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Innovations, Finance, Employment and Social Security

Some Views

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A central feature of modern society is the vital importance of innovations. Schumpter (1934) differentiated between inventions and innovations and stated that invention is an idea that might be used in production, while an innovation is the process of turning an invention into an actual product[1]. The term innovation is associated mainly with the features of the goods or services as well as the method of providing (producing, marketing, selling etc) them[2]. Technological innovation has many definitions in the innovation literature. The most appropriate: the creation, development, and implementation of an idea from problem solving or opportunity identification that alters (innovation) the current state of theoretical and practical knowledge, skills and artifacts (technology) in the production and delivery of economic activity. In the context of innovation, technology matters because it is the engine that drives change and economic growth. This is in response to society's needs or in the conception of new economic opportunities that induce demand. Without effective demand generating the commercialization of new technology, the idea remains merely an invention without exploitation (Courvisanos 2005). In Marxian terminology the circulation process under capitalism has to overcome the limits of production by expanding over barriers of declining additions to surplus value time. This results in creation of technological innovation in three forms viz., (i) opening up new markets, (ii) creating new needs and demands, (iii) investing in increasingly technologically efficient means of production. As Marx would say, these three would create instability, unemployment, inequality and unsustainable development that lead to an economy with fundamental uncertainty. To control this uncertainty, innovation is necessary. What we get is power to manipulate production to alter physical aspects of the economy. As Dasgupta (1985) articulates right from Adam Smith, Ricardo and Marx, innovation revolves around specialization, employment and exploitation and economic surplus. Additionally, innovation has a cost and finances involved and they impact employment. Innovations have relationship with social security due to labour displacement and relocation of labour. It influences wage changes and earnings. There are government policy implications of innovation and state is involved in promotion of Research and Development (R&D). The education system and skills are important elements of investments in R & D. Thus, there are issues of (R&D), employment, social security and distribution. Labour laws also influence innovation process. This paper tries to look at innovations and its nexus with finance, employment and social security though the lense of aggregate and micro-level studies. It also presents innovation processes in India.

1. Finance and Innovation

It has always been a central question in economic growth and development as to why does large disparities exist in income and development across countries despite increasing globalization. Zvi Griliches attributed it to differences in productivity. Cross country differences in credit market development considerably contribute to cross-country differences in incomes and productivity (Levine 1997; 2005). Development of financial markets is strongly correlated with the development of a country (Singh, 2008) at macro-level. What happens at the micro-level? There is lack of micro-level evidence for dynamic aspects of productivity gains such as innovation flows. Literature does show that in emerging and transition economies foreign owned firms are more productive than the domestic

firms and these differences are not observed to diminish over time (Haddad and Harrison 1993; Estrin *et al* 2009). It is argued that foreign firms embody technological frontier, domestic firms are prevented by some factors from emulating best practices and techniques. Financial frictions affect investment along with research and development (R&D) spending by firms (Hall 2002; Hall and Lerner 2009). Financial constraints prevent firms from releasing gains from trade liberalization which could boost productivity growth. Ayyagari *et al* (2007) report, on the basis of 47 developing countries, positive relationship between the use of external finance and the extent of innovation, though Himmelberg and Peterson (1994) did find an economically large and statistically significant relationship between R&D expenditure and internal finance for a panel of small high-tech firms. There are inter-country variations in this relationship as found by Bond *et al* (2006) and Mulkay *et al* (2001), especially in case of the US, France, UK and Germany. Also studies show that adoption of new technologies in a country is more likely to occur after trade liberalization. For instance, Bustos (2007), in case of Argentina, reported that new entrants in the export market upgrading technology faster than other firms after trade and capital account liberalization in the early 1990s.

Another facet of this debate is that domestic firms may engage more in imitation and adaptation of already created and tested technologies, rather than generating new inventions or expending resources on R&D (Gorodnichenko and Schnitzer 2010). It is cost effective. Firms from high tech industries and small firms are more likely to report a project being abandoned or delayed due to financial constraints (Canepa and Stoneman (2008). Innovating firms are more likely to hit financial constraints and therefore one may find a positive relationship between financial constraints and incidence of successful innovations (Hajivassiliou and Savignac 2007). Large firms are more likely to report innovations than small firms (akin to Schumpeterian hypothesis). Besides, higher share of skilled workers does not affect the probability of developing new product and acquiring new technologies. On the other hand, as the share of workers with a university education rises, all types of innovation are boosted (Gorodnichenko and Schnitzer 2010). This calls for need of a highly educated labour force to improve the capabilities of the product or service.

Another dimension is that older firms are not likely to innovate with respect to product and technology, as new firms. Firms that compete/operate in national markets are more likely to innovate in any of the three areas firms that only compete/operate in a local or regional market. This may reflect both the capability of the firms operating in the larger national market, as well as the characteristics of the national as opposed to local environment. Lower competition has a positive effect on innovation (Gorodnichenko and Schnitzer 2010). Also more intensive capacity utilization is associated with less intensive innovative activities. New firms are more sensitive to financial constraints than old firms. The integration of international product markets does not have the desired effects of pushing domestically owned firms towards the technology frontier if it is not accompanied by complementary financial market reforms. Multi National Companies (MNCs) may ease local credit constraints by bringing in foreign capital which is consistent with the negative correlation between foreign presence and self-reported financial constraints. On the other hand, to the extent MNCs borrow locally, they can crowd out domestic borrowers and exacerbate financial constraints by domestic firms. Retained earnings has important role in the R&D investment decisions, independent of their value as a signal of future profitability. There is, thus, a good reason to think that positive cash flow may be more important for R&D than for ordinary investment (Hall 1992).

Finally, R&D and innovative activities are difficult to finance in a freely competitive market place. It is argued (Arrow 1962) that the primary output of R&D investment is the knowledge of

how to make new goods and services, and this knowledge is non-rival; use by one firm does not preclude its use by another. To the extent that knowledge cannot be kept secret, the returns to the investment in it cannot be appropriated by the firms undertaking the investment, and therefore such firms will be reluctant to invest, leading to the under- provision of R&D investment in the economy (Hall 2002). Many studies have tested this argument and found that imitating a new invention was not costless, but could cost as much as 50 to 70 percent of the original cost. This will mitigate, but not eliminate the under-investment problem. On positive externalities created by research, studies have shown that a social return to R&D is higher than the private level (Hall 1992). Also one person's use of knowledge does not diminish its utility to another. Policy makers have applied these arguments to design interventions such as intellectual property system, government support of R&D, R&D tax incentives and so on. However, Arrow also articulated that an additional gap exists between the private rate of return and the cost of capital when the innovation investor and financer are different[3].

Carrying the argument further, studies have tested a variety of issues concerning financing constraints and cost of R&D investment across countries and come a conclusion that there is evidence that debt is a disfavoured source of finance for R&D investment, Anglo-Saxon economies with their thick and highly developed stock markets and relatively transparent ownership structures, typically show more sensitivity and responsiveness of R&D to cash flow than continental economies. Besides, greater responsiveness may arise because they are financially constrained and thus, view external sources of finance as much more costly than internal. In this situation, they require higher rate of return to investments on the margin when they are tapping these sources. It is here that many governments have set up venture capital and start-up finance approach for small and new firms' innovation financing.

2. Employment and Innovation

There exist a relationship between innovation and employment. The fear of technological unemployment has always been there. Arrow has amply demonstrated this through his writings. The economic theory has pointed out that there exist economic forces that can compensate for the reduction in employment due to technological progress. There are two views: working class opinion of dismal because of innovation and academic and political debate propelled by an ex-ante confidence in the market compensation of dismissed workers. The effects of innovation on employment depend on the relative intensity of the displacement and compensation effects that it might induce. New processes are introduced generally by labour cost consideration and tend to reduce labour. New products/ services once introduced may replace or add to the list of existing products/ services with different effects on the generation of employment.

Employment Effects of Innovation

Product Innovation ⇩

	Process Innovation	Product Innovation
Displacement	Productivity effect (–): less labour for a given output	Productivity differences of the new product (– or +)
Compensation	Price effect (+): cost reduction, passed on to price, expands demand	Demand enlargement effect (+)

⇧ Depends on firms' behaviour ⟺ ⇧ Depends on competition

Adapted from Harrison *et al* (2008).

It has been shown that in order to understand the employment effects of innovations, a distinction between product and process innovation is vital. Studies show that individual process innovation account for a small share of the changes observed in employment, inducing small displacement effects. Product innovations are important source of firm-level employment growth.

There are six possible ways of compensation. First, compensation mechanism via new machines- the same process innovations that displace workers in the users industries, create new jobs in the capital sectors where the new machines are produced (Vivarelli 2007). Second, compensation mechanism via decrease in prices- innovations lead to decrease in unit costs of production and in a competitive market would reduce prices. Supply creates its own demand and technological change fully takes part in this self-adjusting process. Third, compensation mechanism via new investments- innovative entrepreneurs may accumulate extra profits that are invested and so new productions and new jobs are created. Fourth, compensation mechanism via decrease in wages- decrease in wages should lead to a reverse shift back to more labour-intensive technologies. Fifth, compensation mechanism via increase in incomes- cost savings due to innovation leads to higher income and higher compensation due to union interventions (Fordist mode of production). Six, compensation mechanism via new products- product innovation has positive impact on employment. Literature has criticised these processes. Labour market functioning has changed a lot. Fordist mode of production is over for many reasons. It is well established now that technological change could be of cumulative and irreversible nature. Compensation theory has limitations. Relation between employment and technological change is a complex problem, which cannot be solved through partial equilibrium models.

2.1 Other Issues

Large and persistent differences in firm productivity and firm size exist. Reallocation of workers across firms and establishments is an important source of aggregate economic growth. There is no correlation between employment size and labour productivity and a positive correlation exist between value added and labour productivity (Lentz and Mortensen (2005).

Another aspect is relationship between technical change and wages. The literature begins this debate with return to skills. Tinbergen had argued that there exists relative demand for skills that are linked to technology and there is skill bias related to technical change. It has varied overtime and across countries (Acemoglu and Autor 2010). The 1980s and 1990s observed acceleration in skill bias. It means that improvements in technology naturally increase the demand for more skilled workers. Also, historically it has been observed that artisan shop was replaced by the factory and later by interchangeable parts and the assembly line, and products previously manufactured by skilled artisans began to be produced in factories by workers with relatively few skills (Goldin and Katz 2008).

Changes in the wage structure are linked to changes in factor-augmenting technologies and relative supplies. Overall inequality rises in tandem with the skill premium. The economy-wide average wage and the real wage of each skill group should increase overtime as a result of technological progress, particularly if supply of high skill labour is increasing. Wages for a skill group can of course fall if its supply becomes relatively more abundant. The rate and direction of technological change do not respond to the relative abundance or scarcity of skill groups (Acemoglu and Autor 2010)[4]. However, clear distinction should be made between workers'

skills and job tasks and allow for assignment of skills to tasks to be determined in equilibrium by labour supplies, technologies and task demands (Autor, Levy and Murnane 2003). Related to this is impact of organizational change on shaping the demand for skills. It has been shown that substitution of machines for tasks previously performed by semi-skilled workers, or outsourcing and off shoring of their tasks may necessitate significant organizational changes (see Dessein and Santos 2006; Garicano and Rossi-Hansberg 2008). Organizational change might also create tasks, demanding both low and high skill labour inputs that were not previously present, exerting another force towards polarization. Also, it should be understood that in reality many frictions-related to information, collective bargaining, social norms, firing costs, minimum legislation etc- create wedge between wages and marginal products. Such labour imperfections render allocation of skills to task more complex. Therefore, implications of different type of technical change are potentially different in presence of labour market imperfections.

Labour institutions also play a role in the changes in employment and inequality in recent times. Such institutions may restrict substitution of machines for certain tasks previously performed by workers, particularly in the case of labour unions. Even if it is allowed, the process may be very slow. Another aspect is cross-country variations in changes in the occupational distribution. So have been the changes in the earning distribution across countries. Technological changes have influenced occupational structures in advanced countries. One possible explanation of this is that the adoption of new technologies either replaces or complements workers in certain tasks that require fixed investments and the incentives for adopting these technologies are not affected by labour supply and demand, but also by existing regulations. Here the possibility exists for firms to select different technologies in different countries in accordance with these constraints. This may affect the evolution of real wages for various skill groups.

There are other aspects– gender, race and service occupation differentials and their technological linkages. Female workers have also been substantially displaced over the last few decades from a different set of middle skill tasks (administrative support and clerical jobs) without seemingly experiencing the adverse wage and employment consequences observed among men.

Finally, the positive aspects of new technology have become a persuasive marketing tool, whereas the negative aspects have become a source of dread (the Frankenstein hypothesis). Negative aspects are technological unemployment, information (technology) poor areas, technological determinism, environmental non-sustainability of new technology, false technological indestructibility, technological trade deficits in export commodity-based countries, a long and unpredictable process of development and commercializing, labour deskilling and dehumanising and increasing stress and social limits to technological growth (Courvisanos 2005). Globalization has further complicated the issues. It has not induced a pervasive race to the bottom in welfare state regimes.

3. Innovations and Social Security

> *"Everyone, as a member of society, has the right to social security" Article 22 of the Universal Declaration of Human Rights. This right to security encompasses "..... the right to security in the event of unemployment, sickness, disability, widowhood, old age or other lack of livelihood in circumstances beyond his control (Article 25).*

Literature has concerns about European social security system because social expenditure is huge. And if social security systems should prove to be an impediment to innovation, in the

long-term European social model would get eroded. Internationally, it is observed that collective work relationships and the welfare state cushioned the social effects of long period of fundamental industrialization (Heidenreich 2005). Expansion of educational sector was thought to raise individual employability. Employees and citizens have been overtime protected from the uncertainties of the market economy by entrepreneurial, educational, commercial and welfare state correction of market outcomes. Social security is thus an integral part of public, family, economic and labour market structures of developed countries and increasing become part of developing countries.

It is expected that innovations can be pushed more easily if more potential innovation losers are protected from the negative consequences of innovations. Education, laws against unfair dismissal or social security payments can be interpreted as insurance against risks to employment and income.

Forms of Social Security

	Individual Security	**Collective Security**
Parity of Results	Income replacement schemes (sickness and unemployment benefits etc)	Collective protection against dismissable, family ties
Equal opportunity, Employability and competitiveness	Educational facilities	Research and Development facilities and innovations

Governments are providing side payments and institutional guarantees in order to avoid possible resistance to innovations. It is argued that if the anticipated benefits of innovations are less than the anticipated costs of innovations, then potential innovators will stop their activities (Heidenreich 2005). Innovations when treated as processes of creative destruction, then they endanger previous securities. Creative destruction could be made more difficult by social protection rights for less efficient employees and businesses. Literature shows that the USA and Japan with high share of R&D expenditures have low level of social security expenditures while Scandinavian countries have high R&D and high proportion of research- intensive industries with high social expenditures. The nexus and controversy is explained through compensation hypothesis and efficiency hypothesis. Falling inequality (as in Brazil) is underpinned by a comprehensive social security system with sizeable cash transfers to the poor (OECD 2005). Therefore under-performance in poverty reduction in India calls into question the effectiveness of existing welfare safety nets and the provision of essential social services. Spending is relatively high but the system is fragmented and coverage is poor (OECD 2010).

3.1 Law and Social Security

Do legal institutions of an economy affect the pattern of its real investment and thereby economic growth? Literature is concerned with inefficiencies and rigidities associated with stringent labour laws. Recent studies show that such laws and contracts that exhibit tolerance to failure can be instrumental in fostering innovation and economic growth. The governments invariably articulate that workplace rights are holding back economic growth, even though there is precious little evidence to support its claim and a lot of countries with greater employment protection outperform others with less protection. But what if the opposite were true? Could it be that, rather than holding business back, employment protection actually improves the way companies

operate? This isn't as crazy as it might sound. It has long been received wisdom among economists and historians that one of the factors enabling western economies develops so rapidly compared to that elsewhere in the world was the rule of the law. In some societies, the total absence of order meant that there was no point in investing your surplus because it might simply be stolen. At the other extreme, in autocracies, there was no point in setting up a new venture because the ruler might decide he liked your idea and take it for himself. Only where law applied both to the rulers and the ruled was there protection for those inventing new products and developing businesses. It was because its merchants and entrepreneurs knew that their ventures could not be taken over by the ruler or stolen by robber rich that industry developed in Europe.

Could something similar be true of organizations? It is argued often that management stifles innovation. There is a lot of pressure to maintain the status quo in most organizations. Hierarchies tend to crush creativity. Could protection from arbitrary management work in the same way as protection from arbitrary rulers? Doesn't employment law offer that little bit of cover to those who speak out? Challenging the boss or coming up with ideas that threaten powerful interests is risky but at least it's illegal to sack people for it. Does employment protection provide the safety net that makes people more willing to challenge and take risks? Acharya, Baghai and Subramanian (2012) argue that by limiting employers' power to act against employees, employment law enhances employees' innovative efforts and increase the likelihood of firms investing in mould breaking projects. To demonstrate this, they compare US states with employment protection to those without it. Allowing for other variables, they found a strong correlation between innovation and the presence of employment protection. The numbers of patents filed and the amounts invested in R&D were higher in states with employment protection and, furthermore, both increased after employment laws were enacted. They conclude that laws limiting employment-at-will (or hire-and-fire) encourage employees to take risks, leading to more innovation. Dismissal laws on innovation supports arguments for enhancing employment protection in light of recent financial crisis and the extraordinary rise in the number of long-term unemployed (Rajan 2010). Laws against unfair dismissal thus lead to more innovative firms: Laws affecting employment and dismissal are an important part of the policy toolkit for promoting innovation and possibly economic growth. Acharya, Baghai and Subramanian (2012) also argue that extension of unemployment benefits when aggregate risk in the economy is high, can embolden individuals to retrain themselves for newer jobs (a form of risk-taking), boost aggregate consumption and demand, and in turn corporate investment. It is argued that dismissal laws should be disproportionately stronger in industries that exhibit a greater propensity to innovate than in other industries. It is also pointed out that some types of stringent labour laws can motivate a firm and its employee to pursue value-enhancing innovative activities (Menezes-Filho and Van Reesen 2003).

Some studies have tested the hypotheses, viz., (i) stronger dismal laws lead to greater innovation. The effect is economically significant; (ii) stronger dismal laws lead to relatively more innovation in the innovation-intensive industries than in the traditional industries and (iii) Laws governing dismal of employees influence innovation more than other dimensions of labour laws. Dismissal laws may be correlated with GDP growth/ business cycles in a country. Studies have also shown that higher economic growth rate reduces the political support for dismal laws. However, since

incumbent workers are most fearful of losing jobs during periods of slow economic growth, the political support for dismal laws should be high in such periods. In many European countries employment protection increased in the early 1970s and proved very difficult to reduce in the 1980s since this was a period of slow growth (Saint-Paul 2002). To cater to political constituencies, more left oriented governments may be inclined to strengthen labour laws (Botero *et al* 2004). Such governments are more likely to invest in education and other public services, which may have a positive impact on innovation in a country.

One can argue that a study of a few thousand firms in one country could not be taken as conclusive but the USA is the OECD country with the lowest level of employment protection at national level. That makes it an ideal laboratory for such comparisons. It's the hire-and-fire states with no employment rights that score less well on measures of innovation. And innovation is one of the major factors behind economic growth. It may well be, then, that far from holding the economy back employment protection has created safe havens for new ideas. In which case, scrapping employment protection is the last thing suggested.

4. Innovation and Indian Economy

Innovation is a key driver in enhancing growth and competitiveness of the industry and economies. The Indian government declared 2010-2020 as the decade of innovation[5] with focus on inclusive development. In this regards, Science, Technology and Innovation Policy 2013 was formulated (GoI 2013). The previous policy (STP) was initiated in 2003 that brought science and technology together and emphasized the need for investment in R&D (GoI 2003). It called for integrating programmes of socio-economic sectors with the national R&D system to address national problems as well as creating a national innovation system. With the new policy, National Innovation Council (NInC) has also been set up. It is felt that science, technology and innovation (STI) can separately exist individually in disconnected spaces. However, it is the integration that leads to new value creation. The policy articulates that India's global competitiveness will be determined by the extent to which the STI enterprises contribute to social good and/ or economic growth. The key elements of STI policy include: (i) promoting the spread of scientific temper amongst all sections of society, (ii) enhancing skill for applications of science among the young from all social strata, (iii) making careers in science, research and innovation attractive enough for talented and bright minds, (iv) establishing world class infrastructure for R&D for gaining global leadership in some select frontier areas of science, (vi) positioning India among the top five global scientific powers by 2020, (vii) linking contributions of science, research and innovation system with the inclusive economic growth agenda and combining priorities of excellence and relevance, (viii) creating an environment for enhanced private sector participation in R&D, (ix) enabling conversion of R&D outputs into societal and commercial applications by replicating hitherto successful models as well as establishing of new Public Private Partnership (PPP) structures, (x) seeding S&T based high-risk innovations through new mechanisms, (xi) fostering resource-optimized, cost effective innovations across size and technology domains, (xii) triggering changes in the mindset and value systems to recognize, respect and reward performances which create wealth from S&T derived knowledge, and (xiii) creating a robust national innovation system.

With the above in mind, the policy expects that by next five years, gross expenditure in R&D (GERD) as percentage of GDP would touch 2 percent. It can be obtained provided the private

sector raises its R&D investment to at least match the public sector R&D investment from the current ratio of around 1:3. Thus, industrial R&D was to grow by 250 percent and sales by 200 percent between 2005 and 2010. This has not happened. India currently ranks 9th globally in the number of scientific publications and 12th in the number of patents filed. The compound growth rate of Indian publications is around 12-13 percent and its global share has increased from 1.8 percent in 2001 to 3.5 percent in 2011. However, the percentage of Indian publications in the top one percent impact making journals is only 2.5 percent. By 2020, it must double and the number of papers in the top one percent journals must quadruple from the current levels. As per the Global Science Report of UNESCO, India's current global ranking is commensurate with its number of Full Time Equivalent (FTE) of R&D personnel. It is imperative that the total number of FTE of R&D personnel increase by at least 66 percent of the present strength within next five years. Also India's share in gobal trade in high trade technology products is presently only about 8 percent and the technology intensity of the sector is a low of 6-7 percent. This should double through greater technology inputs from R&D. Small and Medium Enterprises generally have low R&D intensity. The R&D in service sector is also low. This needs to be enhanced considerably and the skill base has to expand significantly.

4.1 Innovation Surveys

Government of India has initiated national innovation surveys. Innovation literature places firms at the centre of innovation. Innovations in firms refer to planned changes with a view to improving the firm's performance. A Pilot national innovation survey was conducted in 2008-09 by the Department of Science and Technology (DST) that covered 101 industrial manufacturing and service firms, spanning three year period during 2004-05 to 2006-07. It was spread over various sectors and locations in the country. The survey reveals that firms are successful in introduction of a new or signficantly improved product or process, engagement in innovation project is either ongoing or seriously delayed or projects are abondoned (24% abondoned) before the implementation of innovation (20% yet to be implemented) and expenditure is incurred in areas such as intramural R&D, acquisition of external knowledge, or machinery and equipment, training, outsourcing of R&D, market introduction or innovations and other activities such as procedures and technical preparation designing etc linked innovation activities. The share of large firms in abondoned innovation activity is considerably higher than the ongoing (or delayed) innovation. Poor performaning sectors are engineering and food, though in auto sector 50 percent of innovative projects face serious delays for implementation or get abondoned at the concept stage or in the middle stage. Internal sources in varied combinations account for more than 90 percent of the product and process innovation developed by firms. Auto, IT, paper, textiles and watches sectors utilize external sources while both external and internal sources are utilized by electronics, engineering, biotech sectors. Acquiring patented technology, knowhow or trade secret, either form of collaboration, open domestic or foreign market, is the popular external source adopted by the firms. But large firms prefer incurring onetime payment for a full set or partial or complimentary technology and which could even be licensed or purchased or borrowed. On the other hand, medium sized firms prefer having technology with agreement to upgrade and maintain including training either by financing through own or other borrowed sources (table 1).

Table 1: External Sources of Technology for Innovation and Funding (%)

External source of technology and funding category	A	B	C	All
Acquired patented tech/ knowhow/trade secret	32	16	53	58
Acquired from collaborator/ open domestic market/ foreign market	37	26	37	58
Full set technology/ partial or complimentary technology	43	29	29	42
Licensed/ purchased/ borrowed	43	21	36	42
Agreement to upgrade/ maintenance/ training	30	40	30	30
Expenditure incurred as onetime payment/ upfront/ royalties	50	25	25	24
Funds arranged from own sources/ borrowed from domestic financial institutions/private/ government funding scheme/profit sharing with supplier	23	46	31	39

Note: A, B and C are firm sizes. A- with greater than Rs.10 billion sales turnover, B- Rs.1-10 billion sales turnover and Rs.1 billion sales turnover.
Source: DST (2011).

At the sectoral level, the survey reveals that auto sector firms display relatively high preference for varied categories of external sources of technology and funding, when electronics firms show higher preference over others for the *full set of technology* and with agreement to upgrade and maintain including training catgories. The survey also shows that *new to the firm* innovations mainly considered as diffusion of innovation dominate across the firms while large firms contribute relatively high in the introduction of *new to the market* innovations. Besides, firms in sectors like auto, biotechnology, electronics and food products contribute more than 80 percent towards *new to the firm* innovation while IT and pharma firms contribute 100 percent. In case of higher degree of novelty *new to the market* innovations, relatively high contribution is made by firms in auto, biotech and electronics sectors with pharma firms contributing about 80 percent. Further, 92 percent of innovation expenditure by firms comprise of in-house R&D. It is followed by 6.4 percent on acquisition of machinery, equipment and software. Just one percent of turnover is spent on innovation (innovation intensity). Small firms spend relatively higher expenditure on acquisition of machinery, equipment and software and are more innovative than large and medium firms as reflected by their higher innovation intensity. Sector-wise innovation intensity is: biotech- 6.2 percent, engineering- 5.7 percent, paper, textiles and watches and electronics- 3 percent, IT sector- 1 percent, others- less than 1 percent. Confidentiality is the main reason why engineering, pharma, electronics sector firms depend on in-house research (> 80%), while firms in auto, chemicals and food products acquire advanced machinery, equipment and elevant software apart from doing in-house R&D for carrying out innovation activities. Also expenditure on market introduction of innovation with relatively low share is visible in few sectors like biotech, chemicals and food products. External funding (23%) is from government sources. Internal funding is largely used for the financing of human resources and training needs. Finally, the survey shows that innovation has a positive and significant impact on the firm resulting in increased range of goods and services, enhanced market share with improved quality. There is also improved flexibility of production or service provision with increased capacity and reduction in the cost per unit of output while meeting the government regulatory requirements, environmental impacts for improved health and safety. But market pressure does hinder development of innovative activities. Lack of finance within the enterprise, weak facilities for testing and research including lack of skilled manpower is cited as other important reasons of barriers to innovation by firms.

Another innovation survey was conducted of 3378 firms in ten states namely Maharashtra, Andhra Pradesh, Delhi, Rajasthan, Goa, Uttar Pradesh, Jammu & Kashmir, Punjab, Madhya Pradesh and Uttarakhand by Department of Science and Technology. This survey aimed at identifying innovative firms and their innovation related activities. The survey shows that Goa (69.79%) has highest percentage of innovative firms. Maharashtra (58.67%) closely follows it and then comes Andhra Pradesh (56.35%) and Delhi (53.85%), Rajasthan (33.88%) occupies the middle position in terms of innovative firms while Uttar Pradesh (19.73%), Jammu & Kashmir (18.82%), Punjab (14.25%), Madhya Pradesh (14.20%) and Uttarakhand (9.04%) are far behind (figure 1).

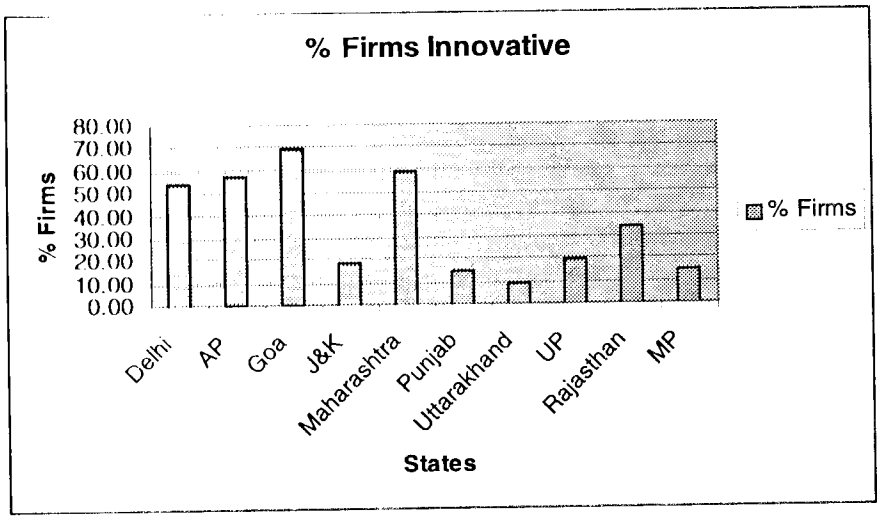

Figure 1: Source: GoI (2012)

Delhi and Punjab has the largest share (46% and 55% respectively) of firms established before 1990 and about the same percentage of these firms are innovative. Goa and Rajasthan have 45 percent firms each set up between 1990 and 2000. Uttarakhand has 74 percent firms established after 2000 and 67 percent claim innovative activities in the enterprises. J&K has 42 percent firms set up after 2000 and 58.3 percent are innovative. Firms covered by the survey reports various types of innovative activities (table 2). The involvement of firms in the innovation activities in these 10 states is quite diverse. However, main activity is acquisition of machine, equipment and software. It is interesting to note that innovative firms in Uttar Pradesh and Madhya Pradesh (both at the bottom of innovation intensity) are related to innovations. In-house R&D is more visible in the firms of Uttar Pradesh and Madhya Pradesh. On the other hand, states with higher innovation intensities like Goa, Andhra Pradesh and Delhi are mainly engaged in innovation activities related to acquisition of machine equipment and software. A few firms reported introducing their innovations to the Indian market. Madhya Pradesh, Maharashtra and Punjab are widely different in this respect where firms claim their innovations to be new to Indian as well as international market. It is revealed that innovations through introduction of new machines and product innovation are most common types of innovation. Quality and standard are important components of innovation activities. Innovations are mainly adoption of the market trend in terms of process technology, product quality machine etc. at the firm level.

Table 2: Involvement of Firms in the Activities Pertaining to Innovation (%)

Activities	1	2	3	4	5	6	7	8	9	10
Intramural R&D	24.9	37.5	38.4	39.6	52.0	25.9	41.5	45.2	63.6	33.3
Extramural R&D	2.4	13.8	3.1	12.5	28.0	20.5	15.1	11.3	28.4	10.0
Acquisition of machinery, equipment & Software	72.3	49.5	70.8	75.0	48.0	64.1	77.4	62.1	60.9	43.3
Acquisition of other external knowledge	6.6	4.9	13.4	22.9	38.0	24.1	22.6	7.3	31.1	13.3
Training	19.7	14.8	54.9	70.8	42.0	32.3	33.9	25.9	44.6	36.7
Market introduction of innovation	2.8	3.3	8.5	25.0	30.0	32.7	20.8	3.2	32.4	20.0
Other activities	2.6	0.6	8.5	22.9	34.0	45.5	20.8	0.8	25.7	3.3

Note: 1- Andhra Pradesh, 2- Delhi, 3- Goa, 4- J&K, 5- Madhya Pradesh, 6- Maharashtra, 7- Punjab, 8- Rajasthan, 9- Uttar Pradesh and 10- Uttarakhand.
Source: GoI (2012).

Firms reportedly gained from both product and process innovation in Madhya Pradesh, Maharashtra, Uttar Pradesh and Delhi while firms in other states are discrete and selective about gains. Also most innovative firms see themselves either at par or ahead of the other firms in their respective industries. Most of the gains appear to be in increased range of goods and services as outcome of the product innovation and improved flexibility of production or services as outcome of the process innovation. This is indicative of the main trends of innovation activities. Innovative firms in Maharashtra claim close interaction with institutions like universities and R&D institutions for sourcing information for innovative activities. In other states competitors in the market are the most important source of information. It indicates that innovation is more market-driven than strategy-driven. Most firms depend on own internal sources for innovation (table 3). Most firms have less than 10 technical personnel. Thus, innovative activities constitute minor part of the firm's activities. Most firms do not have any major human resource development programme either. Firms in Delhi and Maharashtra do undertake training for human resource development, though. Accessing skill development programmes outside the firm is a rarity among the innovative firms. It is only in-house training (see also figure 2).

Table 3: Sources of Finance for Innovative Firms (%)

Activities	1	2	3	4	5	6	7	8	9	10
Internal	78.40	70.87	88.41	77.08	44.00	72.73	77.36	87.10	35.14	83.33
External (foreign+ govt.)	0.00	1.65	0.00	2.08	6.00	6.82	3.77	0.81	1.35	3.33
Internal+ external	15.02	4.95	10.37	12.50	24.00	11.36	1.89	7.26	21.62	3.33
NA	6.57	22.53	1.22	8.33	26.00	9.09	16.98	4.84	41.89	10.00

Note: 1- Andhra Pradesh, 2- Delhi, 3- Goa, 4- J&K, 5- Madhya Pradesh, 6- Maharashtra, 7- Punjab, 8- Rajasthan, 9- Uttar Pradesh and 10- Uttarakhand.
Source: GoI (2012).

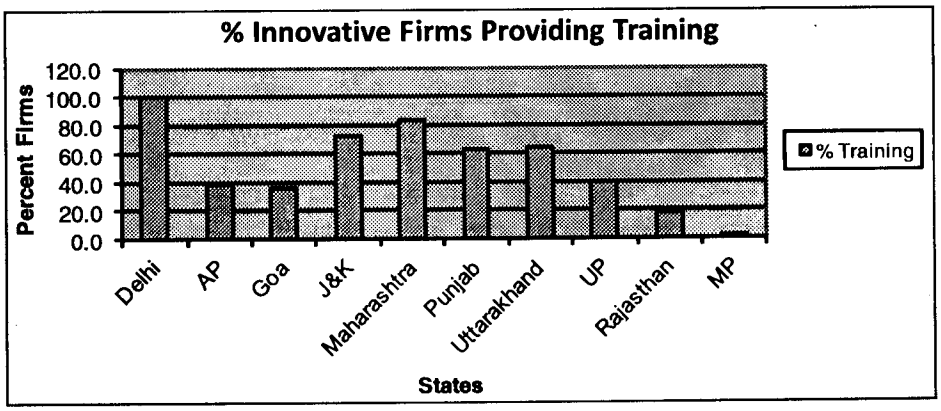

Figure 2: Source: GoI (2012)

Table 4 shows for innovative and non-innovative firms alike, cost and access to new knowledge of innovation are considered as most important factors that required to be strengthened. Madhya Pradesh firms lay similar importance to all the factors. Same is true for Maharashtra, Punjab and Uttar Pradesh.

Thus, the survey reveals that the nature of innovation differs across states in terms of sectoral pattern, types and nature of innovations. These factors together create the overall innovativeness of the state. The innovation intensity differs substantially across states. Overall status of innovative activities in the production system of a region is the result of the dynamics of the production system and the technological and non-technological support available to the enterprises. This creates innovation eco-system that has both demand and supply sides. An innovative production dynamics creates demand on the state for appropriate technological and non-technological support to facilitate and augment its own initiatives towards innovation. Such types and nature of demands depend on the overall economic status of the region/ state, industrial policy, historical pattern of growth of different sectors, entrepreneurship development etc. Institutional arrangements for addressing such demands are done at the national level as well as at the regional/ state levels[6].

Table 4: Factors Important for Influencing Innovation (%)

Activities	1	2	3	4	5	6	7	8	9	10
Cost factor										
All firms	35.4	47.0	37.0	44.7	42.9	41.6	43.3	45.9	47.7	47.0
Innovative	36.1	47.8	37.8	47.9	46.0	45.0	47.2	47.6	47.3	46.7
Knowledge factor										
All firms	33.6	40.2	43.8	43.9	43.8	41.6	45.7	41.8	46.1	47.3
Innovative	33.7	41.2	44.5	47.9	48.0	43.2	49.1	42.7	45.9	46.7
Infrastructure factor										
All firms	7.4	25.4	12.3	27.5	42.6	41.6	33.6	21.6	32.3	17.8
Innovative	10.2	25.8	14.0	22.9	44.0	28.2	39.6	22.6	32.4	23.3
Market factor										
All firms	18.5	32.0	28.1	37.6	42.0	41.6	38.7	21.6	44.8	41.3
Innovative	21.0	31.3	29.3	41.7	44.0	41.4	41.5	23.4	41.9	40.0
Others										
All firms	14.8	30.5	23.0	43.1	43.5	41.6	44.1	23.0	44.5	47.3
Innovative	18.5	29.7	26.2	47.9	40.0	38.6	45.3	22.6	37.8	46.7

Note: 1- Andhra Pradesh, 2- Delhi, 3- Goa, 4- J&K, 5- Madhya Pradesh, 6- Maharashtra, 7- Punjab, 8- Rajasthan, 9- Uttar Pradesh and 10- Uttarakhand.
Source: GoI (2012).

The survey indicates broad understanding of the reach of national innovation system (NIS), sectoral innovation system (SIS) and regional system of innovation (RIS). It is observed that accessing institutional sources of finance is a rare action by the innovative firms. Accessing institutional facilities for technological and non-technological support to innovation is significant in Uttar Pradesh followed by Madhya Pradesh and Delhi. Firms in Goa are more active in accessing information/ knowledge from R&D institutions (table 5). Accessing institutional training programme for human resources is rare. It is noted that both Uttar Pradesh and Madhya Pradesh are at the bottom and Goa is at the top in innovation intensity among ten states. The comparative status on RIS of the state is shown in table 6. Madhya Pradesh is at the bottom in all the parameters, where as Goa is at the top. Andhra Pradesh ranks low (7) in HDI but ranks high (3)

in RIS and innovation intensity ranking (3). Uttar Pradesh ranks low on RIS (10) and HDI (9) but ranks relatively better in innovation intensity (6). Punjab has low rank (8) innovation intensity but ranks higher in HDI and RIS. It appears that though Uttar Pradesh and Madhya Pradesh are better in accessing NIS components as compared to other states, they seem to fail in reflecting it in their own, this is also indicative of the fact regarding the states poor RIS. It means that NIS alone may not be sufficient always; need is to better combine NIS and RIS.

Table 5: Access of National Innovation System (NIS) by the Innovative Firms (%)

NIS component	1	2	3	4	5	6	7	8	9	10
Source of knowledge (educational institution)	6.1	19.7	12.2	45.8	76.0	59.6	37.7	15.3	67.6	30.0
Source of knowledge (R&D institution)	15.5	20.9	36.6	43.8	80.0	62.3	47.2	12.9	75.7	30.0
Institutional source of finance	14.0	6.6	8.5	14.5	30.0	17.7	5.7	8.1	18.9	6.7
Training in institutions	0.5	2.2	3.7	6.3	0.0	12.3	7.6	0.8	2.7	0.0
Novelty of innovation	64%#	76%#	51%#	66%#	72%*	19%*	52%*	88%#	69%*	60%#

Note: 1- Andhra Pradesh, 2- Delhi, 3- Goa, 4- J&K, 5- Madhya Pradesh, 6- Maharashtra, 7- Punjab, 8- Rajasthan, 9- Uttar Pradesh and 10- Uttarakhand. #- new to firm and *- new to market.

Source: GoI (2012).

Table 6: Indicative Factors of Regional System of Innovation (RIS)

States	1	2	3	4	5	6	7	8	9	10
NSDP Per capita (Rs) at constant prices 2009-10	36345	89037	98807	26739	19736	57458	43539	23669	16182	41126
Industry share in NSDP (%)	12.83	6.10	30.98	9.81	15.87	20.99	20.53	16.68	14.66	22.51
Highways per 100 sq km	1.65	4.86	7.27	0.56	1.52	1.36	3.09	1.63	2.81	3.82
Health centres per 100 villages	51.30	29.70	55.43	35.88	18.70	29.18	27.82	31.63	23.01	12.24
Educational institutions per million population	317	139	371	170	178	242	192	265	109	298
Power generation per million population	1040.30	733.00	238.20	1127.30	802.50	861.90	976.80	520.20	531.20	1152.00
Innovation intensity Rank	3	6	1	8	9	5	4	7	10	2
HDI rank	7	1	2	5	10	4	3	8	9	6

Note: 1- Andhra Pradesh, 2- Delhi, 3- Goa, 4- J&K, 5- Madhya Pradesh, 6- Maharashtra, 7- Punjab, 8- Rajasthan, 9- Uttar Pradesh and 10- Uttarakhand. States are ranked separately under each column and assigned the rank value 10 for the lowest and 1 for the highest scores. Rank values are added (unweighted) laterally to derive overall rank values.

Source: GoI (2012).

5. Conclusions

Innovations are necessary for societies to be dynamic. There is of course variety of views on the subject and macro- and micro-level studies are inclusive. Faster economic growth requires innovations and technological changes. There are issues of funding of innovation and public policies. Employment repercussions are both negative and positive and so are social security linkages. Economics of technological innovation through the prism of power and politics needs to be critically examined. Kalecki calls the *innovation effect* a *development factor.* He says they create a dynamic process. Innovations prevent the system from settling to a static position and engender a long-run upward trend. The accumulation of capital that results from the fact that long-run investment is above the depreciation level, in turn increases the scope of the influence

of the development factors and thus contributes to the maintenance of the long-run trend (Kalecki 1954)

In the Indian situation the innovation surveys show that the pattern of innovation expenditure varies significantly by firm size and industry sector. Small firms spent relatively high expenditure on non R&D activities such as investment in machinery and market introduction of innovation and are more innovative having high innovation expenditure intensity than the large and the medium firms. Firms depend highly on internal resources for financing innovation activities, including human resource development, while the external resources to a limited extent are from the government. India requires better schemes to encourage innovation in the private enterprises. Like international experience, innovation has a positive and significant impact on firms resulting in increased range of goods and services with improvization in quality and enhance market share. It also improves the flexibility of product or service provision with reduction in per unit output cost

- Earlier version of the paper was presented in the workshop on "Innovations and Development" organised by Economics Department, Punjabi University, Patiala in November 2012.

Notes

1. Jolly (1997) calls innovation process getting ideas from the *mind to the market* and puts five stages in this process: (i) *imagining* which generates technological solutions with problem-solving skills (invention), (ii) *incubating*- which develops concrete applications of the technological solutions, (iii) *demonstrating*- which tests designs and validates outcomes of technological applications, (iv) *promoting*- which positions the demonstrated technology into appropriate market, (v) *sustaining*– which improves functionality through incremental improvements.
2. Schumpter (1976) wrote "there is no more of paradox in this than there is in saying that motorcars are travelling faster than they otherwise would *because* they are provided with brakes (p.88).
3. In relation to R&D investment, economic theory propound a variety of reasons as to why there might be a gap between the external and internal cost capital: (i) asymmetric information between inventor and investor, (ii) moral hazard on the part of the inventor or arising from the separation of ownership and management, and (iii) tax considerations that drive a wedge between external finance and finance retained earnings (Hall 2002).
4. See various studies on assignment models and task -based models in this regard.
5. Address of the President of India in June 4, 2009 and Address of the Prime Minister to the 97th Session of Indian Science Congress on January 3, 2010 (http://www.parliamentofindia.gov.in).
6. There are three interconnected facets of these arrangements. Some are activated through Indian government that creates national innovation system (NIS). Another set is created at the regional/ state level by the states authority according to the states' own planning for economic; development and industrialization. It is called regional system of innovation (RIS). There are sectoral specificities of innovation too. Different sectors have different innovation dynamics. Under a particular economic, industrial and policy environment certain sectors might show more dynamism towards innovation compared to other sectors. Such sectors develop their own systems of innovation and innovation dynamics. In many cases such sectors grow in clusters that create a new innovation dynamics. It is called Sectoral Innovation System (SIS). Thus, it is possible to witness higher innovation intensity in a region even in the absence of strong RIS and NIS but in the presence of strong SIS and clusters. An effective innovation system would require large number of institutions extending various types of technological and non-technological inputs for promotion of innovation. In India, there are several initiatives through national level organizations/ institutions engaged in technology generation, technology diffusion and marketing, technological consultancy, tools equipment and prototype development, common facilities and testing centres, raw material, machine and equipment supply, finance and refinance, infrastructure development, training and skill development, entrepreneurship development etc. Many of these organizations function through the corresponding departments under state government for extending services at the state and district levels. Such arrangements are under network of NIS. While at the state level, state government is the main agent of activating the NIS, on its part state government also creates its own institutions for providing technological and financial services to enterprises. The important role played by the state government is to guide and build the industrial structure of the state, create physical infrastructure (roads and transport, power etc.) and create education and

health infrastructure for human resource development. This arrangement is a part of RIS. Clusters come into existence in various ways viz., location advantage for certain industrial sectors, led by industrial policy of the state or due to set of historical reasons. Both NIS and RIS do contribute to the growth of clusters and development of a particular sector in a particular region. But important distinctive factor is its own dynamics of growth and innovation, which might get complemented by RIS and NIS.

7. In the US and Europe, financial markets and national innovation system (NIS) are well structured to support the risky ventures for innovation

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Appendix 1: Government Education Spending in India

Year	% Total Govt. Spending		Total % GDP	Sector %		
	State	Centre		Elementary	Secondary	Higher and Others
1992-93	18.9	2.3	3.7	45.0	34.0	21.0
1993-94	18.4	2.6	3.6	46.0	33.0	21.0
1994-95	18.4	2.4	3.6	46.0	33.0	21.0
1995-96	19.1	3.5	3.6	48.0	32.0	20.0
1996-97	18.5	3.1	3.5	49.0	32.0	19.0
1997-98	18.8	3.0	3.5	50.0	32.0	18.0
1998-99	19.4	3.4	3.9	49.0	33.0	18.0
1999-00	20.3	3.6	4.2	46.0	34.0	20.0
2000-01	20.7	3.1	4.3	48.0	32.0	20.0
2001-02	17.4	3.9	3.8	50.0	32.0	18.0
2002-03	16.4	3.9	3.8	49.0	32.0	19.0
2003-04	16.4	3.6	3.5	50.0	32.0	18.0
2004-05	16.5	3.6	3.4	51.0	30.0	18.0
2005-06	17.0	4.5	3.4	53.0	29.0	18.0
2006-07	16.4	5.8	3.6	54.0	29.0	17.0
2007-08	16.2	5.4	3.7	55.0	28.0	17.0
2008-09	16.2	6.1	3.8	52.0	29.0	19.0

Source: Indian Statistical Abstract, various issues.

Appendix 2: Competitive Status of the Innovative Firms (%)

Activities	1	2	3	4	5	6	7	8	9	10
R&D	51.6	79.1	76.2	75.0	68.0	82.7	62.3	86.3	94.6	73.3
Quality of manpower employed	84.1	95.6	95.7	91.7	96.0	98.2	92.5	92.7	95.9	90.0
Technology in licensing	50.7	69.8	84.8	87.5	96.0	90.5	88.7	25.0	85.1	76.7
New collaborations	29.1	30.8	39.0	72.9	68.0	80.9	52.8	14.5	70.3	63.3
FDI	18.7	17.0	44.5	54.2	48.0	77.7	35.8	8.9	55.4	53.3
Sourcing of raw material & other inputs	87.8	91.8	90.9	93.8	90.0	94.1	92.5	94.4	95.9	90.0
Efficient cost management	93.9	94.5	96.3	91.7	96.0	95.9	94.3	86.3	98.6	80.0
Quality of machine & equipment	94.3	96.2	97.6	93.8	96.0	95.5	92.5	91.9	98.6	96.7
Efficient organizational practice	79.8	94.5	97.0	93.8	90.0	93.6	94.3	63.7	91.9	90.0
Efficient marketing arrangement	84.5	96.2	92.7	87.5	90.0	96.4	88.7	83.9	98.6	90.0
Better information management	73.2	94.5	92.1	87.5	90.0	96.4	94.3	48.4	97.3	90.0
Successful brand development	69.4	91.2	95.1	97.9	92.0	87.3	90.6	44.4	93.2	83.3

Note: 1- Andhra Pradesh, 2- Delhi, 3- Goa, 4- J&K, 5- Madhya Pradesh, 6- Maharashtra, 7- Punjab, 8- Rajasthan, 9- Uttar Pradesh and 10- Uttarakhand.
Source: GoI (2012).