

# The impact of technological change



## **1. Introduction**

The impact of technological change on employment has become a centre of attention all over the world since the origins of economic thoughts. The technological innovations include progresses in information and communication technology, industrial robots, and manufacturing systems (Mark 1987). These innovations are being diffused throughout the world. The modern technology incorporates powerful microelectronic devices that increase productivity in the office and factory at lower cost. However there are conflicting opinions regarding the effects of changing technology on employment.

Some scholars defend that innovation displaces jobs that require massive physical power, accuracy or repetition. They argue that information technology will soon also include many administrative functions thus replacing workers. They also advocate that technological changes accelerate production, increases demand and demand for skilled labour and affects workers as labour savings is being diffused widely. Experts argue that innovations represent a change, and that policies and techniques to secure jobs will be essential. Therefore technological innovations affect negatively the welfare condition of jobs creation for its citizens (Bartel 1989).

In contrast other analysts defend that technological changes are good for the entire society. And they argue that technical innovation are evolutionary processes and creates more jobs than eliminates. However interests about changing technology increased over the period of high unemployment rates. The microeconomics empirical results suggest a positive relationship

between technological change and employment at the firm level. (Piva & Vivarelli 2003).

Evaluating the impact of technology changes is very complex, because it interacts with and is affected by variations in output, consumption, international competition, and other factors. The main purpose of the paper is evaluating the impact of changing technology on employment including: theoretical and empirical reviews, the relationship between technological change employment, technology and employment in South Africa, the complementarities between education and technical change, and lastly conclusions and recommendations

## **2. Theoretical and empirical reviews**

The debate about the effects of innovations on employment has been motivating scholars to try unfolding the empirical and theoretical points of view and different results were found:

Studies by (Katz, & Krueger, 1999; Bartel & Lichtenberg, 1987; Bartel & Sicherman, 1998; Goldin & Katz, 1998), found that the effect of technology change depend on whether technology change and employment are complements or substitutes. Thus when they are complements, progresses in technology increase the absolute and relative demand for skilled and educated and hence increase in human capital investment. In contrast, when technology progress and employment are substitute, the demand for labour decreases thus automation takes place.

Another studies by Bartel 1989 & Sicherman 1999, Lillard & Tan 1986, Mincer 1989, and Tan 1989, found that firms and workers invest more in

training and education under high rates of technological innovations, so as to match the requirements of the innovation. However other studies depict that high level of education have a comparative advantage in adopting and implementing new technologies. (Bartel & Lichtenberg, 1987; Nelson & Phelps, 1966)

Zimmermann 1991, using cross sectional data found that the fall in employment during the 1980s was caused by progresses in technology. And Peters 2004 found that product innovation has a significant positive on employment and negative impact for process innovation.

The innovation within firms or industries varies according to strategies: the typology (product and process innovation), sources (Internal or external), input (R&D, design etc) target (reduce costs, enlarge markets), and barriers to overcome (financial, risk and uncertainty) (Lachenmaier & Rottmann 2006).

### **Indicators of technological change:**

Typically the indicators of technological changes are patents, R&D, and investment also used as proxy for technological activities, and a variety of innovative activities may take place within firms. The technology indicators based on innovations surveys give a wide range of information on characteristics, objectives, nature quality and economic impact of the innovation (Archibugi & Pianta, 1996, Lundvall, 1992).

There is distinction between product innovation and process innovations. Process innovation is introduces through new investment while product innovation is based on internal innovative activities. Thus, the two are

complementary and depending on the sector it may be difficult to separate the two.

### **3. The relationship between technological change employment**

There are various factors that act together to influence how changes in technology affect employment:

- The rate at which the innovation is absorbed
- The size and rate of growth of the market for new products
- The size of reduction/increase in labour requirements

The magnitude of reduction in output prices as a result of production increases

The change in wage rate due to technological changes

The above factors exert an offsetting influence on the labour demand within the sector.

Traditionally, innovations are seen as a mere instrument to increase speed and strength in the plants. And that machine still requires man's supervision. Any job displacement by technology would be anticipated by an increase in education. Thus being able to design or supervise new machines and programs. Therefore manufacturing firm owners were interested in hiring and having new skilled workers and they were willing to support the workers' training as well as technology education (Bartel 1989).

The net impact of technological change on employment depends on the supply and the demand for labour. On the supply side, the new technologies increase productivity and, subsequently, the production capacity and

production cost. On the demand side it increases the attractiveness of the product due to its new features. In addition, new products may be developed attracting consumers to spend on them. Due to Technological innovations the production processes may become efficient thus, increasing the value of the product (Vivarelli 1995; Vivarelli & Pianta 2000).

Compensation mechanisms arbitrate the impact of innovations on employment. Conversely, technical innovations tend to improve employment, but it depends on the degree of replacement of exiting products in the market. Therefore new technology differs in accordance with the propensity to generate employment. E. g., the introduction of automobile had increased the demand of labour as compared to the diffusion of the personal computers (Vivarelli 1995; Vivarelli & Pianta 2000).

### **At Firm level**

Many manufacturing firms have adopted new technologies in the recent decades. The technologies include: computer aided manufacturing (CAM), computer aided design (CAD), computer numerical control (CNC) and others. The implementation of the new technologies, can dramatically affect the working environment since they may result in a restructuring of the organization. E. g., downsizing, retraining of the workforce and changes in responsibilities due to integration across the business functional areas such as manufacturing, marketing, logistics, accounting and finance (Siegel 2003). However experts are getting sceptical of the traditional displacements that result from technological changes.

Studies done at firm level depicts that product innovation has a positive direct influence on employment. Innovative firms tend to increase demand for labour than the non innovative ones, regardless of the area of activity or size of the firm (Mastrostefano & Pianta 2005).

Piva and Vivarelli 2003, in a micro econometric study made using panel data of Italian firms found a positive and significant relationship between technological innovation and employment. A study on a more representative sample of sample of French firms found innovative firms have created more job opportunities than non innovative firms. In contrast a negative impact of technological change and employment was found in Dutch firms, however product innovation show positive effect on employment. However the results found at firm level can not be generalized to industry level thus a macroeconomic level study is required (Mastrostefano & Pianta 2005).

Evidences from the United States suggest that firms that adopted new advanced technologies have more secure jobs and better wages and tend to increase employment opportunities more rapidly than other firms. Thus advanced technology firms create high quality jobs and hire high skilled workers at better wages. There is a positive relationship between technological innovations and employment at firm level (Entorf & Pohlmeier 1990, Blanchflower, Millward & Oswald 1991, Van Reenen 1997; & Smolny 1998). However, the results are not extended to industry level.

### **At industry level**

Studies in industry level not only account for technological innovations within the sector but also accounts for both direct and indirect impact of

technological innovations within the industry. Studies on industries suggest that the impact of technological change on employment varies according to individual industries (Pasinetti 1981).

A study in Italian firms from 1989 to 1996 found a strong heterogeneity in production efficiency. However no systematic differences in growth rates across firms. Expansion high wages and lower product innovation contributed to job losses due to process innovation (Pianta, Evangelista & Perani 1996).

A study carried out by (Vivarelli, Evangelista and Pianta 1996) in Italian manufacturing industry found a negative effect between technological innovation and employment and a positive effect of product innovation and process innovation.

A study in 21 manufacturing industries in five European countries found a positive impact of product innovation on employment and an overall negative employment impact of technological innovation (Pianta 2001), same result was found in by Evangelista & Savona 2003) on service industry in Italy based on the same data. Therefore, technological innovation has a net positive impact on employment in the manufacturing and service industry. Industry level studies of impact of innovation are more appropriate and viable because the innovation survey at this level provides adequate empirical evidence on its nature and impact (Mastrostefano & Pianta 2005). In the service sector, technology led to the creation of new jobs and shift from demand for tangible good to intangible goods and knowledge.



Information and communication technology lead to a positive impact on employment (Evangelista & Savona 1998; Evangelista & Perani 1998).

The positive correlation between innovation and employment is associated with overall labour cut at sectoral level. Furthermore, while in one side the technology increase employments and market share in other side firms are forced to downsize or leave the market. Consequently, microeconomic studies suggest that innovation is good for some innovative firms and its employment, but say little about overall relationship between employment and a specified technology (Entorf and Pohlmeier 1990; Blanchflower, Millward and Oswald 1991; Van Reenen 1997; and Smolny 1998). At sectoral level, the evidences also suggest a positive relationship between employment and technological innovations but, not strong as at the firm level.

#### **4. Technology and Employment in South Africa**

The South African economy depicts major change in the in composition of the labour with the increase in employment growth unable to reduce unemployment (Jenkins 2008). South Africa, the impact of technological change on employment depends on the nature of the technology. However evidence suggests that technology is skill biased. Hicks- neutral, technological changes affects negatively the demand for skilled and unskilled labour per unit of output. In contrast trade induced technology change, affects the relative demand for skilled and unskilled labour (Wood 1994). Technology transfer from developed to developing countries can cause wage inequalities in developing countries, because technology transfer increases the demand for skilled labour (Pissarides, 1997).

The pace and speed of technological seems to be increasing as a many industries tend to reduce costs and compete effectively in the market. However, conventionally technology changes including, larger capacity equipments, computers, and faster machines has often impacted in productivity and employment. In general technological change increased the level of employment and reduced the displacement rate in strong economies. In contrast decline in employment were found in developing countries.

### **5. The complementarities between education and technical change**

Empirical studied suggest countries that reduce the gap between education and technology experience sustainable economic growth. The reason being the complementarities between technology and skills, thus, technological innovations impact positively on the demand for skilled workers and negatively on unskilled workers; the availability of skilled workers incentives firms to invest in new technologies and skilled workers are required to produce significant adaptation and to start up new technologies. In addition, often the diffusion of the existing or new technology requires a minimum education level. As a result countries with low level of education remain stagnated and limiting adoption of new technologies and weakening growth and demand for education, in contrast countries with high level of education demand high skilled workers and the demand for education is also high (Perry 2003).

### **6. Conclusions**

Several conclusions emerged from the impact of technology change on employment according to different levels of analysis and the speed of

change in technology within the firm or industries. However many studies suggest that technology change displaces few workers when introduced but is likely to involve employee transfer. Professional and technical occupation increases while lower operatives and skilled jobs decline. In short run, technology change, impacts negatively on employment due to changes in consumer preferences. On the other hand, technological innovations are expected to impact positively on employment in the long run. Such technological advances include advances in materials applicable in manufacturing, electronics, construction, communication etc).

Most microeconomic studies found a positive relationship between Technology changes and employment while others fears the generalization of the micro studies, because at this level it is important to differentiate product and process innovation and the results are not robust.

At industry level studies suggest different results within and between sectors. The distinction between product innovation and process innovation are also relevant for the results.