ICT Adoption and Organizational Change in Public and Private Enterprises

Rakesh Basant
Shruti Sharma

W.P. No. 2014-01-04
January 2014

INDIAN INSTITUTE OF MANAGEMENT
AHMEDABAD-380 015
INDIA

ICT Adoption and Organizational Change in Public and Private Enterprises[1]

An Exploration of Plant and Enterprise Level Data in India

January 2014

Abstract

In this paper we explore whether there are differences in IT adoption, as well associated organizational change between private and state owned enterprises. We use two datasets from India to conduct this analysis- primary survey data of about 500 firms in India that contains detailed information on IT related organizational changes at these firms, and a secondary plant-level panel dataset by the Annual Survey of Industries which comprehensively covers the Indian manufacturing sector. We find important differences across the two kinds of enterprises in terms of extent and intensity of adoption as well as organizational structures across both datasets. The survey data suggests that IT induced organizational changes especially in terms of removal of levels of hierarchy are higher in state owned enterprises. The secondary data on the other hand shows that there are no statistically significant differences between the two kinds of enterprises as far as adjustment in composition of supervisory and managerial staff and other skilled workers is concerned.

1. **Rakesh Basant**, faculty, IIM Ahmedabad (email: rakesh@iimahd.ernet.in)

2. **Shruti Sharma**, faculty, IIMA Ahmedabad (email: shrutis@iimahd.ernet.in)

[1] This is a revised version of a paper prepared for the EGPA Annual Conference at Edinburgh during September 11-13, 2013. The authors are grateful to Vidhya Sachita Reddy for excellent research assistance.

1. Introduction

Firm level evidence across various countries now confirms a strong and positive association between investments in Information and Communications Technology (ICT) and productivity (Brynjolffson and Hitt, 2002, Commander et al., 2011). There is also an emerging consensus in the literature that complementary investments in organisational and managerial practices are critical for deriving potential productivity gains from investments in ICT (Bloom et. al 2012, Breshanan et. al. 2002, Black and Lynch, 2001). Yet, evidence on ICT adoption, associated organizational changes and consequences of adoption in developing countries is very limited. Studies that provide a comparative assessment of these issues in public and private enterprises in the context of a developing economy are virtually non-existent. Using plant level panel data from Annual Survey of Industries and Primary Survey Data of about 500 firms, this paper tries to partly fill this gap.

Two strands of the literature are relevant for our analysis. One that explores the role of management and organizational practices as complements to IT investment and another that compares the differences in organizational and managerial practices between the private and public sectors.

Various studies have been undertaken to understand the complements to IT investment that play an important role in enhancing firm and plant-level productivity. In a comparative analysis, Bloom, Sadun and van Reenan (2012) show that not only do US based firms experience higher gains in productivity from IT than European firms, but that US multinationals in Europe have stronger productivity effects from investment in IT than non-US multinationals. This leads them to conclude that it is not so much a simple natural advantage but rather management practices (complementary to IT investment) that explain this differential effect of IT investment on productivity. Using firm level panel data, Breshanan, Brynjolfsson and Hitt (2002) show that skilled labour is complementary with a cluster of three distinct changes at the firm level- information technology, new work organization and new products and services. In related work Brynjolfsson, Hitt and Yang (2002) show that not only are organizational practices correlated with computer investments, but firms that combine higher computer investments with organizational practices experience disproportionate increases in their market valuations.

Similar investigations in developing countries also echo the same findings. Basant et al (2006) explore the impact of ICT adoption on skills and organizational change at the firm level in India and Brazil. ICT adoption is found to be associated with increases in the employment shares of more educated workers. Their results also suggest that ICT adoption is skill-biased for both production and non-production workers. There is also some evidence for effects on complementary organisational changes once firms cross a threshold level of ICT adoption. In a study focusing on India, Sharma and Singh (2013), find that within the Indian manufacturing sector, plant fixed effects significantly reduce the impact of IT investment on plant-level Gross Value Added, concluding that these effects capture managerial capabilities of plants that play an important role in enhancing plant-level productivity.

At a broader level, a general consensus that has been emerging is that management practices matter for the overall productivity of a plant. One recent study that empirically investigates this question to find a causal relationship between the two is by Bloom et al. (2012) which considers the impact of improvements in management practices through consulting in a randomized experiment in India's textile industry. A comparison between the treatment (plants that were given free consultancy and training) and control group reveals that the treatment group experienced an increase in productivity by 17 per cent in the first year and further led to an increase in opening of more production plants within three years.

Empirical studies that refer to the differences between private and state owned enterprises (PEs and SOEs) in management practices are also relevant for this paper. There is evidence that while SOEs have a more conflict ridden decision making process, decisions are made more smoothly in PEs and non-profit organizations (Rodriguez and Hickson, 1995, Perry and Rainey 1998, Ring and Perry, 1985). In a more recent study, Nutt (2005) finds that public and private enterprises differ across numerous other dimensions. In the private sector there seems to a greater emphasis on analytics and networking whereas the public sector focuses more on bargaining. Also perceptions of risk vary across both kinds of enterprises, where the level of risk that is considered typical in a public enterprise would be considered too risky for a private enterprise.

Broadly, given limited autonomy, lower threat of bankruptcy due to soft budget constraints, a more complex principal-agent relationship and absence of threat for their managers of getting fired through the capital market, SOEs are expected to behave differently as compared to PEs. Such differences in the behaviour are also expected to get reflected in the nature and level of ICT adoption and the associated organizational change. With the help of a unique primary data set that provides a wealth of information on IT related organizational change and the secondary dataset which comprehensively surveys the manufacturing sector, we investigate whether these differences exist in public and private enterprises for the Indian firms and plants. The survey data also looks into related questions such as motivations and constraining factors for and IT investments by both kinds of enterprises

The rest of the paper is divided into five sections. Section 2 is a discussion on the two data sets used for this study. Insights from the survey data analysis are provided in Section 3 followed by the findings from the ASI panel data in Section 4. The final section summarizes key findings and provides concluding remarks.

2. Data

Combining the two strands of literature, the paper investigates whether there are indeed changes in management in response to increase in IT investment, and how these differ across SOEs and PEs. The linkages between ICT adoption and organizational change in the two types of enterprises are explored using two data-sets:

1. Firm level data from a detailed survey conducted in 2005; and
2. Annual Survey of Industries (ASI) data at the plant level for the period 2004-2007

We begin our analysis with the survey data which provides nuanced information on the nature/level of ICT adoption, organizational changes and skills of the workforce. A comparison of these for SOEs and PEs is expected to provide us with insights on the linkages between ICT adoption and organizational change in the two types of enterprises. The dataset is based on a unique firm level survey of 476 firms in India. The survey was implemented in April-May, 2005 through a series of face-to-face interviews. The survey instrument was designed to collect detailed data on ICT adoption and its

timing, as well as changes to management and organisational features associated with adoption. In addition, changes to the skill and educational structure of employment, firm level constraints to ICT adoption as well as variables capturing key characteristics of the firm in terms of size and performance and the competitive environment were collected. This survey covered firms in six three digit manufacturing industries representing about 17 per cent manufacturing employment and 20 per cent value added in India. These industries were auto-components, soaps and detergents, electrical components, machine tools, wearing apparels and plastic products. Stratification was done by industry, region and size (employment) with quota sampling. Firms were sampled in nine states. For most questions, data was collected for either two or three points in time, namely 2003, 2004 and 2005. The ratio of refusals to responses was 4.5. *Appendix 1* provides more information about the sampling distribution across states and industry groups.

The ASI is not as nuanced but allows us to understand how firms adjust to IT adoption over time. Using this plant level data which is the most comprehensive survey of the manufacturing sector in India, we will first see how IT adoption varies between SOEs and PEs. Then, using detailed data on labour, we will examine how the employment of managers and supervisory staff changes with investments in IT across both kinds of enterprises. We will also analyse how total employment changes as IT investment increases in the two types of enterprises. The plant level data will be a panel from 2004 to 2007 and over time changes can also be explored. Detailed data are available on production, fixed assets (including investment in IT) and labour (production workers, non-production workers, wages, hours/days worked). There is data on ownership of plants and we broadly classify them into State Owned Enterprises (SOEs) and Private Enterprises (PEs) to allow for comparison.

3. Insights from Survey Data

The survey data provides us with rich details on the extent and usage of IT adoption along with changes in educational and organizational profiles of workers. For some variables information was available for three years (2003-05). For most of the other variables, information is available for only 2005, however some of the questions refer to the changes made over the past three years and so they give us an idea about the

adjustment in organizational structure in the firms over time. The ASI data, while not as detailed provides a more robust analysis of differential adjustment across public and private enterprises. It needs to be mentioned at the outset that the measures of ICT adoption and organizational change are measured differently in the two analyses. While the ASI data has information on IT capital as a stock, this information is not available in the survey data where expenditure on IT has been used. A variety of questions were asked to capture both the nature and extent of adoption and the associated organizational change. Given the nature of data, bulk of the analysis is descriptive in this section but eventually some regression analysis is undertaken to ascertain broad patterns, controlling for a variety of firm level variables.

3.1 Descriptive Statistics

Table 1 provides some basic descriptive statistics for the sample providing mean and standard deviation values of size of enterprises, export share in sales and various measures of IT adoption and organizational change for SOEs and PEs. On average SOEs in the sample are much larger than PEs in terms of employment and assets but approximately the same in terms of sales turnover. The export orientation and R&D intensity is somewhat higher for PEs than SOEs. Various measures of ICT adoption (ICT expenditure to sales ratio, PCs and servers per worker, proportion of employees using PCs and ICT intensity index) suggest that there is hardly any difference between SOEs and PEs. However, interestingly ICT adoption related organizational change is higher in SOEs than in PEs.

Admittedly, the sample size of SOEs is small to make very robust comparisons but such an attempt is made here to generate some initial insights that can be used as hypotheses in subsequent work. Such detailed data on IT adoption and organizational change is not available elsewhere.

3.2.1 Extent and usage of IT adoption

In addition to the expenditures on ICT (hardware and software), the survey distinguished between five categories of firms in terms of extent/intensity of ICT adoption: (i) ICT is not used at all; (ii) ICT is used only for some office applications along with accessing the internet, emailing, etc.; (iii) ICT is used for some advanced

applications. Most processes are automated but there is no integration into a central system; (iv) Most processes are automated and some of them are integrated into a central system; and (v) Almost all processes are automated and integrated into a central system. For collecting data on the use of different functions, these aggregate five categories of IT intensity are modified to create 4 levels of adoption: (i) ICT not used at all; (ii) ICT used for some processes; (iii) ICT used for most processes; and (iv) ICT used for all processes. Data on these levels of ICT adoption are available for five main functional areas - accounting, marketing, production, inventory and HR. If any of these IT functions for different areas are outsourced, information was collected for the four levels of ICT outsourcing: (i) No outsourcing; (ii) for some processes; (iii) for most processes; and (iv) for all processes.

In addition, information from the survey allows us to compare SOEs and PEs on the percentage of production and non-production workers using ICT.

On the basis of the information collected on extent of use of IT (categories i – iv defined above) in different functional areas, we created a simple index of IT intensity for the sample firms. The values of the index can range from 10 to 40. It is calculated by summing the responses ranging from 1 to 4 for intensity of using IT within the firm and outsourcing.

The aggregate ICT adoption estimates for (i) to (v) categories are shown in Chart 1. It can be seen that as compared to PEs a smaller proportion of SOEs report automation and integration into a central system; almost 60 per cent of SOEs belong to Category II using IT only for some applications, email and the Internet while the share of such firms among PEs is less than 40 per cent.

The use of ICT varies across functions. In general the use of ICT is more prevalent for accounts and HR functions and less for marketing and product design functions. Its use in inventory management is somewhat in-between. Except for HR related functions, SOEs tend to use IT more intensively than PEs (Chart 2). The proportion of SOEs using ICT for production, marketing and product design is particularly higher than PEs. While this could be due the fact SOEs on average are larger but the same logic cannot be used to explain lower adoption of ICT by SOEs.

Outsourcing of IT functions is quite restricted (Chart 3). Across functions, less than 15 percent firms report any outsourcing. This is true of both PEs and SOEs. Outsourcing is used the least for HR and accounting functions although a small proportion of PEs, probably smaller ones, tend to use it a bit for accounting. Interestingly, a somewhat larger proportion of SOEs (than PEs) seem to use outsourcing for marketing, product design and inventory management.

The data on the adoption of IT utilities (Chart 4) shows that a larger proportion of PEs than SOEs use websites for data transfers and e-commerce. On the other hand a larger proportion of SOEs use central servers and have Internet access; intranet is used by a larger proportions of PEs than SOEs.

3.3 Changes in organizational and educational profiles

The survey collected data on the changes in the educational profile of the workforce and to what extent this change was linked to the adoption of IT. This information was collected for different categories of workers.

3.3.1 Educational Profile

Chart 5 shows that more than 50 per cent of PEs and more than 60 per cent of SOEs hired more educated *production workers*; for about 30 per cent of PEs and 15 per cent of SOEs, the educational profile of such workers remained the same. In SOEs this change was related to IT in more than 35 per cent of the firms while only about 5 per cent PEs attributed the change in educational profile of production workers mainly to IT

adoption; another 15 per cent SOEs and 25 per cent PEs partly attributed this change to IT adoption (Chart 6).

About 60 per cent SOEs and 45 per cent PEs reported hiring of more educated workers for the *clerical and administrative* workforce (Chart 7). Once again, the change in the educational composition of this category of the workforce was attributed to IT by a much larger proportion of SOEs than PEs (Chart 8).

The limited evidence that we have on changes in educational profile due to IT suggests that the skill bias linked to IT is more prominent in SOEs than PEs, an interesting finding that would require more exploration.

3.3.2 Organizational Change

Data was collected on ICT adoption related changes in hierarchy, monitoring and managerial decision making. Four types of organizational changes were defined:

i. Removed a level of hierarchy, or reduced number of reporting levels
ii. Improved monitoring of individual workers or groups of workers
iii. Replacement of repetitive tasks by computerization/Improved management decision making based on up-to-date information
iv. Part/whole outsourcing of activities previously performed inside the firm

These organizational changes were captured for production, clerical/administrative and managerial workers. Overall, for all types workers, the IT related organization changes were more prevalent among SOEs as compared to PEs (Charts 9-11). A much larger proportion of SOEs reported reduction in hierarchy/reporting levels than PEs due to IT adoption for all the three categories of workers. This may partly be due to the fact that SOEs were more hierarchical to begin with as compared to PEs. Similarly, as compared to PEs, a significantly larger proportion of SOEs also reported improvements in monitoring due to IT adoption for all types of workers. Once again, this may partly reflect absence of such systems in SOEs. Replacement of repetitive tasks through computerization was reportedly somewhat higher for a larger proportion of firms for administrative and clerical workers than for production workers. However, there was not much difference between SOEs and PEs in this regard. Improvements in managerial

decision making due to IT adoption were reported by a larger proportion of SOEs than PEs.

ICT adoption and the associated organizational change can be due to a variety of factors, apart from the ownership structure. And therefore, the differences above cannot be attributed to the ownership structure till we control for such variables. We shall explore that below but before doing that we analyze if the reported motivations and constraints on IT adoption are different for the SOEs and PEs.

3.3.3 Motivations for IT Adoption

A variety of strategic and other factors can influence IT adoption. At one end it can simply be a response to the adoption of IT by the firms' competitors. Demands from suppliers and customers can create pressures to do so. Firms can proactively adopt ICT to enhance range/quality of goods or services , reduce labour and other costs, increase production flexibility, improve decision making & monitoring (as noted above) or access new markets. ICT adoption can also facilitate inter-firm interaction and enhance the efficacy of the relationship with foreign partners. IT adoption has reputational effects while creating entry barriers for new entrants. Lastly, investments in IT can simply be a response to government support. The survey collects data on all these motivations. Chart 12 reports the proportion of SOEs and PEs reporting these motivations to be important for the enterprise.

It is evident that both types of firms have multiple motivations for adopting ICT. Ability to improve decision making and to increase range of goods and services are important motivations for both SOEs and PEs with almost 60 per cent of the firms reporting them to be important motivations. Interestingly, motivations like cost savings and access to new markets are important as motivations for a much larger proportion of PEs than SOEs. To some extent the same is true for motivations like enhancing the relationship with foreign partners and inter-firm interaction. Evidently, interactions with other firms, both foreign and domestic, are not as important for SOEs as for PEs. Surprisingly, improved monitoring of employees as a motivation is reported by a higher proportion of PEs than SOEs even though a much higher share of SOEs had reported IT adoption linked improvements in monitoring of employees. These differences may reflect the

difference in *intent* and *impact or implementation.* If such is the case then SOEs ability to implement while PEs find it more difficult is an interesting finding, the reasons for which may need to be explored.

As compared to PEs, a significantly larger proportion of SOEs report competitors use of IT, pressures from suppliers and customers, reputation and government support as important motivations for adopting ICT. Typically, except for government support, one would not expect these motivations to be more relevant for SOEs as compared to PEs. Are SOEs becoming more responsive to such demands and concerned about reputation? If yes, what are the reasons?

One of the reasons could be that the nature of competition faced by them is different. As a part of the survey it was asked if the price sensitivity of their customers has changed in recent years. An increase in price sensitivity would reflect enhanced competition, making the firms more sensitive to supplier and customer demands and to what competitors are doing, apart from influencing the enterprise's overall IT investments. Chart 13 summarises the responses on changes in price sensitivity for SOEs and PEs. The estimates suggest that while price sensitivity has gone up for the majority of firms by varying degrees, the PEs have faced a higher increase in competitive pressures (as reflected in the proportion of firms reporting increase in price sensitivity) than SOEs. Thus, while enhanced competition may be one of the reasons for being responsive to competitors actions and the demands of suppliers and customers, that is unlikely to be the major reason for SOEs being motivated by these factors to adopt IT.

3.3.4 Constraints on IT Adoption

Finally, the survey collected information on the constraints to adopt ICT. As was the case with motivations, a variety of constraints can adversely affect investments in IT. These can include labour issues - union related problems, resistance to change among employees or inflexible labour laws and regulations that constrain hiring of workers with appropriate contracts. These constraints can get accentuated if workers with relevant skills are not already available within the enterprises. Cash flow/credit related financial constraints can be binding too. Organizational constraints ranging from lack of integration between different departments in the firm and complexity and/or cost

relating to multiple locations can also influence IT investments. Some enterprises may face supply side constraints in the form of inadequate local availability and/or high price of internet access or high computer / IT prices. Apart from lack of government support, IT adoption may be constrained if a small number of enterprise customers and suppliers using IT as investments in such situations are less efficacious. Chart 14 reports the percentage of SOEs and PEs reporting all these as important constraints to IT adoption.

Overall, lack of government support, limited use of IT by suppliers and customers, high hardware/software prices, inadequate local availability and high price of Internet access and lack of integration among departments in the firm are reported to be important constraints by a large percentage of PEs and SOEs. A comparison of important constraints across PEs and SOEs throws up interesting results. A significantly larger proportion of SOEs than PEs report inflexible labour laws and regulations to be a constraint on IT adoption. This is intuitively correct as one expects such issues to be more relevant for SOEs. A small number of customers and suppliers using IT has also been reported by a much higher proportion of SOEs than PEs as a constraint. It may be recalled that SOEs are larger and have also reported pressures from customers and suppliers as an important motivation to adopt IT. It is difficult to say if this is an inconsistency in response or SOEs would be motivated by pressures from customers and suppliers to adopt IT but currently the absence of IT use by them creates a situation that SOEs IT related investments are not as efficacious as they would be if other parts of the supply chain adopt IT. A larger proportion of PEs than of SOEs report lack of appropriate IT technician skills, complexity of multiple locations and high software/hardware prices. Evidently, IT technician skill constraints and prices affect PEs more adversely than SOEs.

Problems relating to power as a constraint seem to be similar for SOEs and PEs. Table 1 reports that on average SOEs experience 20.2 days of power outage in a year while the estimate for PEs is slightly higher at 23.4.

3.4 Does Ownership Make a Difference?

All things considered, does state ownership affect ICT adoption and associated organizational change? To explore this question, we estimated exploratory regressions where ICT adoption and IT related organizational change were regressed on ownership characteristics (a dummy variable) and a set of other firm level characteristics, essentially as controls. Appendix 2 provides the details of the variables used.

Table 2 reports the results of the regression equation for ICT adoption. Since we did not have the stock of IT variable in this data set, we have used Index of IT use (described earlier) and proportion of workers using computers as the two IT adoption (dependent) variables. It should be emphasized that unlike the regressions using ASI data in the next section, these variables reflect extent of use rather than ICT capital. The variable is admittedly crude. The only two variables that seem to affect ICT use is the size of the enterprise (employment/gross fixed asset) and the stock (number) of PCs and servers per employee. Thus, the extent of use is primarily affected by the availability of hardware and the size of the firm. Changes in the nature of competition faced (change in price sensitivity), power supply issues, foreign ownership and most importantly for us state ownership does not make any difference to ICT use. In two of the specifications (Model 1 and 3, Table 2), existence of a foreign alliance affects ICT use positively.

Table 3 reports the results of the organizational change regressions. Unlike in the ICT use regressions, state ownership does positively influence IT related organizational change. While size, stock of PCs per worker, multinational ownership and foreign alliance do not affect organizational change, use of IT affects it positively. That is, higher the intensity of IT use, higher is the possibility of IT related organizational change. Due to multicollinearity problems, we are not able interact ICT use with public/private ownership as was done in the ASI regressions in the following section.

4. Insights from Annual Survey of Industries (ASI) Data

This part of the paper explores the relationship between organization (measured as skill composition) of the plant and IT adoption. Further, it investigates whether this relationship is different for SOEs and PEs. IT capital may either increase or decrease

skill composition depending on whether it complements the existing workers and management (Breshanan, Brynjolfsson and Hitt (2002) and Basant et al (2006)) or displaces skilled workers by automating most of their services. We will therefore, distinguish between the two kinds of skilled workers in our data: supervisory and managerial staff and other skilled employees (technical staff, engineers, accountants etc.). This will give us a better picture of the mechanisms underlying the relationship between IT capital and Organization.

4.1.1 Data and Summary Statistics

The data used in this study is from the Annual Survey of India, a comprehensive survey of the manufacturing sector of India. The time period considered is from years 2004-2007. The data used for the study only considers the panel of plants repeated across all four years. This gives us about 19,000 plant-year observations. Of this about 17,500 observations belong to the PEs category and about 1,500 observations fall under the SOEs. We have grouped plants wholly or partly owned by the government in the category of SOEs. We create the variables skill composition, composition of supervisory and managerial staff, and composition of other skilled employees for our analysis. These are created by taking the ratio of skilled workers to total plant-level employment, supervisory and managerial staff to total employment and other skilled employees to total employment respectively. Each of these ranges from 0-1. Summary statistics reported in Table 1 are also presented for the opening stocks of plant and machinery, IT capital and of working capital along with gross sales by a plant. Table 1 report the mean for the whole sample, only PE (private) plant-observations, only SOE (public) plant-observations and the difference between the means of the two. It also reports whether the difference is statistically significant or not.

A brief glance at the summary statistics provided in Table 4 reveals that the skill composition and opening stock of IT capital is higher for public enterprises as compared to private enterprises. In addition, there is a starker difference between public and private enterprises as far as composition of other skilled employees is concerned, as compared to composition of supervisory and managerial staff. However, public enterprises are also bigger as measured by other variables such as sales, plant and machinery and working capital. It becomes important therefore, to control for size

when we are examining the relationship between skill composition (which captures the management structure), adoption of IT (as measured by opening stock of IT) and ownership (public or private).

4.1.2 Empirical Estimation

In this sub-section, we empirically explore the relationship between Organization (measured as composition of various skilled workers), IT capital and Ownership. We want to understand if there are strong complementarities between Organization and IT Capital and whether Ownership matters for IT adoption and how it influences the relationship between IT adoption and Organizational change. In unearthing these relationships, we are not necessarily trying to establish causality. Of bigger interest is whether IT adoption and Organizational change go together and if Ownership matters for the relationship between the two.

The empirical results are discussed in three main subsections. The first investigates how skill composition, composition of managerial and supervisory staff and composition of other employees-our measure for organization, changes with IT adoption. The second subsection considers the actual employment of all skilled employees and production workers to better understand the mechanisms underlying the compositional changes. Finally we try to understand how private and public enterprises differ in terms of ICT capital, and whether organizational changes within these two kinds of plants have a differential impact on ICT adoption. All estimations in the three subsections include plant fixed effects which incorporate any time-invariant plant-level characteristics that could be influencing the relationships under investigation. Further, all models also include year fixed effects which control for any policy-wide or other changes that took place during a particular year and affected all plants uniformly. Controls for size such as opening stock of plant and machinery, sales and working capital are included in all estimations. Standard errors for all estimations are robust.

4.2.1 Skill Composition, IT adoption and Ownership

In Tables 5 and 6, the dependent variables are a ratio ranging from 0-1, of either composition of skilled workers in the total workforce, or the composition of supervisory

and managerial staff in the total workforce or the composition of other skilled employees in the total workforce. We use the opening stock of IT capital to partially control for endogeneity. In Model 1, we find that increases in IT capital are accompanied with increases in overall skill composition. In Models 2 and 3, we consider the two sub-categories of skilled workers- supervisory and managerial staff and other skilled employees (including technical staff). We find that while there is no strong relationship between the composition of supervisory and managerial staff and ICT capital, it is the composition of other skilled workers, i.e. the technical and other trained staff that gets impacted by increases in IT capital. This suggests that instead of substitution of skilled workers such as engineers and accountants there exist strong complementarities between ICT capital and non-managerial skilled employees.

In Models 4, 5 and 6 we explore how the composition of skilled workers, followed by composition of supervisory and managerial staff and that of other skilled workers differs across SOE and PE plants. The 'Ownership' variable is a dummy that takes on a value of 1 if the plant has public ownership and 0 otherwise. We find that after controlling for size (using fixed assets, working capital and total sales) there is a significant difference in the composition of supervisory and managerial staff between SOEs and PEs, but not for composition of other skilled workers. Private plants, on average, have a higher share of supervisory and managerial staff by about 0.4 percent.

Table 6 explores the interaction effects between ownership and IT adoption on organizational change. It helps us understand whether for a change in investment in IT capital, SOEs experience a differential change in skill composition as compared to PEs. Given that PEs are leaner and less hierarchical, organizational change as warranted by increased IT adoption should be smoother in these plants as opposed to SOEs. The interaction term between IT capital and the Ownership dummy, is of most interest here. It is interesting to see that this term is not significant across all three models- considering skill composition, composition of supervisory and managerial staff and further, the composition of other skilled employees, respectively. This suggests that with changes in IT adoption, it is not necessary to expect a different response in terms of organizational change from public enterprises as opposed to private enterprises.

4.2.2 Employment Effects

The next set of estimations consider the impact on employment of skilled workers, supervisory and managerial staff, other skilled workers, production workers and total employment to better understand the compositional effects. An increase in skill composition in response to increase in IT capital, as observed in the previous subsection can be a result of a greater increase in skilled workers than that of production workers, a bigger decline in employment of production workers as compared to skilled workers, or a simultaneous decline in production workers and an increase in skilled workers. We find that employment of skilled workers, supervisory and managerial staff, other skilled employees, production workers and total employment all increase with an increase in investment in IT capital (Table 7). The increase in employment of skilled workers, however, is higher than the increase in employment of production workers, giving rise to our previous result of an increase in skill composition in response to an increase in IT capital. There are no interaction effects between IT capital and ownership on employment of skilled workers, supervisory and managerial or others, just like in the case of compositional effects.

4.2.3 IT Adoption

Finally, we try to understand how public and private enterprises differ in terms of ICT adoption. Further, we will also examine whether changes in the organizational structure at these organizations have differential impacts on adoption of IT. Table 8 considers Log (IT capital) as the dependent variable, and we find that as skill composition increases, the stock of IT capital increases with it. There is no significant difference in ICT capital across public and private enterprises once we control for size (using variables such as plant and machinery, working capital and sales). It is interesting to note that ICT capital does not significantly change with changes in composition of supervisory and managerial staff. It does change significantly with changes in composition of other skilled employees. Ownership interacted with either skill composition (Model 4), composition of supervisory and managerial staff (Model 6) or composition of other skilled employees (Model 8) is not significant. This suggests that the effects of organizational change on IT capital are not differential for public and private enterprises.

Again, while we cannot infer causality from the above estimations, we can conclude that there are strong complementarities between IT investment and skill composition, more specifically for non-managerial skilled workers.

4.2.3 Some Concluding Observations from Analysis of ASI data

In summary, for the sample from the ASI data of the Indian manufacturing sector, we find that ownership does not matter. Public and private enterprises are not much different as far as IT adoption is concerned, and also as far as linkages between organizational changes and increased adoption of IT is concerned. While these enterprises differ slightly in terms of their employment of non-managerial skilled employees, there isn't a significant difference between them in adjusting these workers to changes in IT adoption.

Another important result that emerges from this study is that for India, while skill composition and therefore, organizational structures of organizations change with IT adoption, this mainly arises from technical and other professional workers and not so much from managerial and supervisory staff.

5. Conclusion

The paper explores two data-sets – a large plant level panel data set available from secondary sources and firm level data set based on a primary survey of 476 firms - to compare public and private enterprises in terms of ICT adoption and organizational change. The ICT adoption variable in the large data set is a stock variable measuring ICT stock at the plant level while the primary survey collected more detailed data to capture intensity of ICT use at the firm level. These are not strictly comparable but capture different dimensions of ICT adoption. One significant result of the panel data analysis is that public ownership does not have any significant effect on IT adoption once other factors are controlled for. Thus, whether we measure ICT adoption as a stock (value) variable or as some indices of the intensity of use, ownership does not matter. However, results of the two sets of analyses differ in terms of the linkages between organizational changes and increased adoption of IT. The analysis of the plant level data suggests that increased adoption of IT does not affect organizational change. While these plants (SOE/PE) differ slightly in terms of their employment of non-managerial skilled employees, there isn't a significant difference between them in adjusting these workers to changes in IT adoption. The analysis of the firm level data

suggests that the use of IT affects organizational change positively and surprisingly, after controlling for extent of use of IT and other factors, IT related organizational changes are higher in SOEs than in PEs.

It should be emphasized that the measures of ICT adoption and organizational change in the two data sets are different and therefore it is difficult to argue that they are contradictory. For the aggregate set of firms (SOEs as well as PEs), one can argue that organizational change is more likely to be linked to the *use* of IT rather than the *stock* IT. And therefore, the positive relationship between IT use and organizational change observed in the analysis of primary data while the same is not seen at the plant level data can be understandable. However, a positive link between public ownership and IT related organizational change is somewhat surprising. One explanation could be that given more hierarchical structures, the scope for organizational change is higher in SOEs than in PEs. Further, it's possible that these differences disappear in the panel data analysis (ASI) because of the use of fixed effects which control for unobserved time invariant characteristics that matter for differences in organizational structures across these two kinds of enterprises. But this result needs to be explored further. The primary survey data showed that motivations and constraints for IT adoption are different for the two sets of firms. A more systematic effort to understand those differences may provide us with some useful insights.

References

Basant R, S Commander, R Harrison and N Menezes-Filho (2006), "ICT Adoption and Productivity in Developing Countries: New Firm Level Evidence from Brazil and India. *IZA Discussion paper No 2294*, September, Bonn, Germany

Black Sandra and Lynch Lisa (August 2001), "How To Compete: The Impact Of Workplace Practices and Information Technology on Productivity," The Review of Economics and Statistics, MIT Press, vol. 83 (3), pages 434-445

Bloom Nicholas, Eifert Benn, McKenzie David, Mahajan Aprajit and Roberts John (February 2013) Does management matter: evidence from India *Quarterly Journal of Economics, Volume 128 (1): 1-51.*

Bloom, Nicholas, Raffaella Sadun, and John Van Reenen. 2012. "Americans Do IT Better: US Multinationals and the Productivity Miracle." *American Economic Review*, 102(1): 167-201.

Bresnahan Timothy, Brynjolfsson Erik, and Hitt Lorin (February 2002) "Information Technology, Workplace Organization, and the Demand for Skilled Labor: Firm-Level Evidence". *Quarterly Journal of Economics,* Vol. 117 pp. 339-376.

Brynjolfsson Erik and Hitt Lorin (November 2003) "Computing Productivity: Firm-Level Evidence," The Review of Economics and Statistics, MIT Press, vol. 85 (4), pages 793-808

Brynjolfsson, Erik, Hitt, Lorin M. and Shinkyu Yang (2002) "Intangible Assets: Computers and Organizational Capital," *Brookings Papers on Economic Activity*: Macroeconomics (1): 137-199.

Brynjolfsson, Erik, Lorin M. Hitt, and Shinkyu Yang (December 2000) "Intangible Assets: How the Interaction of Computers and Organizational Structure Affects Stock Market Valuations" MIT Working paper.

Commander, S & Harrison, R & Menezes-Filho,N, (May 2011)"ICT and Productivity in Developing Countries: New Firm-Level Evidence from Brazil and India," The Review of Economics and Statistics, MIT Press, vol. 93(2), pages 528-541

Nutt, P (March 2005) "Comparing Public and Private Sector Decision Making Practices,"Journal of Public Administration Research and Theory 16: 289-318

Perry, J. L., and H. G. Rainey. 1988. The public-private distinction in organization theory: Critique and research strategy. Academy of Management Review 13 (2): 182–201.

Rainey, H. G. 1989. Public management: Some recent research on the political context and the management roles, structures, and behaviors. Journal of Management 15 (2): 229–50.

Ring, P., and J. Perry. 1985. Strategic management in public and private contexts. Academy of Management Review 10 (2): 276–86.

Rodriguez, S. B., and D. H. Hickson. 1995. Success in decision making: Different organizations, different reasons for success. Journal of Management Studies 32 (5): 655–78.

Schwenk, G. 1990. Conflict in organizational decision making: An exploratory study of its effects in for profit and not-for-profit organizations. Management Science 26 (4): 436–48.

Sharma Shruti and Singh Nirvikar 2013, Information Technology and Productivity in Indian Manufacturing, *India Policy Forum* 2012-13, vol. 9, chapter 5, pp 189-231

Tables and Figures

Table 1: Summary Statistics (Average of three years 2003-05)

Variable	State Owned Enterprises (SOEs)		Private Enterprises (PEs)	
	Mean (Standard Deviation)	*No. of observations*	*Mean (Standard Deviation)*	*No. of observations*
Employment (no. of employees)	756.2 (2585.7)	37	320.2 (951.4)	461
Sales (Million Dollars)	7.75 (27.7)	34	8.1 (20.9)	455
Exports as % of sales (Million Dollars)	20.9 (29.7)	23	24.8 (32)	321
Gross fixed assets (Million dollars)	4.5 (14.94)	30	2.8 (11.5)	402
R&D as % of sales	0.03 (0.06)	26	0.07 (1.13)	387
ICT expenditure as % of sales	0.05 (0.18)	34	0.07 (0.41)	461
PC and servers per worker (2005)	0.2 (0.2)	37	0.2 (0.3)	458
IT intensity index (2005)	19.65 (5.90)	37	19.392 (4.976)	467
Proportion of employees using PC's	33.5 (23.67)	37	34.65 (23.25)	468
Organizational change index	8 (5.77)	37	5.49 (5.56)	471
Average power (no. of days)	20.21 (27.15)	36	23.41 (46.38)	431

Note: The calculations for dollars is done at the rate of $1 =Rs60

Table 2: Determinants of ICT use

Variable	[1]	[2]	[3]	[4]
Log Gross Fixed Assets	0.574 (0.105)****		3.467 (0.495)****	
Log Employment		1.139 (0.150)****		5.280 (0.681)****
Change in Price sensitivity	0.004 (0.522)	0.217 (0.466)	0.178 (2.432)	1.385 (2.246)
Stock of PC's and servers as a proportion of no. of employees	2.741 (0.76)****	4.215 (0.727)****	13.79871 (3.545)****	20.249 (5.037)****
Average no. of Power cuts	0.001 (0.005)	0.003 (0.005)	-0.002 (0.024)	0.016 (0.028)
Ownership dummy	0.056 (0.884)	0.321 (0.797)	-0.465 (4.136)	-1.420 (3.865)
Multinational dummy	1.175 (1.036)	0.892 (0.876)	6.106 (4.844)	5.212 (4.892)
Alliance dummy	1.731 (0.84)*	1.118 (0.785)	7.764 (3.93)*	4.169 (3.552)
IT intensity index				
Observations	**377**	**453**	**379**	**453**
R-squared	**0.189**	**0.221**	**0.234**	**0.234**
Adjusted R-squared	**0.162**	**0.200**	**0.208**	**-**
F-statistic	**7.06**	**10.4**	**9.29**	**9.88**

NOTE: 1.The sector dummy's (dums1, 2, 3, 4, 5, 6) are not listed because they were found insignificant. Model 4 in this table is heteroscedasticity robust.

2. p-value < 0.05 = *, p-value < 0.01 = **, p-value < 0.001 = ***, p-value = 0.000 = **

Table 3: Determinants of ICT Related Organizational change

Variable	[1]	[2]	[3]	[4]
Log Gross Fixed Assets	0.084		0.122	
	(0.131)		(0.128)	
Log Employment		0.090		0.263
		(0.174)		(0.157)
Change in Price sensitivity	0.083	-0.179	0.140	-0.110
	(0.586)	(0.514)	(0.595)	(0.535)
Stock of PC's and servers as a % of no. of employees	1.059	1.059	1.312	1.640
	(0.709)	(0.749)	(0.72)	(0.702)*
Ownership dummy (SOE = 1)	2.946	2.793	2.981	3.00815
	(1.011)**	(0.897)***	(1.075)**	(0.923)***
Multinational dummy (MNC = 1)	0.367	0.307	0.398	0.344
	(1.356)	(1.051)	(1.409)	(1.091)
Foreign Alliance dummy (With alliance = 1)	0.775	0.736	0.834	0.823
	(1.066)	(0.969)	(1.078)	(0.969)
IT intensity index	0.302	0.318		
	(0.053)****	(0.053)****		
Index of Proportion of workers using PC's			0.047	0.046
			(0.014)***	(0.012)****
Observations	**406**	**493**	**408**	**493**
R-squared	**0.166**	**0.177**	**0.138**	**0.141**
F-statistic	**8.22**	**10.31**	**5.16**	**6.93**

NOTE: 1.The sector dummy's (dums1, 2, 3, 4, 5, 6) are not listed because they were found insignificant. All models in this table is heteroscedasticity robust.
2. p-value < 0.05 = *, p-value < 0.01 = **, p-value < 0.001 = ***, p-value = 0.000 = **

Table 4: Summary Statistics –ASI Data

	Mean (Overall)	Mean (PEs)	Mean (SOEs)	Difference (PEs-SOEs)
Skill Composition	.232	.228	.277	-.049***
	(0.001)	(0.001)	(0.003)	(.003)
Composition of Supervisory &Managerial Staff	0.105	0.105	0.109	-0.005**
	(0.001)	(0.001)	(0.002)	(0.001)
Composition of other Skilled Employees	0.139	0.136	0.174	-0.038***
	(0.001)	(0.001)	(0.003)	(0.001)
Log (Skilled Employment)	3.380	3.307	4.242	-0.935***
	(0.008)	(0.008)	(0.026)	(0.028)
Log (Supervisory & Managerial Staff)	2.290	2.226	3.070	-0.844***
	(0.008)	(2.226)	(0.028)	(0.030)
Log (Other Skilled Employees)	2.643	2.563	3.640	-1.077***
	(0.008)	(0.008)	(0.027)	(0.030)
Log (IT Capital)	13.961	13.956	14.017	-0.062***
	(0.014)	(0.014)	(0.050)	(0.050)
Log (Plant and Machinery)	17.813	17.755	18.394	-0.639***
	(0.014)	(0.015)	(0.046)	(0.049)
Log (Sales)	18.265	18.220	18.843	-0.623***
	(0.013)	(0.013)	(0.051)	(0.050)
Log (Working Capital)	16.060	15.957	17.405	-1.448***
	(0.013)	(0.014)	(0.046)	(0.051)

Standard errors in parentheses
$^{*}p< 0.10$, $^{**}p< 0.05$, $^{***}p< 0.01$

Table 5: Skill Composition, IT Capital and Ownership

Variable	(1) Skill Composition	(2) Composition of Supervisory &Managerial Staff	(3) Composition of Other Skilled Employees	(4) Skill Composition	(5) Composition of Supervisory &Managerial Staff	(6) Composition of Other Skilled Employees
Log(IT Capital)	0.007***	0.002	0.005***	0.007***	0.002	0.005***
	(0.002)	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)
Ownership (SOE=1)				-0.005	-0.004**	-0.001
				(0.004)	(0.002)	(0.004
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Plant Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Constant	0.571***	0.372***	0.318***	0.569***	0.371***	0.318***
	(0.072)	(0.059)	(0.065)	(0.072)	(0.059)	(0.065)
N	17655	18219	17754	17655	18219	17754
adj. R^2	0.027	0.014	0.026	0.027	0.014	0.026

Standard errors in parentheses, $^{*}p<0.10$, $^{**}p<0.05$, $^{***}p<0.01$

Table 6: Interaction Effects

Variable	(1) Skill Composition	(2) Composition of Supervisory & Managerial Staff	(3) Composition of Other Skilled Employees
Log (IT Capital)	0.006***	0.002	0.005***
	(0.002)	(0.001)	(0.001)
Ownership	-0.056*	-0.022	-0.025
	(0.033)	(0.017)	(0.028)
Log(IT-Capital)*Ownership	0.004	0.001	0.002
	(0.002)	(0.001)	(0.002)
Controls	Yes	Yes	Yes
Plant Fixed Effects	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes
Constant	0.569***	0.371***	0.318***
	(0.072)	(0.059)	(0.065)
N	17655	18219	17754
adj. R^2	0.027	0.014	0.026

Standard errors in parentheses, $^{*}p< 0.10$, $^{**}p< 0.05$, $^{***}p< 0.01$

Table 7: Employment Effects

Standard errors in parentheses, $^{*}p< 0.10$, $^{**}p< 0.05$, $^{***}p< 0.01$

Variable	(1) Log (Skilled Employm-ent)	(2) Log (Skilled Employme-nt)	(3) Log (Employ-ment of Supervisio-ry and Managerial Staff)	(4) Log (Employm-ent of Supervisor-y and Manageria-l Staff)	(5) Log(Other Skilled Employees)	(6) Log (Other Skilled Employees)	(7) Log (Production Workers)	(8) Log (Total Employment)
Log (IT Capital)	0.063***	0.063***	0.048***	0.048***	0.0710***	0.071***	0.029***	0.034***
	(0.010)	(0.010)	(0.013)	(0.013)	(0.013)	(0.013)	(0.010)	(0.010)
Ownership (SOE = 1)	0.033*	0.112	0.0131	0.0109	0.0523**	0.198	0.242**	0.159
	(0.0190)	(0.130)	(0.021)	(0.163)	(0.025)	(0.176)	(0.121)	(0.110)
Log (IT Capital)* Ownership		-0.006		0.0001		-0.010	-0.014*	-0.008
		(0.009)		(0.011)		(0.012)	(0.008)	(0.008)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Plant Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	-1.908***	-1.909***	-2.516***	-2.516***	-2.484***	-2.486***	-1.402***	-1.228***
	(0.443)	(0.443)	(0.629)	(0.629)	(0.450)	(0.450)	(0.487)	(0.442)
N	17654	17654	18216	18216	17749	17749	18282	18334
adj. R^2	0.089	0.089	0.052	0.051	0.045	0.045	0.134	0.183

Table 8: IT adoption

Variable	(1) Log (IT Capital)	(2) Log (IT Capital)	(3) Log (IT Capital)	(4) Log (IT Capital)	(5) Log (IT Capital)	(6) Log (IT Capital)	(7) Log (IT Capital)	(8) Log(IT Capital)
Skill Composition	0.242***		0.243***	0.245***				
	(0.064)		(0.064)	(0.065)				
Ownership		0.025	0.029	0.036	0.024	0.022	0.030	0.037
		(0.020)	(0.020)	(0.039)	(0.020)	(0.030)	(0.020)	(0.031)
Ownership*Skill Composition				-0.028				
				(0.115)				
Composition of Supervisory and Managerial Staff					0.123	0.122		
					(0.089)	(0.090)		
Ownership*Composition of Supervisory Staff						0.017		
						(0.206)		
Composition of Other Skilled Employees							0.272***	0.276***
							(0.075)	(0.076)
Ownership*Composition of Other Skilled Employees								-0.046
								(0.131)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Plant Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	6.120***	7.237***	6.130***	6.128***	6.767***	6.767***	6.706***	6.703***
	(0.807)	(0.851)	(0.807)	(0.808)	(0.873)	(0.873)	(0.857)	(0.858)
N	17655	18353	17655	17655	18219	18219	17754	17754
adj. R^2	0.198	0.188	0.198	0.198	0.190	0.190	0.196	0.196

Standard errors in parentheses, *p< 0.10, **p< 0.05, ***p< 0.01

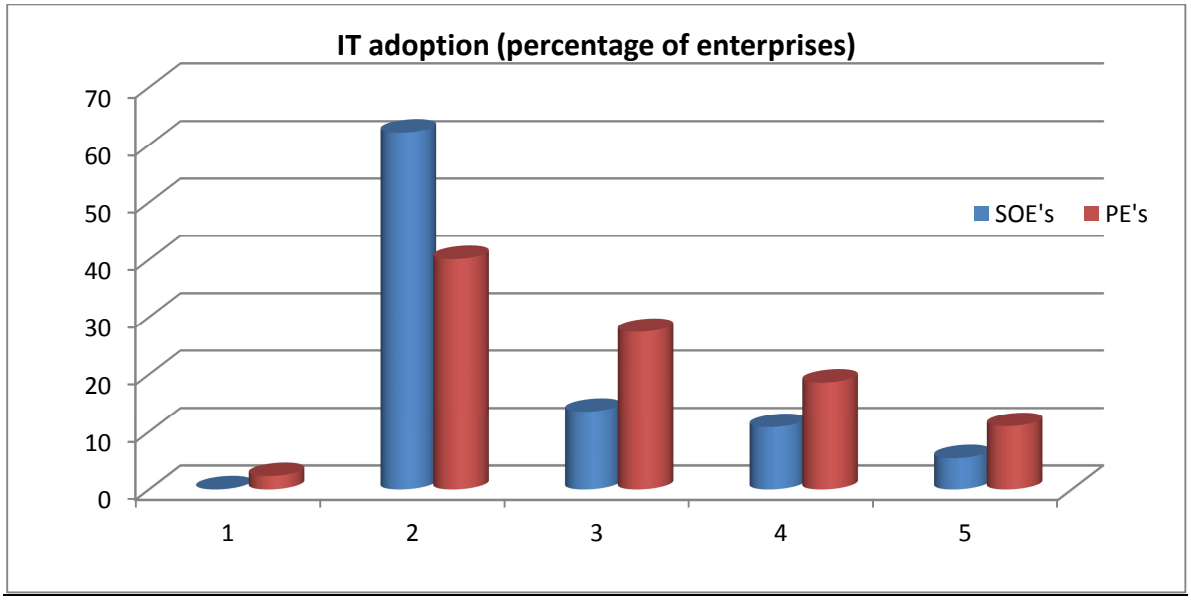


***Chart 1:* Intensity of IT Adoption (Per cent of enterprises)**

Note: 1- IT is not used at all; 2- IT is used only for some office applications along with accessing the internet, emailing etc.; 3-IT is used for some advanced applications. Most processes are automated & integrated into the central system; 4- Most processes are automated and some of them are integrated into the central system; 5- Almost all processes are automated and integrated into a central system.

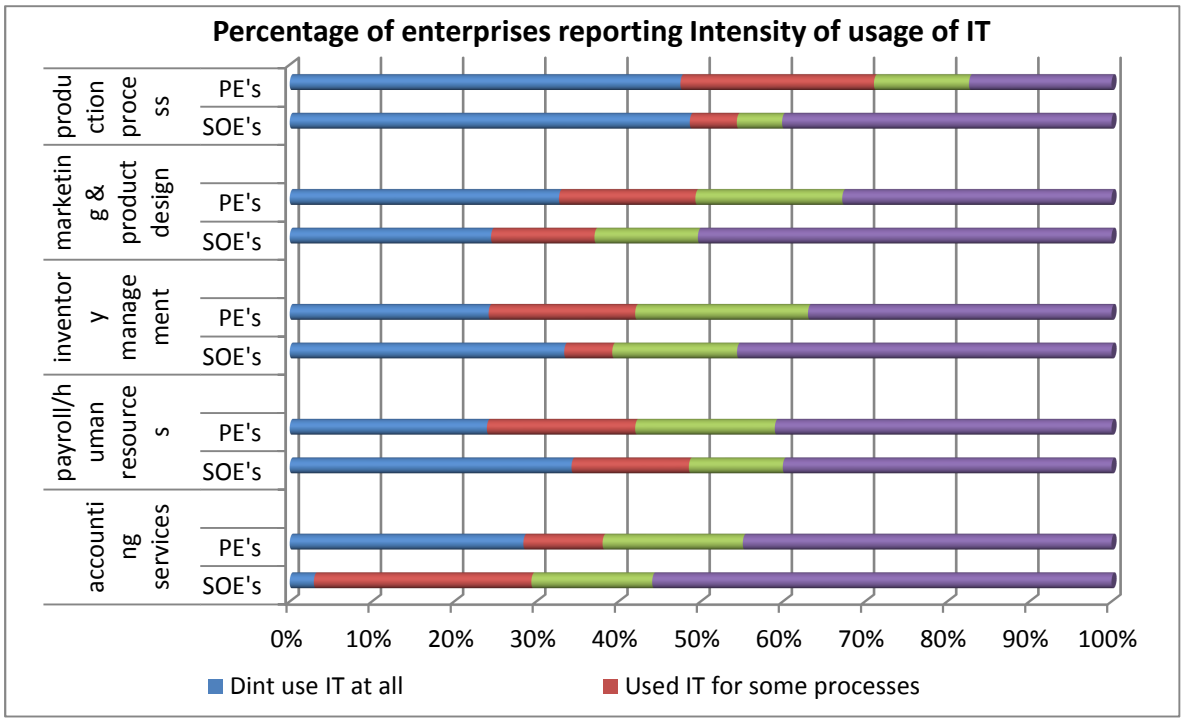


***Chart 2*: Intensity of IT Adoption in Different Functions (Per cent of Enterprises)**

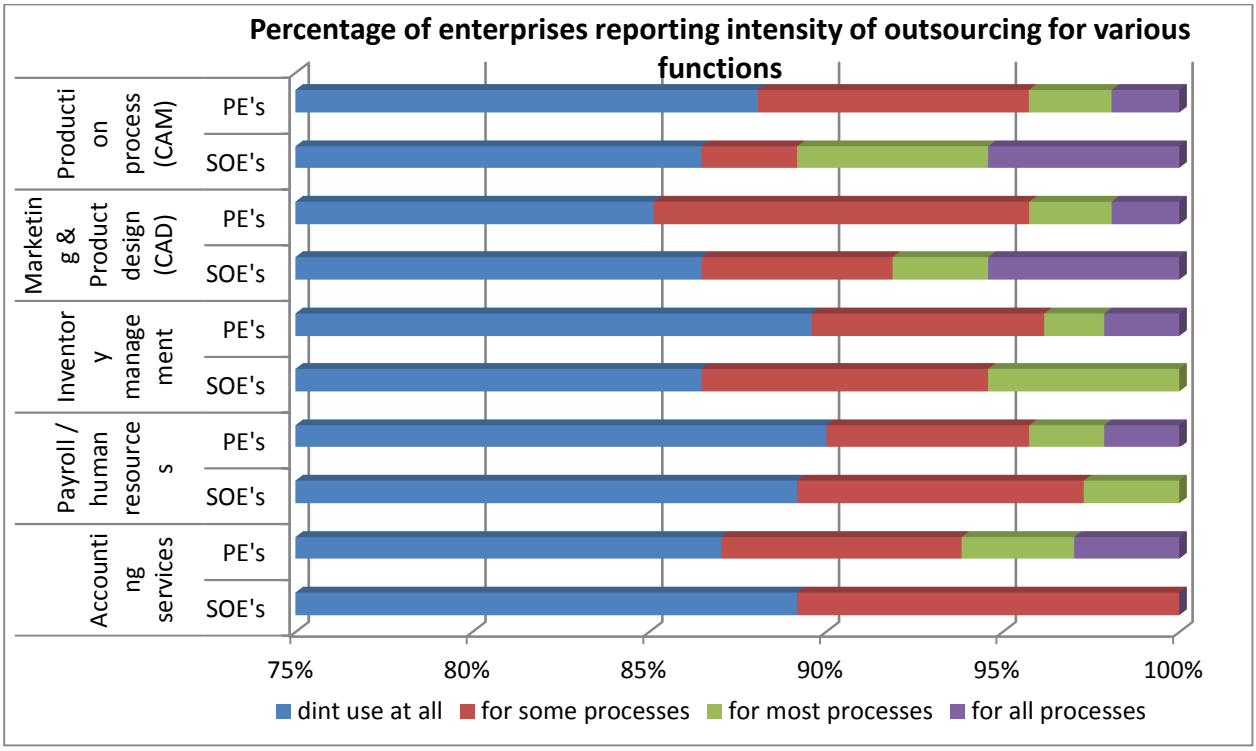
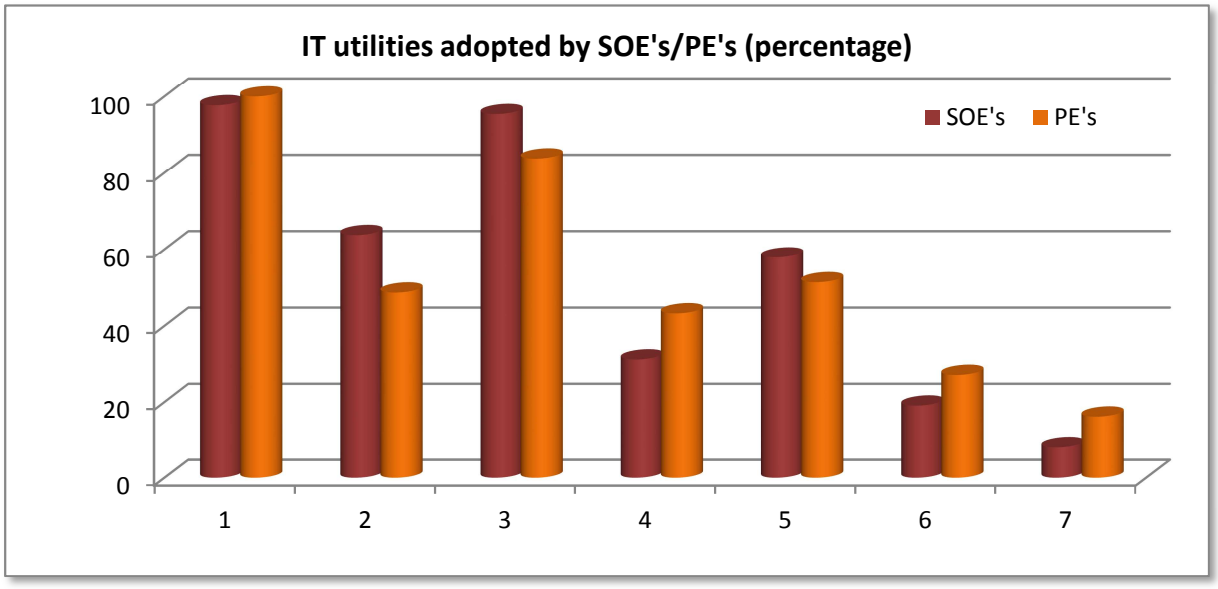
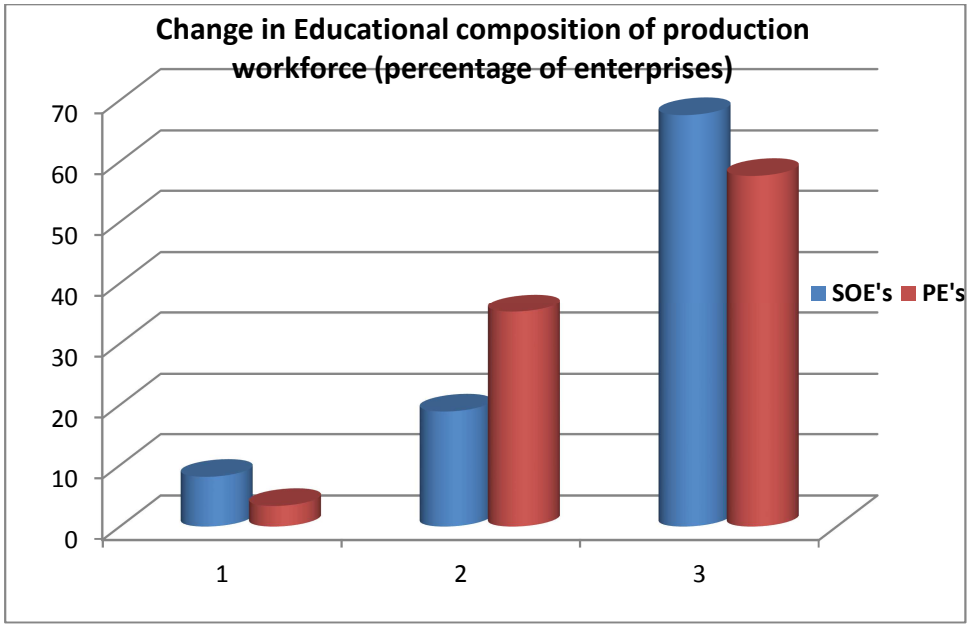


***Chart 3*: Intensity of IT Adoption for Different Functions through Outsourcing**



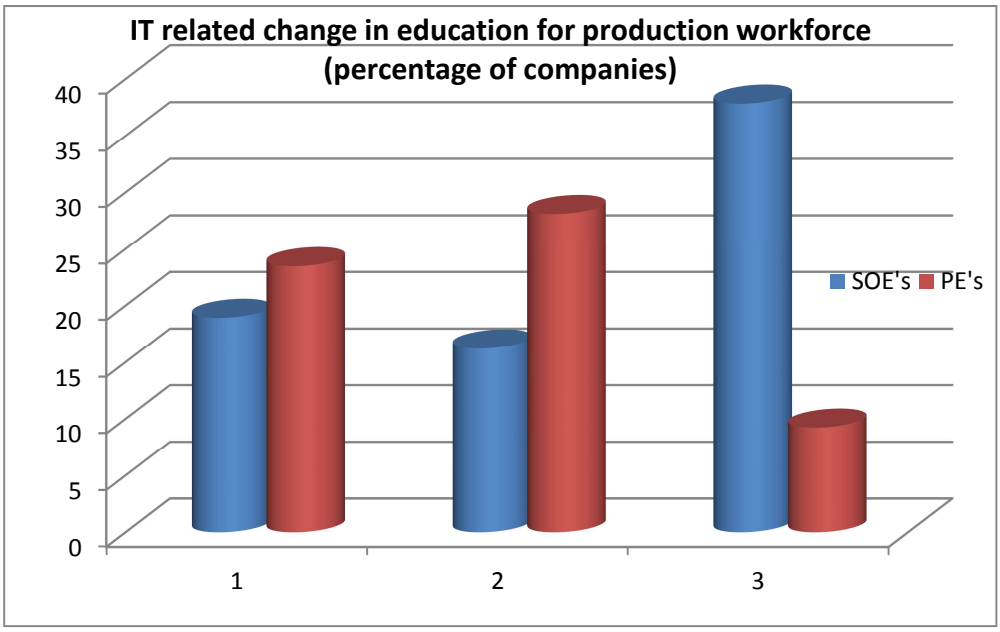
Note: 1-PC/work stations; 2-central processors/servers; 3-internet access; 4-intranet; 5-website (information on product and services); 6-website (allowing data transfers); 7- Website (allowing e-commerce).

***Chart 4*: Adoption of IT Utilities by Enterprises (Percentage)**



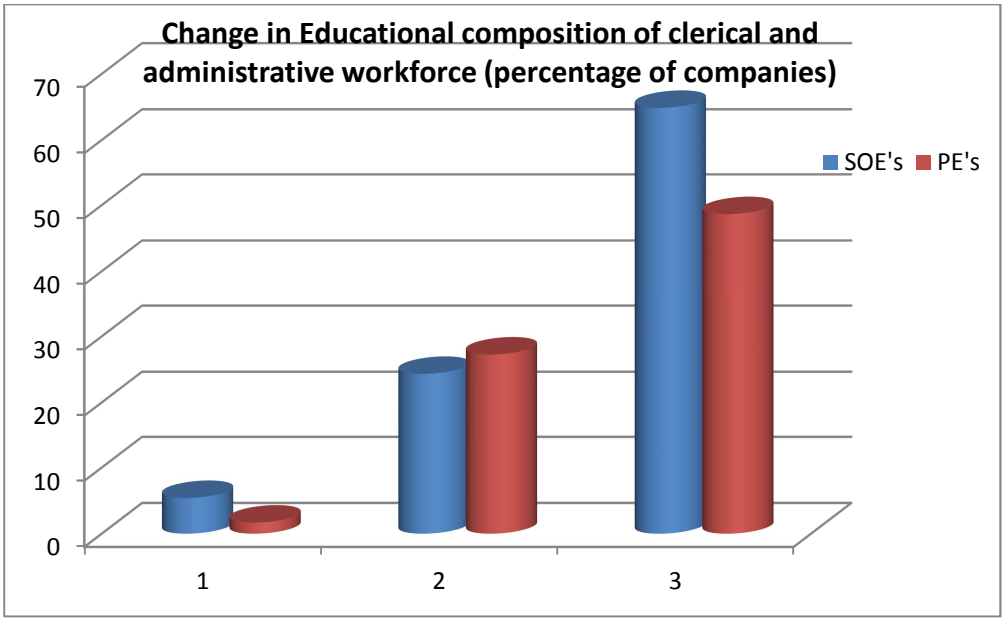
Note: Employment of 1-Less educated; 2- No change; 3- More educated

***Chart 5*: Percentage of Enterprises Reporting Change in Educational Composition of the Production Workforce**



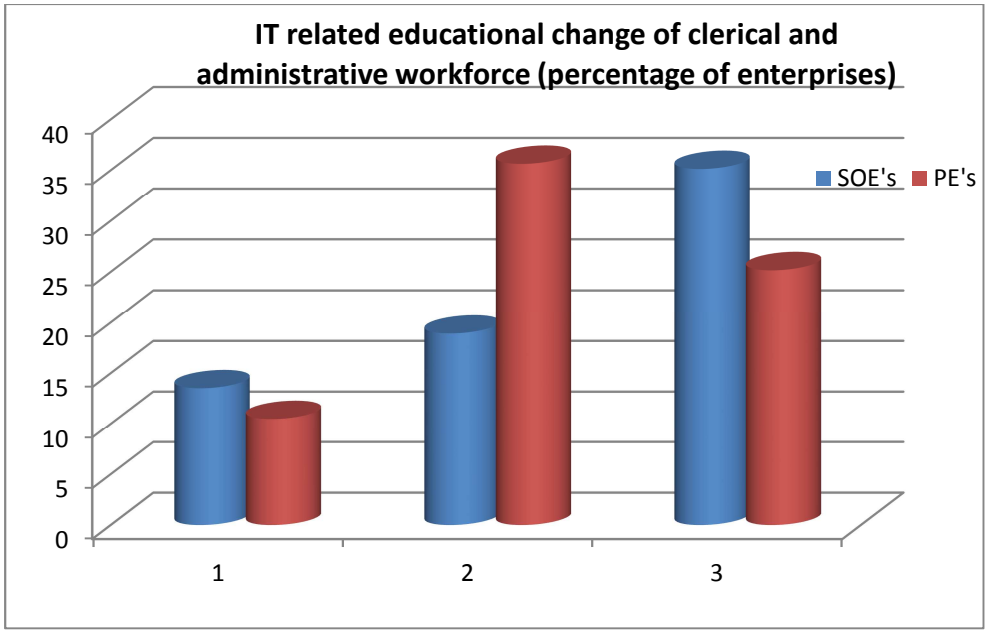
1-Not related to IT 2- Partly related to IT 3- Mostly related to IT

***Chart 6*: Percentage of Enterprises reporting that Change in Educational Composition of the Production Workforce was related to IT**



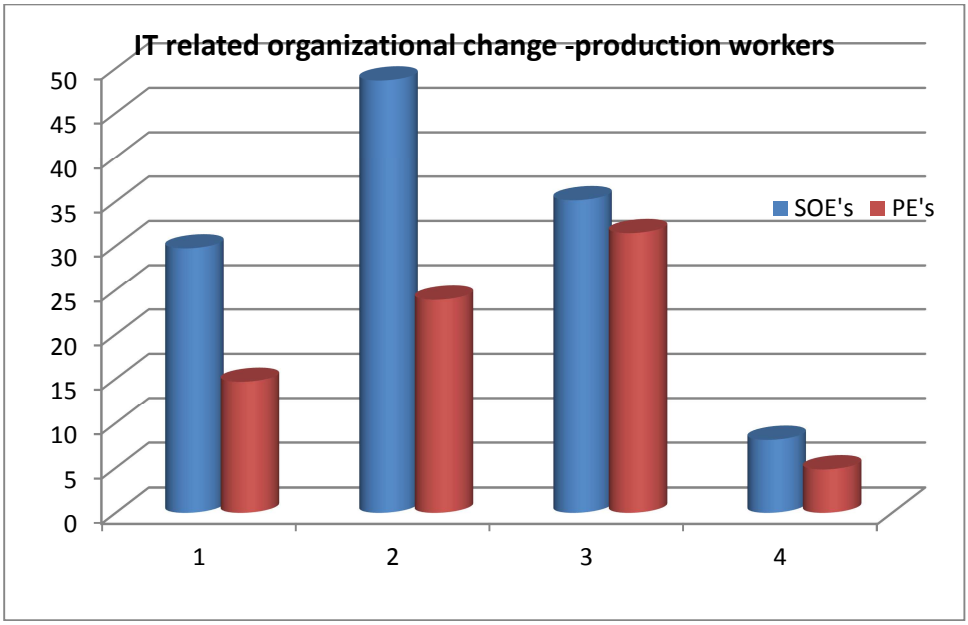
1-Less educated 2- No change 3- More educated

***Chart 7*: Percentage of Enterprises Reporting Change in Educational Composition of the Clerical and Administrative Workforce**



1-Not related to IT 2- Partly related to IT 3- Mostly related to IT

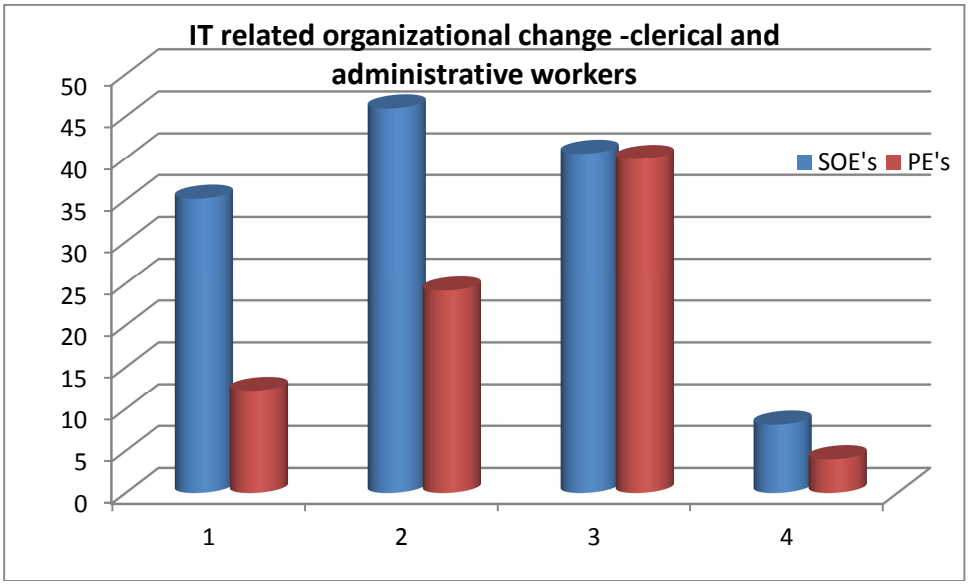
***Chart 8*: Percentage of Enterprises Reporting that Change in Educational Composition of the Clerical and Administrative Workforce was related to IT**



1 Removed a level of hierarchy, or reduced number of reporting levels

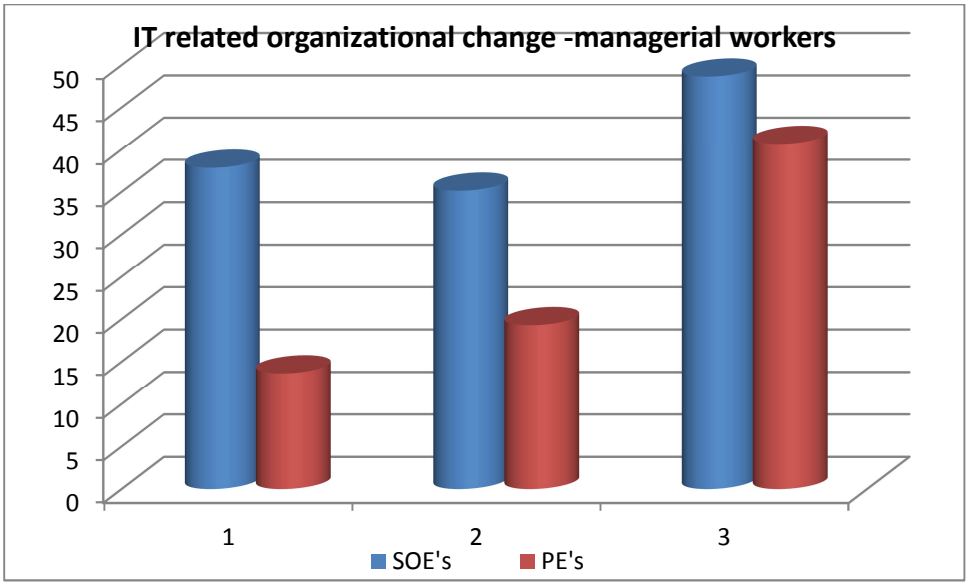
2-Improved monitoring of individual workers or groups of workers
3-Replacement of repetitive tasks by computerization
4-Part/whole outsourcing of activities previously performed inside the firm

***Chart 9*: Percentage of Enterprises reporting IT Related Organizational Change among Production Workers**



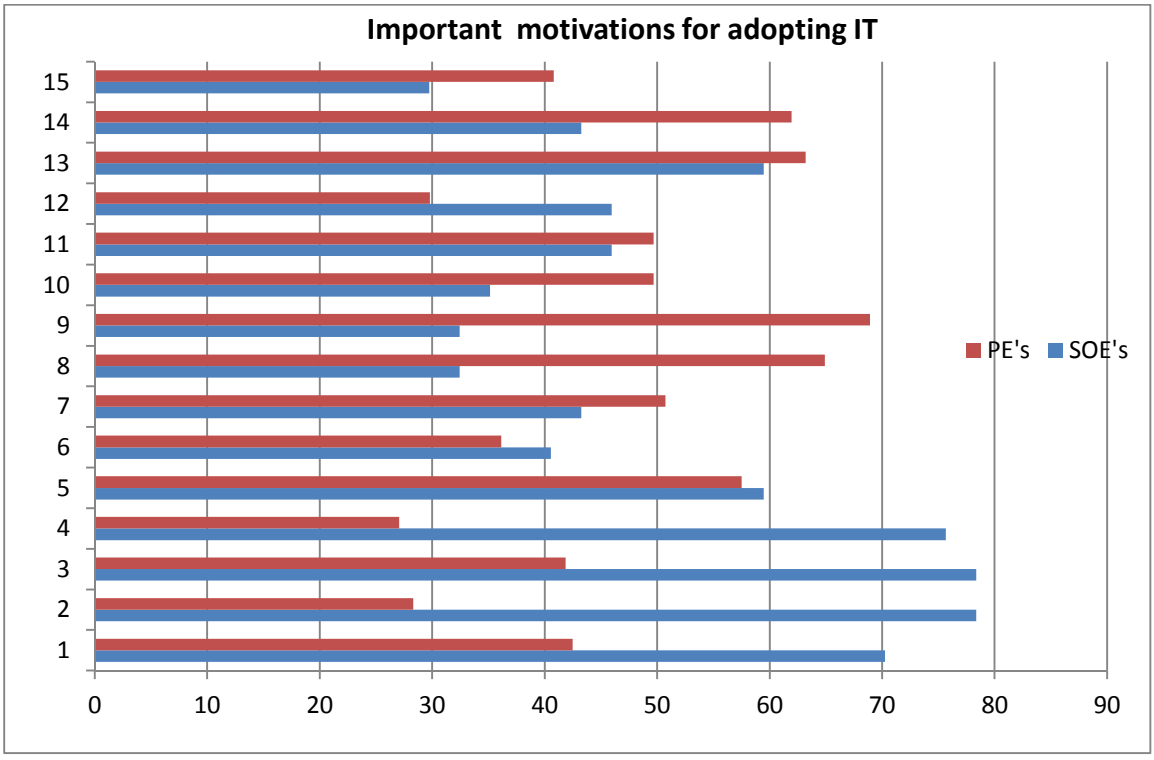
1 -Removed a level of hierarchy, or reduced number of reporting levels
2-Improved monitoring of individual workers or groups of workers
3-Replacement of repetitive tasks by computerization
4-Part/whole outsourcing of activities previously performed inside the firm

***Chart 10*: Percentage of Enterprises reporting IT Related Organizational Change among Clerical and Administrative Workers**



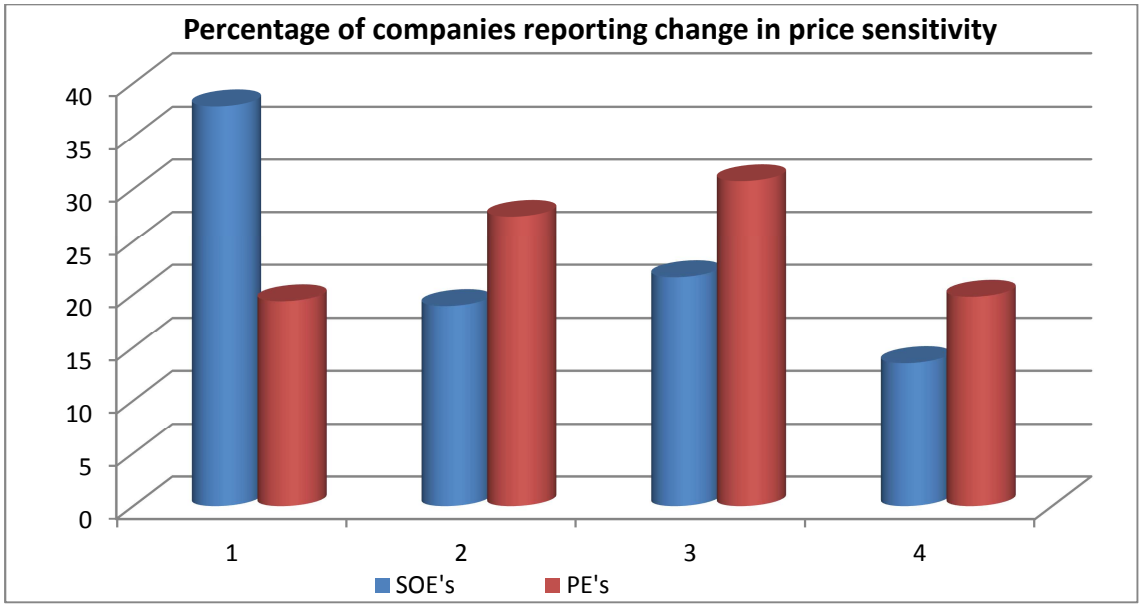
1. Removed a level of hierarchy, or reduced number of reporting levels
2-Improved monitoring of individual workers or groups of workers
3- Management decision making based on up-to-date information

***Chart 11**: Percentage of Enterprises reporting IT Related Organizational Change among Managerial Workers*



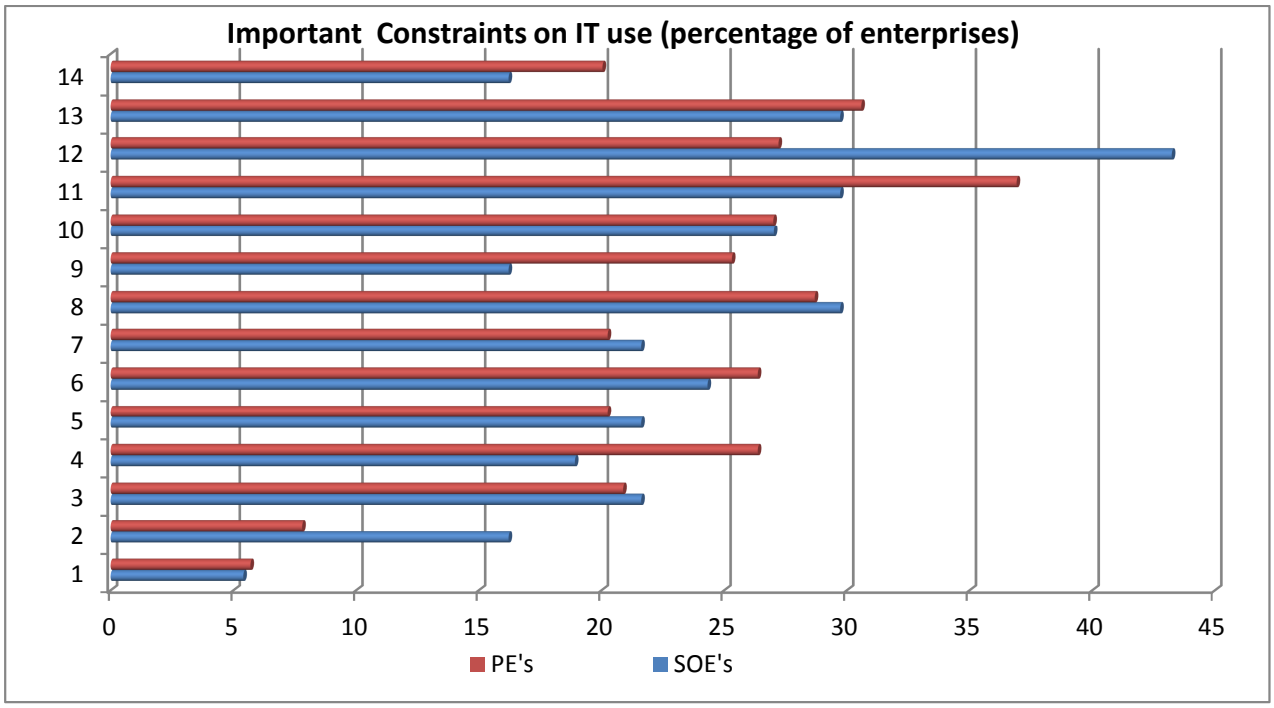
1-Competitors' use of IT, 2-Pressure from suppliers ,3-Pressure from customers , 4-Government support ,5-Increased range/quality of goods or services ,6-Reduced labor requirements ,7-Increased production flexibility ,8-Cost savings, 9-Access to new markets,10-To facilitate inter-firm interaction 11-Barriers for new entrants, 12-To enhance reputation, 13-Improved decision making, 14-Improved monitoring of employees, 15-Relationship with foreign partners.

***Chart 12**: Important Motivations for Adopting IT (Percentage of reporting enterprises)*



1-Our customers would continue to buy from us in the same quantities, 2-Our customers would continue to buy from us, but at slightly lower quantities, 3-Most customers would continue to buy from us, but at much lower quantities, 4-Many of our customers would buy from our competitors instead.

***Chart 13*: Change in Price Sensitivity of Customers (Percentage of Enterprises)**



1-Union related problems, 2-Inflexible labor laws and regulations, 3-Lack of production workers with relevant skills, 4-Lack of IT technicians with relevant skills, 5-Lack of clerical and administrative workers with relevant skills, 6-Lack of managers with relevant skills, 7-Cash flow / credit constraints, 8-Lack of integration between different departments in the firm, 9-Complexity and/or cost relating to multiple locations, 10-Inadequate local availability and/or high price of internet access, 11-High computer / IT prices, 12-The small number of customers and suppliers using the internet, 13-Lack of government support for IT, 14-Resistance to change among employees.

***Chart 14*: Important Constraints on IT Adoption (Percentage of reporting enterprises)**

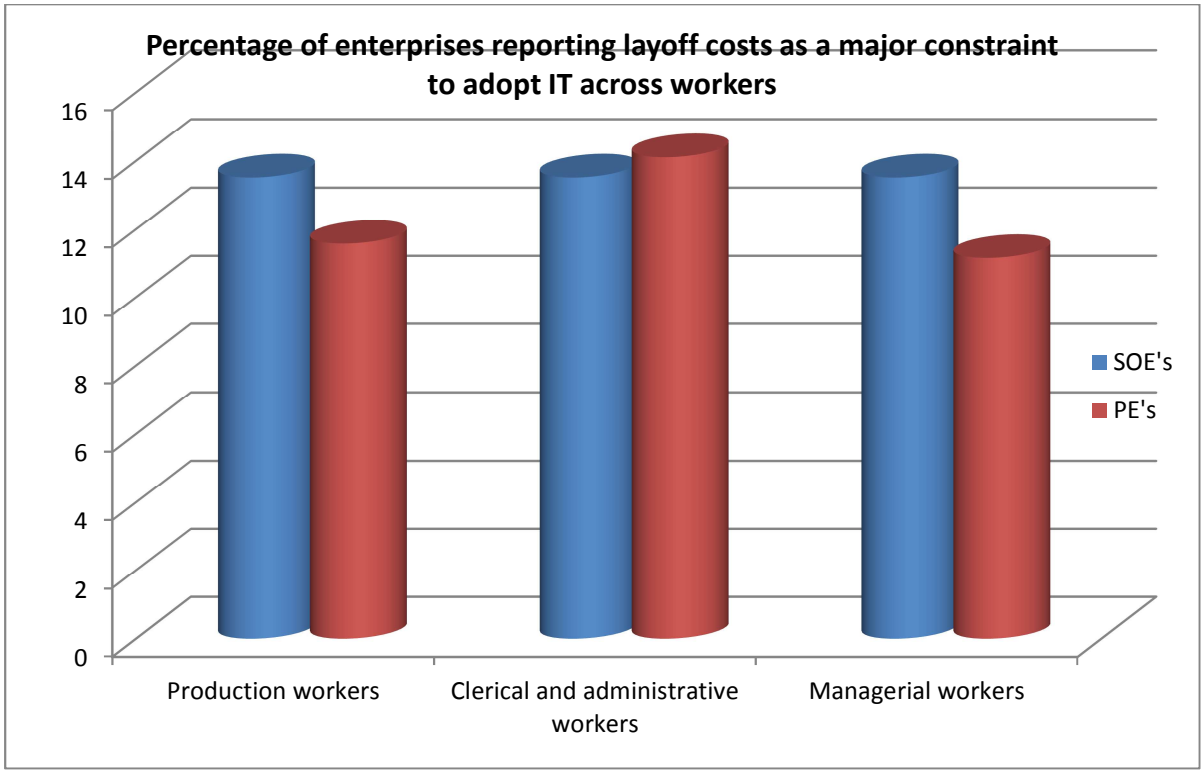


***Chart 15**: Layoffs Costs as a Constraint on IT Adoption*

Appendix 1: Sample distribution of firm-level survey by region/state and sector

	Electronic Components	Plastic Products	Soap & Detergents	Auto Parts	Machine Tools	Wearing Apparel	*Total*
Andhra Pradesh	8	10	1	4	4	0	*27*
Delhi	14	22	10	27	5	23	*101*
Gujarat	2	15	2	1	1	4	*25*
Haryana	0	0	0	6	0	0	*6*
Karnataka	12	4	1	8	10	3	*38*
Maharashtra	25	56	22	32	17	22	*174*
Tamil Nadu	10	8	2	18	9	7	*54*
Uttar Pradesh	3	1	1	5	0	0	*10*
West Bengal	4	10	8	9	6	4	*41*
Total	*78*	*126*	*47*	*110*	*52*	*63*	*476*

Appendix 2: Variable definition for survey data

***LOG GFA*:** The natural logarithm of simple average of *Gross fixed assets* (Rs) across 2001-02,02-03,03-04.

LOG Employment: The natural logarithm of simple average of*the number of employees* across 2001-02, 02-03, 03-04.

Price sensitivity: A dummy that takes a value 1 if the price sensitivity to the customers has increased over time. Otherwise, 0

Stock of PC's and Servers: the summation of the stock of PC's and servers used in the firm for the year 2005

Average number of power cuts: It is the simple average of number of power cuts in 2003 and 2001

State dummy: takes the value 1 if it is a state owned enterprise otherwise, 0

Multinational dummy: Takes a value 1 if it's a multinational company otherwise, 0

Alliance Dummy: Takes a value if there is foreign alliance of the firm otherwise, 0

IT intensity Index: Takes a value from 10 to 40. It is calculated from summing the responses ranging from 1 to 4 for intensity of using IT and Outsourcing in the functions such as accounting services, payroll, Inventory management, Marketing & Product design (CAD), Production process (CAM).

Index for proportion of workers using PC: An index calculated from taking a simple average of the proportion of production and non-production employees using PC's on a daily basis.

Organizational change index: Takes a value from 0 to 30. It is calculated from aggregating the responses to IT related organizational changes such as Removed a level of hierarchy, or reduced number of reporting levels, Improved monitoring of individual workers or groups of workers, Replacement of repetitive tasks by computerization, Part/whole outsourcing of activities previously performed inside the firm across three categories of workers – production, clerical and administrative and managerial workers.