Journal of Intellectual Property Rights
Vol 17, September 2012, pp 390-399

A Review and Analysis of a Selection of India's Innovation, Entrepreneurship, Knowledge Management and Technology Policy Literature

Robert H Meyer†
Austin, Texas, USA

Received 30 May 2012

A substantial body of professional and academic literature addresses India's policy with regard to innovation, knowledge management, intellectual property rights, entrepreneurship, incubation, and, technology transfer and commercialization. Given the nature of the modern global economy, such matters are crucial to India's economic development. In the quest for economic growth based on knowledge assets, policy makers are wise to consider the degree to which the literature repetitively recommends similar improvements in policy formulation and implementation. The occurrence of repetitive similar policy recommendations in the literature likely indicates less than optimum linkage between policy goals and national resource utilization. Effective policy-making strives to foster the evolution of a dynamic value chain, facilitated by good policy governance, along which new technologies and innovations can move even more effortlessly towards the market. This paper reviews and analyses a selected literature sampling, sheds light on the scope of the body of subject literature, and, identifies reoccurring concerns and recommendations.

Keywords: Innovation, start up, intellectual property rights, entrepreneurship, technology transfer, technology commercialization, technology policy, university-industry links, economic development, R&D, knowledge management, incubation

The principle that technology plays a fundamental role in economic development has been well documented in the Indian literature for at least three decades.[1] The awareness among Indian academics that innovation is crucial to national economic growth has long been recognized.[2] Multiple industries have been assessed [3] with traditional sectors receiving special attention.[4] Gross inefficiencies in financial infrastructure have been well documented.[5] A substantial number of economic research papers have highlighted the importance of technology policy initiatives to harness the benefits of innovation for growth and competitiveness.[6]

The crucial need for a well-devised comprehensive national strategic technology and innovation policy has not been obscure for the Indian government. Experts have been outspoken in directing attention to specific government policy initiatives. Exogenous input, in terms of policy measures and a facilitating and enabling environment, have been deemed essential for developing in India a nurturing culture for technology commercialization.[6] Research conducted by Indian academics into innovation and technology entrepreneurship has looked outward internationally and found evidence that government support and intervention via ambitious policy initiatives are crucial to the aggregated growth of new business ventures.

The science and technology policy framework in India has been ambitiously articulated through the years. While politics was driving policy formulation, a steady stream of publications consisting of assessments, studies, reports and white papers was pouring out from academia, governmental agencies, think tanks and international NGOs in an attempt to guide and influence policy makers. This paper presents a review and analysis of a selection of some of the more significant publications comprising a total output of more than 1000 pages. The repetitive concern expressed in the literature over the same themes, as documented in this paper, indicates misdirected, or less than optimally leveraged, national resources and therefore warrants refocused awareness by policy makers.

Discussion

Empirical evidence supports the proposition that the technology perspective in national planning is vital to the competitiveness of a country in the modern global economy. Research has highlighted the

†Email: Robert_Meyer@utexas.edu

importance of policy initiatives to successfully harness technology and innovation for growth and competitiveness. A country's technological capabilities, including the effectiveness of its related policy frameworks, are among the most important elements in the process of economic and social development. However, bottlenecks and gaps along the value chain of innovation and technology growth cycles constantly frustrate the efforts of the most well intentioned policy makers.[7]

A knowledge asset value chain characteristically is plagued with funding and finance challenges. Traditional commercial financial institutions normally have no capacity for evaluating new technology projects, assessing their intrinsic potential for successful commercialization or performing valuations to project market performance. Most institutional lenders refrain from financing new technology commercialization ventures because of the high relative risk of speculative start up companies that as a rule have no place in the lender's portfolio. On the other hand, in the leading developed countries, institutional lenders have become major actors and play a crucial role in financing and supporting innovation and commercialization of new technologies. Their decision to risk-sharing loans makes possible the entrepreneurial investigation into commercial applications. A national purpose of commitment to industrial development fomented US policy in the last decades of the 20th century that forged cooperation between institutional lenders and technology entrepreneurs. Subsidy programs, income tax concessions and private venture capital companies encouraged start up formation; from 1980 to 2005, firms less than five years old accounted for nearly all net job growth in the United States.[8] The cumulative effect of US technology policy measures was the marshalling of angel investment and the rapid development of venture capital funds as a major source of financing for new technology commercialization ventures. External debt markets are increasingly important to startups as they age.[8]

Circumstances in India have uniquely evolved. A Global Entrepreneurship Monitor study published in 2001 indicates that the most reliable source of funds for entrepreneurial start-ups in India traditionally is the personal resources of the entrepreneur with 68% reporting self-funding while only 55% of start ups report institutional funding and only 21% report government program funding.[9] With the goal of creating a culture that encourages science and technology professionals to create their own employment, the Science and Technology Entrepreneurs Park Program (STEP) had been created in 1984 to promote technology and business incubation. In order to infuse the system with greater financial resources, a high priority was placed on developing closer interactions between academic research and industry. By 2001, 14 science and technology parks were established undertaking science and technology incubation.

In 2002, Jain observes that Indian government support and intervention are essential and must continue since innovations and their financing cannot be sustained on their own due to uncertainties and risks during the initial stages. She argues that policy initiatives have not achieved the desired impact. Financial institutions, as well, share the view that both quality and quantity of available financing facilities and services for new technology commercialization ventures need significant improvement. The Indian banking industry reportedly was still in the process of developing mechanisms to provide capital for new technology commercialization ventures and the pace of activity and the amount of funds being allocated were far from levels that would have a significant impact. Special funds, financing mechanisms, and fiscal incentives which had been successfully utilized in other Asian countries at the beginning of the millennium are deemed appropriate for India.[6]

Beyond financial matters, in 2002, a need for policy initiatives to encourage R&D in industry and to promote close interactions between private and public institutions in science and technology was recognized. A foreign direct investment trend is becoming evident with the establishment of over 300 R&D centres by foreign companies eager to tap the output of Indian scientists and technologists especially in the pharma and biotech sectors. The 1991 National Industrial Policy had invited Indian industry to negotiate and execute international technology transfer collaborations. Ten years later, substantial financial incentivization and funding programs for small and medium enterprises (SMEs) was provided for in the Comprehensive Policy for SMEs 2000.

At the start of the millennium in India, changes in policy formulation, particularly with industrial licensing, reduce emphasis on the public sector so that divestment, privatization and free trade all conspire to put entrepreneurship at the centre of a new innovation

paradigm. The National Science and Technology Entrepreneurship Development Board since 1982 had been serving as the nodal agency for the promotion of high tech enterprise development but the literature shows a new urgency for entrepreneurial leadership to be exercised by key players in different sectors of the economy and in the public sector. Policy initiatives directed at investment, to strengthen research infrastructure, at skills acquisition in technology commercialization, to compete in global markets, and, at the vigorous protection of intellectual property rights (IPR), were all called for.[10]

The government's policy goal to encourage the highest level of innovation and R&D in industry and to promote close productive interactions between the for-profit sector and the relevant public institutions in science and technology were clearly enunciated in the literature by 2003. However, the business environment and support systems were generally viewed as not sufficiently congenial for the desired speed of commercialization of R&D outputs. Unacceptable delay was experienced in the commercialization of R&D outputs and in a majority of cases R&D outputs were not commercialized due to poor initial investment, the lack of a nurturing environment and inadequate dynamic networking.[11] The critique was made that technology business incubators too often were not managed by a professional management team as a business with a clear mission of achieving rapid self-sufficiency for the client companies.[11]

Since technological obsolescence traditionally had been a characteristic of small-scale industries in India, technological up-grading of small-scale enterprises on a continuous basis earned renewed importance. In the rapidly changing modern commercial environment, the role of technical entrepreneurship assumes central importance because technical entrepreneurs possess the ability to generate high wage employment and high levels of wealth. As Indian engineering and science educators began to overcome traditional disciplinary resistance, a multi-disciplinary approach was promoted with heavy emphasis on economic, business and entrepreneurial skills for technical science and engineering curriculum. Programs that steer technical students towards entrepreneurial ventures as a career option increasingly are favoured.[12]

By 2005, the Indian Department of Science and Technology had established 19 technology business incubators. Under the auspices of the National Institute of Technology, a survey was administered to 50 small-scale industry entrepreneurs and 250 students and 40 faculty members of technical institutes. The data collected indicated that dramatic transitions are underway.[12] Survey respondents report that small-scale industry cannot afford R&D investment because of their modest resources and so technical institutes have to fill the gap. From the student's perspective, technical institutions need to impart entrepreneurial awareness and more industrial exposure to comprehend the problems and requirements of industry. A preference is expressed that entrepreneurism in engineering curriculum be mandatory. The survey respondents feel that engineers would have greater career potential and contribute more to the economy if curriculum focused more on entrepreneurial skills, significant communication and persuasion skills, the ability to lead and work effectively in a multidisciplinary team, and, the understanding of the non technical factors that profoundly affect technical decisions.[12] Student employability and potential contribution in the work place would be enhanced if study programs included real life examples from industry for developing entrepreneurial capabilities and innovative approach and problem-solving skills.

Beyond the role that academic institutions play in providing industry with properly trained graduates, the relationships between academia, research institutions and industry warrant introspection. In 2006, Basant and Chandra identified key strategic and policy lessons learned by well-known educational institutions in their efforts to enhance their links with industry for the purpose of enterprise creation. Based on a 2006 survey of 14 educational institutions in Bangalore and Pune, the hindrances to spin-out-company-formation potential as a result of university-industry links were attributed primarily to the lack of seed funding, the inappropriateness of most research generally for commercialization and the absence of institutional regulations to set up firms. Few of the institutions responding have high-end university-industry links for basic and applied research or are able to raise funding for research activities with industry. The absence of angel and venture funding policy initiatives for start-ups is a critical problem.[13] The author laments that the venture capital industry in India is still in its infancy and start-up funding is not easily available. Scientists consider enterprise creation too risky for lack of managerial expertise and

inhibited by institutional infrastructure. Counter intuitively, Indian culture discourages university faculty members from being entrepreneurs and even the faculty reward system generally considers only academic output.[13] In the case where a technology with commercial potential is available for development, the authors report the success of the new venture hinges on appropriate mentoring and managerial inputs and networks that facilitate the flow of knowledge and finance.

In 2007, a major World Bank study addressed nearly the entire universe of relevant issues in India including R&D, IPR, foreign direct investment, technology transfer; grassroots innovation, education, infrastructure and funding and financing issues including both seed and venture capital. The study called for interdependent action over an extremely long-term time frame across the entire population of stakeholders including multiple ministries, the private sector and civil society. In order to broadly spur competition across India's industry sectors, recommendations include the removal of nonessential regulations, greater transparency in the application of essential regulations and the unblocking of a skills bottleneck through the support of in-service training and higher education curriculum initiatives.

The World Bank study cast a harsh spot light on the relatively meager human resources skillful with technology management matters and the sparse financial resources available in India, relative to other nations similarly situated, that are required for the development of innovation. New start ups are being formed at only 1/6th the targeted rate and early stage deals account for only 5% of all new equity finance arrangements.[14] The World Bank in 2007 recommended that facilitating regulations for early-stage venture capital investments be put in place with government providing leveraged returns for private investments in innovation areas. The report acknowledged the need for the creation of a fund of funds offering distinct windows for growth via venture capital funds managed by the private sector.

The World Bank expressed the viewpoint that Indian Government funding has played an important role in early-stage technology development but has not achieved the desired scale and quality of R&D investment and commercialization. The study cautioned that the risk of ignoring the financing needs of entrepreneurs at the conceptualization and proof-of-concept stage represents a serious loss of macro-economic potential. Efforts were encouraged to develop initiatives that stimulate knowledge creation by building on successful programs and expanding and consolidating others. Program resources are fragmented and often operated by government agencies with little private sector expert participation. Early stage funding, especially in the range below $2m, is a bottleneck. Although Indian entrepreneurs possess technical and domain expertise, they lack skills in marketing, sales, business development and financial planning. The report recommends that the supply of early-stage venture capital be increased by extending government incentives for providing domestic liquidity to the industry. Access to adequate, timely finance on competitive terms is identified by the World Bank and Indian government analysts as a problem for micro, small and medium enterprises across the country.[15]

In 2007, the World Intellectual Property Organization (WIPO) undertook a major survey comparing India with 6 other Asian countries: China, Japan, Philippines, the Republic of Korea, Singapore and Thailand. A number of metrics have to do with university-industry relationships, funding schemes and IPR management. System bottlenecks were found to restrict the commercialization of university research. An explicit purpose of the WIPO Report was to crystallize insights for policy-makers to engage in finding the most effective ways to promote the development of mutually reinforcing relationships in university-industry partnerships in the field of scientific and technological research. Ascertaining the most adequate frameworks to promote university-industry partnerships for the transfer of technology is deemed critical.[16] Few examples in 2007 are found to exist of the Indian industries supporting research projects within universities. Most collaborations are in the form of consultancies that typically do not involve large-scale projects. The survey indicated that Indian universities and their faculties generally are not fully aware of the importance of IPR. A lack of resources on the ground to manage IPR is problematic.

WIPO found that the subject of relations between science and industry had gained importance throughout the 1990s to become a top priority issue for policy-makers across the entire Asian survey sample. Experiences from a number of technology clusters demonstrate that innovation systems work best when there is active interaction among multiple stakeholders ranging from commercial enterprises to

government support agencies, to business associations, research centres and universities. Silicon Valley, Boston, Seattle and other thriving clusters have long offered evidence that knowledge spillovers in technology clusters contribute to an increased rate of innovation leading to creation and growth of new businesses.[17] In countries such as India where a substantial percentage of R&D investment is made in the public sector, WIPO argued that it is increasingly important that investment in R&D enhance the technological development of domestic industries that are facing heavy pressure from global competition.[16]

The WIPO Report noted that Indian university scientists traditionally attach far greater importance to publishing academic papers in scientific journals rather than transferring technology to the private sector or applying for patent protection. The research community broadly is just coming to understand that IPR increasingly are considered a mechanism to incentivize stakeholders and to transfer technology. Generally, however, in the Indian academic culture, low awareness of the true importance of the process of IPR protection is problematic. In the case of venture-capital-funded technology where shareholders demand fungible readily transferable ownership rights, IPR protection is crucial to the commercialization process.

WIPO puts heavy emphasis on the attitudes and policies of individual research organizations. Indian academic institutions had practised relatively poor IPR protection procedures however, the performance of the Council of Scientific and Industrial Research (CSIR) had been outstanding. In the 39 CSIR labs, the number of patents filed and issued had at least doubled every year after 2001 due to systematic IPR policy implementation. Since the commercial success of biotech and organic chemistry technologies is highly correlated with the scale and scope of scientific research agendas in university and public labs, countries struggle to narrow the gap with more resourced nations. Computing, IT and manufacturing on the other hand demonstrate low correlation to scientific linkage since engineering skill as opposed to scientific expertise is the key input to produce new patentable discoveries. Consequently, the Asian countries in the sample have more success narrowing the engineering, rather than the scientific, economic gap with the American and the Japanese.[16] The role of Government technology policy is to overcome the handicap.

A 2007 National Knowledge Commission (NKC) Report is the first detailed in-depth quantitative and qualitative survey on the topic of Indian innovation. Aggregated firm-level national statistical data is derived from a survey of 58 large-firm industry leaders and from 79 SMEs across multiple industry sectors. The scope of the report is limited to innovation as defined as value enhancement through a breakthrough or incremental commercial activity via new or improved goods or services or operational and organizational/managerial processes that improve market share, competitiveness and quality while reducing costs. Innovation may be new to the company, new to the industry, new to the Indian market or new to the global market. The report for the most part excludes high-tech scientific inventive activity from its scope. With 8% GDP growth and exports achieving a 30% cumulative annual growth rate, the Indian economy in 2007 was booming. The vast majority of large firms in the NKC survey sample rank innovation among their top three corporate priorities and identify innovation as a critical factor for international growth and competitiveness. More than half the increase in market share, competitiveness, profitability and reduction in costs due to innovation occurring in SMEs is attributable to innovation in new products, new processes and new services. Not surprisingly, the survey data demonstrate that SMEs have much larger revenues from innovation than large firms, firms are more innovative in industries where innovations are patented, firms with more patent filings and greater use of IPR consultants are more innovative, and, firms that partner with government agencies and collaborate with universities and R&D labs are more innovative.[18] The survey respondents express the opinion that the most problematic external barriers to innovation lie with academia. Both large firms and SMEs see a cause and effect relationship between their employees' innovative skill shortage and the lack of emphasis in education curricula with pragmatic problem-solving and application-learning in experimentation. The lack of effective collaboration between large firms and SMEs with research in universities and R&D institutions limits innovation. The most common internal barriers to innovation reported by large firms include inefficient knowledge management systems within the company. For SMEs the leading internal barrier to innovation is a lack of effective in-house training programs; employees lack

skill in developing sustainable models for continuous innovation. The NKC recommends curriculum changes to develop the intellectual capital needed for effective collaboration between industry, academia and government.[18]

The NKC followed up a year later in 2008 with a report focusing on entrepreneurship. The methodology consisted of interviews with 155 entrepreneurs from diverse backgrounds across India and data collected from over 200 stakeholders including educational institutions, incubators, the financial community, chambers of commerce, entrepreneurial associations and others. A significant amount of the report is dedicated to soft metrics including individual motivation, preferences, socio-cultural issues, goals, inspiration and other qualitative factors. Regarding funding events, 63% of interviewed entrepreneurs are self-financed. A perception widely held among entrepreneurs is that it is very difficult to acquire bank loans at the start-up stage but becomes comparatively easier during the growth stage. Banks, financial institutions, VCs, angels and private equity funds are reportedly unimaginative in assessing debt and equity positions. Risk adverse private financiers are extremely cautious in assessing the business opportunities of Indian entrepreneurs. Progress in risk management assessment is called for to reduce information asymmetry. Angel investors, VCs and private equity funds need incentives for greater involvement in knowledge-intensive sectors. To create incentives for seed capital funding the creation of new instruments for start-up funding is recommended along with providing advanced financial literacy to entrepreneurs.[19]

The NKC entrepreneurship report recommended aggressively promoting dynamic synergies between education, innovation and entrepreneurship. PhD and other research scholars need to be encouraged with a very proactive supportive environment for entrepreneurship. Policy options to improve access to financing should be explored. Indian incubators should adopt an entrepreneurial mindset by providing services such as market data, business plan services and skilled employee recruitment.[19] The Report considered it essential to move beyond informal angel investing by promoting more incentive schemes to encourage seed capital funding. It is recommended that a public fund for start-up entrepreneurs be set up using innovative public-private mechanisms.

India's innovation from a corporate perspective was reported by an international research team in 2008.[20] A preliminary field study in Delhi was conducted through 22 explorative interviews with participants including government officials who routinely deal with India's national innovation system, researchers and senior level management of publicly funded research institutions, a representative of a major industry association and executives of privately held firms. Field research was conducted in Delhi, Ahmedabad, Mumbai, Pune and Bangalore where interviews with 85 representatives of stakeholders were conducted. Thus, the study enables an empirical characterization of India's innovation system as perceived by the stakeholders themselves. Due to an abundance of cost competitive skilled labour educated in world class institutions and a market of one billion with rising incomes, India has emerged as a major R&D hub for multinational corporations that concurrently with their R&D activities are strategically creating capacity to produce and sell products domestically in India and for international markets. Often in such scenarios, the domestic venue is shut out and has little leverage to bargain with the more resourced foreign entity for IPR co-ownership or licensing rights. The study analysed innovation-off-shoring to India from the perspectives of national and international firms engaged in such activities in India and from the perspective of the institutional bodies involved including government, industry organizations and academia. Survey respondents bemoan procedural bureaucratic delays when forming a new company. With regard to industrial networks, the public sector generally lacks enthusiasm to overcome bureaucracy for collaborations while private sector entities seem more abundant.

Another significant 2008 study argued that despite ambitious research agendas, university-industry interface remains sub-optimum as reflected in the patenting, licensing and commercialization activity of Indian academic researchers in technical disciplines.[21] Survey results indicated that less than half of faculty members engage in patenting activity. Only a relatively small percentage of university patents have been licensed and commercialized. The standard practice in the Indian academic research community has been to introduce research outputs directly into the public domain. One enduring lesson of the US Bayh-Dole Act is that without exclusive ownership, a party has no protectable stake in a venture and thus no motivation to commercialize. The study noted that the

success of the publicly funded system of higher education has enjoyed in generating adequately scientifically trained manpower but not accompanied by greater competitiveness and technological competence in Indian industry. The study advised caution with any attempt to streamline IPR provisions by assigning to universities and research institutions the management of patent rights of inventions arising out of government funded research grant as with the US Bayh-Dole Act. Such attempts, it is argued, must be examined in the context of a thorough analytical understanding of Indian academic research culture and perceptions. Faculty with overseas PhD credentials and younger faculty with professorial dynamism offer more potential for cooperation in research commercialization than traditionally trained mature Indian faculty. A survey that the study reports on fails to find evidence that extrinsic motivations, particularly financial reward, drive faculty research. Intrinsic motivation, such as the social obligation of public service, dominates the mindset of the Indian academic profession. So it is recommended that the concept of IPR should be articulated to traditional faculty as a vehicle for social service. An academic institution's IPR royalty policy can provide a reward for passive inventors and innovators that are non-participatory in the commercialization process. Faculty appreciate the fact that they benefit from industry interactions but instances of actual interface for the most part have been on the initiative of industry approaching faculty ad hoc individually. Anecdotal evidence suggests that such one-on-one collaborations normally are not on an equal footing since faculty are inexperienced with IPR and tech transfer matters while industry is well experienced and aggressively profit motivated.[21] Thus, a profound cultural gap between industry and academia remains to be bridged.

The six Indian states of Punjab, Gujarat, Delhi, Tamil, Nadu, Karnataka and Maharashtra are evaluated in a KPMG study on entrepreneurism in 2009. Best practices are identified and benchmarked and specific policy initiatives that would enhance the environment for entrepreneurship are recommended. The study found that government regulations, cumbersome procedures and restricted access to capital make starting and running a new business an unduly challenging proposition. The most limiting factor for entrepreneurship from the entrepreneurs' perspective is a deficiency of financial support across the board in the form of debt, equity and venture capital funding, government subsidies and government agency funding programs.[22] Entrepreneurs across all six states complain of bureaucracy and corruption, poor implementation of existing policies and inadequate support mechanisms. To remove limits on high growth entrepreneurship, entrepreneurs surveyed recommend that national and state government agencies should proactively engage in public private partnerships to act as true catalysts for entrepreneurship. From the state's perspective, implementation of programs is both limited and preferentially focused at only larger enterprises. A superior policy would forge broad collaborations of entrepreneurs, educational and research institutions, independent agencies, the media and the government.[22]

Jayaraman observed in a 2009 study rich with supporting data that what has been missing in Indian technology and innovation policy is a vision of technology as an independent autonomous activity with a need for the development of its own knowledge base.[23] The author expresses regret that an enclave scientific and technological research sector has emerged that is primarily an outsourcing appendage to a global system of knowledge production in specific fields. Alas, such a science, technology and innovation system is unlikely to provide an adequate outlet for India's vast creative potential.[23]

Against the backdrop of the global economic decline, India is sustaining a healthy 6.7% growth in 2009. A 2010 academic study meticulously traced the history of US technology commercialization policy from a university centric viewpoint in the context of the 1980 Bayh-Dole Act comparing and contrasting India's circumstances. The author expressed admiration for the Act's success moving taxpayer supported patents out of the federal bureaucracy and into the market place while rejuvenating US economic prowess. A major concern with the Act regarding inter-institutional collaborations between academic and research institutions for the public good prompts a word of caution that any country looking to emulate the Bayh-Dole Act should consider embedding in the policy a push for such collaborations. The Bayh-Dole Act is heralded for successfully harmonizing different technology commercialization national and state policies existing at the time of its promulgation and allowing more patents to move from the federal bureaucracy into the marketplace with significant effect on the cumulative economic impact.[24]

Conclusion

Jugaad is a colloquial Hindi term referring to a creative improvisation or a quick work around and connotes out-of-the-box thinking that maximizes resources. Entrepreneurial spirit is a fundamental element of India's social history. The unshackling of an indigenous spirit of enterprise undoubtedly has contributed to making India a fertile ground for entrepreneurship.[19] In response to the modern economy with technology changing at an ever faster pace and product lifetime cycle shrinking, technical entrepreneurship has clearly assumed a central role in India's economic growth. It is abundantly clear that India over the last several decades has made laudatory progress in terms of the growth of scientific and technological culture, surpassing many other nations in the competitive landscape and successfully sustaining its advantage. However, persistent impediments to further progress in these matters are repetitively addressed in the policy literature. The following representative quotations drawn from the literature of the last few decades articulate recurrent themes of concern:

1 *All financial institutions share the view that both quality and quantity of available financing facilities and services for new technology commercial ventures need significant improvement* (Kumar 2002).

2 *The idea is to provide necessary infrastructure and other facilities to the entrepreneur to reduce his initial investment in his project so that its viability can be demonstrated before graduating from the incubator and setting up the complete unit elsewhere* (Menon 2002).

3 *…Create a multiplier effect of government support by increasing private participation… identify and develop a panel of professionals who provide critical support services for start-ups...facilitate access to venture capital scheme and other innovative financing mechanisms* (Prasad 2003).

4 *The absence of any significant increase in the annual number of patents granted, especially over a period that covers both the pre-reform and the reform era suggests that foreign direct investment has not increased patenting activity by domestic entities* (Jayaraman 2005).

5 *Very few institutions are able to raise funding for research and for activities that they do with industry. Lack of funding hinders the creation of links (*Basant 2006).

6 *A problem researchers or scientists often face is that of their lack of expertise in filing patent applications and negotiating agreements with industry. This raises a fundamental issue for all Asian countries and points to the strategic importance for universities to have a strong and effective office devoted to managing technology transfer staffed with legal and technical experts* (WIPO 2007).

7 *The level of rigor practiced to asses the technology risk and market risk have positive correlation as well as association of highest degree with the success of new technology commercialization venture (Kumar 2007).*

8 *In fact, more than half of the large firms and small and medium enterprises claim that the lack of co-operation with universities and R&D labs is an important barrier (*NKC Innovation 2007).

9 *There is considerable scope for strengthening India's performance in knowledge creation and commercialization, raising R&D, increasing the effectiveness of public R&D, and deepening interactions among R&D labs, universities, and the private sector by, among other things, restructuring or scaling up grant-based initiative* (World Bank 2007).

10 *New efforts in seed and angel funding that are trying to fill the gap still have insufficient capital to meet the needs of early-stage finance (*World Bank 2007).

11 *The supply of early-stage venture capital could be increased by creating incentives for domestic liquidity from wealthy individuals* (World Bank 2007).

12 *Possible government actions include providing matching grants for technology absorption as well as addressing constraints to MSME finance* (World Bank 2007).

13 *India's basically Government funded educational and research institutions are focused on publication…so that they are more academically oriented and less interested in industry cooperation…* (Hamburg U/East-West Center 2008).

14 *Ensuring a ready supply of seed capital and a wider source of capital across geographies is a critical financial issue for entrepreneurs in India. It is essential to move beyond a few informal angel investors and promote more incentive schemes to encourage seed capital funding in India* (NKC Entrepreneurship 2008).

15 *…Suitable public private partnerships could be promoted…loans are then invested as equity in start-ups, where the seed investor also provides crucial mentoring skills and contacts with business networks. Such a scheme allows the government to share some of the high risks involved in start-ups and, at the same time, encourages more seed investors and VCs to enter start-up and early-stage financing* (NKC Entrepreneurship 2008).

16 *Most entrepreneurs cited the lack of appropriate financial help, resources and the inaccessibility of available financing. There is a deficiency of sufficient debt, equity and venture capital funding, government subsidies and funding available through government agencies* (KPMG 2009).

It is evident from a reading of the literature that chronic areas of concern for improvement fall under headings having to do with curing the lack of dynamic finance mechanisms for start ups, growing more dynamic university-industry collaborations, building reliable networks of mentors and trusted service providers, promoting technical entrepreneurship curriculum and internships, and, providing for appropriate intellectual property protection. It is not out of the question that a single project could be smartly tailored to simultaneously embrace all the recurrent challenges that the literature continually draws attention to. Such a project, if facilitated by academic institutional involvement and enabled by streamlining nonessential bureaucratic government regulations in order to bring multiple stakeholders together via a public-private partnership financed by government-backed funding leveraged by private investment, could, conceivably, raise the standard for entrepreneurship capabilities, lower start up company risk through value-add activities, and, properly protect the knowledge assets entrepreneurial ventures are founded upon. Given the availability of the necessary resources, hopefully such a project could be mounted in the not distant future.

Acknowledgement

Special thanks to my friend and colleague Dr Kalyan Kankanala without whom the inspiration for this research would not have been possible and the determination to address the matters herein would not have sustained. Critical editing and insights were offered by Kim Hewitt PhD, Assistant Professor and Academic Coordinator for American History and American Studies, Empire State College NY USA, and, Scott Hancock, Director for IP Management and Licensing, Office of Entrepreneurship & Innovation Partnerships at Binghamton University, Ithaca NY, USA.

References

1 Chaudhuri S and Shyam S, Technological and economical perspectives in corporate strategy decisions, *LokUdyog* 18 (1994) 7-24.

2 Chaudhuri S and Moulik T K, Learning by doing — technology transfer to Indian manufacturing firm, *Economic & Political Weekly* , 21 (8) (1986) 9-16.

3 Akhilesh K B, Srinivasan M N and Krishnaswamy K N, Technology transformation in relation to imported technologies: The case of the Indian manufacturing sector, Department of Management Studies, Indian Institute of Science, Bangalore, 1997.

4 Chaudhuri S, Technology development in Indian textile industry, Working Paper No. 1316.: Indian Institute of Management, Ahmedabad ,1996.

5 Sikka P, Technology support and financing system for development and commercialization — perspectives in India, *Technovation* 17(11/12) (1997) 707-14.

6 Kumara V and Jain P K, Commercializing new technologies in India: A perspective on policy initiatives, Technology in Society, 2002, http://eprint.iitd.ac.in:8080/bitstream/2074/1071/1/kumarcom2002.pdf .

7 Mukherjee Rupali, Innovation comes home to go global, The Times of India, 6 April 2012, http://timesofindia.indiatimes.com/business/india-business/Innovation-comes-home-to-go-global/articleshow/12551082.cms (29 May 2012).

8 Kaufman Foundation, Entrepreneurship and the Economy, http://www.kauffman.org/uploadedFiles/FactSheet/entrep_and_economy_fast_facts.pdf (29 May 2012).

9 GEM Global 2001 Executive Report, USA, Missouri, Global Entrepreneurship Monitor.

10 Menon P K B, Bavadekar Pradeep, Gupta Anita, Shivaram M N, Sri Jayachamarajendra, Raghavendra Prasad V and Jawahar R M P, Promoting business and technology incubation for improved competitiveness of small and medium-sized industries through application of modern and efficient technologies in India, 2002 , http://www.unescap.org/tid/publication/indpub2323_part2iva.pdf, 3 March 2011.

11 Raghavendra Prasad V, India's experience in promoting business and technology incubation. From a paper prepared by V Raghavendra Prasad, Executive Director of PSG College of Technology Science and Technology Entrepreneurial Park, India, 2003, and presented at the National workshop on promoting business and technology incubation for improved competitiveness of small and medium-sized industries through application of modern and efficient technologies at Ulaanbaatar, Mongolia, http://www.unescap.org/tid/publication/indpub2323_part2ivD.pdf.

12 Soni V K, Khare V K and Wani V P , Strategic approach for technology business incubators in the context of sustainable growth of small-scale sector in India, Maulana Azad National Institute of Technology, Bhopal and National Institute of Technology, Kurukshetra, 2005.

13 Basant Rakesh and Chandra Pankaj, University-industry links and enterprise creation in India: Some strategic and

policy issues, 2006, http://ciieindia.org/file_manager/papers/WP-02%20UIL-Enterprise%20creation-WB.pdf.

14 Dutz Mark A, Unleashing India's innovation towards sustainable and inclusive growth, World Bank 2007, http://siteresources.worldbank.org/SOUTHASIAEXT/Resources/223546-1181699473021/3876782-1191373775504/indiainnovationfull.pdf .

15 Among government documents, see the Abid Hussain Committee on Small Enterprises (Ministry of Industry 1997), S L Kapur High Level Credit Committee on SMEs (Reserve Bank of India 1998), and S P Gupta Study Group on Development of Small Enterprises (Planning Commission 2001, World Bank (2002, 2003, 2004).

16 Risaburo Nezu, Technology transfer, intellectual property and effective university-industry partnerships: The experience of China, India, Japan, Philippines, the Republic of Korea, Singapore and Thailand, WIPO 2007, http://www.wipo.int/freepublications/en/intproperty/928/wipo_pub_928.pdf .

17 Milken ranking of top high tech metro clusters in North America, CC-Conrad Clyburn-MedForeSight, 18 June 2009 , http://medtechiq.ning.com/profiles/blogs/milken-ranking-of-top-high (29 May 2012).

18 Kolaskar Ashok, Anand Shriya, Goswami Amlanjyoti, Innovation in India, India National Knowledge Commission, 2007, http://www.knowledgecommission.gov.in/downloads/documents/NKC_Innovation.pdf.

19 Goswami Amlanjyoti, Dalmia Namita, Pradhan Megha, Kolaskar Ashok, Bahri Sunil, Entrepreneurship in India, India National Knowledge Commission, 2008, http://www.knowledgecommission.gov.in/downloads/documents/NKC_Entrepreneurship.pdf .

20 Herstatt Cornelius, Tiwari Rajnish, Ernst Dieter and Buse Stephan, India's national innovation system: Key elements and corporate perspectives, Hamburg University of Technology/East-West Center, Technology Innovation Mgt, 2008, http://www.global-innovation.net/publications/PDF/Working_Paper_51.pdf.

21 Ray Amit Shovon and Saha Sabyasachi, Drivers of academic research in India and the role of IPR: Some econometric evidence, JNU/CRIER, PPT slide presentation, 2008, http://www.spicyip.com/docs/ppt-amit%20ray.pdf .

22 Utamsingh Vikram, Thakkar Jehil, Iyengar Sridhar, Entrepreneurial India, Sculpting the landscape, KPMG 2009, http://www.in.kpmg.com/TL_Files/Pictures/KPMG_TiE_Report.pdf .

23 Jayaraman T, Science, technology and innovation policy in India under economic reform: A Survey, 2009, http://www.networkideas.org/ideasact/jan09/PDF/Jayaraman.pdf.

24 Singh Roop and Tare Sonali, India's emerging technology commercialization policy: Lessons from the American Model, *Journal of Emerging Knowledge on Emerging Markets*, 2 Nov 2010, http://digitalcommons.kennesaw.edu/cgi/viewcontent.cgi?article=1025&context=jekem .