EMPLOYMENT IMPACT OF PRODUCT AND PROCESS INNOVATIONS IN TURKEY

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ÖZET

Teknolojik gelişmenin sürdürülebilir ekonomik büyümeyi belirleyen anahtarlardan biri olduğu anlayışı, yeniliğin istihdam üzerindeki etkilerinin firma, endüstri ve ülke düzeyinde belirlenmesine yoğunlaşan geniş bir ampirik literatürün oluşmasını sağlamıştır. Bu çalışmanın amacı klasik " Teknoloji istihdamı arttırır mı yoksa azaltır mı?" sorusuna cevap bulmak ve ürün ve süreç yeniliğinin istihdamın yaratılması üzerindeki olası farklı etkilerini Türk imalat sanayiinde 1995-1997 ve 1998-2000 yılları arasında incelemektir. Yapılan incelemeler, ürün ve süreç yeniliği yapan ve özelikle düşük teknoloji seviyesindeki firmaların istihdam büyüme hızlarının pozitif olduğunu vurgulamaktadır.

ABSTRACT

The intuition that technological progress was a key determinant of sustained economic growth provided the impetus of a large body of empirical literature that focused on understanding the employment consequences of innovation within and between firms, industries and countries. The aim of this study is to find an answer to classical question "Does technology creates or destroys jobs?" and evaluate the potential differences in the impact of product and process innovations in terms of employment generation in Turkish manufacturing industries over the periods 1995-1997 and 1998-2000. Our analysis states that the employment growth rates of both product and process innovators are positive especially in low technology industries.

INTRODUCTION

Innovation is one of the main factors underlying a country's international competitiveness, economic growth rate and performance. Neoclassical economics has long ignored the role of innovation in economic change but since mid 1980s, the new growth theory has started to perceive innovation as an engine of growth. The intuition that technological progress was a key determinant of sustained economic growth provided the impetus of a large body of empirical literature that focused on understanding the processes, determinants and outcomes of innovation within and between firms, industries and countries.

The application of inventions and design of new products and processes by firms is seen crucial to the survival and success of firms as it alters the production costs, market competitiveness and hence economic performance of innovative firms. The employment consequence of such technological activity is often regarded as having mixed outcomes: improvements in product design mainly affecting the demand for product will have a positive effect on the market share of the firm that innovates and thus on its employment. However, the adoption of new process technology mainly affecting the cost structure and hence the supply of product is frequently labor saving due to the increase in the productivity of labor generating a reduction in labor demand. These two divergent outcomes have led economist and policy makers to debate the economic and social consequences of technological change on labor market.

In the literature, the answer to classical question "*Does technology creates or destroys jobs*?" is evaluated with potential differences in the impact of product and process innovations in terms of economic performance. The relationship between innovation and employment is a complex one and the empirical studies try to find an answer to the above question by involving new questions to be answered like "what type of innovation are we considering?", "what type of jobs are created or destroyed by innovation?" and "what are the structural, demand and institutional factors which determine the employment effect of innovation?"

The aim of this study is to analyze the effect of product and process innovations on employment in Turkish manufacturing firms over the periods 1995-1997 and 1998-2000. We hypothesize that these two types of innovations have different impacts on employment and evaluate these impacts by analyzing the employment structure of innovative firms descriptively. The study is organized as follows. The next section provides a brief discussion on the theoretical framework regarding the employment effect of technological change and also demonstrates the empirical evidence so far. The third section presents an overview of different types of innovations having different outcomes in terms of employment growth in Turkish manufacturing industries regarding low, medium and high technology orientation separately. The last section summarizes and discusses the findings of this study.

INNOVATION AND EMPLOYMENT GROWTH: THEORETICAL FRAMEWORK

The full view of the employment impact of innovation has to come from a macroeconomic perspective that can consider all the indirect effects through which technological change affects employment. This is usually referred as debate on "*compensation mechanisms*" and a detailed analysis of this debate is in Vivarelli (1995) who evaluates the compensation mechanism theoretically and the way they operate in the economy. The compensation mechanisms via decrease in prices, via new machines, via new investment, via new products, via decrease in wages and via increase in incomes are basically based on the argument that new technologies may make lower prices possible, increasing international competitiveness and leading to new form of products and greater output, to the recovery of the job losses due to the original innovation, to extra profits available to the innovator and to the distribution of part of the gains from innovation leading to welfare effects (Vivarelli, 1995:29). These outcomes, however, are conditional on the lack of demand constraints, on the decision of firms to transfer in lower prices the productivity gains due to the innovation, on the lack of oligopolistic power in the relevant markets, on substitution effects and on the feasibility of any combination of labor and capital, competitive markets, flexibility of wages and labor markets (Pianta, 2003:10).

The abovementioned theory established that the relationship between technical change and employment is highly complex and involves direct labor saving effects, compensation forces and alternative forms of technical progress. While this perspective of macroeconomic analysis is the most comprehensive and satisfactory for explaining the overall impact of technological change on employment, the complexity of the construction of the model, the problems in specifying all relevant relationships and the lack of adequate data limit the feasibility of this perspective (Pianta, 2003:11). Alternative to this analysis is to study the effects of technological change and hence innovation (both product and process innovation) on employment at firm and sector level.

The empirical literature analyzing the impact of innovation on employment at firm and sector level mainly breaks into two main categories. The first one analyzes the impact of technological change on *quality* of employment, leading to a large literature on composition of skills and wage structures giving emphasis to skill biased technological change (Chennells and Van Reenen (1999), Sanders and Weel (2000), Addison and Teixeira (2001) and Brown and Campbell (2002) survey the empirical literature on skill biased technological change emphasizing how technological change has affected wage and employment structures and whether the expansion of international trade is another cause of increased wage differentials between skilled and unskilled workers that is associated with increased imports of manufacturing goods from less-advanced countries. Acemoğlu (2002) takes another point of view and explores the differences between technological advances of nineteenth century having replaced skilled workers and expanded tasks performed by unskilled and technological advances of twentieth century being skill biased) (Chennells and Van Reenen (1999), Sanders and Weel (2000), Addison and Teixeira (2001) and Brown and Campbell (2002) survey the empirical literature on skill biased technological change emphasizing how technological change has affected wage and employment structures and whether the expansion of international trade is another cause of increased wage differentials between skilled and unskilled workers that is associated with increased imports of manufacturing goods from less-advanced countries. Acemoğlu (2002) takes another point of view and explores the differences between technological advances of nineteenth century). The second category of empirical studies analyze the impact of innovations on *quantity* of employment change, leading to a large literature on the type of innovation (product or process innovations) giving emphasis to structural, demand and institutional factors affecting creation or destruction of jobs.

The studies analyzing the impact on *quality* of employment, report empirical evidence on different country studies comparing the relative composition between skilled and unskilled workers and their wage differences. The issue has generally been

investigated using a factor substitution framework, showing that direct and indirect measures of technology like R&D intensity, computer usage and different types of innovation are important in explaining the relative increase in skilled labor (Pianta, 2003:13). The dominant finding of this empirical literature on skill bias in industries and firms is that the diffusion of technologies has a strong skill bias effect, while it has a less evident effect on wages.

The firm level studies analyzing the relation between technological change and the change in the decomposition of skilled and unskilled workers using labor demand framework by estimating employment share equations are Bauer and Bender (2004) for Germany covering the periods 1993-1995, Haskel and Heden (1999) for UK covering the periods 1972-1992 using computerization as an indirect measure of technological change, Maurin and Thesmar (2004) for French manufacturing firms over the 1984-1995 period and Falk and Seim (2001) for West German service sector firms over the period 1994-1996. On the other hand, firm level studies like, Baldwin and Rafiquzzaman (1999) for Canada over the period 1973-1993, Berman *et al.* (1994) for US manufacturing firms over the period 1979-1989, Piva and Vivarelli (2003) for Italian firms over the period 1991-1997, Dunne *et al.* (1997) for US manufacturing for 1970s and 1980s and Gera *et al.* (2001) for Canadian manufacturing firms over the period 1981-1994 analyze the shift in demand for skilled workers utilizing a translog cost function for the share of skilled and unskilled workers in total wage bill emphasizing the within and between compositional changes in the wage structures.

There are also sector level studies comparing different countries in their changing structures in the composition of skilled and unskilled workers and their shares in total wage bill with giving emphasis to cross country similarities. These are Hollanders and Weel (2002) for six OECD countries from 1975 to 1995 estimating employment share equations for skilled and unskilled workers, Machin and Van Reenen (1998) for US and six other OECD countries from 1973 to 1989 estimating the share of skilled and unskilled workers share in total wage bill, Berman *et al.* (1998) for several countries including US and OECD countries for 1980s and Machin (2001) surveying the changing nature of labor demand giving emphasis to increasing demand for skilled workers, comparing UK and US.

The second category of empirical studies analyzes the impact of innovation on *quantity* of employment by estimating employment equations (total or as growth rate) or analyzing job creation and destruction rates. The evidence on the overall employment impact of innovation at the level of firm tends to be positive; firms which innovate grow faster and are more likely to expand their employment especially product innovators than non-innovative ones (Pianta, 2003:7). Moreover, the evidence on sector level states that in addition to technological change demand structures have also different impacts on employment.

Firm level studies analyzing the impact of technological change on job creation and destruction rates are Greenan and Guellec (2000) for French manufacturing firms between 1984 and 1991 and Klette and Forre (1998) for Norway over the period 1982-1992. These studies suggest that there is no clear-cut positive relationship between technological change and net job creation giving emphasis to differences in R&D intensities between different technology levels.

Another firm level studies analyzing the effects of technological change on employment growth are Blanchflower and Burgess (1998) for UK and Australia for 1990 and Peters (2004) for Germany in the period 1998-2000. The first one estimated three year employment growth rate using dummy variable for introducing new technology and found that the introduction of new technology is more likely to be associated with employment growth (Blanchflower and Burgess, 1998:130). Following a different methodology, the second one estimated employment growth rate by utilizing innovation output in terms of sales growth rate generated by new product and process innovations and found that product innovations have a positive impact on the employment growth rate (Peters, 2004:27).

Last form of firm level studies measuring the effect of technological change on total employment estimated reduced employment equations similar to labor demand formulation. Using this method, Van Reenen (1997) analyzed for UK manufacturing firms over the period 1979-1982 including measures of product and process innovation, R&D intensity, capital and lagged employment and found that technological innovation especially product innovations was associated with higher firm level employment (Van Reenen, 1997:269). In addition, Piva and Vivarelli (2004) for Italian manufacturing firms over the period 1992-1997 found a positive relationship between innovation and employment. Greenhalgh *et al.* (2001) for UK from 1987 to 1994 estimated a derived demand for total employment depending on targeted output and measures of technological activity like R&D intensity and found a positive impact of technology on firm-level employment.

The studies at the sector level evaluating the impact of innovation on *quantity* of employment analyze both direct employment effects of innovation within firms and indirect effects operating within the industry. These sector level studies evaluates first the competitive redistribution of output and jobs from low to high innovation intensive firms and second the evolution of demand and sectoral value added resulting from the lower prices due to innovation (Pianta, 2003:8). These studies state that the sources and opportunities for innovation and job creation are specific in different sectors determining the employment performance. The empirical evidence shows that the employment impact is positive in industries characterized by high demand growth and an orientation towards product innovation, while process innovation leads to job losses (Pianta, 2003:8). For sector level studies, demand factors are important because, an industry's demand is constrained by the composition and dynamics of domestic and foreign demand differently from that of individual firm.

One of the studies at the sector level analyzing the effects of technological change on employment is Antonucci and Pianta (2002) for eight European countries (including Italy, UK, France, Germany and The Netherlands) over the period 1994-1996. They estimated employment growth equations giving emphasis to demand conditions and the type of innovation and found that these countries rely on active price competitiveness and introduce process innovations having negative impact on employment that also depends on the evolution of demand (Antonucci and Pianta, 2002:303). Another study Pianta (2001) analyzed the relationship between technological change and employment growth for five European countries (Denmark, Italy, Germany, The Netherlands and Norway) in 1989-1993 with variables accounting for changes in demand, value added, innovation intensity and share of product innovations. He found that product innovations and also changes in demand have a positive impact on employment changes (Pianta, 2001:154).

The employment outcomes of technological change depends on the way job creation and destruction takes place, wages are set, learning, flexibility and welfare protection are managed and the way compensation mechanisms work. On the other hand, labor market institutions influence the supply of labor, which should match the skill and competence requirements emerging with new technologies (Pianta, 2003:18). The above literature leads to a stylized fact that different measures of technological change and hence different types of innovation have different effects on employment also differentiating with industry structure and demand factors. In other words, it is essential to compare the direct labor-saving effect of process innovations with product innovations having a labor-intensive impact.

The impact of technical change on employment can be analyzed by differentiating the product and process orientation of innovation (Edquist *et al.* (1998) review extensively the existing literature with the aim of developing framework for assessing the employment effect of different types of innovation.). Firms that innovate successfully gain an advantage over their competitors in terms of market share or in terms of profits. Whether this advantage results in more or fewer jobs depends upon the type of innovation. A product innovation mainly affecting the demand for product, will have a positive effect on the market share of the firm that innovates and thus on its employment when productivity is held constant (Greenan and Guellec, 2000:549). This positive effect of product innovations on employment level can be limited if there are high substitution effects with other goods provided by the same firm and if new products that become process innovations in a later embodiment (Edquist *et al.*, 1998:143). If the new product functionally replaces an old one, either increased or decreased employment may result depending on whether demand for this old replaced product changes.

The effect of process innovation, mainly influencing the cost structure and hence the supply of product, on employment can be analyzed at firm and sector level (Reati (1998) discussed the different employment effects of product and process innovations with emphasizing that the analysis of process innovations depend on two conflicting forces: (1) the productivity effect which reduces employment and (2) the compensation effect that is the increase in demand resulting from the increase in the price of the commodity involved which expands employment (Reati, 1998:110). The net effect of process innovations on employment depends on the level of price and income elasticities of demand.). At the firm level, on the one hand, the market share of the firm increases thanks to the reduction in price due to higher productivity. On the other hand, the productivity of labor increases generating a reduction in labor demand for a given production level (Greenan and Guellec: 2000:549). Thus, the immediate impact of process innovation depending on the rate of change, the direction of change and the elasticity of substitution between inputs will be labor-saving (Taymaz, 1996:194). At sector level, with the diffusion of new technology, the employment loss in less efficient plants will be partially compensated by growth of new technology using plants in turn depending on the price elasticity of demand, the degree of economies of scale, the monopoly power enjoyed by the

innovators and the extent of competition (Taymaz, 1996:194).

I will last mention two studies on Turkey focusing on the effects of innovations on employment in Turkish manufacturing industries. The first study Taymaz (1996), analyzed the impact of technological change but especially process innovations on employment for manufacturing industries at the sectoral level over the period 1985-1992. He first estimated the rate of technological change and later an employment growth equation using the rate of technological change and R&D intensity and found that technological change has a negative but weak impact on employment growth at sector level (Taymaz, 1996:206). The other study Taymaz (2001) analyzed the effect of product and process innovations on employment growth rate calculated for 1993-1997 period. He tried to determine the employment growth rate by using product and process innovations and found that product innovations have a positive impact on employment growth while process innovations have no significant impact (Taymaz, 2001:242).

INNOVATION AND EMPLOYMENT GROWTH: DESCRIPTIVE ANALYSIS

The vast of evidence indicate that there is a strong positive association between product innovation and employment growth whereas process innovations generally have a net negative effect on employment even though compensation effects exist. In what follows, we will explore the structure of employment growth and its relation with product and process innovations. The first survey that has the proper scope in line with *Oslo Manual* regarding the innovative activity in Turkish manufacturing industries was conducted by SIS at the end of the year 1998. This survey includes the data on innovative activities conducted between 1995-1997 periods. The second survey covering innovative activities was conducted for the period 1998-2000. These data sets are matched with the data set that covers all manufacturing firms employing more than 10 employees.

Three different employment growth rates for 1995-2000 taking into account different technology levels (We classified the manufacturing industries into three categories according to their technological level. These categories are low tech, medium tech and high tech industries. The industries in low tech, medium tech and high tech were defined according to OECD classification.) are calculated (Table 1). The first one is the employment growth rate calculated for three years forward. For example, the three year employment growth rate over the period 1995-1998 is 0.132 in low technology industries. The second one is the two year and the last is the one year employment growth rate, respectively. All of the employment growth rates calculated for medium and high technology industries are relatively higher than that of low technology industries when the employment growth rate is positive. Moreover, the employment growth rates started to decrease gradually becoming negative with the year 1997. This is due to the fact that Turkish manufacturing firms faced with an economic crisis in 1998. For example, one year employment growth rate over the years 1998-1999 was (-0.03) in low technology industries and this rate is relatively lower in medium and high technology industries (-0.06).

Table 1. Employment growth rates, 1995-2000
Source: State Institute of Statistics

	1995	1996	1997	1998	1999	2000
Low tech industries						
3-year employment growth rate	0.132	0.041	-0.005	-0.053		
2-year employment growth rate	0.119	0.069	-0.011	-0.016	-0.033	
1-year employment growth rate	0.066	0.053	0.021	-0.029	0.007	-0.036
Medium and high tech industries						
3-year employment growth rate	0.180	0.050	-0.017	-0.096		
2-year employment growth rate	0.157	0.104	-0.032	-0.032	-0.046	
1-year employment growth rate	0.090	0.085	0.021	-0.056	0.015	-0.065

Note: employment growth rates are calculated as mean of firm growth rates

Table 2. Employment growth rates by innovativeness, 1995-1997 and 1998-2000
Source: State Institute of Statistics

	1995-1997			1998-2000		
	non innovator	innovator		non innovator	innovator	
Low tech industries						
3-year employment growth rate	0.09	0.23	***	-0.09	0.07	***
2-year employment growth rate	0.09	0.19	***	-0.04	0.10	***
1-year employment growth rate	0.05	0.10	***	-0.04	0.04	***
Medium and high tech industries						
3-year employment growth rate	0.11	0.18	**	-0.15	-0.02	***
2-year employment growth rate	0.11	0.14		-0.05	-0.01	
1-year employment growth rate	0.07	0.08		-0.07	-0.04	*
Note: (*), (**) and (***) means the difference between innovators and non-innovators is statistically significant at 1 %, 5 % and 10 % levels						

Table 3. Employment growth rates by product innovativeness, 1995-1997 and 1998-2000
Source: State Institute of Statistics

	1995-1997			1998-2000		
	non innovator	innovator		non innovator	innovator	
Low tech industries						
3-year employment growth rate	0.09	0.34	***	-0.07	0.07	***
2-year employment growth rate	0.09	0.27	***	-0.02	0.12	***
1-year employment growth rate	0.05	0.15	***	-0.03	0.03	***
Medium and high tech industries						
3-year employment growth rate	0.13	0.16		-0.13	-0.02	***
2-year employment growth rate	0.12	0.13		-0.04	-0.01	
1-year employment growth rate	0.07	0.10	*	-0.07	-0.04	
Note: (*), (**) and (***) means the difference between innovators and non-innovators is statistically significant at 1 %, 5 % and 10 % levels						

After a recovery seen in 1999 for one year employment growth rate, manufacturing firms faced the other crisis year of 2000. Furthermore, the decrease in all of the employment growth rates was lower in low technology industries than that of medium and high technology industries. In other words, the employment growth rates in medium and high technology firms were affected from economic crisis severely than that of low technology firms and this is observed as a reduction in employment growth rates.

Table 2 demonstrates the average employment growth rates for innovators and non innovators over the period 1995-1997 and 1998-2000 for different technology levels. For low technology industries, the employment growth rates of innovators are significantly higher than that of non innovators. In medium and high technology industries, the employment growth rates of innovators are higher than that of non innovators. The only significant difference between the employment growth rates of innovators and non innovators in medium and high technology industries is attained for three year employment growth rate. The employment growth

rates for both low and medium and high technology firms for the period 1998-2000 are clearly lower than that for the period 1995-1997. Although, the employment growth rates for non-innovators become negative for both technology levels in this second period, innovators in low technology industries have positive employment growth rates. We can conclude that in low technology industries, being an innovator has a significant positive impact on the employment growth rates.

Table 3 demonstrates the average employment growth rates for product innovators and non innovators over the period 1995-1997 and 1998-2000 for different technology levels. For low technology industries, the employment growth rates of product innovators are significantly higher than that of non innovators. In medium and high technology industries, the employment growth rates of product innovators are also higher than that of non innovators. But in these industries, the only significant difference between the employment growth rates of innovators and non innovators is attained for one year employment growth rate in the first period and three year employment growth rate in the second period. Moreover, for the period 1998-2000, the employment growth rates for both low and medium and high technology firms are clearly lower than that for the period 1995-1997. That is to say, in low technology industries, being a product innovator has a significant positive impact on the employment growth rates.

The employment growth rates for process innovators are significantly higher than that of non innovators for both technology levels over the period (Table 4). Moreover, as indicated for product innovators, being a process innovator has a significant positive impact on the employment growth rates for low technology industries.

I further compare the average employment growth rates for product and process innovators over the period 1995-1997 and 1998-2000 for different technology levels. The employment growth rates for the period 1995-1997 are positive regardless of the type of innovations and technology level. The employment growth rates for product innovators in low technology industries are higher than that for process innovators over the period 1995-1997. Over the same period, three year employment growth rate for process innovators is positive and higher than that of product innovators in medium and high technology industries. On the other hand, one year employment growth rate in medium and high technology industries is slightly higher in product innovators.

Changing patterns in employment growth rates concerning the type of innovations and technology level is observed for the period 1998-2000. In low technology industries, except for the two year employment growth rate, the employment growth rates of process innovators are higher than that of product innovators and in addition these figures are positive contradictory to the literature. There may be compensation effects such as increased demand resulting from lower production costs or from rising incomes or consumption. In medium and high technology industries, it is interesting to observe that product innovators have negative employment growth rates. This can be due to the fact that this period covers the crisis year of Turkish economy and there may be demand structure factors such as the price elasticity of demand being less than one, leading to a decline in employment in product innovations. Besides, one year employment growth rate in process innovators is negative in medium and high technology industries for the period 1998-2000.

So far, we explored that both being product and process innovator have a positive impact on the employment growth rate especially for the period 1995-1997 regardless of technology level. The changing employment impact of product and process innovators are observed in medium and high technology industries. For the period 1998-2000, the employment growth rates for product innovators operating in these industries are negative and these rates are positive for process innovators. For a detailed analysis, the employment growth rates are differentiated into positive and negative for product and process innovators and demonstrated in Table 5.

In low technology industries, regardless of the employment growth rates being positive or negative, the share of process innovators is higher than that of product innovators. For the first period, the share of process innovators is higher than that of product innovators if the two and one year employment growth rates are negative for medium and high technology industries. Moreover, the share of product innovators is higher than that of process innovators if the same employment growth rates are positive.

However, for the consecutive period, regardless of the employment growth rates being positive or negative, the share of product innovators is higher than that of process innovators. If the employment growth rates are positive, the share of process innovators is higher and the opposite holds for product innovators over the period 1995-1997. In other words, in low technology industries, the share of process innovators is higher than that of product innovators regardless of the employment growth rate being positive or negative. In medium and high technology industries, the positive employment

growth rates are attained when the share of product innovators is high and the negative employment growth rates are realized when the share of process innovators is high.

Table 4. Employment growth rates by process innovativeness, 1995-1997 and 1998-2000
Source: State Institute of Statistics

	1995-1997			1998-2000		
	non innovator	innovator		non innovator	innovator	
Low tech industries						
3-year employment growth rate	0.11	0.20	***	-0.08	0.08	***
2-year employment growth rate	0.10	0.16	**	-0.03	0.10	***
1-year employment growth rate	0.05	0.09	*	-0.03	0.04	***
Medium and high tech industries						
3-year employment growth rate	0.13	0.18		-0.14	0.01	***
2-year employment growth rate	0.12	0.13		-0.05	0.01	*
1-year employment growth rate	0.07	0.09		-0.06	-0.05	
Note: (*), (**) and (***) means the difference between innovators and non-innovators is statistically significant at 1 %, 5 % and 10 % levels						

Table 5. Innovativeness by employment growth rates, 1995-1997 and 1998-2000
Source: State Institute of Statistics

	1995-1997		1998-2000	
	product	process	product	process
Low tech industries				
positive 3-year employment growth rate	0.14	0.16	0.17	0.24
Negative 3-year employment growth rate	0.07	0.13	0.11	0.15
positive 2-year employment growth rate	0.14	0.17	0.18	0.24
Negative 2-year employment growth rate	0.07	0.13	0.10	0.14
positive 1-year employment growth rate	0.14	0.18	0.17	0.25
Negative 1-year employment growth rate	0.09	0.13	0.11	0.15
Medium and high tech industries				
positive 3-year employment growth rate	0.32	0.34	0.37	0.33
Negative 3-year employment growth rate	0.20	0.20	0.31	0.25
positive 2-year employment growth rate	0.34	0.29	0.35	0.29
Negative 2-year employment growth rate	0.19	0.30	0.32	0.28
positive 1-year employment growth rate	0.35	0.34	0.35	0.28
Negative 1-year employment growth rate	0.22	0.27	0.33	0.27

Figure 1. Share of surviving firms by technology level, 1995-1999

Source: State Institute of Statistics

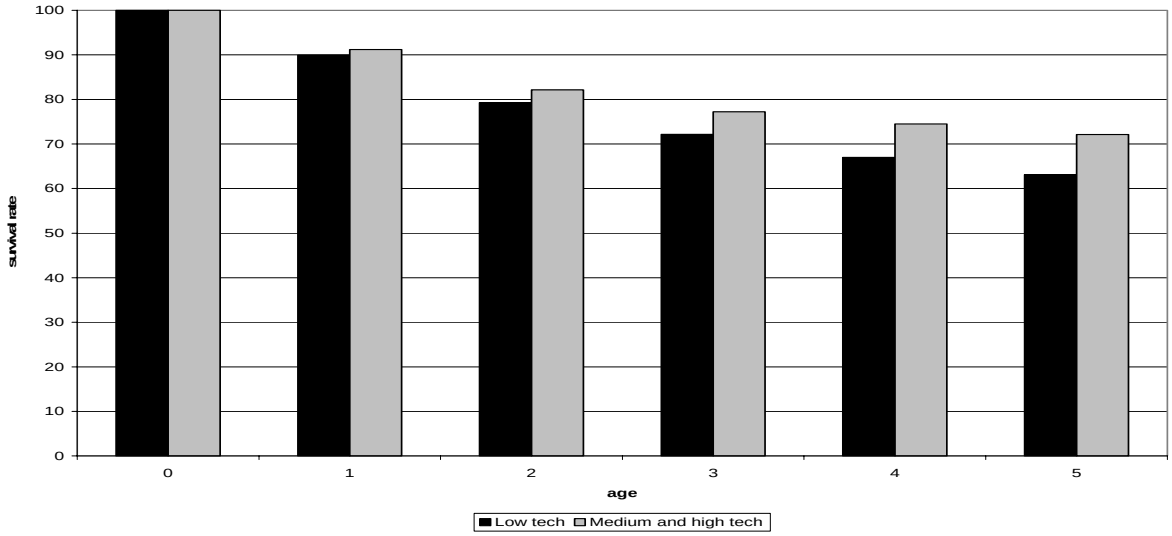

Table 6. Innovativeness by survival status, 1995-1997 and 1998-2000
Source: State Institute of Statistics

	1995-1997		1998-2000	
	product	process	product	process
Low tech industries				
Survivor	0.13	0.20	0.15	0.20
non-survivor	0.05	0.03		
Medium and high tech industries				
Survivor	0.32	0.28	0.33	0.28
non-survivor	0.19	0.29		
Note: We label a firm as survivor if it still exists in 2000 and as non-survivor otherwise				

The data analyzed indicates that the employment growth rates for product innovators are negative especially in medium and high technology industries for the period 1998-2000 which contradicts with the empirical findings in the literature. As one year employment growth rates displayed in Table 1 for years 1998 and 2000 are negative regardless of technology level, I further analyze the employment growth rates taking into consideration whether firm survives or not until the end of the period. This will help us to analyze the effect of crisis period on firms that may lead to possible exit behavior from the industry and contraction in economic performance evaluated here by employment growth rate.

A firm is labeled as survivor if it still exists in 2000 and as non-survivor otherwise. Figure 1 demonstrates the share of surviving firms in low and medium and high technology industries for different time durations. The first two columns display the share of surviving firms in different technology levels for the period 1999-2000. In other words, the share of surviving firms in total number of firms that were operating in 1999 was 90 % in low technology and 91 % in medium and high technology industries. The share of surviving firms that were also operating in 1995 was 63 % in low technology industries and this share is 72 % for medium and high technology industries. Moreover, the share of surviving firms in medium and high technology industries are higher than that of low technology industries even though for the crisis

year of 1998 (labeled as period 4). This can be due to the fact that operating in a higher level of technology provides firm a higher propensity to survive. The share of surviving firms that introduced innovations in 1997 was 87 % regardless of technology level.

The share of process and product innovators in survivor and non-survivor firms by technology level is demonstrated in Table 6. The share of process innovators in survivor firms is higher than that of product innovators in low technology industries. However, the share of product innovators in non-survivor firms is slightly higher than that of process innovators. In low technology industries survivor firms have a higher probability to be process innovators and non survivor firms have a higher probability to be product innovators. In medium and high technology industries, the share of product innovators is higher than that of process innovators for survivor firms. In contrast to survivor firms, the share of process innovators is higher than that of product innovators in non-survivor firms that is opposite to the case in low technology industries. This clarifies the different strategy of product and process innovators in search for technological competitiveness and price competitiveness in different technology levels.

Table 7 demonstrates the different employment growth rates for survivor and non-survivor firms in low and medium and high technology industries. The employment growth rates for survivor firms in low technology industries are higher than that of non-survivor firms. This outcome is an expected one because the firms may exit as they face with lower rates of employment growth. The employment growth rates for survivor firms in medium and high technology industries are also higher than that of non-survivor firms. The employment growth rates are higher in medium and high technology industries than that of low technology ones regardless of surviving status.

Table 7. Employment growth rates by survival status of firms, 1995-2000
Source: State Institute of Statistics

	1995	1996	1997	1998	1999	2000
Low tech survivor						
3-year employment growth rate	0.164	0.058	-0.009	-0.059		
2-year employment growth rate	0.147	0.095	-0.003	-0.025	-0.033	
1-year employment growth rate	0.086	0.069	0.030	-0.024	0.007	-0.041
Low tech non-survivor						
3-year employment growth rate	-0.026	-0.148				
2-year employment growth rate	0.030	-0.052	-0.176			
1-year employment growth rate	0.032	0.000	-0.061	-0.106		
Medium and high tech survivor						
3-year employment growth rate	0.227	0.063	-0.025	-0.096		
2-year employment growth rate	0.197	0.128	-0.027	-0.034	-0.046	
1-year employment growth rate	0.108	0.099	0.030	-0.042	0.015	-0.063
Medium and high tech non-survivor						
3-year employment growth rate	0.029	-0.154				
2-year employment growth rate	0.085	-0.037	-0.183			
1-year employment growth rate	0.059	0.021	-0.064	-0.130		
Note: We label a firm as survivor if it still exists in 2000 and as non-survivor otherwise						

Table 8. Employment growth rates for survivor firms by innovativeness, 1995-1997 and 1998-2000
Source: State Institute of Statistics

	1995-1997		1998-2000	
	product	process	product	process
Low tech industries				
3-year employment growth rate	0.075 ***	0.065 ***		
2-year employment growth rate	0.041 **	0.057 ***		
1-year employment growth rate	0.084 ***	0.044 *	-0.061	-0.026
Medium and high tech industries				
3-year employment growth rate	-0.061	-0.056		
2-year employment growth rate	-0.030	-0.068		
1-year employment growth rate	0.043	-0.005	-0.010	0.012
Note: (*), (**) and (***) means the difference between innovators and non-innovators is statistically significant at 1 %, 5 % and 10 % levels				

The employment growth rates of a firm that survived and also introduced product innovations may be different than that of the one introducing process innovations. Looking at Table 8, in low technology industries, survivor firms introducing product innovations has positive and higher employment growth rates than that of firms introducing process innovations in the period 1995-1997. For this period, the difference between the employment growth rates for product and process innovators is also significant. For the second period, one year employment growth rate is observed only due to survival status definition. The employment growth rate for both product and process innovators turns out to be negative but this time, it is higher for process innovators in this second period. In other words, if low technology process innovator firms have the chance to survive until 2000, they have a higher employment growth rate than that of product innovators.

In medium and high technology industries, survivor firms introducing both product and process innovations have negative employment growth rates except for one year employment growth rate. For one year employment growth rate, survivor firms introducing product innovations have a positive employment growth rate in the period 1995-1997 which is also higher than that of process innovators. However, this situation is reversed for the second period. So, for medium and high technology process innovator and survivor firms have a higher employment growth rate than that of product innovators.

CONCLUSION

This study tries to find an answer to classical question "*Does technology creates or destroys jobs*?" and evaluate the potential differences in the impact of product and process innovations in terms of employment generation in Turkish manufacturing industries over the periods 1995-1997 and 1998-2000. The descriptive analysis states that the employment growth rates for the period 1995-1997 are positive regardless of the type of innovations and technology level but for the next period (1998-2000), changing patterns in employment growth rates concerning the type of innovations and technology level are observed.

For the period 1998-2000, in low technology industries, the employment growth rates of process innovators are higher than that of product innovators and in addition these figures are positive contradictory to the literature. This leads us to conclude that there may be compensation effects such as increased demand resulting from lower production costs or from rising incomes or consumption. In medium and high technology industries, it is interesting to observe that product innovators have negative employment growth rates. This period covers the crisis year of Turkish economy and there may be demand structure factors such as the price elasticity of demand being less than one, leading to a decline in employment in product innovations.

The finding of descriptive analysis can be evaluated by the offsetting compensation mechanism

operating in the case of process innovations. The fact that product innovations affect mainly the demand for the product leads to an increase in the demand for labor at the sectoral level. However, employment at the economy level depends on interactions among all sectors and the interaction between supply and demand conditions. Moreover, a new product may require less labor input as a result of improvements in product design. In such a case, the demand for labor may even decrease at both firm and sectoral level.

The employment growth rates for survivor firms are higher than that of non-survivor firms. These survivor firms are dominantly product innovators in medium and high technology industries and are process innovators in low technology industries. In low technology industries, the employment growth rates for survivor and product innovators are positive and higher than that of firms introducing process innovations in the period 1995-1997. If low technology process innovator firms have the chance to survive until 2000, they have a higher employment growth rate that that of product innovators in the second period. For medium and high technology industries, survivor firms introducing both product and process innovations have negative employment growth rates except for one year employment growth rate. Moreover, those medium and high technology process innovator and survivor firms have a higher employment growth rate than that of product innovators in the period 1998-2000.

The evidence shows that it is essential to discriminate between product and process innovation having different employment impacts. Moreover, aggregate demand and macroeconomic conditions are important because they play a key role in creating the conditions for a positive impact of innovations on employment. The employment impact of innovations also depends on the way compensation mechanisms work.

The finding that innovators having higher employment growth rate especially in low technology industries shows that innovativeness relatively identify the economic performance more in these industries. This is a very important finding for Turkish manufacturing firms especially operating in low technology industries. The higher employment performance of low technology innovator firms also strengthens if they are able to survive in the economic environment of their sector. This confirms all possible policy actions that has been taken and will be taken further to improve financial, technological and operational conditions of low technology industries. Last but not least, the necessity to encourage a strong national innovation system and to complement technology policy with industrial policy should be emphasized once more with reference to the findings of this study.

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