KERALA ECONOMY
2024, VOL. 5, NO.3. pp 50-67

ISSN : 2583-4436

GIFT GULATI INSTITUTE OF FINANCE AND TAXATION

Explaining the Transition towards Knowledge Economy: Empirics from Kerala

Veena Renjini K K

Associate Professor, University College, Thiruvananthapuram

Abstract

The paper is an effort to analyse the dynamic association that exists among the selected variables in transforming Kerala into a knowledge economy with a robust long-term growth. The concept of knowledge or innovation-led economy is one where knowledge is the key catalyst behind economic upturn and in a knowledge economy context, the necessity is the continual investment in education, health, ICT, innovation and research and a conducive institutional arrangement which utilizes knowledge in economic production accordingly resulting in a state of long-term economic growth. An econometric examination unfolds the truth that the development experience of Kerala is the result of investments in knowledge economy pillars which placed the economy in a much advantageous position with a significant leap in its economic growth. The transmission mechanism and the dynamism involved among these mutually dependent variables placed the economy towards a knowledge hub led economic development.

Keywords: *Knowledge Economy, Unit root, Cointegration, Economic growth*

1. Introduction

As enlightened by the endogenous growth models Romer (1986, 1990); OECD (1996), Powell and Snellman (2004) argued that the determination of the rate of economic growth is based on knowledge. Thus, generation and diffusion of knowledge becomes imperative and

knowledge is revealed out to be a pivotal factor of production in economic activities. OECD (2000) put forward a new approach to compare the generation, propagation and application of knowledge to different sectors inclusive of health and education. The global economic development has prioritized knowledge rather than physical factors of production and it has become the order of the day. The economy based on knowledge will thus serve as the cornerstone for gearing up the growth process of an economy and thus enhancing global competitiveness. This has been demonstrated by the fact that, on an average, technological advancements have resulted in approximately 70% of the current economic expansion in the US and other developed nations (Hogan, 2011). It has become the need of the day to turn the economy to a knowledge or innovation driven one. As India accounts for fifth largest youth population, this productive group are to be trained to imbibe skills so as to drive the economy in knowledge power (National Youth policy, 2021). OECD (2001) has attributed that for a sustainable growth of the knowledge economy, there should always be an increasing demand for innovation and technological change.

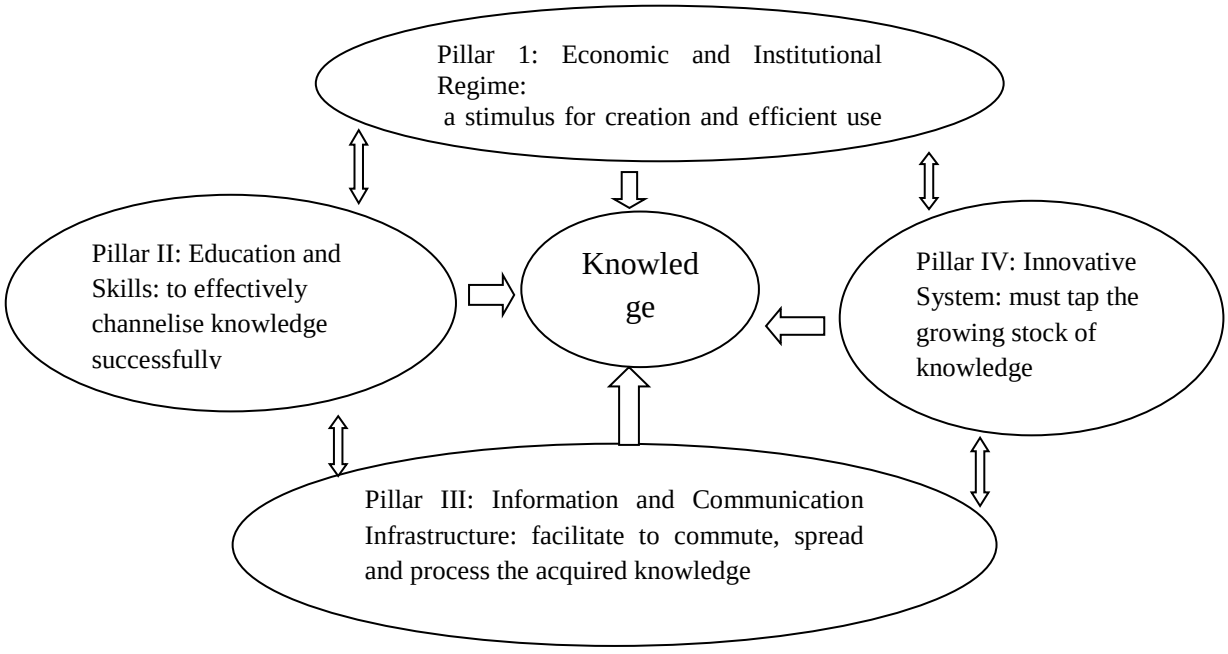
Dahlman et. al (2006) explained how the development of the knowledge economy positively favoured all economies irrespective of their factor endowment and stage of development. Knowledge economy has provided advanced industrialized economies with skilled labour and infrastructure a competitive edge in the manufacturing of high-tech goods and other service industries. Economies with rich natural resource base is credited with better technologies and higher valued products and ICT development provides closer customer links paving the path for sustainable development. The knowledge economy for developing countries, has made it possible to skip various stages of development, leap forward with technologies and jump into the global economy by attracting foreign investors.

The knowledge economy of Kerala has been indebted to social reformers and is rooted on economic stability and cultural integrity. An evolution of democratic, secular, receptive and vibrant population is the hallmark of Kerala's asset. This has generated an inbuilt capacity to absorb any change and to move forward. The policies that the Government of Kerala has followed overtime; the much-applauded universal education and health care system etc set a groundwork for the road map towards economic progress (Elamkulam, P. N. K, 1970). The successive Governments which reigned Kerala is much committed to make it a knowledge hub. This farsightedness has paved the way for monotonically increasing government expenditure to meet the demands of all sectors and that too reflected in health, ICT, education sectors as well. With this base, Kerala was able to achieve reasonably higher standards in

education. Thus, the entire administration procedure has been in tune with revamping radical changes, which are in fact unique. Thus, Kerala has much been accredited as a knowledge economy in the backup of social cum economic and cultural progress. All these factors positively contributed to transform Kerala into knowledgeable society and economy as well.

The Building Blocks of Knowledge Economy: The Framework of World Bank

World Bank (1998) has highlighted the use and conception of knowledge as a prerequisite for the realization of sustained progress of economic growth. Economic production is realized only with the availability of knowledge base which is aided and abetted by economic institutions, innovation infrastructure and innovative technology. This has its reflections on sustained economic growth via an uprising in total factor productivity. The World Bank has come up with what is called Knowledge Assessment Methodology to index the knowledge economy drivers. Broadly speaking, they form the building blocks of the knowledge centric economy. It is understood that all the pillars are important determinants that leads to sustained economic advancement from the dimension of the framework of knowledge powered economy.



Source: Based on World Bank, 2018

The adaptability of knowledge centric economy is evaluated grounded on the four pillars - Institutional regime and financial incentive, information and communications technologies (ICT) backbone; innovation and technological acquisition and education and training.

Primarily, Economic Incentive and Institutional Regime offers enticements for the effective application of both innovative and existing knowledge as well as the growth of entrepreneurship. Secondly, a resident with the essential education and training can harvest, distribute, and employ knowledge successfully. Thirdly, a robust innovation mechanism consisting of universities, research facilities and other think tanks which can attract the escalating body of knowledge so as to absorb and modify as per regional requirements, and produce new technology. Fourthly, easily accessible ICT infrastructure with efficient communication system to disseminate information infrastructure need to be facilitated. The Indian Innovation Index uses "Enablers" as inputs and "performance" as output for evaluation[1] to explain the concept of knowledge economy (India Innovation Index, 2020).

The four pillars that hold on knowledge economy are interconnected because an economy's ability to advance along all four of these frontiers determines its level of success. The dynamic growth of these variables will transform and elevate the economy towards higher standards of economic development led by intellectual input in production. Hence, the objective of the paper is an attempt to explain the span of contributing factors that explains the growth process of Kerala economy in a knowledge economy frame work.

Methodology and Data Source:

The knowledge economy index (KEI), a collective index representing an economy's overall readiness towards the knowledge economy (KE), is created by the World Bank's knowledge assessment methodology. This framework asserts requires sustained investment in these pillars so as to effectively create a conducive climate for economic production. Relying on this, the present study takes variables which are intertwined to explain the knowledge economy base pertaining to Kerala's economic development. The paper integrates the knowledge economy framework, as explained in the World Bank methodology and delve into explaining the knowledge economy of Kerala for the time span 1980-2021.

Therefore, the variables designated for the analysis are the breadth of variables relevant to explain the research objective such as Net Gross State Domestic Product (NSDP), Gross Enrolment Ratio at primary, secondary and tertiary level - higher education and technical education, the literacy rate, Government expenditure on education, ICT related variables,

[1] "Enablers" pillar variables are inputs - human capital, investment, knowledge workers, business environment, safety and legal environment, for the innovation environment. "Performance" pillar variables capture the outcome, that is, knowledge output and knowledge diffusion.

research output proxied by the total patent counts coming up per year and the viability of financial system measured by steady increase in bank deposits and bank branch expansion. The variables measured under different base periods has been approximated under the single base period (1995=100).

Hence, data has been collected from different secondary sources. The data related to the variables like NSDP, Gross Enrolment Ratio at primary, secondary and tertiary level - higher education and technical education and Government expenditure on education is source from Kerala Economic Review, State Planning Board, Government of Kerala. Data pertaining to literacy rate has been drawn from Census of India, Government of India and Kerala State Level Literacy Mission, Government of Kerala. The influence ICT have on the knowledge-centric economy of Kerala has been proxied by using the variable government expenditure on ICT, collected from the Plan outlay and expenditure, Plan Document, Government of Kerala. The data compiled form RBI Reports and Banking Statistics of Kerala Reported by State Level Banker's Committee on bank deposits and branch expansion measures the financial viability of the banking system.

Related Literature

Romer and Lucas's seminal first-generation endogenous growth theories have also brought attention to the reputation of knowledge and human capital in the growth process, which in turn produces externalities and ever-increasing returns (Romer, 1986; Lucas, 1988). Winter (1987) in his pioneering research study on knowledge and management explained the issue of vagueness involved, lacking an appropriate terminology and conceptual construct for analysing knowledge as an input variable in the growth procedure of an economy. The paper goes on arguing that it is really cumbersome to analyse the meaning of knowledge and to measure knowledge output and thereafter to link knowledge, production and its effect on economic development in a single framework. The epicentre of economic movement and its long term growth is based on the creation, dissemination and application of technology along with relevant information (OECD,1999). Drucker (1998) advocates that knowledge has sidelined both capital and labour and now constitute to be important factor of production. The Government should frame effective R and D and innovation strategies that may benefit an economy from the perspective of transfer, attainment and diffusion of new knowledge and technology (ibid). Bhattacharya and Kunal (2007) make a compelling argument in favor of funding information and communication technology (ICT) in order to develop high-caliber

human resource capital for Indian economy's knowledge-led development. The study has been conducted to investigate the potential of online learning and e-learning in enhancing the quality of human resources in higher education for developing countries like India. The paper makes the case that traditional institutions must invest in ICT immediately in order to provide e-instruction and use the information super highway to deliver knowledge.

Arrow (1962) made a significant contribution to the field of "learning by doing" whereby he showed the efficiency of experience-based learning leading to higher output levels by citing the case of a complex system of production unit which produces the frames of aeroplane frames. Subsequently, Rosenberg (1982) proposed "learning by using" to clarify how efficiency of production improves overtime, by highlighting the case of airline companies even though the system of production is complex. APEC (2003) argued that accumulation and production of new knowledge in an innovative economy requires focus and attention on the development of the variables like developing business capabilities locally, modernisation of legal system, launching more research institutions, development of higher education and ICT infrastructure. Hvidt (2016) argued that the existence of a sound innovation system, as well as an institutional and economic framework that supports the upturn of the knowledge economy, are also necessary to complement the incidence of a trained and skilled labor force and a strong technological infrastructure.

Manoj and Sandeep (2017) explained that a favorable socioeconomic environment, which includes a high level of social equity and an abundance of technically qualified and skilled human resources, the State will be in an advantageous position with exceptional potential for executing ICT-led economic development, leading to rapid prosperity without experiencing a digital divide. OECD, 2001 and World Bank, 2004 highlighted the importance of ICTs and education by arguing that those who lack access to it will be marginalised by denying space for engaging in social and economic activities.

Abramovitz & David (1996) argued that the success of the knowledge economy is based on its vibrant components such as the greater dependence on capital, capacity to absorb and integrate innovations at every stage of the production process from R and D lab to the factory floor and then to consumer interface. His argument proposes that the growing proportion of the gross domestic product can be attributed to "intangible" capital. Barro (1991) analysed the effect of school enrolment rates on growth of per capita real GDP and the results explained statistically significant positive effects. The data taken for the analysis was cross-

sectional in nature and included 98 countries from 1960 to 1985. The proxy variable for initial human capital is taken to be the 1960 values of school enrolment rates.

The economy of the modern world is rapidly becoming more information-based, and advancing knowledge is essential to economic advancement. As the current economic scenario with the trend of globalization, all economies vigorously involve in the global economy, making competition the main force behind advancement. It is imperative for knowledge-based economies to have competitive environments (Barkhordari, 2019).

Framing Kerala's Knowledge Economy:

The knowledge economy index, or KEI, is determined by averaging an economy's normalized performance scores on the four knowledge economy pillars: ICT, education and human resources, the innovation system, and institutional and economic incentives. The World Bank has referred to these components as the Knowledge Economy's pillars and collectively, they form the bedrock or cornerstone of the knowledge economy. It is understood that all the pillars are important determinants that leads to sustained economic growth, thus lends support to the knowledge economy framework. Given the knowledge base, it is assumed that Kerala economy is reasonably sound to analyse its economic development from the perspective of the knowledge economy pillars it has acquired overtime. The analytical question of what constitutes the knowledge base is to be seen. It is here that the education sector has a dominant part to play, to strengthen the knowledge base. Though education at all levels is important intercession or practice of knowledge along with the role of government in knowledge production requires much attention. Government policy is justified to bear the burden by either directly controlling or subsidizing knowledge production[2]. This line of thinking has motivated public funding for universities, schools, and generic technologies such as ICT. Moreover, there is need as the creation of knowledge drives innovation and hence requires knowledge protection through patent systems.

Knowledge Economy and Kerala: Empirics from selected variables

An examination of the mainstays of the knowledge economy, the founding stone established by 'enablers' and 'performers' along with the scores and the rank of Kerala as compared with

[2] Classical contributions such as Nelson's 1959 article "The Simple Economics of Basic Economic Research" and Arrow's 1962 paper "Economic Welfare and the Allocation of Resources for Invention" showed that in these kinds of circumstances, government policy has a basis for either directly controlling or subsidize knowledge production.

other states is furnished in table 1 below. It is crystal clear that Kerala account for one among the highest scoring states in human capital with a score of 59.72 and ranked second whereas the topmost position goes to Tamil Nadu and the score being 62.80. Similarly, Kerala is ranked first for business environment with a score of 37.12. An analysis of "enablers" and "performers" reveal that Kerala ranks favourably well as compared to other states and union territories of India.

Table 1: Score and Ranks of "Enablers" and "Performers"

	Parameters	Score	Rank
Enablers	Human Capital	59.72	2
	Investment	9.18	7
	Knowledge Workers	15.34	8
	Business Environment	37.12	1
	Safety and Legal Environment	63.46	5
Performers	Knowledge Output	17.86	7
	Knowledge Diffusion	30.54	7

Source: India Innovation Report, 2021

Furthermore, Kerala is elevated to third position regarding the employability of its youth (India Skills Report, 2022). Kerala is pushed up and ranked 15 considering the criteria of "Ease of Doing Business'' (DPIIT, 2022 cited by The Hindu dated Published - July 04, 2022). The state administration has avowed the year 2022–23 as the "Year of Enterprises." (GoK, 2023) with the inventiveness to open up one lakh innovative enterprises in the State throughout the year 2022–23 and was successful in its venture by achieving the target with the opening up of 1.39 lakh enterprises. Kerala retains its top position in the ladder of national health metric among other states in national health rankings with an overall score of 82.2 (Niti Ayog, 2020).

Economic and Institutional Regime:

It is one amid the pillars of the knowledge economy. This proposes that enticements should be given to economic agents to endorse resource efficiency, which leads to the creation of knowledge unfolding the way for open competition and efficiency. A "knowledge-conducive "economic regime expects an economy with less instances of price distortions and Barro (1991) argued for sustainable government expenditure and budget deficits with low and stable inflation. Government of Kerala has taken every effort such as setting up of the Centre for Price Research Kerala at the Commissionerate of Civil Supplies to keep track of changes in the costs of basic goods in the state so as to have a control over price and to monitor the

costs of necessities.[3] Moreover, the state Government directly intervenes in the public market and entrusted district collectors along with to examine and make sure that there are no arbitrary price increases. Legal Metrology and Food Safety Departments jointly squad for the inspection of public markets as per the directions of District Supply Officers. Shopkeepers who failed to display price lists received notices. Thus, an effective mechanism operates at administrative level successfully managing inflationary pressures.

The financial system should be viable enough to channelise resources to investment opportunities for promising knowledge economy outcomes. Levine et al (2000). While navigating through the viability of the financial system, it is understood that Kerala has 6724 scheduled commercial bank branches, which is 4.34 percent of the total bank branches in India (GoK, 2023). Bank networking system has been very effective in Kerala as is understood from the branch expansion and increase in bank deposit. The statistical significance of the variables with their growth rate has been seen by taking the log of the respective variables and regressing against time by estimating equation (1) and the results are furnished in table 2.

$In(x) = \beta_0 + \beta_1 t + Ut$……. (1)

Table 2: OLS Regression Results

Dependent Variable	Coefficient Constant	Coefficient Time	R^2
log(Bank Deposit)	7.407*** (180.7)	0.144*** (84.95)	0.994
log(Bank Branches)	7.588*** (193.7)	0.0283*** (17.42)	0.88

Source: Author's
*(figures in the parentheses are t ratio's and *** implies significance at 1% level)*

The financial inclusivity analysed with respect to branch expansion and bank deposit by making use of the OLS regression result represented in equation (1) and the corresponding 't' statistics with significant 'p' value at 1 per cent tend to support the hypothesis that on an average the proportional rate of growth of bank deposit turned out to be 14.4 per cent and that of branch expansion is 2.8 per cent a year. This growth over the span of 1980-2021 tailors the pace at which the economy has been progressing with consistent and steady growth in branch

[3] Starting in January 2023, a weekly price analysis report that includes the wholesale and retail prices of thirteen essential commodities is being prepared and published.

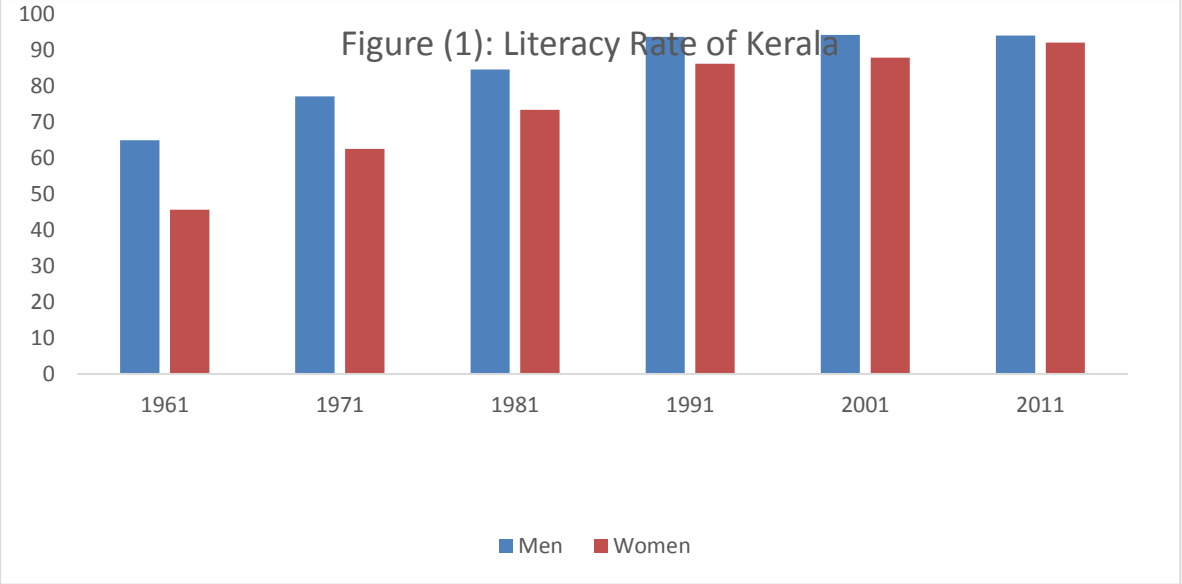
expansion and bank deposit, thus accessing financial services such as banking, credit, investment and insurance, laying the foundation for sustained economic development with economic empowerment.

Educated and Skilled Labour Force:

The knowledge economy is fundamentally made possible by education. Higher education serves as the bridge for interacting with knowledge production. Basic education is a pre-requirement for a person's capacity to learn and use the acquired information. Technical, secondary and postsecondary education in science and engineering fields are essential for technological innovation.

Cohen and Soto (2001) and Barro (1991) explained statistically significant positive effects of education on economic growth using cross-country time-series data on educational attainment or average years of school. Hanushek and Kimko (2000), discussed how economic growth is impacted by the quality of education. They find that educational quality does have a positive impact on economic growth using scores from international tests as a proxy for educational system quality. The importance of education is that it acts as the builder of human capital. As human capital improves, so does the ability of an economy to innovate, create new technologies, and improve processes, leading to increased output and economic growth (Benhabib and Spiegel, 1994).The dream of universal literacy have been achieved first by the state of Kerala. The marvellous achievement in primary and secondary education the strive for excellency in the higher education are the hallmarks of our education system (Gok, 2023).

Knowledge economy is being assessed by the human capital index and it is reflection of investment in education and health care. Literacy is the most important measure of a nation's human capital quality. The following facts add aroma to the achievement that Kerala gained in literacy. Kerala has 94 per cent literacy rate and 92.07 per cent female literacy rate and is the forerunner among other states. The male- female literacy gap has narrowed down from 22 per cent point in 1951 to 4.04 per cent in 2011 (Census of India, 2011). The literacy rate with respect to male and female since 1961 has been charted out in the figure (1) below.



The institutional set up such as Kerala State Literacy Mission Authority (KSLMA) strives to establish lifelong learning, continuing education, and literacy initiatives throughout the State. The primary recipients of these programs are those who are illiterate, neo-literate, dropouts from school, or who are interested in lifelong learning or continuing education[4].

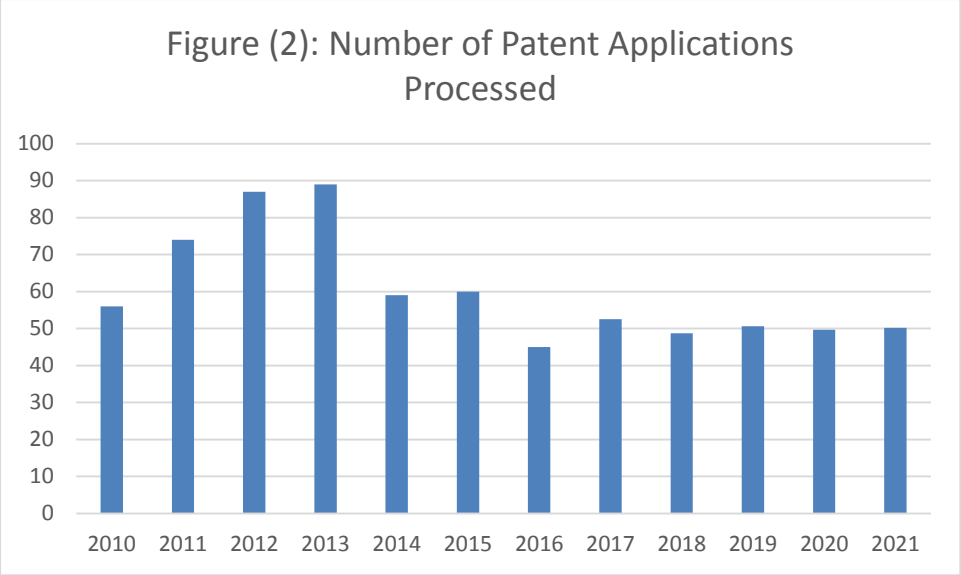
Innovation System and ICT Infrastructure

The efficiency of the innovation system is primafacie knowledge workers in the creation and diffusion of knowledge, can be attributed to universities, research centres, policy think tank. The patent applications, startups, new business registrations, the ease of doing business ranking, online service transactions, internet subscribers, incubator centres[5], common facility centres, and cluster strength.[6] facilitate an environment that nurtures knowledge economy. The number of applications processed since 2010 is shown in the figure (2) below.

[4]The central government kicked off the Padna Likhna Abhiyan (PLA) project with the aim of eradicating illiteracy, which KSLMA has also carried out at the state level (GOK, 2023). The various tribal literacy programs are called Attappadi Tribal Literacy Program, Wayanad Tribal Literacy Program, Navachethana Special Literacy Program for Scheduled Castes, Changathi Special Literacy Program for Migrant Laborers, and Samanwaya Special Project for Transgender Continuing Education adds flavour to the commitment of the state government for a literate state. Moreover, there are equivalency programs at hand for dropouts. With initiatives like the "Kerala Knowledge Economy Mission" and "Vidya Kiranam," which are parts of the Nava Kerala Mission and a continuation of the "PothuVidyabhyasa Samrakshana Yajnam," the government commits to significantly contribute towards the requirements for both secondary and vocational education.

[5] The credit of having incubators goes to Kerala Startup Mission. Thiruvananthapuram, Ernakulam and Malabar occupy start-up facility with 50 startups, 66 startups and 54 startups respectively as on 31.03.2022 (GoK,2023).

[6] KSIDC & KINFRA are nodal agencies the Government of Kerala for spearheading investment promotion initiatives for nurturing and developing medium and large scale units in the state, creating sector-specific industrial infrastructure and ecosystem, and nurturing entrepreneurship and start-ups.



Kerala ranked 15th in Ease of Doing Business, ranks 12th in terms of number of MSMEs and accounts for 5.62 per cent of MSME enterprises in India, force that drives entrepreneurial expansion through their innovative business practices. In the MSME sector, Government of Kerala declared the Financial Year 2022-23 as the "Year of Enterprises" with the motto "My enterprise, Nation's pride" and took the initiatives for setting up of One Lakh Enterprises in 2022-23". Hence a positive correlation with Kerala's economic development and the growth of MSMEs (GoK, 2023)[7].

ICT production and usage that channels for substantial productivity gains led economic growth have been substantiated with empirical evidence Pilat and Lee (2001), Jorgenson and Stiroh (2000) and Oliner and Sichel (2000). World Bank (2003) ascribed ICTs as the backbone of the knowledge economy and refers to usability, efficiency of computer's, telephone, radio and all networks that connect one another inclusive of hardware, software, image, voice and data along with storage, processing and presentation of information.

Kerala is the IT hub accomplished with the help of receptive skilled labour and the innovative initiatives implemented by the State Government. Kerala's commendable range of mobile

[7] The District Industries Centres (DIC) and baking system by advancing credit act as a moderator for the growth and promotion of MSME and conventional industries. It constitutes handicrafts, khadi, food processing industries, coir, wood, bamboo, garment making etc

and telephone infiltration, juxtaposing extensive attendance of broadband and mobile internet access has reached out to a larger mass[8] (GoK, 2013).

Empirical Estimation: Testing for Cointegration

Stationarity Test

Unit root testing is a pre-requisite to determine the order of cointegration. All the eight variables considered are found to be nonstationary in level forms. However, the first difference I(1) of all the variables were identified as stationary. Hence, it is worth moving forward for cointegration test.

The table 3 below presents the results of stationarity test. The test results show that all the variables are stationary at its first difference.

Table 3: Unit Root Test: The KPSS and ADF test results

Variable	Model	Level/Differenced Series	ADF Test statistic(tau)	KPSS	Inference
log(NetState Domestic Product)	Constant Constant& Trend	First Difference	-4.369*** -4.351***	0.196	I(1)
log(Bank Deposit)	Constant Constant& Trend	First Difference	-3.831*** -3.739***	0.195	I(1)
log(Students Enrolled)	Constant Constant& Trend	First Difference	-7.983*** -7.841***	0.413	I(1)
log(Government Expenditure on Education)	Constant Constant& Trend	First Difference	-35.305*** -4.161***	0.359	I(1)
log(Government Expenditure on ICT)	Constant Constant& Trend	First Difference	-6.593*** -6.654***	0.171	I(1)
log(Higher Education)	Constant Constant& Trend	First Difference	-6.345*** -6.299***	0.207	I(1)
log(Engineering Graduates & Post Graduates)	Constant Constant& Trend	First Difference	-7.609*** -7.819***	0.260	I(1)
log(Branch Expansion)	Constant Constant& Trend	First Difference	-6.593*** -6.654***	0.394	I(1)

*Source: Author's *** shows significance at 1 per cent level*

[8] KFON project with high-speed fibre connectivity. Kerala Infrastructure and Technology for Education (KITE) materialised schools throughout the State with the newest ICT devices backed by ultra-fast broadband internet access, the essential digital resource portals, and trained teachers, fashioning an ICT-enabled ecosystem as a whole. Department of Science and Technology by providing research and development support, incentivise science and technology to reach out towards the entire sector of the economy thus positively contributing towards Kerala's knowledge economy.

To proceed with the cointegration analysis, so as to fix the lag length, the variables are subjected to AIC, BIC and HQC information criteria for lag selection. The result of the analysis is furnished in the table 4 below. The asterisks specify the best (that is, minimized) values of the respective information criteria, AIC = Akaike criterion, BIC = Schwarz Bayesian criterion and HQC = Hannan-Quinn criterion. The results show significance at one lag with respect to BIC criteria and two lags with respect to AIC and HQC criteria. Hence, two lags have been selected to carry forward the cointegration analysis.

Table 4: Lag Selection Criteria and Significance

Lags	Loglik	P(LR)	AIC	BIC	HQC
1	428.77127	….	-18.295962	-15.224772*	-17.194046
2	533.52839	0.00000	-20.386071*	-14.584933	-18.304673*

Source: Author's Estimation

The intertwined variables that could explain the knowledge economy of Kerala has been analysed by testing for cointegration using the Johansen's Methodology subject to maximum eigen value and trace statistics test for cointegration, as the variables are empirically relevant and have same order of integration.

Table 5: Johansen Cointegration Test Results

Rank	Eigenvalue	Trace test	L.max test
0	0.87926	281.90 [0.0000]	82.450 [0.0000]
1	0.80913	199.45 [0.0000]	64.590 [0.0001]
2	0.74754	134.86 [0.0000]	53.684 [0.0003]
3	0.59009	81.176 [0.0040]	34.781 [0.0349]
4	0.44187	46.395 [0.0667]	22.743 [0.1895]
5	0.30071	23.652 [0.2226]	13.950 [0.3833]
6	0.17872	9.7022 [0.3100]	7.6785 [0.4211]
7	0.050566	2.0237 [0.1549]	2.0237 [0.1549]

Source: Author's Estimation. Figures in parentheses are p values

.

Table (5) presents the results from the cointegration test, both the tests reject the null hypothesis of zero cointegrating vectors, as the results have four cointegrating equations which is edified by the Trace test statistic and Max-Eigen value test statistic. The cointegration test results explain that since these variables are cointegrated though there may be short-run deviations from equilibrium which impact on changes in other variables so as to regain the momentum of movement towards long term equilibrium. The findings again confirm the assumption that the variables integrated of order one, I(1), having a long run relationship cannot slide away from the equilibrium, as economic forces will automatically

restore equilibrium. Thus, it can be observed that the eight variables explained do have a long run equilibrium relationship and will move in the same direction so as to spur effective economic growth. Thus, it may be inferred that all these variables have a co-movement in the progress of Kerala towards having a knowledge-based economy.

Conclusion

Endogenous growth theory positively correlates the increase in knowledge base with economic growth. A supply chain which is the knowledge driven information revolution paves the way for social as well as cultural change, absolutely contributes to economic growth. After delineating the key drivers that facilitated and spurred the enhancement of the knowledge economy in the Kerala context, the variables that revolve around the production, transmission and application of knowledge have been analysed for the period 1980-2021 in a time series framework. The conclusion of the empirical analysis is that the selected time series variables such as NSDP, Government expenditure for education, Gross Enrolment of students at primary, secondary, higher education, technical education proxied as students enrolled for engineering at graduate and post graduate level, ICT related variable represented by Government expenditure on ICT and financial viability of the economy being represented by bank deposits and bank branch expansion are integrated in first order I(1) and indicates long run cointegrating relationship among all these variables. It may be concluded that knowledge economy has been the driving force behind Kerala's development process by prioritizing its investment in education at all levels such as primary, secondary and tertiary level. The attention provided for science, technology and innovation has provided the pathway for sustained economic progress. The cointegrating results assure that the interconnected and mutually reinforcing nature of relationship among the variables generate a long-lasting impact on the other. Thus, the policies targeted for any of the variables in question has generated a spillover effect on the other, transforming Kerala into a knowledge fuelled development.

References

Abramovitz, M., & David, P. A. (1996). Technological change and the rise of intangible investments: The U.S. economy's growth path in the twentieth century. In *Employment and growth in the knowledge-based economy*.

APEC Secretariat. (2003). *The drivers of new economy in APEC*. APEC Secretariat.

Arrow, K. J. (1962). The economic implications of learning by doing. *Review of Economic Studies, 29*(3), 155-173.

Bhattacharya, I., & Sharma, K. (2007). India in the knowledge economy—An electronic paradigm. *International Journal of Educational Management, 21*(6), 543-568.

Arrow, K. J. (1962). The economic implications of learning by doing. *Review of Economic Studies, 29*(80), 155-173.

Barro, R. J. (1991). Economic growth in a cross-section of countries. *Quarterly Journal of Economics, 106*(2), 407-443.

Barkhordari, S., Fattahi, M., & Azimi, N. A. (2019). The impact of knowledge-based economy on growth performance: Evidence from MENA countries. *Journal of the Knowledge Economy, 10*(4), 1168-1182.

Benhabib, J., & Spiegel, M. M. (1994). The role of human capital in economic development: Evidence from aggregate cross-country and regional US data. *Journal of Monetary Economics, 34*(2), 143-173.

Bhattacharya, I., & Sharma, K. (2007). India in the knowledge economy—An electronic paradigm. *International Journal of Educational Management, 21*(6), 543-568.

Census (2011) Office of the Registrar General & Census Commissioner, Government of India.

Cohen, D., & Soto, M. (2001). Growth and human capital: Good data, good results. *OECD Economics Department Working Papers*, No. 262, OECD Publishing.

GoK (2023). Kerala Economic Review, Kerala State Planning Board, Government of Kerala.

Drucker, P. (1998). From capitalism to knowledge society. In D. Neef (Ed.), *The knowledge economy* (pp. 15-34). Butterworth-Heinemann.

Elamkulam, P. N. K. (1970). *Studies in Kerala history*. National Book Stall.

Hogan, T. (2011). An overview of the knowledge economy, with a focus on Arizona. *A Report from the Productivity and Prosperity Project (P3), An Initiative Supported by the Office of the University Economist/WP Carey School of Business*.

Hvidt, M. (2016). Challenges to implementing 'Knowledge based economies' in the Gulf region. *Videnscenter om det moderne Mellemøsten*.

Hanushek, E. A., & Kimko, D. D. (2000). Schooling, labor force quality, and the growth of nations. *American Economic Review, 90*(5), 1184-1208.

India Innovation Index. (2020). NITI Aayog, Government of India, New Delhi.

India Skills Report. (2023), Confederation of Indian Industries.

Jorgenson, D. W., & Stiroh, K. J. (2000). Raising the speed limit: U.S. economic growth in the information age. *Brookings Papers on Economic Activity, 2000*(1), 125-211.

Lundvall, B.-Å., & Johnson, B. (1994). The learning economy. *Journal of Industry Studies, 1*(2), 23-42.

Lucas, R. E. (1988). On the mechanics of economic development. *Journal of Monetary Economics*, *22*(1), 3-42.

Manoj, P. K., & Sudeep, S. (n.d.). Information and communication technology for economic development: The case of Kerala economy. *ResearchGate*.
https://www.researchgate.net/profile/Sudeep-Subramanian/publication363480305

National Youth Policy (2021) *Ministry of Youth Affairs and Sports*, Government of India.

NITI Aayog. (2020). Healthy states, progressive India: Fourth edition of the State Health Index for 2019–20. *NITI Aayog*. https://www.niti.gov.in

OECD. (1996). *The knowledge-based economy* (No. OECD/GD(96)102). OECD Publishing.

OECD. (2000). *Knowledge management in the learning society*. OECD Publishing.

OECD. (2001). *The wellbeing of nations: The role of human and social capital*. Centre for Education Research and Innovation, OECD Publishing.

Oliner, S. D., & Sichel, D. E. (2000). The resurgence of growth in the late 1990s: Is information technology the story? *Journal of Economic Perspectives, 14*(4), 3-22.

Pilat, D., & Lee, H. (2001). The role of information technology in economic growth: A survey of the evidence. *OECD Economics Department Working Papers*, No. 280. OECD Publishing.

Powell, W. W., & Snellman, K. (2004). The knowledge economy. *Annual Review of Sociology*, *30*, 199-220.

Romer, P. M. (1986). Increasing returns and long-run growth. *Journal of political economy*, *94*(5), 1002-1037.

Romer, P. M. (1990). Endogenous technological change. *Journal of political Economy*, *98*(5, Part 2), S71-S102.

Rosenberg, N. (1982). *Inside the black box: Technology and economics*. Cambridge University Press.

Winter, S. G. (1987). Knowledge and competence as strategic assets. In D. J. Teece (Ed.), *The competitive challenge: Strategies for industrial innovation and renewal* (pp. 159-184). Ballinger Publishing Company.

World Bank (1998), '*Knowledge for Development'*, World Development Report,

World Bank, Washington, DC.

World Bank. (2003). *Information and communications technology: A world bank group strategy*. World Bank.

World Bank. (2018) http://web.worldbank.org/archive/website01503/WEB/0__CO-10.HTM