



R&D Strategy of Small and Medium Enterprises in India: Trends and Determinants

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and growth due to:

- liberalization of economic policies in the last two decades
- intensifying market competition (entry of foreign firms and cheap imports)
- Change in the IPR regime from process to product patent system.

□ The promotion of R&D among SMEs is therefore critical as these firms possess limited financial and intangible resources unlike their large counterparts:

- SME R&D behaviour continue to be an under-researched area in India
- There is hardly any systematic analysis of the R&D determining factors among SMEs.

□ In this study, we have presented trends in the R&D investment of Indian manufacturing SMEs and analyzed their R&D behaviour during 1991-2008.

- SMEs are defined as per the Micro, Small and Medium Enterprise Development (MSMED) Act, 2006:
 - A manufacturing enterprise with a cumulative investment in plant and machinery up to Rs. 5 crore is defined as small firm;
 - an investment of above Rs. 5 crore and up to Rs. 10 crore is defined as medium size firm;
 - an investment above Rs. 10 crore is taken as large firm.
- Updated Prowess database (2009) with over 9200 manufacturing firms, of which
 - a set of 5237 Indian manufacturing SMEs could be identified (single counting of a firm during 1991-2008).

intensity of such activities:

- just about 8.5 per cent of the total number of small firms in the sample reported R&D expenses for at least single year during 1991–2008. This ratio is 16 per cent and 38 per cent for medium and large firms respectively.
- The study period R&D intensity of all small firms is very small at 0.1 per cent; experienced a 21 per cent fall from 0.12 per cent in 1991–99 to 0.09 per cent in 2000–08.
- Medium firms' R&D intensity continued to be below 0.2 per cent; fell by 10 per cent in 2000s to 0.13 per cent, from 0.14 per cent in 1990s.
- large firms' R&D intensity has generally been increased over 1991–2008; grown by 39 per cent from 0.27 per cent in 1990s to 0.38 per cent in 2000s.

of R&D doing firms across different firm sizes:

- R&D-doing SMEs generally outperformed R&D-doing large firms in terms of R&D intensity
- R&D intensities of SMEs have consistently been higher than that of large firms (except for two years in the case of small firms) during 1991-2008.
- R&D intensities of SMEs incurring R&D expenses have generally increased in 2000s to reach 1.5 per cent in 2008, nearly twice that of R&D doing large firms.

■ These results suggest that SME R&D in Indian manufacturing is increasingly getting concentrated among a small group of R&D doing SMEs in the last decade.

- Domestic business group affiliated SMEs are the largest source of SME R&D in Indian manufacturing during the last two decades, contributing nearly half of the total amount of R&D investment; standalone domestic SMEs (40%), followed by 10% share of SMEs with foreign investment.

- SMEs with foreign investment tends to have highest R&D intensities (0.18% and 0.32% respectively for small firms and medium firms), followed by group affiliated SMEs (0.16% and 0.24% correspondingly).

■ Industry Trends:

- Concentrated: top four industries (chemicals, electrical & optical equipment, pharmaceuticals and machinery & equipment) accounted for as much as 80% of the total SME R&D in 1990s, which went up further to 88% in 2000s.

- Higher SME R&D intensities confined to technology intensive sectors (in 2000-08: chemicals→0.34%, pharmaceuticals →0.28%, electrical & optical equipment→0.27%, machinery & equipment→0.2%, coke & petroleum products→0.16% and transport equipment→0.1%.

- Indian SMEs' R&D intensity further dwindled between 1990s and 2000s: the most significantly in transport equipment (-50%), followed by pharmaceuticals (-31%), machinery & equipment (-12%) and

Firm size (FSIZE), firm age (FAGE), external technology purchase (ETP), export orientation (EX), raw material Imports (RMI), affiliation to foreign firm (AFF), business group affiliation (BGA) and profit margin (PM).

Firm-specific characteristics

R&D OF A SME

Policy factors

Sectoral characteristics

Liberalization of economic policy, public investment in general innovation infrastructure, forging stronger networks of firms with government R&D laboratories and universities,

inter-industry differences in technological opportunities, innovation supporting infrastructure and institutions, market structure degree of competition from imports and foreign investment, etc.

Dependent Variable

R&D Intensity

RDINT_{it}

R&D expenditure as a per cent of total sales of *i*th SME in *t*th year.

Independent variables

Firm-specific variables

Firm Age

FAGE_{it}

The age of *i*th SME in number of years from the year of its incorporation.

Firm Size

FSIZE_{it}

Total sales (Rs. Million) of *i*th SME in *t*th year.

External Technology
Purchase

ETP1_{it}

Expenses in royalties, technical and other professional fees by *i*th SME as a per cent of sales in the year *t*.

ETP2_{it}

Expenses on imports of capital goods and equipment by *i*th SME as a per cent of sales in *t*th year.

Export Intensity

EX_{it}

Goods and services exports of *i*th SME as a per cent of sales in the year *t*.

Raw Material Imports

RMI_{it}

Imports of raw materials by *i*th SME as a per cent of sales in *t*th year.

Affiliation to Foreign Firm

AFF_i

Assume 1 if *i*th SME has affiliation to a foreign firm, 0 otherwise.

Business Group Affiliation

BGA_i

Assume 1 if *i*th SME has affiliation to a domestic business group, 0 otherwise.

Profit Margin

PM_{it}

Profit before tax of *i*th SME as a per cent of sales in the year *t*.

Industry-specific variables

Sectoral R&D Intensity

IRD_{jt}

R&D expenses of *j*th industry as a per cent of industry sales in *t*th year.

Sectoral Concentration

HI_{jt}

Herfindahl Index of *j*th industry in *t*th year based on domestic sales.

Competition from Foreign
Investment

CFI_{jt}

Foreign firms' share in domestic sales of *j*th industry in *t*th year.

Import competition

IMP_{jt}

Imports as a per cent of domestic demand (= production + imports - exports) of *j*th industry product in *t*th year.

- All firm-specific and policy variables are drawn from Prowess database (2009), CMIE. Fiscal benefits for R&D is obtained as total fiscal benefits minus fiscal benefits related to exports, oil pool and sales tax (but there is a measurement problem).
- Sectoral R&D intensity, Herfindahl index and foreign firms' share in domestic sales are also computed from the same database (i.e. Prowess).
- Import competition at ISIC Rev.3 industry groups is based on industry-wise trade (i.e. exports and imports) and production data related to India were respectively drawn from the OECD dataset and the ASI, CSO.

■ **Method of analysis:**

- The dependent variable, R&D intensity is extremely censored (for example less than 10% of small firms do R&D). In this case, the assumptions of normality and homoscedasticity is most likely to be violated leading to inconsistent coefficient estimation by Tobin's ML method. In fact Skeels and Vella's conditional moment test conducted after Tobit show that errors in the estimated models are not normally distributed.
- We used Chernozhukov and Hong's (2002) three step algorithm to estimate Powell's (1986) censored quantile regression (CQR). It provides consistent estimates when there is heteroscedastic non-

variables

SMEs

Large Firms

FAGE _{it-1}	(+) ^{***}	(+) ^{***}
FSIZE _{it-1}	(+) ^{***}	(+) ^{***}
FSIZE ² _{it-1}	(-) ^{***}	(-) ^{**}
ETP1 _{it-1}	(+)	(+)
ETP2 _{it-1}	(-)	(-)
EX _{it-1}	(+) ^{***}	(+) ^{***}
RMI _{it-1}	(+) ^{***}	(-)
PM _{it-1}	(+) ^{***}	(+) ^{***}
AFF _i	(+) ^{**}	(+) ^{***}
BGA _i	(+) ^{***}	(+) ^{***}
HI _{jt}	(+)	(+) ^{***}
CFI _{jt}	(+) ^{***}	(+) ^{***}
IRD _{jt}	(+) ^{***}	(+) ^{***}
IMP _{jt}	(+) ^{***}	(+) ^{***}

characterized by following facts:

- SMEs possess a very low incidence of doing R&D and spend a small proportion of their sales in such activities.
- The magnitude of R&D intensity of SMEs has gone down in 2000s as compared to 1990s.
- The low and declining SME R&D intensity seems to suggest that small firms are falling behind in upgradation of technological capabilities than their large counterparts---a serious concern for policy makers.
- A number of policy observations can be derived from the quantitative study on the determinants of SME R&D:
 - Policies encouraging SMEs participation in international markets through exports and facilitating access to imports of raw materials may increase SME R&D.
 - Encouraging greater investment participation of domestic business groups and foreign firms in the SME sector may also help small firms to increase their R&D performance.
 - Promotion of industrial cluster among SMEs can be useful to minimize the limitation of their small size on R&D.
 - Facilitating SMEs access to cheap finance, capital markets and venture capital funding could act as a catalyst for SME R&D.
 - Industry-specific policies can be considered to further open up industrial sectors that are relatively less open to the dynamics of international