APPROPRIABILITY OF INNOVATIONS IN INDIAN MANUFACTURING

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EXECUTIVE SUMMARY

1. This report is based on information collected through a survey of the R&D managers of firms belonging to the Indian manufacturing sector. The Directory of R&D Institutions compiled by the Department of Science and Technology (DST), Government of India (2010) was used extensively to obtain the contact details of the respondent firms.
2. A total of 156 firms were surveyed, with those belonging to the drugs and pharmaceuticals, chemical and chemical products, machinery, and electronics industries, represented more heavily.
3. The key questions asked in the survey related to the:
    - effectiveness of alternative appropriability mechanisms
    - total number of innovations, and the number that were patented
    - motivations to patent
    - limitations in using patents
4. Respondents were asked to rank the effectiveness of various appropriability mechanisms for capturing and protecting the competitive advantage resulting from their new products and processes, on a scale of 1 to 7, where 1 equals 'not effective', 4 equals 'moderately effective', and 7 equals 'very effective'. The alternative mechanisms were:
    - Patents
    - Other IPRs - Copyrights, Trademarks, Industrial Design Rights
    - Secrecy
    - Continuous Innovation (Lead Time)
    - Complementary Sales And Manufacturing Services
    - Technical Complexity
    - Production Scale

Consistent with earlier studies relating to developed countries, patents and other IPRs are found to be the least effective appropriability mechanisms, both for product as well as process innovations. Secrecy turns out to be of paramount importance for the majority of the firms.

5. Further, the study attempts to look more formally at the factors associated with the effectiveness of patents as an appropriability mechanism. Based on the effectiveness scores given to patents as an appropriability mechanism by the responding firms, we classify firms into two categories – those that consider patents to be important, and those that do not. Using suitable regression techniques, it is found that the importance of patents does not vary systematically with firm size or a firm's age. Patent importance increases with the innovative potential of firms, where the latter is measured by increases in their R&D expenditures. Another factor that significantly increases the probability of a firm considering patents important is whether the firm is part of a larger group. Sectoral differences were not found to be significant.
6. Patent propensity rates, defined as the number of patents per employee and alternatively as the number of patents per unit of R&D expenditures, are low across the board, with the highest values for the pharmaceuticals and chemicals sector. Group firms show higher average patent propensity rates than the non-group firms.
7. The most important motivation for firms to patent is to enhance their reputation and strengthen their position in inter-firm negotiations. The least important motivation is to earn license revenue. These results are invariant across discrete and complex industries.
8. The most significant reason for not patenting is the high costs involved, and the difficulty in proving patentability, and these results do not vary with firm size.

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PREFACE

Very little is known about the way firms in developing countries protect their innovations, and about their perceptions of the role that intellectual property rights (IPRs) play in this regard. There is an urgent need to collect data from micro-studies that inform us about the appropriability strategies of firms in developing countries. This would facilitate informed and more potent policy making. This study is an attempt to broad base our knowledge about the relative effectiveness of the various appropriability mechanisms available to firms, by adding a developing country perspective to this very important issue. Accordingly, this study conducts a survey of the appropriability mechanisms that firms employ in the Indian manufacturing sector. Analysis of the resulting data provides several insights into the phenomenon in question.

CONTENTS

1. INTRODUCTION

Innovation is more often than not the outcome of the concerted allocation of resources to R&D for long and uncertain periods of time. Thus, the R&D expenditures undertaken by firms are like investments that can be justified only on an ex-ante expectation of enhancing profitability or some alternative measure of firm performance such as productivity, stock market value, etc. The public good nature of innovation drives a wedge between the ex-ante and ex-post profitability of an innovating firm. Imitators may be able to reproduce the innovations made by firms at a fraction of the cost and time involved, thereby creating a dynamic disincentive for the innovating firm insofar as the competition erodes its ability to appropriate the entire potential profit from the innovation. Thus, ex-ante the firm will have an incentive to undertake innovative expenditures only if it expects to be able to retain the fruit of its labour. The mechanisms which enable the firm to do so are called appropriability mechanisms, and these are what we study here in the context of Indian manufacturing industries.

The importance of appropriability issues for encouraging innovation was recognized as early as Nelson (1959) and Arrow (1962). The literature in this area (Levin et al. 1987; Harabi1995; Arundel and Kabla 1998; Cohen et al. 1998; Arundel 2001) informs us that various mechanisms enable firms to appropriate the fruits of their R&D investment, including patents, trademarks, copyrights, trade secrets, complementary sales and manufacturing services, etc. The firm's perceived relative effectiveness of different methods dictates, partially, its preferred choice of appropriability mechanisms. This choice is partial insofar as factors such as scale of production and technical complexity are not quite choice variables of the firm, but are dictated (more) by the technological regime of the sector of production to which the firm belongs.

The limited effectiveness of intellectual property-related mechanisms such as patents has been the conclusion of most research in this area. Further, the developed country experience has revealed that lead time and complementary manufacturing and sales services are extremely important for appropriation, followed by secrecy, as effective alternatives to patents. However, it is important to note that this conclusion has been based almost entirely on the experience of developed countries (Levin et al. 1987; Harabi 1995; Konig&Licht1995, Cohen et al. 2000, 2001; Arundel 2001; Sattler 2002; Lauren and Salter 2005; Hanel 2005; Blind et al. 2006; Gonzalez-Alvarez and Nieto Antolin2007; Hurmelinna and Puumalainen 2007), with very little evidence available for developing countries (Gupta 2004; Hu and Jefferson 2006; Lopez and Orlicki2007).

Firms in developing countries may behave differently from those in developed countries in a number of respects. On the one hand, it appears reasonable to hypothesize that their dependence on patents is likely to be even less than that of the developed countries, simply because very few of them take out patents. However, not many have the resources to be able to maintain a lead or develop complementary manufacturing and sales services as means of appropriating the rents from whatever innovations they perform. On the other hand, the rampant corruption prevalent in developing countries like India may limit the effectiveness of secrecy as an appropriability mechanism, and could therefore make firms turn towards some other methods for ensuring appropriability. Cohen et al. (2002) found differences in the patenting behaviour between firms in Japan and the U.S indicating that differences in the external environment may be important. Additionally, the year 2005 marked the entry of India into a fully TRIPS compliant world. Through a series of amendments to its intellectual property law, executed in three tranches, the intellectual property regime has become more strict and in line with international standards. The natural question that arises then is whether this has led to a realignment of firms' appropriability strategies, tending towards the wider adoption of IP-related appropriability mechanisms. Unfortunately, there is no baseline, using which one can compare the pre-TRIPs scenario with the post-TRIPs scenario. However, post-TRIPs Indian firms have upped their commitment to innovation by increasing their R&D allocations. Therefore, one may not be absolutely mistaken in expecting an enhanced IP output leading to a greater reliance on mechanisms such as patents to ensure appropriability.

Very little is known about the way firms in developing countries protect their innovations, and about their perceptions of the role that IPRs play in this regard. There is, therefore, an urgent need to collect data from micro-studies that inform us about the appropriability strategies of firms in developing countries. This would facilitate informed and more potent policy making. For example, before offering concessions to small and medium enterprises on patent application fees it may be desirable to know whether cost is really a concern for such enterprises, or patents are in any case unimportant for these firms because they find them an ineffective appropriability mechanism. This study is an attempt to broad base our knowledge about the relative effectiveness of the various appropriability mechanisms available to firms by adding a developing country perspective to this very important issue. The study is based on data collected through a survey of R&D managers of R&D performing firms belonging to the Indian manufacturing sector. These data are also used to gain insights into the determinants of the propensity to patent, as well as to study the various motivations to patent.

Section 2 gives a brief introduction to each of the appropriability mechanisms considered. Section 3 describes the primary survey. Section 4 discusses the survey results of the relative effectiveness of the various appropriability mechanisms and the econometric exercise based on it. Section 5 lists the results for patent propensities calculated from the survey data. Section 6 and 7 analyse the responses to the questions relating to the motivations to patent and the reasons to not patent respectively. Section 8 concludes.

2. ALTERNATIVE APPROPRIABILITY MECHANISMS

As we stated above, an appropriability mechanism is a method employed by the firm to appropriate or capture the fruits of its investment into research and development or innovation, and prevent them from being captured by others. We now discuss briefly the different ways in which firms attempt to achieve this end.

2.1. *Patents*

A patent is a right granted to an innovating firm over the intellectual property it has created for a specific period of time. This right confers ownership and thus allows the innovating firm to use its innovation in any way that it wants and gives the firm the right to prevent others from using and hence benefitting from its innovation. Thus, it amounts to granting a temporary monopoly to the firm during which period the firm should be able to recover the resources that it has spent in developing the innovation. In the absence of the guarantee provided by the patent right, imitating firms would be able to imitate the innovation at a fraction of the cost of producing it, and thus rob the original innovator of his 'fair' reward for developing the innovation. This would dampen the incentives of firms to indulge in innovative activities in the first place, and thereby discourage economic growth.

One of the necessary conditions that the innovator needs to comply with in order to obtain a patent is disclosure, where the details of the innovation need to be explicitly laid down in the patent application. Society at large benefits from this disclosure, at least in principle, insofar as the innovation in question is available to other firms once the patent period expires. Other firms can then legally produce the products in question, generics being an apt example. These other firms can also base further research on the earlier innovation, and attempt to come up with newer products and processes for the benefit of mankind. Thus, the static inefficiency due to the legal monopoly that patents confer on the innovators is sought to be balanced against the dynamic efficiency that patents are designed to cause (Moschini 2002).

While patents are supposed to serve as an appropriability mechanism in this manner, in practice they may not be relevant in certain situations, and may not be the preferred choice in others. Thus, not all innovations are patentable, making patents irrelevant in such cases. Even if an innovation is patentable, a firm may choose not to patent it for a variety of reasons. For instance, a patent may be difficult to obtain since several criteria need to be satisfied for this purpose.[1] Competitor firms may be able to invent around the patent, limiting the gains from obtaining the patent, thereby rendering it a less preferred instrument of appropriation. Countering patent violations may be very difficult as in the case of process patents, and fighting patent infringements by other firms through recourse to legal action may be prohibitively costly, especially for small firms (Lanjouw and Shankerman 2004), and so on. As a result, firms often end up not choosing patents as a means of capturing the returns from their innovations, and prefer to rely on alternative methods to do so (Cohen et al. 2000, Levin et al. 1987)

2.2. *Other Intellectual Property Rights*

Intellectual property includes rights other than patents such as copyrights, trademarks and industrial design rights may also be used by firms to appropriate the returns from their innovations. A copyright gives the creator of an original work exclusive right to that work for a limited period of time. It does not cover ideas and information, but rather their expression. Trademarks are recognizable signs or indicators that business

[1] To obtain a patent, the innovation in question must satisfy the following four criteria: patentable subject matter, novelty, inventive step or non obviousness and usefulness (see Scotchmer 2004 for details).

entities use to distinguish their products and services from those of others. They take the form of symbols, logos, names, phrases, words, images, designs or some mix of these elements. Industrial design rights provide protection to the visual design of objects such as a shape, configuration or composition of pattern, colour or a combination in three dimensional forms, containing some aesthetic value. While not much attention has been paid by scholars towards copyrights and industrial design rights, there is a lot of marketing literature devoted to trademarks. Some recent economics literature has explored the relation between trademarks and innovation and the role played by them in ensuring appropriability to innovators (Schmoch 2003; Mendonca et al. 2004; Malmbeg 2005).

2.3. *Trade Secrets*

Secrecy or trade secrets are defined by Torres (2001) as *any confidential information with commercial value, reasonably protected from disclosure by its rightful holder. It could be a formula, process, device or compilation of information used in a business, which bestows the owner an advantage over competitors*. The advantage of using secrecy is that they there is no time limit to the period for which protection is provided and the threat of disclosure is nonexistent. Thus secrecy provides them 'perpetual' protection and supernormal profits, or at least till as long as their innovation remains a secret, which may be a period longer than the patent length. Applying for a patent involves disclosure of the innovation in the patent application, and this information becomes available to society at large once the patent protection expires. In other words, the innovation is protected only for a finite length of time. In addition patenting involves application and maintenance costs. Therefore, in some cases firms prefer not to apply for patents, and opt to keep the innovation a trade secret. Trade secrets such as the composition of Coco-Cola and Nutella are well-known cases in point.

Secrecy may be implemented in a variety of ways such as signing confidentiality contracts with employees, physical scrutiny of employees, limiting access to certain areas of production to family members, etc. Secrecy as a mechanism to appropriate the returns from innovation may work well for process innovations but may be of limited use for product innovations. According to Teece (1986) secrecy should be used only if a firm can put its product before the public and still keep the underlying technology secret. However, from the societal point of view, the use of secrecy has a disadvantage versus that of patents. While patents and the accompanying disclosure are conducive to the diffusion of knowledge, secrecy is dynamically inefficient insofar as it eliminates spillovers completely.

Sometimes firms may act strategically by keeping some minor but crucial element of the innovation a trade secret when patenting the innovation (Arora1987).This prevents the competition from replicating the innovation easily even after the patent has expired. Cases of inadequate disclosure have been well-documented in the literature (Merges and Nelson 1990)[2]and these amount to combining the two instruments of patents and trade secrets. Studies have also shown that patents and secrecy can play complementary roles in the appropriability strategies of firms (Hounshell and Smith 1988; Graham 2003)[3].

[2]They cite the case of Scripps Clinic and Research Foundation whose patent was invalidated on the grounds that that the innovator had failed to disclose the best mode of operation for carrying out the innovation.

[3]Houndshell and Smith (1988) described the complementarity between patents and secrecy in German dye firms. Graham (2003) reveal how the use of 'submarine patents' in the US revealed the complementarity between the two.

2.4. *Continuous Innovation* (*Lead Time*)

It has been suggested that firms whose R&D is not permanent and consistent discover a relatively smaller number of technological opportunities arising from scientific research (Malerba and Torrisi 1992; Torrisi 1998).A firm that innovates continuously is able to develop and maintain a lead over its competitors. By the time the competitors catch up with the original innovation and begin to pose a serious threat to the associated profits, the firm is ready with another innovation, which once again pushes it in the lead. Such continuous success on the innovation frontier imparts a reputation premium that enables the firm to remain in the lead. Compared to patents, where precious resources may have to be spent to detect and prove infringement, the resources allocated to developing lead time result in an expansion of the knowledge base of the firm, resulting in a virtuous cycle of innovation leading to more innovation.

2.5. *Complementary Sales and Manufacturing Services*

When a firm comes up with an innovation, it is able to leap ahead of the other firms, in terms of sales, profits, market share, etc. One way of maintaining that success is to make use of resources that competing firms may not have access to in equal measure. These resources called complementary assets by Teece (1986) consist of complementary sales and manufacturing services. For example, firms that have large networks are able to provide complementary services such as repair and after sales services at significantly lower cost than the competition. Such firms can thereby capture the market, and corner the benefits of their product innovations in the form of higher revenue, and of their process innovations in the form of greater cost savings.

2.6. *Technical Complexity*

At the time of the launch of a firm's innovation, by default it possesses a lead time over the other firms in the industry which gives it a competitive edge over the others. Crucial to the sustenance of this competitive advantage is the firm's ability to prevent other firms from imitating its innovation. As the innovation matures, i.e. it becomes freely available in the industry, competitor firms succeed in developing imitations thereby ending the firm's competitive edge. However, the time taken by an innovation to mature depends upon its technical complexity which amounts to the creation of a barrier to entry. For example, a modern airplane design typically involves 100 technical specialities such as advanced mechanics, digital information technology, knowledge about new materials etc. Crucial elements of the end product are developed during interactions between these specialities thereby involving knowledge that is largely unavailable to imitators because it "sits in the walls". It may just not be worthwhile or even possible for an imitator to put together all the 'ingredients' required to manufacture a technically complex innovation. Hence, by lengthening the time elapsed between the launch and the maturity of the innovation, technical complexity serves as a means to appropriate returns from it. Rogers (1980) and Winter (1987) use five dimensions to describe innovations, one of which is complexity.

2.7. *Scale of Production*

In some situations the requisite scale of production may help to keep out the competition. This may happen when the scale required to initiate production of the imitated product is so large that it is beyond the means of petty imitators to enter the market.

It is important to emphasize that firms do not exactly have the option to choose from the above menu of appropriability mechanisms. Some of the mechanisms are the outcome of the technological characteristics of the production process or the product itself. So in a certain area of production the production process may be technologically so complex so as to deter imitation. Similarly, scale of production may confer appropriability advantages but this is not necessarily the reason behind functioning at a certain scale of production.

3. PRIMARY SURVEY

The data for this research were obtained by conducting a survey of the R&D heads of a sample of R&D performing firms belonging to the Indian manufacturing sector. This sample was randomly selected from the firms listed in the Directory of R&D Institutions compiled by the Department of Science and Technology (DST), Government of India (2010). The DST has been compiling information on the addresses of research and development institutions since 1978 to facilitate national level surveys on the R&D activities of firms. The survey responses were obtained by conducting interviews telephonically. The firms were classified into industries at the two digit level of the National Industrial Classification(NIC 2008).The data obtained from the above-mentioned survey were used to address a number of important questions about innovation and how its gains are harnessed by firms in the Indian manufacturing industries. The key questions relate to the effectiveness of various appropriability mechanisms, the motivations to patent and the importance of the various reasons not to patent. The results of these investigations are presented and discussed in detail in the sections that follow.

4. SURVEY RESULTS:

4.1. Effectiveness of Alternative Methods of Appropriation

The purpose of the survey is to make an assessment of the methods that firms in the Indian manufacturing sector use to appropriate the returns from their innovative efforts with a special emphasis on the role of patents. The appropriability mechanisms considered are patents, other IPRs, secrecy, continuous innovation, complementary sales and manufacturing services, technical complexity and production scale. The survey requires respondents to score the effectiveness of each appropriability mechanism on a scale of 1 to 7, where 1 equals 'not effective', 4 equals 'moderately effective', and 7 equals 'very effective'.

The exact wording of the question is "Given below is a list of the means of capturing and protecting the competitive advantage of your **new products**, a result of product innovations. How effective is each one of them in your line of business?" The question is first asked for product innovations as above, and then for process innovations, where the phrase 'product innovations' in the above-stated question is replaced by 'process innovation'. Using other information collected through the survey, we subsequently analyze if there are any systematic patterns in the relative effectiveness of the different mechanisms.

The mean effectiveness scores of the different instruments used to secure the returns from product innovations are presented in Table 2, and those pertaining to process innovations in Table 3. The two sets of results are largely consistent. In brief, secrecy is considered the most effective way to appropriate the returns from an innovation, irrespective of whether it is a product or a process innovation. At the other end of the spectrum, patents and other IPRs are considered the least effective appropriation mechanisms for both product and process innovations.

For product innovations, secrecy has the highest mean respondent score of 5.8. The second highest score is for lead time or continuous innovation, an average of 5.2. The third place is occupied by complementary sales and manufacturing services (4.9), followed closely by scale of production (4.6), and technical complexity (4.2). Patents are the second least effective mechanism with a mean score of 2.4, surpassed in ineffectiveness only by 'other intellectual property rights'. However, the effectiveness scores for patents show substantially greater variability across respondents, relative to the other appropriability mechanisms (standard deviation = 2.15). The differences in the means of the various appropriability mechanisms are significant at the 5% level of significance (on the basis of paired t-tests).

One finds much the same picture with the mean effectiveness scores for process innovations. Again secrecy is revealed to be the most effective mechanism with the highest mean score of 5.5. At second place is production scale, followed closely by complementary sales and manufacturing services, lead time and technical complexity in that order, with mean effectiveness scores ranging between 4.9 and 4.1. Again, patents are in the second last slot with a mean effectiveness score that is similar to the score for product innovations (2.31), and an identically high variance. Comparing the effectiveness scores of secrecy between product and process innovations, we find that effectiveness of secrecy for protecting product innovations is significantly higher than that for process innovations, though the effectiveness of patents between product and process innovations is not significantly different.

Columns 5, 6 and 7 of Table 2 report the first, second and third quartile scores for each of the appropriability mechanisms for product innovations, and columns 5 to 7 of Table 3 do the same for process innovations. Looking at Table 2 first, we see that for product innovations there isn't much variability in the scores for secrecy. Both the first and the third quartile scores are 6, implying that only 25% of all respondents gave it a score of less than 6. This indicates that it is indeed a mechanism that the majority of firms rate highly as a means to appropriate the returns from their innovations. The maximum variability is seen in the effectiveness scores for patents; the first quartile score is 1 and the third quartile is 5, so that the middle 50% of the firms score patents between these two values. Only 25% of the respondents rate them higher than 5. Also notable is the fact that the median value is 1, so that 50% of the respondents give it a low score of 1. Similar results are seen for process innovations in Table 3; patents showing the highest inter-quartile range, and secrecy the lowest. These results indicate that secrecy is rated highly by most of the firms, whereas patents are given a low score by more than half the firms.

To our knowledge, the only other study to have looked at the effectiveness of appropriability mechanisms in the Indian context is Gupta (2004), which was limited in terms of sectoral coverage and hence the results are not directly comparable to those of our study. Gupta (2004) collected survey data for 120 firms in information technology, and concluded that the most effective mechanisms are lead time and complementary sales and manufacturing facilities. Patents were found to be as effective as complexity and secrecy.

To put our results in perspective, we briefly compare them with some international evidence. Levin et al. (1987) interviewed senior R&D managers from 650 US firms belonging to 130 different lines of business. They found that patents were considered ineffective as appropriability mechanisms in all industries except drugs and pharmaceuticals, though there were substantial differences across product and process innovations. Lead time was the most effective, followed by learning curve advantages[4], complementary assets, secrecy and then patents. Cohen et al. (2000) studied how appropriability conditions in large US manufacturing firms changed over time. The most important change was the relatively greater reliance on secrecy which now occupied a very close second place to lead time, with patents still at the end of the spectrum, although there were a handful of industries that reported high patent effectiveness. However, patent effectiveness seemed to have improved since the Levin et al. (1987) study, as the reported effectiveness was higher, at least for the larger firms.

The results from our study appear to be consistent with the studies reviewed in the previous paragraph, at least as far as patent effectiveness is considered. Patents show very limited effectiveness, both for product and process innovations. Secrecy is the most effective appropriability mechanism. One result that needs explanation is the near equivalence of the effectiveness scores and the ranking of these scores across the different appropriability mechanisms between product and process innovations. Secrecy being considered an effective appropriability mechanism for process innovations is understandable, but it is not so clear how secrecy may be effective in protecting product innovations. One explanation could be derived from the recognition that the kind of innovations taking place are not the ones that expand the frontier, rather they are the "me too" kinds that involve reverse engineering of new products and adaptation of frontier technologies. It would then make sense to protect the innovation by keeping it secret till it is launched (in the case of a product innovation). And further, for such innovators, the only way to maintain the competitive edge is to keep on innovating. This explains the close and second highest score given to continuous

[4] Learning curve advantages refers to the process where the firm is able to produce successive units of its cumulative output at lower costs due to the learning that happens from an essentially repetitive process. Since imitators cannot reap the benefits of learning, the cost and time for imitation may remain high enough to deter imitation.

innovation, in the case of product innovations. For process innovations, secrecy is followed by production scale and complementary sales and manufacturing services. Process innovations benefit the producer primarily by lowering the cost of production. The larger the scale of production, the greater the cost savings from the innovation in question, thereby making production scale an important appropriability mechanism. Thus, it appears that firms use a combination of mechanisms to appropriate the returns from their innovations.

Factor analysis is conducted to see if the data can be reduced to a smaller number of dimensions that could meaningfully and adequately capture the way firms appropriate the returns to their innovations. Factor analysis is a statistical technique that uses the correlations between observed variables to say something about underlying or latent variables referred to as factors. Potentially, the maximum number of factors is the number of variables included in the analysis but the key idea is to keep only those factors that explain a substantial part of the variation in the observed factors. The correlations between the factors and the observed variables are called factor loadings. The higher is the factor loading of a variable on a factor the greater the contribution of the factor in describing the latent variable. So the data on the effectiveness scores of the various appropriability mechanisms may be a reflection of some underlying appropriation strategies such as those based on the use of IPRs and otherwise. Factor analysis conducted on the effectiveness scores of the various appropriability mechanisms considered yields two factors which together explain a substantial percentage (78.5%) of the total variance in the correlation matrix of the observed variables. The first factor loads heavily on patents and other IPRs, the second on secrecy, continuous innovation, technical complexity and production scale. Thus the correlations between the responses to the effectiveness of the various appropriability mechanisms may be attributed to two underlying latent factors, one relating to the formal methods of appropriation and the second relating to the informal methods, some of which pertain to the regime of appropriability to which the firm belongs.

On the basis of the above results, we categorise the appropriability mechanisms into two: formal methods and informal methods. Formal methods consist of patents and other IPRs, while secrecy, continuous innovation, complementary sales and manufacturing services, technical complexity and production scale, comprise informal methods. Of the formal methods of appropriation, the one that is mostly used to protect technical innovations is patents, and hence in the analysis further on, we restrict ourselves to studying the significance of patents and its determinants.

4.2.1. Econometric Analysis:

In this section we attempt to study more formally the factors associated with the effectiveness of patents as an appropriability mechanism. As mentioned earlier, the survey requires respondents to score the effectiveness of patents on a scale of 1 to 7, where 1 equals 'not effective', 4 equals 'moderately effective', and 7 equals 'very effective'. Based on these perceptions, a new variable called patent importance (PATIMP) is created, where this variable is assigned value 0 for effectiveness scores between 1 and 4, and assigned value 1 for effectiveness scores between 5 and 7. This variable serves as the dependant variable for our econometric analysis, which given its binary nature, requires logistic regressions.

Several explanatory variables are considered. Firm size could be one possible explanatory factor. In the literature firm size as an explanatory variable is usually linked to the ability to conduct R&D i.e. in terms of the resource argument. The argument is that the larger the firm, the greater the availability of resources for R&D. An additional argument may be made in terms of the availability of other appropriability mechanisms. Smaller firms may find patenting attractive for a variety of reasons. Unlike larger firms, they typically cannot rely on large marketing networks or manufacturing capacities to appropriate the returns from their investments in innovative activities. Also, they may not have the resources to engage in continuous innovations that could build lead time for them. These factors could make them rely on patents to appropriate the returns from innovations. Patents may be employed by firms to signal quality and technological leadership, and this role may be especially important for smaller firms(Long 2002;Hsu and Zeidonis2008;Cockburn and MacGarvie 2009;Graham et al. 2010;Greenberg2013;Conti et al. 2013; Gambardella 2013; Czarnitzki et al. 2014),and even more so for smaller start-ups (Mann2005). On the other hand, many of the innovations of smaller firms may not be patentable. With arguments running in both directions, we take a preliminary look at the data to see if there is any relation between the effectiveness of patents and size of the firm.

We divide all firms into three classes based on firm size, where firm size is captured by the number of employees. Firms employing up to 500workers are classified as small firms, those employing between 500 and 2000 are classified as medium firms, and those with more than 2000 are classified as large firms. Looking at the descriptive statistics (Table 4), we find that the average firm size is 2669 employees. With 75% of the firms employing more than 500 workers, the majority of the firms in our survey belong to the category of large firms (75.6%), with 19.9% belonging to the medium category, and only 4.5% to the small category. A comparison of the mean effectiveness scores across these firm size categories shows that patents are the least effective and secrecy the most effective instrument in all categories. However, the mean effectiveness score for patents increases slightly as we move from the small to the medium to the large size classes, though the difference is not significant (see Figure 7 for product innovations, and Figure 8 for process innovations). However for the logistic estimation, we use the logarithm of the number of employees (SIZE) as an explanatory variable.

As mentioned above, firm size is often used to reflect the ability of the firm to innovate, often for the lack of a better indicator. Patents are likely to be considered more significant by firms with greater innovation potential (INPOT). The level of R&D expenditure undertaken by a firm may be considered as a measure of the intensity with which it pursues its innovation objectives, and therefore higher R&D expenditures may signify greater innovation potential. Also, larger R&D budgets may raise the average value of innovations. Therefore, it may be reasonable to expect that the larger the R&D budget of the firm, the greater the possibility of its coming up with innovations that could potentially be protected by patents. While Duguet and Kabla (1998) show that propensity to patent increases with R&D expenditures, Rassenfosse (2010) reports that an increase in the R&D budget has no effect on the patenting rate. We measure the variable innovation potential (INPOT) as the logarithms of the R&D expenditures, and expect the coefficient to be positive.

A firm may be classified into one of two categories – a group firm that is part of a larger group of firms, or a non-group firm. The business environment of an independent firm may be substantially different from that of a firm belonging to a multidivisional parent firm. A firm that belongs to a group is likely to have access to combined resources (of various kinds) of all the firms in the group. Given the lack of familiarity of most firms with the patenting process, especially of first timers, it requires specialized resources in the form of IPR departments. Firms may find patenting a cumbersome process involving intricacies that may be taken care of only by employing expensive patent attorneys. Research shows that firms may be discouraged from using patents, as acquiring them is very costly, and enforcing them costlier still (Graham et al. 2009). Lanjouw and Shankerman (2004) find that small firms are discouraged from patenting due to litigation costs. For this reason, a firm that has access to an IPR department or hires IPR attorneys is likely to be more comfortable and capable of using patents as an appropriability mechanism as compared to firms that have no regular access to such resources. Since patenting as an activity may be subject to substantial economies of scale, it is more likely that an IPR department will be available to firms belonging to a group than to a non-group firm. Therefore, it is expected that such firms will perceive patents to be an important appropriability mechanism and will also use them more intensively than others. Quite apart from the access to legal resources, group firms may be able to benefit from the combined pool of R&D expertise and facilities and various other tacit synergies that may make them more successful innovators. These differences between group and non-group firms may contribute to differences in perceptions about patents as appropriability mechanisms. To see whether the data provides any support to this hypothesis we examined the mean effectiveness scores for patents for group and non-group firms. For product innovations, group firms show a mean effectiveness score of 2.89 while non-group firms show a lower mean effectiveness score of 1.99 and this difference is highly significant (Figure 9). For process innovations also, the group firms show a higher mean effectiveness score of 2.69 compared to non-group firms (2.07), but the difference is now significant only at the 10% level of significance (Figure 10). This variable (GROUP) is defined as a dummy taking value 1 if the firm belongs to a group and 0 otherwise.

Mansfield (1986) reported that barring a few sectors such as pharmaceuticals, chemicals and petroleum, the absence of patent protection would have had no impact on innovation. Thus, while 65% of the inventions in the pharmaceuticals sector and 30% in the chemicals sector would not have happened in the absence of patent protection, this figure was reported to be less than 20% in most other sectors. Levin et al. (1987) also reported sectoral differences in patent effectiveness, with patents being considered effective only in sectors such as chemicals, biotechnology, drugs and petroleum refining. Cohen et al. (2000) also reported similar results. A variety of factors may lead to the sectoral variability of the effectiveness of patents, mostly derived from differences in the characteristics of the technology and the underlying knowledge base of the innovations seeking protection. For one, if technology is changing at a very fast pace, patent protection may not make sense as the cost of enforcing the patent may exceed the benefits there from. Then there are characteristics related to the knowledge base of the innovations to be protected, such as whether the knowledge leading to the innovation is tacit in nature or codified. Codified knowledge can be translated into a patent document whereas tacit knowledge may be better protected through secrecy. If the innovation is based on cumulative knowledge then firms that possess such knowledge acquire lead time which new entrants or imitators may find difficult to overcome. And then again the threat of imitation may be lower if the innovation has a specific use rather than a more general applicability making patents more valuable in the latter case. Since information on these aspects of technology i.e. codability, cumulativeness and specificity (González-Álvarez, and Nieto-Antolín 2007) is not available we cannot analyze their impact on patent importance separately. However, these aspects are likely to be closely related to the sector to which the innovating firm belongs. Further, sectors where technologies are characterized by huge economies of scale in research, production or marketing or by great degrees of complexity pose natural barriers to imitation reducing the need to rely on patents. To see whether such sectoral differences exist in our data, we calculate mean patent effectiveness scores at the sector level (Tables 5 and 6), and test whether these were different across the sectors. No significant differences are found. A notable point is that even the chemicals and pharmaceutical sectors show mean effectiveness scores that are just a little above the overall average and are accompanied by high effectiveness scores for secrecy and most other mechanisms considered, indicating that patents are never enough. Probing further, we look at the distribution of the data on the sectoral patent effectiveness scores. Most sectors show very low scores at the 75th percentile indicating that 75% of the firms rank patent effectiveness at very low levels. The sectors that have 75th percentile scores above 5 are chemicals, pharmaceuticals, machinery, paper and paper products, non-metallic minerals, electrical equipment, basic metals and transport equipment. Another way to identify the sectors where patent effectiveness may be relatively high is to carry out a sectoral classification of the firms that give patent effectiveness a score of 6 or 7. There are 27 such firms out of which 12, or 44%, belong to the chemicals and the pharmaceutical sectors, 4 each to the electronics and machinery sectors, the remaining to the electrical equipment, transport equipment and the basic metals sectors.

These results indicate that the significance of patents as appropriability mechanisms may differ at a relatively broader level of disaggregation. The very existence of technological opportunities may differ between sectors. According to Robson, Townsend and Pavitt (1988), certain sectors are "central" to the generation of technology as they produce a disproportionately larger number of innovations relative to others. Their taxonomy classifies all sectors into the Core and Secondary technology sectors. The Core sectors are net sources of technology and consist of the electronics, machinery and chemicals sectors. On the other hand, the secondary sectors are net users of technology and consist of sectors such as food, textiles, transport etc. Patent effectiveness is expected to be higher for the core sector than the secondary sector as the former is likely to have greater technological opportunities than the latter, leading to more innovations. The data are explored to see if it supports this hypothesis. Both for product and process innovations, we find that the core sectors show higher patent effectiveness than the secondary sectors. For product innovations, the mean effectiveness for firms belonging to the core sectors is 2.48 while that for the secondary sector is 2.13. However, the difference in the means between the two groups is not significant. Similarly, for process innovations by firms in the core sector the mean score is 2.53 and that for the secondary sector it is1.84 and this difference is significant at the 6% level of significance. To capture this difference in technological opportunities in the logistic regression we define the dummy variable technological opportunity (TECHOPP) which takes value 1 if the firm belongs to one of the core sectors as defined above and value 0 if the firm belongs to a secondary sector.

Another factor that could lead to differences in perception regarding the importance of patents is the age of the firm. The current age of the firm is calculated as the current year less the year in which the firm was incorporated. One may argue that older firms may perceive the role of patents differently from the way younger firms do. While the older firms were set up and possibly flourished in an era where intellectual property rights were either weak or irrelevant and in any case are well established now, the crop of young firms are more tuned in to the idea of intellectual property protection and hence more willing to use it as an appropriability mechanism. The age of the firm (AGE) as calculated above is used as a regressor in the estimation. Another line of reasoning could be to capture this effect in terms of a binary variable (NEW) which takes the value 1 for firms that were formed on or after 1985 and 0 for those formed before that date. The choice of the cut off date is somewhat arbitrary but may be justified in the light of the fact that the TRIPs agreement was signed in 1995. So expectations that property rights may be strengthened in the near future may have lead to the creation of some of these firms, thereby making them likely candidates that consider patents important.

4.2.2. *Results*

The results, summarized in Table 7, show the exponentiated coefficients for the variables included as explanatory variables. For a logistic regression these may be interpreted as the odds ratios. All regressions report robust standard errors. The null hypothesis that all the coefficients are simultaneously zero is rejected in all regressions. Column (1) reports the results of the model that includes the intercept and the variable firm size (SIZE). The estimated coefficient is 1.35 and highly significant. Thus, for a unit increase in the log of employee strength, we expect to see a 35% increase in the odds that the firm will consider patents important. However, the effect becomes smaller and loses significance when we augment the model to include the variable INPOT that measures the innovation potential of the firm. Thus, for a unit increase in log R&D expenditure, we expect the odds of the firm considering patents to be an important appropriability mechanism, holding all other variables constant, to increase by 46%.In the next regression, when we add the variable GROUP to the set of regressors, the results for the innovation potential variable remain largely unaltered while its own coefficient shows strong positive significance. Holding everything else constant, the odds of a group firm considering patents important are 182% higher compared to a non-group firm. Likelihood ratio tests indicate significantly improved model fit as we move from model 1 to model 3.The coefficient on the variable TECHOPP is positive but not significant, indicating that the existence or otherwise of technological opportunities has no significant impact on the probability of a firm considering patents to be an important appropriability mechanism. The data are also used to confirm whether the age of the firm matters (NEW). However, the data do not support any significant difference in the probability of young firms considering patents more important than older firms or vice versa.

5: Patent propensities

Scholars have at different times and in different contexts, measured the propensity to patent in varied ways. Scherer (1965, 1983) referred to it as the number of patents per unit R&D expenditure. Mansfield (1986) defined the propensity to patent as the percentage of innovations patented by a firm. Our survey aimed to calculate the firm's propensity to patent using Mansfield's definition by asking firms to indicate the number of innovations made in the last three years and the number thereof for which patents had been filed. One would then be able to measure the propensity to patent as a continuous variable taking values between 0% and 100%. However, during the course of the survey, it was felt that the respondents were not able to provide accurate information on the total number of innovations in a given period, and of this the number for which patents were filed. Rather they were only able to recall the total number of patents filed. These two pieces of information are not identical, nor can they be substitutes for each other, and most importantly cannot be used to calculate an exact value of the propensity to patent. For example, a situation in which the number of patents filed is equal to the number of innovations made may not imply a patent propensity of 100%. This is so because a particular innovation may be protected by more than one patent, and if a firm uses all the patents filed by it to protect perhaps its single most important innovation, then its propensity to patent is not really as high as it might first appear. Thus, capturing the propensity to patent is extremely difficult unless accurate innovation-related information is available. We, therefore, restrict ourselves to calculating patent propensities in terms of the number of patents filed.

We compute three measures of patent propensity– the number of patents filed per employee (PFE), the number of patents filed per technical employee [5](PFTE), and the number of patents filed per unit of R&D expenditure (PFRD), where R&D expenditures are measured in lakhs of rupees. Table 8 provides the summary statistics for all the three measures. The first point to note is, that the mean patent propensities for all three measures are very low – merely 0.01 for 'patents per employee' (ranging from 0 to 0.29), 0.02 for 'patents per technical employee' (ranging from 0 to 0.31), and0.03 for 'patents per unit R&D expenditure' (ranging from 0 to 0.71).

Analysing patent propensity vis-à-vis firm size, we find that domestic patents per employee decline from about 0.02 for small firms to 0 for medium and large firms (Table 9). The measure patents per technical employee, yields similar results – namely, a decline from about 0.04 for small firms to about 0.01 for medium and large firms (Table 10). The picture is a little different for patents per unit of R&D expenditure (in lakhs), as this measure first falls from 0.03 for small firms to 0.02 for medium firms, and then rises to 0.04 for large firms (Table 11).

Progressing to sectoral variations in the propensity to patent, we find that the sectors with the highest propensities are the pharmaceuticals and the chemicals & chemical products sectors, by all three measures. Thus, patents per employee for the pharmaceuticals sector are 0.016, more than three times the overall average of 0.005 (Table 12). Patents per technical employee are 0.03 for the pharmaceuticals sector and 0.026 for the chemicals sector, compared to the overall mean of 0.016 (Table 13). Finally, patents per unit R&D expenditure are higher across the board, with an overall mean equal to 0.03, and the pharmaceutical and chemical sectors showing higher than

[5] The technical workforce of the firm is the sum of the number of scientists, engineers and full time researchers employed by the firm.

average values at 0.04 and 0.06 respectively (Table 14). The other sectors that show positive patent propensities by at least one measure are computers, electronics & optical products, electrical products, transport equipment, machinery, and rubber & rubber products. Note that the propensities for these sectors are only marginally higher than their respective averages.

6. Motivations to Patent

The intellectual property protection regime, of which patents are a major component, was conceived as a solution to the problem of non-appropriability of intellectual property. Since the raison d'être of patents is to provide a mechanism to appropriate rent from innovations by preventing other firms from copying a given firm's innovations, this exclusion motive is considered to be the traditional function of patents. However, patents do not provide perfect appropriability and this is reflected in their being considered as ineffective appropriability mechanisms with firms relying on a plethora of other mechanisms to do so. At the same time, the huge surge in patenting observed worldwide posed a conundrum to researchers, who then focussed on the other roles that patents could possibly play, such as facilitating technology transfer, securing access to markets, signalling reputation, use as bargaining chips for obtaining the patents other firms possess, etc. These functions of patents may be referred to as their non-traditional functions. It is considered important to understand the alternative motivations behind patenting insofar as some of them hinder innovation and prevent its diffusion, thereby conflicting with the long term purpose of their conception.

Strategic patenting in particular may be of concern. Prevention of rivals from patenting related inventions called patent pre-emption or blocking is one of the most pervasive motives for patenting (Cohen et. al.2000). Patent blocking may take one of two forms. When the related inventions are substitutes then it may take the form of patent fencing which involves patenting (and not licensing) of variants in order to pre-empt rivals from introducing competing innovations. When the related inventions are complementary, blocking patents may be used to force inclusion into cross licensing negotiations. Hall and Ziedonis (2001) show that the huge increase in patenting in the US semiconductor industry is associated with the assembly of large patent portfolios with a purpose to prevent hold up by rival firms that own patents on technology that may be necessary for the manufacture of semiconductor chips. Such strategic patenting need not always be defensive. When firms accumulate large patent portfolios they are able to control the direction of research and the diffusion of inventions (Gallini and Trebilcock1998), or they acquire 'sleeping patents' to preserve market share (Barton 1998; Kanwar and Evenson2001).

These "other" uses to which patents may be put, are pervasive, and manifest themselves as the following disturbing outcomes:

(i) **Patent races**– where firms race against time to come up with a given innovation first. This leads to unnecessary duplication of research effort as well as over-investment in R&D which is socially wasteful.

(ii) **Patent flooding**– is a patent strategy where an incumbent firm obtains so many patents on trivial variants of the original patent that a competing firm is unable to make improvements without cross-licensing patent(s) from the incumbent.

(iii) **Patent trolling**–a phenomenon closely related to the previous one, wherein firms obtain patents exclusively with the objective of extracting settlements by accusing others of infringement. The strategy is to slap a lawsuit on the alleged infringer once the technology has been widely adopted and become something of a standard, so that the defending firm has a lot to lose.

(iv)**Fee stacking**– or transactions costs, which may result in the breakdown of negotiations in complex technology industries, and thereby prevent the commercialization of innovations. Heller and Eisenberg(1998) point out that the greater the number of patent holders who need to be brought into agreement for any downstream discovery to occur, the greater the risk that rising transactions costs or 'fee-stacking' will prevent the commercialization of that innovation. This has been referred to as the 'tragedy of the anti-commons'. It occurs where multiple owners, each with the right to exclude others from using a scarce resource, cause a situation in which no one is effectively able to use the resource. The larger the breadth of patents granted to earlier innovators, the greater the transactions costs for later innovators, limiting the appropriability of their innovations (Scotchmer1991; Green and Scotchmer1995).

None of the reasons for patenting discussed above are in keeping with the spirit of the system of intellectual property protection. Their outcome is more likely to be a stifling of innovation rather than its promotion. The extent to which patents are used strategically could vary across nations. Cohen et al. (2002) compared the motives for patenting between Japan and the US, and found that strategic patenting in the US was limited to certain sections of industry, whereas in Japan it occurred across the board. This is consistent with the results of the survey of Japanese manufacturing firms (Cohen 2001) that revealed patents as being the most effective mechanism, and secrecy the least effective, for the purpose of appropriation, which is in complete contrast to the results for the US and Europe.

The Indian Experience

Our study analyses the importance of various motives for patenting in the context of manufacturing firms in India. In the survey questionnaire ten different reasons for patenting were put before the respondents – namely, prevention of copying, prevention of other firms' attempts to patent a related invention, earning licence revenue, strengthening a firm's position in negotiations with other firms, prevention of infringement suits, as a measure of internal technological performance of the firm, firm's reputation, access to international markets, to enable tapping the capital market, and pressure to patent in competition with the patent practices of other firms. The respondents were asked to score each of the motivations on a scale from 1 to 5, where 1equals 'not important', 2 equals 'slightly important', 3 equals 'moderately important', 4 equals 'very important', and 5 equals 'extremely important'.

The 'reputation motive' was accorded the highest mean score of about 3.0, followed by 'strength in negotiations' at 2.6, and 'prevention of imitation' at third place with 2.2 (Table 16). The least important motive is to 'earn licence revenue' with a score of 1.4. Our results are similar to those of Cohen et al. (2000), insofar as patents are reported to be the least important instrument to earn license revenue. They find prevention of imitation to be the most important motivation to patent, though studies have shown other motivations to be of greater significance. Our results are also similar to those of Harabi (1995) who points out that for Swiss firms patents are more instrumental in building strength in negotiations than in preventing imitation. Hall and Ziedonis (2001) and Blind et al.(2009) find strategic motives to be more important than the traditional exclusion motive.

The importance of the reputation motive is emphasized by the remarks of many respondents in our survey. One respondent said that a patent is a "trophy of achievement" indicating high quality, but did not really provide protection against imitation. Another respondent said that "filing for a patent gives us an elevated platform, a prestige that differentiates our firm's products from those of competitors. This enables us to charge a premium price for our product". Another respondent said, that “The firm may opt for patenting just to obtain the tag of ‘applied for patenting’ in order to differentiate themselves from their competitors. Ultimately, the innovation may or may not be granted a patent, but till then some mileage would have been achieved from the application”. These comments seem to be in sync with a puzzling result in empirical literature that looks at the signalling role of patents, particularly in the context of attracting capital. While an increase in the stock of patent applications filed significantly improves the chances of a firm being financed, the impact of awarded patents is not so conclusive; they may have no impact(Haussler et al. 2009), or may increase the likelihood of receiving financial aid(Greenberg 2013).

Motivations to patent may differ across technologies. Levin et al. (1987), Merges and Nelson (1990), Kusonoki, Nonaka and Nagata (1998), and Kash and Kingston (2000) made a distinction between complex and discrete technologies. If the characteristics of the technology underlying an innovation are such that it may be decomposed into several separately patentable components, it belongs to the complex technology category. In such cases, a single firm is unlikely to have proprietary control over all the components required to develop an innovation. Similarly, the technology developed by the firm may form an essential component of another firm’s innovation. Thus, there is mutual dependence between firms, so that the utility of patents may lie more in their ability to bundle technology into parcels that firms can trade in and use as bargaining chips. Therefore, firms belonging to sectors that involve complex technologies are expected to be motivated to patent primarily to strengthen their position in negotiations. On the other hand, an innovation involving a discrete technology is one that cannot be decomposed into several separately patentable parts. The firm developing the innovation in such a case need not depend upon other firms, and hence has greater control over its innovation. The motivations for firms to patent may in such cases tilt towards patent blocking (Cohen et al. 2000).Discrete technologies are involved in the food, textiles, chemicals, drugs, metals and metal products, rubber and rubber products, paper and paper products and non-metals industries. Complex technologies are used in machinery, computers, electronics, electrical products, and transport equipment industries. In our sample, 83 firms (53% of the total) belong to the discrete group, and 73 firms (47% of the total) belong to the complex category. We found that the data does not support the hypothesis of differences in the motivations to patent between the complex and discrete technology sectors. The results are broadly similar to the aggregate results reported above. Comparisons of the mean scores across the discrete and complex categories showed no significant differences for any of the patent motives. Thus, reputation and strength in negotiations remain the two most important motivations to patent, and potential license revenue is still the least important across both groups of industries.

7. Reasons to Not Patent

Even if an innovation is patentable, it may not be patented by a firm for several reasons. A large body of literature has studied the propensity to patent (Horstmann et al.1985; Choi1990; Scotchmer and Green1990; Gallini 1992; Harter 1994; Saarenheimo 1994: Takalo 1998; Denicolo and Franzoni 2003, 2004; Anton and Yao 2004: Langinier 2005; Kultti et al. 2007). Patenting is a costly process, and a firm may not consider it a cost-effective option to patent an innovation (Graham et al. 2009), or specific innovations (Anton and Yao 2004). Lanjouw and Shankerman (2004) find that small firms are discouraged from patenting due to litigation costs. Until the seminal work of Horstmann et al. (1985), it was assumed that all patentable innovations are patented. Thus, patents were seen as a perfect indicator of the output of a firm's R&D effort, implying that the number of patents granted is identical to the number of innovations produced. Horstmann et. al. (1985) challenged this presumption based on two arguments. One reason why a firm may not want to patent is that the patent document reveals private information which competitors might use to fabricate imitations. Concern over disclosure is seen as a key reason for the propensity to patent falling short of unity. Second, even when the patent document is able to minimize disclosure, it may not be able to prevent it altogether, and competitors may be able to introduce close substitutes of the innovation that 'inspired' them. Such inventing around the patent may further reduce the firms' propensity to patent. Third, difficulty in proving patentability may be another important factor, as many of the inventions may be incremental and adaptive in nature.

In order to assess the reasons for the low usage of patents as an appropriability mechanism, our survey suggested a list of six reasons that could potentially dissuade firms from patenting, and asked them to score each on a five point Likert scale. The survey question was: "How important were the following reasons to not patent your most recent innovation?"The reasons provided were: difficulty in proving patentability, ease of legally inventing around patents, disclosure concerns, quick obsolescence making patents irrelevant, cost of patenting and difficulty in detecting and proving infringement. The respondents were asked to score each potential cause for not patenting on a scale of 1 to 5,where 1 equals 'not important', 2 equals 'slightly important', 3 equals 'moderately important', 4 equals 'very important', and 5 equals 'extremely important'.

The survey responses reveal that the most important factors that discourage patenting in our sample are the cost of patenting and the difficulty faced in proving patentability, both with average scores of about 2.8 (Table 15). At the other end of the spectrum, the least important reason was concern over disclosure.

It also became apparent during the interviews that patenting cost was a widespread concern amongst the respondents. Thus, some remarked that: the "cost of patenting becomes high when one looks at the cost of hiring extra resources, the number of reviews that happen over a period of time. Even after all that, the patent application may be rejected". Again, "We are a small company and patenting is costly and we do not want to get into such an expensive process. Patent licence fees are not so high, but patent attorneys and the other resources required for patent filing are all very expensive".

8. CONCLUSIONS

This study uses survey based information obtained from R&D managers of firms belonging to the Indian manufacturing sector to make an assessment of the importance of the alternative methods that firms use to appropriate the returns from their technical innovations. Consistent with earlier studies relating to developed countries, patents and other IPRs are found to be the least effective appropriability mechanisms, both for product as well as process innovations. Secrecy turns out to be of paramount importance for the majority of the firms. Further, no significant variation is found across either the 'core' or the 'secondary' industry groups or across the various sectors. Our study of the appropriability mechanisms used by firms in the Indian manufacturing sector suggests that the institutional specificity of the Indian economy and the policy induced changes in the appropriability environment exemplified by the changes made in Indian laws to make them TRIPs-compliant, were not potent enough to change the perceived ineffectiveness of patents as appropriability mechanisms.

Patent propensity rates defined as the number of patents per employee as well as the number of patents per unit of R&D expenditures are low across the board, with the highest values for the pharmaceuticals and chemicals sector. Patent propensity rates are higher for the core sector than for the secondary sector. Also, group firms show higher average patent propensity rates than the non-group firms.

The most important motivations for firms to patent areto enhance their reputation and strengthen their position in inter-firm negotiations. The least important motivation is to earn license revenue. These results do not change even when a distinction is made between discrete and complex industries. The most significant reason for not patenting is the high costs involved, and the difficulty in proving patentability, and these results do not vary with firm size.

Patent importance at the firm level is assessed by an econometric analysis of firms' perceptions about the effectiveness of patents as an appropriability mechanism. It is found that patent importance does not vary systematically with firm size. Patent importance increases among firms as their innovative potential increases as measured by increases in their R&D expenditures. Another factor that significantly increases the probability of a firm considering patents important is group membership. Sectoral differences are not significant at any level of disaggregation and neither is the age of the firm.

However, the absence of sectoral differences suggested by the survey results cannot be generalized primarily because of the paucity of data. Even as it has been mentioned in the literature that the response rates for corporate surveys are very low, we must mention that obtaining the 156 survey responses was extremely challenging. Given that the thrust of the survey was to capture firm perceptions, the ideal method to collect data would have been the interview mode. However, the pan India spread of the firms made the interview option economically infeasible. We therefore turned to e-responses but were faced with a near zero response rate. The method that eventually gave us the responses were telephonically conducted interviews. Needless to say, there were numerous constraints such as the duration for which such interviews can be conducted without losing the interest and focus of the respondent. This change in the strategy led us to shorten the questionnaire considerably, resulting in the loss of substantial auxiliary information that may have been potentially useful. In the light of these challenges, this study may be seen to be of greater value in raising questions than providing generalizable answers. These questions may then be framed as hypothesis that can be tested using an augmented dataset.

Recommendations

1. The Government of India should make it mandatory for firms to report any R&D activity that they undertake, on an annual basis. The firms should be required to report information on their R&D expenditures, R&D personnel, any innovations (product or process) that they introduce, and any formal instrument of intellectual property protection that they employ. By implication, 'zero' entries for such fields would indicate the absence of any deliberate R&D activity on the part of the firms.

   Our survey revealed that firms are often not willing to part with such data to random researchers, and yet its availability would go a long way in helping researchers study the phenomenon of invention and innovation in the Indian context, and in designing public policy in this context.

2. The Government of India should undertake a programme to inform and educate entrepreneurs about:

   (a) the different methods of protecting innovations, formal and informal,

   (b) the procedure involved in seeking formal protection, and

   (c) the costs involved in protecting them formally at any given point of time.

   This is necessitated by our finding that entrepreneurs/R&D managers were often unaware of the full menu of appropriation mechanisms available to them. Such knowledge could go a long way in boosting the formal protection of innovations.

3. The Government of India should introduce the system of utility models or petty patents that several developed countries such as Germany and Japan have had, and some developing countries such as China have also adopted. Given the small

nature of many of the innovations involved in the Indian context, as our survey also revealed, this would be an appropriate mechanism of protection. Further, it would also involve lower costs of protection, given its less stringent examination procedure.

4. The Government of India should study the elements of the cost of formal protection of innovations, and deliberate on the possibility of reducing it for ‘small’ firms and individuals, while charging higher rates from ‘large’ firms.

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TABLE 1

CLASSIFICATION OF SURVEYED FIRMS BY SECTOR

Sector	NIC Code	Number of firms	Percentage of all firms
Food products	10	4	2.6
Tobacco products	12	1	0.6
Textiles	13	4	2.6
Leather and leather products	15	1	0.6
Paper and paper products	17	4	2.6
Coke and petroleum products	19	1	0.6
Chemicals and chemical products	20	26	16.7
Pharmaceuticals	21	28	17.9
Rubber and plastic products	22	6	3.8
Non-metallic mineral products	23	2	1.3
Basic metals	24	3	1.9
Metal products	25	4	2.6
Electronics and Optical Products	26	21	13.5
Electrical equipment	27	15	9.6
Machinery	28	22	14.1
Transport equipment	29	13	8.3
Other transport equipment	30	1	0.6
All firms		156	100

TABLE 2						
SUMMARY STATISTICS FOR EFFECTIVENESS SCORES OF APPROPRIABILITYMECHANISMS: PRODUCT INNOVATIONS:						
Appropriation Mechanism	Observations	Mean	Standard Deviation	First Quartile	Median	Third Quartile
SECRECY	156	5.821	1.178	6	6	6
LEAD_TIME	156	5.212	1.181	5	6	6
COMPLEMENTARY_SERVICES	156	4.891	1.375	4	5	6
SCALE	156	4.590	1.553	4	5	6
COMPLEXITY	156	4.192	1.301	3	4	5
PATENTS	156	2.378	2.150	1	1	5
OTHER_IPRs	156	2.051	1.692	1	1	3

TABLE 3						
SUMMARY STATISTICS FOR EFFECTIVENESS SCORES OF APPROPRIABILITY MECHANISMS: PROCESS INNOVATIONS:						
Appropriation Mechanism	Observations	Mean	Standard Deviation	First Quartile	Median	Third Quartile
SECRECY	142	5.514	1.357	5	6	6
SCALE	142	4.873	1.496	3	5	6
COMPLEMENTARY_SERVICES	142	4.704	1.352	4	5	6
LEAD_TIME	142	4.282	1.456	3	4	6
COMPLEXITY	142	4.134	1.354	3	4	5
PATENTS	142	2.317	2.043	1	1	5
OTHER_IPRs	142	2.042	1.637	1	1	2

TABLE 4 : SUMMARY STATISTICS

Variables	N	Mean	Min	Max	First Quartile	Median	Third Quartile
Continuous							
Employees	156	2669	42	12000	500	1225	4382.5
R&D Expenditures(in Rs Lakhs)	151	696	2.82	35500	30	67	200
Age(years since incorporation)	155	40	7	213	23	32	50
Ordinal							
Patent Importance (%)	156	26.28	0	1	0	0	1
Group membership (%)	156	40.38	0	1	0	0	1
Core Sector (%)	156	71.15	0	1	0	1	1

TABLE 5

Sectoral Summary Statistics for Patent Effectiveness scores: Product Innovations

Sector	Observations	Mean	Standard Deviation	First Quartile	Median	Third Quartile
Chemicals & chemical products	26	2.46	2.32	1	1	6
Computer, electronics &optical	21	2.43	2.20	1	1	4
Electrical equipment	15	2.33	2.06	1	1	5
Food products	5	1.00	0.00	1	1	1
Machinery	22	2.50	2.28	1	1	5
Metal & metal products	7	2.14	2.04	1	1	4
Non metallic minerals	2	3.50	3.54	1	3.5	6
Paper & paper products	4	2.00	2.00	1	1	3
Pharmaceuticals	28	2.54	2.35	1	1	5
Rubber & plastic products	6	2.33	2.07	1	1	5
Textiles & leather products	5	1.00	0.00	1	1	1
Transport equipment	14	2.86	2.28	1	1	5
All sectors	156	2.38	2.15	1	1	5

TABLE 6

Sectoral Summary Statistics for Patent Effectiveness Scores: Process Innovations

Sector	Observations	Mean	Standard Deviation	First Quartile	Median	Third Quartile
Chemicals & chemical products	24	2.46	2.19	1	1	5
Computer, electronics &optical	15	2.53	2.39	1	1	6
Electrical equipment	13	2.62	1.94	1	2	5
Food products	5	1.40	0.89	1	1	1
Machinery	22	2.00	2.00	1	1	1
Metal & metal products	6	1.83	2.04	1	1	1
Non metallic minerals	2	3.50	3.54	1	3.5	6
Paper and paper products	4	2.00	2.00	1	1	3
Pharmaceuticals	26	2.92	2.24	1	1	5
Rubber & plastic products	6	1.67	1.63	1	1	1
Textiles and leather products	5	1.00	0.00	1	1	1
Transport equipment	14	2.14	1.92	1	1	4
All Sectors	142	2.32	2.04	1	1	5

TABLE 7

Logistic Model Estimates for Patent Importance (odds ratios)

Model	[1]	[2]	[3]	[4]	[5]
SIZE	1.35**	1.19	1.08	1.1	1.12
	[0.163]	[0.168]	[0.168]	[0.171]	[0.169]
INPOT		1.460***	1.479***	1.471***	1.48***
		[0.106]	[0.114]	[0.118]	[0.118]
GROUP			2.817**	3.096***	3.06***
			[0.406]	[0.414]	[0.419]
TECHOPP				1.77	1.71
				[0.469]	[0.471]
NEW					1.32
					[0.395]
Constant	0.040***	0.16***	0.020***	0.011***	0.009***
	[0.043]	[0.189]	[0.0234]	[0.014]	[1.441]
N	156	151	151	151	151
Log likelihood	-87.52	-78.29	-75.16	-74.39	-74.17
Model Chi Square	4.67***	15.93***	22.20***	23.74***	24.18***
Psuedo R Square	0.026	0.092	0.1287	0.1376	0.1402

a. The reference firm is a non group firm
b. The reference firm belongs to a secondary sector
c. the reference firm is an old firm

d. Robust Standard Errors reported

TABLE 8: Summary Statistics for Patent Propensities

Variable	Observations	Mean	Standard Deviation	Min	Max
Domestic Patents per employee	156	0.01	0.0	0	0.29
Domestic Patents per technical employee	156	0.02	0.1	0	0.31
Domestic Patents in lakhs of R&D expenditure	151	0.03	0.1	0	0.71
Foreign Patents per employee	156	0	0.0	0	0
Foreign Patents per technical employee	156	0	0.0	0	0
Foreign Patents in lakhs of R&D expenditure	151	0.01	0.1	0	1

TABLE 9						
PATENT PROPENSITY BY FIRM SIZE (Domestic patents per employee)						
Firm Size Category	**N**	**Mean**	**Standard Deviation**	**First quartile**	**Median**	**Third quartile**
Small	38	0.02	0.05	0	0	0.01
Medium	50	0.00	0.01	0	0	0
Large	68	0.00	0.01	0	0	0
Overall	156	0.01	0.03	0	0	0

TABLE 10						
PATENT PROPENSITY BY FIRMSIZE (Domestic patents per technical employee)						
Firm Size Category	**N**	**Mean**	**Std Dev**	**First Quartile**	**Median**	**Third Quartile**
Small	38	0.04	0.08	0	0	0.01
Medium	50	0.01	0.04	0	0	0
Large	68	0.01	0.03	0	0	0.01
Overall	156	0.02	0.05	0	0	0.005

TABLE 11						
PATENT PROPENSITY BY FIRM SIZE (Domestic patents per lakh R&D expenditure)						
Firm Size Category	N	Mean	Std Dev	First Quartile	Median	Third Quartile
Small	35	0.03	0.07	0	0	0.01
Medium	50	0.02	0.10	0	0	0
Large	66	0.04	0.09	0	0	0.02
Overall	151	0.03	0.09	0	0	0.01

Table 12

Patent Propensity by Sector (Patents per employee):

Sector	N	Mean	Std Dev	First Quartile	Median	Third Quartile
Food Products	5	0	0	0	0	0
Textiles and leather products	5	0	0	0	0	0
Paper and paper products	4	0.003	0.01	0	0	0.005
Chemicals and chemical products	26	0.004	0.01	0	0	0
Pharmaceuticals	28	0.016	0.05	0	0	0.01
Rubber and plastic products	6	0	0	0	0	0
Non metallic mineral products	2	0	0	0	0	0
Metal and metal products	7	0	0	0	0	0
Computer, electronics and optical products	21	0.005	0.01	0	0	0
Electrical equipment	15	0.005	0.02	0	0	0
Machinery	22	0	0	0	0	0
Transport equipment	14	0.005	0.01	0	0	0
All	**156**	**0.005**	**0.025**	**0**	**0**	**0**

Table 13

Patent Propensity By Sector
(Patents per technical employee)

Sector	N	mean	Std Dev	First Quartile	Median	Third Quartile
Food Products	5	0	0	0	0	0
Textiles and leather products	5	0	0	0	0	0
Paper and paper products	4	0.003	0.01	0	0	0.01
Chemicals and chemical products	26	0.026	0.07	0	0	0.01
Pharmaceuticals	28	0.030	0.07	0	0	0.02
Rubber and plastic products	6	0.002	0.00	0	0	0.00
Non metallic mineral products	2	0.005	0.01	0	0.01	0.01
Metal and metal products	7	0.003	0.01	0	0	0.01
Computer, electronics and optical products	21	0.018	0.04	0	0	0.00
Electrical equipment	15	0.018	0.06	0	0	0.00
Machinery	22	0.004	0.01	0	0	0.00
Transport equipment	14	0.018	0.05	0	0	0.00
Total	**156**	**0.016**	**0.05**	**0**	**0**	**0.01**

Table 14

Patent Propensity by Sector
(Patents per one lakh of R&D expenditure)

Sector	N	mean	Std Dev	First Quartile	Median	Third Quartile
Food Products	5	0.00	0.00	0	0	0.00
Textiles and leather products	5	0.00	0.00	0	0	0.00
Paper and paper products	4	0.03	0.05	0	0	0.05
Chemicals and chemical products	23	0.06	0.16	0	0	0.02
Pharmaceuticals	28	0.04	0.07	0	0	0.02
Rubber and plastic products	6	0.04	0.10	0	0	0.00
Non metallic mineral products	2	0.01	0.01	0	0.01	0.02
Metal and metal products	4	0.03	0.07	0	0	0.07
Computer, electronics and optical products	19	0.04	0.09	0	0	0.01
Electrical equipment	14	0.03	0.09	0	0	0.01
Machinery	22	0.03	0.09	0	0	0.01
Transport equipment	14	0.01	0.02	0	0	0.00
Total	**151**	**0.03**	**0.09**	**0**	**0**	**0.01**

Table 15

Comparison of patent propensities across core and secondary sectors

	Mean propensity	
Patent propensity	Core	Secondary
patents per employee	0.006	0.001
patents per technical employee	0.020	0.006
patents per unit R&D expenditure	0.039	0.013

Table 16

Motivations to Patent: Summary Statistics

Motivation to Patent	Mean	Standard Deviation	First Quartile	Median	Third Quartile
Prevent copying	2.19	1.50	1	1	4
Prevent other firms from patenting related invention(s)	2.10	1.44	1	1	3
Earn license revenue	1.42	0.92	1	1	1
Strengthen negotiating position	2.64	1.51	1	3	4
Prevent infringement suits	1.93	1.14	1	2	2
Measure of internal performance of the firm's technologists	1.91	1.15	1	1	2
Reputation	2.99	1.56	1	4	4
Opening up of international markets	2.11	1.47	1	1	4
Tap capital markets	1.96	1.19	1	1.5	2.5
Forced to patent due to other firms' patenting	1.52	1.02	1	1	2

TABLE 17

REASONS NOT TO PATENT: SUMMARY STATISTICS

Reasons not to patent	Mean	Standard Deviation	First Quartile	Median	Third Quartile
Difficulty in proving patentability	2.76	1.52	1	4	4
Ease of inventing around a patent	2.45	1.50	1	2	4
Concern of disclosure	1.86	1.44	1	1	3
Fast pace of technology	2.07	1.30	1	2	3
Cost of patenting	2.77	1.50	1	3	4
Difficulty in detecting infringement	2.52	1.47	1	2	4

Figure 1: Mean Effectiveness Scores: Product Innovations

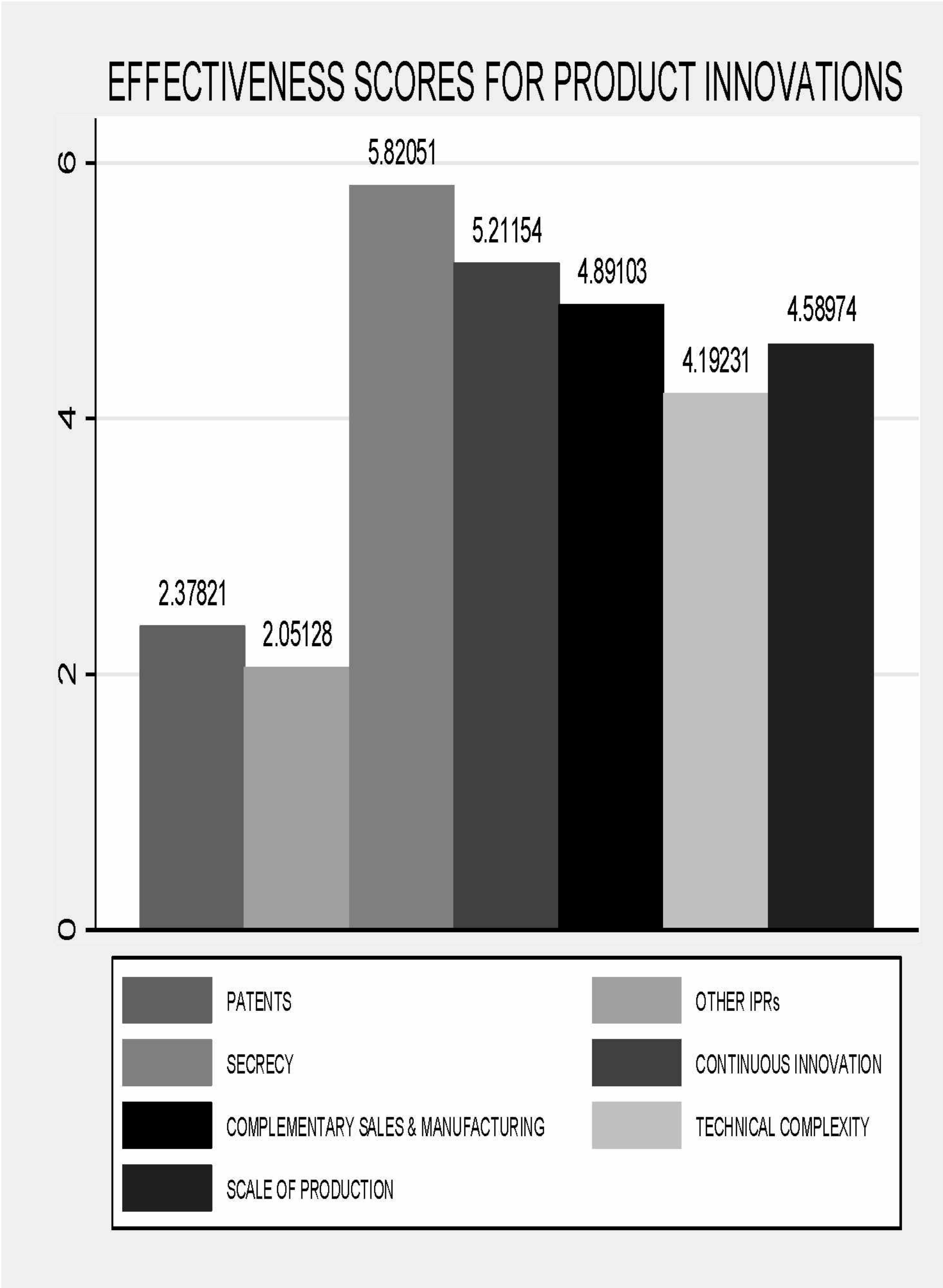


Figure 2: Mean Effectiveness Scores: Process Innovations

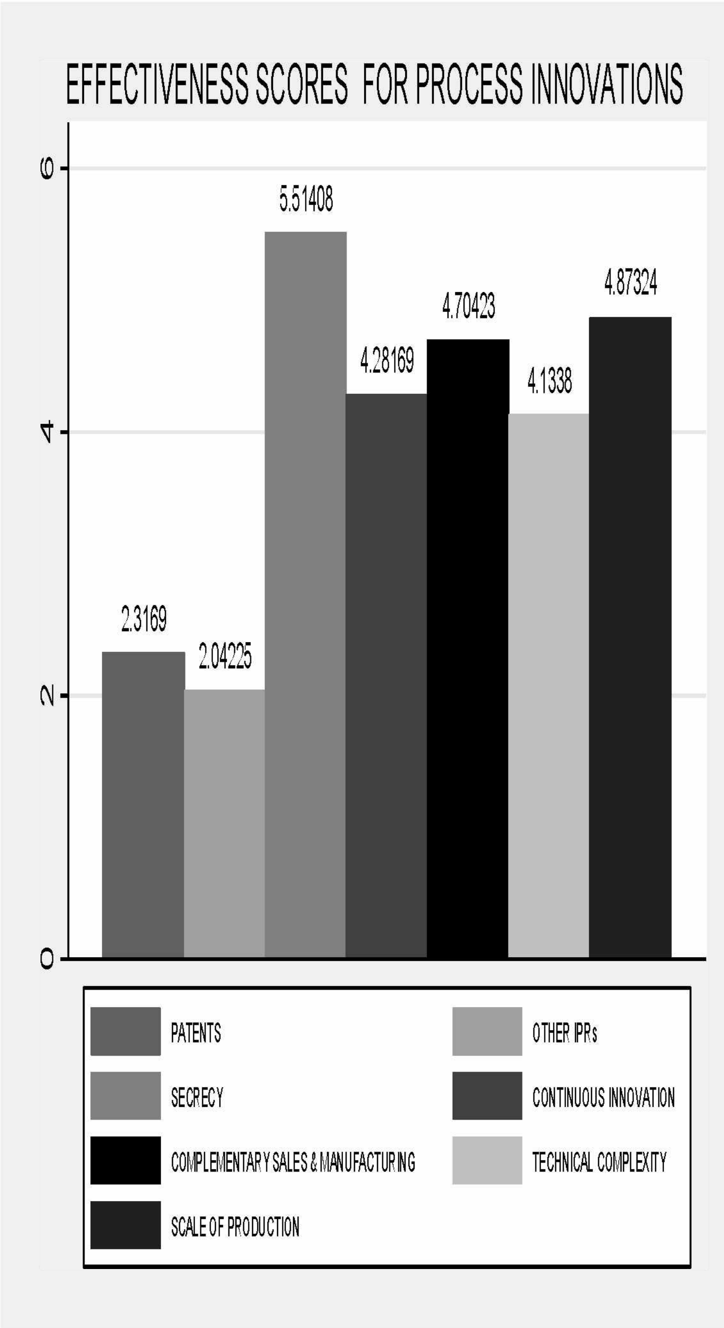


FIG 3: MEAN EFFECTIVENESS SCORES FOR PRODUCT INNOVATIONS
PATENT UNINTENSIVE VS. PATENT INTENSIVE SECTORS

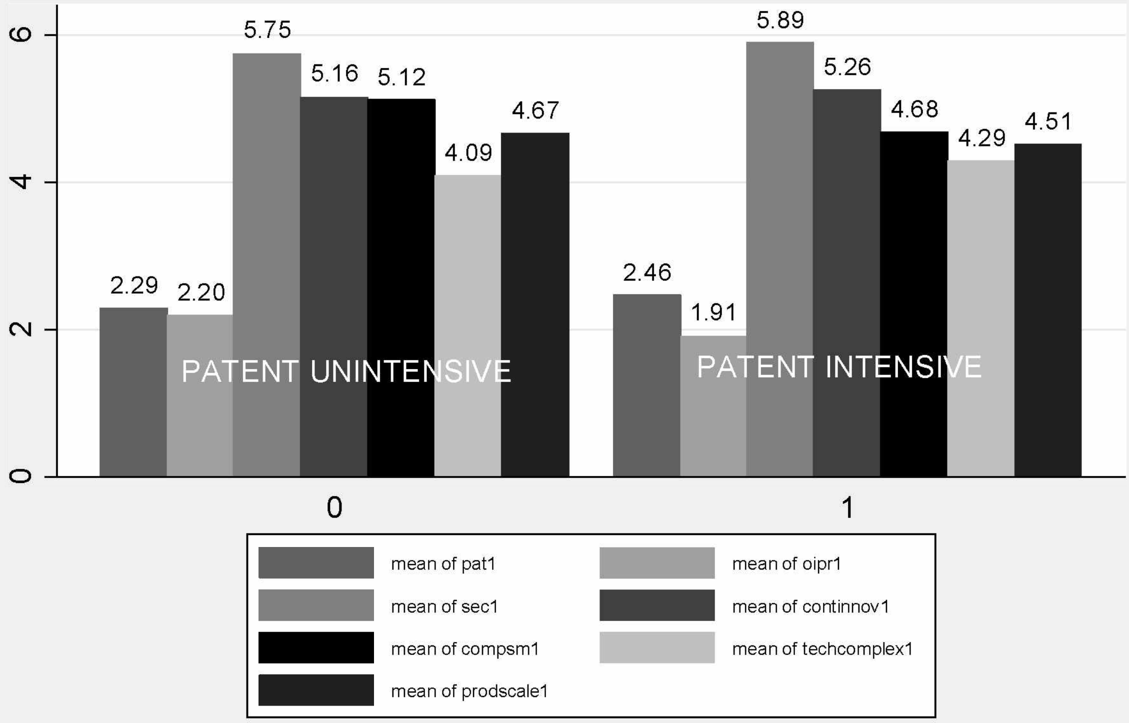


FIG 4: MEAN EFFECTIVENESS SCORES FOR PROCESS INNOVATIONS
PATENT UNINTENSIVE VS. PATENT INTENSIVE SECTORS

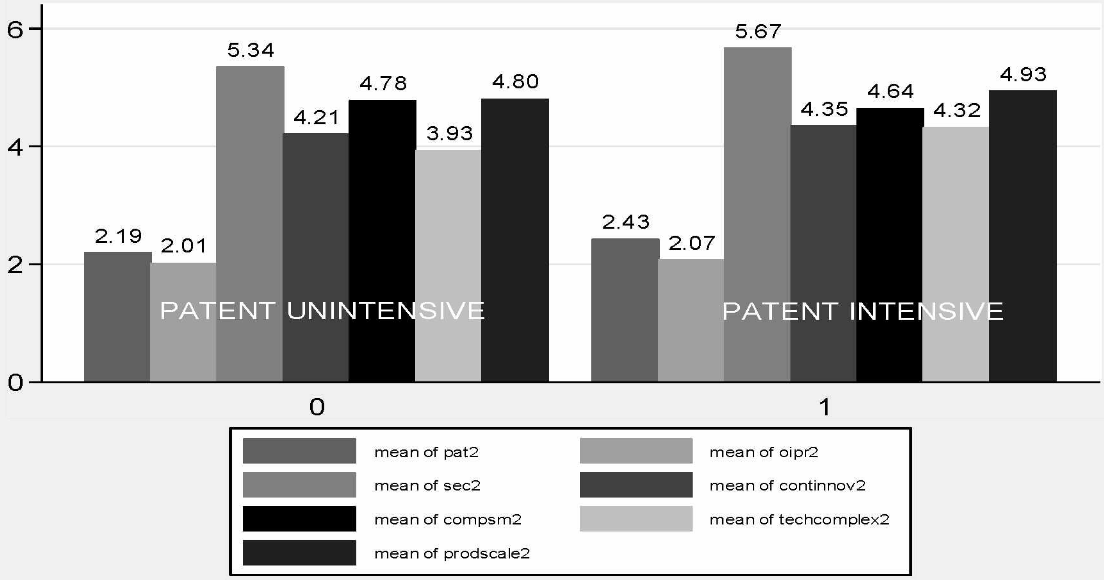
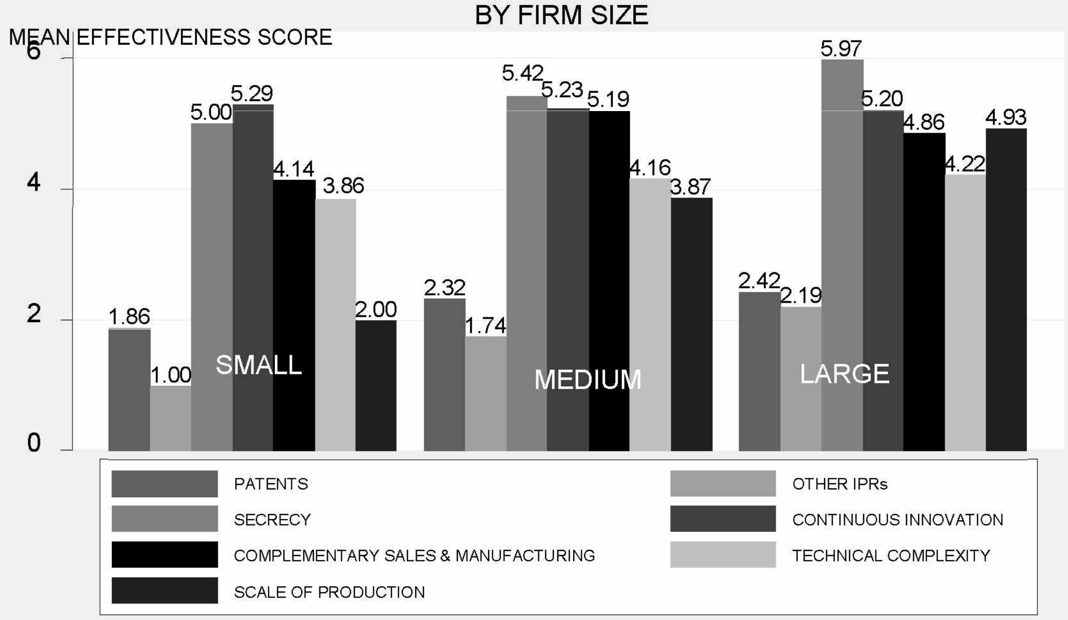
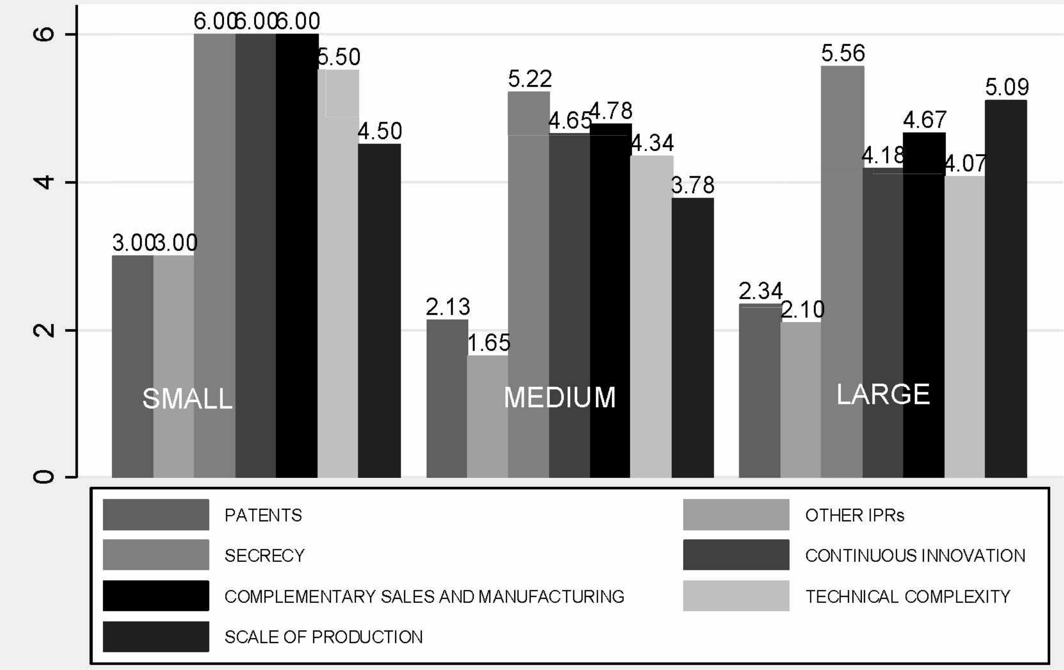


FIG 5: MEAN EFFECTIVENESS SCORES FOR PRODUCT INNOVATIONS BY FIRM SIZE

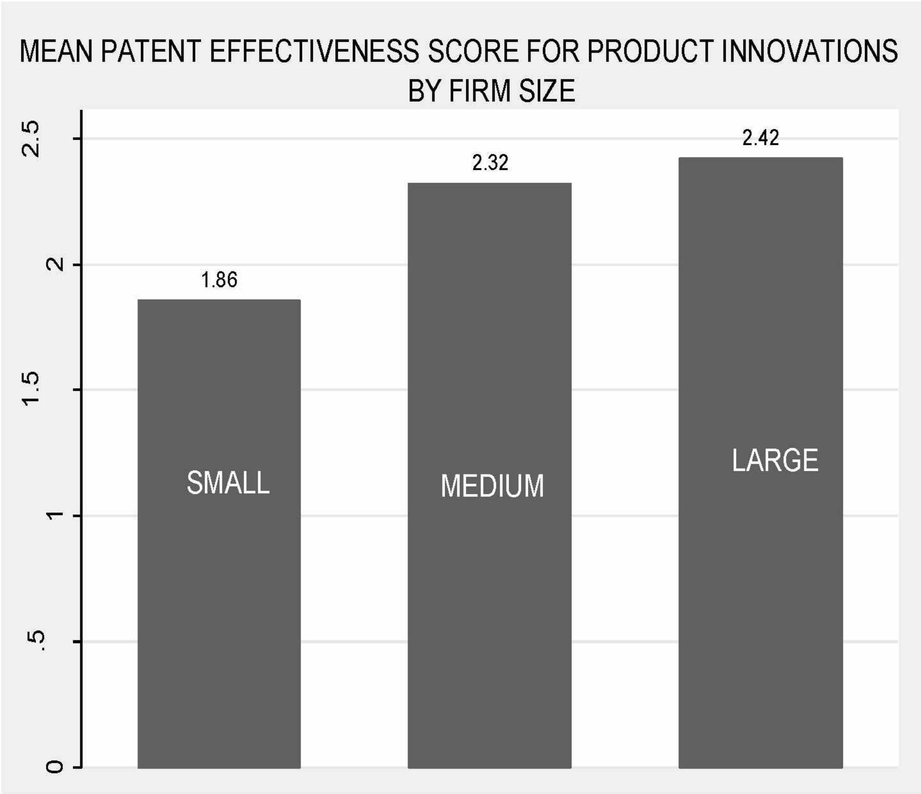


SMALL FIRMS- THOSE EMPLOYING LESS THAN 100 WORKERS; MEDIUM- 100-500 WORKERS; LARGE - ABOVE 500 WORKERS

FIG 6: MEAN EFFECTIVENESS SCORES FOR PROCESS INNOVATIONS BY FIRM SIZE



SMALL FIRMS- EMPLOYING UPTO 100 WORKERS; MEDIUM- 100-500 WORKERS ;LARGE- ABOVE 500 WORKERS


MEAN PATENT EFFECTIVENESS SCORE FOR PRODUCT INNOVATIONS BY FIRM SIZE
0
.5
1
1.5
2
2.5
1.86
2.32
2.42
SMALL
MEDIUM
LARGE

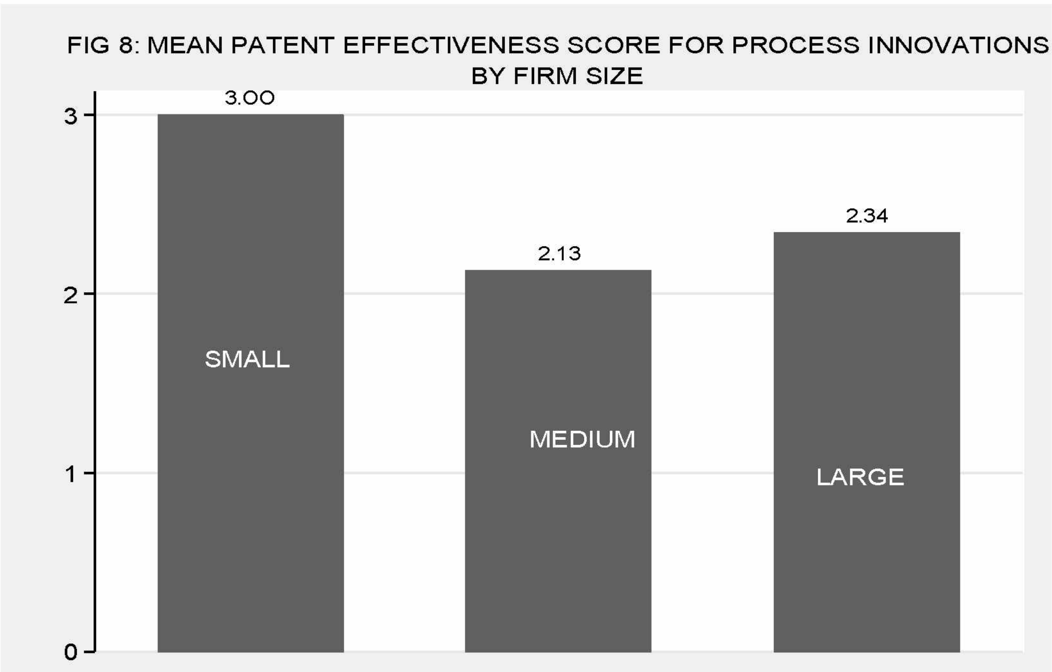


FIG 8: MEAN PATENT EFFECTIVENESS SCORE FOR PROCESS INNOVATIONS BY FIRM SIZE
0
1
2
3
3.00
2.13
2.34
SMALL
MEDIUM
LARGE

FIG 9:MEAN PATENT EFFECTIVENESS SCORE FOR PRODUCT INNOVATIONS
GROUP FIRMS VS NON GROUP FIRMS

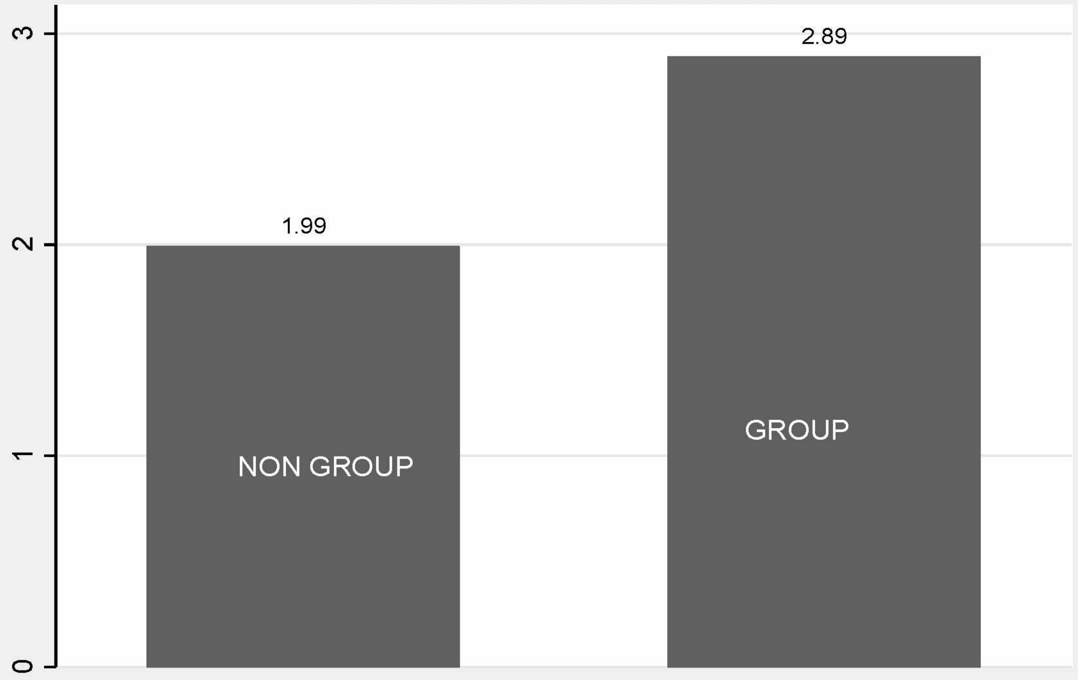
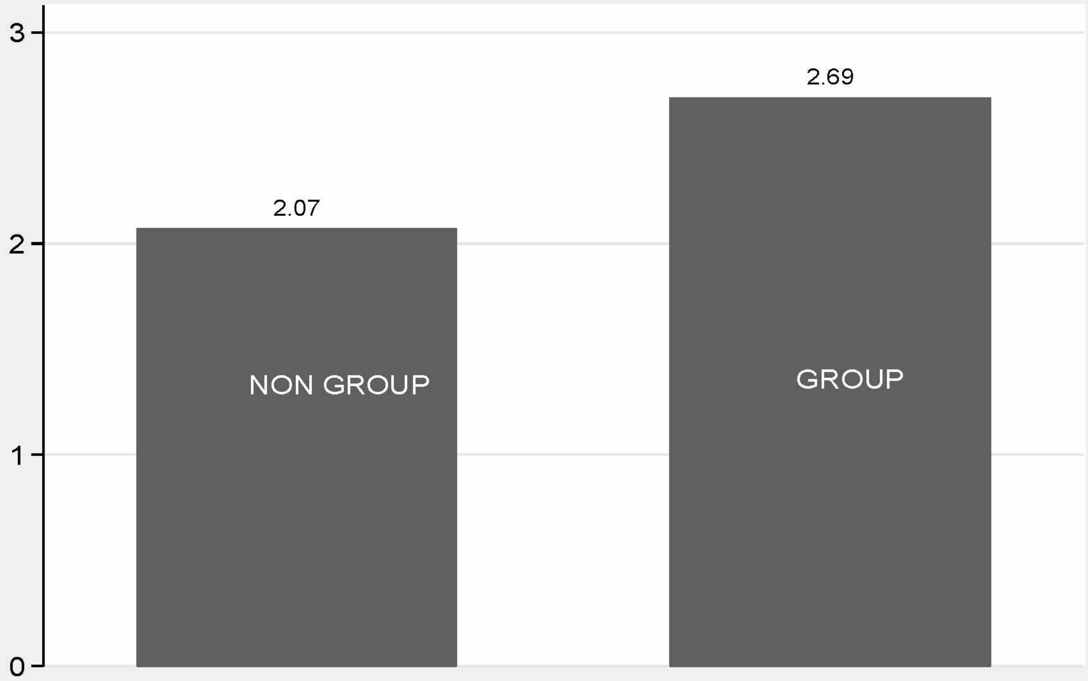


FIG 10:MEAN PATENT EFFECTIVENESS SCORE FOR PROCESS INNOVATIONS
GROUP FIRMS VS. NON GROUP FIRMS



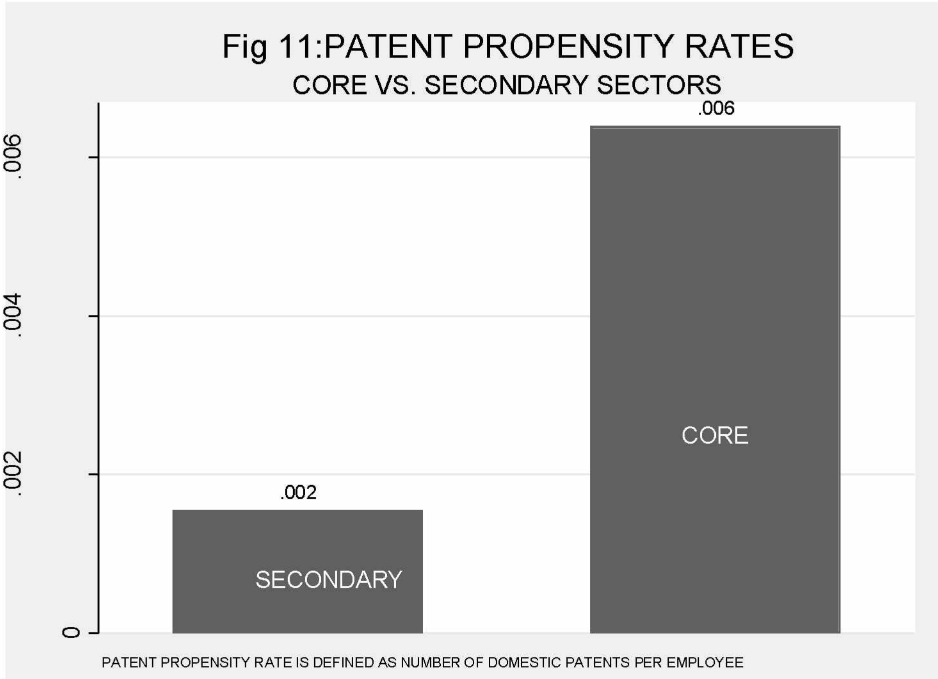


Fig 11:PATENT PROPENSITY RATES
CORE VS. SECONDARY SECTORS
.006
.004
.002
0
.002
SECONDARY
.006
CORE
PATENT PROPENSITY RATE IS DEFINED AS NUMBER OF DOMESTIC PATENTS PER EMPLOYEE

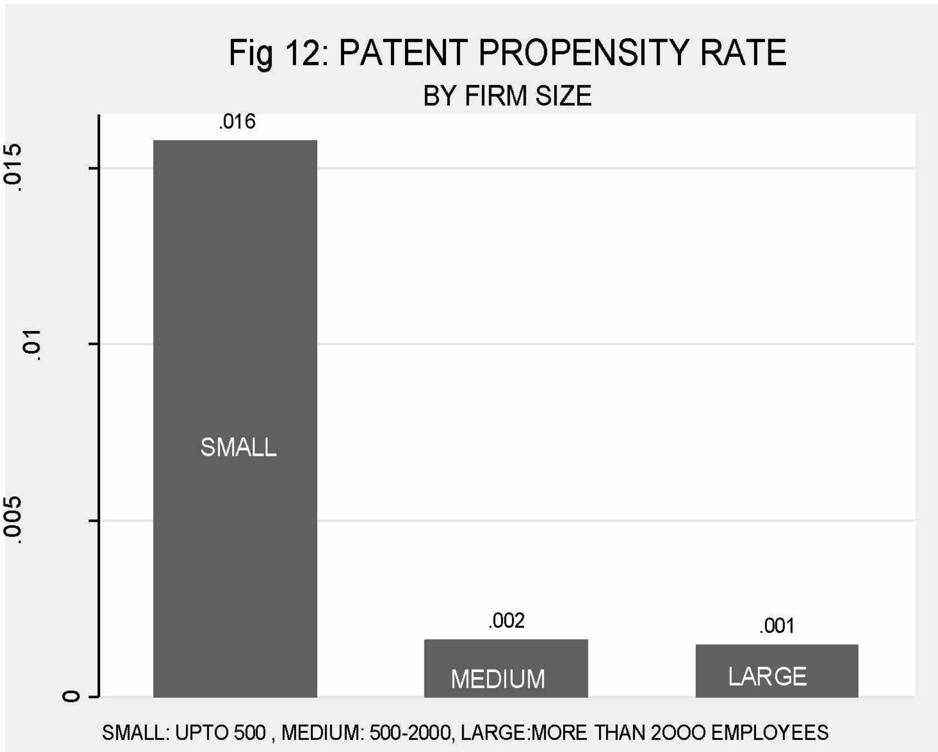


Fig 12: PATENT PROPENSITY RATE
BY FIRM SIZE
.015
.01
.005
0
.016
SMALL
.002
MEDIUM
.001
LARGE
SMALL: UPTO 500 , MEDIUM: 500-2000, LARGE:MORE THAN 2OOO EMPLOYEES

Fig 13: PATENT PROPENSITY RATE
BY FIRM SIZE

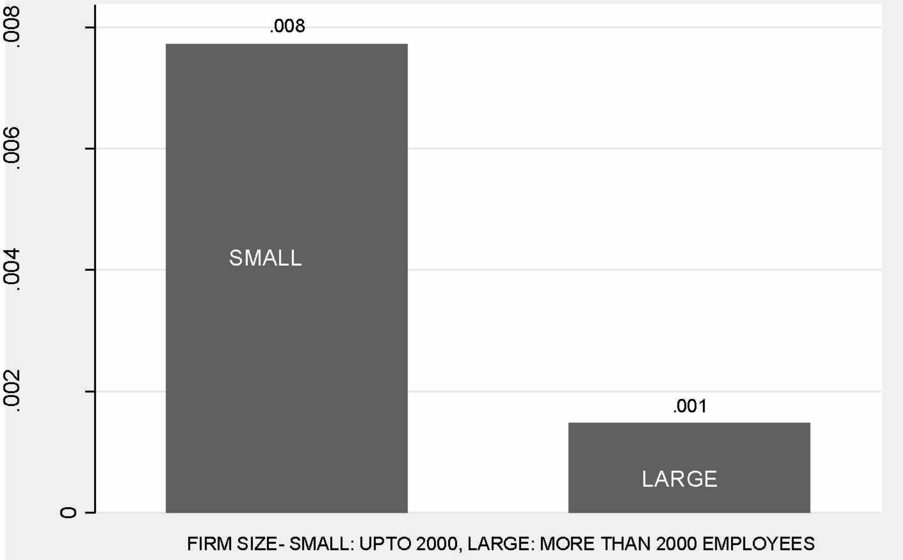
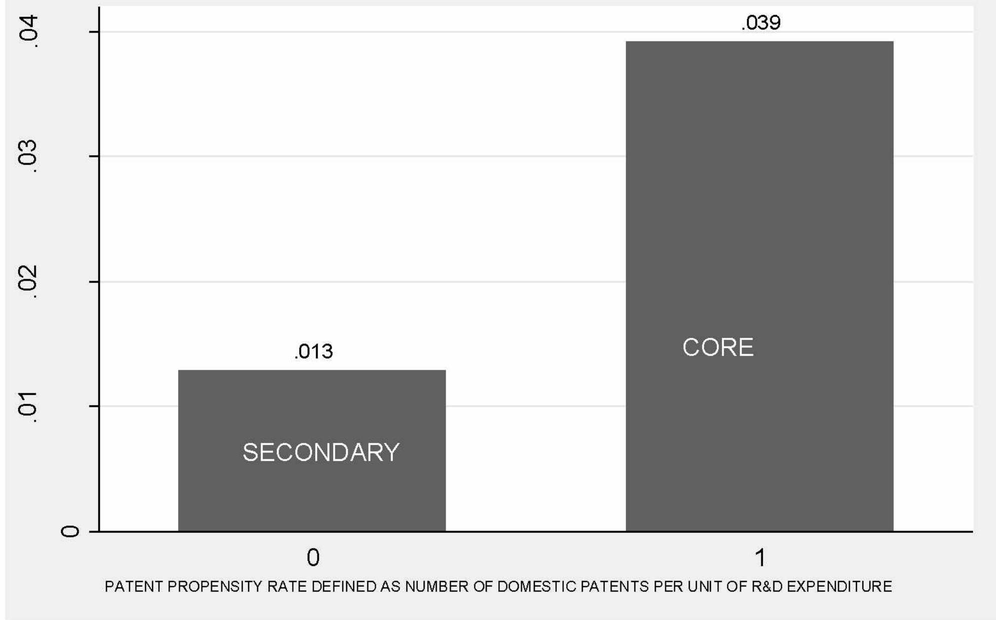


Fig 14: PATENT PROPENSITY RATES
CORE VS SECONDARY SECTORS



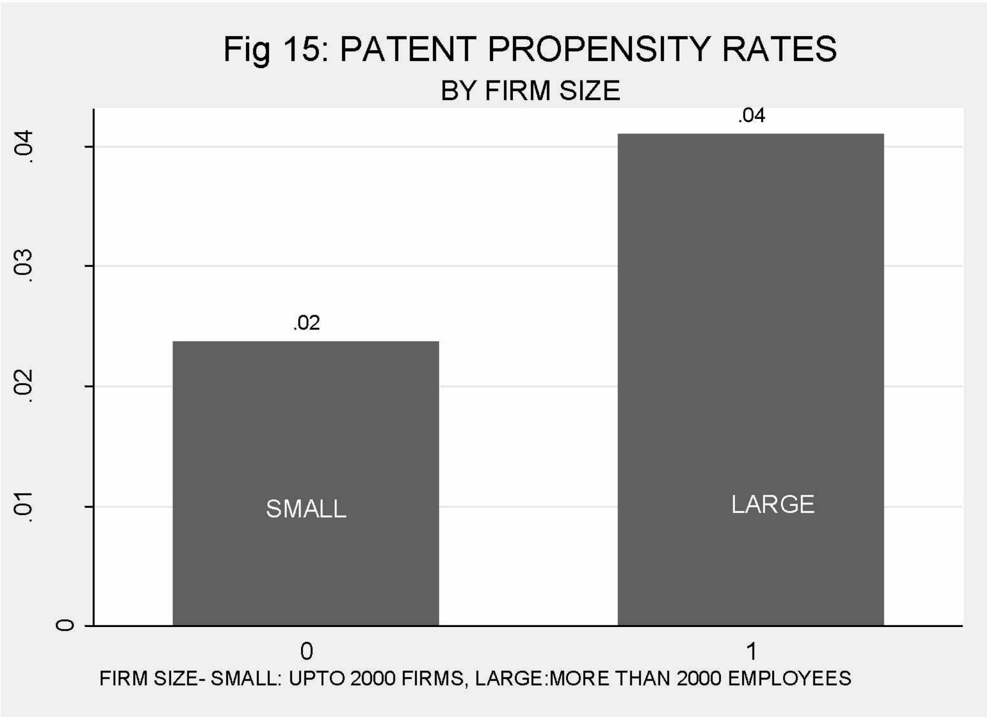


Fig 15: PATENT PROPENSITY RATES
BY FIRM SIZE
0
.01
.02
.03
.04
.02
.04
SMALL
LARGE
0
1
FIRM SIZE- SMALL: UPTO 2000 FIRMS, LARGE:MORE THAN 2000 EMPLOYEES

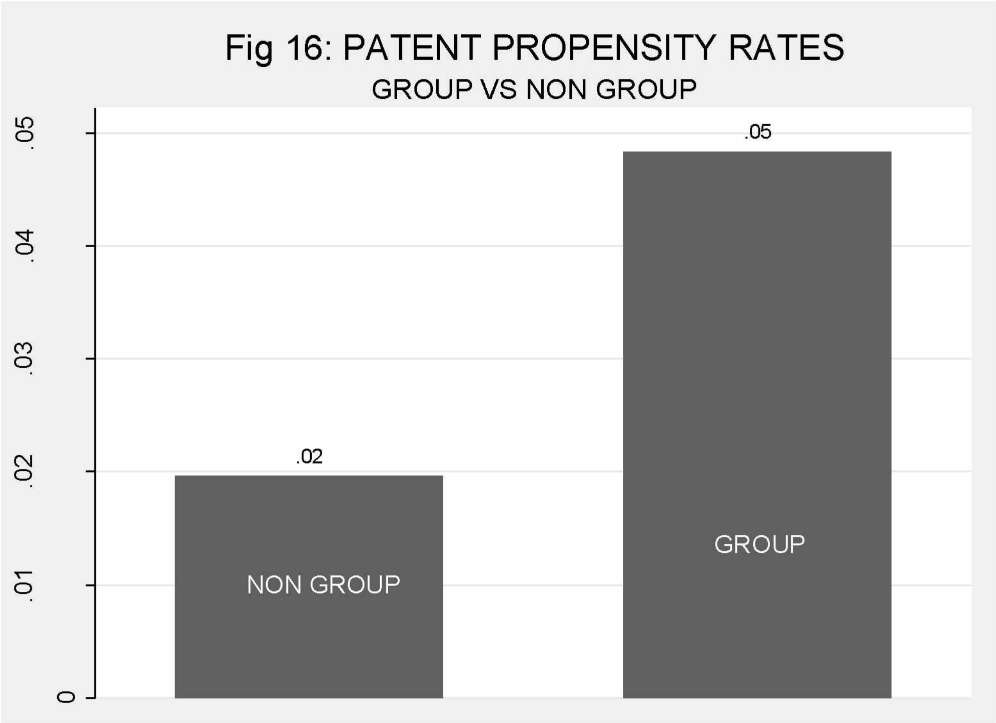


Fig 16: PATENT PROPENSITY RATES
GROUP VS NON GROUP
0
.01
.02
.03
.04
.05
.02
.05
NON GROUP
GROUP

APPENDIX A

SURVEY QUESTIONNAIRE	
SECTION I. INFORMATION ON THE BUSINESS UNIT	
Answer all queries for the business unit that you work in.	
1.1. In what country is the head office of your unit located?	
1.2. Number of employees that are:	
a. Scientists/engineers	
b. In-house intellectual property attorneys	
c. Full time researchers-	
d. Others	
e. Total number of employees (a+b+c+d)	
1.3. In which geographic markets did your enterprise sell goods and/or services in the last three years? (Tick appropriate answer below)	
a. Regional	
b. National	
c. International	
1.4. Public financial support received for innovation activities from any level of government (tick whichever applicable)	
(a) Tax credits or deductions	
(b) Grants	
(c) Subsidised loans	
(d) Loan guarantees	

1.5. Innovation co-operation is active participation with other enterprises or non-commercial institutions on innovation activities. Both partners do not need to commercially benefit.

Exclude pure contracting out of work with no active co-operation.

Did your enterprise co-operate on any of your innovation activities with other enterprises or institutions?

	Location	
Type of co-operation partner	**Within the country**	**Outside the country**
Other enterprises within your enterprise group		
Suppliers of equipment, materials, components, or software		
Clients or customers		
Competitors or other enterprises in your sector		
Consultants commercial labs, or private R&D institutes		
Universities or other higher education institutions		
Government or public research institutes		

SECTION 2: INNOVATION PERFORMANCE OF YOUR UNIT

This section is an attempt to assess the amount and the kind of technical innovation that your unit is engaged in.

Innovation may take the form of a product or a process innovation. A product innovation is the commercial introduction of a new or technologically changed product but does not include aesthetic or minor design changes. A process innovation includes improved production methods for existing products through changes in equipment or organization and new production methods for making products. The product/process innovation must be new in the sense that it is developed at least in part, through the firm's own R&D efforts and hence potentially patentable.
2.1. How important is innovation as a strategy to your firm, to achieve or maintain an advantage over competitors? Indicate on number scale below:

Not important	Slightly important	Moderately important	Important	Very important
1	2	3	4	5

2.2. Has your firm come up with any technical innovations during the reference period? If yes, describe your major innovations below:
2.3. Number of technical innovations made in the last three years

Product Innovations	
Process Innovations	

Section 3

This section is designed to evaluate the extent to which patents and other appropriability mechanisms are effective in protecting your innovations from imitation by other firms, thereby allowing you to maintain your competitive advantage. Thus the focus is only on excluding other firms from profiting from your innovations. For example if patents are applied for due to any other motivations such as to signal reputation or attract venture capital, then such patenting is not a part of the kind of effectiveness of patents being considered in the following questions.

3.1. Number of innovations for which patent applications filed

	India	Abroad
Process Innovation		
Product Innovation		

3.2. For each of the following instruments, indicate its effectiveness in capturing the competitive advantage of your new products resulting from product innovations, using the scale below:

	Not effective			Moderately effective			Very effective
Patents	1	2	3	4	5	6	7
Other IPRs	1	2	3	4	5	6	7
Secrecy	1	2	3	4	5	6	7
Lead time	1	2	3	4	5	6	7
Complementary Services	1	2	3	4	5	6	7
Technical Complexity	1	2	3	4	5	6	7
Scale of Production	1	2	3	4	5	6	7

3.3. For each of the following instruments, indicate its effectiveness in capturing the competitive advantage of your <u>improved products</u> resulting from process innovations, using the scale below:

	Not effective			Moderately effective			Very effective
Patents	1	2	3	4	5	6	7
Other IPRs	1	2	3	4	5	6	7
Secrecy	1	2	3	4	5	6	7
Lead time	1	2	3	4	5	6	7
Complementary Services	1	2	3	4	5	6	7
Technical Complexity	1	2	3	4	5	6	7
Scale of production	1	2	3	4	5	6	7

3.4. Approximately how long would it take a competitor to imitate your innovations? Tick the appropriate answer below:

(a) < 1.5 years	(b) 1.5 – 3 years	(c) 3 – 5 years	(d) > 5 years

3.5. Would the absence of patent protection have had an impact on the innovations produced by your firm? Tick appropriate answer below:

(a)No – innovations would still have happened	(b) Insignificant impact	(c) Yes – innovations would not have happened

3.6. The Trade Related Intellectual Property Rights (TRIPs) agreement is an international agreement administered by the World Trade Organization that has set down minimum standards for intellectual property protection internationally. India became fully TRIPS compliant in 2005 leading to a considerable strengthening of intellectual property protection in the country.

Post-TRIPs is your firm willing to rely more on patents to benefit from its innovations? Tick appropriate answer to the right:

Yes No

3.7. If you answered 'No' in 3.6 above, is it because:

(a) patents are an inherently ineffective protection mechanism	(b) weak rule of law makes patents ineffective	(c) If any other reason, please specify

SECTION 4: REASONS TO PATENT

4.1. Did your unit decide not to apply for a patent for one or more of its Innovations? Tick the appropriate choice to the right: Yes No

4.1a. If 'yes', how important were the following reasons not to patent the most recent innovation that you decided not to patent? Indicate choice below.

	Not important	Slightly important	Moderately Important	Important	Very important
(a) Difficulty in proving patentability	1	2	3	4	5
(b) Ease of legally inventing around patents	1	2	3	4	5
(c) Disclosure concerns	1	2	3	4	5
(d) Quick obsolescence makes patents irrelevant	1	2	3	4	5
(e) Cost of patenting	1	2	3	4	5
(f) Difficulty in detecting and proving infringement	1	2	3	4	5
(g) If other, please specify and indicate importance as above.					

4.2. With what frequency would you patent your most valuable innovation?	Always	Mostly	Sometimes	Never

4.3. How important to your unit are the following reasons for patenting new products?

	Not important	Slightly Important	Moderately important	Important	Very important
(a) Prevention of copying	1	2	3	4	5
(b) Earning of license revenue	1	2	3	4	5
(c) Strengthen firm's position negotiating with other firms	1	2	3	4	5
(d) Prevention of infringement suits	1	2	3	4	5
(e) Measure of internal performance of firm's technologies	1	2	3	4	5
(f) Enhancement of firm's reputation	1	2	3	4	5
(g) Opening up of international markets	1	2	3	4	5
(h) Tap capital market	1	2	3	4	5
(i) Forced to patent due to patent practices of other firms	1	2	3	4	5

4.4. Were patents instrumental in attracting the capital required to start your firm?	Yes	No
4.5. Were any of your innovation activities or projects hindered by patents held by other firms?	Yes	No
4.6. If 'yes', indicate whether it led to delay or abandonment of the affected project.		
Delay	Yes	No

Abandonment	Yes No
SECTION 5: R&D PROFILE OF THE UNIT	

5.1. Research and development expenditure on the following (Rs crores):

	2009-2010	2010-2011	2011-2012
Basic research			
Applied research			
Design and/or Development			
Technical services			
Total R&D expenditures			

5.2. What percentage of your R&D effort focuses on

(a) New or improved products	
(b)New or improved processes	

5.3. What is the approximate time gap between the initial expenditure on R&D that might lead to patent applications and the first patent filling?

5.4. Expenditure on employee training under following heads (Rs.crores)

	2009-2010	2010-2011	2011-2012
In-service training expenditure per employee trained			
Number of in-service training hours per employee trained			
Access rate to employee training, i.e. number of employees that undergo training out of total number of employees			