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Importance of Technological Innovation for SME Growth

Evidence from India

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Abstract

This paper probes the drivers, dimensions, achievements, and outcomes of technological innovations carried out by SMEs in the auto components, electronics, and machine tool sectors of Bangalore in India. Further, it ascertains the growth rates of innovative SMEs vis-à-vis non-innovative SMEs in terms of sales turnover, employment, and investment. Thereafter, it probes the relationship between innovation and growth of SMEs by (i) estimating a correlation between innovation sales and sales growth, (ii) calculating innovation sales for high, medium, and low growth innovative SMEs and doing a ……./

Keywords: technological innovations, sales growth, auto components, electronics, machine tools, Bangalore

JEL classification: L25, L26

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aggregate one-way ANOVA, and (iii) ascertaining the influence of innovation sales, along with investment growth and employment growth on gross value-added growth by means of multiple regression analysis. The paper brings out substantial evidence to argue that innovations of SMEs contributed to their growth.

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Tables and figures appear at the end of the paper.

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1 Introduction

Small and medium enterprises (SMEs) have been considered one of the 'driving forces' of modern economies due to their multifaceted contributions in terms of technological innovations, employment generation, export promotion, etc. Of these, the ability of SMEs to innovate assumes significance because innovation lends competitive edge to firms, industries and ultimately, economies. Therefore, technological innovation has the potential to spur growth of individual enterprises at the micro level and aggregate industries and economies at the macro level.

Given the above, this paper attempts to understand issues such as what factors drive SMEs to innovate, what is the nature of SME innovations, what are the achievements of SME innovations, and what are the outcomes of these achievements. Overall, this paper attempts to address the question: does SME innovation facilitate the growth of firm size? This question has been probed in the context of SMEs in auto components, electronics, and machine tool sectors in the city of Bangalore, the only global hub of technological innovation in South Asia and the highest ranked global hub in the entire Asia (UNDP 2001).

2 Review of literature and theoretical framework

Technological innovation is a key factor in a firm's competitiveness. Technological innovation is unavoidable for firms which want to develop and maintain a competitive advantage and/or gain entry in to new markets (Becheikh et al. 2006). Among firms of different sizes, SMEs are generally more flexible, adapt themselves better, and are better placed to develop and implement new ideas. The flexibility of SMEs, their simple organizational structure, their low risk and receptivity are the essential features facilitating them to be innovative (Harrison and Watson 1998). Therefore, SMEs across industries have the unrealized innovation potential (Chaminade and Vang 2006).

There is substantial evidence to show that a number of SMEs in a wide variety of sectors do engage in technological innovations, and that these innovations are likely to be an important determinant of their success (Hoffman et al. 1998). However, the ability and innovative capacity of SMEs varies significantly, depending on their sector, size, focus, resources, and the business environment in which they operate (Burrone and Jaiya 2005). Particularly innovation in the manufacturing sector is a very complex process which is propelled by numerous factors (Becheikh et al. 2006).

This leads us to the question—what drives manufacturing SMEs to technologically innovate? If a firm has to technologically innovate, it should have in-house technological competence in the form of technically qualified and motivated entrepreneurs or managers with innovative ideas and technically skilled employees. Similarly, there must be a market demand for the innovated products in the form of an explicit customer demand or implicit market opportunities. Of course, the relative importance of these internal as well

as external factors might vary from firm to firm or from industry to industry or even from economy to economy and from time to time.

Lehtimaki (1991) attributed the emergence of new ideas for product innovations in SMEs of Finland to top management. These small firms very actively explored new product ideas and the most frequent way of achieving this included contacts with customers. Chanaron (1998) identified demand placed on business by customers/clients, close working relationships with a key customer and close analysis of competitor products are the major drivers of innovation in SMEs covered in three different countries: UK, France, and Portugal. Reid (1993) in his coherent, integrated and nationwide profile of the UK's SME sector on technology and innovation (which covered 2028 SMEs drawn equally from manufacturing and key professional, technical, and business service sectors) found that internal technological capability is important but SMEs at the same time access technical information from a range of external sources, of which suppliers or customers are the most frequent. According to Ussman et al. (2001), SMEs in Portugal do not just depend on internal sources but are also strongly influenced by the overall environment. Hoffman et al. (1998) based on a survey of studies pertaining to UK, found that on balance, internal factors are likely to be more important core determinants of whether innovation plays a key role in success or failure than are external factors. By and large, these studies underlined the importance of both internal and external factors as the driving forces of innovation.

Vonortas and Xue (1997), while studying the process innovations of small firms in the USA, observed that economic incentives, internal resources, and technical and organizational competencies that a firm has developed or accumulated over time and a firm's linkage to external sources of expertise for learning about new technological development were the major forces that influenced these firms in adopting a process innovation. Danneels and Kleinschmidt (2001) in the context of new product development argued that it consists of bringing together two main components: markets and technology. According to them, product innovation requires the firm to have competences relating to technology (enabling the firm to make the product) and relating to customers (enabling the firm to serve certain customers). These studies strongly indicate that neither internal competence of the firm nor customer requirements alone will drive a firm to undertake innovations. Innovation will emerge only when a technically competent firm is able to identify and respond to customer requirements by developing and/or improving products/processes.

The above discussion leads to the next question: do SMEs necessarily engage themselves in product innovations or process innovations, or both? In practice, SMEs might undertake: (i) only process innovations in the form of material substitution, change in technical process of manufacturing, etc. to achieve cost reduction or quality improvement or (ii) only product innovations in the form of changing product shapes/dimensions/sizes or introducing improved or new products, or (iii) both. According to Hoffman et al. (1998) SME innovations are more likely to involve product innovation than process innovation (which is important nonetheless). Lehtimaki (1991) found that innovation in most of the Finnish SMEs is both product- and process-oriented.

The same held good for SMEs in UK, France, and Portugal (Chanaron 1998). Reid's (1993) study ascertained that 60 per cent of the surveyed firms had undertaken both product and process innovations. In a subsequent study, Cosh and Hughes for the University of Cambridge (1996) covered the same 2028 SMEs for the period 1986–95, and found that product and process innovations amongst the surviving SMEs increased during 1992–5 as compared to 1986–91. However, introducing new, improved, and high quality products was the most important objective of SME innovation. Bala Subrahmanya (2001) found in the context of North East England that SMEs are predominantly engaged in product innovations.

Martinez-Ros (1999) found that product and process innovations are interdependent and closely linked. Lumiste et al. (2004) found that Estonian SMEs were engaged in developing their products together with processes. However, Becheikh et al. (2006) based on a review of literature covering empirical studies on innovation in the manufacturing sector, found that researchers have primarily focused on product innovations in SMEs, and therefore recommended that future research should consider both product and process innovations.

What do innovative SMEs achieve? Irrespective of the dimensions of technological innovations, SMEs intend to achieve either cost effective, quality improved, improved versions of existing products, or altogether new products. This is because SMEs need innovative products if they have to gain and maintain technological advantages (Lee 1998). If they succeed, they will be able to realize a greater share of such innovated products in their total sales. Lehtimaki (1991) observed in the context of Finnish SMEs that on the average, the contribution of innovated new products was more to total sales than to profits. Roper (1997) whose study focused exclusively on product innovations in German, UK, and Irish SMEs, ascertained that the output of innovative SMEs grew significantly faster than that of non-innovators implying that innovated products contributed to the faster growth of the former. Engel et al. (2004), similar to Roper, found that sales turnover of innovative firms grew faster than that of non-innovative firms. They detected a significant relationship between the share of innovative sales and sales turnover change of firms. Lumiste et al. (2004) found that innovation effects were felt in terms of both product-oriented results such as (i) improvement in quality of goods and services, and (ii) increased range on goods and services, and process-oriented results like increased production capacity and improved production flexibility.

If SMEs are able to reduce costs, improve quality, improve product shapes/dimensions, increase the range of products, and as a result increase the share of innovated products in their total sales, does that directly contribute to the growth of firm size in the form of growth of sales turnover, investment, and employment? In other words, does innovation contribute to SME performance directly? According to Hoffman et al. (1998) the vast majority of empirical studies on innovation in SMEs have not covered the link between innovation practices and firm performance. Roper (1997) comparing the innovation strategies of German, UK, and Irish SMEs, observed that there is a strong association between innovation and turnover growth. But Edwards et al. (2001) argued that growth is not necessarily dependent on those factors attributed to 'innovative potential'. Of course,

they further stated that this does not mean that innovation does not lead to growth, rather there is a need to develop methods to assess the relationship.

Bala Subrahmanya (2001) observed that SMEs of North East England pursued radical innovations as a strategy of firm growth though he did not explicitly probe the relationship between innovation and growth. Danneels and Kleinschmidt (2001) claimed that innovative products present great opportunities for SMEs in terms of growth and expansion into new areas though they did not study the relationship between innovation and growth. Lumiste et al. (2004) found that innovation helped Estonian SMEs to improve their performance in terms of market share and diversified range of goods and services. However, they did not study whether the size of those SMEs changed over time.

Of the empirical studies, Engel et al. (2004) and Coad and Rao (2008) have explicitly focused on probing the relationship between innovation and growth in the context of SMEs of craft dominated industries in Germany and high tech sectors in the USA, respectively. The estimation results, based on a probit model, emphasized a positive impact of innovation output on the sales turnover change of SMEs (Engel et al. 2004). Innovative sales secure small firm's market position and offer some opportunities for growth. Coad and Rao (2008) probed the relationship between innovation and sales growth for incumbent firms in high tech sectors. A firm, on average, might experience only modest growth and may grow for a number of reasons that may or may not be related to innovativeness. But using a quantile regression approach, they observed that innovation is of crucial importance for a handful of 'superstar' fast growth firms.

However, all of these studies are related to industrialized countries and therefore their relevance to an industrializing country like India might be questioned. Two empirical studies on Indian SMEs conducted in this decade have significant relevance here. The first one was confined to Karnataka state in India, which covered 648 micro enterprises on a sample basis and 1358 small scale enterprises on a census basis across all industries in the manufacturing sector (Bala Subrahmanya et al. 2001). The study found that 258 (about 40 per cent) micro enterprises and 716 (about 53 per cent) small scale enterprises had undertaken technological innovations primarily due to external factors such as competition, technological change, customer requirements, and internal factor of self-motivation. They were involved in both product and process innovations though emphasis was relatively more on product innovations than on process innovations. The major achievements of their innovations comprised competitiveness enhancement in the form of improved quality, reduced rejection, improved product designs, increased output, etc. A higher proportion of innovative firms have penetrated the export market relative to non-innovative firms.

A more recent survey-based study (NKC 2007) on innovation in India covered 79 SMEs in both manufacturing and service sectors across the country. The major types of innovation carried out by SMEs were new products, new processes, and new services, new methods of production, and new ways of organizing administration. More than half of the increase in market share, competitiveness, profitability, and reduction in costs due

to innovation occurred due to three types of innovation: new products, new processes, and new services.

The above discussion brings out that no empirical study has explicitly probed the relationship between innovation and firm growth in the Indian context. Further, Indian studies done so far, have clubbed SMEs of different sectors together and thus lacked sector-specific focus. Moreover, these studies focused on a particular year for data collection and are therefore, cross-sectional in nature. But the impact of innovation, as argued by Coad and Rao (2008), will not be instantaneous, rather there would be considerable lags between innovation and its achievements and outcomes. Therefore, there is a need to focus on SMEs of specific sectors and over a period of time, to understand and analyse the nature and system of innovation in SMEs and probe the relationship, if any between innovation and growth. It is towards filling up this research gap that we have undertaken this study.

To put the research problem in the right perspective, we propose the following theoretical framework. There are four primary issues concerning innovation and growth of SMEs: (i) driving forces, (ii) dimensions, (iii) achievements, and (iv) outcomes (Figure 1). What factors drive SMEs to innovate? Are they internal factors or external factors, or both? Internal factors could be self-motivation, technical education background, work experience, and innovative ideas of entrepreneurs. On the other hand, external factors such as customer requirements, information given by suppliers of equipments/materials, market opportunities, availability and accessibility of institutional support, economic incentives, competition, etc. might also prompt some entrepreneurs to undertake innovation. However, for a successful innovation to emerge a combination of both internal and external factors may be required.

What kind of innovations do SMEs undertake? Are they exclusively product focused or process focused or do they necessarily have to undertake both together? Firms might focus on the development of new products with either old or new technology, or on the improvement of existing products by changing the shapes/designs or on quality improvement and cost reduction through substitution of raw materials, etc. What are the achievements of innovation by SMEs? If innovation is successful, whether new products or improved products emerge due to product or process innovations, the share of such innovated products is likely to increase in the total sales of the firm. If this happens, such firms would be able to achieve growth in their sales turnover, investment and employment resulting in the growth of firm size. It is with the above theoretical framework that we have set the objectives of the study.

3 Objectives, scope, and methodology

The study has the following objectives:

- To ascertain the growth rates of sales turnover, investment, and employment of innovative SMEs *vis-à-vis* non-innovative SMEs

- To probe the relationship between innovation and growth of sales turnover of SMEs

These objectives are studied with respect to auto components, electronics, and machine tool manufacturing SMEs in Bangalore urban and rural districts of Karnataka state in India. Karnataka was the pioneer in the field of industrialization and an industrially progressive state in the country. Bangalore, the capital city of Karnataka state, is one of the 46 'global hubs of technological innovation' and the highest ranked global hub in Asia (UNDP 2001). Among the districts of Karnataka, Bangalore urban and Bangalore rural districts had the highest proportions of small scale industry (SSI) enterprises engaged in R&D and innovations. Similarly, among the two-digit level industries (as per National Industrial Classification 1987) machinery and equipments (35–6) and transport equipments & parts (37) industries had the highest proportions of SSI enterprises engaged in R&D and innovations (Bala Subrahmanya et al. 2001). The former comprises electronics and machine tools industries and the latter includes auto component industry, among others. The Bangalore region is industrially more developed with a relatively high concentration of engineering and electronics industries in the country today (Bala Subrahmanya 2005). Therefore, we felt that the three identified sectors in Bangalore urban and rural districts would be appropriate and adequate to study the aforesaid objectives.

We developed a semi-structured questionnaire containing about 60 questions/items covering characteristics of SMEs, entrepreneurial background, driving forces, dimensions, objectives, sources, frequency, dimensions, achievements and outcomes of technological innovation, recognitions won, proportion of innovated products in total sales, and data on economic variables such as employment, investment, sales turnover, etc. The validity and reliability of the questionnaire was ensured and based on the knowledge and experience of the authors, discussions held with industry experts and representatives of SME associations. Further, based on a pilot study covering about 10 enterprises each in the three sectors, we did an item analysis for the questions excluding those which are (i) opinions on policies, (ii) dichotomous questions, and (iii) descriptive questions, which yielded a Cronbach's α (alpha) of 0.653.

In the absence of an official database, we relied on the databases of SME associations like 'Karnataka Small Scale Industries Association', 'Bangalore and Peenya Industries Association', among others. Accordingly, with the validated questionnaire, we approached about 150 to 200 SMEs in each of the sectors and gathered primary data from 72 auto component SMEs, 67 electronic SMEs and 75 machine tool SMEs. Only those SMEs which have come up prior to 2001/2 were covered by the study. The quantitative data were gathered for a period of five years from 2001/2 to 2005/6. Data collection was done during January–December 2007. While the first objective was analysed descriptively making use of frequency tables for innovative SMEs, the second objective was analysed in terms of percentage growth of economic variables for both innovative and non-innovative SMEs. The third objective was analysed for innovative SMEs using correlation analysis, analysis of variance (ANOVA), and regression analysis.

4 Technological innovations of SMEs: a backdrop

A description of general features of SMEs in the three sectors is in order, to set the stage for subsequent analysis. On average 90 per cent of SMEs in all the three sectors were started as new ventures and the rest were either inherited or acquired. About 80 per cent of the auto component as well as electronic SMEs and 70 per cent of machine tool SMEs have come up in the 1980s and after, whereas the rest had come up earlier. The entrepreneurs of about 50 per cent of the SMEs in auto, about 43 per cent in electronics, and about 60 per cent in machine tool sectors were in the age group of 30 to 40 years. Technical education background in the form of diploma or degree (BE/ME/PhD) is a significant feature of entrepreneurship of these SMEs: 70 per cent entrepreneurs of auto, 69 per cent of electronics, and 81 per cent of machine tool SMEs were technically qualified. What is more significant is that it was to gain self-employment by implementing their innovative ideas and/or to exploit market opportunities that majority of these entrepreneurs have set-up their firms. Their size characteristics revealed that size structure of the SMEs was more skewed towards micro and small enterprises than towards medium sized enterprises.

Given this, it would be appropriate to know how many of the SMEs in the three sectors are innovative and how many not. The majority of SMEs are innovative in all the three sectors (Table 1). A greater proportion of SMEs in the auto sector is innovative relative to electronics and machine tool sectors.

SMEs are generally known for informal innovations. That is they carry out their innovations along with their day-to-day manufacturing operations within the same premises. The obvious reason is resource constraint. The same holds good for the SMEs in Bangalore in all the three sectors. About 95 per cent of the SMEs in auto and machine tool sectors and 77 per cent of the SMEs in the electronics sector carry out innovations informally, without any exclusive innovation department. Given this, it is important to know the driving forces of innovation. A sizable majority of the SMEs identified both internal and external factors as the driving forces of their innovations (Table 2).

However, a considerable number of SMEs in the machine tool sector has also identified external factors as the only driving force of their innovations. Those who have attributed their innovations exclusively to internal factors are not many. By and large, it is clear that both internal factors such as self-motivation, technical education background, work experience, and innovative ideas of entrepreneurs on the one hand, and external factors such as customer requirements, information given by suppliers of equipments and materials, competition, etc. are responsible for a majority of SMEs to innovate. This implies that both firm level technological competence (technology push) and market demand (demand pull) are important if innovations have to emerge.

Given this, it is appropriate to understand the dimensions of SME innovations. In general, SME innovations may be product focused or process focused or both. A higher proportion of SMEs in auto and electronic sectors have undertaken both product and process focused innovations whereas the majority of machine tool SMEs have undertaken

process-based innovations (Table 3). Product focused innovations comprised the introduction of new products and/or the improvement of existing products through changing product designs and dimensions or quality improvement to suit customer requirements. Process-based innovations involved the introduction of new process technology for existing products, adoption of cost reduction techniques, etc.

What did SMEs achieve out of their innovations is an important issue. Only if they are able to convert their product and process innovations into sales, their innovations will be fruitful otherwise not. Irrespective of whether new or improved products emerged due to improved designs, quality improvement, cost reduction, material substitution, introduction of new or improved processes, innovative firms must be able to sell such innovated products in the market as part of their total sales. More successful innovative firms might realize a higher share of innovated products in total sales compared to less successful innovative firms. Table 4 presents the distribution of innovative SMEs in terms of varying ranges of innovative products in total sales. A higher percentage of innovative SMEs have succeeded in converting their innovations into sales in the auto component sector relative to electronic and machine tool sectors. Among those SMEs which have succeeded in converting their innovations into sales, the majority accounted for a share of innovated products in total sales in the range of 10 per cent to 25 per cent in all the three sectors.

A more significant reflection of innovation achievements of SMEs will be in terms of recognitions won by them in the previous five years. Table 5 gives a view of different recognitions such as product and process patents, citations, and awards won by the innovative SMEs. None has received process patents whereas two of the electronic and three of the machine tool SMEs have got national product patents and two machine tool SMEs have won international product patents. The recognitions won in terms of citations and particularly national awards, are more impressive in all the three sectors. Overall the 'patenting culture' is low among innovative SMEs, as has been observed internationally (Freeman and Soete 1997). The limited resources of SMEs generally constrain them from going for obtaining product and process patents.

Finally, it is interesting to find out the outcomes of innovation achievements of these SMEs. If innovative SMEs are able to convert their innovations into sales, they might be able to increase their sales turnover and increase capacity utilization or energy utilization or manpower utilization or improve inventory management or enter the international market. The relative rankings of innovative SMEs are given in Table 6. It is clear that the majority of the SMEs in all three sectors have identified increase in sales turnover as the most significant outcome of their innovation achievements indicating that innovation has helped them to achieve growth in sales.

To get a clearer picture of the relative ranks of various innovation outcomes, we calculated composite ranks for each of the innovation outcomes for all the three sectors. The composite rank of each innovation outcome is calculated as follows: the number of SMEs of each rank is multiplied by that rank and the summation of the scores for the three ranks is divided by the summation of the number of SMEs for the three ranks. For

example, under the auto component sector, 33 SMEs gave sales turnover rank 1, seven SMEs have rank 2 and six SMEs gave rank 3. Therefore, the summation of the scores for the three ranks = 33 X 1 + 7 X 2 + 6 X 3 = 65 and the summation of the number of SMEs for the three ranks = 33 + 7 + 6 = 46. Therefore, the composite rank of sales turnover for the auto component sector = 65/46 = 1.413. Similarly, composite ranks have been calculated for the remaining innovation outcomes. Even composite ranks clearly indicate that sales turnover increase is the most significant outcome of innovative SMEs in all the three sectors.

To sum up, it is the combination of internal and external factors which drive the majority of the SMEs to undertake both product and process innovations. As a result, many of them have been successful in selling innovated products in varying proportions of their total sales. Though the recognitions won, particularly in terms of patents is not noteworthy, a considerable number of them have won national awards. More significantly, more than half of the innovative SMEs have achieved sales growth due to their innovations. In this context, a comparative growth analysis in terms of sales, investment and employment for innovative and non-innovative SMEs is appropriate.

5 Innovative and non-innovative SMEs: growth of sales, investment, and employment

The growth performance of SMEs has been analysed in terms of sales turnover, investment, and employment. The growth performance has been analysed for all the SMEs of each sector—for innovative and non-innovative SMEs separately and within the innovative group of SMEs, for innovative SMEs which involved in new product and process developments *vis-à-vis* those engaged in improvement of products and processes. For measuring growth, we have clubbed all the SMEs together in each sector and we did not separately identify growing ones from the rest. Further, when we looked at innovative and non-innovative SMEs, we measured growth for the respective group of SMEs together, without segregating growing ones from the rest. The same holds good for further analysis in terms of (i) innovative SMEs, which have claimed to have developed new products/processes and (ii) innovative SMEs, which have claimed to have only improved products/processes. Thus we are interested in the growth performance of SMEs belonging to the definite groups in terms of degrees of innovations.

We have gathered data on sales at current prices as well as on employment and the current value of investment (in plant and machinery) from the SMEs of auto, electronics, and machine tool sectors for a period of five years from 2001/2 to 2005/6. While the calculation of the growth of employment is fairly simple, it is necessary to make the five years' data on sales comparable by converting the values of current prices into values at constant prices. But the values of investment in different years represent their current values for the respective years and therefore they are comparable between years. Using the latest series of data on SSI production, which are given at current prices as well as at 2001/2 prices from 2001/0 onwards by the Ministry of Micro, Small, and Medium Enterprises we derived the output deflator for 2005/6. Using this output deflator, we

converted the value of the 2005/6 sales at current prices into value at constant (2001/2) prices. Thereafter, we calculated the compound average rate of growth of sales between 2001/2 and 2005/6.

Table 7 presents the figures for the growth of sales, investment, and employment for innovative and non-innovative SMEs. It is clear that innovative SMEs have registered a higher rate of growth compared to non-innovative SMEs in terms of sales, investment, and employment in all the three sectors. However, the growth rates of the three variables differ within as well as between sectors. In the auto component sector, both innovative and non-innovative SMEs registered a higher growth of investment followed by sales and then employment. In fact, employment of non-innovative SMEs declined absolutely. In the electronics and machine tool sectors, sales growth was higher than that of investment and investment growth was higher than that of employment for both innovative and non-innovative SMEs. In the electronics sector, non-innovative SMEs registered negative growth in terms of investment and employment. Overall, the growth analyses for the three sectors clearly indicate that innovative SMEs are better off relative to non-innovative SMEs.

If innovative SMEs are better off compared to non-innovative SMEs, how do innovative SMEs engaged in new products/processes compare with innovative SMEs engaged in improvement of existing products/processes? In auto and electronic sectors, innovative SMEs engage in the improvement of existing products/processes registered a higher sales growth than innovative SMEs engaged in the development of new products/processes whereas in the machine tool sector, sales of the latter grew faster than that of the former (Table 8). How far SMEs have benefited from their innovations to increase their sales and grow in size of investment and labour would depend more on how far they have been able to satisfy their customers' needs and requirements rather than on the nature of innovations in terms of new products/processes or improved products/processes. If improvement of existing products/processes as demanded/required by their customers is appropriately done, it may prove to be more useful to increase sales than development of new products/processes. What might be more decisive is customer satisfaction to expand the market base of an enterprise and grow. Given this, it would be difficult to say whether new products/processes or improved products/processes are more helpful to SME growth.

6 Innovation and growth of SMEs

The core objective of this paper is to ascertain the relationship between innovation and firm growth in the identified SME sectors. The central hypothesis underlying our analysis is that innovations are positively associated with firm performance in the form of growth of sales turnover. If innovation helps a SME to improve sales performance, the following may hold good:

1. There is a positive relationship between percentage of innovated products in total sales and rate of growth of sales of innovated SMEs;

2. Higher growth SMEs will have higher shares of innovated products in total sales relative to medium growth SMEs, which in turn will have higher shares of innovated products in total sales compared to low growth SMEs;

3. Share of innovated products in total sales, along with rate of growth of capital as well as that of labour, has a significant influence on the rate of growth of sales turnover of innovative SMEs.

At the outset, we would like to explore whether there is any relationship between shares of innovated products in total sales, innovation sales, and sales growth of innovative SMEs. To ascertain the answer, we probed whether there is any statistically significant positive correlation between the compound average rate of growth (CARG) of sales and percentage of innovated products in total sales. The results of the correlation analysis are presented in Table 9. The results indicate that there is indeed a statistically significant positive correlation (at 0.01 level) between sales growth and percentage of innovation sales in total sales.

This being the case, higher growth SMEs should have higher shares of innovated products in total sales compared to lower growth SMEs. To know whether this holds good, we divided the innovative SMEs of each sector into three groups: (i) high growth SMEs, (ii) medium growth SMEs, and (iii) low growth SMEs. This is done by dividing the range of CARG of sales of innovative SMEs by three and calculated the average share of innovated products in total sales for each group. The results clearly indicate that higher growth innovative SMEs, on average, have a higher share of innovated products in total sales compared to medium growth innovative SMEs, which in turn, on average have a higher share of innovated products in sales, compared to low growth innovative SMEs in all the three sectors (Table 10).

To further ascertain the difference in the shares of innovated products in total sales between the three groups of SMEs in the three sectors, we did a one-way ANOVA for the three sectors separately. The calculated F-values of all the three sectors are statistically significant (Table 11). These results substantiate that the difference in the percentage shares of innovated products between high, medium, and low growth innovative SMEs is statistically significant in all the three sectors.

Given the relationship between the share of innovated products in total sales and sales growth, we would like to know whether the former has any influence on enterprise growth. To ascertain the influence, we have carried out a regression analysis with the following equation:

$$S_g = K_g + L_g + IS_p + D_s + D_{s1} + D_{s2}$$

where S_g is CARG of gross value added (GVA) of individual SMEs of all the three sectors during 2001/2–2005/6. Similarly, K_g and L_g are CARG of capital and labour, respectively, during 2001/2–2005/6 and IS_p is average percentage of innovated products in total sales of individual SMEs during 2001/2 to 2005/6. We have used deflated values

for both GVA and capital (at 2001/2 prices). The analysis covers both innovative and non-innovative SMEs. For non-innovative SMEs, IS_p is taken as zero. To ascertain the influence of initial firm size, we have used a size dummy (D_s) which assumed the value of 0 for all SMEs which had investment in plant and machinery up to Rs.1 million and 1 for the rest (since the investment limit for an enterprise to be considered small was Rs.1 million, as per the law of the Government of India, then). Since we have clubbed all the three sectors together for the analysis, we have used two sector dummies, namely, D_{s1} representing auto components and D_{s2} representing machine tools. Since we did not find any statistically significant interaction effects of industries/sectors with the explanatory variables of labour and capital, we have not used any interaction term for the present analysis.

The results of the regression analysis are given in Table 12. The regression model is statistically significant as indicated by the F-value and the explanatory variables together (adjusted R^2) explain about 45 per cent of the variation in the rate of growth of GVA. We have ensured that all the assumptions of the multiple regression models held good. Both the sector dummies (D_{s1} and D_{s2}) are not statistically significant. Even the firm size dummy (D_s) is significant only at the 0.20 level implying that the initial firm size did not make much of a difference to the growth of GVA in the three SME sectors.

The results clearly indicate that the percentage share of innovated products in total sales has a significant influence on the average rate of growth of GVA in innovative SMEs in all the three sectors. With a one percent improvement of innovated products in total sales, the rate of growth of GVA is likely to improve by 0.50 per cent. However, equally important is the increase in capital as well as labour. Thus if an innovative SME could expand the scale of production in terms of capital and labour and achieve an increase in innovation sales, it will be able to experience a significant improvement in the growth of GVA. This enables us to conclude that innovation sales do contribute to firm growth in terms of GVA.

7 Conclusions

This paper has ascertained the driving factors, dimensions, achievements, and outcomes of technological innovations carried out by SMEs in the auto, electronics, and machine tool sectors in Bangalore. It has further probed how far the growth rates of innovative SMEs are different from that of non-innovative SMEs. Finally, it has explored and analysed the relationship between innovation and growth with respect to innovative SMEs of the three sectors.

A substantial proportion of SMEs in all the three sectors are innovative, mostly informally. Most of the innovative SMEs attributed the origin of their innovations to a combination of (i) firm level technological capability owing to internal factors such as self-motivation, technical qualification, knowledge, experience, and innovative ideas of entrepreneurs, and (ii) market pressure due to external factors like customer requirements and demand, information provided by suppliers of equipments and materials, market

opportunities, and competition. Thus, both 'technology push' and 'demand pull' have contributed to the emergence of innovations.

The major objective of SME innovations was enhancement of competitiveness in the form of quality improvement, cost reduction, extension of product range and replacement of phased out products, apart from penetrating the international market. Accordingly, they have primarily focused on both product and process innovations in the auto and electronics sectors and process innovations in the machine tool sector. What is significant is that a substantial majority of the innovative SMEs could convert their innovative efforts into sales as they realized varying proportions of innovated products in their total sales. This has enabled the majority of them to achieve sales growth more than anything else. However, hardly anybody could obtain international patents and the recognitions are largely confined to winning of awards from large enterprise customers and financial institutions.

Innovative SMEs registered higher growth relative to non-innovative SMEs in terms of not only sales turnover but also employment and investment in all the three sectors. There was a statistically significant positive correlation between innovation sales and sales growth. Innovative SMEs, which experienced higher growth accounted for a higher share of innovated products in their total sales relative to those which experienced lower sales growth. Innovation sales, along with investment growth and employment growth, had a positive influence on GVA growth, in all the three sectors. To conclude, our overall analysis lends substantial credence to the argument that innovation contributes to the growth of firms.

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Table 1: Innovative SMEs and non-innovative SMEs

Group	Number of SMEs		
	Auto components	Electronics	Machine tools
Innovative	69 (95.8)	61 (91.0)	57 (76.0)
Non-innovative	3 (4.2)	6 (9.0)	18 (24.0)
Total	72 (100.0)	67 (100.0)	75 (100.0)

Note: * Figures in parenthesis are percentages.

Table 2: Drivers of innovations

Drivers of innovation	Number of SMEs		
	Auto components	Electronics	Machine tools
Internal factors	6	10	2
External factors	18	13	25
Internal & external factors	45	38	30
Total	69	61	57

Table 3: Dimensions of SME innovations

Dimensions of innovations	Number of SMEs		
	Auto components	Electronics	Machine tools
Product innovations only	2	7	3
Process innovations only	21	6	29
Product & process innovations	46	48	25
Total	69	61	57

Table 4: Share of innovated products in total sales (2005/06)

Range of shares	Auto components	Electronics	Machine tools
Nil	6	9	15
Up to 5 per cent	15	17	12
>5 per cent up to 10 per cent	14	8	9
>10 per cent up to 25 per cent	29	21	15
>25 per cent up to 50 per cent	5	6	6
Total number of SMEs	69	61	57

Table 5: Recognition achieved due to innovations

Recognition		Auto components	Electronics	Machine tools
Product patents	National	0	2	3
	International	0	0	0
Process patents	National	0	0	0
	International	0	0	0
Citations	National	2	3	5
	International	0	1	1
Awards	National	16	6	28
	International	0	0	1
Total innovative SMEs		69	61	57

Table 6: Innovation outcomes

Outcomes	Rank 1			Rank 2			Rank 3			Composite rank		
	A*	E*	M*	A*	E*	M*	A*	E*	M*	A*	E*	M*
Sales turnover	33	34	31	7	6	3	6	5	3	1.4	1.4	1.2
Exports	1	5	2	6	6	4	1	2	2	2.0	1.8	2.0
P & M utilization	11	4	9	13	12	9	23	10	17	2.3	2.2	2.2
Material utilization	9	11	12	23	14	23	13	15	6	2.1	2.1	1.8
Energy utilization	2	2	1	5	3	6	9	5	13	2.4	2.3	2.6
Manpower utilization	7	7	4	15	14	11	12	12	11	2.1	1.8	2.3
Inventory management	5	1	0	0	3	2	5	4	3	2.0	2.4	2.6

Note: * A = auto components, E = electronics, and M = machine tools.

Table 7: Growth of innovative SMEs and non-innovative SMEs in %

Sector →	Auto		Electronics		Machine tools	
Variable ↓	Innovative SMEs (65)*	Non-innovative SMEs (2)*	Innovative SMEs (57)*	Non-innovative SMEs (3)*	Innovative SMEs (51)*	Non-innovative SMEs (17)*
Sales	18.86	7.89	20.16	10.64	26.93	17.01
Investment	25.66	12.91	15.53	-1.81	22.17	8.75
Employment	14.43	-14.63	7.06	-20.34	6.87	3.27

Note: * Number of SMEs.

Table 8: Growth of innovative SMEs: new vs. improved products and processes in %

Sector →	Auto		Electronics		Machine tools	
Variable ↓	NP&P (51)**	IP&P (16)**	NP&P (51)**	IP&P (6)**	NP&P (26)**	IP&P (25)**
Sales	15.91	32.24	14.48	23.09	22.44	17.71
Investment	28.60	19.98	16.07	9.49	20.17	24.39
Employment	13.95	16.79	7.04	4.05	3.55	11.3

Note: * NP&P = new products & processes, IP&P = improved products & processes, ** number of SMEs.

Table 9: Correlation between sales growth and innovation sales

Sector →	Auto components	Electronics	Machine tools
Correlation coefficient	0.45*	0.41*	0.44*
N	54	52	47

Note: * Significant at 0.01 level.

Table 10: Shares of innovated products in total sales

Group	Auto components		Electronics		Machine tools	
	No. of SMEs	% of IPs* in sales	No. of SMEs	% of IPs* in sales	No. of SMEs	% of IPs* in sales
High growth	12	25.00	10	20.50	10	16.30
Medium growth	20	18.15	18	14.50	28	9.00
Low growth	22	10.32	24	9.21	9	4.89

Note: * IPs = innovated products.

Table 11: ANOVA results for percentage share of innovated products in sales

Auto components sector				
Sources of variation	Sum of squares	Degrees of freedom	Mean squares	F-ratio
Between groups	1212.48	2	606.2407	3.57*
Within groups	8645	51	169.5098	
Total	9857.481	53		
Electronics sector				
Sources of variation	Sum of squares	Degrees of freedom	Mean squares	F-ratio
Between groups	1023.35	2	511.6748	5.93*
Within groups	4229.324	49	86.31273	
Total	5252.673	51		
Machine tool sector				
Sources of variation	Sum of squares	Degrees of freedom	Mean squares	F-ratio
Between groups	490.151	2	245.0755	2.35**
Within groups	4580.275	44	104.0971	
Total	5070.426	46		

Note: * Significant at 0.05 level, ** significant at 0.10 level.

Table 12: Influence of innovation sales on enterprise growth

Dependent variable: GVA growth	
Variables	Coefficients
K_g	0.30 (4.39)*
L_g	0.49 (6.79)*
IS_p	0.50 (4.02)*
D_S	4.11 (1.30)**
Sector D_1	-2.38 (-0.83)
Sector D_2	-3.16 (-1.11)
Intercept	2.96 (1.22)
Adj R^2	0.45
F	27.43*
N	195

Note: figures in brackets are t-values. F-value is significant at 0.05 level,
* significant at 0.05 level, **significant at 0.20 level.

Figure 1: Innovation and growth of SMEs