEMS, Reserve Bank India.

Figure 12: Ratio of Value Added to Capital Stock (2011-12 Prices) of Trade and Finance, 1980-81 to 2018-19



Source: India KLEMS, Reserve Bank India.

Figure 13: Capital Stock (2011-12 Price) in Trade Relative to Finance, 1980-81 to 2018-19



Source: India KLEMS, Reserve Bank India.

This paper attempts to examine the reasons and factors behind the higher output growth and low employment generation in trade and finance in India unlike the developed countries and to develop insights into the unbalanced nature of structural change in India. The paper has come up with the following key conclusions about how the comparative stories of trade and finance reflect the nature of structural change in India:

1) Trade and finance are distinguishable from each other in terms of a) their basic nature—trade being a traditional labour-intensive service, growth of which is intimately connected with the growth of commodity sectors of the economy and thus caters to distributive services to the economy, while finance is a more modern and relatively capital-intensive sector, growth of which is more closely connected to the process of financial development rather than goods production; and b) their structural features—trade being dominated by small enterprises in the unorganized sector with a high proportion of self-employment, while large organizations in the organized sector with regular salaried employment playing the more prominent role in finance.

2) Due to nature of trade, it accounts for a much larger share of total as well as service GDP, and also employment, than does finance. But the productivity of trade is much lower than that of finance.

3) The dependence of trade on goods production constrained its growth in post-1980. It grew faster than the past and contributed to the service-dominated growth acceleration. In contrast, finance as a whole tended to grow much more rapidly because of the increasing importance of financial activities—resulting from both the impact of financialization of the global economy, which too has been a feature of this period, as well as the increased significance of financial savings and growth of credit. In other words, increasing inequalities and global integration impacted the two sectors differently—by aggravating the demand constraints for manufacturing in particular (which checked the growth of trade). The growth of finance, however, had a complementary relationship with the same process, particularly in the period before the global crisis.

4) Particularly since 2000-01, the combined employment effects of the growth of trade and finance may further be explained by a trend of rapid increase in the capital-intensity of trade which facilitated a process of labour-substitution. This delinking of growth of trade GVA from trade employment reflected the onset of a new phase, as such a delinking was not seen in the past. A remarkable feature of this was a faster growth of productivity in trade than in finance. Such a growth in trade may have been complementary to the growth of finance, as the rapid growth of capital formation in trade implies likely faster growth of the finance sector.

In a nutshell, it can be said that the structural change in trade and finance has had profound impacts on output and employment trends. Trade has roughly exhibited equi-proportional rise in output and employment till 2003-04. Since 2003-04, the sector has experienced higher capital intensity and, therefore, rise in productivity which reduced employment share. On the contrary, finance has shown more employment generation till 2003-04, and afterwards output share has risen faster. Moreover, trade largely accounts for self-employment owing to the fact that unorganized sector dominates activities, while finance produces regular employment due to the fact that the sector is dominated by organised sector. In addition, structural change in output is faster for both trade and finance, while employment sector is showing slow structural change.

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ON QUANTIFICATION OF FIREWOOD DEPENDENCE OF THE FRINGE VILLAGERS: A CASE OF FOREST DEPENDENCE IN NORTHEAST INDIA

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Abstract: This study develops a multidimensional index to measure forest dependence of the fringe villagers for firewood consumption based on the empirical pieces of evidence from northeastern states in India. The study observed that forest firewood dependence is significantly influenced by the factors like size of landholding, availability of alternative fuels, wealth possessed by the households, distance to the nearest firewood market, existing forest management rules and education level of the head of the household. The study is expected to be beneficial for the policymakers with a view to designing sustainable forest and energy policies. The Forest Firewood Dependence Index (FFDI) will facilitate the researchers to add a new dimension in forest and livelihood based research.

Keywords: Livelihood, Entropy weight, Multidimensional index, Degradation, Tribal households

1. Introduction and Objectives

Households' dependence on common forest for various benefits is an age-old phenomenon (Garekae et al., 2017), and it is more prominent in the tribal belt of the Eastern Himalayan Region (Nongbri, 1997). Empirical evidence shows that forest products play a significant as well as crucial role in rural livelihood, particularly for the poor (Beyene, 2011). People used to collect a wide variety of goods apart from receiving ecological benefits from the common forest (Haimendorf, 1985; and Elwin, 1959), and firewood is considered the most important one out of all forest collections (Jodha, 1986).

Until the recent time, forest dependence had not been well understood or was wrongly understood, and therefore different concepts or indicators were used by the researchers to quantify forest dependency. The monetized value earned from the forest product collection was primarily considered for the calculation of forest dependency as such, and the non-monetised component of forest product has largely been overlooked.

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In the northeast India context, forest dependency is mostly due to the purpose of firewood consumption in the household sector (Ramakrishnan, 1987) and also commercial extraction of such products to meet livelihood requirements (Wonder, 1996; Iyenger, 1989; Ali, 2004). Almost every tribal household collects and uses firewood. Firewood consumption in the tribal households is also influenced by the food habit of the tribals and non-availability of alternative fuels at affordable prices (Khataniar and Benazir, 2018). The emergence of the market has paved the way for commercial extraction of forest products (Wonder, 1996; Iyenger, 1989; Ali, 2004). At the same time, researchers also observed that the failure of the existing common property resources management system has resulted in the emergence of a 'neo-rich' class in society which has been exploiting common forest by extracting the resources for commercial purposes (Khataniar, 2009). Because of all these issues, the matter of firewood consumption has now gained global importance as it has been an important source of household energy and a vital cause of deforestation around the world (Sharpe, 1976; Amacher et al., 1999). It has also been emerged as a thrust area of research in the region and has been studied widely. Researchers have tried to address the issues of firewood consumption and its probable implication to deforestation, but the previous studies failed to capture and quantify comprehensively the multidimensional aspects of forest dependency. Understanding the true nature of forest dependence is very important for any appropriate policy intervention. Studies also fail to work out the socio-economic drivers of forest dependence under a strong methodological framework. The present study is a modest attempt in this regard. The specific objectives of the study are as follows:

i. To develop a comprehensive index to measure households' dependence on common forest (CF) for firewood requirements.

ii. To identify the determinants of household's dependence on common forest, using the FFDI (Forest Firewood Dependence Index) approach.

2. Materials and Methods

2.1 Data Source

This is an empirical study based on primary survey data collected from 9 tribal villages located in forest proximity and remote areas of two northeast Indian states, namely, Assam and Nagaland. The data were taken into consideration to develop the multidimensional Forest Firewood Dependence Index (FFDI) and to explore the determinants of FFDI.

2.2 Sampling Procedure

A multi-stage sampling technique was followed for selection of the households. In the first stage, as indicated above, two states, namely, Assam and Nagaland, were purposely selected. The state Nagaland represents the typical firewood consumption behaviour, norms and customs of remote as well as tribal-dominated societies. Assam is relatively a forest-scarce state amongst the states of the northeast Indian region. The state is selected to see how people respond to firewood scarcity.

In the second stage, two districts from each state were purposely selected. The selected districts represent different communities. At stage three, some tribal-dominated villages were randomly selected from each district. In the next stage, altogether 211 sample households were selected applying a stratified random sampling technique—of which 77 households were selected from the districts of Assam, and 134 households were selected from the districts of Nagaland. Primary data was collected from the household using a semi-structured schedule.

3. Conceptual and Analytical Framework

3.1 Approach to Measure Forest Dependence for Firewood

Until the recent time, forest dependence had not been well understood or wrongly understood and, therefore, different concepts or indicators were used by the researchers to quantify forest dependency. In the existing literature, forest dependency has been captured in different ways. Some people consider the extent of benefits derived from forest to quantify forest dependency (Jodha, 1986; Bokil, 1996), whereas some others have used forest income—either in absolute or in relative terms—to quantify the same. Recently some authors have pointed out that human dependence upon forests is a multifaceted phenomenon because forests provide a diverse stream of benefits to humans (Beckley, 1998) and, therefore, a multidimensional index may be more appropriate to capture forest dependence.

Traditionally, forest dependence for firewood is understood in terms of the quantity of firewood collected from the forest. The more is the quantity, the greater is the dependence. Again, the traditional nature of forest firewood collection is that it is collected by the household members and meant for own consumption only. However, labour market incorporation of forest-based activities and commercialization of forest products make people's dependency on common forests more crucial and complex. In this complex scenario, the mere quantity of a collection does not reflect dependency in the true sense, as the collection may be done through hired labour and for sale rather than for own consumption. Under these circumstances, the present research focuses on the households' firewood dependence on the forest as a multifaceted phenomenon, and hence a multidimensional approach is used to measure it. The multidimensional index, called as Forest Firewood Dependence Index (FFDI), is developed based on two livelihood aspects (sub-indices) of households which are related to firewood consumption.

The first-dimensional index captures the importance of forest firewood collected as a part of the total household requirement (i.e. own consumption plus sale). The indicators used to capture the index are the quantity of firewood collected from the forest and the relative significance of forest firewood collection which is measured as a ratio of forest firewood collection in a year over the total firewood consumption from various sources including those purchased from the market.

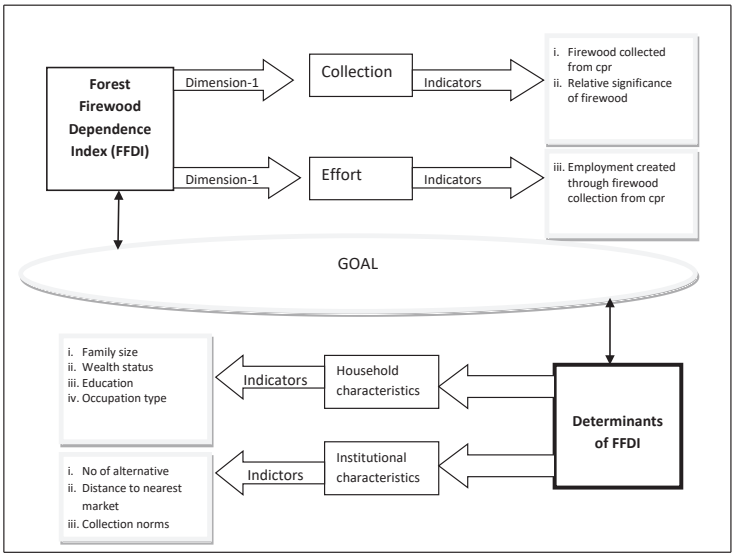
The second-dimensional index is the effort dedicated to firewood collection from the forest. The affluent households may collect and maintain a huge stock of firewood without spending much time and labour. This is possible either through market purchase or through deploying hired labour for firewood collection from the forest. But the poor households who collect firewood from the forest spend substantial time for collecting firewood. As such time spent on the collection of firewood in terms of man-day (one man-day is equal to eight hours of collection time) is considered another indicator to measure forest firewood dependence. Thus, FFDI is developed based on two dimensions comprising three indicators. Figure 1 shows the conceptual and evaluation framework of the study.

3.2 Range Standardization Method

The range standardisation method is used to standardise data related to the selected indicators. This method has widely been used by academicians to standardize variables. The method allows variables to have different mean and variance but equal ranges. In this method, variables are converted such a way that it contains minimum value 0 and maximum value 1. Standardisation is necessary as the indicators are taken from different dimensions and apparently these indicators have different units of measurements, contents and formats. Some variables have a very wider range and variance

compared to others. For example, the variable FSIZE (family size of the household) recorded its range and variance to be 7 and 1.218, respectively, whereas variable like F_RULE (forest products extraction norms) has recorded smaller range and variance, i.e., 1 and 0.206 (Table A-1), respectively. Thus, unless these data are standardised, some variable will get more weight only because of having high variance and wide range, which require the standardisation of the data of the selected variables.

Figure 1: Conceptual and Evaluation Framework of the Study



3.3 Entropy Weight Determination

Existing literature fails to provide any information regarding the weight of different criteria/ indicators selected for the development of the index. Therefore, the Entropy weight determination method is employed to fix the weight of each indicator. The Entropy can be used to determine the objective weight of criteria when the decision-maker has conflicting views on the values of weight (Zhu et al., 2020). As such entropy weight is a parameter that describes how many different alternatives approach one another with respect to certain criteria. The weight calculated by this method is called objective weight. Following steps were followed for the determination of entropy weight.

Step 1: To determine the criteria (dimensions) for Forest Firewood Dependence Index (FFDI): Two criteria were selected, namely, Collection (importance of forest firewood collection) and Effort (effort made for forest firewood collection).

Step 2: To select the indicators of each dimension: The selected indicators of different dimensions are shown in Table 1.

Step 3: To standardise the indicators applying Range Standardisation Method: Standardisation formula adopted here includes:

$$X'_{ij} = \frac{X_{ij} - X_{min}}{X_{max} - X_{min}} \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Step 4: To calculate the index weight by Entropy Method: Here, entropy value is calculated as:

$$e_j = -h\sum_{i=1}^{n} r_{ij} \ln r_{ij}, \; j = 1, 2, 3, ..., n$$

where

$h = \frac{1}{\ln(m)}$; where m = number of alternatives.

Step 5: To multiply each value in the cell with the log value of that particular value, i.e., calculate

$$\sum_{i=1}^{n} r_{ij} \ln(r_{ij})$$

Step 6: To calculate the value of entropy (e_j), multiplying the sum values with the negative value of h, i.e.,

$$e_j = -h\left(\sum_{i=1}^{n} r_j \, h \, r_j\right)$$

Step 7: To calculate weight vector applying the formula:

$$w_i = \frac{1-e}{\sum_{i=1}^{n}(1-e_j)}$$

Here, (1- e_j) is known as the degree of diversification.

$$0 \le w_j \le 1; \sum_{j=1}^{4} w_j = 1$$

Each value of w_j can be used as the objective weight of the criteria.

4. Results and Discussion

4.1 Entropy Weight Calculation

We have calculated entropy weight for the pre-determined three indicators applying the proper methodology. The result is presented in Table 1.

Table 1: Estimated Entropy Weight of the Indicators

Target Variable	Dimensions	Indicators	Index	Influence	Weight
Forest Firewood Dependency	Importance of forest firewood	1. Firewood collected from common forest;	Quantity collection qntl/year;	+	0.3218
		2. The relative importance of firewood;	Forest firewood collection / Total firewood consumption;	+	0.2016
	Effort	3. Time spent on collection of firewood in terms of man-day.	8 hours of collection time = 1 man-day.	+	0.4766

Source: Primary data, 2018.

4.2 Quantification of Forest Firewood Dependence

Once the weight of each index is determined through weighted comprehensive evaluation, this study builds its model of forest firewood dependence as follows:

$$D_i = \sum_{i=1}^{n} X_j^i W_j \quad \text{..... (2)}$$

Here, D_i = Comprehensive forest firewood dependence value of the i[th] index (households);

X'_{ij}= Standardized value of jth evaluation index; and W_j = weight of the j[th] index.

The descriptive statistics of FFDI is presented in Table 2.

Table 2: Descriptive Statistics of the FFDI

Overall Forest Firewood Dependence			
Parameters	**Minimum**	**Maximum**	**Mean**
FFDI	0	0.9567	0.5087
Dimensions-wise Forest Firewood Dependence			
Firewood collection	0	0.3200	0.2702
The relative importance of firewood	0	0.2000	0.7535
Effort	0	0.4800	0.1632

Source: Author's calculation based on field-survey data, 2018.

4.3 Exploring the Determinants of FFDI

FFDI is a multidimensional index and its value is determined by some socio-economic and demographic variables. To determine the significant predictors of FFDI, we regressed FFDI upon all theoretically presumed predictors. These predictors, their measurement aspects and their expected influences upon the regressand (dependent variable) are shown in Table 3.

Table 3: Predictors and Their Expected Influence

Sl. No.	Variable Name	Description	Variable Type	Expected Sign
1	ALT_FUEL	Availability of alternative to firewood (actual number);	Continuous	Negative
2	WEALTH	Value of wealth possessed by the household (Rs. 000);	Continuous	Negative
3	FSIZE	Size of the household (actual number);	Continuous	Positive
4	D_MARKET	Distance to the nearest market (distance in km.);	Continuous	Positive
5	F_RULE	Existence of forest extraction rules;	Dummy: Yes = 1; No = 0	Negative
6	OCCUPTYPE	Type of occupation of the head of the household;	Dummy: Agri & allied = 1; Otherwise = 0	Positive
7	EDUCATION	Education level of the head of the household.	Categorical: 1 = illiterate 2 = primary 3 = secondary 4 = higher education	Negative

The results of regression analysis along with the model summary and multicollinearity test results are presented in Table 4. As shown in Table 4, variance inflation function (VIF) lies between 0 and 5; this means that there is no multicollinearity among the predictors. F-statistic, a test for

detection of heteroscedasticity,[1] is found to be 1. It indicates that the variance of the disturbance term is homoscedastic.

The regression analysis shows that a good number of predictor variables are statistically significant with the expected sign of influence. The R Squared and Adjusted R Squared are found to be 0.58 and 0.565, respectively. Overall, the model is fitted well which is signified by the high value of F (F = 39.847 and significant at 0.00 level). The estimation shows that all the explanatory variables have a statistically significant influence upon the forest firewood dependence except the variable occupation type (OCCUPTYPE).

Table 4: Results of Regression Analysis

Variable	B	SE	t-value	Sig.	VIF
Constant	0.588	0.098	6.026	0.000	
ALT_FUEL	-0.046	0.015	-3.098	0.002	1.414
WEALTH	-0.075	0.015	-5.104	0.000	1.240
FSIZE	0.018	0.008	2.137	0.034	1.082
D_MARKET	0.040	0.013	3.061	0.003	2.471
F_RULE	-0.143	0.028	-5.061	0.000	2.135
OCCUPTYPE	0.033	0.021	1.628	0.105	1.368
EDUCATION	-0.046	0.012	-3.849	0.000	1.311

Dependent Variable: FFDI

Model Summary			Test of Multicollinearity
R Squared	Adjusted R Squared	ANOVA	Mean VIF: 1.279
0.580	0.565	F = 39.847	Test of heteroscedasticity:
		Sig = .000	F = 0.00 P = 1.00

Sample size: 211

Source: Field survey, 2018

If more alternative fuel sources (ALT_FUEL) are available for households, dependence of such households on forest firewood goes down significantly. Forest firewood dependence also declines significantly with an increase in wealth (WEALTH) of the household. Another variable that influences forest firewood dependence is family size (FSIZE). FSIZE influences forest firewood dependence positively and the relationship is found significant at 0.05 level. It indicates that the requirement of firewood (quantity) increases significantly with an increase in the size of the household. The alternative sources of domestic fuels like LPG, kerosene, non-forest firewood, etc. are normally available in the markets or in township. If such markets are located in a far distance, that gives rise to the transportation costs, and the consumers have to bear higher expenditure. People may be reluctant to spend such a higher cost for fuel and thus may rely on own collection of firewood from forests. Therefore, the variable D_MARKET (distance to the nearest market) is expected to influence forest firewood consumption positively. The positive sign of the β coefficient

[1] One way of testing heteroscedasticity is to regress the residual against all explanatory variables. Here, the null hypothesis is that the residuals have homoscedastic variance. We need to observe the F-value in the ANOVA table. If F is significant, i.e., the p-value is less than or equal to 0.05 ($p \leq 0.05$), we can reject the null hypothesis and conclude that the variance is not homoscedastic. In case $p > 0.05$, we conclude that the variance of the disturbance term is homoscedastic.

indicates that the forest firewood dependence increases significantly with the increase in the distance to the nearest market. Forest produce collection rules or norms (F_RULE) set by the local resource users can restrict forest collection and thereby forest dependence to a significant extent. Forest firewood dependence is significantly greater in the case of agricultural and agri-allied households than non-agricultural households (variable OCCUPTYPE), but the relationship is not found statistically significant. Attainment of higher level of education (EDUCATION) also reduces forest firewood dependence significantly.

5. Conclusions

The study reveals significant forest dependence of the tribal households for firewood collection. The forest firewood dependency index is estimated to be 0.5087, which is high enough and signifies that most of the households in fringe villages rely on forest firewood for domestic cooking and heating. Energy substitution is though on the rise, this could not yet reach the majority of the tribal households. People are also reluctant to use modern fuels like LPG, as it involves substantial transportation costs. Besides, firewood consumption is very much connected to traditional activities like local food processing practices, traditional beverage preparation, preservation of meat, etc. Hence, the demand for firewood is almost inevitable in a tribal household. Under such a situation, mere availably of alternatives may not considerably attract people, unless they are aware of the environmental costs of firewood consumption and negative health issues arising from it.

It cannot be recommended to stop the consumption of firewood but the consumption level can certainly be minimized by popularizing scientific *chullha* (oven). Improved wood stoves not only raise energy efficiency but also reduce indoor pollution. Another appropriate measure in this context may be the cultivation of quick-growing firewood trees. These trees can be grown in the common forest through the active involvement of the fringe villagers.

It is also necessary to reduce forest firewood dependence considering the problems of forest depletion and related health impacts.[2] If appropriate measures are not taken soon, the common forest resources will become degraded. Hence, policies should be designed to empower and encourage the local management institutions in this regard. Local-level decentralized management of common forest can be emphasized ensuring active participation of the local stakeholders. Policy initiatives must attempt at improving livelihood assets and education level of the members of the tribal households as well as ensuring subsidized and equitable LPG distribution policy. It is also necessary to create awareness among the people about the environmental cost and health hazards of firewood consumption to motivate people towards modern fuels like LPG.

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[2] Extensive forest dependence may lead to forest degradation on the one hand and may have adverse health impacts on the other. Globally, 3.8 million premature deaths happen due to smoke from fires and stoves (WHO, 2016).

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Appendix

Table A-1: Descriptive Statistics

Variable Name	N	Range	Minimum	Maximum	Mean	Std. Deviation	Variance
ALT_FUEL	211	3.00	0.00	3.00	1.5403	0.69832	0.488
WEALTH	211	2.00	1.00	3.00	1.6398	0.67127	0.451
FSIZE	211	3.00	1.00	4.00	2.4171	0.84318	0.711
D_MARKET	211	7.00	2.00	9.00	4.8578	1.10353	1.218
F_RULE	211	4.00	1.00	5.00	4.1137	1.05846	1.120
OCCUPTYPE	211	1.00	0.00	1.00	0.2891	0.45442	0.206
EDUCATION	211	1.00	0.00	1.00	0.4787	0.50073	0.251
Valid N (listwise)	211						

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ETHNICITY, SOCIAL EXCLUSION AND EXTREMISM IN NORTHEAST INDIA: UNDERSTANDING ELITE CONFLICT AND POLITICAL MOBILISATION

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Abstract: The politics of Northeast India has been highly ethnicised because of the awakening of ethno-cultural consciousness and assertion of ethnic identities and the region has been passing through a serious ethnic conflicts and turmoil ever since the independence of the country. The ethnic groups inhabiting this region have been pressing either for the creation of separate states or for special constitutional safeguards of their respective identities. The ethnic assertion of different groups is the manifestation of their urges and aspirations against exclusion and for their all round development. The emergence as well as growth of ethnic consciousness based on ethnic identities has manifested through ethnic political mobilisation and ethnic movements. These assertions may be understood as a form of elite conflict. In fact, ethnic assertion is not something which is irrational and impulsive but it is a cover through which the elites compete and struggle for power. This paper is an attempt to deal with the following questions. How do the elites of different communities mobilise people of their respective communities? What strategies do they adopt to push through their objectives? What kind of exclusion does motivate the elites of the ethnic communities to organise their respective communities? It is found in the study that the existing exclusion and conflict among the diverse communities of Northeast India may be removed to some extent by mobilisation of the masses of all sections of people far beyond the interest of the dominant Assamese elite and the elites of the ethnic communities.

Keywords: Ethnicity, Social exclusion, Ethnic mobilization, Elite conflict, Extremism, Northeast India

Introduction

The Northeast India comprises of seven Indian states, i.e. Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland and Tripura. It is covered by both the hills consisting nearly 70% areas and the plains consisting of 30% areas. The hill areas of Northeast are sparsely populated and the plains are densely populated. For example, the state of Arunachal Pradesh, which is surrounded by hills only, has a population density of 17 persons per sq. km. whereas the state of Assam, which

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is mainly plains except three hill districts of East Karbi Anglong, West Karbi Anglong and Dima Hasao, has a density of 398 persons according to the 2011 census. It may be noted that out of seven states in the region, four states are predominantly tribal and the remaining three states—i.e., Assam, Manipur and Tripura—too possess substantial tribal population. The tribal population inhabiting this region are of Mongoloid origin. In addition to this, the Northeast India is rich in mineral resources like oil, natural gas, coal and limestone. Besides, there are fertile soils for producing tea, rice, jute; and immense forest resources like timber, rivers, and waterfalls with enormous potentialities to produce hydroelectric power. These issues of geography, culture, economy and other primordial identities have decisively influenced the politics of the region because of the awakening of ethno-cultural consciousness and assertion by different ethnic groups. The ethnic groups follow their own language, dialect, culture, customs, tradition, historical background and so on. As a means of maintaining their distinct identity, the different ethnic groups inhabiting this region have been pressing either for the creation of separate states or for special constitutional safeguards.

The emergence and growth of ethnic consciousness based on ethnic identity has manifested through ethnic political mobilisation and ethnic movements. The ethnic issues have always influenced the political agenda of all the states of Northeast India. All the states have experienced ethnic conflict and its resultant violence and counter-violence. In fact, identity consciousness among different ethnic groups in Northeast India may be traced much before the days of the Indian Statutory Commission 1927, which submitted its report in 1930. Due to specific historical and administrative traditions the self-determination aspiration in the hill tribes, such as the Nagas, the Mizos, the Khasi-Jaintias-Garos, the Karbi-Dimasas etc., has been from the beginning political in nature. On the other hand, tribals of the plains began their assertions mainly with non-political focus such as safeguarding cultural identity, preservation of language, choice of script, instruction through mother tongue, continuation of English as medium of instruction in higher education etc. Finally, all the demands have culminated into political demand—a separate political identity (Datta, 1993: 12). In addition to this, the profound social, economic and cultural changes during the colonial period among the tribals also influenced their aspirations for separate statehood. These 'aspirations for cultural and political autonomy' among the tribals were energized by the government. Many argue that demands were, indeed, raised for creation of new states on the basis of distinct identities, but the divisive politics of the government as well as 'inciting ethnic passions' played a crucial role in the articulation of demands for separate states in Northeast India (Misra, 1989: 1146-1149).

Thus, ethnic issues have decisively influenced the political agenda of all the states of Northeast India. All of them have experienced ethnic conflict and its resultant violence and counter-violence. The tribal loyalties, language, social discrimination on the basis of sharing of political power and economic opportunities have been utilised by ethnic groups for ethnic mobilisation. It is a kind of mobilisation and manipulation of group identity which leads to ethnicity (Phukon, 2003: vii). More importantly ethnicity is harnessed as an ideology as well as device to wrest greater share of power. The growing sense of awareness and modernisation has intensified ethnic assertion. Modernisation increases the level of competition for jobs and other economic resources among the ethnic groups. As a result, ethnic movements occur when ethnic competition increases. Besides, denial of basic human rights, breakdown of political order, discriminatory economic policy, and conflicting theory of modernisation are seemed to be responsible for ethnic conflict. In view of all these, the phenomenon of ethnicity has been an intrinsic component of the socio-political realities of the multi-ethnic states of Northeast India. Thus, ethnicisation of politics and politicisation of ethnic identity has sharpened the ethnic consciousness in the region.

In the post-independence period, the different ethnic groups of Northeast India such as the Nagas, Mizos, Meities, Karbis, Khasis, Garos, Bodos, Tiwas, Rabhas, Misings, Ahoms, Deories, Moran, Matak etc. are aspiring for all round development of their respective groups on the basis of their ethnicity. These ethnic assertions should not be understood as emotive and irrational sentiments only. It may be understood as a form of elite conflict through which the elites compete and struggle for power. Therefore, it is interesting to understand the inherent objective and strategies of leadership of ethnic movements. In this connection, several questions may arise such as what kind of elite back up ethnic movement? What changes take place in the traditional elite structure under the impact of modernisation? What strategies do the elites adopt to push through their objectives? How the various sets of ethnic elite influence the movement for sub-national identities? What kind of exclusion motivates the elites of the ethnic communities to organise their respective communities? This paper is an effort to deal with some of these questions in the context of rampant social exclusion taking place in Northeast India.

The work is based on the information collected from various primary sources such as government documents, relevant official Census Reports, pamphlets, leaflets, memorandums of different organisations, etc. Besides, views based on intermittent statements and opinions expressed by the leaders of the political parties, students organisations, legislators and ethnic organisations have been largely used. In addition, newspapers and periodicals, relevant articles and books have been utilized as the secondary sources of information to uphold the findings of the study. An empirical-cum-analytical method involving both objective and subjective observations has been adopted to uphold the findings of the study. The data and information so collected have been analysed and empirically verified and an endeavour has been made to develop a conceptual framework of the study.

Understanding Social Exclusion

Exclusion is a multidimensional process covering social, economic, cultural and political domains. It is linked to the recognition of social identities, resource allocations and power relations. Social exclusion refers to both individual exclusion and group exclusion from society, other groups or individuals. The socially excluded are deprived of social recognition, self-respect and social values. The basis of exclusion can be race, ethnicity, gender, religion, language, region, caste etc. Each form of exclusion has its nature and manifestation.

Social Exclusion is the process in which individuals are blocked from various rights, opportunities and resources that are normally available to members of a different group, and which are fundamental to social integration and observance of human rights within that particular group. It refers to the process and outcome of keeping a social group outside the power centres and resources. Social exclusion is a powerful form of discriminatory practice. Exclusion has taken the form of segregating a group of people from the social, political, economic, cultural, educational and religious domain of societal life. Further it also culminates into a system of domination and subjugation. All these processes not only lead to oppression and exploitation, but also keep certain social groups away from the mainstream development. Social exclusion describes a state in which individuals are unable to participate fully in economic, social, political and cultural life, as well as the process leading to and sustaining such a state. The outcome of social exclusion is that affected individuals or communities are prevented from participating fully in the economic, social, and political life of the society in which they live (Young, 2000: 35-49). As long as the individuals and social groups who/which are subject to exclusion remain silent, there would be no conflict.

Social exclusion may be of various kinds, such as exclusion from livelihood, exclusion from social services, welfare and security networks, exclusion from political choice, exclusion from popular organization and solidarity, and exclusion from understanding of what is happening (Wolf, 1995: 81-101). It results in the denial of access to opportunities, public goods, public offices and institutions and self respect in public spheres. Social exclusion is the inability of our society to keep all groups and individuals within reach of what we expect as a society or to release their full potentials (Power and Wilson, 2000: 27). There is an inbuilt tendency towards social exclusion in liberal democratic states (Taylor, 1998: 147). It leads to injustice to certain communities as it denies the access to public offices and primary goods (Rawls, 1971.)

Although there is no universally agreed definition or benchmark for social exclusion, lack of participation in society is at the heart of nearly all definitions. Participation may be hindered when people lack access to material resources, including income, employment, land and housing, or to such services as education and health care. Participation is also limited when people cannot exercise their voice or interact with each other, and when their rights and dignity are not accorded equal respect and protection. Thus, social exclusion entails not only material deprivation but also lack of agency or control over important decisions as well as feelings of alienation and inferiority. In almost all countries, to varying degrees, age, sex, disability, race, ethnicity, religion, migration status, socioeconomic status, place of residence, and sexual orientation and gender identity have been grounds for social exclusion over time.

Conceptualizing Ethnicity

Ethnicity refers to the ideas of primordialism based on descent, race, kinship, territory, language, history, etc. with distinctions from another group of people sharing certain common attributes among themselves. It is also defined as "the sense of collective belonging to a named community of common myths or origin and shared memories, associated with a historic homeland" (Smith, 1999: 262). Ethnicity is based on group identity and often invented or constructed. In certain cases, ethnic identity is intrinsically connected with language. Ethnicity is often considered as the outward expression of discrimination—for example, discrimination in access to resources and opportunities (Yinger, 1997: 169). For Paul Brass, the ethnic groups are any group of people dissimilar from other groups in objective cultural criteria containing within its members. This has become the cultural basis of ethnicity which is 'a sense of ethnic identity to create internal cohesion and to differentiate themselves from other groups (Brass, 1991: 19). For T.K. Oommen, ethnic group is one which maintains its life style outside its homeland. Oommen starts with the French word 'ethnie' which means "a people who share a common history, tradition, language and life-styles, but are uprooted from and/or unattached to a homeland" (Oommen, 2009: 10). Caroline F. Ware uses 'ethnic communities' to denote groups bound together by common ties of race, nationality or culture, living together within an alien civilization but remaining culturally distinct.1 In Northeast India, those groups which evoke 'ethnic consciousness' or shared cultural traits are not necessarily uprooted from or unattached to their ancestral homeland. Jackson makes terminological distinction between ethnic category, ethnic group and ethno-nation. Ethnic category signifies persons of the same social and cultural characteristics that identify them as members of a recognizable social category. Characteristics may include race, religion, colour, customs, language, and geographical origin. Thus the emphasis is on primordial characteristics. Ethnic group indicates an ethnic category that has acquired additional characteristics of identity and organisation. Identity means to value one's

[1] Encyclopaedia of Social Sciences, 1938.

membership in an ethnic category. Ethno-nation arises when an ethnic group aspires an interest in public authority which may be constitutional status of special rights, provincial autonomy and not outright sovereignty. The process by which ethnic category may be awakened and transformed into ethnic group or ethno-nation is called by Jackson 'ethnic mobilisation'. Ethnicity, which is an American creation, may, perhaps, be used synonymously with Jackson's ethnic mobilisation. Ethnicity is more appropriately applied to the minority groups of United States and Canada. These groups designed their identity from ancestral culture but unattached their homeland. They are ethnic groups vying for identity employing ethnic mobilisation at various levels (Nunthara, 2000: 51-52).

Social exclusion leads to ethnic identity crisis and in turn identity assertion. Paul Brass identified that ethnic identity formation involves three processes. Firstly, "within the ethnic group itself for control over its material and symbolic resources", secondly, "between ethnic groups as a competition for rights, privileges, and available resources", and thirdly, "between the state and the groups that dominate it, on the one hand, and the populations that inhabit its territory on the other" (Brass, 1991: 247). Social exclusion prevents groups from full participation in social, economic and political life and from asserting their rights. It is viewed that "ethnicity or ethnic identity also involves, in addition to subjective self-consciousness, a claim to status and recognition, either as a superior group or as a group at least equal to other groups" (Brass, 1991: 19).

Ethnicity and Extremism in Northeast India

The Northeastern region of India is often described as the 'miniature India' consisting of different races, cultures, languages and religions, leading to a diversity rarely seen elsewhere in India. With an area of about 2.6 lakh square kilometer, it is a conglomeration of around 475 ethnic groups and subgroups, speaking over 400 languages (Bhaumik, 2009: 1). The region, connected to the mainland India with a narrow corridor, consists of eight states and has international border with neighbouring countries, namely Bangladesh, Myanmar, Nepal, China, and Bhutan. In the international scene, it is a strategic location linked to South and South-East Asia. From internal security point of view, the region has been seen as the 'problem child' since the very inception of the Indian republic because the region has been experiencing law and order problems in the form of inter and intra ethnic conflicts and resultant human rights violations. The region shares an international border of 5,182 km. with the neighbouring countries. What distinguishes these states from the rest of the country is the sensitive geopolitical location with diverse ethnic groups with different historical backgrounds. The Northeast as a whole is not a single entity with a common political identity. Instead, it comprises many other tribes, each with their vision of political future. The Northeast region of India is of immense geopolitical importance to the sub-continent due to its terrain, location and peculiar demographic dynamics. In post-independent period, the history of this region has been marred with bloodshed, tribal feuds and underdevelopment. The oldest insurgency dates back to 1947 with the Nagas raising the issue of their sovereignty. Since then, insurgent movements have sprung up in most parts of the region.

The politics of Northeast India has been marked by ethnicity and extremism for decades. The assertion of various ethnic identities and the policies of the Indian state in containing ethnic extremism make the region distinct from the rest of the country. The root cause of ethnic assertion can be found in the identity crisis of various tribal communities. Most of the ethnic assertions are due to ethnic groups' veiled attempts to protect their identity, culture and language. In fact, ethnicity is a sense of ethnic awareness. Ethnic mobilization is conditioned by the overall political and economic environment. As the state operates under the laws of market economy within the broad politico-economic environment giving birth to uneven economic development, it widens the gaps among

ethnic groups. Therefore, ethnicity is the outward reaction of various socio-cultural groups against the existing politico-economic system wherein either inequality or competition acts as catalyst in mobilizing people on the basis of ethnicity (Phukon, 2003: 15). In other words, the basis of ethnic assertion can be seen in two contexts. Firstly, the tribal communities' subjective consciousness of being excluded, oppressed and marginalized. Secondly, the process of development failed to address the legitimate concerns of the people. Though after independence, the Indian state tried to integrate and assimilate various ethnic communities in the mainstream national identity, the development process generated a feeling of alienation among them. Moreover, development led to the unequal distribution of resources across the communities and regions. Thus, both non-economic (subjective consciousness) and economic (material) factors created a sense of exclusion among some ethnic communities (Bijukumar, 2013: 19-35).

The ethnic mobilization assumes an extremist posture when various ethnic movement arousing emotive issues expand its mass base among the society. The region witnessed the emergence of a number of extremist organizations challenging the sovereignty and integrity of the Indian state. These include United Liberation Front of Assam (ULFA), National Democratic Front of Bodoland (NDFB), National Socialist Council of Nagalim (NSCN), Kuki National Army, Garo Liberation Front, Bru National Liberation Front, National Liberation Front of Tripura, Hmar People's Convention (Democratic), Zomi Revolutionary Army, All Tripura Tigers Force, Liberation Tigers of Arunachal, National Liberation Army of Arunachal, United Liberation Tigers of Arunachal, Revolutionary Army of Arunachal Pradesh, etc. The demands of these extremist groups vary from autonomy to secessionism and sovereignty. Since independence, this region witnessed the emergence of number of movements which mobilized the people on ethnic lines. For instance, the Assam Movement of 1979-84 was against illegal migration and protection of Assamese identity, the Naga movement can be seen in the context of crisis of Naga identity and the Mizo movement was the outcome of the neglect of Central and state governments during the famine. Though India adopted liberal democracy with inherent institutional safeguards for the protection of the interest of various communities and groups, extremist tendencies based on ethnicity is taking roots in recent past. In this context, it is pertinent to ask the question as to why extremist trends are developing in Northeast India in spite of accommodative initiatives of Government of India. The ethnic mobilization often leads to virulent form of extremism and violence in a society (Bijukumar, 2013). Extremism is a tactic adopted by a group or individual to achieve their goals which are not reflected or achieved through normal channels of liberal democracy. In the present world, no society is free from extremist challenges of one or the other forms. Ted Gurr views that violent or extremist acts pose a threat to the political system in two senses: "they challenge the monopoly of force imparted to the state in political theory; and, in functional terms, they are likely to interfere with and, if severe, to destroy normal political processes" (Gurr, 1970: 4; and Bijukumar, 2013). Thus, the difficult terrain, the state of socio-economic development and the factors such as ethnicity, language, tribal rivalry, migration, control over resources and a widespread feeling of exploitation and alienation have resulted in fragile security situation in Northeast India. This has resulted in extremism and diverse demands by various extremist organisations in Northeast India.

India's Constitutional Democracy and Ethnic Communities of Northeast India

In post-independent period, India's constitutional democracy followed a policy of accommodation and assimilation and protected the interests of tribal communities by adopting special provisions. These provisions ensure the protection of cultural identities, customs and economic and political interests of the original inhabitants of these areas. These regions include the tribal areas of

Northeast India. According to Article 244 of the Constitution, the Sixth Schedule lays down special provisions for the protection of the interest and cultural identities of the hill tribes of Northeast India. The most important provision of the Sixth Schedule is creation of the Autonomous District Councils. The hill regions of Northeast India have a history of being governed by different criterion in comparison to the rest of India. The British did not interfere with their traditional system of authority. They were declared "backward areas" according to Government of India Act, 1919. The Government of India Act, 1935 turned them into "excluded" and "partially excluded" areas. The "excluded" areas were not represented in the legislature of Assam, though they were located in the province of Assam. The "partially excluded" areas were privileged to have some legislative experience within the state of Assam. The "excluded" areas were administered by the Governor-in-Council as his reserved jurisdiction. On the "partially excluded" areas there was some authority of the provincial legislature. Jurisdiction of the courts of British India was limited in such areas. In order to retain their distinctness, this region was recognised by providing special provisions regarding their governance in independent India. These provisions were included on the basis of the recommendations of the North-East Frontier (Assam), Tribal and Excluded Area Sub-Committee of the Advisory Committee of the Constituent Assembly of India. The main recommendation of the Sub-Committee, popularly known as Bordoloi Sub-committee, was establishment of the Autonomous District Councils and Regional Councils in the tribal areas within the state of Assam. With the commencement of the Constitution on January 26, 1950, Autonomous District Councils came into existence in the hill districts of Assam except the Naga Hills.

In spite of this special provision, the ethnic communities of Northeast India are confronting with multiple kinds of exclusion. All these institutional mechanisms proved to be futile as in the process of nation-building some communities were left out either because of their low numerical strength or due to low bargaining power with the power structure. Though the postcolonial states initiated a number of policies to ensure 'inclusiveness' for the discontented communities, the efforts did not yield much result. While the state is engaging in nation-building through the construction of national identity, smaller identities move in the opposite direction, when they feel that they are about to lose their identity. In this context, various ethnic groups are seeking larger space in state and are trying to protect their peculiar identity. Even after decades of independence of the country, the same feelings and sentiments continued among the ethnic tribes and races of Northeast India. They increasingly felt that they remained much more backward than other sections of the people of the region. Indeed they had not only been experiencing the problems of land alienation, unemployment, economic and political oppression under the existing socio-economic system but also discrimination in achieving their "rightful" share in society. Therefore, it appeared to them that unless they are organised on a sound footing nobody would care for the development of their respective communities. As a result, since the late sixties in Assam the socio-cultural organisations such as the Bodo Sahitya Sabha, Mising Bane Kebang, Rabha Sahitya Sabha, Tai Historical and Cultural Society, Ban ok Publik Mung Tai, Deuri Sahitya Sabha, Chutia Jati Sanmilan, Koch Rajbonshi Sanmilan, and so on became articulate and began to revitalise the ethnic consciousness among them on the basis of their distinct socio-cultural traits. The students wing of most of the ethnic groups such as the All Bodo Students Union, Kachari Students Union, All Rabha Students Union, Moran Students Union, All Tai Ahom Students Union, Karbi Students Union, Tea Tribes Students Union, Mising Students Union, All Tribal Students Union etc. became very active in mobilising their respective communities in order to generate a sense of identity among them (Phukon, 2003: 65).

Many argue that the Indian postcolonial development process tried to integrate and assimilate ethnic communities towards the mainstream development process while ignoring their cultural and

economic specificities. The centralized planning and the capitalist modernization further lead to the exclusion of various tribal communities from mainstream (Biswas and Suklabaidya, 2008: 124). The indigenous way of development of the ethnic communities was disturbed by the penetration of the capitalist development leading to underdevelopment, displacement of communities from their settlement and livelihood and erosion of community life. Thus, the postcolonial modernization initiated by the newly independent India generated some kind of discontent among the communities leading towards violence (Gurr, 1970: 317; Gohain, 1997: 391). The problem of ethnicity and extremism is further aggregated by the regional consciousness aroused by elites, especially the middle class (Singh, 1998; Baruah, 1991; Sharma, 1990). Again the dominant communities allied with state power exclude certain groups from accessing resources, institutions and opportunities, generating a feeling of exclusion of other groups. In such situation, smaller ethnic communities assert for resources and opportunities. The assertion of marginalized identities and its extremist posture are giving a new direction to state politics. The Northeast region of India was to be reorganized in the sixties and early seventies of the last century creating a number of states such as Nagaland (1963), Meghalaya (1972), Arunachal Pradesh and Mizoram (1987) to meet the demands of these ethnic groups. Even after reorganization of original state of Assam, the demand for creation of more states still continues. It is argued that the creation of separate state further fanned the fire when "various smaller and bigger communities started to demand establishment of more states; on the other hand, the state showed their inability to deliver the basic goods" (Madhab, 1999: 320).

National and Regional Elite and Exclusion of Ethnic Communities

In a federal country like India the ruling class operates at two levels national and regional. The national elite with the help of regional elite reap benefit of development and convert weaker nationalities into "colonial hinterland". At the regional level, the hegemonic dominant ruling class enables it to impose its culture in a manner that the smaller nationalities feel threatened (Hussain, 1997; and Phukon, 2003: 41). As such together with the Indian ruling class the Assamese ruling class have been asserting their autonomy and identity at the regional level. They use the state machinery for their interest and try to establish their socio-cultural hegemony over the entire Assamese society. It has always been reluctant to share power and benefits even with the other oppressed and backward sections of the Assamese nationality. Therefore, the ethnic communities, who once considered themselves as a component of the larger Assamese society and had assimilated with the Assamese community, are now trying to revive their own identity and demand for political autonomy because of their oppressed status and hatred against the caste Hindu dominated Assamese ruling class (Hussain, 1997; Phukon, 2003: 43). This feeling manifests in the movements for distinct identity launched by the ethnic groups under the leadership of their respective emerging educated elites. Hence, these suppressed ethnic communities have initiated some measures to protect and preserve their identity. Though they share common Indian identity, they equally carry their regional or in some cases sub regional or community based identities. Such regional or community based identities were not given due importance by nationalist leadership and regional ruling elite who viewed it as a threat to India's unity and integrity; instead they used a number of coercive measures to subside these identities. The inability of successive Indian national and regional state governments to understand these diversities itself created crisis of Indian nation-state. Therefore, it would be worthwhile to study the problem of social exclusion to understand ethnic mobilization and extremism in the context of Northeast India.

Understanding the concept 'Elite Conflict'

The term 'elite' refers to influential sub-group within the ethnic group and classes. It is the educated elite who constitute an influential group within the middle class and they take the lead in ethnic movements. In certain specific circumstances elite conflict stems from the larger political and economic environments rather than from the cultural taboos of the ethnic groups. At the same time, the cultural forms, values and practices of ethnic groups become political resources for elite in competition for political power and economic advantages. The resources become symbols for the identification of members of the group which create a political identity. To Paul Brass "the elite mobilise ethnic identities, simplifies those beliefs and values, distorts them, and select those which are politically useful rather than central to the belief system of the group concerned" (Brass, 1991: 17). This process invariably involves competition and conflict for political power, economic benefit and social status between competing elites. The cultural and linguistic differences separate ethnically the relatively "disadvantaged aspirant elite group" from their competitors in the dominant group. These differences become the basis for a special claim for job and other advantages. Such claims are, by and large, associated with the efforts to mobilise the disadvantaged ethnic groups and to create a sense of identity among its members. If the disadvantaged ethnic group is a minority concentrated in a geographical area, its elites will demand the 'legitimate' share of political power in the political system. They will also call for decentralisation of political power or in some cases for secession (Brass, 1991: 33; Phukon, 2003: 37).

The assertion of Hmars in Mizoram against the domination of Mizos and the assertion of Garos against Khasis in Meghalaya is a self-evident factor to prove this argument. There is competition and conflict for political power, economic benefit and social status between competing elites. The cultural and linguistic differences separate the relatively disadvantaged aspirant elite group from their competitors in the dominant group. These differences become the basis for a special claim for job and other advantages. Such claims are associated with the efforts to mobilise the disadvantaged ethnic groups and to create a sense of identity among its members. Thus, the process of intensifying the differences between the disadvantaged group and dominant group may begin. As a result of modernisation process, many ethnic groups may assimilate to the language and culture of the ruling ethnic group. The politicisation of ethnicity, however, stresses the importance of inequality in distribution of available resources, social benefits and opportunities between distinct ethnic groups. In effect, a sense of distinct nationality arises in response to exploitation of an indigenous group by another social class. Keeping in view these ideas on elite conflict we are going to examine the questions raised above in the context of Northeast India.

Ethnicity and Elite Conflict in Northeast India

In Northeast India, during pre-British period, trade and commerce did not grow sufficiently to bring the heterogeneous tribes and ethnic communities together by absorbing them in a common market. Besides during the colonial period, the infrastructure necessary for indigenous economic development were not grown adequately. On the contrary, the imperialist rulers exploited the natural resources without reinvestment for the development of the region. Even after several decades of independence, it appears to the people of the region that Indian state treats the entire region primarily as a supplier of raw materials and a market for goods produced in the rest of the country. The path of development that the Indian state adopted for the country is fundamentally capitalist in nature wherein the private capitalists were given decisive role in developing and modernizing the post-colonial economy. Though, India has a large public sector and a nationalized banking system,

both serve only the private sector, particularly the big business in furthering their class interest. This capitalist path of development has generated severe regional disparities in India. Assam, or for that matter, the entire Northeast India has remained a depressed region because of this (Hussain, 1993: 67). Hence, there has been a widespread feeling that Northeast is being treated as a colony of the Indian state and as such it is portrayed as a "Colonial Hinterland" (Misra, 1980).

The tribal communities of Northeast India remained virtually isolated from social and political development taking place elsewhere in the country. There was little scope, particularly, for the hill tribals for participation in the electoral processes. However, the tribals of the plains like the Bodos, Rabhas, Sonowals, Lalungs (Tiwas), Misings and Deoris were somehow integrated with both pan-Indian and pan-Assamese nationalism. More importantly, they were virtually Aryanised long before Assam was colonised (Phukon, 2003: 39). It may, however, be noted that racially a large number of people of Assam belonged to Mongoloid stock such as Ahoms, Chutias, Koches, Morans, and Sonowal Kacharis who virtually integrated with the Assamese nationality. Another very important segment of Assamese nationality has been the upper-caste minority Hindus and other low caste Assamese and Assamese Muslims. However, two large migrant groups—the tea garden labourers and Muslim peasants—were not well integrated with the Assamese nationality in colonial Assam. Nevertheless, during the colonial period and even after, the Assamese have been the most advanced nationality in the Northeast India and among the Assamese, the upper-caste Assamese Hindus are the most articulate and dominant group in an economically backward, multi-racial, multi-religious and multi-lingual society of the Northeast India.

As a result of exposure to Christianity and western education, there emerged articulate tribal elites in the hills. They acted as opinion builders and motivators of socio-political awareness among the hill tribals. At the advent of independence, they even laboured under a suspicion that the rule of 'white people' in the hitherto 'excluded areas' would be replaced by their 'more advanced' neighbours of the plains in free India.2 By and large, the hill elite believed that in a free India the plainsmen would be in an advantageous position to exploit them on a more permanent basis. This feeling of the hills was mainly shared by the newly emerged western educated hill elite and the tribal chiefs. They thought that if the hill areas were completely integrated with the plains, they would lose their traditional privileges and socio-political dominance in the hills. As a measure of meeting the aspiration of the hill people, the Sixth Schedule of the Constitution was introduced to create an Autonomous District Council in addition to other measures for protecting their interest. As such, the Mizos, Khasis, Jayantias, Karbis and Dimasa Kacharis enjoyed autonomy in respect of managing their affairs. But gradually they started realising that the autonomy accorded to them through this statutory provision was not adequate to safeguard their interest under the Assamese elite dominated Assam administration.3 The language policy of the Government of Assam, 1960, making the Assamese as the Official Language of the state further alienated the hill tribal from the Assamese. In fact, they became concerned with their oppressed status in the Assamese elite dominated undivided Assam.4 As a matter of fact, there was a compulsion on the part of the hill elite to agitate not primarily because of threat to their own ethnic identity, language, tradition and culture but because they felt that their individual right in the political sphere was virtually threatened. Indeed, the personal ambition of the hill elite was very much involved in the Hill State movement

[2] Constituent Assembly Debates (CAD), Vol. XI, p. 711.

[3] Memorandum of the United Mizo Freedom Organisation (UMFO), Lushai Hills, submitted to the Secretary, States Reorganization Commission, New Delhi, on 28 May, 1954.

[4] Ibid. footenote 3.

in the sixties which aroused the tribal sentiment in the hills against the Assamese (Phukon, 2003: 40). Subsequently, therefore, the demand for creating new hill states in the Northeast India had to be conceded. As such in the post-colonial period the hill tribal became increasingly conscious of their distinct identity which they utilized for the purpose of fulfilment of their political aspiration. Therefore, the emerging ethnic tribal elite of the hills increasingly felt that in order to fulfil their lingo-cultural aspiration, they must possess separate political unit. In fact, the introduction of Assamese as the state language of Assam had hastened the formation of All Party Hill Leaders' Conference (APHLC) which submitted a Memorandum to the President of India on 21st August 1960 urging the separation of Hill districts from Assam. As such in due course Nagaland and Mizoram formed separate states reducing the size of Assam (Phukon, 2003: 20-21).

After independence of India, the composition of ruling class had changed significantly. The Indian ruling class is composed of national bourgeoisie, landlords and bureaucrats. It operates at two levels national and regional. Despite being a part of the Indian ruling class, the regional or state ruling class tries to assert its autonomy at the regional level in order to derive concessions to ensure its survival and power. The state enables the ruling class to exercise monopoly over political and economic power. The national bourgeoisie with the help of regional bourgeoisie reap benefit of development and convert weaker nationalities into 'colonial hinterland'. For example, together with the Indian ruling class the Assamese ruling class have been asserting their autonomy and identity at the regional level. The Assamese ruling class use the state machinery for their interest and try to establish their socio-cultural hegemony over the entire Assamese society. Further, it has always been reluctant to share power and benefits even with the other oppressed and backward section of the Assamese nationality. As a result, the ethnic communities, who once considered themselves as a component of the larger Assamese society and had assimilated with the Assamese, are now trying to revive their own identity and demand for political autonomy because of their oppressed status and hatred against the caste Hindu dominated Assamese ruling class (Hussain, 1997). The autochthon tribals and other ethnic groups are not prepared to accept the dominance of the Assamese caste Hindu elite. This feeling manifests in the movements for distinct identity launched by the ethnic groups under the leadership of their respective emerging educated elite. The intolerant attitude of the Assamese ruling class and opinion builders of Assam to the movements further deteriorates the situation.

It may be noted that the tribals communities of Northeast India remained much more backward socially, economically and even politically than other sections of the non-tribal society, in spite of being the first natives of the region. In the post-colonial period the ruling class were not much concerned with the problem faced by the hills as well as the plains tribals. They were experiencing the problem of land alienation, poverty, indebtedness, unemployment and political oppression. The hill tribes were given autonomy in managing their own affairs under the provision of Sixth Schedule but similar facilities were not extended to the plain tribals. Although, the plain tribals dominated areas were classified as 'Tribal Blocks' and 'Tribal Belt' to protect the tribals from the encroachment of non-tribals into their areas, the non-tribals were allowed to acquire land and settle in the tribal areas. In view of this, since the late sixties of the last century, the plains tribals became more conscious and articulate about distinct ethnic identity and started utilising their distinctness as a measure of gaining political power and removing their socio-economic backwardness. The issues of language and culture and other primordial factors came to be articulated in the wake of emerging conflict between the elites at various levels because of clash of interest. The conflict of interest generated by a sense of deprivation and negligence motivates the elites of the ethnic communities to bring about emotional integration in their respective communities so that they can fight against

the dominant community. Thus the elite tend to generalise their conflicts and build up movements mobilising their respective communities politically.

It is worthwhile to mention that upper caste dominant Assamese middle class acquired the hegemonic position not only in Assam but also in the entire Northeast India. The nationalism developed in Assam under the leadership of this class and therefore it became the dominant nationality in the region. As a result, the ideas, values and culture of this class came to be imposed on other ethnic communities. This generated considerable resentment among the non-dominant ethnic groups which culminated in the formation of different organisations among them. Initially the dominant Assamese elite did not show much interest in the cultures of the ethnic groups. But when the emerging educated elite of these groups began to assert their distinctness, the Assamese ruling class wanted them to be assimilated with the so called main-stream Assamese culture. Therefore, they started pressing for recognition of Assamese as the official language of the state. To counteract this move the emerging elite of these communities started mobilising their respective communities in a bid to resist the cultural expansionism of the dominant section of the Assamese (Baruah and Sarmah, 1991: 20). All the ethnic organisations both in the hills and the plains vehemently opposed the language Bill of 1960 and pleaded that it would deprive them from their share of government jobs unless they knew the 'Assamese' well. In fact, emerging tribal ethnic middle class in the hills felt terribly insecure of their interest within a greater Assam. They were never happy with the dominant leadership of the plains since the colonial rule. In fact, introduction of Assamese as the state language of Assam had hastened the formation of All Party Hill Leader's Conference (APHLC) which submitted a Memorandum to the President of India on 21st August 1960 urging the separation of hill districts from Assam. As such in due course Nagaland (1963), Meghalaya (1972), Arunachal Pradesh and Mizoram (1987) were formed as separate states reducing the size of pre-colonial Assam. The formation of hill states inspired the plains tribals of Assam to demand either separate or autonomous states. In the plains, the Bodos elite were the first to resist the Assamese hegemony. Their demand for 'separate homeland' may be traced back to 1967 when the Plains Tribal Council of Assam (PTCA) submitted a memorandum to the President of India on 20 May 1967 demanding full autonomy of the plain areas. The demand for PTCA for autonomy turned into an agitational form when in 1972 'Assamese' was recognised as the medium of instruction. Along with the PTCA, the All Bodo Students' Union (ABSU) opposed the 'Assamese' as medium of instruction in Assam and pleaded for retention of 'English'.5 As such a similar situation arose even in the case of other tribal and non-tribal ethnic groups such as the Misings, Karbis, Tiwas, Rabhas, Deoris, Chutias and Ahoms and so on (Phukon and Yasin, 1998: 181).

However, under the present leadership of either dominant elite or of the ethnic elite a drastic change of the basic socio-economic structure of the country is not possible because of their bourgeoisie class character (Phukon, 2003: 46). The insurgent activities of a section of the Nagas, Mizos, Tripura tribals, Meities of Manipur, the movement by the Assamese on the issue of migration, the ethnic assertion of the Karbis, Khasis, Garos and Arunachalists in the hills and the Bodos, Kacharies, Tiwas, Rabhas, Misings, Ahoms, Chutias, Deories, Koch Rajbanshis, Moran, Matak in the plains are the manifestation of the urges and aspirations of these ethnic communities for their all round development. These assertions may be understood as a form of elite conflict. The ethnic assertion is a cover through which the elites compete and struggle for power. They mobilise the people of their respective communities with emotive slogan mainly for the purpose of their

[5] Memorandum of ABSU on Medium of Instruction in Assam and autonomy for the Plains Tribals, submitted to the Prime Minister of India, 30 November, 1972.

own interest. In fact, they project their interest as the interest of the entire community. The hill as well as plains tribals elite became concerned with their oppressed status in the dominant Assamese elite dominated undivided Assam. As a matter of fact, there was a compulsion on the part of the hill as well as plain tribals elite to agitate not primarily because of threat to their own ethnic identity, language, tradition and culture but because they felt that their individual right in the political sphere was virtually threatened, which was their traditional privileges. Indeed, the personal ambition of the hill elite was very much involved in the hill state movement in the sixties which aroused the tribal sentiment in the hills against the Assamese. As such in the post-colonial period the hill as well as the plain tribals became increasingly conscious of their distinct identity which they utilized for the purpose of fulfilment of their political ambition. Nevertheless, the existing exclusion and conflict among the diverse communities of Northeast India may be removed to some extent by mobilisation of the masses of all sections of people far beyond the interest of dominant elite and the elite of the ethnic communities as well as to end exploitation of the Indian State.

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