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Scientific Research and Technologies: India's Universities in Knowledge Economy

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Abstract: *Political economy has moved to the specificity of development whereby complex interaction of institutions that generates and sustain peculiar trajectory of development. As economic development is moved towards technological driven, even industrial sectors, it is imperative to examine whether current system of education is able to drive innovation, economic competitiveness and economic growth. Furthermore, education has become core component of human as well. On the one hand, 'human capital theory' has now recognized education for overall development as it increases in skills. On the other hand, higher educational institution is ideally envisaged to place of research and expending the frontier of knowledge. In this sense, this paper turns to examine higher education with specific reference to the R & D and scientific research as knowledge based economy gains momentum in India. This paper will, broadly, dwell on the Indian university system by locating its emergence in British period briefly and goes in detail with post-independence experiences. In effect, it allows identifying the institutional structure of India's higher education and evolves governance over period of time. Post 1980s, the universities of India further solidify the bureaucratic structure which was, by the way, inherited from colonial time but its limits have been also becoming apparent whether it is on funding, or Ph.D., or stepping out of conventional discipline of science. Closely connected is examination of scientific research production that is almost stagnant. Thus, it poses challenges for present and future economic development. This paper relies on UNESCO reports, government reports and secondary scholarly work*

Keywords: *university, research, science, technology, and development*

1. INTRODUCTION

The institutionalized education of modern society and it's functioning with special emphasis on the university as ideal as well as practices by using different perspectives. As it is well-known that education in modern society having two equally important reciprocal relation, namely State-Nation and Market (in broader sense occupational engagement) and 'university' as institution work as interlocked within myriad of modern occupation in different institution, e.g. bureaucracy. As the enlightenment saw the secularization of Knowledge that bound to alter education as larger change taking place in Europe and the emergence of nation-state took lead role in the formation of universities. Higher education and its institution aim-what may be broadly called as 'trinity of university'-, namely university, was (and is) ideally envisaged to be following;1)arrange prior(or present) all knowledge so as to be hub of knowledge, 2)generate/expend knowledge through research, and 3) train young who would later become crystal of society in Europe; indeed a champion of this view is Wilhelm Von Humboldt- who is considered as father of modern high school and university (Beteille: 2010).

However, the relation of education with twin, state as well as market, has been shifted in last century development (or expansion) of university and stage has been reached to define present society as 'Knowledge society', to use Druker(2001, pp.23-24) expression. Especially, economic growth and human wellbeing in large measure depends upon scientific research and technological advancement as major component in Solow's growth model during 1950s.In extension, Baker and other writing in the line of human capital clearly vindicated that investment in human capital through education increase the productivity and gave the empirical evidences from developed world like USA, UK, or developing countries of Asia. Therefore this theoretical model have applied in several studies to find the return of schooling-the more years of schooling would yield more income as they have to forgo 'opportunities cost'- a kind of cost one has to bear if she happens to enrol in school and show strong like with overall development(Psacharopoulos,2006 Vinod & Kaushik 2007).

Further, the economic growth of USA has been largely driven by expansion of knowledge and technology in twentieth century. To put in term of (Goldin & Katz, 2008) 'greater level of education results in higher labor

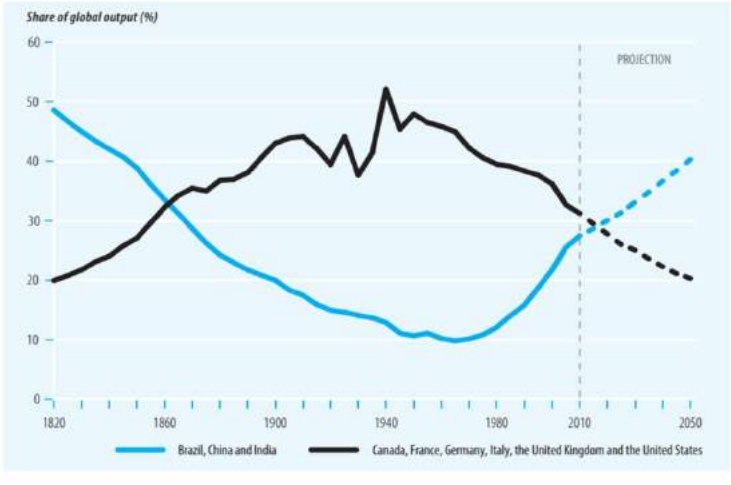
productivity. Moreover, a greater level of education in the entire nation tends to foster a higher rate of aggregate growth. The nation that invested the most in education, and did much of that investment during the century in which education would critically matter, was the nation that had the highest level of per capita income(p.3)'. Take the case, rise of genetic and biotechnology driven firm and business made possible by active engagement of universities like Stanford in post war era (Yi, 2015). What is interesting in the case is devising institutional arrangement in which market and state interdependence on higher education grew substantially and gave impetus to economic growth.

Looking from vantage point of economic development, question is raised that whether higher education of India contributes to the economic growth or not has attracted scholarly attention in recent years.Patel(2016, p.255) argues that higher education institution of India lack the culture of research and in order to rejuvenate it will have to closer examination of other countries experience like Germany seriously. However, it is arguable that whether 'research culture' could be sustained without deployed institution.

In this context, rise of higher education in India is interesting, especially on the question of furthering knowledge by research and technological advancement. It is widely known that modern universities in India- mainly Calcutta, Madras and Bombay- were established during British period in which degree were conferred by regulation of colleges. This way of organising university in India started under British colony but post interdependence development made it to have reach in wider level with active involvement of state in shaping discourse of education (Beteille, 2010, pp.22-24). In other word, rather than drastically revamping the education system India inherited from British Empire after independence, it continued and extended expansion. Post independent India marked by the steady increase in educational institution as well as enrolment.

On the one hand, education and its organizational structure were expended under state funding and regulation. That was identical with economic policy where India adopted planning with import substitution thereby giving strong impetus for state. Twin engagement of state allows tailoring particular institutional structure that could meet demand of industries and state bureaucracy. However,Kudaisya(2015) argues thatplanning mode of development widely criticised by early 1970 and since then it became harder to sustain for longer period to come(pp.712-713). By 90s Indian economy has been able to register rapid economic growth and gone beyond the 'Hindu rate of Growth', although the growth has been achieved largely through service sector. Overall there seems to be structural – definedas the different arrangements of productive activity in the economy and different distributions of productive factors among various sectors of the economy, various occupations, geographic regions, and types of products-changes in world economy including India as data from UNDP (2013) observes. In fact report goes on identifying that there have been structural changes of world economy over period of last forty year and the case of India is not exceptional. Estimation by UNDP(2013)suggests that India along with other developing countries will continue to enjoy higher growth as share of global output increases (Table.1).

Brazil, China and India combined are projected to account for 40% of global output by 2050, up from 10% in 1950



Note: Output is measured in 1990 purchasing power parity dollars.

Source: *UNDP, 2013, P.13*

Undoubtedly, colonization in nineteenth century affected adversely to the economic prosperity in developing countries but post-independent era have had ushered substantial growth that picked up after late 1970s, as graph indicates (HDI, 2013, 13). Under this background, this paper would analyse that what extent emerging trend of service led growth could be possibly square with higher education that is supposed to nurture not only human Capital in terms of skills but scientific and technological advancement as well. In other word, herein lies puzzle: when economic development is moved towards technological driven, even industrial sectors, whether current system of education in India is able to drive innovation, economic competitiveness and economic growth. This will be tackled with detour into institutional arrangement that emerge from colonial India and got momentum in post independent era.

The order of paper is arranged in following way. Firstly, introductory part will, broadly, dwell on the Indian university system by locating its emergence in British period briefly and goes in detail with post-independence development. It allows to critically evaluating whether research and technological advancement were part and parcel of universities institution or not. One of the vital players in higher education had been direct involvement of state under planning era of economic development. Second section deals with expansion of higher education institution that has been accompanied with diverse disciplines (or subjects) accompanied with slow and crucial demise of planning based economy that started by 1980s. Meanwhile, two crucial factors have attributed slow progress of research natural research and engineering: one is institutional structure of higher education that inherited from colonial time, and other is post independent India experiment with establishment of institution that could enhance economic development. The intersection of two set of factors has attributed to the current scenario in which there is, this paper argues, less likelihood of knowledge advancement in natural science by higher educational institution, especially university.

2. ORGANIZATIONAL STRUCTURE OF HIGHER EDUCATION

The 'university' is, ideally, thought to be place of Knowledge in any (or all) form irrespective of any boundary, almost it is agreed upon. In fact, that ideal has been strengthening after emergence of modern university in which the research and teaching learning became equally important activities to reiterate once again.

Particular British model of university was replicated in India whereby the university has to concern with examination and conferring degree and actual classes of teaching learning takes place in affiliated colleges (Ghosh,2009, pp.110-115). That goes to all initial universities of India- namely Calcutta, Bombay, and Madras that would equip student with skills without actively engaging research. However, these initiatives accelerated the demand of education; it had had wider implication on Indian society (Beteille 2010) to which more often met by private players in realm of higher education the Indian Act of university, 1904, paved the way for university to be site of teaching and research(Ghosh,2009, pp. 122-123). In fact, in the convocation address to the Calcutta University in 1922 Sir Ashtosh Mukherjii- who is widely known as person to make university the place of research as well that goes beyond British model(Beteille,2010)- said on the ideal of University;

"*To my mind the University is a great storehouse of learning, a great bureau of standards, a great workshop of knowledge, a great laboratory for the training as well of women/men of thoughts as of men/women of action. The University is thus the instrument <u>of the state</u>* (underline by author) *for the conservation of knowledge, for the discovery of knowledge, for the distribution of knowledge, and above all, for the creation of knowledge-makers*."

Thus, it is not difficult to trace the similarity of idea about the core of modern university, as is pointed out several times, but underlying relation between state and university seems to be not ill-conceived for subsequent development of higher education in general, university in particular. Especially, the expansion of universities since independence have been driven by state, as Gaudino (1965) writes that 'universities in India are invention of law; to put it in other way, it is created under the legislative authorities in which it does lay down purpose and what it would do'(p.3). Indeed, there was feeling among political leaders of that time to see formation of university via state; one might link it with 'public goods' nature of education. This was matched by the state planning with heavy industry and welfare.

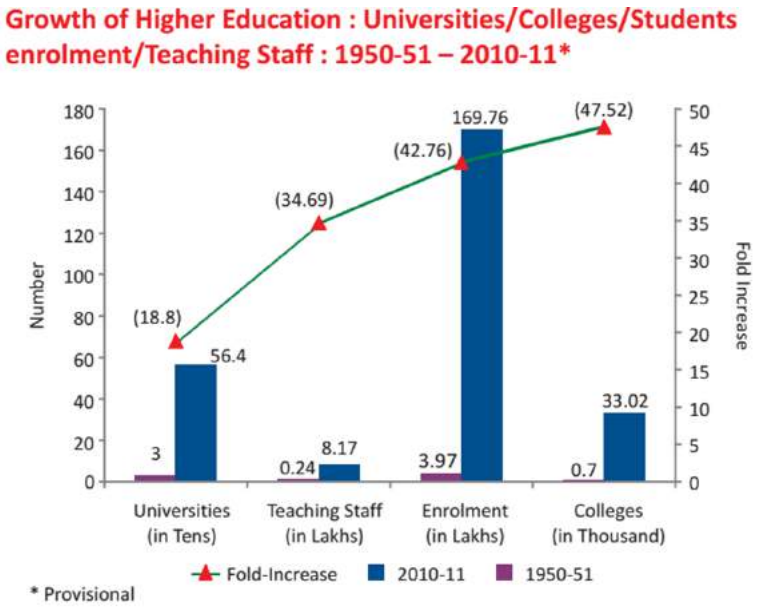
That is exemplified in the establishment of institution like IITs where state actively involves itselfin post independent India. To establishinstitution like IITs in order to accelerate in technology, India received active help of develop countries like USA. On the visit of MIT in 1949, Jawaharlal Lal Nehru- first prime minister of India- said "It

is most important not only that our country advance along known technological lines, but that our technicians should show initiative and add to the existing fund of knowledge" (Bassett, 2016,p.195). This is perfectly consistent with establishment of specialized institution where focus is directed towardsspecific aspect of knowledge.

Therefore, two things must be noted with respect of modern university which are universal in characteristics: 1)university as institution stand for the place of knowledge generation, preservation and diffusion in its unitary way (in single word 'knowledge'),2) it emerges closely linked with the modern nation-state and capitalism. Institutionally, higher education organises around specialise discipline, e.g. IITs, or diverse disciplines as it is case with universities. Thus, we would now turn to the universities and its contribution to knowledge advancement.

3. EXPANSION

Indian universities is expended on the almost frontier off which increase at institutional level is quite substantial as (MHRD, 2016, p.3). In fact, As a matter of fact, the expansion of higher education level is astonishing; there were only 20 Universities at the time of Independence but increased by 29 times and reached to 574 in absolute number in 2011-2012. Similarly, 500 Colleges at the time of independence, but number have as in the case of the Universities and 71times (i.e. 35539) in the case of Colleges (MHRD,2016, p.56). So, many fold increase in college and universities get manifested in diverse disciplines. The governance aspects would be looked from static state centric educational institution in which certain continuity in functioning by affiliation model of university.



Source: *MHRD,2016, p.3*

They follow curricula and examination systems determined by the affiliating universities (p.95). There are 16 Universities, whichhave 500 or more colleges. For instance, Rajasthan University has the maximum number ofcolleges (1117) according to (AISHE, 19). In the sense, the colonial model were replicated with much enthusiasm in which universities are centre for overall governance and monitoring the courses and giving degrees with many colleges and having few universities which have the unitary system in term of teaching-learning. This model of universities has produced immense tension and some scholars like Singh (2) does see the distance between university and college are the real causes of floating norms, low quality of education. But the sheer massifications of universities in India are marked with heavy bureaucracy which might not generate coordination among different college. Rather it dilutes quality of even teaching-learning which resulted in the universities as if factories of degree production. Nevertheless, affiliation model of universities still play

4. DIVERSIFICATION OF DISCIPLINES

The story of disciplines and university is reciprocal and expansion of one is inseparably linked with other. In fact, modern universities, to repeat, stand for the unity of different disciplines under the departmentalization of

universities which started with nineteenth century. And many disciplines were established formally in university by the end of nineteenth century or beginning of twentieth century. Since the generation of now knowledge and mode of enquiry have to have some sort of implication. And, such implication of knowledge growth could be found in proliferation of discipline which largely started in enlightenment period. It has reached a stage where scholar like Betille (2010) does see the difficulty of each and every discipline to be incorporated in universities. However, conceptually there are four way of the forming new disciplines in institution of higher learning across globe to be understood, according to Neumann 2009):

It might be driven by the internal forces.

1) Fission-an increasingly larger and independent specialization within particular discipline leading to the establishment of the new. The case of computing separated from mathematics is of such cases.
2) Fusion-it could be possible through merging of two overlapping specialization in different discipline. The case of biotechnology by consisting of the biology and chemistry is glaring illustration.
3) External forces-the introduction of the professional field such as accounting, nursing, and management in the response of market demand. From the beginning, universities have prepared students for public administration and so.
4) New disciplines could be established to fulfil specific social function. Some recent examples are aeronautical engineering, biotechnology and medical physics. These involve the recognition of existing knowledge and technical specialization to form newly identified areas of study and research. On-technical areas could be of peace and conflict studies or women's studies (pp.490- 491).

To see the distribution of student on the basis of disciplines, it is important to gauge at under-graduate level. In fact highest number 97.3 lakh students enrolled inBachelor of Arts (B.A.) whereas 40.37 lakh studentsgot intoBachelor of Science (B.Sc.) in 2014-2015.

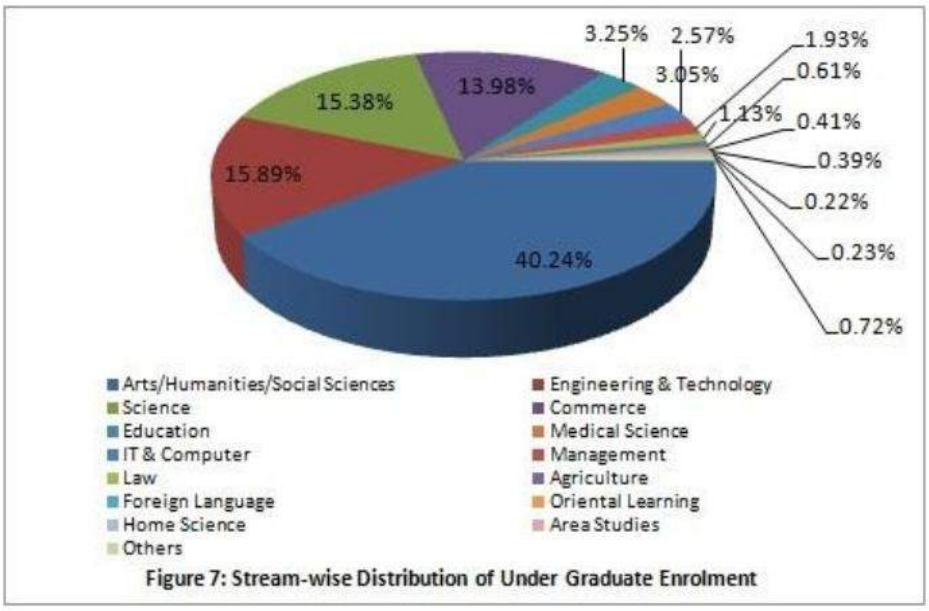


Figure 7: Stream-wise Distribution of Under Graduate Enrolment

Source: *AISHE,2016, p.14*

As chart indicates substantial number of student goes into art and social science, the share of student in natural science and engineering quite lower.

However, the crucial aspect of higher education is to prepare student as researcher which is nurtured through Ph.D. Students opting for Ph.D. after their PG in different disciplines show gap. For instance In Agriculture and Allied courses 21% of the students are opting for Ph.D. after their Post-Graduation followed by Science courses where 6.4% of the students are opting for Ph.D. after their PG. It is followed by Engineering and Technology in which

9.5% of the students are opting for Ph.D. and in Medical science there are 4% of the students. Social Science has 2.2% of students opting for Ph.D. after the PG course in the same field (AISHE, 2016, p. 15).

Overall, most student still enrollment tilted towards social science and humanity. Largest share of Ph.D. students are in state university which happens to affiliation.Interestingly enough,it ishard to gauge the impact of acquired skill on individuals' labor market outcomes as intake enrollment does tell little or nothing about whether person did gain skill or not.

5. RESEARCH & INNOVATION

Earlier it is indicated that substantial part of researchers would have to come from universities and higher education. It is worthwhile to note that overall.In India, total researchers in science and engineering were 154, 827 in 2006 which increased upto 192 819 in 2013 according toUNESCO (2015, p.772) Institute for Statistics. That is much lower than countries like China where it rose from 1, 152, 311 to 1 484 040.

On the frontier of Publications in the major field of science and engineering, India has improved a bit. As matter of fact, UNESCO (2015) Institute for Statistics estimates total paper published in 2008 were 37 228 which went upto 53 733 in 2014(p.784). Similarly, total paper publish in engineering were 4 875 in 2008 that increased upto 7 827 in 2014. What is interesting in the case of engineering is the fact that in spite of substantial increases enrollment of students in engineering, less than 50 percent growth in paper publication. Although it is hard to nudge the point in direction of what is contribution of higher education in general, universities in particular, in publication. Nonetheless, one can argue that given the massive increase in educational institution in India, this is not optimal level of research activity. Partly it has to do with institutional structure- namely affiliation model and its teaching-learning - on which expansion was made possible especially after post independent India.

6. CONCLUSION

The higher education of India is undoubtedly consisting of ambiguous trajectory that is partly driven by expending without diluting for colonial mode of institutional structure. Soon after independence, Nehru's model of plan economy and heavy states apparatus took center stage in which new institution were established, e.g. IITs along with inherited institution from colonial India.In this ways, it should not be surprising to note that plan based development brought rigidities in institution of higher learning.

However, on the ideal level, it is widely known that all universities consist of teaching and research but it has not been easy reconciliation of two seemingly ideal in India. Although higher education For instance, there are numerous disciplines which particular university does not tackle. Similarly, there are numerous universities which do not engage in research, especially in India. Thus the conflict between two ideal- Humboldt's goal of teaching and research and uniformity in knowledge and Napoleon's vision of specialization- is reality of modern university, and somewhere there is a tendency to press one at the cost over other. An institution of modern society, namely University, contains similarity of function across the globe in its ideality, as well as some different features. Two things stands out namely, one, there is firm hierarchy of universities as well as disciplines within nation state and across globe, and 2) there are, broadly, two form of higher education, namely specialized kind of institution and university of all sort of Knowledge. The question is whether it is attributable to the changes made in university education. Notwithstanding this, one must be reminded by the fact that after 1904 Act higher education of India has been driven by culminated policies reform rather completely dismantling existing organizational structure. That does exemplifies in affiliation model of college universities linkage. Most of universities of India are still confined to the teaching even though research is agreed upon integral component of university ideal since planning era gave impetus to have funding and regulation from state.

In subtle ways, expansion of higher education and diversification of disciplines in recent decades have been less about research and innovation eespecially when discipline choices are still tilted toward social science and humanity. Even on research and nurturing of researchers India lag behind other developing countries. Thus, unless significant institutional changes happen, India is less likely to get on the path knowledge production that would substantially add to the development.

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