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ABSTRACT

There has been a marked improvement in India's overall economic performance since 1991. One of the outcomes of this improved performance is the growth of innovations in the country. This was accompanied by or caused by the emergence of a number of knowledge-intensive enterprises. The paper takes a critical look at the available quantitative evidence on the growth of knowledge-intensive entrepreneurship. It then looks at five facilitating factors for the emergence of this phenomenon in terms of the existence of increased market opportunities, availability of financial support schemes in the form of venture capital funds, existence and enlargement of a number of government programmes, a number of private sector initiatives and education and training leading to the supply of technically trained personnel. The paper concludes with certain policy suggestions for the continued sustenance of this activity.

Key words: India, knowledge-intensive entrepreneurship, knowledge process outsourcing venture capital, angel financing, business incubators.

JEL Codes: L26, O16, O30, P12

The recent growth performance of India's economy has attracted a fair amount of attention from various constituencies. The country, which has been variously described as a great underachiever of sorts is now being regarded as a knowledge powerhouse well on the way to become an important player in the international technological arena. There is now considerable interest among researchers and policy makers to understand the real factors behind this spectacular economic achievement of the country. Although there is now a fair amount of consensus[1] on the fact that this growth performance can be largely traced to the process of economic liberalisation set into motion since 1991, it is also equally agreed that India's private corporate sector has responded to the signals provided by the state in a very admirable way.

For instance, both the savings and investments of the private corporate sector have really shown significant increases in the period since 2003-04. The sector has become very dynamic and is in the forefront of enabling the globalisation of India's economy. There are two indicators of globalisation: (i) there has been a significant improvement in the average export intensity of an Indian private sector firm: it increased from about 8 per cent in 1991 to about 25 per cent in

1 The fact that the break in the trend growth rate of India's GDP has occurred in 1991 has sparked off a lively debate with some analysts holding the view that this occurred earlier in the 1980s. However after examining the various issues, technical and otherwise, the consensus is for the break to have occurred in 1991 itself. For a succinct summary of this debate see Basu (2008).

2007; and (ii) Indian firms have made a number of acquisitions abroad and as result the ratio of FDI from India to India now stands at around 0.61 and (iii) a number of knowledge intensive firms have emerged and these firms have become important forces to be reckoned with in their respective field of operations. These firms range from auto components to biotechnology to IT software to wind turbines. See Table 1. Behind the success of each of these "blue chip" companies is the hard work put in by an entrepreneur or a group of entrepreneurs. These "entrepreneurial" firms are different from the conventional enterprises on a number of parameters. But on three traits the 'entrepreneurial firms' stand out from 'conventional firms. They are: (i) corporate governance: the entrepreneurial firms although established by a specific, very often, technically trained entrepreneur, is a listed public limited company with a wide shareholding. Having been listed in both Indian and foreign stock exchanges is subject to more transparent disclosure practices regarding their operations and performance[2]; (ii) technology-intensive industries: almost all the entrepreneurial firms operate in technology-intensive industries and mostly in service industries where the entry barriers are low; and (iii): extent of globalisation: most of the entrepreneurial firms are highly integrated with the global economy. Exports of these enterprises typically range between 30 to 95 per cent of its total sales.

The Indian private corporate sector which did not have a good record during the license-permit Raj phase is now emerging as strong innovation based powerhouse. While there are many factors contributing to this, the key to this success can be traced to successful knowledge-intensive entrepreneurship. This entrepreneurship to a certain extent has been nurtured by the emergence of a number of institutional mechanisms, the most important of which is venture capital. Although

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2. The recent (cJanuary 2009) self admission of fraud by the founder and former CEO of the fourth largest IT company in India have dented one's faith in this belief of better corporate governance.

the absolute level of venture capital investments in India is low, it has been growing at a rate of 90 per cent over the last few years and at this rate of growth, the industry is set to match Europe by 2009 or 2010. Notwithstanding these phenomenal increases in venture capital funding, most Indian companies still finance their growth and expansion through internal resources. A second contributing factor is the availability of technically trained personnel including those trained abroad and willing to return to their homeland to start technical ventures. Apart from the few famous cases of firms, whole industries such as Information Technology, Biotechnology and Aerospace industries have been jump started by the emergence of this knowledge- intensive entrepreneurship.

Contrary to the Indian story of phenomenal growth of knowledge-intensive entrepreneurship, the Chinese experience[3] on this count is somewhat different. Since the mid-1990s, many excited reports have tried to argue that China was undergoing an entrepreneurial explosion and that the state sector was inexorably withering away. This privatisation story exists in defiance of experience: in virtually all industrial sectors state firms play a significant or dominant role. The actual fact is that Chinese policymakers have succeeded in the task they set themselves in 1995 to *zhuada fangxiao* (keep the big, lose the small). The state sector has shed millions of firms and tens of millions of employees, and exited numerous unprofitable business lines. But the remaining public sector enterprises are very large, very profitable, and dominate virtually all major industrial and service sectors except for consumer electronics and certain light industries such as garments and shoes. This fact is sometimes obfuscated by official data, which classify state firms variously as “state enterprises” (meaning unreformed, often non-corporatised traditional state enterprises), shareholding companies, limited liability companies (LLCs) and collectives. All these classes need be put together to get a true picture of the state’s role in the economy.

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3 This is based on Kroeber and Yao (2008)

In the context, the purpose of this paper is to understand the growth of knowledge-intensive entrepreneurship in India. Further it identifies the main facilitating factors or the constraints to this process so that public policy can be applied to correct for this as the case may be.

The study is structured into five sections. The first section summarises the interest in the study of entrepreneurship in India and elsewhere. The survey is, admittedly, very selective. The second section maps out the background to this study the most important of which is a significant increase in the share of knowledge-intensive production in India's GDP and the rise of innovations in the country. The third section explores the growth of knowledge-based entrepreneurship in the country by employing a variety of macro and micro-level indicators. The macro indicators are supplemented with some micro data based on the characteristics of nearly 600 startups who have applied for being the most innovative start ups in the country. The fourth section analyses five major facilitating factors to this process. Further the fifth section distils out the policy conclusions emanating from the study.

I. Growing interest in the study of knowledge-intensive entrepreneurship

Entrepreneurship in general is receiving greater attention from policymakers and experts in developed and developing countries. New dynamic enterprises contribute to economic development in several ways: as an important channel to convert innovative ideas into economic opportunities, as the basis for competitiveness through the revitalization of social and productive networks, as a source of new employment, and as a way to increase productivity. The link between entrepreneurs and economic growth theoretically speaking looks reasonably straight forward: entrepreneurs create new businesses, and new businesses in turn create jobs, intensify competition, and may even increase productivity through technological change. High measured levels of entrepreneurship will thus translate directly into high levels of economic growth. However, the reality is more complicated. It is important to distinguish between "necessity entrepreneurship" and "opportunity entrepreneurship." In necessity entrepreneurship, one has to become an entrepreneur because there is no better option for the person involved, whereas opportunity entrepreneurship is an active choice to start a new enterprise based on the perception that an unexploited or underexploited business opportunity exists. Necessity entrepreneurship has little or no effect on economic growth while opportunity entrepreneurship has a positive and significant effect. Opportunity entrepreneurship will necessarily involve innovation.

There has been recent renewed interest in the study of entrepreneurship in India and indeed in China. A number of new books have been published documenting the emergence and history of recent entrepreneurship in the country (Bansal, 2008, Damodaran, 2008, Khanna, 2008, and Karki, 2008). While these are studies of Indian entrepreneurship in general, the whole issue of knowledge-intensive entrepreneurship is clearly unexplored. In fact the number of studies on this aspect elsewhere too is limited, but with the growth of new technology-based industries there is a renewed interest in the issue. For instance the most important journal in the economics and policy studies of technological change, *Research Policy*, had a special issue devoted to this aspect[4]. The nine articles in the issue examined "the effect of environmental conditions on technology entrepreneurship, the processes by which entrepreneurs assemble organisational resources and technical systems, and the strategies used by entrepreneurial firms to pursue opportunities. The papers drew upon a wide variety of empirical evidence, from large sample analyses of archival data to detailed qualitative investigations". But all the evidences and discussions were with reference to the developed economies.

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4. Volume 32, Issue 2, Pages 181-350 (February 2003).

In the Indian context, Taube (2009), is one of the few studies that have examined the emergence of entrepreneurship in the context of the rapidly growing Information Technology (IT) industry. But the purpose of the study is more on the analysis of geographical, concentrations of IT industry and the co-evolution of supportive institutions. The main hypotheses are, that are explored in the study, that education, venture capital and socio cultural factors such as ethnic and gender diversity influence the pattern of knowledge-intensive industries like software.

The emergence of the knowledge-intensive industries such as IT and Biotechnology (BT) has opened up a world of new opportunities for new companies which hitherto did not exist. Further it appears that the cost of entry to these new economy industries is considerably lower and than the old economy industries especially from the point of view new and young entrepreneurs. It will thus be instructive to see if the knowledge-intensive entrepreneurship is on the increase in India since the liberalisation process. In order to place the discussions of it in the largest context of improved growth performance of India's economy since 1991 and especially since 2000, we start by mapping out the background to our study.

II. The Background

We consider the following noticeable changes, both tangible and not so tangible which in our view provide a meaningful back ground for understanding the growth of this phenomena.These are:

(i) Overall growth performance and contribution of various industrial sectors to this growth process: There is now considerable national and international interest in the growth performance of India's macroeconomy[5]. Although the economy's growth (along with that of China's) is one of the highest in the world, much of this growth has actually emanated from the services sector (Table 1). However both the

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5 For a concise summary of this growth performance see Basu (2008) and Panagariya (2008)

Table 1: Overall growth performance of India's macroeconomy, 1990-91 through 2007-08 (percentages)

	1990-91 to 1999-2000 (Average)	2000-2001 to 2007-08 (Average)	2002-03 to 2006-07 (10^{th} plan)	2005-06*	2006-07**	2007-08#
Agriculture and Allied Activities	3.2	2.9	2.5	5.9(19.6)	3.8(18.5)	4.5(17.8)
Agriculture	3.3	NA	2.5	6.1	3.8	n.a.
Industry	5.7	7.1	8	8(19.4)	10.6(19.5)	8.1(19.4)
Mining and Quarrying	4.8	4.9	6.1	4.9	5.7	4.7
Manufacturing	5.6	7.8	8.6	9	12	8.8
Electricity, Gas and Water Supply	7.3	4.8	5.6	4.7	6	6.3
Services	7.1	9	9.7	11(61.1)	11.2(61.9)	10.7(62.9)
Trade, Hotels, Transport Storage and Communication	7.5	10.3	11.1	11.5	11.8	12
Financing, Insurance, Real Estate and Business Services	8.1	8.8	9.5	11.4	13.9	11.8
Community, Social and Personal Services	6.5	5.8	6.1	7.2	6.9	7.3
Construction	5.6	10.6	12.9	16.5	12	9.8
Real GDP at Factor Cost	5.7	7.3	7.8	9.4(100)	9.6(100)	9(100)

Note: * Provisional estimates; ** Quick estimates; # Revised estimates; n.a: Not Available
Source: Reserve Bank of India (2008a), p. 50

industrial sector and the manufacturing sector within it have been growing extremely fast as the macroeconomy especially since 2000-01. This implies that the liberalisation measures towards the industrial sector have had a lagged effect on the growth performance of this sector. This lagged effect may be due to the fact that most of the liberalisation measures were piecemeal, *adhoc,* unstructured and implemented in a haphazard way especially at the level of individual states and as a result it took quite a bit of time for it to percolate down.

Although the growth rates of the manufacturing sector has clearly started looking up since 2000-01, an analysis (Table 2) of the contribution of various individual industry groups show that much of

Table 2: Weighted contribution* of various manufacturing industries to overall manufacturing sector's growth (percentage share#)

	Basic Goods	Capital Goods	Intermediate Goods	Consumer Goods
1999-00	27.5	10.1	37.4	24.2
2000-01	24.5	3.5	27.2	45.4
2001-02	31.5	-11.8	16.3	64.5
2002-03	27.4	16.2	19.3	37
2003-04	25	18	25.4	31
2004-05	21.3	16	20.2	42.9
2005-06	25.4	20	8.4	46.3
2006-07	27.2	17.6	27	28.5
2007-08	24.7	25	27.4	22.9

Notes *: These are relative contributions are computed as the ratios (in percentage terms) of the change in the index of the respective industry group to the change in the overall index adjusted for the weight of the relative industry group.

#. The individual shares may not add up to 100 due to rounding off.

Source: Reserve Bank of India (Various issues) the growth during this period of high growth was actually contributed by less technology-oriented industries such as basic goods and consumer durables, although the contribution of technology-oriented industries such as capital and intermediate goods have actually shown significant increases over the last two years . It must, however, be stressed that classifying industries such as basic goods and consumer goods as less technology-oriented and capital and intermediate goods industries as technology-oriented ones may sound a bit arbitrary and not based on strict objective criteria.

(ii) Knowledge-intensity of India's overall domestic production has increased: One of the distinguishing aspects of India's growth performance especially since 2000 is that its knowledge-intensity has increased (Table 3: see notes to this table for the empirical definitions). Currently about 14 per cent of overall NDP of the country can be termed as composed of knowledge-intensive production.

Mirroring the general trend, much of the knowledge intensive production comes from the services sector. Further the growth performance of the knowledge-intensive production sector is larger than that of the overall economy.

(iii) Rising innovations in the Indian industrial sector: Mani (2007) had already shown that the share of the industrial sector in the performance of R&D has doubled itself during the post liberalisation period and in 2005-06 accounted for about 30.4 per cent of the overall Gross Expenditure on R&D (GERD). Further the share of the private corporate sector in the performance of this R&D too had increased from about 40 per cent in 1985-86 to about 65 per cent or so in 2002-03. A similar picture is visible when one analyses innovative performance using the patent data (those applied for at both domestic and foreign patent offices), although here the share of government research institutes under the CSIR network too occupy an important role (Table 4). The

Table 3: Share of knowledge-intensive production in India's overall domestic production (Based on knowledge intensive products and services in Rs Crores at 1999-2000 prices)

Fiscal year 1	NDP at factor cost 2	Knowledge-intensive manufacturing industry[1] 3	Knowledge-intensive services industry[2] 4	Knowledge-intensive production 5 = (3+4)	Share of knowledge-intensive production 6 = (5/2)*100
1999-00	1605103	87049	50054	137103	9
2000-01	1670448	92256	66880	159136	10
2001-02	1764137	95257	79041	174298	10
2002-03	1824635	99760	96196	195956	11
2003-04	1981389	110650	120575	231225	12
2004-05	2126018	125795	149060	274855	13
2005-06	2326581	137703	185772	323475	14
2006-07	2549648	153787	100492[3]	254279[3]	

Notes: 1. Knowledge-intensive manufacturing = Chemical and chemical products (24) +Metal products and machinery (28+29+30) +Electrical machinery (31+32) + Transport equipment (34+35); Figures in parentheses indicate the NIC-98 codes of these industries;

2. Knowledge-intensive services = Communication + Computer relating services + R& D services.

3. Excludes communication services as CSO (2008) does not report this for 2006-07.

Source: Central Statistics Organisation (2008).

Table 4: Patent applications by Indian public and private entities (Cumulative 2005-07)

Public enterprises/organizations	IPO	USPTO	PCT	EPO	Total
Council of Scientific Industrial Research (CSIR)	1523	356	381	240	1500
Indian Institutes of Technology	237	19	25	6	287
Bharat Heavy Electricals	189	3	6	0	198
Steel Authority of India	136	0	0	0	136
Defence Research & Development Organisation (DRDO)	83	3	11	4	101
Indian Council of Agricultural Research	82	0	1	1	84
Indian Space Research Organisation	67	1	1	1	70
Indian Institute of Science	51	3	13	5	72
Total	**2368**	**385**	**438**	**257**	**3448**

Ratio of private to public 0.98

Private enterprises	IPO	USPTO	PCT	EPO	Total
Ranbaxy Laboratories	320	108	458	194	1080
Dr Reddy's Laboratories	315	27	113	39	494
Orchid Chemicals & Pharmaceuticals	149	17	47	11	224
Cadila Healthcare	148	17	67	23	255
Cipla	138	27	67	39	271
Larsen & Toubro	123	2	2	0	127
Sun Pharmaceutical Industries	121	18	81	12	232
TVS Motors	121	0	0	0	121
Tata Steel	119	1	10	3	133
Aurobindo Pharma	84	3	52	2	141
Pharma Tata Motors	66	0	0	0	66
Torrent Pharmaceuticals	54	4	20	9	87
Lakshmi Machine Works	52	0	0	1	53
Matrix Laboratories	43	3	47	10	103
Total	**1853**	**227**	**964**	**343**	**3387**

Notes: IPO_ Indian Patent Office; USPTO: US Patent and Trademark Office; PCT: Patent Co-operation Treaty; EPO: European Patent Office.

Source: Evaluserve (2008).

data on these conventional innovation indicators of R&D expenditure and patents applied for too thus clearly show that the Indian private corporate sector's innovative performance has increased rather significantly during the period since economic liberalisation although this rising innovative performance is concentrated in certain specific industries (such as the pharmaceutical ones) and within it in certain specific firms which are entrepreneurial in nature (for instance Dr Reddy's laboratories, Ranbaxi, Torrent, Orchid and so on). Consequent to this there is a change in the perception of India's private corporate sector from being '*bazaar style capitalists*' to those which are interested in improving their long term competitiveness by investing in the creation of new technologies.

III. Growth of knowledge-intensive entrepreneurship in India

First of all the term knowledge-intensive entrepreneurship lacks a very rigorous definition. The term is very often used interchangeably with other terms such as technology entrepreneurship. In our frame of reference it means entrepreneurship in the context of medium and high technology industries, both in the manufacturing and service sectors as well. The medium and high technology industries that we consider are the following: Chemical and chemical products, Metal products and machinery, Electrical machinery, Transport equipment , Communication services, Computer relating services and R& D services.

India's corporate sector, barring some notable exceptions, was not at all known for any major technology related activities until 1991. To a certain extent this somnolent nature of the corporate sector was attributable to the stifling external environment. The external environment was characterised by a web of governmental regulations governing conditions of entry to the industrial sector, expansion and diversification of existing industrial activity, acquisition of technology from abroad etc., All this was to change, albeit, slowly with the announcement of the new industrial policy statement of July 1991. According to Mohan (2006), ‘’massive deregulation of the industrial sector, in fact, constituted the first major package of reforms in July 1991. The obsolete system of capacity licensing of industries was discontinued; the existing legislative restrictions on the expansion of large companies were removed; phased manufacturing programmes were terminated; and the reservation of many basic industries for investment only by the public sector was removed. At the same time restrictions that existed on the import of foreign technology were withdrawn, and a new regime welcoming foreign direct investment, hitherto discouraged with limits on foreign ownership, was introduced. With this massive reform introduced in one stroke in 1991, the stage was set for a policy framework that encouraged new entry, introduced new competition, both domestic and foreign, which thereby induced the attainment of much greater efficiency in industry over a period of time. One area of industrial reform that has been sluggish has been the removal of restrictions that exist on investment in most labour using industries – known as small scale industry reservations. In 1991 as many as 836 industries were reserved for investment by only small firms, defined by the level of investment. The number of these industries has now come down to 326". It is now more or less accepted in the literature that from 1991 onwards the corporate sector in India has grown rapidly. In the following we discuss four macro indicators of this growth performance drawing essentially from a variety of official sources. Subsequently this is supplemented with some micro level indicators of knowledge-intensive venture creations.

A. Macro Indicators

(i) Growth of new venture creation and the relative size of India’s private corporate sector: In order to measure this, I use two indicators (Table 5): first new company formation; and second the size of India’s corporate sector in relation to her GDP.

Table 5: Trends in new company formation and the relative size of India's private corporate sector, 1980-2006

Year	New company formation	New company formation Index	Paid-up Capital as a per cent of GDP
1980	4932	100	
1981	6195	126	
1982	9645	196	
1983	10452	212	
1984	11331	230	
1985	15038	305	
1986	15030	305	
1987	16258	330	
1988	17603	357	
1989	21974	446	
1990	21774	441	
1991	22317	452	3.89
1992	25896	525	3.94
1993	26483	537	4.5
1994	28758	583	4.83
1995	47671	967	5.86
1996	55833	1132	6.78
1997	41804	848	8.04
1998	33547	680	8.42
1999	27484	557	9.18
2000	30428	617	10.36
2001	26645	540	12.09
2002	20151	409	12.86
2003	22887	464	13.6
2004	29331	595	14.44
2005	38118	773	13.89
2006	52496	1064	17.31
Average number of new companies formed 1980-1991 = 14379 Average number of new companies formed 1992-2006 = 33835			

Source: Ministry of Company Affairs (2007)

According to the above table, the number of new companies formed has increased quite tremendously from about 250000 in 1992 to about 730000 in 2006. On an average about 34000 new companies were established every year since 1992 although the rate of growth of new company formation has actually decelerated during the post liberalization period. However we do not have further data on whether these companies are started by new entrepreneurs or by existing entrepreneurs. But there is indirect evidence to show that most of the companies that have entered new technology-based industries such as Information Technology, Biotechnology and even the auto parts industries are new companies set up by hitherto not so well known entrepreneurs[6]. As a result of this phenomenal growth of new companies the size of the corporate sector in India measured by the share of its paid up capital to the country's GDP has increased by 12 percentage points to about a fifth of her GDP by 2006- the latest year for which such data are available.

Another interesting aspect is that increasingly the gross domestic saving and investment rates of the private sector have increased. For instance the gross domestic savings rate of the sector has increased from 3.4 per cent in 2001-02 to 7.8 per cent in 2007-08 and the gross domestic investment rate has increased from 5.4 to 14.5 per cent during the same period (Reserve Bank of India 2008a, p. 70-1). All these points to an improvement in entrepreneurial activity in the country.

(ii). Growth of knowledge-intensive ventures: For measuring this aspect we employ a direct measure and by using a proxy. The direct variable is the number of new company registrations in India according

6 Even though the largest conglomerate group in the country, Tata group, has expanded massively during this period (its total sales revenue now account for over 3 per cent of India's GDP), much of its growth has been outside the country. For instance according to the group's website (http://www.tata.com/tataworldwide/index.aspx?sectid=1y2Y3CZ5A2s =), in 2007-08 about 61 per cent its total sales were derived from its international operations.

to the level of activity (National Knowledge Commission, 2008). According to the National Knowledge Commission, there are four levels of entrepreneurship in terms of the level of technology involved with low technology activities such as agriculture and allied activities at the bottom of the pyramid (Level 1) and knowledge-intensive sectors at the top of the pyramid (Level 4):

- Level 1: Agriculture and other activities: Crop production, Plantation; Forestry, Livestock, Fishing, Mining and Quarrying;
- Level 2: Trading services: Wholesale and retail trade; Hotels and Restaurants;
- Level 3: Old economy or traditional sectors: Manufacturing, Electricity, Gas and Water supply.
- Level 4: Emerging sectors (including knowledge intensive sectors): IT, Finance, Insurance and Business services, Construction, Community, Social & Personal Services, Supply Chain, Transport- Storage-Communications etc.

The data on new company formations that we discussed in Table 3 could be cross classified according to these four levels (Figure 1) and it shows that new companies belonging to knowledge intensive sectors account for the largest share and the number of new companies formed has significantly increased since 2003 or so.

This dominance of technology-intensive sectors in total company formation is further corroborated by our proxy- namely the technology content of all industrial proposals actually implemented since 1991 (Table 6). Once again, with the exception of a few industries such as textiles, majority of the new proposals are in technology-oriented industries such as chemicals, fuel, electrical equipments etc. This once again prompts us to conjecture that technology oriented

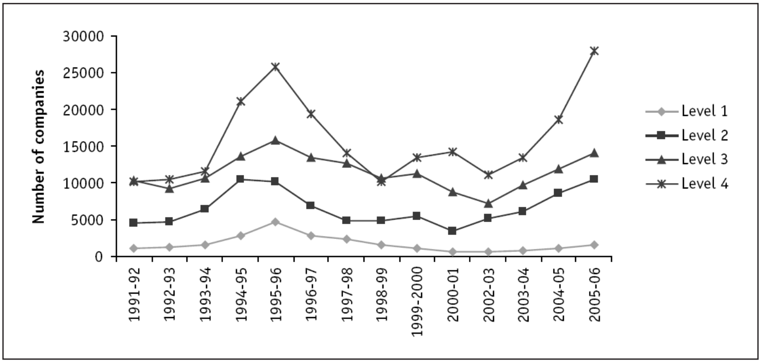

Figure 1: Distribution of new company formations in India according to intensity of knowledge

Source: National Knowledge Commis1sion (2008), p. 6

ventures are on the rise in India since the initiation of economic reforms in 1991.

However we do not have any data on the survival rates of these new ventures as it is quite possible that some of these would have exited from business due to a variety of reasons.

Table 6: Technology-oriented new industrial ventures implemented (Cumulative August 1991 through July 2008, Value in Rs Millions)

	Investments (in Million)	Share
Chemical other than Fertilizer	378690	14.09
Fuels	346430	12.89
Metallurgical Industries	303960	11.31
Textiles	258220	9.61
Prime Movers	232910	8.67
Cement and Gypsum	124710	4.64
Electrical Equipments	108940	4.05
Others	104390	3.88

cont'd......

Table 6 cont'd......

Vegetable oil, Vanaspathi	73960	2.75
Telecommunications	73760	2.74
Leather, Leather goods	70780	2.63
Fermentation Industries	65870	2.45
Food Processing Industry	60990	2.27
Sugar	59000	2.20
Industrial Machinery	57960	2.16
Boilers and Steamgen	38920	1.45
Paper and Pulp	38380	1.43
Transportation Industry	34320	1.28
Rubber Goods	32200	1.20
Drugs and Pharmaceuticals	29950	1.11
Miscellaneous, Mechanical Inds.	26080	0.97
Machine Tools	23320	0.87
Glass	21740	0.81
Glue and Gelatin	19230	0.72
Agricultural Machinery	17000	0.63
Scientific Instruments	16900	0.63
Ceramics	15800	0.59
Soap, cosmetics and toiletries	14340	0.53
Commercial, H.Hold Equpts	10430	0.39
Photographic Raw film, paper	9650	0.36
Fertilizers	6450	0.24
Timber Products	4630	0.17
Miscellaneous Industries	4200	0.16
Medical and Surgical Inst.	1950	0.07
Industrial Instruments	950	0.04
Earth Moving Machinery	360	0.01
Dye stuffs	330	0.01
Total	2687730	100.00

Source: Secretariat of Industrial Assistance (2008)

(iii) Indian investments abroad[7]: An increasing number of Indian companies are now investing abroad in order to access high growth markets, technology and knowledge, boost their positioning in the value chain, attain economies of size and scale of operations, to tap global natural resource banks and leverage international brand names for their own brand building. Over time, Net FDI from India works out to, on an average, 42 per cent of Net FDI to India (Table 7).

An interesting point brought by the Table is that credit on account of FDI from India has been steadily increasing over the last three years and now works out to about US $ 2.5 billion- significantly above debits on account of FDI from India. This implies that investments made abroad by Indian companies are earning for them and the country profits and dividends which when repatriated to India appear as a credit item on the BoP account. Most of these investments are in the manufacturing sector (Table 8), although in the most recent period the investments in trading have shot up.

Within manufacturing a number of technology-oriented industries such as pharmaceuticals, automobiles, basic metals, telecommunications and electrical equipments have been important. This increase in FDI from India has been facilitated by a number of favorable policy changes at the home front which encouraged such investments beginning with the Foreign Exchange Management Act (FEMA) of 1999.

Thus in the above we have seen several related macro indicators of the growth of technology based entrepreneurship in the country. I now present two case studies of technology-based entrepreneurship from the country. The two cases are widely discussed in the literature.

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7 There is now a small but growing literature on the growth and emergence of Indian MNCs. See for instance Nayyar (2008)

Table 7 : Ratio of Net FDI from India to India (Values are in US $ Millions)

	To India Credit	To India Debit	Net FDI to India	From India Credit	From India Debit	Net FDI from India	Ratio of FDI from India to India
1990-91	107	10	97				
1991-92	147	18	129				
1992-93	345	30	315				
1993-94	651	65	586				
1994-95	1351	8	1343				
1995-96	2173	29	2144				
1996-97	2863	22	2841				
1997-98	3596	34	3562				
1998-99	2518	38	2480				
1999-00	2170	3	2167				
2000-01	4031	0	4031	70	829	759	0.19
2001-02	6130	5	6125	99	1490	1391	0.23
2002-03	5095	59	5036	73	1892	1819	0.36
2003-04	4322		4322	142	2076	1934	0.45
2004-05	6052	65	5987	35	2309	2274	0.38
2005-06	8962	61	8901	216	6083	5867	0.66
2006-07	22078	87	21991	881	14393	13512	0.61
2007-08	32453	126	32327	2471	19253	16782	0.52

Source: Reserve Bank of India, Database on Indian Economy, http://dbie.rbi.org.in

Table 8: Industry-wide distribution of FDI from India, 2004-05 to 2007-08 (Values are in Millions of US $)

Industry	2004-05	2005-06	2006-07	2007-08
Manufacturing	1170	3407	3545	6240
Financial Services	7	160	28	26
Non Financial Services	304	895	7486	1635
Trading	192	377	1739	8993
Others	100	207	656	1010
Total	1773	5046	13454	17904

Note: Data include both equity and loan component

Source: Reserve Bank of India (2008a), p 154.

(iv) Findings from the Global Entrepreneurship Monitor[8] (GEM):

Although GEM has been measuring the extent of entrepreneurial activity across the world since 1999, due to changes in data definitions and non coverage of the Indian experience, we are constrained to present the data on entrepreneurial activity in India only for the most recent period of 2007. However to interpret these figures we have tried to

8 The Global Entrepreneurship Monitor (GEM) research programme is an annual assessment of the national level of entrepreneurial activity. Started as a partnership between London Business School and Babson college, it was initiated in 1999 with 10 countries, expanded to 21 in the year 2000, with 29 countries in 2001 and 37 countries in 2002. GEM 2007 conducted research in 42 countries. The research programme, based on a harmonized assessment of the level of national entrepreneurial activity for all participating countries, involves exploration of the role of entrepreneurship in national economic growth.

present two measures[9] of prevalence rates of entrepreneurial activity rates for the BRIC countries and United States. See Table 9.

Table 9: Prevalence rates of entrepreneurial activity in BRIC countries and the United States, 2007

(per cent of 18-64 population)

	Early stage entrepreneurial activity rate*	Overall entrepreneurial activity*	Number of observations
Brazil	12.7	22.4	2000
China	16.4	24.6	2666
India	8.5	13.9	1601
Russia	2.7	4.3	1939
United States	9.6	14.1	1583

Note: * For definitions of these rates, please see foot note no: 8

Source: Global Entrepreneurship Monitor (2007)

Although on the two prevalence rates, India has a lower value than both Brazil and China, her score compares quite favourably with that of the USA especially with reference to the prevalence rate of overall entrepreneurial activity.

9 GEM considers five measures of entrepreneurial activity. These are: (i) Nascent entrepreneurship rate: Percentage of 18-64 population who are currently a nascent entrepreneur, i.e., actively involved in setting up a business they will own or co-own; this business has not paid salaries, wages, or any other payments to the owners for more than 3 months; (ii) New business ownership rate: Percentage of 18-64 population who are currently an owner-manager of a new business, i.e., owning and managing a running business that has paid salaries, wages, or any other payments to the owners for more than three months, but not more than 42 months; (iii) Early-stage entrepreneurial activity: Percentage of 18-64 population who are either a nascent entrepreneur or owner-manager of a new business (as defined above); (iv) Established business ownership rate: Percentage of 18-64 population who are currently an owner-manager of an established business, i.e., owning and managing a running business that has paid salaries, wages, or any other payments to the owners for more than 42 months; and (v) Overall entrepreneurial activity rate: Percentage of 18-64 population who are either involved in early-stage entrepreneurial activity or owner-managers, of an established business (as defined above).

Further there is also now good amount of quantitative evidence that the so called innovation ecosystem is becoming increasingly favourable. This was brought out by a recent study (KPMG India and TiE, 2008) measuring the 'Entrepreneurial Confidence Index' in 10 states of India. Based purely on the perceptions of the entrepreneurs, rather than any factual analysis of the factors, the study aimed to identify the elements involved and benchmark the development of a conducive 'entrepreneurial ecosystem' across the country. The conclusions have thrown up the general confidence in the Indian economy and the belief that 'things are moving in the right direction' or in other words entrepreneurs are bullish about the ecosystem. Expectations of entrepreneurs from the states like Gujarat, generally considered being leaders in entrepreneurship, expected more from their ecosystem and thereby held the state to a higher standard. The study reinforced the widely held assumptions that risk capital is still not available in the desired quantities; and governance issues and local environment in the ecosystem get low scores.

B. Micro Indicators

(i) Analysis of recent innovative start ups

An analysis of a unique dataset on entrepreneurship based on the nominees at the Tata-NEN Hottest Startups competition run by a not-for-profit organisation, National Entrepreneurship Network (NEN)[10], has thrown up some additional insights into the emergence and growth of technology-based entrepreneurship in the country in recent times. Table 10 summarises the main features of the sample entrepreneurs in terms of: (a) industry-wide distribution (b) geographic spread; (c) year of establishment.

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10 The National Entrepreneurship Network (NEN), founded in 2002, is a not-for-profit initiative of the Wadhwani Foundation, working to inspire, educate and support the next generation of high-growth entrepreneurs in India. NEN was co-founded by five of India's premier academic institutions: IIT Bombay; IIM Ahmedabad; SP Jain Institute, Bombay; IBAB, Bangalore and BITS Pilani. Over the past three years, NEN's focus on introducing a new paradigm in entrepreneurship education in India — and its innovative method of doing so — has made it its leading catalyst on campuses across India. NEN's ultimate goal is to help launch thousands of new entrepreneurs, who in turn will create hundreds of thousands of much-needed valuable jobs for India.

Table 10: Main features of the NEN Startups (Industry-wide and geographic distribution as on November 5, 2008)

Industry-wide distribution			Geographic spread			Year of establishment		
	Number	Percentage		Number	Percentage		Number	Percentage
IT/Internet/software	195	33	Bangalore	147	25			
Telecom/Mobile	35	6	Mumbai	112	19	2003	35	6
Media/Entertainment	56	10	Delhi (plus NCR)	110	19	2004	36	6
HR,recruiting,training, consulting,outsourcing	43	7	Chennai	52	9	2005	61	10
Education	42	7	Hyderabad	44	7	2006	118	20
Retail/consumer-based	33	6	Pune	42	7	2007	197	34
Hospitality/travel	24	4	Ahmedabad	15	3	2008	141	24
Finance	16	3	Kolkata	8	1	**Total**	**588**	**100**
Others	144	24	Jaipur	7	1			
Total	**588**	**100**	Coimbatore	7	1			
			Chandigarh	5	1			
			Indore	4	1			
			Other cities	35	6			
			Total	**588**	**100**			

Source: National Entrepreneurship Network On line: http://www.nenonline.org/

It is seen that approximately 40 per cent of the start ups are technology-based (IT and telecoms), largely based in the larger cities with a quarter of them in Bangalore itself and most of them having been established in the last three years. The earliest one in the sample was set up in 2003. This latter finding is quite consistent with our earlier finding in Table 3 that the real fillip to entrepreneurial activity took place only in the current millennium and specifically since 2004 or so. The background of these new entrepreneurs also also presents us with some interesting results (Table 11).

Table 11: Background of the NEN startups

Age	Percen-tage	Family back ground	Percen-tage	Educa-tional back ground	Percen-tage	Number of business	Percen tage
Nominees in their early to mid 20s	25	Business	24	Studied abroad	17	First timer	65
Nominees in their late 20s	22	First generation	76	Tier I Institutes	41	Serial entrepreneur	35
Nominees in their 30s	42	Total	100	Tier II Institutes	40	Total	100
Nominees in their 40s	11			NA	2		
Total	100			Total	100		

Source: National Entrepreneurship Network On line: http://www.nenonline.org/

It is interesting to that note that majority of them are in their 20s, first generation entrepreneurs having their first business and having studied abroad or in tier 1 institutions in India where they were exposed to the nitty gritty of starting a new business venture. Further, in terms of gender, women formed only 8 per cent of the total number. In terms of head count, the total employee strength ranged from 5 to 15 employees and their mean revenue per year.

(ii) **Deloitte Technology Fast 50 India:** Deloitte Touche Tohmatsu (DTT), one of the leading management consultancy firms, has been conducting a competition for the fastest growing technology company[11] in the Asia Pacific region known as the Deloitte Technology Fast 500 Asia Pacific[12]. In 2003 when the competition was started only 12 India companies made it into this ranking. However in 2007 there were 82 from India- and India was ranked number two in the top 500 with the largest set of high achievers. A run through this list showed that all the companies were new companies and more than half of them were in IT software. This again further substantiates the growth of this phenomenon.

In sum, the macro and micro indicators that we have presented of thus reinforce the point that the process of economic liberalisation and international integration of India's economy has served to unleash a spate of entrepreneurship that was hitherto not seen or experienced in India's recent economic history.

IV. Facilitating and constraining factors: The basic proposition that we have advanced so far, with the help of a variety of macro and micro indicators, is that there has been an increase in knowledge-intensive entrepreneurship in India since the onset of economic reforms in 1991. In this section, we will attempt to identify those facilitating factors and those which are still constraining a faster emergence of this

11 To be a technology company, the following three sets of conditions must be fulfilled, namely (i) It owns proprietary technology that contributes to a significant portion of the company's operating revenues; (ii) It manufactures a technology related product; and or (iii) it devotes a significant proportion of operating revenues to research and development.

12 For the details, see http://www.deloitte.com/dtt/article 0,1002,cid%253D206929,00.html (accessed on December 10, 2008).

activity. According to the Global Entrepreneurship Monitor (GEM)[13], there are ten facilitating factors or framework conditions for this activity to flourish and sustain. These are: financial support, government policies, government programmes, education and training, R&D transfer, Commercial, professional infrastructure, internal market openness, access to physical infrastructure, cultural, social norms and Intellectual Property Rights protection.

While all these factors are important, in the case of India, we could identify five facilitating factors[14]. These are:

(i) the new market opportunities presented by a liberalising economy;

(ii) availability of financial support schemes from both official and private sources;

(iii) the existence of a large number of governmental programmes and public-private partnership programmes;

(iv) the emergence of a number of private sector initiatives for supporting knowledge-intensive entrepreneurship by complementing government programmes and by reducing information asymmetries; and

(v) the increased availability of technically trained manpower due to a phenomenal increase in the enrolment rate for engineering and technology education at especially the tertiary level in the country.

I deal with each of these issues seriatim.

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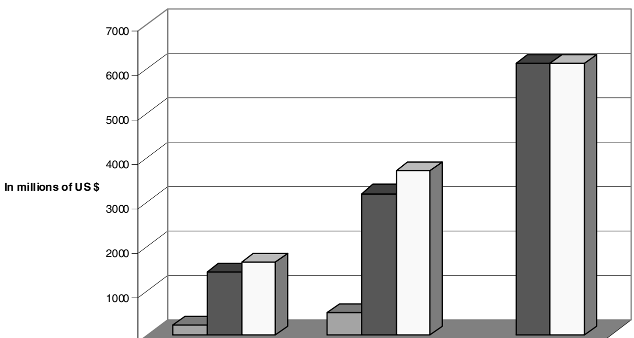
13 See Global Entrepreneurship Monitor (2007)

14 See also National Knowledge Commission (2008)

(i) Growth in market opportunities: An important aspect of liberalisation that was set into motion since 1991 was that it pared down the discretionary role of government with respect to economic matters and increased the scope of market forces. One of the important components of this increased space was the dispensing of the industrial licensing and other regulatory measures thereby reducing the height of barriers to entry to new entrepreneurs. This ease of entry, we argue, is one of the reasons for the rise of entrepreneurship in general (which was seen earlier in Table 3). Against this back- ground, an aspect that has engineered knowledge intensive entrepreneurship is the emergence and growth of new technology based industries such as Information Technology and Biotechnology which really opened up a new vista of opportunities. A run through the list of the top twenty enterprises (in terms of domestic and export sales) in each of these two industries show that almost all the enterprises were established during the 1990s or in the more recent period. Most of these are small and medium type of enterprises initially set up by technology-oriented entrepreneurs. We further argue that a common factor in spurring opportunities in these two areas is the growth of knowledge process outsourcing. As can be seen from Figure 3, KPOs (proxied by receipts of R&D services,



	2004-05	2005-06	2006-07
R&D services	221	519	
Architectural, engineering and other services	1417	3193	6134
Total	1638	3712	6134

Figure 3: Growth of Knowledge Process Outsourcing in India

Source: Reserve Bank of India (2006 and 2008c).

architectural, engineering and other technical services) has been on the rise indicating further market opportunities in addition to the organic growth that is taking place in both the IT , BT and other high technology industries such as mobile telecommunications.

(ii) Availability of finance and especially risk capital: One does not have to emphasise the availability of financial resources, equity and debt, for new and growing firms including grants and subsidies. The availability of external risk capital has often been constraining factor for financing company formation in India. Increasingly firms in India have relied on internal sources of capital and in terms of debt capital rather than equity for financing their long term investment goals (Table 12). It is interesting to note that with the onset of the reforms and the liberalisation of the capital markets, the external sources of funds have actually come down till 2004-05 and in the lat two years external financing has, once again, become important but with debt capital becoming more important. It should of course be mentioned that the data for the last two years 2005-06 and 2006-07 need to be taken with some caution as the number of companies covered by the RBI survey on the basis of which these numbers have been arrived at shows a dramatic halving compared to those covered in the previous years. So it may well be possible that the increased share of external finances may actually be a statistical artifact. Companies seem to be depending, increasingly, on self generation. Within the external source of finance, bank borrowings are more important (due to the current global financial crisis and with the likely existence of a liquidly crunch within the banking system bank borrowings, despite the steps taken by the central bank of India, the RBI, can become very tight). More recent data from the RBI (contained in RBI, 2008a) too confirms this trend. While this pattern of financing, with the internal generation accounting for the larger share, may be important for existing companies, new companies may have to depend on external sources. For this the emergence and growth of the private equity market and the venture capital funding has been somewhat helpful.

Table 12: Sources of funds for private corporate sector manufacturing firms in India, 1995- 96 through 2006-07

(Percentage shares)

Item/Year	1995-96	1996-97	1997-98	1998-99	1999-00	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07
Number of Companies	1930	1930	1948	1914	1927	2024	2031	2201	2201	2214	1064	1431
A.Internal sources of which	36.6	35.9	33.4	38.4	40.3	57.1	65.3	69.8	53.4	55.5	34.4	38.3
a)Reserves and Surplus	20.8	16.4	11.2	8.8	9.1	6.7	-18.8	18	20	26.6	13.8	27.8
b)Depreciation	12.2	17.9	20.8	29.1	30.7	41.8	47.9	37.3	25.7	19.2	14.2	9.3
B.External Sources	63.4	64.1	66.6	61.7	59.7	42.9	34.7	30.2	46.6	44.5	65.6	61.7
a)Paid up capital	13.9	10.1	7.6	11	21.9	12.8	10.5	9.4	9.3	10.8	22.8	12.8
Net Issues	3.4	2.6	2.9	7.1	5.4	4.6	4.7	7.3	4.9	4.1	na	na
Premium	10.4	7.5	4.7	4	16.5	8.2	5.8	2.2	3.6	6.4	19.4	12.5
b)Borrowings of which	31.4	45.6	45.9	37.5	20.1	9.3	8.8	5.6	17	15.3	25.8	31.0
Debentures	3.5	5.4	12.2	5.1	3.8	9.5	-1.5	-5.6	-3.5	-1.1	-4.1	-1.1
From Banks	17.7	13.3	10.1	29.3	8.4	-0.8	21.5	27.1	21.4	15.2	30.7	22.8
From FIs	6.1	10.2	10.1	11.1	5.2	-3.2	-0.7	-0.7	-5.06	-2.9	na	na
c)Trade dues & other current liabilities	17.9	8.2	12.8	12.8	17.2	20.2	14.3	14.3	20.3	18.5	17.0	17.9
C.Total(A+B)	100	100	100	100	100	100	100	100	100	100	100	100

Source: Securities and Exchange Board of India (2008)

Evidence from NEN Micro data: The micro data further complements our earlier finding that as of now most companies place a heavy reliance on internal sources of finance. This is all the more evident in the NEN start up dataset, where we observe that over 70 per cent of the entrepreneurs (Table 13) relied on personal savings for their initial funding needs and about 40 per cent of them continue to rely on the same personal sources for their additional funding.

Table 13: Sources of initial and additional funding of NEN start ups

Primary source of initial funding			**Primary source of additional funding**		
Source	Total no	Percentage	Source	Total no	Percentage
Angel investors	21	4	Angel investors	66	11
Bank Loans	22	4	Bank loans	45	8
Family and friends	102	17	Family and friends	113	19
Personal savings	409	70	Personal savings	234	40
Personal credit cards	4	1	Personal credit cards	12	2
Venture capitalists	9	2	Venture capitalists	48	8
Not mentioned	21	4	Not mentioned	70	12
Total	**588**	**102**	**Total**	**588**	**100**

Source: National Entrepreneurship Network On line: http://www.nenonline.org/

However we see that the external sources such as bank loans, venture capital, and angel investors become very important for expansion of the scale of activity. It is interesting to note that equity capital is conspicuous by its absence as a source of funding even at the expansion stage. These additional sources of venture capital and angel investments are analysed in some depth below. In fact we argue that both venture capital and angel investing are market-based solution to market failures in the financing of knowledge-intensive entrepreneurship.

Growth of private equity and venture capital in India: Universally private equity (PE) and venture capital (VC) has been the main source of risk capital for technology-based entrepreneurs.

But there are some differences between the two, namely that venture capital focuses on investing in private, young, fast growing companies. Buyout and mezzanine investing focuses on investing in mature companies. The history of the VC industry in India can be traced to the late 1980s (Mani, 1997) and since then history of the fledgling industry can be divided into four phases (Indian Venture Capital Association, 2007):

- Phase I - Formation of TDICI in the 1980's and regional funds as GVFL & APIDC in the early 1990s.
- Phase II - Entry of Foreign Venture Capital funds (VCF) between 1995-1999;
- Phase III - (2000-2007). Emergence of successful India-centric VC firms;
- Phase IV – (2007)Global VCs and PE firms actively Investing in India.

At this point it is necessary to point out that there no official sources of data on venture capital in the country, but what is available in the public domain is from the website of Indian Venture Capital Association and it clubs both VC and PE deals together (Table 14). However we have obtained the share VC in the total PE from another reliable private source of data (US-IVCA / Venture Intelligence (2006 and 2007)). The phenomenal growth of the PE/VC industry can be gauged from the fact that average size of a deal has shown an increase of 51 per cent per annum since 2000. However, based on the data provided in US-IVCA / Venture Intelligence (2006 and 2007) real VC investments in 2007 was only 4 per cent in terms of total value of deals, but about 25 if one take in terms of the number of deals.

Table 14: Growth of the private equity/venture capital industry in India, 2000- 2007

(Value in US $ Millions)

	No. of deals	Value of deals	Average per deal
2000	280	1160	4.14
2001	110	937	8.52
2002	78	591	7.58
2003	56	470	8.39
2004	71	1650	23.24
2005	146	2200	15.07
2006	299(92)	7500(508)	25.08(5.52)
2007	387(98)*	14234(543)*	36.78(5.54)

Note: * Figures in brackets are the VC deals.

Source: Indian Venture Capital Association (2007); US-IVCA / Venture Intelligence (2006 and 2007) (2006 and 2007).

About two-thirds of the value of deals have gone towards the IT and ITES industry. Although the VC industry is, largely, private and foreign owned, the government has played a very important role in establishing the industry and nurturing it through a variety of fiscal concessions (Mani, 1997). Once again, the growth of the VC industry has provided some financial support to knowledge-intensive entrepreneurship and is thus a market based solution to a market failure in the financing of knowledge-based entrepreneurship.

Growth of Angel funding: Entrepreneurs who have untested business models or innovative ideas typically get their first round of funding from angel investors. If and when their business model works and they are ready for scale up, they approach venture capitalists who usually invest more money (at least Rs 250 million) in the company in return for an equity stake. Angel investors, broadly differ from venture capitalists in the scale of funding. Besides, angels invest their personal wealth as opposed to venture capitalists who mostly work as fund managers. The size of the angel investments have been variously estimated to about Rs 10 billion in 2007. There is an inexorable link between the growth of angel investment and the growth of High Networth Individuals (HNIs)[15]. This can be further explained as follows:

Though the risk with start-ups is much higher than other asset classes such as real estate, equity, mutual funds, commodities and sometimes even art funds, HNIs are betting on the opportunity of considerably higher returns associated with start-ups . To institutionalise this process of channeling funding from HNIs to technology-oriented start-ups, the Indian Angel Network (IAN)[16] was founded in 2006. Around 80 HNIs are part of this network today, up from about six when they started in 2006. In the recent past, the angel community has grown considerably in India. A typical investment by an HNI in a start-up falls in the range of Rs 1 to 5 million and the exit duration is usually between 4-7 years. The returns, on the other hand, can vary from 400 per cent to even zero if the investment goes bad. Hitherto the network has supported around 12 technology-oriented ventures primarily in the arena of IT software.

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15 High Net worth Individuals (HNIs) hold at least US$1 million in financial assets, excluding collectibles, consumables, consumer durables and primary residences. According to World Wealth Report 2008 prepared by Capgemini and Merril Lynch the number of HNIs in India has gone up by 23 per cent in 2007 compared to 2006 and there are about 123 000 HNI's in India as of 2007 . Further, the report said that the combined wealth of the HNIs has increased to $440 billion until 2007. The rapid expansion of economy, increased foreign investment, increase in the savings rates and gains on the country's stock markets are the prime factors responsible for increase in the number of Indian HNIs. As of December, 2007, HNIs in India have investible surplus of more than $1million.

16 Indian Angel Network is India's first and largest Angel network with successful entrepreneurs and high profile CEOs interested in investing in early stage businesses across India, which have potential to create disproportionate value. The Network has invested in multiple sectors like Information Technology, Intellectual Property, Hospitality, Mobile, Education, Internet, etc.

In a bid to promote funding for start-ups, the government plans to offer tax breaks to angel investors, who provide a part of their personal wealth as seed capital for such firms. A proposed legislation, the National Innovation Act[17], envisages doing away with the stamp duty currently levied on shares held by angel investors and the tax imposed on profits they make in early-stage firms. However, these tax breaks would apply only to companies that are incubated in designated areas—called special innovation zones (SIZs)[18]—and are likely to include technology parks and incubation facilities of academic institutions such as the Indian Institutes of Technology, or IITs.

(ii) Government and public private partnership programmes: There are a number of government programmes and institutional arrangements that are put in place to encourage technology based entrepreneurship mostly by the central government but in some cases by individual state governments as well. One of the earlier attempts has been the establishment of the National Science and Technology Entrepreneurship Development Board (NSTEDB) in 1982 under the administrative purview of the Department of Science and Technology. It is an institutional mechanism, with a broad objective of promoting gainful self-employment amongst the Science and Technology (S&T) manpower in the country and to setup knowledge based and innovation driven enterprises. The NSTEDB has two major responsibilities. First is to establish technology parks and incubators for nurturing already existing entrepreneurs. It thus provides the crucial infrastructure and other value added support for growing entrepreneurs. Second, it organizes a series of training programmes to initiate freshly graduated engineers

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17 For details of the draft National Innovation Act, see the website of the Government of India 's Department of Science and Technology at http://dst.gov.in/draftinnovationlaw.pdf (accessed on December 7 2008).

18 Although the government is yet to notify these called SIZ, the recently established biotechnology cluster at Mohali in Punjab, and the IIT Madras Research Park etc., will qualify for this status.

and other technically qualified students to learn the *nitty grity* of entrepreneurship. The actual achievements of NSTEDB in carrying out these two responsibilities are outlined in Annexure 1.

Another important programme to facilitate knowledge-intensive entrepreneurship is the Technopreneur Promotion Programme (TePP) administered by Department of Scientific and Industrial Research (DSIR) of Government of India. The programme was launched in 1998 to help realise the vast latent innovative potential of the people. The basic objective of TePP isfor individual innovators to emerge as technopreneurs – technology oriented entrepreneurs. TePP support is provided for in all areas except software development for which there are other avenues of support. It helps the inventor to identify and network with an appropriate R&D/academic institution for guidance, technical consultancy, development of models/prototypes, etc., assists in for filing and securing of intellectual property rights and last but not the least, linking with appropriate source of finances for commercialisation of the product. TePP by itself provides financial support of upto Rs.1 million as a grant-in-aid to prove the idea and a similar amount for the second phase for commercialization. As of March 31, 2008, about 80 projects are under various stages of completion. But there is precious little information on the number of entrepreneurs that may have emerged consequent to this programme.

Public-private partnership for reducing information asymmetries: Technology Innovation Management and Entrepreneurship Information Service (TIME IS), a joint project of NSTEDB, DST, FICCI is now one of the credible ladder towards the enhancement of India's entrepreneurial economy. The project has taken initiatives to provide guidance and assistance to the entrepreneurs especially the techno-preneurs to find technologies, projects, funding options and information about policy environment, incentive schemes and industrial infrastructure available in the country covering both the central and state government and have become proficient at tapping the local talent pool. TIME IS facilitates entrepreneurs with “Online Interactive Tools and Templates” for developing ‘Project Profile’, ‘Feasibility Reports’, calculating ‘Financial and Profitability Ratios’ and estimating the ‘Market Potential’.

The **DST-Lockheed Martin India Innovation Growth Programme** is a two-year, nation-wide project, created to enhance the growth and development of India’s entrepreneurial economy. The programme is wholly funded by Lockheed Martin Corporation, and was developed with the assistance of the IC2 Institute at the University of Texas, and FICCI. Its overall goal is to accelerate the launch of Indian early-stage technologies into the global marketplace. The programme features a competitive selection process. Selected participants may receive specialised training and funding opportunities. Top selectees will also be eligible to receive professional business development support to assist them in entering global markets.

Business incubators in India: This is a relatively new concept in India and unlike in other BRIC countries such as Brazil or China, even now the concept is not so well developed in India as a support system for engineering technology-based entrepreneurs. As of 2007, there are approximately 40 incubators spread throughout the country[19]. See Figure 2.

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19 The number of incubators in India compares very poorly with that of China: she had 500 incubators in 2004 employing six lakh people as against a handful in India. The incubation market place in China, though relatively recent, is well developed, with the Government playing a predominant role in the business of incubation by channeling resources to tie up with the mandate of high technology-led economic growth.

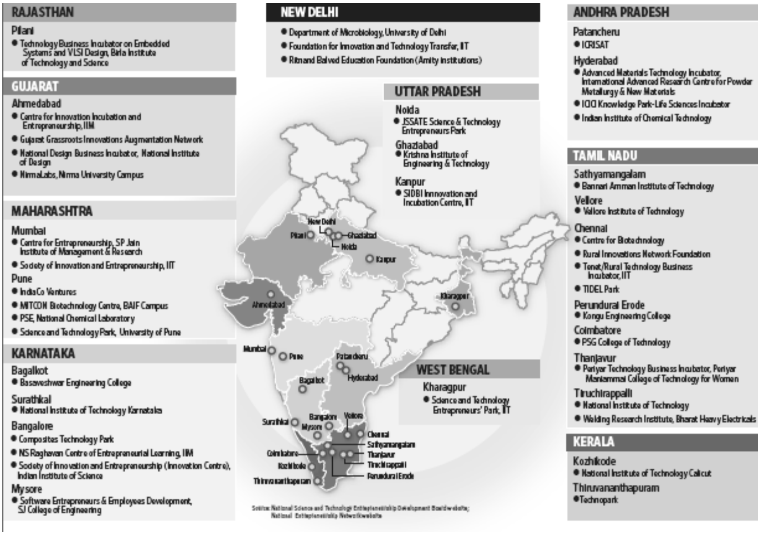

Figure 2: Spatial distribution of incubators in India (cFebruary 2008)
Source: Rosen (2008)

There are essentially three types of incubators depending upon the physical location and ownership of these incubators. They are those which are established: (i) under the aegis of leading institutions of engineering technology and management, for instance within the IIMs and the IITs; (ii) within the Science and Technology Parks (STEPS), for instance within the Technopark in Trivandrum; and (iii) by leading private sector enterprises such as Nirmalabs.

The history[20] of business incubators in the country could be traced to 1985 when in that year, the Tiruchirappalli Regional

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20 This is based on a presentation by R.M.P. Jawahar, Executive Director of Triuchirappalli Regional Engineering College – Science and Technology Entrepreneurs Park (TREC-STEP) accessible at http://www.infodev.org/en/Publication.34.html

Engineering College-Science and Technology Entrepreneurs Park (TREC-STEP) was set up within the Regional Engineering College at Tiruchi (now known as National Institute of Technology). Once can see two broad phases in the growth of incubators in the country: the first phase is from 1986 through the late 1990s when incubators were set up in broad based Science and Technology Entrepreneur Parks (STEPS) and the second phase from late 1990s to the present when more focused Technology Business Incubators (TBI) were established within the leading national institutes of technology, engineering and management.

The incubation idea has received a fillip with the NSTEDB deciding to create an incubation fund with an initial corpus of Rs 50 million to facilitate the development of entrepreneurship in knowledge-based, high-growth businesses. The corpus of Rs 50 million would be allocated in equal measure to five out of the 32 Science and Technology Entrepreneurs Park (STEP) and technology business incubators (TBI) that were under the administrative ambit of the Centre's Department of Science & Technology (DST). The idea behind the initiative was to ensure that technology entrepreneurship based on business ideas was not hindered for want of initial funds required for market research, etc. The fund is essentially for bridging the financing needs of a technology based entrepreneur between the time she floats her business venture and the time she begins to attract venture funding.

Since the incubator idea itself is new and evolving, there are no detailed studies on the effectiveness of these as an instrument for promoting technology-based entrepreneurship excepting to say that it is an experiment which is worth watching especially when a number of prominent centres such as the IIM-Ahmedabad are engaged in the nurturing of this fledgling idea of incubation and entrepreneurship among its student community.

(iii) Private sector initiatives in promoting entrepreneurship: The 1990s external environment is charecterised by the importance it has attached to enlarging the scope of market forces in all matters with respect to economy. Since the creation of private entrepreneurship and its sustenance is a necessary condition for increasing the share of the private sector in India's economy, one sees an increased activity by various private sector agencies towards creating this activity on their own in addition to complementing the efforts of the state through various public-private initiatives. Two such private sector initiatives that have become very active in recent times are:

(a) the TiE network (The Indus Entrepreneurs)[21]; and (b) the Wadhwani Foundation, which seek to promote entrepreneurship by, among other things, organising workshops and seminars nationally. Founded by entrepreneur Romesh Wadhwani, the foundation funds various entrepreneurship education-related projects like the National Entrepreneurship Network (NEN)[22], which brings together prestigious Indian higher education institutions and entrepreneurs. Again both these private initiatives are more of a mentoring in nature sand act as a

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21 TiE was founded in 1992 in Silicon Valley. It is a network of entrepreneurs, professionals, and venture capitalists active worldwide in technology-related sectors, who share the same geographical and cultural origins. At present TiE can count on over 10,000 members subdivided into 44 chapters in 9 countries including among others U.S., Australia, U.K., Singapore, United Arab Emirates and India. Every year TiE holds a conference in Silicon Valley attended by numerous stakeholders form the IT industry. Although TiE is not directly involved in funding enterprises, it may provide important mentoring services to its affiliates and help would-be entrepreneurs in many ways such as: assistance to preparation of business plan, fund raising, strategic guidance.

22 NEN is working to inspire, educate and support the younger generation of entrepreneurs in India. NEN helps its 403 member academic institutes build comprehensive, high-impact entrepreneurship programmes on their campuses; reaches over 400,000 young people; has helped launch more than 350 student entrepreneurship clubs; and has an individual membership base of more than 60,000. In addition to working with institutes, NEN provides support to India's growing pool of young and future entrepreneurs. In 2008 NEN also launched the TATA NEN Hottest Startups awards, a national programme to increase the visibility of high-potential startups, and engage the public to create more support for these startups.

"catalyst" for the creation of technology-based entrepreneurship. Of the two, the NEN has been particularly active in catalyzing technology-based entrepreneurship. Of the various strategies that it has employed is the NEN Hottest Startup Competition.

(iv) Education and training: The general assumption is that the country has a veritable supply of scientists and engineers and many of these who graduate from a variety of universities and technological institutes can be trained and encouraged to become entrepreneurs. This assumption is usually substantiated by invoking the gross enrolment the undergraduate degree programmes in engineering and architecture: the enrolment has increased from 7.08 lakhs in 2002-03 to 16.68 lakhs in 2005-06 (Ministry of Higher Education, 2008). Given the high failure and drop out rates, although these enrolments need not translate itself into such a quantum jump in outturn rates, it does indicate the likely addition to the stock of technical manpower in the country. Questions have often been raised on the quality of these graduates which is highly varying. We had also seen (from the NEN startup dataset) that most of the successful entrepreneurs have either studied in Tier 1 institutes such as the IITs or NITs or they have secured degrees from foreign universities[23]. This is because a typical engineering graduate does not receive much training in becoming an entrepreneur during her four year degree programme. Although most engineering graduate level programmes have management and economics papers in their curriculum these are in most cases badly taught and largely theoretical in nature.

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23 In order to improve the quality of technical education, the central government is in the process of establishing a number of tier 1 institutions of higher learning in engineering and management. In addition to thirty Central Universities during the 11th Plan period (2007-12), the Government will also set up eight Indian Institutes of Technology (IITs), 10 National Institutes of Technology (NIT), 20 Indian Institute of Information Technology (IIITs) as far as possible in the Public-Private Partnership mode, three Indian Institutes of Science Education and Research (IISERs) seven Indian Institutes of Management (IIMs) and two Schools of Planning and Architecture(SPA).

More formal training in entrepreneurship: In order to give formal training to engineering graduates in entrepreneurship training, as mentioned earlier, the NSTEDB has actually a limited number of schemes in this direction. Even an exclusive national institute devoted to entrepreneurship training in the form of the Entrepreneurship Development Institute (EDI) has been established at Ahmedabad for this purpose. The NEN and Indian Institute of Management at Bangalore have also initiated a number of courses of varying duration and content to provide systematic training in this area[24].

Finally it may be said that, given the positive entrepreneurial ecosystem (consisting of market opportunities, government and private support systems of various kinds, venture capital etc) is beginning to have a positive impact on the students graduating from Tier I institutes taking up entrepreneurship as a career compared to the lure of the labour market (Basant and Chandra, 2006 and Bansal. 2008).

V. Conclusions: Our study has sought to highlight a number of positive indicators as far as technology-based entrepreneurship in India is concerned in the post liberalised regime. This, however, by no means mean that everything is fine. Following Gupta (2001), the state has to do four facilitating factors for technology-based entrepreneurship to be sustained. They are: (i) creating the right environment for success:

24 In 2005, 16 colleges across the country sent faculty members to the entrepreneurship educators course conducted by the National Entrepreneurship Network (NEN); at the end of 2007, 269 colleges across the country had signed on to the programme —an initiative of the Wadhwani Foundation, which is focused on accelerating entrepreneurship in emerging economies, and has trained more than 470 faculty members in Indian colleges so far. The NS Raghavan Centre of Entrepreneurial Learning (NSRCEL) in the Indian Institute of Management, Bangalore (IIM-B), in collaboration with the Singapore-based Universitas 21 Global, a distance learning educator, has started a programme for entrepreneurial training in family-owned businesses. Both NSRCEL and the Stanford Technology Ventures Programme (STVP), the entrepreneurship centre at Stanford University's School of Engineering, provide faculty and learning material for the NEN programme, which trains teachers who can in turn teach entrepreneurship as an academic course to college students across India.

Entrepreneurs should find it easy to start a business; (ii) ensuring that entrepreneurs have access to the right skills: According to Gupta (2001) most Indian start-up businesses face two skill gaps: entrepreneurial (how to manage business risks, build a team, identify and get funding) and functional (product development know-how, marketing skills, etc.). In other countries, entrepreneurs either gain these skills by hiring managers or have access to "support systems" such as universities or other institutions that may nurture many regional businesses. In addition, business schools give young graduates the skills and knowledge required for business today. India can move toward ensuring that the curriculum at universities is modified to address today's changing business landscape, particularly in emerging markets, and to build "centres of entrepreneurial excellence" in institutes that will actively assist entrepreneurs; (iii) ensuring that entrepreneurs have access to "risk" capital: For a long time, Indian entrepreneurs have had little access to capital. As mentioned earlier it is a fact that in the last few years, several Venture Funds have entered the Indian market; and (iv) enabling networking and exchange: Entrepreneurs learn from experience - theirs and that of others. Much of the success of Indians in Silicon Valley is attributed to the experience, sharing and support which organizations such as The Indus Entrepreneurs (TiE) members have extended to young entrepreneurs. Given the positive contribution of knowledge-intensive entrepreneurship and given the on going financial crisis which would turn some of the facilitating factors into strong constraints, one cannot de emphasize the catalytic role that the government has to play in growing this desirably activity.

Annexure 1: Achievements of the NSTEDB (c2007)

Programme	**(Physical Achievements)**
Entrepreneurship Awareness Camp (EAC)	
Conducted	1850
Students Exposed	110000
Entrepreneurship Development Programme (EDP)	
Conducted	717
Persons Trained	16159
Technology based EDPs (TEDP)	
Conducted	413
Persons Trained	8450
Faculty Development Programme (FDP)	
Conducted	160
Faculty Trained	3200
Entrepreneurship Development Cell (EDC)	
ED Cells Established	55
ED Cells being supported currently	36
Science & Technology Entrepreneurs Park (STEP)	
No of STEPs	15
Units Set up	910
Jobs Genertaed	6300
Technology Business Incubator (TBI)	
No of TBIs	15
Units Setup	85
Science & Technology Entrepreneurship	
Development (STED) Project	
STED Projects currently operating	42
Skill Development through Science & Technology (STST)	
Persons trained	113000

Source: NSTEDB Website, http://www.nstedb.com/institutional/step-centre. htm (accessed on October 21 2008)

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