

## CHANGE IN SKILL REQUIREMENTS DUE TO ADVANCEMENTS IN TECHNOLOGY : A REVIEW ARTICLE

Dr. Ekrem Dönek \*

### *1. Introduction*

Employment is a great controversial issue in both economic theory and practical life. Whenever employment is concerned, there is a full of debate among the economists. It is indeed a central subject matter of many economic schools of thought. The main difference among the classical and the Keynesian schools are the understanding of full employment and therefore the definition of unemployment whether it is voluntary or involuntary. Outside the capitalist orthodoxy, the core of Marxian theory is the theory of value stem from the surplus in labor.

Considering the practical side of the problem, labor market is again one of the most volatile and crucial market in the world. Beyond the depression and recession periods in the past, the structure of the labor market has been continuously changing, so the skill formation of many countries is directed away from unskilled-workers to mostly skilled-workers. Accordingly, unemployment has been mostly started to be seen among the unskilled-workers, indicating the huge increase in the need for the skill requirements consistent with the new technologies.

The developments in labor market in the recent decades have not been fully captured by the theory. The developments are more beyond the theories of full employment, homogeneous of labor and effective demand. Labor market has been highly hit by the structural change. The mass production techno-economic paradigm that has been taken place after the World War II has been highly labor-saving in production and service sectors in many areas during the 1950s, 1960s and 1970s.

This paper aims to analyze the changes in skill requirements due to advancements in technology and accordingly the consistency of employment theories with these developments first by glancing at the developments in the OECD area and then, review some of the empirical literature on the issue in different perspectives. The summary and conclusion will take place in the end.

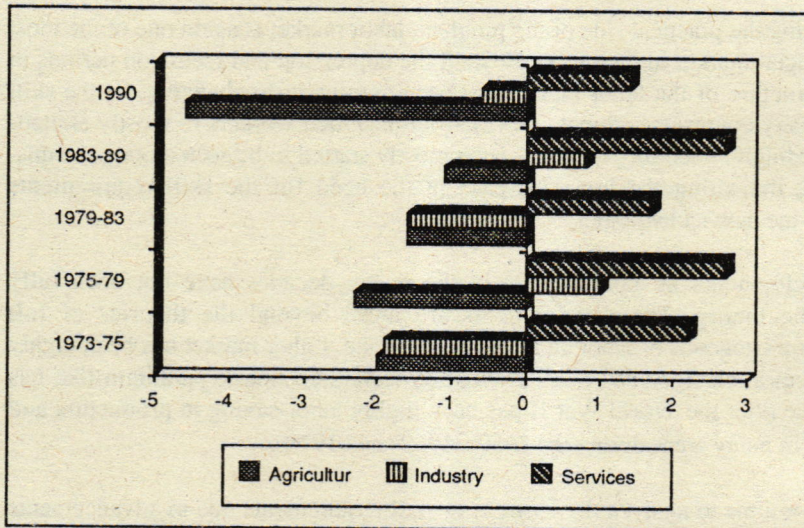
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\* Erciyes University, Faculty of Economics and Administrative Sciences Economics Department. This study has been partially taken from my Ph.D. thesis, namely *Employment, Skill Formation and the New Techno-Economic Paradigm: An Empirical Study of Turkish Manufacturing*, 1994, R.P.I., Troy, NY, USA.

## 2. Labor Market Developments in the OECD Area

Employment continued growing in many countries during the 1970s, although unemployment was also on a rising trend. During the 1980s, total employment growth has become positive in many OECD countries. For example, the annual employment growth in the OECD area is 1.3 percent, in the European Community (EC) countries 0.7 percent, in Japan 1.3 percent, in the U.S. 1.9 percent and in Turkey 2.2 percent. In the recession year 1991, employment growth fell very sharply while unemployment rates increased very fast in many countries. For example, employment growth in the total OECD countries fell to -0.1 percent in 1991 from 1.3 percent in 1990 while unemployment rate raised to 7.1 percent in 1991 from 6.2 percent in 1990. On the other hand, labor force participation rate has little bit increased from 68.3 percent in 1973 to 71.5 percent in 1990 in the OECD countries.<sup>(2)</sup>

Figure 1: Civilian Employment in OECD by Sectors (1973-1990)



Source : Data is from OECD Labour Force Statistics.

When we glance at the developments by sector level, we can see the job shifts to service sector in almost all the countries. During the last two decades, while the growth rates of employment in agriculture and manufacturing sectors have declined, the rate has substantially increased in service sector. Developments are pictured on Figure 1.

(1) OECD, *Employment Outlook*, 1992 July.

(2) OECD, *Labour Force Statistics*, and *Quarterly Labour Force Statistics*.

There has been a fundamental change in the occupational structure of the workforce in the OECD area over the past two decades. In the 1970s, more than half of the workforce was unskilled; in the 1980s, the situation has been reversed, the majority of the workforce has become skilled; and when we came to the 1990s, all the countries fell in the skilled category except Spain<sup>(3)</sup> and probably Turkey.

### 3. Skill Requirements

There is a variety of studies on the labor market explaining the changes in employment, unemployment, and skill formation. A recent study by Topel (1993) finds that the unemployed in the U.S. are among the low-skilled workers. What is more important is that all the long-term increases in joblessness occur among low-wage men. These changes come from the decline in the demand for low-skilled workers and so their wages and time worked. It is argued that none of the existing unemployment theories can explain this fact.

A similar study by Murphy and Welch (1993) examines changes in the occupational wage and employment structure at ten year intervals from 1940 to 1990 to identify the hypothesis that the demand for skill increased greatly during this period. Their results support the view that the demand for skill (as measured by education and wages for the occupation in 1960) increased over the 1940-1990 period. Murphy and Welch (1993) found that, during the period, employment growth shifted from less-educated and lower-paid occupations towards more-educated and higher-paid occupations (similar to the Topel's findings). For example, the employment share of professionals/technicals, high-skilled miscellaneous managers and operatives are 0.74, 1.46, and 0.93, respectively, while the same numbers for low-skilled miscellaneous managers and operatives are -0.08 and -0.87 for the 1940-1980 period.

There are some studies investigating whether the recent 1990-91 recession can be characterized as "white-collar". For example, the paper by Groshen and Williams (1992) examines both skilled and unskilled-workers' situations considering their employment/unemployment status during the last recession as well as the previous recessions in order to clarify the problem.

Gossen and Williams' findings are as follows: One, during the period from January 1958 to July 1992, skilled-employment grew dramatically while unskilled-employment remained flat. Two, skilled-unemployment rates are both lower and less cyclical than unskilled rates for the same period. Three, skilled unemployment was not higher during the 1990-91 recession than the latest (at least two) downturns. Four, skilled job growth stopped during the last recession while it was just slowing in the previous ones. Five, the 1990-91 recession was relatively more severe, compared to their own experience in the

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(3) OECD, *Employment Outlook*, 1992 July.

earlier recessions, for skilled than for unskilled-workers. Finally, unskilled-workers bore again the brunt of the 1990-1991 slump, like all those since 1960.

A very similar study by Farber (1993) investigates the change in the incidence and costs of job loss in the last ten years. His findings for the incidence of job loss are as follows: First, male younger workers have substantially higher rates of job loss than do older ones. Also, the rates of job loss for males were higher in the two slack periods. Second, older and more-educated workers were more likely to suffer from job loss in the 1990-91 recession than the 1982-83 recession. But, this rate is still lower than the rate of job loss suffered by younger and less-educated workers in the 1980s boom (similar to the Groshen and Williams' findings). Third, job loss was relatively more common in manufacturing in the 1982-83 period while it was more common in some important service industries in the 1990-91 period. Fourth, the rate of job loss by tenure was not different during the two recessions

On the other hand, his findings for the costs of job loss are as follows: Displaced workers, relative to non-displaced workers, were less likely to be employed. If they were re-employed, they were more likely to be employed part-time. Finally, even if they are re-employed on a full-time job, the earning losses of these displaced workers are substantial.

These findings have some important implications for employment policies to facilitate the matching of labor demand and supply, probably introducing more education and training programs by public and private sectors.

#### *4. Significance of the Employment Theories*

Some authors searched for the significance of the employment theories from a practical point of view. For example, Frey and Vivarelli (1991) investigated the significance of the existing technological (Ricardian), Keynesian, and classical unemployment theories for the sharp fall in the Italian telecommunications manufacturing employment in the 1980s.

The aggregate employment trends of the five main Italian manufacturing telecommunications firms have shown a rapid growth until the mid 1970s, a stagnation during the second half of the 1970s, and a steep decrease in the 1980s. The increase in labor-saving technological change has been found the main determinant of the unemployment. As far as the quantitative effects of technological change are concerned, the Keynesian and classical unemployment theories are found not to be adequate to describe the problem. Therefore, technological unemployment has to be introduced to the model, which means that technological change needs to be "endogenized". Although it has been found that service sector employment presents much more positive trend, "the mix of functions and skills will continue to change extensively".<sup>(4)</sup> On the other hand,

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(4) Frey, M. and M. Vivarelli, "New Technology and Employment in Italian Telecommunications", *Technovation*, 1991, 11: 5, 303-314., p.308.

qualitative results have shown that technological change caused a marked decrease in the number of unskilled-workers in the manufacturing, which were often allocated to female workers, and a considerable increase for skilled-workers in both manufacturing and service sectors. These results indicate the need for training and retraining by the firms and the state.

Topel (1993) also finds that the unemployed in the U.S. are among the low-skilled workers. What is more important is that all the long-term increase in joblessness occurs among low-wage men. These changes come from the decline in the demand for low-skilled workers, and so their wages and time worked. Topel argues that none of the existing unemployment theories can explain this fact. Finally, the cost of unemployment on earnings is found to be large and persistent.

Kugler, Muller and Sheldon (1990) have recently done a comprehensive aggregate study. It is based on the econometric/production theoretical approach<sup>(5)</sup> to analyze the effect of technological change on the skill structure of employment using the translog cost function for Germany for the period from 1960 to 1984.

They found first that technological change is clearly labor-saving for unskilled-workers while the results are ambiguous for skilled-workers. Second, there is a clear substitutive relationship between unskilled-workers and equipment as well as between unskilled-workers and skilled-workers. Also, a complementary relationship between skilled-workers and equipment was found.

### 5. Incorporating Other Factors : Indeterminate Results

Not all the studies in the area found clear negative employment effects of technological change, but some others found positive effects depending on the conditions within the individual firms or industries. For example, Flynn (1985) analyzed almost 200 case studies of the employment effects of technological change in firms during 1940-1982. In terms of data, it is sufficiently rich in detail to draw some general conclusions. Because, it is a review of large number of case studies (197) for a long period (1940-1982), representing many countries<sup>(6)</sup>, different firms and industries, public and private sectors, and for different purposes. Almost sixty percent of them are manufacturing firms,

(5) The complete estimation model consists of J-cost share equations ( $V_i$ ) and an equation for the negative growth rate of Total Factor Productivity (TFP), ( $-V_t$ ). A stochastic disturbance variable ( $e$ ) is added to each equation to measure the unsystematic influences. The following model specification is estimated using a three stage least squares (3SLS) method:

$$V_i = a_i + S_j b_{ij} \ln p_j + b_{it} t + e_i \quad i, j = 1, \dots, J$$

$$-V_t = a_t + S_i b_{it} \ln p_i + b_{tt} t + e_t$$

(6) The countries are the U.S. (mostly), the U.K., Germany, France, Italy, India and ext.

two-thirds of which are in the durable goods sector.

He found that the technological change in skill intensive processes often eliminated high-skilled jobs and generated low-skilled jobs, while the office automation in data and word processing technologies eliminated low-skilled jobs and generated high-skilled jobs. The review of studies showed that technological change may increase the average level of employment and skill at some firms, while it may decrease them for others. Also, "some workers are promoted, while others are downgraded. Some workers are hired for new jobs, while other workers are laid off. Still others are forced to transfer to another department or relocate in order to remain employed by the firm".<sup>(7)</sup>

Brainard and Fullgrabe (1986) reach the following three conclusions. One, technological change had a small effect on national employment and unemployment levels in the past. The main impact of technological change was redistribution of jobs among occupations, sectors, industries and regions. Other economic factors, such as changes in demand patterns, macroeconomic growth and international competition were much more influential on employment, and this will continue in the coming years. So, the countries that introduce high technology first in internationally competitive sectors will get more benefit from competition and employment. Two, the impact of technological change on employment has varied among sectors. For example, it has a negative employment effect in the manufacturing sector while it has a positive effect in services sector. Finally, technological change leads to growth in professional and technical occupations and increases the need for skilled-workers.

Similarly, Hunt and Hunt (1986) find that the decline in employment levels of some occupations can not be tied to any single factor, such as technology. There are some other determinants, for example, output (GNP) and productivity of clerical employment trends. Therefore, to get more reliable results, we need to include some of the major factors effecting employment and occupations.

Also, unskilled-workers are hard hit by technological change more than skilled-workers, especially woman and young people are affected more by technological change. Finally, since the net effect of technological change on employment and working conditions remains inconclusive, the report suggests the policies that lead to co-operation between employers and workers as well as all other agents.

One of the major effects of technological change is to increase the country's competitiveness. Some studies analyze the employment effects of technological change with the competitiveness effect to reach more reasonable results. The study by Erber and Horn (1990) attempts to estimate the effects of R&D on employment, prices and foreign trade for Germany by sector. Two fundamental values are taken for the measurement of

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(7) Flynn, P. M., *The Impact of Technological Change on Jobs and Workers*, paper prepared for the U.S. Department of Labor, Employment Training Administration 1985, p. 1.

technological change. One is the cumulative expenditure for R&D. R&D expenditure may come from within the sector or may be "bought in" embodied in investment goods. The other is "degree of modernity" of productive plant; i.e., the rate of current investment to the capital stock of productive plant.

Erber and Horn found that R&D expenditure within the sector has a positive employment effect while purchased embodied R&D has a negative employment effect. The effect of R&D capital stock on the labor market (the rationalization effect) was overcompensated because of the factors of working time reduction and rising demand. Therefore, the net effect of these three factors (R&D capital stock, working time reduction, and rising demand) was positive. They found that employment in manufacturing industry was negatively affected by technological change while positive employment effect was seen in the service and trade sectors.

On the other hand, the results regarding the effects of R&D activity on foreign trade in selected sectors showed that an increase in R&D expenditure increases the real net exports of Germany and export prices. The country's volume of trade with the rest of the world (in both real and nominal terms) increases. As we have seen in this study, technological change has a positive impact on foreign trade while it has a negative impact on employment. Therefore, losing the competitiveness especially on international markets would have had a more negative effect on employment. Because the idea is that, the long-run employment gain through international competitiveness may compensate the short-run employment losses by technological change in the future.

### *6. Considering Regional Development*

Finally, there are some studies in the literature searching the employment effects of technological change in the context of regional development. The study by Foley, Watt and Wilson (1992) for the U.K., as a good example of these studies<sup>(8)</sup>, found that new technologies lead to a reduction in employment levels and but an increase in skill levels.

This shows the importance of local employment policies encouraging local institutions of higher education to develop their engineering and technology programs and make the graduates to stay in the region as well as pushing the local firms to increase employer-led training programs for both existing employees and the unemployed.

### *7. Summary and Conclusion*

In this paper, we have reviewed and analyzed some of the empirical studies investigating the structural changes in employment. Especially, the theme that we have

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(8) Another important study considering the issue in the light of regional development is Flynn, P. M., (1988): *Facilitating Technological Change*, Ballinger Publishing Company.

stressed is how the advancements in technology affect skill formation of employment. First of all, the three studies that have been done in the recent years, as an example, have shown us that there is a structural change going on in the labor market in the sense of skill formation. The studies done by Topel (1993), Murphy and Welch (1993), Groshen and Williams (1992) and Farber (1993) find that demand for low-skilled workers decreased while demand for high-skilled workers increased in the last a couple of decades. Therefore, the growth of skilled and more-educated employment has been substantial compare to low-skilled and less-educated workers in the past. However, Groshen and Williams (1992) and Farber (1993) find that high skilled workers have more suffered from job loss in the 1990-91 recession than the previous recessions.

The studies by Frey and Vivarelli (1991), Kugler, Muller and Sheldon (1990), Erber and Horn (1990) and Foley, Watts and Wilson (1992) found very clear negative employment effect of technological change, especially for the unskilled-workers. Some studies in the area usually found different effects (positive or negative) depending on industry, policies that are followed by governments and firms, and finally, whether the competitiveness effect of technological change is incorporated to the analysis. For example, Flynn (1985) states that technological change has different effects on different industries, therefore the result is indeterminate. Brainard and Fullgrabe (1986) is very similar to Flynn's result at micro level; the effect is negative for manufacturing while it is positive in some services industries.

On the other hand, when competitiveness is included to the model, such as Cyert and Mowery (1987), Erber and Horn (1990) and Foley, Watts and Wilson (1992), the results need to be interpreted more carefully. Because, the long-run employment gain through international competitiveness may compensate the short-run employment losses by technological change in the future.

As a conclusion, technological change, in a disaggregated labor market, has different affects on employment according to its skill structure; it has increased the demand for high-skilled workers while it has decreased the demand for low-skilled workers. Hence, this causes technological unemployment mostly to be seen among low-skilled workers and an increase in skill requirements. Technically saying, technological change is becoming more and more labor-saving for low-skilled workers and labor-using for high-skilled workers.



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