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ORIGINAL SCIENTIFIC PAPER

Technology and Demand for Skilled Labor in Turkish Private Manufacturing Industries*

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Summary: This paper examines the relationship between technology and demand for skilled labor both historically and empirically. First, it is pointed out that the Industrial Revolution substituted skilled labor with unskilled labor since it has a de-skilling characteristic. Second, the skill-bias feature of Information and Communication Technologies Revolution is suggested. Finally, the effect of technological progress on the demand for skilled labor is tested for Turkish Private Manufacturing Industries. According to the static panel data estimation results, there is a positive but weak relationship between technological progress and demand for skilled labor.

Key words: Skill bias, Technological change, Manufacturing.

JEL: O33, J23, J24.

Introduction

Since the Industrial Revolution, the relationship between employment and technology has been the subject of widespread debate. This debate has intensified over the last three decades due to several stylized facts. In the 1980s, American economists observed that skill premium (the wage differential by skill) was increasing in the United States (U.S.). Moreover, demand for skilled workers was also increasing despite an increase in wages. The employment gap between high- and low-educated groups seems to be on the rise in practically all Organization for Economic Cooperation and Development (OECD) countries (Organization for Economic Cooperation and Development, 2004, p. 186). The ratio of employment with primary education in total employment has a downward tendency in almost all over the world. In Turkey, the share declined from 74% in 1997 to 58% in 2005 (World Bank, 2008[1]).

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[1] **World Bank**. 2008. *World Development Indicators*.

There were two major changes in world economy during the last three decades. World trade volume, and thus, trade between developed and developing countries has increased. U.S. imports from less-developed countries were 0.4 percent of Gross National Product (GNP) in 1970, before rising to 2.5 percent of GNP in 1990. Additionally, in the European Union, imports from less-developed countries increased from 0.5% in 1970 to 2.1% of GNP in 1990 (Richard B. Freeman, 1995, p. 16). Pervasion of Information and Communication Technologies (ICTs) has radically influenced the sectoral composition of production. The services share in gross production increased substantially[2]. In the same period, the commencement of the use of Computer Integrated Manufacturing (CIM) systems in manufacturing has lead to major developments in manufacturing industries. As these developments occurred simultaneously with the increases in demand for skilled labor, explanations were sought in either trade or technology.

In response to those stylized facts, a great volume of empirical studies have been carried out (mostly for the U.S.) in the late 1980s and during the 1990s in order to explore the determinants of rising demand for skilled labor. Empirical studies with this objective fall into two categories: they seek an explanation either from a labor perspective or a trade perspective. The labor perspective states that new technologies are by their nature complementary to skills and the recently witnessed rapid introduction of new technologies leads to acceleration in skill bias (Daron Acemoglu, 1998, p. 1055). Therefore, the main contributor to the rising skill demand is technological progress.

This paper contributes to the existing literature in three ways. First, we analyze how and why technology complements or substitutes labor historically, before the empirical analysis. We argue that the characteristics of technological revolutions are closely related to the labor demand. Second, the studies cited above mainly focus on developed countries. This paper concentrates on the case of a developing country and attempts to contribute to this literature by filling this very shortcoming. Third, most of the previous studies employed nonproduction and production labor as skilled and unskilled labor respectively. In this paper, we use alternative data for this distinction and make a comparison between these two types of data.

The paper proceeds as follows. The next section documents the relationship between technology and employment within the historical perspective. Section 3 outlines the main findings of several empirical works on different countries. Section 4 analyses the employment and technological features of

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http://ddpext.worldbank.org/ext/DDPQQ/member.do?method=getMembers&userid=1&queryId=6 (accessed June 5, 2008).

[2] In U.S. the share of value added of services in Gross Domestic Product (GDP) is 62% in 1971, 70% in 1990 and 75% in 2000. The employment share of services in total employment is 66% in 1980, 71% in 1990 and 74% in 2000. In Euro area, the share of services value added in total GDP is 53% in 1971, 64% in 1990 and 70% in 2000. The employment share of services is 52% in 1981, 58% in 1991 and 64% in 2000 (World Bank, 2008).

Turkish Private Manufacturing industries. Section 5 sets out our empirical analysis and some concluding remarks are made in section 6.

1. Technology and Employment Relationship in the Historical Context

The effects of technological progress on composition of labor vary with the nature of technology. Francesco Caselli (1999, p. 78) states that technological revolution is de-skilling if the new skills can be acquired at a lower cost than the skills associated with preexisting technologies. Yet, technological revolution is skill-biased if the new skills are more costly to acquire than the skills required by the preexisting type of equipment.

The subject of this section is the evolution of the relationship between technology and employment within the historical perspective. First the Industrial Revolution, and then ICTs Revolution dominant in the second half of the twentieth century will be examined.

1.1 The Industrial Revolution

The major innovation of the Industrial Revolution was the substitution of steam power for water power and animal muscle power (Robert U. Ayres, 1991, p. 29). This new energy source greatly affected the mining, metallurgy and textile sectors. Coal production was 200 thousand tons in the 1550s, whereas it reached 10 million tons in the 1800s (Tevfik Guran, 1999, p. 117). The textile sector was based on the putting-out system during the feudal era. Invention of the cotton-textile machine working with steam power contributed to the expansion of the sector. Thanks to these improvements, the demand for England’s raw cotton increased extremely. Imports of raw cotton grew from an average of 16 million lbs[3] pa in 1783-1787 to 29 million lbs in 1787-1792 and 56 million in 1800 as the source changed from the West Indies to the United States slave plantations (Chris Freeman and Luc Soete, 2000, pp. 37-38).

Although the Industrial Revolution started by the invention of steam engine, it did not end there. On the contrary, the eighteenth and nineteenth centuries witnessed various types of inventions and these inventions led to increased mechanization. The mechanization of production was rationalized with the factory production. Cities were an abundant source of unskilled labor (early peasants came from villages) and entrepreneurs employed these new workers. Classical economists examined the employment impacts of mechanization (technological change) and offered compensation mechanism. In other words:

> *The class of labourers [just as landlords and the capitalist who made the discovery of the machine] also, I thought, was equally benefited by*

[3] Libra, an English unit of weight = 0.4536 kg.

> *the use of machinery, as they would have the means of buying more commodities with the same money wages, and I thought that no reduction of wages would take place, because the capitalist would have the power of demanding and employing the same quantity of labour as before, although he might be under the necessity of employing it in the production of a new, or at any rate of a different commodity… There would be the same demand for labour as before, and that wages would be no lower, I thought that the labouring class would, equally with the other classes, participate in the advantage, from the general cheapness of commodities arising from the use of machinery* (David Ricardo, 2001, pp. 392-393).

A historical analysis indicates that the relationship between technology and employment is bilateral. First of all, technology affects the labor composition either by complementing or substituting. Second, technology affects organization of labor in the workplace.

From the first viewpoint, the new technologies of the eighteenth and early nineteenth centuries of replaced rather than complemented skills, seen in such innovations as the spinning jenny, weaving machines, Jacquard's loom, printing cylinders, and later the assembly line (Acemoglu, 1998, p. 1056). For instance, in the cotton factories, the employment of a few skilled male workers were enough for production, and it was possible to receive the rest of the necessary labor from unskilled and low-wage women and children. (Guran, 1999, p. 118). Nevertheless, the best example of de-skilling technological change is the Fordist production system.

We define Fordist production, characterized by an assembly line, as a kind of de-skilling technological change. Despite the previously mentioned examples of de-skilling through Industrial Revolution, craft-based production continued in some areas until the twentieth century, which was defined as hybrid or late craft system by Freeman (2002, p. 273). This system persisted until the introduction of interchangeable-parts, such as screws and hour wheels, which allow the substitution of unskilled assembly workers for skilled machinists. Ergun Turkcan (1981, p. 124) states that production of interchangeable parts was the second most important stage of the factory system after applying steam power to machine. As long as parts were irregular in shape and not machined to a precise specification, skilled craftsmen were required to fit the parts and assemble each product. (Freeman and Soete, 2000, pp. 137-138) Only with interchangeable parts could machines be produced incessantly in a factory, just like consumer goods (Turkcan, 1981, p. 124), which means standardization. The machining of parts was reduced to a few simple operations by the redesign of the tools and presses to each carry out one simple repetitive task. As a result, the need for skilled workers was reduced to a minimum and the plant was controlled and coordinated by the new profession of industrial (production) engineers and an army of foremen and indirect workers responding to their orders (Freeman, 2002, p. 276).

Claudia Goldin and Lawrence F. Katz (1998, p. 4) provide the example of the U.S automobile industry. Before the assembly line system, automobiles were produced in large artisanal shops. In these shops, automobiles were assembled by craftsmen who hand-fitted each of the various pieces. However, with the assembly line system, the relative demand for skilled workers declined as technological progress standardized the production process.

In addition to the technological improvements, the managerial characteristics of Fordism also contributed to de-skilling. With fragmentation of tasks and a more detailed division of labor, tasks were broken down and further simplified, removing previous skill requirements for the job. Control over all aspects of production was exercised by management through a hierarchical chain of authority (John Allen, 1996, p. 289). Discipline was strict and unions were banned (Freeman, 2002, p. 276). In the Fordist system, the labor force has nothing to contribute to the production process. As James P. Womack, Daniel T. Jones, and Daniel Ross (1990) points out:

> *The assembler on Ford's mass production line had only one task-to put two nuts on two bolts or perhaps to attach one wheel to each car. He didn't order parts, procure his tools, repair his equipment, inspect for quality, or even understand what the workers on either side of him were doing. Rather he kept his head down and thought about other things. The fact hat he might not even speak the same language as his fellow assemblers or the foreman was irrelevant…the assemblers required only a few minutes training* (Womack et al., 1990, p. 31 as cited in Freeman and Soete, 2000, pp. 143-144).

1.2 ICTs Revolution

Since the late 1970s, post-fordist production techniques have become dominant throughout the world economy. The key word is flexibility, the ability to change or react with little penalty in time, effort, cost or performance. This flexibility, which has dominated the production system for three decades, has two dimensions. First, it means changing organized labor. More importantly, Flexible Manufacturing Systems (FMS) are related with the ICTs Revolution.

In the eighteenth and nineteenth centuries, innovations were driven by individual inventors. However, in the twentieth century, innovations were driven by professional Research and Development (R&D) departments within the firm, by qualified scientists as well as engineers with scientific training. Equally important is the fact that throughout the two world wars and during the Cold War period, governments supported R&D activities for military purposes. Especially after World War II, in the Cold War era, research in areas like space exploration and nuclear weapons received a relatively generous increase in funding in many countries (Freeman and Soete, 2000, p. 375). The most important invention of the twentieth century that resulted from military concern is the invention of computer. Although they would not be directly applied to manufacturing problems until two decades later (Ayres, 1991, p. 85), with the improvements in semiconductors and microprocessors, electronic devices became much smaller, cheaper and faster. Microprocessors were successfully adapted to machine tools (and robots) in the 1970s. Developments in software technology and rapid technological progress in microelectronics led to the creation of new manufacturing technologies (more flexible machine controls), called CIM systems or FMS. The tools of CIM systems are Computer Numerical Control (CNC), Computer Aided Design (CAD) and Computer Aided Manufacturing (CAM). As the average cost of these tools declined, they began to be more widely used.

Freeman (2002, p. 313) states that John Diebold (1952) envisioned many applications of computers but had pointed out that they could be successfully developed and used only after a prolonged period of training people with new skills, reorganizing management systems, and redesigning production processes. As envisaged long before, ICTs affected both labor composition and organization of the labor in the workplace. First, the type of workers that FMS needed changed since the manufacturing process was replaced by FMS. New machines, as expected, were implemented by the motivation of reducing labor cost (Ayres, 1991, p. 87). However, this crucially impacted the skill levels of the labor force. ICTs Revolution substituted CIM systems for semiskilled and low skilled workers, such as machine loaders, operators and assemblers (Ayres, 1991, p. 90) and led to new priorities regarding worker skills, requiring multi-skilling, or polyvalent skills, and continuous, rather than minimal and narrow training (Edward J. Malecki, 1997, p. 138) and redirected progress down the path of craft production. In other words, the advent of the computer restored human control over the production process; machinery was again subordinated to the machinist (Michael J. Piore and Charles F. Sabel, 1984, p. 261).

Malecki (1997, pp. 133-134) points out that flexibility is much more of an organizational property than a technical one. The centralized, hierarchical structure of Fordist production was eroded by the universal availability of personal computers, the introduction of local area networks (LANs), and the rapid changes in product and process design (Freeman, 2002, p. 326). Jobs and specific work tasks were knowledge-based, independent and controlled by workers rather than the traditional Fordist rules (Malecki, 1997, p. 141). As a result, horizontal, de-centralized organization forms became dominant in the workplace.

2. Literature Survey

As previously mentioned, the stylized facts of increasing demand for skilled labor give rise to empirical research on technology skill relationship-Skill Biased

Technological Change (SBTC) Hypothesis[4]. The results of the selected studies are summarized below.

Eli Berman, John Bound, and Zvi Griliches (1994) examines U.S. manufacturing industries between 1959 and 1987 and finds a positive relation between technological progress (R&D expenditures and computer investments) and non-production share of wagebill and employment.

David H. Autor, Lawrence F. Katz, and Alan B. Krueger (1998) studies the U.S. labor market from 1940 to 1995 and states that rising demand for skilled labor despite increasing wage bill of this group supports the SBTC hypothesis. The relative demand for more-skilled workers grew more rapidly on average from 1970 to 1995 than during 1940-1970. Moreover, educational and occupational skill upgrading occurred more rapidly in industries with greater computer utilization.

Ann P. Bartel and Frank R. Lichtenberg (1987) investigates U.S. manufacturing industries between the 1960s and the 1980s and states that the relative demand for educated workers declines as the capital stock, which embodies technology, ages. Hence, highly educated workers have a comparative advantage with respect to the adjustment to and implementation of new technologies.

Mark E. Doms, Kenneth R. Troske, and Timothy Dunne (1997) differs from the other studies. This study states that the results of the regressions are different according to the type of technology. It is found that the adoption of factory automation technologies (CIM systems tools such as CAD, CAM and CNC) is uncorrelated with changes in the nonproduction labor share, while computer investment is strongly correlated with the changes in the share of nonproduction workers in the plant. This should not be too surprising since computers are a primary tool of overhead labor, while many of the factory automation technologies are primarily used by production workers. Furthermore, when automation technologies are used, it is clear that plants using more advanced production technologies employ production workers who earn higher wages.

Ann P. Bartel, Casey Ichniowski, and Kathryn Shaw (2007) examines valve manufacturing industries for the years between 1980 and 2002. They state that due to automation -increasing use of CAD, CAM- demand for less skilled operators declined. Employers wish to hire skilled machinists since CNC machines have a broader range of machining activities; newer technologies require employees to undertake more problem-solving activity and more computer skills such as programming. Moreover, they show that new information technology is correlated with the use of new human resources management practices such as problem-solving teams and incentive pay.

[4] SBTC refers to any introduction of a new technology, change in production methods, or change in the organization of work that increases the demand for more-skilled labor (e.g., college graduates) relative to less-skilled labor (e.g., non-college workers) at fixed relative wages (Lawrence F. Katz, 2000, p. 1).

Stephen Machin and John Van Reenen (1998) studies SBTC hypothesis in seven developed countries (U.S., United Kingdom, France, Germany, Denmark, Sweden and Japan). The results provide evidence that skill-biased technological change is an international phenomenon that has a clear effect of increasing the relative demand for skilled workers.

Mariacristina Piva and Marco Vivarelli (2002) investigates Italian manufacturing industries between 1991 and 1997. He concludes that organizational change is the main factor for the upskilling of the labor force. Technological change seems to play a negligible role.

Julian R. Betts (1997) analyzes Canadian manufacturing industries from 1962 to 1986 and found a positive relation between technological change and skill upgrading.

Surendra Gera, Wulong Gu, and Zhengxi Lin (2001) examines both service and manufacturing sectors of Canada from 1981 to 2004 and found that skill upgrading is related to different types of technology, such as the stock of patents and the age of capital stock.

Kojiro Sakurai (2001) investigates Japanese manufacturing industries in the 1980s. By using computer investments as a technology variable, the author finds that technological progress contributed substantially to the increase in the wage-bill share of nonproduction workers.

Burca Kizilirmak (2003) studies SBTC hypothesis for Turkish private manufacturing industries between 1988 and 1998. This study employs total factor productivity (TFP) as a technology variable instead of using R&D intensity or investments in computer and software. The results state that technological change had no effect on the skilled labor demand in Turkish private manufacturing industries in the first half of 1990s, however, there are indications that it had a positive effect in the second half.

3. Employment and Technological Progress in Turkish Manufacturing Industries

In this section we briefly overview employment and technological features of Turkish Private Manufacturing industries. In this way, we hope to provide a clear understanding of the topic before the empirical analysis. Table 1 shows the shares of production, nonproduction and technical workers. According to the table, there is an increasing tendency in neither nonproduction nor technical labor share. Changes in all variables are negligible. Over the years, nonproduction labor constitutes averagely 80% of the total labor, whereas technical labor has little place in the total.

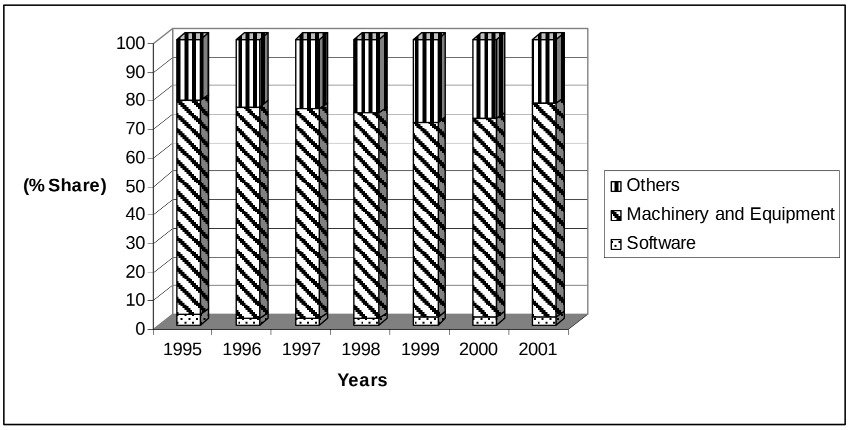
Table 1. Production, nonproduction and technical labor share in Turkish private manufacturing industries (1992-2001)

Year	Production labor share	Nonproduction labor share	Technical labor share
1992	19,21	80,79	5,19
1993	20,68	79,32	4,74
1994	21,24	78,76	5,27
1995	21,08	78,92	5,18
1996	20,74	79,26	5,45
1997	19,93	80,07	5,2
1998	19,89	80,11	4,92
1999	20,42	79,58	5,28
2000	19,98	80,02	5,42
2001	20,81	79,19	5,75

Source: Author's calculation by using TURKSTAT[5] data.

Figure 1 presents the details of fixed capital investments in private manufacturing industries. As the figure illustrates, in total investments there is almost no share of computer and software investments. In the examined period, it has come to the maximum share in 1995 as 3.7%. On the other hand, machinery and equipment investments are the highest type of investments. They constitute on average 72% of total investments.

Figure 1. Details of fixed capital investments in Turkish private manufacturing industries (1995-2001) (a)



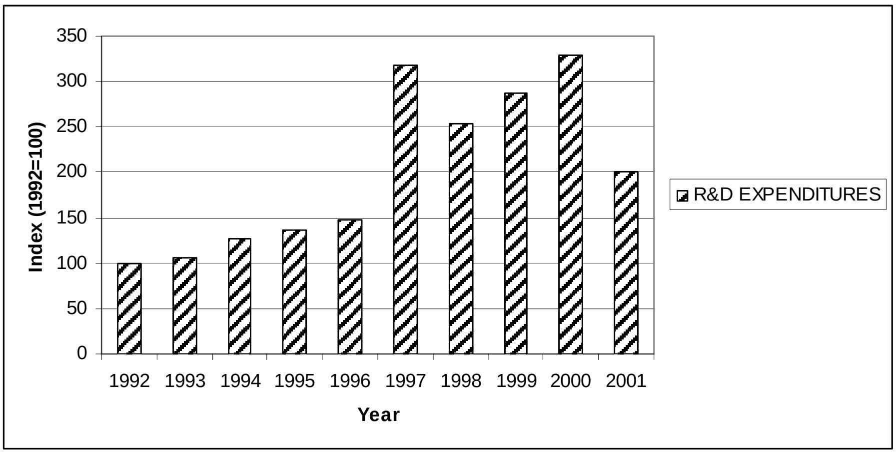
Source: Author's calculation by using TURKSTAT data.

[5] **Turkish Statistical Institute-TURKSTAT**. 2006. *Statistical Indicators (1923-2005)*. www.turkstat.gov.tr (accessed December 10, 2007).

a) The other types of investments are transportation vehicles; building construction; improvement of land and other construction; land; official materials which are fixtures and equipment; original film, advertisement films, programming of Radio and TV.

Figure 2 depicts R&D expenditures of Turkish private manufacturing industries. The expenditures increased despite the crisis in 1994 and have decreased in the crisis of 2001. In a period of ten years, R&D expenditures increased two times. However, the best way to analyze R&D expenditures is to make an international comparison. In this respect, Figure 3 presents R&D shares (the share of R&D expenditures in total manufacturing production) of selected countries.

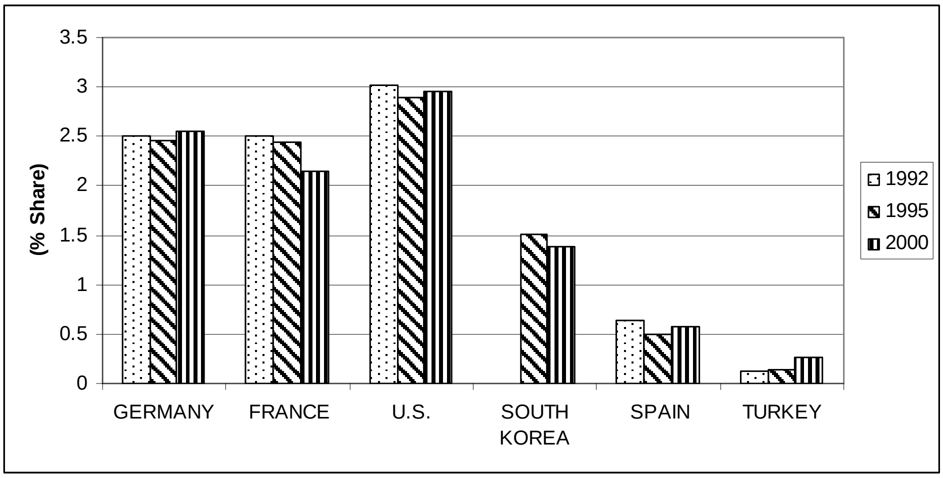
Figure 2. R&D expenditures in Turkish private manufacturing industries (1992-2001)



Source: Author’s calculation by using TURKSTAT data.

In Germany and France, R&D share is nearly the same. However, the share has decreased during the 1990s in France. For all years, R&D share of U.S. is the highest one. Although R&D share has increased during 1990s, Turkey has the lowest proportion in these countries. When compared with Turkey and Spain, it is clear that South Korea is much more advanced in this area.

Figure 3. R&D shares for selected countries (1992-2000) (a)



a) 1992 data of South Korea is unavailable.

Source: TURKSTAT for Turkey; OECD.Stat[6], <http://stat.oecd.org> for the other countries.

4. Empirical Analysis

We use ISIC Rev. 3[7] four digit Turkish private manufacturing industries data which were obtained from Turkish Statistical Institute (TSI). Our data cover the 1995-2001 period and consist of 107 industries after excluding several industries due to lack of data.

We use translog cost function as it is widely used in the literature. This function was originally developed by Jan Kmenta (1967) and empirically tested by Laurits R. Christensen, Dale W. Jorgenson, and Lawrence J. Lau (1973) and Laurits R. Christensen and William H. Greene (1976). Assume that capital is a "quasi fixed" input and cost is determined by variable input prices (skilled and unskilled labor), capital stock and output. The translog cost function can be written as[8];

6 **Organization for Economic Co-operation and Development**. 2008. OECD.Stat. http://stats.oecd.org (accessed May 6, 2008).

7 International Standard Industrial Classification of All Economic Activities Revision 3 is a United Nations system for classifying economic data. ISIC is a basic tool for studying economic phenomena, fostering international comparability of data, providing guidance for the development of national classifications and for promoting the development of sound national statistical systems. For further information, see http://unstats.un.org/unsd/default.htm.

8 The following derivation is based on Christensen and Greene (1976).

$$\ln(TC) = \alpha_0 + \alpha_Y \ln Y + \frac{1}{2}\gamma_{YY}\left(\ln Y\right)^2 + \sum_i \alpha_i \ln P_i + \frac{1}{2}\sum_i \sum_j \gamma_{ij} \ln P_i \ln P_j + \sum_i \gamma_{Yi} \ln Y \ln P_i, \tag{1}$$

where i and t index industry and year respectively. $\gamma_{ij} = \gamma_{ji}$, TC is total cost, Y is output and P_i's are the prices of the factor inputs. In order to correspond to a well-behaved production function, a cost function must be homogeneous of degree one in prices; that is, for a fixed level of output, total cost must increase proportionally when all prices increase proportionally. This implies the following relationships among the parameters;

$$\sum_i \alpha_i = 1, \tag{2}$$

$$\sum_i \gamma_{Yi} = 0, \tag{3}$$

$$\sum_i \gamma_{ij} = \sum_j \gamma_{ij} = \sum_i \sum_j \gamma_{ij} = 0. \tag{4}$$

Applying Shephard's lemma we obtain the following equation,

$$S_i = \alpha_i + \gamma_{Yi} \ln Y + \sum_j \gamma_{ij} \ln P_j. \tag{5}$$

where S_i indicates the cost share of the i th-factor input. The equation we will estimate can be written as;

$$S_{it} = \delta_{it} + \beta_1 \ln Y_{it} + \beta_2 \ln K_{it} + \beta_3 Tech_{it} + \beta_4 \ln\left(W_{it}{}^{s} / W_{it}{}^{u}\right) + u_{it}, \tag{6}$$

S_i is the share of skilled workers in total workers, Y is real output, K is the capital stock, tech represents technology and W^s and W^u represent skilled and unskilled workers' wages respectively.

Following the literature we exclude relative wage term, as it is not plausible to threat it as exogenous[9].

$$S_{it} = \delta + \beta_1 \ln Y_{it} + \beta_2 \ln K_{it} + \beta_3 Tech_{it} + \varepsilon_{it} \tag{7}$$

[9] See Berman et al. (1994).

The output term in the equation represents the size effect. That means if β_1 is positive, large firms employ more skilled labor. However, as we use industry level data, in order to get the size effect the real output is divided by the number of existing firms in the industry.

Capital stock is calculated by performing perpetual inventory method. The equation is;

$$K_t = I_t + (1-\delta)K_{t-1}, \tag{8}$$

where K, I and δ are capital stock, investments and depreciation rate respectively. Depreciation rate is assumed to be 0.05 for all sectors and years. In this method, initial level of capital stock is calculated with the below formula;

$$K_0 = \frac{I_0}{g+\delta}, \tag{9}$$

in this formula, g is the rate of growth of output over the period. The capital-skill complementarity requires positive β_2. The positive β_2 means that new capital is complemented by more skilled labor since it requires some additional skills.

We employ ICTs intensity (share of investments in computer and software in output) as a technology measure. By using investments in computer and software, we assume that more technologically advanced industries make more computer and software investments. We expect positive β_3 to support skill-biased technological change hypothesis in Turkey.

The previous studies which use occupational data deal with nonproduction labor as skilled labor and production labor as an unskilled labor. Although this method is open to question, we follow the same methodology in order to compare our results with other studies. As an alternative approach, we define technical workers as skilled labor and investigate the relationship between technological progress and these workers.

The equations, which we finally estimate are the followings;

$$S_{nonpit} = \delta + \beta_1 \ln Y_{it} + \beta_2 \ln K_{it} + \beta_3 Tech_{it} + \varepsilon_{it}, \tag{10}$$

$$S_{technicalit} = \delta + \beta_1 \ln Y_{it} + \beta_2 \ln K_{it} + \beta_3 Tech_{it} + \varepsilon_{it}, \tag{11}$$

where; S_{nonpit} is the share of nonproduction workers in total workers,

$S_{technicalit}$ is the share of technical workers in total workers,

Y_{it} is the output,
K_{it} is the capital stock,
$Tech_{it}$ is ICTs intensity.

Table 2. Fixed effects estimation results[10]

	Dependent variable	
	Nonproduction labor share	Technical labor share
	[1]	[2]
Independent variables		
Constant	3.75	6.15
	(0.73)	(0.08)
K	-1.15	-0.07
	(0.02)	(0.69)
Y	3.11	0.14
	(0.00)	(0.54)
Tech	-0.22	0.88
	(0.71)	(0.06)
Diagnostic statistics		
R-square	0.25	0.07
Observations	749	749
Hausman test	p-value=0.00	

Based on heteroscedasticity robust standard errors. Estimations include year dummies. p-values are in parentheses.
Source: author's estimations.

Table 2 presents the estimation results of equation 10 and 11. In column 1, capital stock has negative and significant effect on nonproduction labor share. In contrast, output is positive and statistically significant. Finally, ICT intensity has a negative sign, but is statistically insignificant.

In column 2, the estimated coefficient of capital stock has a positive sign but is found not to be statistically significant. It can be explained as capital-skill complementarity does not hold in Turkey. Output is also insignificant and has a negative sign. The technology variable, ICTs intensity, is positively correlated with technical labor share in spite of high p-value. The positive coefficient esti-

[10] Since the Haussman test has zero p-value, it rejects random effects. Therefore the estimates are not reported.

mate of the ICT intensity can be considered as direct evidence of skill-biased technological change[11].

These results can be interpreted as follows: Although the literature employs nonproduction labor as skilled labor, it is not appropriate for the Turkish case. The estimation results clearly highlight that technological progress is not related to nonproduction labor share. On the other hand, output variable has a positive and quite strong relationship to nonproduction labor share. These results are not surprising and occur as a result of the size effect. Since nonproduction labor consists of management and administrative personnel, such as officers, managers, accountants, sales persons and secretaries, bigger firms employ more managers, accountants and even more drivers. For this reason it is plausible to explain the nonproduction labor share with the size effect.

When we employ technical workers as skilled labor, the estimation results change. ICTs intensity is positive and significant despite 0.07 p-value. The high p-value indicates that there is a weak relationship between technological change and skilled labor share. The weak relationship may be the result of the low level investments in software, as we saw in figure 1. In addition, we argue that employing technical labor as skilled labor rather than nonproduction labor is more plausible. Since these workers are directly involved in the production process, this method yields better results in the context of our historical analysis.

The capital stock has a positive sign, but is statistically insignificant. Therefore, our results do not support capital-skill complementarity in Turkish private manufacturing industries.

Concluding Remarks

There are two significant features of the Industrial Revolution. First, it became possible to establish factories, thanks to the use of steam energy. Second, standardization in production emerged as interchangeable parts were produced. Until the end of nineteenth century, craftsmen could maintain their existence by working in factories despite the mechanization of production in the early Industrial Revolution. Because of this, the second half of the nineteenth century may be described as a late craft system. But, as interchangeable parts were put in use, the need for skilled workers disappeared, as it was possible to standardize production by only employing unskilled workers. In other words, the Industrial Revolution embodied a de-skilling characteristic. ICTs Revolution has different characteristics when compared with Industrial Revolution. The former occurred in the second half of the twentieth century, and it has completely changed the standardized formation of production and rendered possible the production of commodities for diversified consumer demands. That change in the form of pro-

[11] Previous studies also used R&D expenditures as a technology variable. Since the coefficient of R&D expenditures are insignificant in our models (both for nonproduction and technical labor share) we did not display the estimation results.

duction has required a workforce that is more educated and able to use computer technologies. In other words, ICTs Revolution has possessed a skill-bias as a feature.

As a result of this skill bias, demand for skilled labor increased in developed countries for three decades. Most of the empirical studies singled out technological progress as a determinant of this increasing demand for skilled labor. In this study, nonproduction labor was defined as skilled labor to establish a basis of comparison with the other studies. However, econometric results indicate that nonproduction labor is not related to technological progress but strongly related to the output volume of the industries. Although the results contradict the other studies, it is not much of a surprise. Because the nonproduction workers consist of managers, accountants, sales persons etc., more output volume requires more nonproduction workers.

Alternatively, when technical workers in manufacturing industries are defined as skilled labor, there is a weak but positive relationship between technological development and skilled labor. It can be proposed that the more realistic approach would be to define skilled workers as technical workers, rather than nonproduction workers.

Finally, in Turkey, SBTC hypothesis is not as clear as it is in developed countries. The low level of R&D expenditures and investments in computers and software seems to be the cause of this weak relation.

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