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Impact of Technology on the Competitiveness of the Indian Small Manufacturing Sector

A Case Study of the Automotive Component Industry

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Abstract

This paper endeavours to study the impact of technology on the competitiveness of the Indian small-scale automotive component units. The effect of technology is measured by directly introducing it in the production function along with the conventional inputs. For the purpose of analysis, we have taken sales turnover which reflects competitive strength of firms as a dependent variable instead of output. Three technology variables representing transformation (mechanization), organization and information aspects of technology are taken along with the three conventional inputs, i.e., capital, labour and materials as explanatory variables. Empirical analysis of the paper is based on the unit-level data collected through the primary survey of a sample of units located in and around Delhi. Results of the study indicate that a higher degree of mechanization in terms of the use of NC machines has a significant positive impact on the sales turnover, followed by materials, labour and capital.

Keywords: small-scale enterprises, competitiveness, technology, production function

JEL classification: D24, L62, O30

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1 Introduction

Small-scale units play a critical role in the Indian economy in the creation of employment opportunities and wider dispersal of industrial production across regions and individuals. However, the general observation has been that the majority of these units are not competitive.[1] Notwithstanding their lack of competitive strength, the small-scale units of India have survived so far due to product and geographical market segmentation and policy protection.[2] The importance of all three factors is decreasing, as expected, as the economy becomes more and more liberalized and globalized.[3] Ultimately, in a market economy, small-scale units have to sustain themselves on their own competitive strength by successfully facing competition from large-scale units, including multinationals. Even to provide employment (an argument that has been widely articulated in favour of protection to small-scale units in India) in a sustainable way[4] and at higher wages,[5] these units have to be competitive and commercially viable. Commercial viability and competitive strength of any industrial unit primarily depend on the technology they use. Technology helps to improve the competitive strength of any industrial unit either through cost reductions, productivity/quality improvements, or a combination of all. It is in this context that the study of the impact of technology on the competitive strength of small-scale units assumes significance.

The automotive component industry has a good number of small-scale units and it is one of the dynamic sectors of the Indian economy. With the entry of multinational corporations in the more liberalized and globalized 1990s, the industry is undergoing rapid transformation both in its structure and product composition. In addition, the automobile industry is one of the sectors that is organized in the form of global commodity chains forcing auto component units to integrate with these chains. The automotive component units, to get into a supply chain and to remain there, have to be at par with other units in the chain in terms of technology and operational efficiency, including the multinational companies. In this respect, the paper seeks to examine the impact of technology on the competitiveness of small-scale auto component units in India.

Two interesting features of the study deserve to be highlighted. First, the paper considers technology in a comprehensive form by covering three dimensions of it, namely,

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1 Ayyar (1994: 39); Report of the Expert Committee on Small-Scale Enterprises (Abid Hussain Committee, 1997: 151); and Tendulkar and Bhavani (1997: 50-1).

2 Tendulkar and Bhavani (1997: 40).

3 Bhavani (2001b).

4 Sustainable employment refers to providing employment over longer periods of time. This depends on the continued existence and growth of the concerned industrial units. If these industrial units close down fast because of failure to become viable, they generate only short-run employment, which is neither good as a source of income nor as an instrument for developing skills.

5 The importance of employment generation flows from the fact that employment is the only source of income to a majority of population. In order to raise the levels of living of majority, the primary objective of our development strategy, it is essential to create high wage employment.

transformation (mechanization), organization and information at the firm level. Second, technology variables are included directly in the production function along with the conventional inputs, i.e., capital, labour and materials.

The paper is organized into six sections. We follow the production function approach for the purpose of our analysis. Section 2 briefly discusses the treatment of technology in the neoclassical theory of production and presents the analytical framework used in the paper. In section 3, we describe the Indian automotive components industry with a special emphasis on small-scale units. This is expected to provide us with the variables relevant for our study. Empirical analysis of the paper is based on the data collected through the primary survey. Section 4 presents the survey data and introduces the empirically relevant technology variables. Section 5 discusses the empirical evidence relating to the impact of technology. In the final section, we summarize the important features and findings of the study.

2 Analytical framework

It is widely accepted in the economics literature that technology plays a significant role both in macro (economic growth) and microeconomic spheres (such as competitiveness of firms). Partly due to its own fast changing nature and partly because of the increasingly integrated world economies, technology *per se* has moved to the centre stage in the economic analysis. Rapid technological advancements are shifting fast the frontiers of technology and thus raising the scope for tremendous improvement in the competitive strength of firms. Increased globalization of economies is necessitating further improvements in the competitiveness of firms by intensifying international competitive pressures.

It is the competitiveness of the microeconomic units like firms that explains most of the variations in macroeconomic growth.[6] The competitiveness of a firm can be taken as its ability to do better than comparable firms in sales, market shares, or profitability.[7] In a highly competitive market environment, the relative performance of a firm in sales, (or market shares, or profitability) depends primarily on technology. Technology makes higher sales possible in many ways, either through the introduction of a new and superior product; by improving the quality of existing products, or through efficient utilization of resources (productivity improvements) resulting in cost reductions; by improving access to customers, or through a combination of all. In other words, technology enables firms to expand their sales by making it possible for them to supply increasing quantities of quality goods at cheaper prices.

Neoclassical economics, which is widely practised, considers technology as exogenous and given to the economic systems especially at the firm level. Further, it maintains that all firms are aware of, and have access to, all existing technologies. Of these, firms select

6 Porter and Christensen (1998).

7 Lall (2001: 4).

a particular technology depending on the relative factor prices. Once the selection of a technology is done, its installation is easy and its impact on the productive efficiency, which is taken to be positive and measured through factor productivities, is automatic. Neoclassical economics, thus, measures the impact of technology *indirectly* in terms of the changes in factor productivities, especially through the total factor productivity.

Total factor productivity, which takes into account all factors of production used in the production process, is measured either through the growth accounting approach, or production function approach. In the growth accounting approach, it is taken as the residual of the growth in output after deducting the growth in inputs by giving appropriate weights to them under the assumption of constant returns to scale, perfect competition, and factors of production are paid according to their marginal productivity. The production function (econometric) approach, on the other hand, measures total factor productivity without any such assumptions as a derivative of the production function with time variable.

Whatever the method of measurement—growth accounting or production function approach—total factor productivity growth (TFPG) has initially been identified with the technical change (progress). Later studies, while recognizing technical change as the primary determinant, also considered the influence of many other factors on total factor productivity growth such as labour skills, learning-by-doing, capacity utilization and scale economies.[8] Some of these studies tried to decompose TFPG into different components. In some other studies, technology has been taken as one of the main explanatory variables of productivity.[9]

In this paper, we are trying to measure the impact of technology *directly* by considering it explicitly in the production analysis. To be specific, we introduce technology as one of the inputs along with conventional inputs like capital, labour and materials in the production function. Further, we take sales turnover as a dependent variable instead of the conventionally used production, because sales turnover represents the actual size of the market the unit is catering to and hence its competitiveness, which is a much wider concept than the productive efficiency given by the production. Accordingly, our production function is written as:

$$Y = A(T)\,f\,(K, L, M) \qquad (1)$$

where:

Y = sales

K = capital

L = labour

[8] See, for example, Ahluwalia (1991); and Griliches (1996).

[9] See Link (1987); and McGuckin *et al.* (1996).

M = materials, and

T = technology.

By taking sales as a dependent variable and technology as one of the explanatory variables, we can directly measure the impact of technology on the competitiveness of the units.

For the purpose of analysis, *technology is taken to include the physical processes of transformation of inputs into output, organizational methods that structure these processes, and the information flows required to carry out these processes*. Thus, the study covers three dimensions of technology, namely, transformation, organization and information.[10]

We take the *transformation* aspect of technology to include broadly plant and machinery, tools, components, accessories, materials and products. The *organization* aspect refers to the organization of the production process that encompasses plant layout, material management, production schedules, work allocation and quality management. The *information* aspect includes the means of communication with such outside agents as customers and suppliers as well as the information management (data), i.e., ways of storing, processing and exchanging information within the unit.

We rewrite the production function given in (1) by taking simple Cobb-Douglas form and the three technology variables discussed above:

$$Y = A\, K^{\alpha}\, L^{\beta}\, M^{\gamma}$$

$$\text{Where, } A = e^{\theta_1 T + \theta_2 O + \theta_3 I} \qquad (2)$$

In the log-linear form, it is written as:

$$\ln Y = C + \alpha \ln K + \beta \ln L + \gamma \ln M + \theta_1 T + \theta_2 O + \theta_3 I + \mu \qquad (3)$$

Y, K, L and M are as defined earlier in (1).

T = transformation technology,

O = organization technology, and

I = information technology.

All these technology variables are qualitative variables. μ is random error term.

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10 Bhavani (2001a). We have added the information aspect to the definition of technology given in Dahlman and Westphal (1982).

We determine the unit-level characteristics representing the transformation, organization and information technologies from the industry background and the survey data presented in the following sections.

3. Automotive components industry in India

The automotive components industry in India produces the entire range of parts required by the domestic automobile industry.[11] It caters to nearly 82 per cent of the domestic market demand while the remaining 18 per cent is served by imports.[12] Production of the automotive components industry for the year 1997-98 has been estimated as 120.318 million rupees. Of the industry's total production, the organized sector[13] produces goods worth 92.552 million rupees, i.e., 77 per cent. The unorganized small-scale sector is estimated to contribute nearly 23 per cent to the industry's total production.[14]

As regards the market for automotive components, a major portion (nearly 55 per cent) is the vehicle industry for the original equipment. Replacement demand constitutes 35 per cent of the domestic production. Exports account for the remaining 10 per cent.[15] Exports mostly serve the replacement market abroad. Demand both in the OEMs (original equipment manufacturers) market and replacement market has been growing since 1980s owing to a rapid growth in the passenger car and two-wheeler segments, and poor road conditions.[16]

The Indian automotive components is a low volume and fragmented industry.[17] It has nearly 400 firms in the organized sector and more than 5000 firms in the unorganized small-scale sector.[18] The industry structure can be taken as a minor variant of 'dominant firm with a competitive fringe', which theoretically refers to an industry which has a

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[11] An automobile consists of more than 20,000 components, each performing a different function (ICRA 1999: 31).

[12] The percentages refer to the year 1996-97. Domestic demand is calculated as the sum of the domestic production and imports minus exports. The contribution of the domestic industry is taken as the percentage of share of domestic production minus exports in the domestic market demand. Domestic production, exports and imports of the automotive components are given in ACMA (1997-98: 35, 82 and 89).

[13] Organized sector refers to the factory sector units. All those units which employ ten or more employees if using power, twenty or more employees if not using power, are expected to get registered under Factories Act 1948 and taken as factory units.

[14] ACMA (1997-98: 35).

[15] ICRA (1999: xi).

[16] ICRA (1997: 33-4, 110).

[17] In terms of turnover, it is only about one-tenth of the size of the world's largest automotive company, namely, Delphi Automotive Systems Corporation of USA (ICRA 1997: 36; and AIAM 1999: 80).

[18] ICRA (1999: 38). The figures are likely guesstimates as they differ from study to study. See NCAER (1999: 2)

single firm with a dominant market share and many fringe or small firms each with a trivial share of the market. A firm is dominant either because of a superior product or lower costs or both. Further, the costs of a firm can be lower because of better technology and management, economies of scale, and experience.[19] In the automotive components industry of India, it is not a single firm but a few firms together that control the dominant market share, leaving a tiny share to numerous small firms. Three to five firms control more than 75 per cent of the market for almost all the products.[20]

The majority of the small-scale units are located in Delhi and the surrounding areas of Faridabad and Gurgoan, which came into existence mainly due to Maruti Udyog Ltd. in the 1980s. Small-scale automotive component units mostly produce items that require simple production setup such as sheetmetal products and articles on which excise duties are very high. This is because small-scale units are given excise duty concessions that lower product prices. The unorganized small-scale sector caters mostly to the replacement demand, with a few exceptions like sheetmetal components. In most cases, small units use manual machines and, at times, secondhand machinery. There is no system of quality control in the small manufacturing sector at large.

The development and structure of the components industry is closely connected with that of the vehicle industry. Until the 1980s, the vehicle industry was characterized by small-scale operations, and technological obsolescence. Numerous government regulations forced these units to resort to in-house production of components, and component manufacturers started to cater mainly to the replacement demand.[21] In the 1980s, the relaxation of government regulations, particularly on foreign collaboration that triggered the entry of many joint ventures including Maruti Udyog Ltd., along with the programme of phased manufacturing, caused an upsurge in the components industry. Foreign collaboration, technological upgradation, and close relations with the buyers marked the automotive components industry during this period.[22]

The new economic policy of liberalization and globalization of the 1990s changed the game rules in the industry once again. Following its endorsement of the WTO agreement, India has opened its economy to transnational corporations and imports. This resulted in the entry of many international players: General Motors, Ford, Honda, Hyundai and Daewoo in the vehicle industry along with Delphi and Visteon in the components industry.[23] Domestic market has become more competitive, forcing the Indian automobile industry to restructure itself along the lines of global industry.

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19 Carlton and Perloff (1990: 180-5).

20 ICRA (1999: 32, 40); Narayana (1989: 39-40) and Gumaste (1988: 70). ICRA (1999) discusses the industry leaders of many automotive components.

21 Narayana (1989: 10-12).

22 ICRA (1999: 30); Narayana (1989: 44-6); and Varadharajan and Kannan (1998: 299).

23 Delphi and Visteon are controlled by General Motors and Ford, respectively, and these are the largest automotive component manufacturers in the world.

The severe competition that is forcing cost reductions is compelling the global vehicle industry to consider consolidation at the vehicle manufacturing level and tierization in the component supply chains.[24] International vehicle manufacturers are consolidating their positions through acquisitions and mergers, and trying to reduce their costs through rationalization of their supply chains. Instead of buying individual components from the numerous manufacturers and assembling them in their own premises, vehicle manufacturers have started purchasing entire systems, such as complete engines. These systems suppliers form the first-tier companies in the supply chain and are expected to play a significant role in the development and production of the vehicle. Systems suppliers further procure subsystems or components from other suppliers, who constitute either the second-tier or the third-tier suppliers in the chain.

To gain entry to a supply chain, the Indian auto component units need to acquire a level of technology that is at par with the parent company. Indian component manufacturers, including some of the smaller ones, have already recognized this fact,[25] and these units are moving towards adopting better machinery (fully automated), superior organizational methods (total quality control systems like ISO9000), and information technology. In particular, the established small units are increasingly converting from manual operated to semi and fully automatic machines. Accordingly, tasks are allotted to workers on a rotation basis and more than one job can be assigned to each at a time. These units are also trying to introduce quality check-ups which have been missing and to slowly adopt new means of communication with their customers, for example, electronic mail correspondence.[26]

4 Survey data

As discussed in section 2, we consider the transformation, organization and information aspects of technology. Keeping the industry characteristics discussed in section 3 in mind, we confine transformation technology mainly to mechanization.[27] Here, we consider three levels of machinery, namely, manually-operated, semi-automatic, and numerically controlled machines. We take the organization, as mentioned earlier, to include the plant layout, materials management, quality management, production schedules and work allocations. Under the materials management, we include the suppliers of materials, methods of procuring and financing materials, and material inventories. Quality management is studied in terms of having a total quality system like the ISO9000, a prerequisite for gaining entry to the supply chains. Work allocations refer

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24 ICRA (1999: 20-3).

25 The author observed the same during her survey of the units and interactions with the relevant business associations and individuals.

26 It is a shift away from the earlier means of phone and personal visit.

27 In few cases, one finds product changes in the sense of firms producing additional products that brought in different machines into the plant. Most often changes in transformation technology occurred in terms of changes in machinery.

to the method of assigning jobs to workers, i.e. whether they are fixed or rotating, and whether a worker has a single or multiple job at a time. Information technology is taken to imply the mode of communication with outside agents, and we consider three means of communication, namely person/post/phone, fax and electronic mail. We also collected information about data management, i.e., the storage and processing of data, which in this study include paper files and computers.

For the purpose of the survey, we observe the official definition of a small-scale unit. In India, a small-scale industrial unit is defined in terms of a maximum ceiling on the original value of investment in the plant and machinery, which was 30 million rupees during the period of our field survey.[28] Within this broadly defined set, our sample, based on purposive sampling, was selected from Delhi and its surrounding areas of Faridabad, Gurgoan and NOIDA. This region hosts numerous small-scale auto component units.[29]

The units for the survey were selected with the requirements of the study in mind. To be specific, we have selected the units in such a way that as there is a high likelihood of at least some of the units having undergone technological transformation to sophisticated technology like NC machines, these would be willing to respond and to provide reliable information.[30] Also, given the nature of informational requirements, sample size had to be smaller but richer in relevant information. We tried to obtain the ideal sample by approaching relevant government agencies (such as SIDBI, Small Industries Development Bank of India), industry associations (like ACMA, Automotive Components Manufacturers Association and FSIA, Faridabad Small Industries Association) as well as the informal networks of industrial units. Information is collected through questionnaire responses during personal interviews with the owner-managers of the sample units. In addition to the structured questionnaire, we visited the plants of each selected unit to confirm facts.

In addition to technology variables that are qualitative in nature, we collected quantitative information on production, capital, labour and materials. The quantitative information relates to the year 1998-99.

For the purpose of study, we surveyed 31 small-scale industrial units producing automotive components. Of these sample units, the majority (23) are original equipment manufacturers (OEMs) for the vehicle industry and eight cater to the replacement market. Except for two, all the surveyed units are engaged in the production of metal items such as sheetmetal products, turned components and tubular parts, produced mostly by either pressing, forging and machining. All these operations are possible at different levels of mechanization in the sense that they can either be done by manually operated, semi-automatic, or by numerically controlled machines.

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28 In December 1999, the ceiling was reduced to 10 million rupees.

29 In fact, Faridabad has been the natural cluster of auto component industry (Gulati 1997: 36-40).

30 Indian small-scale units are known to be notorious in this respect. Their response rate to surveys is poor and the majority are not in a position to provide quantitative information as very few of these units maintain records.

Information on production is collected in terms of the annual sales turnover, which ranges in the sample units between 15 lakhs (minimum) and 2000 lakhs (maximum) rupees, with a mean value of 222.1935 lakhs of rupees. The sample varies widely around the mean (174 per cent as given by the coefficient of variation). The annual sales turnover for twelve sample units is less than 50 lakhs of rupees in the reference year; for six units it is between 50 and 100 lakhs of rupees, and for nine units it ranges between 100-300 lakhs of rupees. For the remaining four units, sales turnover is greater than 300 lakhs of rupees.

Original investments in the plant and machinery in the surveyed units range from a minimum of 0.80 lakhs to a maximum of 300 lakhs of rupees. The mean value of the sample units is 48.9532 lakhs of rupees. The plant and machinery investment of the sample units varies 135 per cent around the mean. The majority of the units (12) have an investment in the plant and machinery valued less than, or equal to, 15 lakhs of rupees. Five units have invested amounts that range between 15-25 lakhs of rupees. Another six units have corresponding investments that vary between 25-50 lakhs of rupees, and the remaining units are operating with an investment greater than 50 lakhs of rupees.

Employment in sample units varies between 3 and 375 employees. The mean employment of the sample is almost 46. Employment in the sample units varies 151 per cent (coefficient of variation) around the mean employment. Of the 31 sample units, nine units employed ten employees or less, five units employed somewhere between 10-20, while another eleven units employed between 20-50 persons. Only six units in the sample had more than 50 employees.

The value of materials utilized during the year by the sample units varies between zero to 600 lakhs of rupees. Two units doing job-work show zero value for materials. Otherwise, the minimum value is 7.20 lakhs of rupees, and the mean value of materials utilized by the sample units is around 110 lakhs of rupees. Coefficient of variation shows that the material value of the sample varies around the sample mean by 130 per cent. For twelve units, the annual consumption of materials is less than, or equal to, 20 lakhs of rupees, while the corresponding material consumption for seven sample units ranges between 20-100 lakhs of rupees, and for the remaining twelve units more than 100 lakhs of rupees.

Descriptive statistics, i.e., minimum, maximum, mean and the coefficient of variation of the sales turnover, the plant and machinery, number of employees and material consumption, are given in Table 1 in the Appendix. To better indicate the range of these variables in the sample, these are presented in the Appendix as bar diagrams with the specified size classes.

Let us now summarize the features of the sample units in terms of their technology characteristics, namely, levels of mechanization, the plant layout, production schedules, materials management, presence of total quality system, nature of work allocation, means of communication with the customers and data management (record keeping).

Of the 31 automotive component units surveyed, 14 have only manually operated machinery; nine units have some semi-automatic machines and another eight units have numerically controlled machines in their plants in addition to manually operated machines. The level of mechanization is presented as pie diagrams in the Appendix in terms of percentage distribution of the sample units.

The suppliers of machinery are the primary source of technology in our sample auto component units. All the sample units, with the exception of two, have purchased machinery first hand, and almost all favoured Indian manufactured machinery. The presence of foreign machinery is negligible and is mostly secondhand machinery.

Most of the characteristics of the production organization, i.e., the plant layout, production schedules and materials management, turned out to be quite flexible in the sense that they can be easily adjusted as per the need of the hour. Accordingly, units buy materials depending on their need, availability, costs and available storage space. Production schedules are extended late into evening without much difficulty if orders need to be sent immediately. Hence, these characteristics are not considered in the empirical analysis. Only the allocation of work and quality management varied across the units available. Work allocation is considered, as said earlier, in terms of assignments of workers' fixed or rotating jobs. Twenty-one out of the 31 sample units rotate work assignments. The remaining ten units favoured fixed job assignments for their employees. Most of the units with rotating assignments also assign multiple jobs to their workers. Quality management of a unit is studied in terms of the acquisition of a quality management system, such as ISO9000 certification. The survey results show that this has been done in only nine units. The remaining 22 units have not adopted any similar quality system. Percentage distribution of the sample units in terms of work allocation and quality management is presented in the Appendix in the form of pie diagrams.

As far as information technology is concerned, we have included, as said earlier, the means of communication with customers, and data management (recordkeeping). In communications, only 13 units have started using emails in addition to traditional methods like personal visits and phones. Some of these units, which are OEMs, have even provided mobile phones to their truck drivers to track them down during the transfer of components to the parent companies. Although 16 sample units have installed computers, the majority of them are still in the process of computerizing their data. The remaining 15 units are without computers and thus still record their data according to the traditional method (paper files). The breakdown of the sample units according to the mode of communication and recordkeeping is given in the Appendix.

In sum, we were able to determine the level of mechanization, quality management, work allocations, communication and recordkeeping technologies as empirically relevant for our sample auto component units in the small manufacturing sector. Accordingly, we use these characteristics in our production function in the next section to measure the impact of technology on competitiveness.

5 Empirical evidence

As discussed earlier, we analyse the impact of technology on the competitiveness of the units by introducing the relevant technology variables directly in the production function along with the conventional inputs of capital, labour and materials. As can be seen from the survey data, the level of mechanization (transformation), quality management, work allocations (organization), means of customer communication and data management (information) are empirically relevant technologies in the specified units and hence are included in the production function. As mentioned in the preceding section, we have considered three levels of mechanization, namely, manual machinery, semi-automatic machinery and numerically controlled (NC) machinery. For the purpose of estimating the production function, however, we have regrouped them into two categories, namely, NC machinery and others. This is because NC machines are substantially different from the other two in all respects, i.e., speed of production, quality and precision of the product, and skills required to operate NCs. Hence, we expect the usage of NC machines to lead to distinctly higher degree of competitiveness of the units.

In the study, quality management is considered in terms of the acquisition of ISO9000 certification, which refers to a total quality system aiming at providing consistent quality products to customers. ISO9000 involves the formalization of operations by documenting details of work instructions, quality records, quality procedures and policies. The formalization and standardization of operations according to the ISO9000 should ensure consistency in approach, and consistent quality[31] is thereby expected to increase the market for these components. In fact, it has become a necessary condition for gaining access to the international supply chains. Apart from quality improvements, the formalization and standardization of operations are expected to increase the speed of production and productivity, and hence the competitiveness of the units. The rotation of job assignments among workers and assignment of multiple tasks at a given time are expected to raise labour efficiency, and thus the competitiveness of the units. Work allocations, however, are strongly linked to the type of machinery. For instance, the operation of manual machinery demands constant worker presence, which can tie up employees to a single machine. On the other hand, NC machines require workers for the initial setting-up phase of the operation, after which it functions independently until the operation is over, allowing employees to attend other jobs in the interval.

Modern modes of communication, like electronic mail and data management methods, involve the use of computers and are thus highly related to each other. Of these two, we preferred to utilize communications for our analysis. A shift towards electronic communication methods, which are superior to traditional ones in terms of speed and flexibility, hasten the process of finalizing orders from customers/dealers and are therefore expected to increase productivity by raising the level of capacity utilization through a shorter communication gap.[32] Electronic communication methods enable the units to contact their customers easily.

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[31] Kanji and Asher (1996: 48-50).

[32] In the case of a majority of small-scale units, production is not continuous process of three shifts. Rather, it is batch production with large time gaps between batches, caused not only by the lack of orders but also due to time gaps in communications.

As regards to the conventional variables in the production function, we considered the original investment in plants and machinery as capital; the total number of employees as labour and the value of materials utilized during the year.

As mentioned earlier, we have taken sales turnover as a dependent variable, which gives the actual size of the market served by the concerned firm. Thus, differences in sales turnover across firms can be taken as differences in their level of competitiveness.

In effect, we specify our production function as six-input Cobb-Douglas function and write it in the log-liner form as below:

$$\ln ST = C + \alpha \ln PM + \beta \ln LAB + \gamma \ln MAT + \theta_1 LOM + \theta_2 ISO + \theta_3 MCC + \mu \quad (4)$$

Where, ‘ln’ refers to the logarithmic values of the variables

ST	=	annual sales turnover in lakhs of rupees
PM	=	original value of the plant and machinery in lakhs of rupees
LAB	=	total number of employees
MAT	=	value of materials consumed during the year in lakhs of rupees
LOM	=	level of mechanization; 1 for units with NC machines; 0 otherwise
ISO	=	quality management systems; 1 for units with ISO9000 certification; 0 otherwise
MCC	=	means of communication; 1 for units with email; 0 otherwise
μ	=	random error term.

Equation (4) has been estimated through ordinary least squares (OLS) method using Eviews software package. The estimated parameters are presented below.

$$\ln ST = \underset{(6.709)^*}{0.8685} + \underset{(2.374)^*}{0.0957} \ln PM + \underset{(2.912)^*}{0.2015} \ln LAB + \underset{(14.371)^*}{0.6792} \ln MAT + \underset{(2.523)^*}{0.2471} LOM$$

$$+ \underset{(1.357)}{0.1325} ISO - \underset{(-1.204)}{0.1112} MCC$$ [33]

$$N = 29, \quad R^2 = 0.9827, \quad F_{6,\ 22} = 208.237.$$

Since we are dealing with cross-section data, we have tested for the heteroskedasticity problem using White’s method by regressing the residual squares on all explanatory

[33] Figures in the parentheses are t-values and the asterisk (*) indicates the statistical significance of the relevant variables.

variables, their squares and cross products. Our estimates in this respect are R^2 = 27.2373 and F-statistic = 2.5754, which essentially accept the basic hypothesis of homoskedasticity. In other words, the data do not reveal problems of heteroskedasticity.

The estimated coefficients presented above indicate that all the conventional variables, namely, the plant and machinery, labour, materials and the level of mechanization, have a statistically significant and positive impact on the sales turnover. ISO9000 certification and methods of customer communication do not statistically influence the sales turnover.

ISO9000 certification, implying total quality system, enables the units to produce goods with consistent quality and hence increase their scope for expansion. It seems that in the case of our sample of small-scale auto component units, the expansionary effects of consistent quality have not yet started to kick in. So is the case with electronic communications, given the fact that this is still in the initial phases and needs yet to be established. Owner-managers utilize electronic communications in parallel with the traditional methods (phone and personal visits). The statistically insignificant influence of these two technologies to competitiveness may perhaps be caused by the fact that the benefits depend on the degree of mastery the concerned units have achieved with regard to these technologies. This, in turn, depends on the nature and degree of association with the customer companies. It may take some time for smaller units to tune-in with customer companies.

With regards to the variables showing statistically significant impact on sales turnover, all these yield positive coefficients, as expected. The level of mechanization shows the highest coefficient (1.07), followed by materials (0.6792), labour (0.2015) and the plant and machinery (0.0957). In other words, the sensitivity of firms' sales turnover is the highest in the presence of NC machines. NC machinery emboding advanced technology ensures both quality and productivity improvements, thus increasing sales turnover. This, juxtaposed with the result that investment in the plant and machinery yields statistically significant but smaller impact on sales, implies that it is the machine-embodied technology (or quality of machinery) rather than the stock of machinery, which has the greatest effect on improving sales turnover. Quantitatively, sensitivity of the firms' sales turnover to materials is second, meaning that availability and quality of materials have a considerable influence on the sales turnover of the automotive component units.

6 Summary and conclusions

In this paper, we have tried to analyse the impact of technology on the competitiveness of India's small automotive component units. We recapitulate here the salient features of the study:

- The impact of technology is studied by directly introducing the technology variables in the production function along with the conventional inputs.
- Technology has been taken in its comprehensive form by including all its three aspects, namely, transformation (mechanization), organization and information.

- The study is based on data collected through a primary survey of a sample of small auto component units located in and around Delhi.
- In our sample of small auto component units, the level of mechanization (transformation), quality management, work allocation (organization), means of communication with customers/dealers and data management turned out to be the empirically relevant technology variables. Most of the production organization variables, such as production schedules and materials procurement and inventories, were found to be highly flexible in almost all the units surveyed. Although available in some units, the usage of both information technologies (the mode of communication and data management) had not yet become standardized.
- Of these, we took the level of mechanization, ISO9000 certification and means of communication into our production function as proxies to the transformation, organization and information technologies. These technology variables are specified as dummy variables. In the case of mechanization, dummy variable include units with NC machines and those without. For the organization, we have a dummy variable which considers units with ISO9000 and those without. Information technology is represented by a dummy variable to include units with computers and electronic mail and units lacking these.
- Added to these technology variables are the conventional input variables, namely, original value of the plant and machinery, total number of employees and the value of materials utilized. Sales turnover is taken as a dependent variable instead of production, as it represents the competitiveness of the units.
- Finally, we have specified our production function to be of Cobb-Douglas type and estimated the same by ordinary least squares method.
- Results show that the technology, as represented by the level of mechanization, materials, labour, and the plant and machinery, has a significant positive impact on sales turnover. Units having NC machines achieve benefits in terms of sales turnover that are quite high in magnitude. This is followed by the coefficient of materials. Impact of the plant and machinery on sales turnover is relatively smaller in magnitude.

Based on the empirical results, we conclude that the usage of advanced technology embodied in sophisticated machinery such as NC machines substantially improves the competitiveness of the units in relation to both organization and communication technology on the one hand and the conventional inputs on the other hand.

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APPENDIX

Firm-level characteristics representing technology

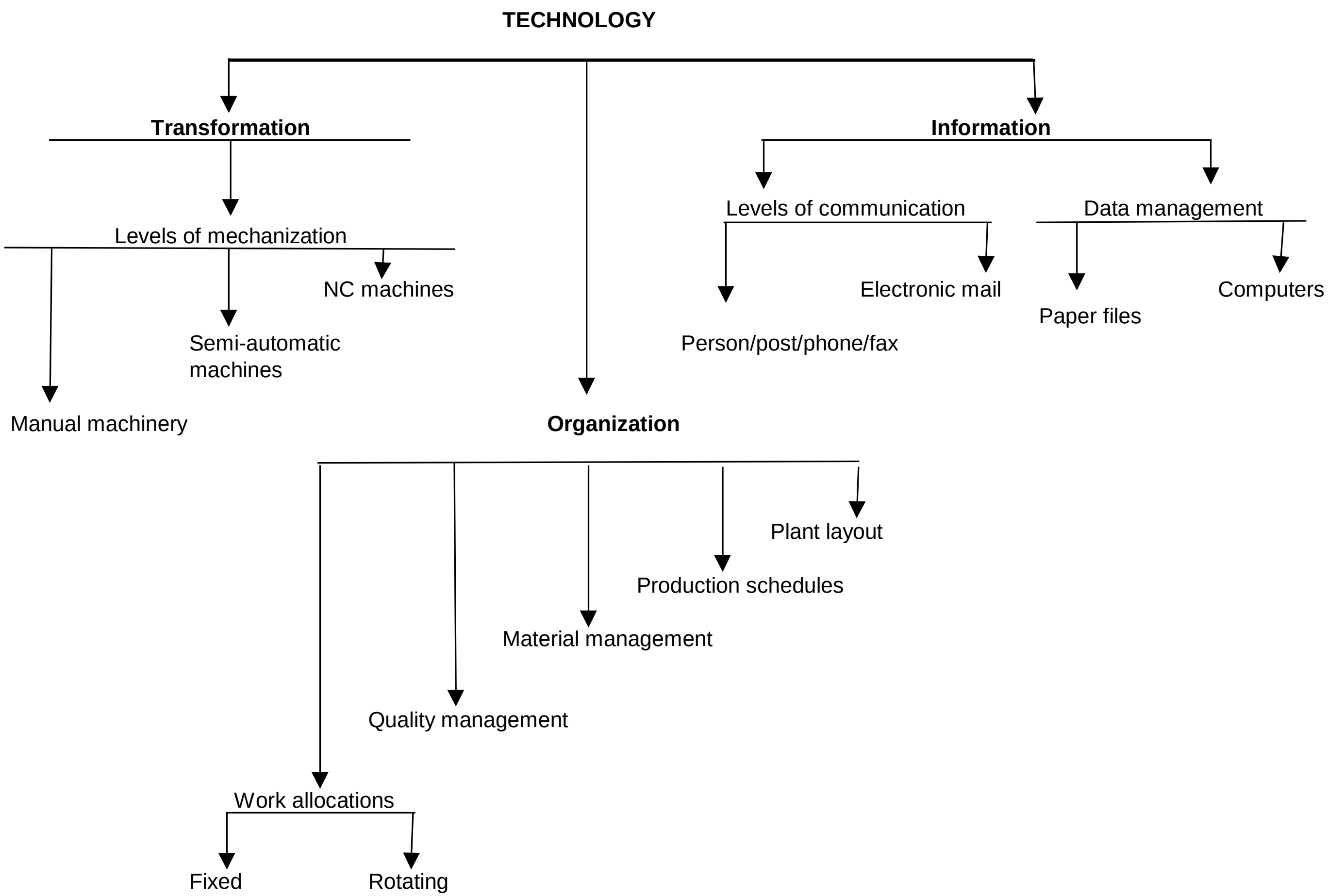
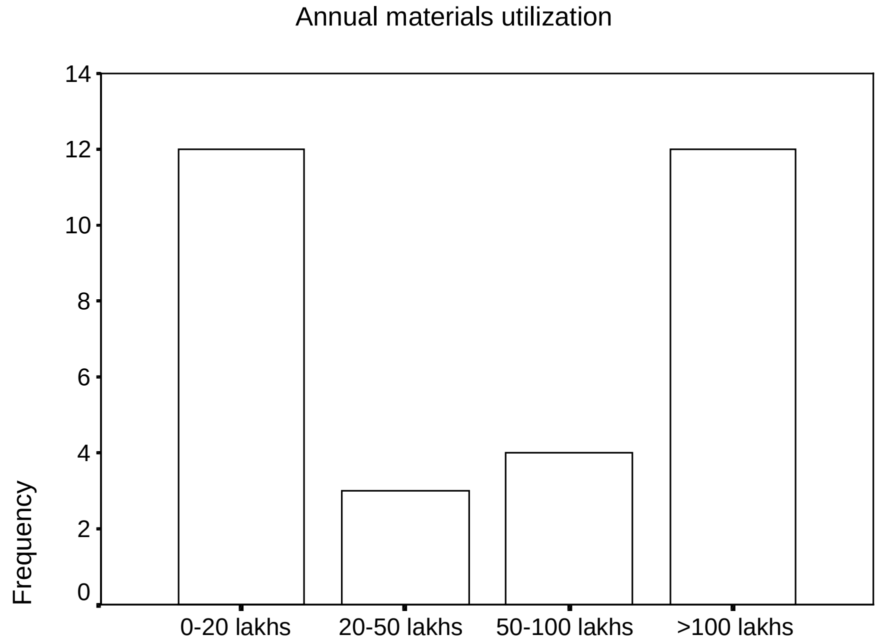
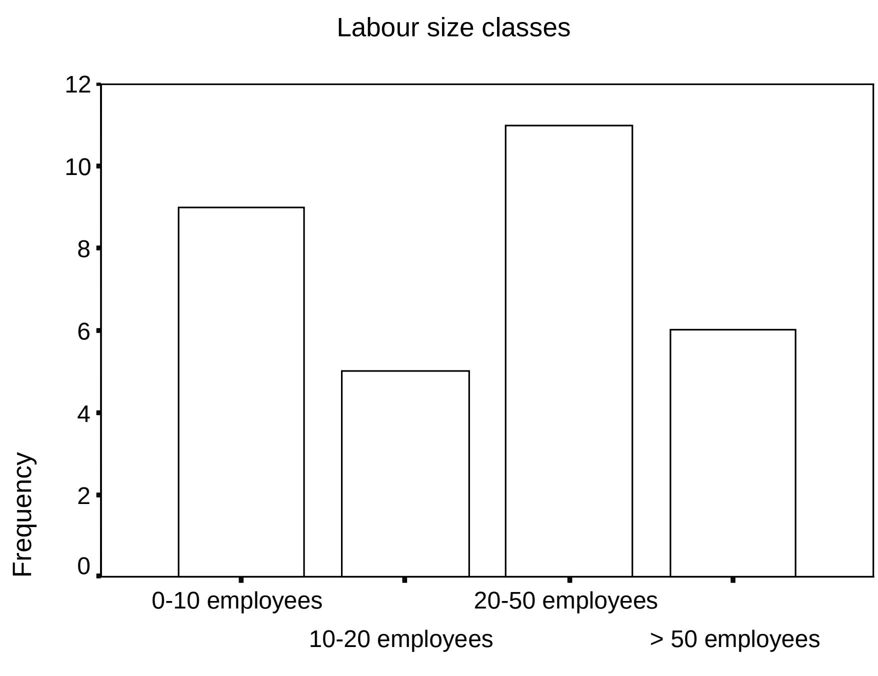


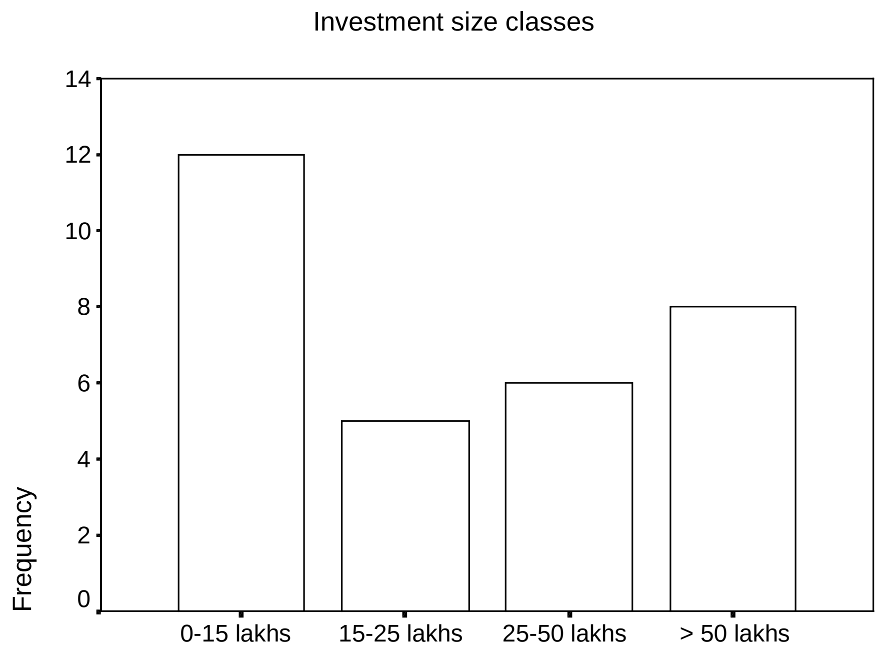
Table 1
Descriptive statistics for output and inputs

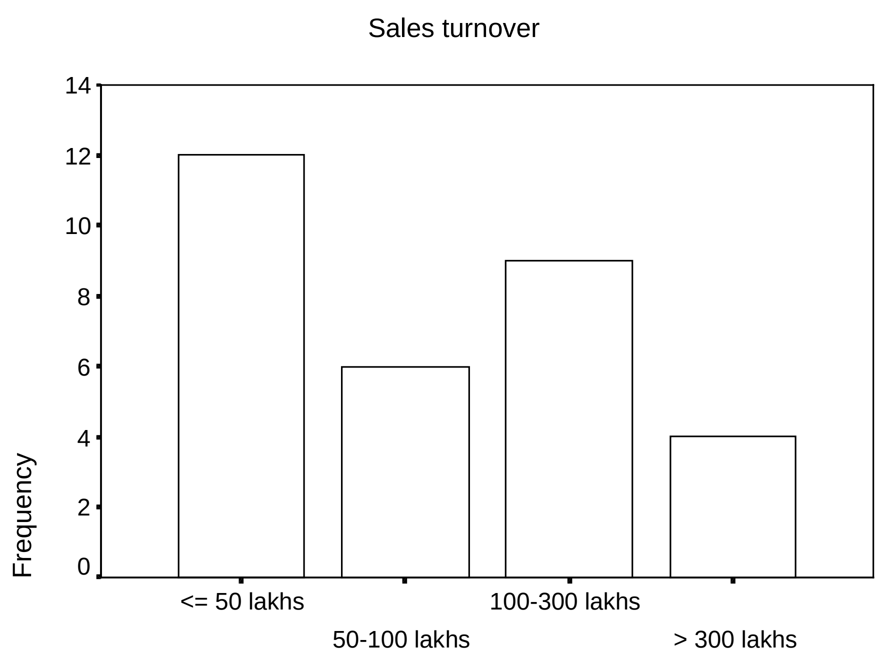
Variable	Mean	Minimum	Maximum	Coefficient of variation	No. of observations
Sales turnover (lakhs of rupees)	222.19	15.00	2000.00	1.67	31
Plant and machinery (lakhs of rupees)	48.95	0.80	300.00	1.35	31
Total employment (no.)	45.65	3.00	375.00	1.51	31
Materials (lakhs of rupees)	110.65	0.00	600.00	1.30	31

Source: Field survey

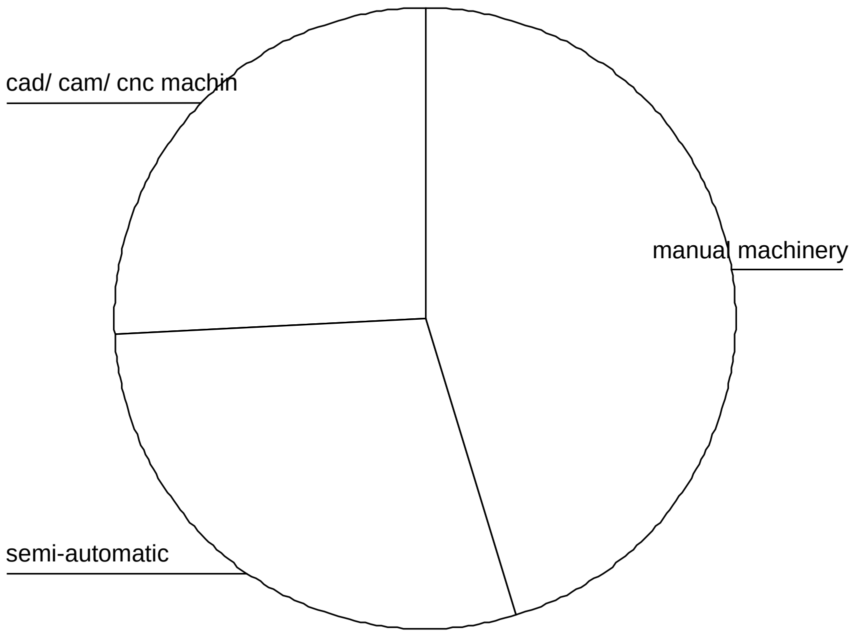

Annual materials utilization
14
12
10
8
6
4
2
0
Frequency
0-20 lakhs
20-50 lakhs
50-100 lakhs
>100 lakhs


Labour size classes
12
10
8
6
4
2
0
Frequency
0-10 employees
10-20 employees
20-50 employees
> 50 employees

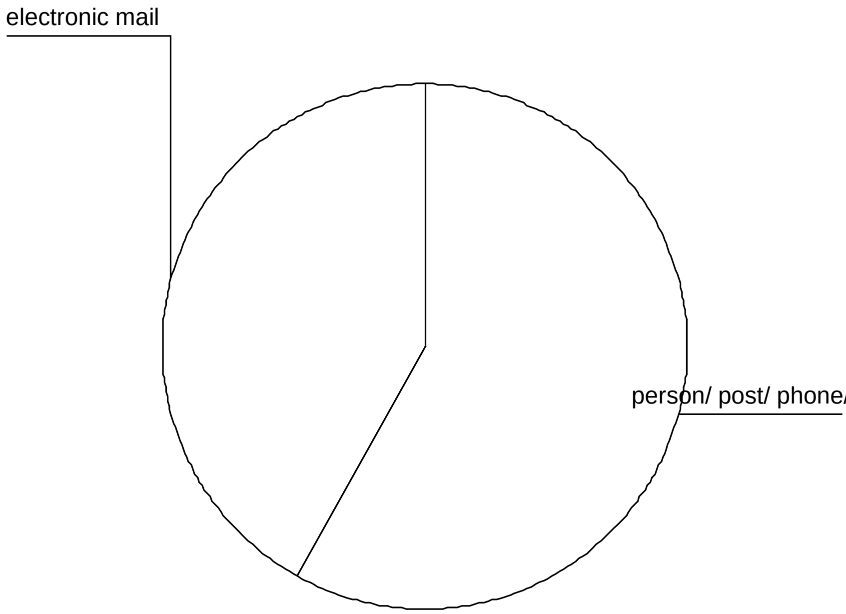

Investment size classes
14
12
10
8
6
4
2
0
Frequency
0-15 lakhs
15-25 lakhs
25-50 lakhs
> 50 lakhs


Sales turnover
14
12
10
8
6
4
2
0
Frequency
<= 50 lakhs
50-100 lakhs
100-300 lakhs
> 300 lakhs

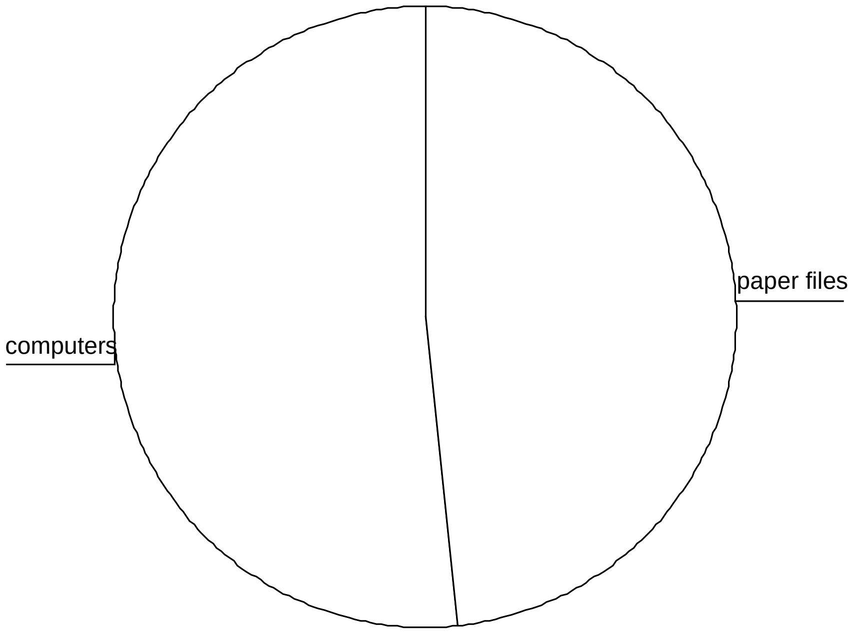
Level of mechanization



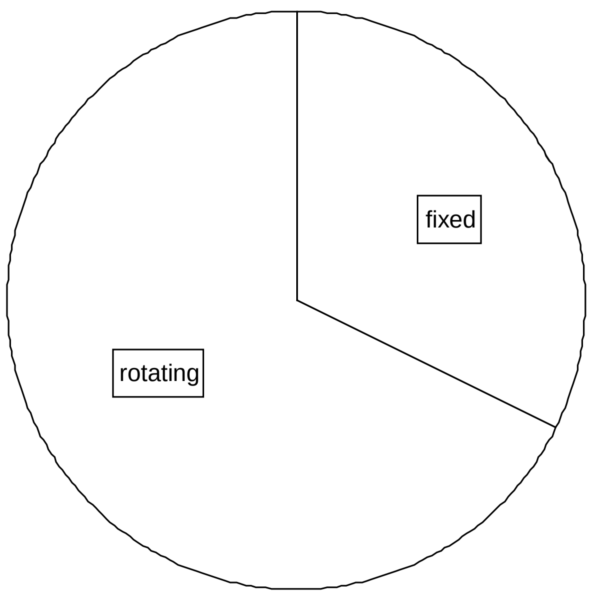
Levels of communication

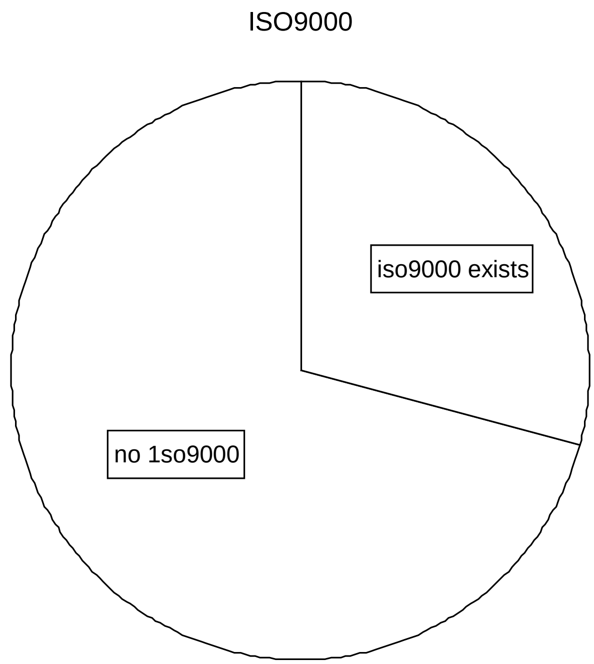


Level of recordkeeping



Work allocation




ISO9000
iso9000 exists
no 1so9000