# BUSINESS ENVIRONMENT AND INNOVATION IN INDIAN FIRMS

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*The present paper identifies the determinants of firm-level innovation in India using the enterprise survey data for the year 2010. Innovation is a key factor affecting firm competitiveness and performance. It has both technological and non-technological aspects and is determined by internal and external factors. Firm-specific characteristics and the domestic business environment, also termed as the national innovation systems (NIS), comprising organizations, institutions and government policy affect firm's ability and inclination to innovate. Comparisons are also made with the 2005 survey which has four different forms of innovation.*

## 1. Introduction

The period after 1991 unleashed the forces of globalization and led to a closer integration of the Indian economy with the world economy. The economic crisis of 1991 brought out the importance of enhancing India's foreign exchange earning capacity which comprised, *inter alia*, concerted efforts to promote exports. India's export performance at this point was still very unimpressive compared to the East Asian Tigers and China with India's share in world exports at less than 1 per cent. The general consensus that emerged was that Indian exports lacked dynamism and were not internationally competitive. Excessive emphasis on the policy of achieving price-competitiveness with currency depreciation as a policy tool to promote exports had clearly not delivered.

Non-price aspects of competitiveness imply a transformation of export structures along with an improvement in quality and a greater variety of products. This requires firms to innovate and introduce new products or processes and improve existing products. This must be complemented with a change in policy and creation of supportive institutions and infrastructure to assist firms in becoming internationally competitive. However, like any other developing country, Indian firms operate below the technology frontier which makes

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firms incapable of creating a niche market for their products. Hence, to alter export structures, create a dynamic comparative advantage and improve product quality and variety makes it imperative for firms to innovate.[2]

All production takes place at the firm or the plant-level. Firms compete with each other irrespective of whether they cater to domestic or international market. Being competitive implies the firm can either retain or increase its market share. Hence, firms have to continually upgrade its product quality and introduce newer, differentiated products. The demand side compulsions have to be addressed by an appropriate supply side response which is determined by the given set of capabilities, the ability to upgrade and innovate on part of firms. Innovation depends on the interaction between firms and the 'knowledge infrastructure'.[3] There are spill-over effects and externalities of firm-level innovation for other firms, sectors and regions. Differential firm-level innovation determines varied firm performance within a sector. Innovation also differs by sector, by region and by nation. The last is influenced by the interaction of firms with their respective factors' markets, policy regimes controlling IPRs and legal and social institutions. Learning and innovation are interconnected with firms embedded in the local social contexts. The latter defines an exogenously given business environment, also known as the national innovation system (NIS) comprising organizations, institutions and state policy.

The present paper examines the effect of firm-specific and business environment variables on a firm's decision to innovate. Firm-size, in-house R&D and access to new technology are some of the important firm-specific variables. The NIS variables such as, corruption, infrastructural constraints and regional and sector specific factors affect firm performance and innovation. This has policy implications for improving competitiveness in the context of globalization.

The paper is organized as follows. Section 2 presents the analytical framework. Data and methodology are discussed in Section 3. This is followed by the empirical model and the hypotheses to be tested in Section 4. Section 5 presents the results and the discussion of the firms' decision to innovate defined in terms of investment in new machinery. This form of innovation is only one of the many forms of technological innovation a firm can undertake and represents acquisition of embodied technology. For comparison we present

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[2]There is a bias in favour of high-tech vis-à-vis medium and low-tech sectors. Innovation modes can be both science-based and experience-based (Jensen, *et al.*, 2007).

[3]Knowledge is the resource and learning is the process. Knowledge infrastructure comprises educational institutions, research institutes and other firms' research and innovation which have externalities for other firms (Lundvall, 2007). Knowledge is largely tacit/embodied in people.

the estimates for the 2005 survey which has data on four forms of innovation[4]. The last section concludes.

## 2. Analytical Framework

Innovation is the use of a new method/discovery/invention. It can be 'new to the firm' or 'new to the market'. Most literature treats the former as a sufficient condition for innovation at the firm-level as it directly affects firm performance. Innovation can be internal or external to the firm. Internal implies that research is conducted in the firm's research & development department. External sources include adoption of techniques invented by public research institutes and universities, import of technical know-how (embodied and disembodied), hiring of external consultants, joint collaboration with an MNC or becoming its subsidiary and lastly, becoming part of a global value chain (GVC) which is the most recent phenomena. Developing country firms operate far below the technology frontier and find it difficult to create a niche for their products. Most firms depend on collaborations with multinationals or arm's-length import of technology (explicit or tacit) and adapt it to local conditions. This requires firms to upgrade their capabilities to adopt, adapt, assimilate and improve upon imported technologies. In this context, incremental innovations rather than radical innovations are crucial for firms.

The core of innovation is technological innovation defined in narrow, conventional terms comprising in-house R&D with a focus on process and product innovation. One can progressively expand the definition of innovation by adding layers to the core definition of innovation. These include using new discoveries made by other firms or public research institutions for a payment of royalty or technical fees. These may be sourced from within the domestic or international spheres. Other forms of innovation include import of intermediate inputs and capital goods i.e. import of embodied technology. Imports of physical goods can be supplemented by tacit or disembodied imports of technical expertise in the form of hiring services of consultants to provide know-how. However, this definition remains focused on the technological aspects only.

The technological aspect of innovation must be broadened to include other forms of non-technological innovation, especially in the context of developing countries. The broad definition allows for management innovation or a 'newer' way of doing things which contributes to overall efficiency and competitiveness (Birkinshaw *et al*., 2008; Chondrakis, 2011; Smith, 2002).

In sum, in-house R&D is not the only source of technological innovation. Rather it

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[4]In the present paper, innovation is confined to the technological form of innovation.

includes outsourcing a part of production to an outside firm which was erstwhile produced within the firm, hiring external agents or experts or technical consultants to provide know-how and know-why and sometimes training the employees, producing niche market goods which are difficult to replace easily and a simultaneous focus on both internal and external markets. Non-technological aspects of innovation involve newer ways of management which range from monitoring worker performance, using multiple indicators for measuring firm performance and sharing the results with workers, taking preventive or corrective measures to stall a problem, better labour management and inclusive participation in management, especially a bottom-up approach. It also involves a change in organization and marketing strategies of the firm.

Niosi and Bellon (1994) note that countries differ in developing technology due to differences in socio-economic institutions and public policy comprising science policy, universities and research institutes. The rationale behind the broader definition given above is that a large majority of firms, particularly in developing countries, may not have the conventional high R&D intensity involving 'new to the market' innovation. At best with access to imported technology, they can introduce 'new to the firm' innovations. Even if the firms do not undertake conventional technological innovation, they can evolve better managerial and business practices either on their own or in the process of their interaction with the buyer/clients. These 'new to the market' organizational and marketing changes collectively known as 'management innovation' have been reported and studied by management experts and are also seen as innovation. The rise in the incidence of business method patents suggests that once a method is successfully implemented in one firm, it has positive externalities for other firms. Most of the successful 'methods' thus get emulated by other firms. This gives rise to appropriability issues necessitating patents. Use of different methods helps firms achieve better performance in terms of growth and profitability. The attention drawn to this concept has important implications also for policies designed to affect international competitiveness with a shift in the focus from a mere price policy and a 'science policy' to an 'innovation policy' (Lundvall, 2007). Lundvall (2007) notes that the 'economic structure' and 'institutions' are two important pillars of innovation system. Innovation in Schumpeterian sense is both technical and organizational change with the latter, along with human development and training, determining the success of converting the former into desired economic performance.

Hobday (2005) notes that the models designed to study innovation in industrially

advanced economies are not suited to the late-comer developing countries[5]. He points out that the innovation models developed in the contexts of advanced developed countries are not directly replicable to developing countries because the latter are much below the frontier and thus indulge more in acquisition, assimilation and improvement of borrowed technology. Developing countries have low levels of education and training, poor infrastructure and weak institutions. Firms in developing countries aim to catch-up with developed countries but encounter problems at the firm-level and in terms of a poor NIS (Waheed, 2012).

Innovation in developing countries, particularly technological innovation, has low R&D-intensity and is more 'incremental' than 'radical' in nature. This ability to innovate depends on a set of internal and external factors. Internal factors are firm-specific and comprise managerial, technological, financial and organizational capabilities of firms which are responsible for firm-heterogeneity and result in varied firm performance. It is not simply the measure of these variables at a given point in time but their cumulative stock at the firm's disposal. External factors are the components of the domestic business environment comprising organizations, institutions and government policy. It varies between sectors, regions and nations. Specifically, it includes social, cultural, political, economic, regulatory, tax, legal and technological environments. These forces are constantly changing, have an element of uncertainty to them and exert a differential influence, whether direct or indirect, on firms' performance at different points in time along with firm-specific factors (Sievers, 2006). Businesses must adapt themselves to the changes in business environment to survive and succeed. Innovation thus depends on firm-specific factors, sectoral specificities and the state of NIS. The context for this approach is provided in the works of Freeman (1982, 1995), Lundvall (2007) and Nelson (1995) who introduced the concept of 'national system of innovation' to provide an alternative dynamic and analytical framework to study innovation and learning in the context of catching-up economies.

Some of the studies on firm-level innovation include Arora (2011) on India. Few studies for other countries are by Prabhu, *et al.,* (2012); de Fuentes and Chaminade (2012); Boermans and Roelfsema (2012); Subramnaya (2011); DST (2011); Seker (2011); Herstatt *et al.*, (2007, 2008);  Girma and Lancheros (2008); Marcelle (2011); Kale (2008); Milesi, Petelski and Verre (2011) and Rammer *et al.*, (2009).

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[5]Hobday (2005) presents a discussion of five innovation models and rejects their applicability to developing countries' innovation needs.

## 3. Data and Methodology

The present paper identifies the determinants of innovation in Indian firms using World Bank's Enterprise Survey Data for the year 2010[6]. In the data-set used, only one measure of innovation is available, which is investment in new machinery or acquisition of embodied technology. This survey is a supplementary survey to the management, organization and innovation (MOI) survey, 2009, conducted for India by the World Bank[7]. The 2010 survey is an improvement over the previous surveys as it classifies the sample into micro, small, medium and large firms on the basis of employment. It also provides data for 482 sample firms in the manufacturing and the service sectors. Table A.1 in the Appendix gives the distribution of firms by sector and by size.

The empirical model presented here uses both the firm-specific factors covering structural and financial aspects and the domestic business environment factors. Innovation is measured in terms of whether firms choose to invest in new machinery or not. This choice is an indication of the firm's decision to innovate. The dependent variable is a binary limited variable which implies that the variable takes the value one if the firm chooses to invest in new machinery and zero otherwise. Hence, a Probit model is used. The results reported are the marginal effects which present the elasticity of the dependent variable with respect to the independent variables.

In the data set, there is a set of variables related to the obstacles faced by the firms regarding electricity, finance, labour and infrastructure. The large number of variables have high and significant pair-wise correlations and hence, principal components analysis (PCA) is used. It reduces the dimensionality of data and allows for a linear transformation of the variables. Each linear combination is a principal component and retains the maximal information of the variables. The first component explains the largest proportion of variation and the contribution of the subsequent components decreases. To decide on the number of components to be used one can also use a 'scree plot' which is a plot of the eigenvalues in the decreasing order. Eigenvalues provide the variation explained by each principal component (PC) and eigenvectors provide the weights to compute the uncorrelated PC. PC scores are the derived composite scores for each observation based on eigenvectors for each PC. These PC scores are used as an independent variable in the estimations. In the 2005 data, there are many such sets of variables which have been combined using PCA.

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[6]The data source is: http://www. enterprisesurveys.org

[7]The theoretical framework and the broad definition of innovation are discussed in Satyal (2014). Stylized facts for 2009 survey are also presented in detail in Satyal (2014) along with the stylized facts for the years 2005 and 2010.

## 4. The Empirical Model

In this section, we outline the empirical model to assess the impact of internal and external factors on the firm's innovation or the decision to invest in new plant and machinery. The data is for the year 2010 for 482 firms. A comparative analysis is made by estimating the role of determinants of firm innovation using the 2005 survey data which also provides data on internal and external factors. The empirical model is:

*FIRM_INNOV = f (SIZE, SIZE$^2$, FIRM_SIZE_DUMMY (SMALL, MEDIUM, LARGE), AGE, DOM_OWNER, POWER_CUT, INFORMAL_COMPT, INFORMAL_PAY, INT_RES_WRK, LOAN, INT_RES_ASSET, EQUITY_ASSET, MANAGER_TIME, PC_OBSTACLES, REGION2 (TN), REGION3 (DELHI), REGION4 (AP), REGION5 (MAHA), SECTOR_DUMMIES)*

The variable *FIRM_INNOV* is the decision to buy new machinery for 2010 survey is denoted by *NEW_MACH*. For 2005 survey, the dependent variable has four variants *NEW_PROD*, *OUT_SOURCE*, *UP_GRADE* and *JOINT_VENTURE*. Introduction of a new product by the firm in the last three years is denoted by *NEW_PROD*. If the firm chooses to outsource part of its production or part of R&D, then the dependent variable is denoted by *OUT_SOURCE*. Technological innovation to improve or upgrade the existing product is denoted by *UP_GRADE*. Yet another form of acquiring latest technology is entering into joint venture arrangements with multinationals and is denoted by *JOINT_VENTURE*.

The set of independent variables are both internal variables and the variables of the NIS or business environment. The internal variables are size, age, ownership and modes of financing working capital and fixed assets. Business environment variables are the amount of informal payments that must be made by firms to obtain licenses, permits, electricity connections and ward off inspectors. Managers' time spent in lobbying with government officials is also taken as another variable for business environment. The infrastructural and financial constraints or obstacles are also part of the NIS. Regional and sectoral specificities are captured by region and sector dummies. The various hypotheses and the expected signs of variables are briefly discussed below.

1. Size: Large firms have resources which allow firms to undertake intramural R&D and innovate. Size is measured by the number of employees and is denoted by *SIZE*. One may observe a non-linear relation between the dependent variable and size and hence, square of size, *SIZE$^2$*, term is used. Another variable which has been used instead of size is the dummy for micro, small, medium and large firms. This is taken

as *FIRM_SIZE_DUMMY (SMALL, MEDIUM, LARGE)* with the reference firm size being micro firm.

2.  Age: The proxy for experience and the level of financial and human resources of the unit is age of the firm. It is measured by the number of years for which the firm has existed since its incorporation and denoted by *AGE*.

3.  Characteristics of owners: The level of education, the gender of the owner and the nature of the firm-whether it is a share holding private limited firm or a sole proprietorship or a partnership firm. There is no data on these variables for the year 2010. However, we have data on ownership i.e., either the firm is domestically owned or is owned by a foreign company or the government. The two dummies used in the estimations are *DOM_OWNER* and/ or *FOR_OWNER*. However, the data does not have any firm which is government owned. Hence, effectively it is either domestic or foreign ownership; therefore, only one dummy is used at a time.

4.  Informal competition: The presence of a competing informal sector affects the firm's ability and willingness to innovate and is given by *INFORMAL_COMPT*. If there is a significant competition from this sector and the firm cannot compete especially on the pricing, then the firm will be discouraged to innovate. On the other hand, such competition may induce firms to innovate faster to remain the pioneer in introducing newer products.

5.  Informal payments: Informal payments reflect the level of corruption of government officials and inspectors. These payments are bribes paid by firms to expedite their work. It is denoted by *INFORMAL_PAY*.

6.  Leverage: Both internal and external funds are used to finance working capital and purchase of fixed assets. The latter include equity versus debt sources. Older firms have higher leverage as banks trust them. Goodwill is generally used as a proxy but no such information is available to us. Instead we have information on sources of financing working capital and fixed assets. These can be internal resources, bank loans and in case of assets also include equity issues. These are denoted separately for working capital (*INT_RES_WRK*) and for purchase of fixed assets *(INT_RES_ASSET* and *EQUITY_ASSET)*. Another variable used is whether the firm has a bank loan (*LOAN*) or not.  It is postulated in the literature that it is financially more sound companies which manage to rely on external sources while new or young firms rely more on internal resources.

7.  In-house R&D and/or patents: If the firm undertakes in-house R&D, then the

probability of buying new equipment, introducing new products and product up-gradation is higher. However, high internal R&D will dissuade firms from outsourcing or entering into joint-ventures. No information on this variable is available for 2010 survey This variable is denoted by *R&D*.

8.  Power cut: One of the most severe obstacles faced by the firms is the shortage of electricity given by *POWER_CUT*. This is specifically used as a dummy = 1 if the firm faces power outages and = 0 otherwise.

9.  Lobbying: This captures the proportion of the working hours in a week spent by senior managers in lobbying with government officials to get permits, licenses and in general to get their work done. This also involves use of middlemen and bribing the officials. The variable used is *MANAGER_TIME*.

10. Severity of obstacles faced: This variable is a summary index of the main obstacles faced by different firms. The scores have been obtained by performing a principal component analysis using the various obstacles which are highly correlated. The notation used is *PC_OBSTACLES*.

11. Region: External factors especially the location of the firm is guided by the level of infrastructural development and the state policy. Regional dummies are used with one region as the control region (in our study, we choose Gujarat as the control region out of the five states covered). The dummies used are *REGION2* (*TN*), *REGION3* (*DELHI*), *REGION4* (*AP*) and *REGION5* (*MAHA*).

12. Sectors: The effect of sector-specific policy on the firms comprising the sector is captured by introducing a dummy for 18 sectors with chemicals as the control sector, denoted by, *SECTOR_DUMMIES*.

## 5. Results and Discussion

The results for the Probit estimation (marginal effects) for the survey data 2010 are presented in Table 1. The dependent variable is *NEW_MACH*. Purchase of new machinery is taken as one form of embodied technological up-gradation on part of firms.

Given the limitations of the data, we have only a few firm-specific variables as the 2010 survey concentrates mainly on the business environment factors or the NIS variables affecting firm's decision to invest in new machinery. Firm-size (*SIZE*) is a significant determinant of purchase of new machinery by firms. The relation is non-linear as investment in new machinery increases once firms attain a particular size. It suggests that economies of

**Table 1: Probit Estimates-Marginal Effects (M6) of Investment in *NEW_MACH*, 2010**

| Variables | (Probit-ME) NEW_MACH Coefficient | z value |
|---|---|---|
| *SIZE* | ***-0.026*** | ***-2.26**** |
| *SIZE*$^2$ | ***0.001*** | ***2.78**** |
| *AGE* | *0.002* | *1.62* |
| *DOM_OWNER* | *0.138* | *0.80* |
| *POWER_CUT* | ***-0.149*** | ***-2.35**** |
| *INFORMAL_COMPT* | ***-0.132*** | ***-2.66**** |
| *INFORMAL_PAY* | *0.089* | *1.63* |
| *INT_RES_WRK* | ***-0.004*** | ***-3.74***** |
| *BANK_WRK* | ***-0.002*** | ***-2.11**** |
| *LOAN* | ***0.253*** | ***5.78***** |
| *MANAGER_TIME* | *0.002* | *1.08* |
| *PC_OBSTACLES* | ***-0.061*** | ***-3.76***** |
| *REGION2 (TN)* | ***-0.135*** | ***-1.77**** |
| *REGION3 (DELHI)* | ***0.201*** | ***2.41**** |
| *REGION4 (AP)* | ***-0.242*** | ***-3.22**** |
| *REGION5 (MAHARASHTRA)* | *-0.027* | *-0.40* |
| *SECTOR DUMMIES* | ***Three significant*** | |
| *LRx*$^2$ | *LRx*$^2$*(34)* | *209.15**** |
| *Log-likelihood* | | *-229.11* |
| *No. of observations* | *482* | |

*Note:* * significant at 1 per cent, ** significant at 5 per cent, *** significant at 10 per cent.

scale is an important consideration in making investments in new machinery[8]. Power cuts (*POWER_CUT*) and competition from the informal sector (*INFORMAL_COMPT*) act as a disincentive to new investment. Poor infrastructure has been cited as a major impediment to firm performance and of this, electricity problem is the most severe problem. Competition from firms in the informal sector also discourages firms to innovate probably because the market penetration of local firms is deeper compared to firms producing branded products. Access to bank loan (*LOAN*) is a positive and a significant determinant of *NEW_MACH*. The firm's internal resources (*INT_RES_WK*) used to finance working capital compete with funds available for investment in new machinery. Similarly, use of bank loans to finance working capital needs (*BANK_WK*) of the firm also cuts into the resources for investment in

[8]Another specification using size as a categorical variable for small, medium and large firms with micro as the control dummy do not give significantly different coefficients.

capital goods[9]. In the above specification, there are a few firm-specific variables which have the expected sign but are not significant. Both *AGE* and *DOMESTIC_OWNER* have positive signs and firm-age is almost significant at 10 per cent level. It shows that older firms with more experience and resources and firms owned domestically are more inclined to undertake investments in new machinery.

Regarding the business environment variables, we find that most of the obstacles captured by *PC_OBSTACLES* affect new investments negatively. These obstacles relate to electricity, land, other infrastructural constraints, finance, labour issues and transportation and marketing. The other business environment variables (*INFORMAL_PAY* and *MANAGER_TIME*) are both positively signed and the former is very close to 10 per cent level of significance. *INFORMAL_PAY* is a proxy for the bribes and other gifts firms have to pay to government officials and inspectors to obtain clearances, licenses and permits. The more they make such informal payments smoother is the operational working and hence, firms feel secure enough to undertake new investments. Lobbying by managers given by *MANAGER_TIME* is also positively signed which once again reiterates that senior managers have to maintain relations with officials to overcome any legal obstacles. Location of firms (*REGION*) also affects the decision to undertake new investments. Compared to Gujarat, which is the control dummy, firms in Andhra Pradesh and Tamil Nadu have a lesser incentive to innovate and firms in Delhi have a significantly higher incentive to undertake new investments. Firms in Maharashtra are less inclined to invest but the difference between Maharashtra and Gujarat is not significant. This highlights the role of regional innovation systems (RIS) comprising institutions and state policy in determining firm-level innovation. Sector specificities or sectoral innovation systems are also relevant in determining the decision to invest in new machinery which is indicated by the significance of three sector dummies.

Hence, the results show that both firm-specific and external variables matter and due attention must be paid by the government to remove the impediments to innovation at the firm-level. Policy must aim at promoting optimal size of firms to reap economies of scale and control the activities of firms in the informal sector which directly impedes innovation in the formal sector. It must also address the issues of lobbying and corruption, institutional credit and infrastructure.

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[9]The variables representing internal resources (*INT_RES_ASSSET*) and equity issues (*EQUITY_ASSET*) to finance purchase of assets cannot be included in the estimations.

## 6. Comparisons with 2005 Survey

In this section, we present the results of the estimations for the 2005 survey. This is relevant as this survey is the most complete among the three surveys of 2005, 2009 and 2010. The 2005 survey has questions relating to firm-specific internal variables as well as the variables relating to the business environment as part of the national innovation system. There are four aspects of innovation-product innovation, up-gradation, joint-venture and outsourcing - that have been covered in this survey. Determinants of these forms of innovation have been empirically estimated and the results are presented in Table 2. The empirical model takes into account firm-heterogeneity and external variables. The list of internal variables includes: legal status, ownership, age, governance, female owner, education of the owner, alternative supplier, quality of inputs supplied, input supplier providing a unique input to the producer, use of imported technology, international quality certification, purchase of new machinery as a proxy for embodied technology, bank loan, acquisition of new technology by the firm, domestic and foreign pressure to innovate, market orientation (local, regional, national or international) and the provision of internal and external training to workers. The business environment or the NIS variables include protection payments, legal system, labour laws, corruption, payment of bribes, presence of middle men, competition from the informal sector, problems relating to land acquisition, obstacles faced by firms (electricity, transport, communication, corruption, finance, etc), informal payments made to acquire licenses and permits, government regulations in a particular industry which restrict the working of the firm, and regional and sectoral differences.

All the estimations are done using a Probit model and marginal effects are reported. The dependent variables are binary limited variables and take the value one if the firm undertakes that particular form of innovation and takes the value zero otherwise. There are five sets of variables which have high pair-wise correlations and hence, have been linearly transformed using PCA. These relate to land acquisition, payment of bribes, labour problems, payment of bribes to inspectors and informal practices. The definitions of all the variables are presented in Table A.2 in the Appendix.

Table 2 presents the empirical estimates of the 2005 survey for four aspects of innovation. The independent variables can be classified into firm-specific technological and non-technological variables and variables related to business environment. The dependent variables in Table 2 are the four aspects of innovation-the decision to introduce a new

**Table 2: Probit Estimates (Marginal Effects) of Four Main Aspects of Technological Innovation, 2005 survey**

| Dependent variable | New product | | Up-grade | | Joint-venture | | Outsource | |
|---|---|---|---|---|---|---|---|---|
| *(1)* | *(2)* | *(3)* | *(4)* | *(5)* | *(6)* | *(7)* | *(8)* | *(9)* |
| | *coeff.* | *z* | *coeff.* | *z* | *coeff.* | *z* | *coeff.* | *z* |
| *LEGAL_STAUS* | | | | | *0.002* | *0.10* | | |
| *Privately traded* | *-0.05* | *-1.29* | *-0.008* | *-0.2* | | | ***-0.06*** | ***-1.76#*** |
| *Sole prop.* | *-0.05* | *-1.23* | *0.02* | *0.5* | | | *-0.05* | *-1.52* |
| *Partnership* | *-0.04* | *-1.04* | *0.03* | *0.75* | | | ***-0.06*** | ***-1.74#*** |
| *Other* | ***-0.24*** | ***-2.80*** | *0.07* | *0.70* | | | *-0.1* | *-1.41* |
| *FAMILY_OWNED* | | | ***0.13*** | ***3.21**** | *0.02* | *1.44* | ***-0.05*** | ***-1.72#*** |
| *AGE* | | | *0.001* | *1.36* | ***-0.001*** | ***-2.25**** | | |
| *OWNER_MANAGER* | | | *0.01* | *0.71* | ***-0.03*** | ***-2.99**** | ***-0.03*** | ***-1.87#*** |
| *FEMALE_OWNER* | | | ***0.05*** | ***1.9#*** | | | *0.02* | *0.81* |
| *ALTERNATIVE _SS* | | | ***-0.13*** | ***-3.9[@]*** | | | *0.01* | *0.67* |
| *OWNER_EDU* | | | | | ***0.03*** | ***2.08**** | | |
| *Secondary* | *0.07* | *1.37* | *-0.06* | *-1.29* | | | | |
| *Vocational* | ***0.14*** | ***2.08**** | *0.09* | *1.41* | | | | |
| *University training* | *0.11* | *1.62* | *0.003* | *0.05* | | | | |
| *B. A. degree* | ***0.08*** | ***1.66[#]*** | *-0.03* | *-0.64* | | | | |
| *Post grad. Degree* | *0.08* | *1.42* | *-0.02* | *-0.34* | | | | |
| *LOW_QUALITY* | *0.02* | *1.35* | ***-0.03*** | ***-1.9#*** | ***0.06*** | ***5.54[@]*** | ***0.05*** | ***2.80**** |
| *UNIQUE_INPUT* | ***0.04*** | ***2.41**** | *0.07* | *3.8[@]* | ***0.03*** | ***2.50**** | ***0.05*** | ***3.23**** |
| *INTL_QUA_CERT* | ***0.11*** | ***4.20[@]*** | *0.10* | *3.9[@]* | *0.058* | *4.04* | ***0.05*** | ***2.80**** |
| *FIRM_RND* | ***0.117*** | ***4.50[@]*** | *0.09* | *3.17*** | *-0.006* | *-0.37* | ***0.07*** | ***3.37[@]*** |
| *NEW_TECH* | ***0.31*** | ***12.3[@]*** | *0.21* | *4.8[@]* | ***0.02*** | ***1.91**** | *0.01* | *0.35* |
| *DOM_PRESS* | | | *0.03* | *1.40* | ***-0.03*** | ***-2.11**** | *-0.01* | *-0.64* |
| *FOR_PRESS* | *-0.07* | *-1.57* | ***0.11*** | ***2.18**** | | | ***0.06*** | ***1.82#*** |
| *TELE_SHORT* | ***0.06*** | ***2.92**** | *0.11* | *4.58[@]* | | | | |
| *POWER_SHORT* | | | *0.02* | *0.88* | *-0.01* | *-0.85* | | |
| *OWN_POWER* | | | *0.03* | *1.43* | ***-0.02*** | ***-1.83#*** | ***-0.05*** | ***-2.62**** |
| *LAW_ORDER* | ***-0.08*** | ***-3.7[@]*** | *0.02* | *0.95* | *-0.02* | *-1.24* | *-0.02* | *-1.13* |
| *POOR_LEGAL* | | | ***-0.02*** | ***-3.4[@]*** | | | ***0.03*** | ***2.24**** |

| Dependent variable | New product | | Up-grade | | Joint-venture | | Outsource | |
|---|---|---|---|---|---|---|---|---|
| *IMPORT_TECH* | | | *0.10* | *2.08\** | *0.05* | *2.53\** | *0.03* | *1.26* |
| *BRIBE_GOVT* | *-0.06* | *-2.63\** | *0.01* | *0.52* | | | | |
| *IMP_TECH_PROB* | *0.07* | *1.19* | *-0.12* | *-2.3\** | *0.05* | *1.79#* | *0.03* | *0.86* |
| *TRAIN_INTERNAL* | *0.08* | *2.90\** | *0.02* | *0.73* | *0.01* | *0.32* | *0.01* | *0.77* |
| *MKT_ORIENTATION* | | | | | | | | |
| *Regional* | *-0.01* | *-0.27* | *0.05* | *1.74\** | *0.02* | *1.31* | *0.03* | *1.67#* |
| *National* | *0.09* | *3.01\** | *0.11* | *3.4ᵃ* | *0.02* | *1.17* | *0.02* | *1.03* |
| *International* | *0.07* | *2.28\** | *0.13* | *3.52ᵃ* | *0.02* | *1.22* | *0.02* | *0.75* |
| *MANAGER_TIME* | *-0.003* | *-0.49* | *0.001* | *1.54* | *0.001* | *2.01\** | | |
| *PROTECTION_PAY* | *0.07* | *2.61\** | *-0.006* | *-0.24* | | | *0.002* | *0.13* |
| *MIDDLEMEN* | | | *-0.02* | *-0.65* | *-0.01* | *-0.93* | *0.03* | *1.85#* |
| *GOVT_UNCERT* | | | *-0.04* | *-1.96\** | | | | |
| *SKILL_LABOUR* | | | *0.004* | *1.62* | | | | |
| *PC_LAND* | *0.01* | *2.15\** | *0.11* | *1.66#* | *-0.01* | *-1.82#* | *0.03* | *7.15ᵃ* |
| *PC_LABOUR* | *0.003* | *0.47* | *0.17* | *2.33\** | *-0.01* | *-1.82#* | *0.02* | *3.97ᵃ* |
| *PC_INSPECT* | *0.003* | *0.69* | *0.01* | *0.65* | *-0.02* | *-3.69ᵃ* | *-0.01* | *-1.80#* |
| *PC_BRIBE* | *0.01* | *0.98* | *-0.01* | *-1.8#* | *0.002* | *0.53* | *-0.01* | *-1.21* |
| *PC_INFORM_PRACS* | *0.013* | *2.13\** | *0.01* | *1.8#* | *0.001* | *0.38* | *-0.01* | *-0.66* |
| *Regional dummies* | *None significant* | | *One significant* | | *Two significant* | | *Four significant* | |
| *Sectoral dummies* | *None significant* | | *Seven significant* | | *Two significant* | | *Ten significant* | |
| *Log likelihood* | *-1245.4* | | *-1186.5* | | *-517.1* | | *-867.1* | |
| *LR (x²)* | *423.19* | | *534.98* | | *271.12* | | *453* | |
| *No. of observations* | *2174* | | *2146* | | *2187* | | *2218* | |

*Note:* significant at 1 per cent, * significant at 5 per cent , # significant at 10 per cent .

product, up-grade in the existing line of production, enter into a joint-venture and outsource part of production or R&D.

The results show that the *LEGAL_STATUS* of firms matters. This is a categorical variable with firms listed in the stock market taken as the control variable. In comparison to the control variable, the sign of other forms of organization is negative but insignificant. This suggests that the publicly listed firms are more inclined to undertake different forms of innovation although the difference is not significant except for outsourcing. For joint-venture a dummy variable is used which takes the value one if the firm is publicly listed and

is zero otherwise. In this case also the variable is positive although not significant.

Family owned firms (*FAMILY_OWNED*) resort more to technological up-gradation of products than introduction of new products or enter into joint-venture. Younger firms (*AGE*) are more open to joint-venture agreements while other forms of innovation are not affected significantly by the age of the firm. Form of governance given by separation between ownership and management (*OWNER_MANAGER*) negatively affects the possibility of joint-venture or outsourcing. If the firm's owner is a female (*FEMALE_OWNER*) it positively affects the inclination to up-grade but relying on one supplier (*ALTERNATIVE_SS*) for all their inputs negatively affects the firms' ability to up-grade. Owner's education (*OWNER_EDU*) is included as a factor or a categorical variable with the coefficients for alternative levels of education higher than the owner being completely uneducated or having only primary education. For introducing new products the coefficient is the highest for vocational education than a BA or a post graduate degree. However, a BA or a higher level of education affects the incidence of joint-ventures positively. The technology variables are given by *LOW_QUALITY, UNIQUE_INPT, INTL_QUA_CERT, FIRM_RND, IMPORT_TECH* and *NEW_TECH*. Low quality of inputs (*LOW_QUALITY*) encourages firms to introduce new products, resort to joint-ventures and outsource part of production and R&D but negatively affects firms' ability to up-grade. If firms procure unique inputs (*UNIQUE_INPT*) it affects all aspects of innovation significantly. Obtaining an international quality certification like the ISO certificate (*INTL_QUA_CERT*) also affects the four forms positively and significantly. The coefficient of *FIRM_RND* is positive and significant for introduction of new products and up-grading. Instead firms with no significant R&D enter into joint-ventures and outsource production/R&D activity. Access to imported technology (*IMP_TECH*) is critical for up-gradation and joint-ventures. Acquisition of new technology (*NEW_TECH*) affects both introduction of new products and up-gradation positively but not the other two forms of innovation. Foreign demand pressures (*FOR_PRESS*) are crucial in promoting up-grading and outsourcing but not introduction of new products. Internal training (*TRAIN_INTERNAL*) has a positive effect on all four modes of innovation but is significant for new products only. The role of skilled labour (*SKILL_LABOUR*) is positive but not significant for up-gradation. Market orientation (*MKT_ORIENTATION*) in terms of the relative importance of local, regional, national and international markets shows that national and international market orientation is important in affecting the introduction of new products and up-gradation of products.

Regarding the business environment variables, *MANAGER_TIME, PROTECTION_PAY* and *MIDDLE_MEN* are three variables which capture the aspects of lobbying and the role of middlemen in getting the official work done and obtaining necessary permits and pushing files through the official channels. Senior managers' lobbying (*MANAGER_TIME*) helps signing joint-venture agreements while protection payments (*PROTECTION_PAY*) are more important for the introduction of new products. The role of middlemen (*MIDDLE_MEN*) in making outsourcing agreements is relatively more important. All the remaining variables except the regional and sector dummies comprise the NIS. Weak legal system (*LAW_ORDER* and *POOR_LEGAL*) negatively affects introduction of new-products and up-gradation and pushes firms to resort to outsourcing. Infrastructural shortages (*POWER_SHORT*) and thus, resorting to firms' own arrangements (*OWN_POWER*) in terms of generators discourage joint-ventures and outsourcing. Uncertainty on part of government officials (*GOVT_UNCERT*) regarding the regulations affecting businesses affects the efforts to upgrade negatively. Land and labour problems (*PC_LAND* and *PC_LABOUR*) push firms to innovate faster except for joint-ventures. Land issues comprise acquisition of land, zoning and land-use issues. Informal payments and bribes paid to inspectors (*PC_INSPECT*) discourage prospective joint-ventures and outsourcing. Bribes paid to government officials to obtain various kinds of licenses and permits (*PC_BRIBES* and *BRIBE_GOVT*) affect introduction of new products and up-gradation of existing products negatively. Anti-competitive practices (*PC_INFORMAL_PRACS*) comprising unequal taxes, labour rules, energy costs, land related obligations and imposition of product standards and intellectual property rights push firms to innovate faster in terms of introduction of new products and product up-gradation. Location of firms in a specific region is relatively more important for outsourcing. Hence, regional development and availability of local infrastructure affects the form of innovation adopted. Sectoral affiliation is also significant in affecting the four modes of innovation with the largest number of significant dummies for outsourcing followed by up-gradation. Thus, once again regional and sector innovation systems are relevant along with the national innovation system in determining firm-level innovation.

## 7. Conclusion

Innovation at the firm-level is determined by both internal and external factors. Empirical results based on 2005 and 2010 survey data show that the firm-specific variables and the business environment variables comprising national, regional and sectoral

innovation systems influence firm innovation which is particularly relevant in the context of globalization. Policy efforts directed to induce firms to undertake innovation and R&D to introduce new products, up-grade in the value chain, attract FDI and joint-ventures or outsource will remain incomplete if the business environment issues are not adequately addressed. It is imperative for firms to innovate to grow but the overall environment in which they perform comprising policy, organizations and institutions, has to be made more favourable. Inter-sectoral and regional differences make a case for a sector-specific and region-specific policy to further make the policy more effective.

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# Appendix

**Table A.1: Distribution of Firms, By Sector and By Size, 2010 Survey**

| Sector | Code | Total firms | Micro | Small | Medium | Large |
|---|---|---|---|---|---|---|
| Food | 15 | 15 | | 5 | 5 | 5 |
| Textiles | 17 | 21 | | 6 | 4 | 11 |
| Garments | 18 | 13 | | 6 | 3 | 4 |
| Chemicals | 24 | 11 | | 2 | 3 | 6 |
| Plastics & Rubber | 25 | 21 | | 7 | 10 | 4 |
| Non-metallic mineral products | 26 | 2 | | 0 | 0 | 2 |
| Basic metals | 27 | 15 | | 3 | 7 | 5 |
| Fabricated metal products | 28 | 40 | 2 | 12 | 16 | 10 |
| Machinery & equipment | 29 | 39 | | 12 | 17 | 10 |
| Electronics | 31 | 23 | | 13 | 7 | 3 |
| Other manufacturing | 02 | 71 | | 16 | 22 | 33 |
| **Total - manufacturing** | | **271 (56)** | **2 (1)** | **82 (30)** | **94 (34)** | **93 (34)** |
| Construction | 45 | 14 | | 5 | 6 | 3 |
| Services of motor vehicles | 50 | 26 | | 5 | 10 | 11 |
| Wholesale | 51 | 28 | 4 | 15 | 8 | 1 |
| Retail | 52 | 71 | 4 | 32 | 18 | 17 |
| Hotel & restaurants | 55 | 26 | | 2 | 17 | 7 |
| Transport | 60 | 27 | 2 | 4 | 12 | 9 |
| IT | 72 | 19 | | 7 | 8 | 4 |
| **Total - services** | | **211 (44)** | **10 (5)** | **70 (33)** | **79 (37)** | **52 (35)** |
| Total - (mfg & services) | | 482 | 12 | 152 | 173 | 145 |
| (percent of total) | | 100 | 2.5 | 31.5 | 36 | 30 |

*Note:* Figures in the brackets are percentage of total. Size is defined in terms of number of employees.

**Table A.2: Definition of Variables for Estimations in Table 2 for 2005 Survey**

| Variable | Definition |
|---|---|
| *LEGAL_STAUS* <br> *traded, Sole* <br> *proprietorship, Partnership, Other* | *The firm is a sole proprietorship or a partnership firm or Privately are its shares traded on the stock market or traded privately. (categorical variable)* |
| *FAMILY_OWNED* | *Firm is owned by an individual or a family* |
| *AGE* | *Number of years since the inception of the firm* |
| *OWNER_MANAGER* | *The top manager is also the owner of the firm or is the ownership and management separated* |
| *FEMALE_OWNER* | *The owner of the firm is a female* |
| *ALTERNATIVE _SS* | *Inputs are supplied by only one suppliers or alternative suppliers exist* |
| *OWNER_EDU* <br> *Secondary, Vocational, University training, B. A. degree,* <br> *Post grad. Degree* | *Level of education of the owner (categorical variable)* |
| *LOW_QUALITY* | *Percentage of inputs which are of an inferior quality* |
| *UNIQUE_INPUT* | *Whether the most important input supplied is to the firm's unique specification* |
| *INTL_QUA_CERT* | *Firm has a ISO quality certification (international certificate)* |
| *FIRM_RND* | *Firm undertakes in-house R&D* |
| *NEW_TECH* | *Firm invests in new technology* |
| *DOM_PRESS* | *Role of domestic pressures to innovate* |
| *FOR_PRESS* | *Role of foreign pressures to innovate* |
| *TELE_SHORT* | *Shortage of telecommunications* |
| *POWER_SHORT* | *Shortage of power* |
| *OWN_POWER* | *Owner has his own power generating unit* |
| *LAW_ORDER* | *State of law and order situation* |
| *POOR_LEGAL* | *Judicial system will enforce firm's rights* |
| *IMPORT_TECH* | *Imported technology* |
| *BRIBE_GOVT* | *Bribes paid to government officials* |
| *IMP_TECH_PROB* | *Acquiring imported technology a problem* |
| *TRAIN_INTERNAL* | *Firm offers internal training* |
| *MKT_ORIENTATION* | *Market orientation firm caters mainly to local, regional, national or international market (categorical variable)* |
| *MANAGER_TIME* | *The percentage of time in a week spent by the senior manager lobbying* |
| *PROTECTION_PAY* | *Protection payments made by the firm* |
| *MIDDLEMEN* | *Use of middlemen to get the official work done* |
| *GOVT_UNCERT* | *Government officials' interpretation of regulations affecting the firm* |
| *SKILL_LABOUR* | *Skill or education level of labour* |
| *PC_LAND* | *Scores to account for problems related to land acquisition, change in land use, zoning and quality.* |
| *PC_LABOUR* | *Scores to account for labour problems* |
| *PC_INSPECT* | *Scores for payments made to inspectors to obtain licenses and permits* |
| *PC_BRIBE* | *Scores for bribes paid to government officials* |
| *PC_INFORM_PRACS* | *Scores for anti-competitive practices by other firms* |
| *Regional dummies* | *To account for location* |
| *Sectoral dummies* | *To account for sectoral affiliation* |