WORKING PAPER 65/2012

Learning and Capability Acquisition: A Case Study of the Indian Automobile Industry

Madhuri Saripalle

MADRAS SCHOOL OF ECONOMICS
Gandhi Mandapam Road
Chennai 600 025
India

January 2012

Learning and Capability Acquisition: A Case Study of the Indian Automobile Industry

Madhuri Saripalle
Assistant Professor, Madras School of Economics
msaripalle@mse.ac.in

WORKING PAPER 65/2012

January 2012

Price : Rs. 35

MADRAS SCHOOL OF ECONOMICS
Gandhi Mandapam Road
Chennai 600 025
India

Phone: 2230 0304/2230 0307/2235 2157
Fax : 2235 4847/2235 2155
Email : info@mse.ac.in
Website: www.mse.ac.in

Learning and Capability Acquisition: A Case Study of the Indian Automobile Industry

Madhuri Saripalle

Abstract

This study analyzes the impact of government policy regime on the learning and capability acquisition of firms over time. Through a case study analysis of the Indian automotive industry, the study develops three hypotheses relating policy regimes with learning strategies of firms. The study tests these hypotheses through a model of learning using a panel data for the Indian automotive industry. It finds that speed of knowledge assimilation is more important in the liberalized policy regime vis-à-vis protection when knowledge assimilation per se was a more important economic goal.

Keywords: *Growth, Learning, Capabilities, Industrial Policy, Automobile industry, Asia, India.*

JEL Codes: *L 62*

ACKNOWLEDGMENT

The author would like to gratefully acknowledge Dr.K.R.Shanmugam (Professor of Economics at Madras School of Economics, Chennai, India) for his comments on the paper. A revised version of this paper is forthcoming in the International Journal of Automotive Technology and Management

INTRODUCTION

It is well recognized in industrial organization theory and empirical literature that learning as a capability is a major factor in explaining inter-firm performance differences. The success of newly industrialized countries (NICs), for example, has shown that technological progress is not merely guided by changes in relative prices, nor does competitiveness depend upon relative factor endowments. It is more than acquiring the technological blue prints and involves a learning process. This is more so in the context of late comers to industrialization, where governments have actively pursued industrial regulation and protection to allow firms to grow and learn to compete. Therefore, it is an interesting research question to ask: how does regulation impact firm learning and growth? This paper analyzes the role played by government policies in transforming the learning abilities of the firms and the markets with reference to the Indian automobile industry.

Based on a case study analysis of automotive firms in the Indian Industry, three hypotheses are developed relating firm learning with policy regime. These hypotheses are then empirically tested using a panel data of 13 firms across a 38 year period, an interval subdivided into three different industrial policy regimes eras: protection, deregulation and liberalization.

The paper is organized as follows. The next section gives literature review on learning. Then, the industrial policy regimes and their impact on learning are outlined in section III. This section also develops three hypotheses based on the discussion. After that the model of learning applied in the paper is explained, followed by the empirical estimation and discussion of results in section IV. The final section discusses the main contributions of the paper and gives the conclusions.

LITERATURE REVIEW

A rich body of literature exists on different types of firm learning and its role in firm's performance. The traditional exposition of firm focused on industry-specific variables to capture the extent of innovations and proxies them through variables like R&D expenditure and number of patents. Differences in inter-firm performances were not captured as firm was modeled in terms of production function with any inter-firm differences arising purely out of productivity changes. In reality, differences in inter-firm performances exist because of the presence of information asymmetries, distributed knowledge and differential capabilities which in turn give rise to different learning processes within firms.[1]

Various types of learning processes have been identified in the literature—learning by doing, learning through acquisition of internal resources, learning through spillovers, learning through innovations, learning by exporting and last but not the least, learning and forgetting.

Learning by doing

Learning curve is defined as curve relating unit costs to accumulated volume, which affect future costs and market position. The traditional method of estimating the learning curve is to estimate the relationship between input use and cumulative output, whereby input units decline

[1] The resource based perspective (Penrose, 1959) recognized the role of various ongoing learning processes that give rise to slack services and the excess capacity arising out of lumpiness of resources resulting in firm diversification. This laid the foundation for the evolutionary and capabilities view of firm that defined firm in terms of the knowledge production function. Knowledge is also distributed in that it is not possessed by a single agent and requires qualitative coordination. This in turn is the source of differential capabilities and firm heterogeneity. Existence of tacit and distributed knowledge implies that there are learning costs for firms, which in turn determine its performance and boundaries. These learning costs are the costs of persuading, negotiating and coordinating with, and teaching others and termed as "dynamic transaction costs" (DTC). They arise in the face of change, notably technological and organizational innovation (Langlois, 1992).

with accumulated output. Spence (1981) models the implications of learning curve on the entry, market shares and profitability of firms. Analogous to economies of scale where the average costs fall slowly relative to output, creating entry barriers; in a similar way, it is in the case of intermediate learning curves where the entry barriers are the greatest. Industries with very slow or very fast learning have low entry barriers with more competition. From the regulation perspective, enforcing competition in industries with moderate learning might reduce technical efficiency.

Learning by Innovation

Learning by innovation posits a relationship between the growth of the firm and the indicators of innovation which include research and development expenditures (R&D) or the number of innovations. Griliches (1979) uses the production function approach to analyze the returns to R&D expenditures and highlights the measurement issues related to the stock of R&D capital. Output is modeled as a function of inputs, the current state of technical knowledge and all other unmeasured determinants of output and productivity. It is recognized that the present technical knowledge is a function of current as well as past levels of research and development expenditures.

Learning Through Internal Resources

One of the important sources of learning is the firm's absorptive capacity, which consists of a set of capabilities that reflect the ability of a firm to learn. Cohen and Levinthal distinguish between two types of capabilities: learning capability and problem solving capability. Although the processes are similar, what is learnt in the two cases is different. Learning capabilities involve the development of the capacity to assimilate existing knowledge, while problem- solving skills represent a capacity to create new knowledge (Cohen and Levinthal, 1990, pp.130). There are also constraints on the speed of knowledge accumulation, similar to Penrose effects (Geroski and Mazzucato, 2002, pp.630). The growth of the firm

then depends not only on the firm's ability to assimilate existing knowledge but also on the speed with which it can accumulate new knowledge.

Learning and Forgetting

According to the learning and forgetting hypothesis (Benkard, 2000), in addition to learning, support is found for organizational forgetting (the hypothesis that the firm's production experience depreciates over time), and incomplete spillovers of production expertise from one generation of an aircraft to the next.

Learning and Industrial Policy Regime

A crucial factor which influences learning costs is the nature of industrial policy regime. From an infant industry argument, a government policy of protection is expected to enable learning and capability acquisition by the firm over a period of time. The infant industry argument (List, 1856) is based on a dynamic theory of comparative advantage and argues for protection for some countries at early stages of industrialization if some countries outdistanced others in manufactures. However such a policy also increases dynamic transaction costs by increasing the coordination and administration costs through the regulatory controls in the industrialization process of developing countries.

For example, the license raj system implemented in the 1950s, to redirect investment towards the state, constrained private sector investment through activities like constant monitoring, negotiations and lobbying; thus redirecting productive assets to unproductive uses (Bardhan, 1984; Ahluwalia 1985). When the government controls relax and the economy liberalizes, coordination costs decline making it favorable for firm and market capabilities to develop. For example, post-1991, the government allowed "broad-banding" in the automobile industry and gave new licenses for broad group of automotive products. This meant that an automotive firm could exploit economies of scale and

scope to diversify its product range from commercial vehicles to car manufacturing. This move allowed firms to take advantage of their core capabilities in manufacturing and outsource non-core capabilities to the market.

Paul Geroski and Mariana Mazzucato (2002) analyze the impact of the policy regime on learning in the American automobile industry by classifying learning into various categories. According to the authors, while learning is not directly observable, the process of learning is observable and can be modeled as an unsystematic stochastic process in the lines of Gibrat's law[2] which models firm growth as a stochastic process, independent of size. This process can be revealed by the time path of output, which tells whether growth rate differences are explained by a systematic learning process. They find that learning was mostly unsystematic (stochastic) in the period of liberalization (post-war period) as opposed to pre-world war period. According to them, unsystematic learning is an indicative of learning and forgetting in periods of rapid changes.

In the Indian context, a number of studies have been done on the effect of industrial policy regime on the growth and the capability acquisition of firms.[3] In all of the studies, the Indian automobile industry is broadly characterized by three industrial policy regimes: protection, deregulation and liberalization, each regime marked by a specific macro economic environment, market structure and technology and external institutions. Narayana (1998) finds that the inter-firm growth differences

[2] Gibrat's finding related to the independence between firm growth and its size has been tested later in various industries with mixed results (Evans 1987; Dunn et al1989; Shamugam et al, 2002).

[3] Kathuria's (1996) study on the acquisition of capabilities by various automobile manufacturers in the Indian industry highlights the competitive strategies of various four wheeler manufacturers in the acquisition of know-how (production) and know why (R&D) capabilities during various policy regimes. D'Costa (2004) studies the emergence of flexible governance forms in the Indian automotive industry that facilitate the transfer of best practices in the context of the industrial policy regimes

and the asymmetry in technology acquisition is largely due to the firms' ability to bring about technological paradigm and trajectory shifts in the post-deregulation period. However, none of these studies specifically address the learning processes within firms as a determinant of inter-firm differences. This study attempts to analyze the various learning strategies employed by firms as a response to different policy regimes. The next section describes the salient features of the major industrial policy regimes in India and its impact on production, market structure and the type of learning process employed to be able to grow and compete effectively.

INDUSTRIAL POLICY REGIMES IN INDIA AND IMPACT ON FIRM LEARNING

Protection: 1970-84 —Macro Economic Environment

During the protection phase, the industry's output was controlled by licensing production capacity and restricting output to single models so as to minimize the foreign exchange outflows due to the imports of components. Industrial policy did not allow capital imports or foreign direct investment (FDI). Further, complicated rules on imports made access to technology difficult and slowed down the learning process of firms.

Market Structure and Technology

The market structure was concentrated with entry barriers and restrictions to creating capacities and adding new product lines. While General Motors and Ford shut down their operations in India, business groups like the Birla and the Walchand group entered the industry. In 1960, there were three manufacturers, initially producing with licensed technology from US, UK and Italy; Premier Automobiles limited, Hindustan Motors and Standard Motors private limited, each producing very small outputs and Mahindra manufacturing jeeps. Product specific licensing policy forced companies to enter niche segments where each

enjoyed a monopoly. The market structure was thus concentrated and the firms relied on licensed technology and foreign equity participation as the means to growth. In mid seventies, the commercial vehicle industry was allowed unlimited production capacity and an automatic capacity expansion of 25% every five years.

External Institutions

Supplier capabilities in India were not well developed, and TML had various training programs to develop its capabilities. Auto component manufacturing was reserved for small-scale industry but lack of volumes did not allow consolidation in the industry through a hierarchical organization of capabilities (also known as tierization) in the supplier industry. It remained highly fragmented and technologically underdeveloped during this phase.

Impact on Learning

In the presence of regulations on product lines and capacity expansions, the only means to growth was access to foreign equity which would give them superior technology. According to Narayana's study (1997), in the protection regime, in the absence of major acquisitions of diversifications, firms with foreign equity grew faster than others because of the resource advantage they possessed. Thus, in the protection phase, the firm growth was dependent on its absorptive capacity that enables them to learn and internalize their foreign partner's technological knowledge.

Proposition 1: Protection Encourages Learning Through Internal Resources.

The initial phase of industrialization was characterized by lack of technological capabilities, which the government sought to develop by protecting its "infant industries" from competition. According to the infant-industry argument, in the initial phase of industrialization, the firm's growth and the learning process is aided by a protectionist regime

that encourages capacity building and acquisition of production and R&D capabilities.

In the automobile industry, the government regulations granted enough time for successful learners to build technological capabilities by restricting competition and encouraging import substituting industrialization. However, the uncertainty in demand and unreliability on suppliers even for mature products resulted in high levels of vertical integration even though assets were not highly specific. By integrating into machine tool industry, Tata could manufacture dies at 20-25% of what it would cost to import them from Japan (Kathuria, 1996, p.215).The incidence of high vertical integration was not limited to machine tool industry, but also in more generalized products like forgings and castings by Ashok Leyland, which was prompted to vertically integrate into castings because of criticality of product and need to minimize on monitoring costs.

Deregulation: 1984-91

Macro Environment

The industrial policy statements of 1977 and 1980 marked the beginning of deregulation by relaxing the regulations governing production licenses, foreign collaboration, asset size and the scope of industrial operations. In 1985, policy of broad banding was introduced with allowed manufacturers to make use of economies of scale and scope by manufacturing several product lines. Further, the technology imports were allowed and firms resorted to imports as a means to growth. Government entered into partnership with Suzuki in 1982 and in 1984, which led to the setting up of Maruti Udyog Limited (Maruti).

The macro economic situation deteriorated in the mid 80s because of liberalized imports, rupee appreciation and drain on foreign exchange reserves. The government was forced to devalue the currency

in 1991 and resort to IMF for liberalization program. Between 1984 and 1987, the Yen appreciated 200 times which hurt the Japanese joint ventures adversely.

Market Structure

Maruti manufactured 12000 vehicles challenging the market shares of the existing manufacturers and eventually becoming the market leader by 1991. Entry in the Passenger car segment was still restricted, with three players until early 1991—Maruti, Hindustan motors and Premier automobiles limited (PAL) with market shares of 60%, 13% and 23%. Standard Motors exited from the industry in the late 1980s. Thus, from this phase, the market structure changed in favor of the government joint venture-Maruti Udyog Limited and the output of automobile industry increased by nearly 400%.The commercial vehicle segment was liberalized and saw the entry of Japanese joint ventures like DCM-Toyota, Eicher-Mitsubishi Swaraj-Mazda and Allwyn-Nissan. However, most of them suffered set backs due to macro economic environment and foreign exchange appreciation.

External Institutions

The entry of Maruti also changed the supplier relations within the industry with the help of government sponsored training programs and cluster building. The presence of Japanese joint ventures in the same region created economies of industrial agglomeration. This also resulted in a widespread use of Japanese work practices that relied on cooperative agreements between suppliers and OEMs.

Impact on Learning

During the deregulation period, firms relied on technology imports and growth through spillovers from new competitors. Allowing firms to invest in several product lines resulted in firm learning as firms like Tata Motors introduced special purpose vehicles and platforms for moving towards passenger car segment. The institutional support for developing supplier

capabilities led to flexible supplier relationships whereby, firms could adjust demand downwards through detailed cost negotiations. For instance, Maruti was also able to expand its capacity in press shop from 130,000 to 180,000 without any significant capital outlays by having flexible labor practices and joint ventures

Proposition 2: Deregulation Encourages Learning Through Spillovers as a Means to Counter Competition.

The influences of external institutions can also speed up learning and place more capabilities in the market. These influences can be in the form of government training programs and cluster creations that can force the firms to adopt captive supplier relations to enable diffusion of capabilities. The case of Maruti demonstrates that the supplier relations have evolved from captive to relational approach where suppliers have become partners in research and development. In the eighties and nineties, supplier development at Maruti involved inviting "quality gurus" from Japan, with government collaboration. These consultants would form supplier clusters and impart training on the principles of Total Quality Management (TQM)/Total Preventive Maintenance (TPM) and various other Japanese management practices. Some of the tier-I companies interviewed in the sample credited the OEM with exposing them to Japanese work practices through the cluster approach in early nineties.

Liberalization: 1992-2008: Macro Environment

In 1993, the passenger car industry was completely delicensed followed by an entry of multinationals in this segment. This also encouraged existing firms to form joint ventures with foreign firms. From August 1991 to April 2002, the auto industry garnered 5.48% of the total foreign direct investment approved during this period (Government of India, Ministry of Commerce and Industry 2002).

Market Structure

The liberalized policies allowed firms to take advantage of low cost sourcing across the globe which in turn gave rise to modular relationships between suppliers and OEMs. For example, Sona Koyo has set up an engineering design and outsourcing company for its international clients. Rico Auto and Sundaram fasteners have laboratories with latest softwares for reverse engineering, designing and testing of parts. Such capabilities enable these firms to take up turnkey projects with low switching costs for the OEMs. At the same time, some firms did not acquire the capabilities to sustain competitiveness in the liberalized policy environment. For example, two firms exited the industry in the nineties: DCM Toyota and PAL. Both firms were taken over by multinationals, Daewoo in case of DCM and Fiat in the case of PAL. PAL exited from the industry after a failed partnership with Peugeot of France, and was taken over by Fiat.

External Institutions

With severe infrastructural and supply bottlenecks, resulting partly from past government policy of neglecting infrastructure and reserving components for the officially defined small scale industries, manufacturers were compelled to encourage partnerships among their suppliers to reduce mutual vulnerability. Supplier associations were introduced by Japanese manufacturers to enable diffusion of best practices. The Automotive component manufacturers association was an industrial lobby actively engaged in pursuing the suppliers' interests in the organized industry.

Impact on Learning

The liberalized environment exposed firms to new competition and encouraged them to undertake research and development activities, which increased during this time period. Firms introduced variety of models and the time span between new launches was also declining rapidly, indicating that firms were actively involved in new product

development. For example, at Tata Motors, a new technology group was set up at engineering research center for simultaneous engineering and joint product development with suppliers. Thus, during liberalization, firms resorted to learning through innovation and spillovers resulting from inter-firm relations. Changing inter-firm relations involved setting up a new organizational form in 1995 to promote technology acquisition in the component industry. The holding company structure gives Tata Motors the flexibility to partner with multiple global majors to access cutting edge technology and also facilitates the pooling of resources, capabilities and the creation of a common infrastructure and managerial expertise.

Similarly, in the year 2004, Maruti started a "Centre for Excellence", a joint investment between Maruti and some of its tier-I suppliers, with the OEM holding the majority stake. The Centre promoted three kinds of activities through a cluster of five to six companies: productivity improvements such as TPM, Kaizen and training for Japanese production systems; quality improvement program, where a top-down approach is adopted and emphasis is on training principles of TQM and system audits.

Proposition 3: Liberalization Encourages Learning Through Innovation and Spillovers

The entry of multinationals made the industry more competitive as OEMs introduced newer models and acquired new technology through partnerships and investment in R&D. The trend in R&D indicates that the R&D intensity (See Table 1) increased significantly during this period. Tata's investment in R&D is one of the highest in the industry. Tata's Engineering Research Center (ERC) has six divisions comprising styling, design, testing (in-door and out-door), vehicle performance, power train and machine shop. It hosts the only crash test facility and 'hemi anechoic noise and vibration test chamber in Asia outside Japan and Korea. It also

has an advanced emission measurement system and a digital prototype laboratory

Table 1: R&D Intensity (R&D expenditure as % of Sales)

Year	Tata Motors	Ashok Leyland	Hindustan Motors	Maruti Udyog Ltd	Mahindra	Premier Automobiles	Bajaj Tempo	Hyundai Motor India Ltd
1990	0.7	0.7	0.4	0.2	0.2	1.6	0.6	
1991	0.6	1.1	0.4	0.4	0.2	1.3	2.2	
1992	1.1	0.7	0.0	0.0	0.2	2.0	2.1	
1993	2.6	0.5	0.4	0.3	0.4	1.2	2.1	
1994	2.7	0.5	0.4	0.2	0.8	0.0	1.9	
1995	1.4	0.9	0.4	0.1	0.0	0.0	1.7	
1996	1.7	0.1	0.4	0.2	1.2	3.5	1.5	
1997	2.0	0.6	0.6	0.2	0.7	0.3	1.3	
1998	1.6	0.5	0.7	0.4	0.9	0.1	1.6	0.05
1999	1.2	0.7	0.0	0.3	0.0	0.4	1.0	0.02
2000	1.1	0.9	0.3	0.5	0.0	0.4	0.0	0.00
2001	1.1	0.9	0.5	0.5	1.8	0.0	2.2	0.00
2002	1.3	1.0	0.6	0.2	1.7		2.3	0.10

Source: SIAM Facts and Figures (2004), Annual reports.

Firms like Tata Motors and Maruti entered into strategic partnerships and also evolved new forms of supplier relations to promote joint product development and learning through spillovers. For example, in the liberalized regime, Tata's technology strategy focused on acquiring strategic partnerships and import of technological know-how. It imported technology for development of fuel injected gasoline engines from AVL, Austria in 1992, body styling from IDEA, Italy, process capability for welding from HLS, Germany and engine testing from Le Moteur Moderne, France. In 1994, the machine tool division built robots for the first time, with technology imported from Nachi-Fujikashi of Japan. Tata entered the passenger car segment in 1998 and in 2000, in an effort to focus on its core business of design and development of vehicles, it hived off the machine tool division into a separate company called Tata Automation Limited (TAL).

LEARNING MODEL BASED ON TIME PATH OF GROWTH

The present study adopts the learning model proposed by Geroski and Mazzucato (2002) which attempts to understand the role of learning in explaining the pattern of inter-firm growth rates. According to the model, while learning can be attributed to various factors, it is not directly observable. What is observable is the consequence of learning whose time series behavior can be analyzed to explain the type of learning employed by the firm. This is because, different types of learning will generate different time series patterns of the outputs. For example, learning can take place in many ways: through learning by doing, internal resources or absorptive capacity, spillovers or research and development. The model nests several hypotheses about learning into a generalized model, with the null hypothesis being that learning is unsystematic or stochastic process.

Starting with a production function on the lines of the simple AK model, the firm output can be modeled as a function of capital or stock of knowledge (K) and all other inputs (A). Learning is defined as the rate of change in the stock of knowledge (K) over time. In short, the growth rate or the performance of firms is the output indicator of the learning process. In the absence of direct measure of labor productivity, the impact of productivity is assumed to be an idiosyncratic shock and a stochastic process, included in A (t)[4].

The purpose of using this simplified model is two-fold:

(i) the choice variables of a profit maximizing firm are affected by learning and therefore a direct relation between stock of knowledge (or capital) and output rates is observable;

[4] The model further assumes that the evolution of A(t) is a white noise process, driven by a large number of small idiosyncratic cost and demand shocks and also that the variance of A(t) and α, the elasticity of output with respect to knowledge is similar across firms.

(ii) The model can be treated as a basic version in which labor productivity and R&D can be added later to refine the results further.

Define a production function,

$$Q(t) = A(t)\, KN(t)^{\alpha}, \quad (1)$$

where, Q (t) is the output produced; KN (t) is the stock of knowledge with the firm and A (t) is the effect of all other inputs on the output. Taking logs and first differencing,

$$\Delta \text{Log } Q(t) = \Delta \text{log } A(t) + \alpha\, \Delta \text{Log } KN(t), \quad (2)$$

where ΔLog Q (t) = growth rate of firm

ΔLog KN (t) = the rate of growth of stock of capital, which is by definition learning LE (t).

The model starts with the simplest of learning LE(t)—unsystematic or stochastic learning. Learning in this case is defined as:

$$LE(t) = \xi(t) \quad (3)$$

where ξ(t) is an i.i.d. random variable with mean zero and varaince which is constant.

In this case,

$$\Delta \text{Log } Q(t) = \varepsilon_t + \xi(t) = v(t) \quad (4)$$

which implies that firm size follows a random walk, as proved by Gibrat's law. This specification serves as the null hypothesis for the model of learning.

The second type of learning is learning through internal resources or the absorptive capacity of the firm which is the set of its entire pre-existing knowledge and experience. In this case the firm's current/future growth is dependent on its past learning or absorptive capacity, thus generating a relationship between the firm's current growth rate to its lagged growth rate. Since learning LE (t) is defined as change in capital stock, Δ Log KN (t), this suggests that the rate of

growth of firm's stock of capital stock or knowledge depends on its level (lagged output variable) as well as any recent increase in that stock (lagged growth of output).

$$LE(t)=\delta LogKN(t-1)+\theta LE(t-1)+ \xi(t), \quad (5)$$

This implies that,

$$\Delta Log\ Q\ (t) = \rho LogQ\ (t-1) + \psi \Delta Log\ Q\ (t-1) + \mu_t \quad (6)$$

where, $\mu(t)= \varepsilon(t) + \alpha*\theta*\varepsilon(t-1) + \alpha*\delta*$ Log $A(t-1)$, $\rho = \alpha^2\delta$ and $\psi = \alpha*\theta$

The coefficient of absorptive capacity "ρ" reflects the increasing returns to knowledge accumulation. If the coefficient is less than zero, then decreasing returns to knowledge accumulation prevail and knowledge will gradually depreciate over time. If the absorptive capacity coefficient is greater than zero, then increasing returns to knowledge accumulation prevail and learning is easier, and the larger is the current stock of knowledge. The sign of this coefficient in turn depends on the industry structure and the nature of the industry appropriability conditions, which are not discussed in the model.

The third type of learning is through spillovers, whereby the firm's growth rate is affected by its competitor's research and development activities. Since the R&D activities get reflected in the firm's output, one can posit a relation between growth rate of firm and its rival firm.

$$LE(t)=\alpha_j \Delta LogKN_j(t-1)+\xi(t) \quad (7)$$

This implies that,

$$\Delta Log\ Q\ (t) = \lambda_j\ \Delta LogQ_j\ (t-1) + v\ (t);\ \lambda_j = \alpha\alpha_j \quad (8)$$

Substituting for LE (t) from the equations (4), (6) and (8) in the production function, We get the following equation incorporating learning through internal resources, spillovers and unsystematic learning:

$$\Delta Log\ Q(t) = \alpha_1\ \Delta Log\ KN(t) + \alpha_2\ \Delta Log\ KN(t-1) + \alpha_3\ \Delta Log\ KNj(t) + \alpha_4 \Delta Log\ KNj(t-1) + \varepsilon_t \quad (9)$$

The different types of learning are summarized in Table 2. The presence of specific type of learning is indicated by the significance of the coefficient representing the learning. For example, when $\alpha_3 = \alpha_4 = 0$, the model reduces to learning via internal resources. When $\alpha_1 = \alpha_2 = \alpha_3 = 0$, the model shows significant learning from output spillovers and finally when there does not exist any systematic pattern of learning, none of the coefficients are significant, except for the lagged output coefficient.

Table 2: Summary of Models of Learning

S.N.	Model	Specification	Authors
1.	**Unsystematic Learning** Gibrat's law	$LE(t) = \xi(t)$ ***$\Delta Log Q(t) = \varepsilon(t) + \xi(t)$***	Sutton (1997)
2.	**Learning by innovation** Learning can be tied to the appearance of a particular innovation or R&D	$LE(t) = \beta I(t) + \xi(t), \beta > 0$ $\Delta Log\ Q(t) = \alpha\beta I(t) + v(t)$	Grilliches (1979)
3.	**Learning through spillovers** Relationship between the growth rate of firms i in period t and that of its rivals in t-1.	$LE(t) = \alpha_j \Delta Log KN_j(t-1) + \xi(t)$ ***$\Delta Log\ Q(t) = \lambda_j \Delta Log\ Q_j(t-1) + v(t)$, where $\lambda = a a_j$***	Grilliches (1979,1992)
4.	**Leaning by doing** Experience and focus on cumulative production	***$\Delta Log\ Q(t) = a\phi\ Log\ X(t) + v(t)$*** $X(t) = \sum_t Q(\tau)$ $LE(t) = \varphi\ Log\ X(t) + \xi(t)$	Spence (1981)
5.	**Learning using Internal resources** Link between stock of knowledge maintained by firm today and tomorrow.	$LE(t) = \delta Log KN(t-1) + \theta LE(t-1) + \xi(t)$, ***$\Delta Log\ Q(t) = \rho Log\ Q(t-1) + \psi\ \Delta Log\ Q(t-1) + \mu(t)$*** where, $\mu(t) = \varepsilon(t) + \alpha\theta\varepsilon(t-1) + \alpha\delta Log\ A(t-1)$, $\rho = \alpha^2\delta$ and $\psi = \alpha\theta$	Evans (1987), Geroski et al (2001)

Source: Geroski & Mazzucatto (2004).

EMPIRICAL MODEL

The base model is tested for the entire data set of 13 firms over 38 years, without introducing the impact of regime specific effects. It is represented as the following:

$$\Delta \text{Log } Y_{it} = \alpha_1 + \beta_1 \text{ Log } X_{it-1} + \beta_2 \text{ Log } X_{jt-1} + \beta_3 \Delta \text{ Log } X_{it-1} + \beta_4 \Delta \text{ Log } X_{jt-1} + \varepsilon_t, \quad (10)$$

In (10), the dependent variable is the growth rate of output and the independent variables are the lagged output of firm and lagged output of rival firms/industry, where the subscripts i and j denote own firm and rival firm output. $\Delta \log X_{1t-1}$ is the lagged growth rate of own firm and $\Delta \log X_{2t-1}$ = lagged growth rate of rival firms/industry. Rival firm output is the industry output minus the own firm output.

In the second representation of the model, regime specific dummies and a time trend are introduced to identify the impact of regime changes on the growth of the firms. Regime specific dummies are interacted with the time trend get the slope coefficients.

$$\Delta \text{Log } Y_{it} = \alpha_1 + \beta_1 X_{it-1} + \beta_2 X_{jt-1} + \beta_3 \Delta X_{it-1} + \beta_4 \Delta X_{jt-1} + \sum_{k=1}^{3} \gamma_k D_k * t + \varepsilon_{it} \quad (11)$$

In (11), all variables are similar to the base model in (10) except for the interaction terms between regime dummies (D) and time trend t; where k represents regimes 1-3.

The third and full specification includes interaction of structural dummies with all explanatory variables including the time trend.

DATA SOURCE

This study is based on annual production data for a sample of 13 firms in the four-wheeler automobile industry, obtained from the Society of Indian Automobile Manufacturers and Automobile Component Manufacturers Association, for thirty-eight years from 1970-2008 and the

time period is divided into three industrial policy regimes: protection (1970-84); deregulation (1985-91) and liberalization (1992-2008). The thirteen firms in the four-wheeler segment can be divided into three groups: Group one is those born in the protection period (pre-1970) and group two those born in the post-regulatory period (post-1985). A third group of firms is the multinational firms which entered after 1996. The data is unbalanced with exit and entry in the liberalized regime.

The descriptive statistics (mean and standard deviation) of the explanatory variables are presented in table 3. Table 4 shows the compound annual average growth rates (CAGR) in different policy regimes. Growth rates of the six firms in the protection phase were higher compared to the liberalization period. In the sample of six firms, only one firm-Tata Motors did better during the liberalization as compared to the protection period. In regime III, multinational firms had the highest growth rates. To summarize, regime I was driven by growth in the commercial vehicle segment, with firms like Ashok Leyland, Tata, Mahindra and Bajaj Tempo displaying above average industry growth rates. Regime II and III were driven by growth in the passenger car segment, with the entry of Maruti in 1985 and multinational players in mid 1990s. The overall industrial growth has been the highest in regime III, the main drivers of which are the multinational firms in the passenger car sector. One can estimate the model using either the random effects or fixed effects models. The former assumes that firm-specific factors are uncorrelated with size and age, whereas, the latter allows for such a correlation. The Hausman's statistics can help to choose the method of estimation. It tests the null hypothesis of no correlation (i.e., random effect model). The Hausman's statistic supports the null hypothesis of zero correlation between firm specific factors with size. Hence, the study uses a one-way Random Effects model to estimate the coefficients.

Table 3: Descriptive Statistics

Firms/ policy regimes	Production (Units)	Growth (Log Differences)	Lagged Output (Log)	Lagged Output (Log)- Rival Firms	Lagged Growth- Rival Firms	Sample Size
Tata Motors-Regime 1	383921	0.143	11.377	12.339	0.116	13
Regime 2	272754	0.160	8.075	8.755	0.111	7
Regime 3	343366	0.113	11.240	12.237	0.115	17
Ashok Leyl-Regime 1	10831	0.085	9.144	11.526	0.042	13
Regime 2	19875	0.074	9.805	12.534	0.125	7
Regime 3	43356	0.047	10.546	13.629	0.102	17
Hind.motors-Regime 1	23173	-0.002	10.020	11.383	0.056	13
Regime 2	26158	-0.068	10.224	12.497	0.137	7
Regime 3	22004	-0.036	9.978	13.643	0.105	17
Mahindras-Regime 1	28019	0.073	10.075	11.372	0.036	13
Regime 2	58227	0.028	10.937	12.383	0.141	7
Regime 3	138516	0.072	11.726	13.514	0.105	17
Premier Auto-Regime 1	18811	0.040	9.771	11.440	0.049	13
Regime 2	35312	0.017	10.442	12.473	0.127	7
Regime 3	14032	52.035	51.341	13.656	0.108	8
BajajTempo-Regime 1	7276	0.109	8.695	11.561	0.041	13
Regime 2	15138	0.010	9.611	12.545	0.127	7
Regime 3	19860	0.004	9.788	13.650	0.103	17
Eicher –Regime 2	3745	28.473	34.060	12.590	0.121	6
Regime 3	12524	0.088	9.089	13.664	0.101	17
Swaraj –Regime 2	3093	14.186	21.031	12.589	0.121	7
Regime 3	6290	64.016	61.606	13.671	0.101	6
DCM-Regime 2	2502	14.272	20.769	12.591	0.121	7
Regime 3	6564	0.072	8.562	13.668	0.101	17
Maruti –Regime 2	98865	0.241	11.223	12.282	0.069	7
Regime 3	415556	0.109	12.717	13.184	0.097	17
Hyundai India -Regime 3	202363	35.713	47.692	13.599	0.090	11
Ford India-Regime 3	24258	47.188	57.084	13.667	0.100	9
Toyota Kirl.-Regime 3	36477	41.397	52.030	13.661	0.099	10
Industry-Regime 1	**122617**	**0.057**	-	-	-	13
Regime 2	**326894**	**0.085**	-	-	-	7
Regime 3	**1101079**	**0.103**	-	-	-	17

Table 4: Compound Average Growth Rate (%)

Firms	Regime 1-1970-84			Regime 2-1985-91			Regime 3-1992-2008		
	CAGR	Mean	CV	CAGR	Mean	CV	CAGR	Mean	CV
Tata Motors	6.06	5.71	2.82	11.83	11.83	0.67	11.28	11	0.57
Ashok Leyland	9.66	8.95	1.89	9.43	7.40	1.36	7.28	7	0.84
Hindmotors	0.81	4.88	7.01	-3.95	-5.33	-3.27	-6.03	-6	-0.63
MUL	0.00			56.57	16.70	1.20	10.02	11	0.28
Mahindra	7.45	10.32	2.22	5.11	3.50	3.00	5.41	7	0.46
PAL	1.98	8.38	4.39	5.16	2.82	5.96	-47.21	-81	-0.71
BT	10.78	11.16	1.53	1.49	1.12	15.00	1.61	6	1.30
Eicher				24.94	42.97	1.79	15.38	12	0.44
DCM				7.03	9.43	3.24	15.77	-10	-7.25
Swaraj				18.86	21.53	1.68	11.02	8	0.65
HMIL							31.19	33.25	0.37
TKMIL							22.22	28.48	0.75
FIL							0.21	20.00	0.71
GMIL							26.59	26.59	0.45
Industry	**6.45%**	**7.42%**	**1.95**	**8.32%**	**7.51%**	**0.96**	**9.84%**	**11.50%**	**0.33**

**Growth rate for PAL for Regime 3 is from 1992-2000 and for DCM it is from 1992-1999.*

Expected Coefficient Signs

Unsystematic learning induces a random walk in firm size; and learning from internal resources creates a correlation between the growth of a particular firm and its lagged output and growth. A negative relation between lagged output and growth means that there are diminishing returns to the stock of knowledge a firm possesses. The coefficient on lagged output represents the previous stock of knowledge a firm possesses. The coefficient on lagged growth of firm represents the learning effect, or, the speed of knowledge assimilation. A negative coefficient of lagged output growth on the other hand means that there are diminishing returns to growth. Both of these imply that differences in firm performances gradually diminish and firm sizes converge to a mean. There could be diminishing returns to stock of knowledge firm possesses but increasing returns to growth or the speed with which the firm accumulates knowledge. In this case, firm's learning ability is more important than the stock of knowledge it possesses in determining its growth performance.

In the protection period (1970-84), competition was limited and growth was constrained by licensing and capacity restrictions. Hence, one would expect diminishing returns to knowledge accumulation but increasing returns to growth. At the same time, output spillovers were limited because of restricted competition and each firm enjoying its market niche.

In the partial deregulation and liberalization policy regime, relaxation in imports, capacity expansion and foreign direct investment should result in increased knowledge flows and greater opportunities for investment. Hence the returns from the stock of knowledge should be positive and the lagged output coefficient should be positive. In the liberalized policy regime, speed of knowledge accumulation rather than the access to knowledge could be more important in the liberalized regime, with a level playing field for all the players. Hence one can expect a negative coefficient for lagged output of rival firms but positive coefficient for lagged growth of rival firms during liberalization (Table 5).

Table 5: Expected Coefficient Signs

Variable	Regime I	Regime II	Regime III
Lagged growth rate	(+)	(+)	(-)
Lagged output	(-)	(+)	(+)
Lagged output-rival firms	(+)	(+)	(+)
Lagged growth-rival firms	(+)	(+)	(-)

RESULTS

In column (1) of Table 6, the results for fixed effects model are presented. The coefficient on lagged output is positive but not significant. Lagged growth in output is positive and significant. A 1% increase in lagged growth resulted in 0.16% increase in current growth. This indicates that for the entire time period of 38 years, the stock of knowledge is not an important variable for explaining inter-firm growth differentials.

Table 6: Panel Model Estimation Results

Variables	(Col.1) One-Way Fixed Effects Model (FEM)	(Col.2) One-Way Random Effects using GLS (REM)	(Col.3) REM- interacting structural dummies with time trend	(Col.4) REM- interacting structural dummies with all explanatory variables
Lagged output	0.028(0.676)	0.017 (0.769)	-0.014 (-0.539)	-1.016 (-2.352)*
Lagged growth	0.159 (6.457)*	0.171(7.507)*	0.164 (7.483)*	0.031 (0.080)
Lagged output-Rival firms	-0.09 (-2.728)**	-0.061 (-2.567)*	-0.485 (-4.11) *	0.361 (0.941)
Lagged growth-rival firms	0.28 (1.652)	0.253 (1.511)	0.440 (2.657)*	-0.43 (-1.376)*
Constant		0.618 (2.086)**	5.481 (4.044)*	5.981 (9.766)*
Time trend * Regime 1 dummy			0.023 (1.251)	0.067 (3.906)*
Time trend * Regime 2 dummy			0.040 (2.791)*	0.084 (1.178)
Time trend * Regime 3 dummy			0.042 (3.552)*	0.044 (8.251)*
Lagged output * Regime 2 dummy				0.551 (0.770)
Lagged growth * Regime 2 dummy				-0.494 (-0.34)
Lagged output-rival firms * Regime 2 dummy				-0.535 (-0.758)
Lagged growth-rival firms * Regime 2 dummy				0.075 (0.068)
Lagged output * Regime 3 dummy				1.005 (2.329)**
Lagged growth * Regime 3 dummy				0.126 (0.327)
Lagged output-rival firms * Regime 3 dummy				-0.891 (-2.304)**
Lagged growth-rival firms * Regime 3 dummy				0.963 (3.006)*
Hausman#	8.51			
R-Squared	0.2297	0.1735	0.2055	0.2153

Figures in brackets refer to t statistics. *denotes Sig at 1%level; **Sig at <5% level. # p = 0.0746, 4df

Rather, it was speed of knowledge assimilation or the growth of output which was a significant determinant of firm growth. The coefficient on lagged output of rival firms is negative and significant, which means there were diminishing returns to rival firm's stock of knowledge. A 1% increase in rival firms' output resulted in 0.09% decrease in firm's growth. In terms of learning, there were increasing returns to the stock of knowledge possessed by firms as well as their ability to assimilate this knowledge. The coefficient on lagged output of rival firms is negative but lagged growth of rival firms is positive for the overall model; suggesting that returns to spillovers were diminishing but there are increasing returns to the speed of assimilation of rival firm innovation.

Due to the Hausman test statistic, the Random Effects model is more appropriate for this dataset. Col. (2) in table 6 reports the results of one-way random effects model; the only difference that emerges is that the constant term turns out to be positive and significant.

In column (3) interaction terms for time trend and regime dummies are introduced. The coefficient on lagged growth is positive and significant. The coefficient signs for lagged output of rival firms and lagged growth of rival firms in the second model are similar as the base model suggesting that more than the stock of knowledge, the speed of assimilation or learning is a more important determinant of growth. Coefficient on time trend is positive and significant for deregulation and liberalized regime, indicating that the growth was much higher during this period compared to protection time period. Lagged variables in a data set generally result in non-stationarity and unit root problems. In this case, the significant coefficient for time trend indicates that the variables are trend stationary with structural breaks. Hence, incorporating structural dummies with the time trend takes care of unit root problem.

Column (4) presents regime specific slope coefficients which highlight the different learning strategies across the three policy regimes. Structural dummies representing the three policy regimes are interacted with the explanatory variables to arrive at regime-specific slope coefficients. Regime 1 (Protection) is taken as the base category against which the results for other two regimes are compared[5].

The Finding Supports Proposition 1 That Protection Encourages Growth Through Internal Resources.

In regime 1, lagged output was significant but negative, implying that returns to knowledge accumulation were decreasing. The negative size effect indicates that smaller plants grew faster than larger ones in the protection period. A negative and significant coefficient on lagged growth of rival firms indicates that there were decreasing returns to the speed of assimilation of rival firm innovation.

In regime 2 (deregulation), lagged output is negative but not significantly different from regime 1 (base category). Similarly, the coefficient on lagged growth of rival firms is positive but not significant. This implies that rival firms' learning had a positive spillover effect on the growth of firms during deregulation but not significantly different from protection, thus giving support to proposition 2 on the positive impact of spillovers.

The Results Support the Proposition that During Liberalization, Firms Grew Through Innovation and Spillovers

The results also support the proposition – proposition 3 – that during the liberalization period, firms grew through innovation and spillovers. The coefficient sign on lagged output is positive and significant, implying

[5] In the case of categorical variables the interpretation of the marginal effects should be made vis-à-vis the base category.

increasing returns to the stock of knowledge. The coefficient on lagged growth of rival firms is also positive and significant implying that there was substantial learning from spillovers in regime 3, significantly higher compared to regime 1. Finally, in regime 3, lagged output of rival firms is negative and significant indicative of decreasing returns to the stock of knowledge acquired by rival firm. In both protection and liberalization, the coefficient on lagged growth of firms is positive –but not significant-- suggesting the importance of the speed of accumulation of knowledge.

The constant term is significant for all firms in regime 3 signifying the role of other factors like demand variables. Table 7 summarizes the different learning strategies in each policy regime.

Table 7: Learning strategies across policy regimes

Regime I			Regime II			Regime III		
Internal resources	Spillovers	Unsyst ematic	Internal resources	Spillovers	Unsyst ematic	Internal resources	Spillovers	Unsyst ematic
√			√	√		√	√	

CONCLUSION

The economic success of emerging economies in the late seventies sparked off debates on several issues like the role of government versus the private sector, export oriented strategy versus import substituting industrialization and a combination of the two. In this context, this thesis undertakes a case study of the growth of the Indian automobile Industry across three policy regimes, focusing on learning and capability acquisition. The objective has been to study whether policy regime can influence firm level learning. If so, then it provides a justification to the infant industry argument from a developing country perspective as well as highlights the lessons to be learnt from successful learners. The study relies on a qualitative case study approach, complemented by quantitative techniques.

While the literature on technological capability acquisition is rich in documenting the empirical details of the process and sequence of capability acquisition, it suffers from subjective classification of capabilities and a static analysis of capabilities that are changing over time. The study has tried to integrate empirical case studies with the literature on learning by applying a dynamic model of learning to the Indian industry. The study examined the dynamic nature of learning process by looking at the time path of output across thirteen major automobile firms. The model is estimated for the Indian industry for a sample of thirteen four wheeler firms across three policy regimes, divided into twelve year, seven year and seventeen year period. The study uses random effects panel data estimation, with time trend and structural dummies as shift variables for the regime changes.

To conclude, the paper demonstrates that learning varies by the policy regime. Learning is also firm-specific, defined by the technology strategy and capabilities of the firms, which is not captured by the traditional industrial organization theory. The study rejects the hypothesis

of independence between firm size and firm growth, known as Gibrat's law. Results indicate that relation between firm size and growth differs by policy regime. The results indicate that during protection accumulation of stock of knowledge was more important, whereas during liberalization, the speed of knowledge accumulation was more important. From a policy perspective, while protection encourages acquisition of production capabilities of, it does not equip the firm with the learning capabilities necessary for survival in a competitive environment. This is shown by the fact that some of the firms that acquired learning also exited the industry in a liberalized policy regime, unable to face the competition. What is required is an ability to adapt to the changing market conditions. These conclusions also give pointers to further research to incorporate the impact of quality and coordination capabilities in the model of learning.

REFERENCES

Ahluwalia, Isher Judge (1985)**,** Industrial Growth in India: Stagnation since the Mid-Sixties, Delhi, OUP, pp.235,

Asia Africa Intelligence Wire (2004), "TAPS Draws up Plans to Expand; Eyes Global Markets", July 17.

Bardhan, Pranab (1984), The Political Economy of Development in India**,** Oxford, Basil Blackwell, pp.118.

Benkard C. Lanier (2000), "Learning and Forgetting: The Dynamics of Aircraft Production," *American Economic review*, American Economic Association, vol. 90(4), pages 1034-1054.

Bowonder (1998), "Competitive and Technology Management Strategy: case study of Telco", *International Journal of Technology Management*, 15(6-7), June-July, pp: 646-681.

Business Line (2004), "Indo-Thai Free Trade Pact: `Thai Imports may Hit Auto Component COS' (ICRA study finds Indian companies could suffer 15-20% percent cost disadvantage)" Feb 4,; pg 2.

D'Costa A.P (2004), "Flexible Governance for Mass Production Goals: Economic Governance in the Indian Automobile Industry", *Industrial and Corporate Change*, Vol.13 (2), , pp:335-367.

Dunne, P., Roberts, M. J. and Samuelson, L. (1989), The Growth and Failure of Manufacturing Plants, *Quarterly Journal of Economics*, 104, 671-698.

Geroski, Paul; Marianna Mazzucato, (2002) "Learning and Sources of Corporate Growth", Industrial and Corporate Change, August; 11;4; pp:623-644.

Grilliches, Zvi (1979), "Issues in Assessing the contribution of R&D to productivity growth", *Bell Journal of Economics*, 10(1).

Griliches, Zvi, 1992. " The Search for R&D Spillovers," Scandinavian Journal of Economics, Wiley Blackwell, vol. 94(0), pages S29-47, Supplemen

List F (1856), *The National System of Political Economy*. Philadelphia, JB Lippincott and Co.

Kathuria Sanjay (1996), "Competing through technology and Manufacturing", Oxford University Press,.

Langlois, Richard (1992), "Transaction-cost Economics in Real time *Industrial and Corporate Change* **1**(1): 99-127.

Narayanan, K (1998), "Technology Acquisition, De-regulation and Competitiveness: A study of Indian Automobile Industry", *Research Policy*, 27(2), 215-228.

Penrose, Edith (1959/1995), The Theory of the Growth of the Firm. Oxford University Press: Oxford.

Prahalad, C. and G. Hamel (1990), "The core competence of the corporation". *Harvard Business Review* 68 (3): 79--91.

Shanmugam, K. R. and S. N. Bhaduri (2002), "Size, Age and Firm Growth in the Indian Manufacturing Sector". *Applied Economics Letters* 9(9): 607-613.

Williamson, Oliver E., (1985), The Economic Institutions of Capitalism, New York: The Free Press.

MSE Monographs

* Monograph 4/2007
  The Reserve Bank and The State Governments: Partners in Progress
  Y.V.Reddy
* Monograph 5/2008
  India's Dilemmas: The Political Economy of Policy-Making in a Globalized World
  Kaushik Basu
* Monograph 6/2010 (For limited circulation)
  MDGS-based Poverty Reduction Strategy for Tamil Nadu
  D.K.Srivastava, K.R. Shanmugam and C.Bhujanga Rao
* Monograph 7/2010 (For limited circulation)
  Urban Poverty Alleviation Strategy: A Study of Six Cities
  D.K.Srivastava, C.Bhujanga Rao, Swarna S. Vepa and Brinda Viswanathan
* Monograph 8/2010
  Review of Trends in Fiscal Transfers in India
  D.K.Srivastava and C. Bhujanga Rao
* Monograph 9/2010
  Feasibility of Incentive Based Environmental Instruments in State and Central Taxation Regimes
  D.K.Srivastava and C. Bhujanga Rao
* Monograph 10/2010
  Economic Instruments for Environmental Management: International Best Practices and Applicability to India
  D.K.Srivastava Dr K.S. Kavikumar , and C.Bhujanga Rao
  With inputs from Dr Bodhisattva Sengupta, Dr Brijesh C. Purohit, Ms Asha Mariam Abraham, Ms Ishwarya
* Monograph 11/2011
  Taxation of Goods and Services in India
  D.K. Srivastava and C. Bhujanga Rao
* Monograph 12/2011
  Coping with Pollution: Eco Taxes in a GST Regime
  D.K. Srivastava, K.S. Kavi Kumar and C. Bhujanga Rao, with inputs from Brijesh C. Purohit and Bodhisattva Sengupta
* Monograph 13/2011
  Recent Bouts of Inflation in India: Policy Paralysis?
  T.N. Srinivasan
* Monograph 14/2011
  Impact of Fiscal Instruments in Environmental Management through a Simulation Model: Case Study of India
  D.K. Srivastava and K.S. Kavi Kumar, with inputs from Subham Kailthya and Ishwarya Balasubramaniam
* Monograph 15/2012
  Environmental Subsidies in India: Role and Reforms
  D.K. Srivastava, Rita Pandey and C.Bhujanga Rao with inputs from Bodhisattva Sengupta

MSE Working Papers

Recent Issues

* Working Paper 55/2010
  Valuing the Environment in Developing Countries: Modeling the Impact of Distrust in Public Authorities' Ability to Deliver on the Citizens' Willingness to Pay for Improved Environmental Quality
  Ekin Birol and Sukanya Das

* Working Paper 56/2010
  India's Low Carbon Inclusive Growth Strategy
  U. Sankar

* Working Paper 57/2011
  Shifting Preferences at the Fed: Evidence from Rolling Dynamic Multipliers and Impulse Response Analysis
  Matthew Greenwood-Nimmo and Yongcheol Shin

* Working Paper 58/2011
  Household Level Pollution in India: Patterns and Projections
  K.S. Kavi Kumar and Brinda Viswanathan

* Working Paper 59/2011
  Dependence of States on Central Transfers: Aggregate and State-Wise Analysis
  D K Srivastava and C Bhujanga Rao

* Working Paper 60/2011
  Discount Rate for Health Benefits and the Value of Life in India
  K.R. Shanmugam

* Working Paper 61/2011
  Evidence on Changes in Time Varying Volatility around Bonus and Rights Issue Announcements
  Madhuri Malhotra, M. Thenmozhi and Arun Kumar Gopalaswamy (forthcoming)

* Working Paper 62/2011
  Patterns of Labour Market Insecurity in Rural India: A Multidimensional and Multivariate Approach
  Padmini Desikachar and Brinda Viswanathan

* Working Paper 63/2011
  Determinants of Child Morbidity and Factors Governing Utilisation of Child Health Care: Evidence from Rural India
  Anindita Chakrabarti

* Working Paper 64/2012
  Arsenic Contamination in Water: A Conceptual Framework of Policy Options
  Zareena Begum I

---

* Working papers are downloadable from MSE website http://www.mse.ac.in
$ Restricted circulation