Skill-Biased Technological Change Hypothesis with Different Market Structures: The Case of Turkish Manufacturing Industries*

Beceri Yanlı Teknolojik Gelişme Hipotezinin Farklı Piyasa Yapıları İçin Analizi: Türk İmalat Sanayi Örneği

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Abstract

The purpose of this study is to investigate the skill biased technological change (SBTC) hypothesis using 1985-2001 data from Turkish manufacturing industries. The role of market structure in this process will also be explored. Market structure will be proxied by concentration ratios in industries. This paper contributes to the literature in two different ways. Firstly, this is the first study to empirically test SBTC hypothesis for Turkey. Secondly, and more important is to incorporate market structure into the investigation of the SBTC hypothesis. The results from this study are as follows: (i) wage differentials have a positive and significant effect on productivity; (ii) this effect does not differ importantly between low and high concentration ratios.

Keywords: *Wage Inequality, Market Structure, Manufacturing Industry, Panel Data Econometrics.*

Öz

Bu çalışmanın amacı, beceri yanlı teknolojij gelişme hipotezini (BYTG) ve piyasa yapısının bu süreçteki rolünü Türk imalat sanayiinden derlenen veriler ile 1985-2001 dönemi için incelemektir. Piyasa yapısını temsilen endüstri yoğunlaşma oranları kullanılmıştır. Çalışma literature iki açıdan katkı sağlamaktadır. İlkin, BYTG hipotezi ilk defa Türkiye için test edilmektedir. İkincisi ve daha önemlisi BYTG hipotezi piyasa yapısı göz önünde bulundurularak ilk kez incelenmektedir. Çalışmadan elde edilen sonuçlar (i) ücret eşitsizliğinin verimlilik üzerinde pozitif ve anlamlı etkisi olduğunu göstermektedir; (ii) bu etki düşük ve yüksek yoğunlaşma oranına sahip endüstriler için önemli oranda farklılaşmamaktadır.

Anahtar Kelimeler: *Ücret Eşitsizliği, Piyasa Yapısı, İmalat Sanayi, Panel Veri Analizi*

Introduction

The differentiation in labor demand that became common among developed countries, mainly in the USA, in the 1980s has brought about large wage differentiation between skilled and unskilled labor. One of the main reasons behind these wage differentials is the high rate of technological change over this period. The technological advancements in areas such as; computers and communication, has increased the demand for skilled labor that can use these technologies and decreased the demand for unskilled ones. As a result of this increase in skilled labor demand, the economic returns to education have also increased.

The technological improvement that took place in developed countries in the 1980's presented itself a decade later in developing countries. The differentiation

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in labor demand and therefore wage differentials has increased in the 1990s in developing countries.

The skill biased technological change (SBTC) hypothesis tries to explain the change in the labor demand caused by technological change. SBTC hypothesis describes the increase in the demand for skilled labor and the simultaneous decrease in the demand for unskilled labor demand that is associated with improvements in technology. According to SBTC hypothesis, this increase in the demand for skilled labor increases the returns to skill, education and information. As a result; with technological advancement, the demand for skilled labor can keep up with the pace of advancement and thus raises productivity (Kim and Sakamoto 2008).

The purpose of this study is to investigate the SBTC hypothesis for industries with different concentration ratios. This paper contributes to the literature in two different ways. Firstly, this is the first study to empirically test SBTC hypothesis for Turkey. Secondly, and more important is to incorporate market structures into the investigation of the SBTC hypothesis. The paper is organised as follows: Section 2 reviews the literature related to SBTC and investigates the theoretical relationship between technological change and market structure. Section 3 examines the wage differentials and productivity in Turkish manufacturing industry. Section 4 discusses the data set and methodology. Finally section 5 examines the results of the empirical applications and concludes the study.

Skill-Biased Technological Change Hypothesis with Different Concentration Ratios

Theoretical and Empirical Background

Within the last two decades, the changes in demand as a result of technological improvements caused a shift in the wage differentials in favour of skilled labor in most developed countries. Throughout the 1980s, relative wages for unskilled labor has decreased dramatically in developed countries like U.K, USA, Austria, Belgium, Canada, Japan, and also in Portugal and Spain. It is possible to observe similar patterns in Netherlands, Denmark, France, Germany, Italy and Sweden however the effect is less pronounced (Sanders and Weel 2000). The long run empirical evidence from numerous developed countries indicates that the number of skilled workers has risen over time. In the past two decades the economic literature has tried to explain this evidence in the context of Skill Biased Technological Change (SBTC) hypothesis.

The SBTC hypothesis which relates technological change to the labor demand, basically argues that new technologies raise the demand for skilled labor. According to the hypothesis, technological change increases the demand for the labor which has the appropriate skills to use advanced technological equipments. On the other hand, less skilled labor which cannot keep up with the technological change will be unemployed. The wage differentials between skilled and less skilled labor will change in favour of the more demanded skilled labor. As a result of these changes in the labor market, technological change will affect productivity positively by creating wage differentials.

Numerous studies which investigate the relation between wage differentials and productivity argue that the SBTC hypothesis is the most important reason behind the shifts in labor demand. A vast number of empirical studies show that, adoption of skilled labor has a positive correlation with capital intensity and the usage of new technologies (Bartel and Lichtenberg 1987[1]; Berman, Bound and Grilliches, 1994; Levy and Murnane 1996; Doms, Dunne and Troske 1997). These findings indicate that physical capital and new technologies are complementary to skilled labor. Thus, the increase in capital/labor ratio becomes a source of relative demand for skilled labor.

There are also numerous studies that investigate the validity of the SBTC hypothesis as well as the studies that repute the SBTC hypothesis. According to Bernstein and Mishel (1997) there have been serious rises in the wage differentials during 1980s and 1990s where there was no considerable change in productivity. This is called the productivity paradox. Because of this empirical evidence, we can say that the SBTC hypothesis may be inadequate to explain the situation in the 1980s and 1990s. Additionally the hypothesis cannot explain the wage differentials other that the skilled-unskilled differentials, such as gender gaps and age differentials (Card and DiNardo 2002).

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[1] Bartel and Lichtenberg (1987) used the age of capital stock to represent the SBTC hypothesis for 61 manufacturing industries in America in 1960, 1970 and 1980's and found a positive correlation between new capital stock and skill adaptation. Dooms et al. (1997) showed that the usage of advanced technologies leads to greater utilisation of workers with high skills.

It is possible to state that the empirical studies for USA and most other developed countries have confirmed the SBTC hypothesis. Katz and Murphy (1992) use a simple supply model to investigate the volatility in the wages of college graduates in USA during the 1970s and 1980s. They found that in the 1980s there was a rise in the demand for college graduates and the wages of these workers rise more rapidly.

Murphy and Welch (1993) examined the rising returns to education especially for youths in the USA during 1980s and investigated the demand for skilled labor for the 1940-1980 period and found that there has been an increase in skilled labor demand.

There are numerous empirical studies that use the white collar-blue collar distinction as a skill proxy. Most of these studies are mainly for the developed countries such as USA, and mainland Europe.

Haskel and Slaughter (1998) investigated the SBTC hypothesis for UK and USA with industry level data. They find that there is a skill bias among white and blue collar workers in employment shares, supporting the SBCT hypothesis. They also used white and blue collar wage differentials without a technology proxy and found similar results.

Machin and Van Reenen (1998), used white and blue collar employment share differentials and wage differentials as a skill proxy and used R&D intensity as a technology proxy to test the SBTC hypothesis for Denmark, France, Germany, UK, Japan, Sweden and USA using industry level data. They found that skill upgrading to be highly correlated with R&D intensity for all seven countries.

Aguirregabriri and Alonso-Borega (1997), used white and blue collar employment share differentials on establishment level for Spain to test the SBTC hypothesis. They used R&D expenditures on technological capital as a technology proxy and found no evidence that suggests R&D has an unskilled bias, however they found the dummy variable for the introduction of new technological capital has a negative effect on blue collar workers wages.

Haskel and Heden (1999), used white and blue collar employment share and wage share differentials as a skill proxy on establishment level to test the SBTC hypothesis on UK. They used change in computer use

from 1973 to 1992 as a technology proxy. They found evidence suggesting skill upgrading is mostly driven by within establishment changes in skill composition.

Holanders and Ter Weel (1999), again used white-blue collar employment share differentials as a skill proxy and they tested the SBTC hypothesis on Germany, Finland, France, UK, Japan and USA using firm level data. For all countries they found evidence supporting the SBTC hypothesis.

Berman, Bound and Griliches (1994), found that in the US manufacturing industry in 1980's, the demand for labor has changed mostly in the favour of skilled labor and made and indirectly supports the SBTC hypothesis. They used white-blue collar employment shares as a skill proxy and control for R&D investments and computers on changes in non-production workers wage bill on firm level data.

Bresnahan (1999) find evidence suggesting technical change has a skill biased using white and blue collar employment shares as skill proxy and use of and application of computers as a technology proxy and tested the SBTC hypothesis on industry level for USA.

Bartel and Lichtenberg (1987) used proxies for age of capital stock as a technology measure and tested the SBTC hypothesis for the USA with industry level data. They found presence of a positive relation between younger capital and higher utilization of skills.

Dunne et al. (1996) have investigated 1820 manufacturing plants in USA at firm level and found that there is a positive and significant relationship between R&D and skilled labor for the1972-1988 period.

Siegel (1995) investigated the SBTC hypothesis using educational attainment in years as a skill proxy rather than white and blue collar distinction for USA and found also a positive effect of technology on skill composition of employment and wage bill shares for the investigated 1987-1990 period.

Autor, Katz and Krueger (1998) emphasize that the demand for skilled labor rose more rapidly in the 1970's and 1980's compared to the 1960s. The demand for skilled labor starts to rise in the beginning of 1970s but the effects of this situation on the returns of education was only to be observed with a lag in the 1980s.

Acemoglu (2002) states that, there have been rises in wage differentials on the basis of education and experience in the USA starting in the 1970's. Additionally between 1979 and 1995, college or equivalent graduates wage shares' rise 25% more comparing to high school and equivalent graduate workers.

Baltagi and Rich (2005) investigate the changes of shares of the workers for production and non-production between 1959 and 1996 for the US manufacturing industry and found results consistent with the SBTC hypothesis.

Autor et al. (2006) investigated the changes in wage structure in the USA for the last 15 years. They demonstrated the divergent trends between the upper and lower half of the wage bill shares. The results show that although there have been rises in the wages of both group there is a divergent trend in this growth. Autor et al. characterize these patterns as "polarization" in the US labor market in favour of highly skilled labor.

Besides USA, UK and some developed countries in Europe wage inequality has been a serious topic of debate for the most of the developed OECD countries. Starting from 1970's almost every OECD country started to experience rises in the skilled labor demand and increased wage differentials between skilled and less skilled workers[2].

Nickell and Bell (1996) tested the SBTC hypothesis for OECD countries using educational attainment aggregated into low-high skill as a skill proxy for national level comparisons and found that the rising levels of unemployment among low-skilled workers might be due to both technical change and trade.

Berman Bound and Machin (1998) used the white-blue collar employment share differentials as a skill proxy and tested the SBTC hypothesis for OECD countries both on industry and national levels. They found that the skill biased technical change to be the main reason behind the rising unemployment rates for unskilled workers rather than trade.

Developing countries have also experienced technical change, it is expected that there should be similar impact as to that observed in developed countries. Empirical research on Mexico and Chile indicate that imports of new technologies have a significant effect on skill differentiation in these countries (Hanson and Harrison 1995, Pavnick 2000, Kızılırmak 2003). Tan and Batra (1997) conclude that R&D and training have a positive impact on skilled workers for Colombia, Mexico and Chile (Sanders and Weel 2000).

There are also studies on the SBTC hypothesis considering the change in labor demand caused by technological change. Takeuchi (1985), Frank and Cook (1995) hypothesise that rising income inequality increases productivity. Liu and Sakamoto (2005) use 1979-1995 data for Taiwan manufacturing industry and examine the effects of efficiency wage on productivity and found that efficiency wage has no positive impact on productivity. Kim and Sakamoto (2008) investigate the relationship between wage inequality and productivity with a fixed effects panel data method for 1979-1996 American manufacturing industry and found results reputing the SBTC hypothesis.

Technological Change and Market Structure

Can the SBTC hypothesis explain the situation in markets that have different concentration ratios? In order to answer this question, this section examines different theories which investigate technological change and market structure.

Market structure and firm size are important issues for explaining the impact of technological change. There are two main approaches to this subject. One is the neoclassical approach which emphasizes the incentives of small size firms for

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2   When comparing internationally the results for the US and the UK are strongest. For mainland Europe the results are less pronounced. Aguirregabriria and Alonso-Borrega (1997), Hollanders and Ter Weel (2000) and Machin and van Reenen (1998) find weaker results for Spain, Germany, Finland and France and Sweden and Denmark respectively.

profit and the other one is the Schumpeterian approach which emphasizes the advantages of large size firms.

Neoclassical theory is mainly characterized by Arrow's 1962 work. According to Arrow (1962), innovations take place in competing markets. Arrow compares competitive and monopolistic firms with same demand conditions and concludes that the incentives of innovation in competitive firms are greater than monopolistic firms. The main reason behind this conclusion is the possibility of making monopolistic profits, even in the short term because of technological advancements for firms that normally in a competitive market can only make normal profits. Innovative firms in competitive markets obtain all the monopolistic profit that comes with technological improvement. According to Arrow, this excessive profit motive is not available for monopolistic firms, because these firms are already facing excessive profits.

According to the Schumpeterian or evolutionary approach, there is a contradiction between technological advancement and perfect competition. The main reason for this contradiction is the imitation of the innovative firm by other firms; therefore the incentive of the firm to innovate will disappear (Kamien and Schwartz, 1982). In contrast to Arrow, the Schumpeterian approach argues that the innovation will be made by oligopolistic firms.

There are two main hypotheses related to Schumpeter. The first one states that there is a positive relationship between monopoly power and technological change. The second hypothesis states that large sized firms are more successful at innovation than small sized firms. But these two hypotheses are independent by means of; being a large sized firm does not bring monopoly power and monopoly power does not mean being a large sized firm (Kamien and Schwartz, 1982).

According to Schumpeter, innovations are greater in monopolistic markets because a firm which has monopoly power can prevent imitation and obtain more profit from the innovation. And also a firm which has monopolistic profits can invest more in R&D (Kamien and Schwartz, 1982).

Shumpeter (1976) posits that the incentives of innovation of a small sized firm in competitive markets will be more costly than large sized firms. According to Schumpeter large sized firms are more innovative because large sized firms can finance the costs of R&D and technological advancements without taking on debts, can get advantage of economies of scale and protect their new technologies from their opponents in comparison to small sized firms. Also large sized firms can hire a larger number of R&D personnel. Large sized firms with product differentiation; are can better use unexpected technological advancements than small sized firms. According to Schumpeter because of all the above reasons technological changes are made by large sized oligopolistic firms.

To summarize, Schumpeter argues that technological improvements will take place in industries with high concentration ratios. Considering Schumpeterian approach, one can think that wage differentiation will be higher in highly concentrated industries and skill biased technological change will be observed more rapidly than industries with low concentration ratios.

If technological change has an effect on labor demand and therefore raises productivity, this positive effect of technological change on productivity is expected to be greater in high technology industries relative to others[3]. As a result the motivation of this study is to answer this particular

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3   It is assumed that highly concentrated industries are technology abundant industries. OECD's publication on 2006; "Science, Technology and Industry Outlook" classifies industries according to technology levels. According to this classification, it is clear for Turkey that industries with low competition levels are high-tech industries. As an example high concentrated industries like chemical-petroleum, coal, rubber and plastic industries, metal, machinery, transport vehicle industries are also high-tech industries. And low concentrated industries like food, alcohol and nicotine industry, textile, clothing and leather industries are low-tech industries.

question: does the effect of wage differentiation change among industries with different concentration ratios?[4]

Employment and Productivity in Turkish Manufacturing Industries

In Turkish manufacturing industries, real value added rose by three times in the 1980-2001 period; but because of economic crisis in 1994, 2000 and 2001, it faced an unstable growth. And there was no employment rise parallel to this growth. The level of technological change, which was static between the years 1980-1985, has improved significantly between the years 1992-1995. After 1996 this acceleration has slowed down, in 2000 there has been significant slowdowns and after 2001 it started to rise again (Saracoglu and Suicmez, 2006).

There again, similar to the developed countries, demand for skilled labor in Turkey has also risen over time. Figure 1 shows the percentage distribution of employment by education. As seen in the figure, for 1988-2007 period, less than high school graduate group compromises 60% of the labor force. This group's part in the labor force has declined to 56% from 62% in the time period. In this period, the illiterate group's part has fallen to 4% from 16%. And the percentage of high school and equivalent graduate which represents skill labor has risen in this period. The percentage of high school and equivalent graduates has risen to 19% from 8% and the percentage of college graduates has risen to 12% from 4%. This figure shows that the part of highly educated in total employment has risen gradually in Turkey.
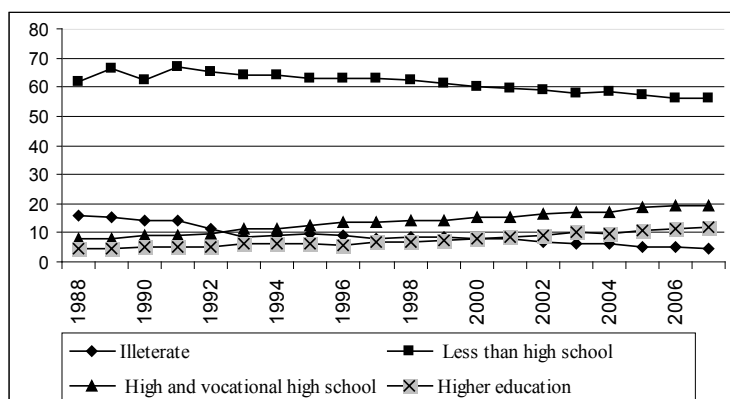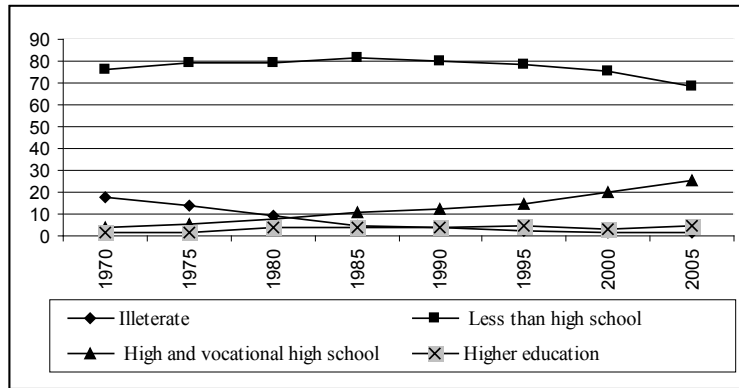

Source: TurkStat (2001) Household Labor Force Surveys

Figure 1. Employment Rates by Education % 1988-2006 (Turkey)

This pattern for skilled labor demand for Turkey is also valid for Turkish manufacturing industry. Figure 2 shows, percentage distribution of employment by education for Turkish manufacturing industry for the 1970-2005 period. According to this figure, the percentage of less than high school graduates and illiterates has fallen in the labor force and the percentage of high school graduates and college graduates has risen, as in the case for the overall Turkish economy.

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4 Taymaz (2000) had results consistent with Schumpeterian approach which argues innovations take place in highly oligopolistic markets for Turkish manufacturing industry. He found that –being not statistically strong- highly concentrated industries tend to have high technological advancement rates.

Source: TurkStat (2001) Household Labor Force Surveys

Figure 2. Employment Rates by Education % (Manufacturing Industry)

Less than high school graduates are better represented in the manufacturing industry more than the overall Turkish economy. This means that manufacturing industry uses labor abundant technology more than other industries. The service sector is the industry with highest employment ratio and employs the highest educated labor force in the Turkish economy.

Figure 3 shows the value added in Turkish manufacturing industry for the 1985-2001 period. The value added seen on the left hand side of the figure, reflects the realized values taking 2000(=100). It can be seen in the figure that for the whole period, value added has been raised gradually. This movement is quite similar to the findings of Saracoglu and Suicmez, 2006.
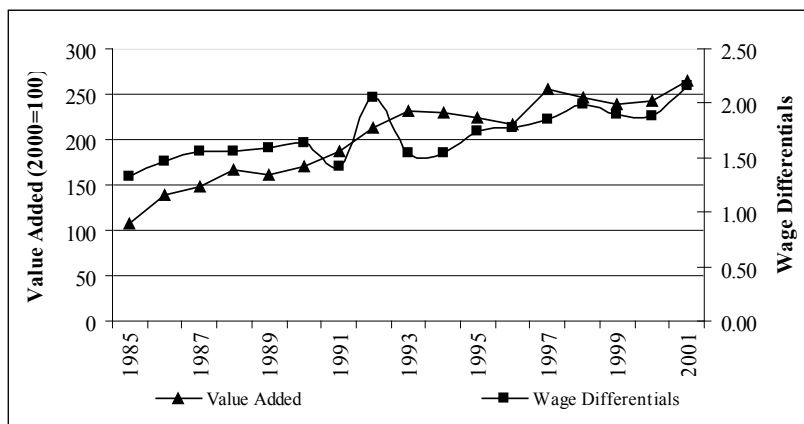
Source: TurkStat (2001) Annual Manufacturing Industry Statistics

Figure 3. Value Added and Wage Differentials in Turkish Manufacturing Industries 1985-2001

The right hand side of figure 3 shows the progress of wage differentials for the period. Because there is no direct data set for wage differentials, this data has been developed by the authors by ra-

tio the wages of production and non-production workers, following the literature (Berman et al. 1994, Kizilirmak, 2003). Production and non-production workers reflect blue and white collar

workers respectively. And white collar workers reflect skilled worker and blue collar workers reflect less-skilled workers. In the beginning of the period white collar workers have earning wage 1.33 times more than blue collar workers. This differential has risen to 2.17 at the end of the period.[5] This differential is considerably higher than in developed countries.[6]

Data Set and Methodology

The data set for the Turkish manufacturing industry is from the Turkish Statistical Institute (TurkStat). The data set covers the 1985-2001 period for 4-digit manufacturing industries (ISIC Rev 2). The reason the data set ends at 2001 is the change of classification after this year[7] and TurkStat has not collected the data for production and nonproduction workers' wages after 2001. The estimation sample includes 1309 observations and covers 70 industries.

To investigate the effect of wage differentials on productivity, following Kim and Sakamoto (2008) the wage differential data constructed for every industry is placed in the Cobb-Douglas production function in equation (1).

$$Q_{it} = A K_{it}^{\beta_1} L_{it}^{\beta_2} M_{it}^{\beta_3} W D_{it}^{\beta_4} \qquad (1)$$

In this equation Q_{it}, shows the deflated value added variable, taking 2000=100, for period t and industry i. K_{it} shows the transformation power capacities (enegy consumption) in a year as proxy for capital stock[8]. This variable has also been deflated with the GDP deflator taking 2000=100. L_{it} shows annual average labor working in industry i during period t. M_{it} consists of raw materials, intermediate goods, wrapping material, fuel stocks, goods and services purchased and the value of electricity purchased. And WD_{it} shows the wage differentials for industry i in period t.

Equation (2) shows the logged version of equation (1), to be used in regression models.

$$\ln (Q)_{it} = \beta_1 \ln (K)_{it} + \beta_2 \ln (L)_{it} + \beta_3 \ln (M)_{it} + \beta_4 \ln (WD)_{it} + e_{it} \qquad (2)$$

Equation (2) will be estimated by panel data method as explained.

$$y_{it} = a_i^* + \sum_{k=1}^{K} \beta_{kit} X_{kit} + \varepsilon_{it} \qquad (3)$$

In this panel data equation, y_{it} shows the dependent variable; value added. a_i^* is the time invariant fixed term. β_{it} shows the coefficient vector. The term ε_{it}

shows the time and unit specific effects of the variables which are not included in the equation.

To find out the effects of market structure on the relationship between wage differentials and productivity, we use m firm concentration ratio CR_m. m firm concentration ratio (m; showing the firm with highest share and n; showing the number of firms in the industry, for $m<n$) can be showed as follows (Tirole, 1988; 221).

$$R_m \equiv \sum_{i=1}^{m} a_i$$

$a_1 \geq .... \geq a_m \geq .... \geq a_n$ is used to order the firms.

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5   Similar results can be found in Kizilirmak (2003) which tries to explain the differences in labour demand.

6   The highest rate reported by Machin and Van Reenen (1998) is in USA, which is 1.623 in 1989. The difference between developed countries and Turkey must be reflecting either relative scarcity of skilled workers or the level of technology. The employment share of non-production workers in the developed countries in 1989 is around 31-32% (Machin and Van Reenen, 1998). This difference illustrates the fact that skilled workers are used less intensively in Turkey than in the developed countries (Kizilirmak, 2003).

7   NACE Rev 2 industry classification has not been used by TurkStat after 2001 and the new measure is not covertable to ISIC Rev 2 in the context of concentration ratios.

8   The capital stock data for 4-digit Turkish manufacturing industry does not exist. The above variable has been used to reflect capital stock following Saracoglu, 2012.

The empirical analysis will focus on 4 basic concentration ratios: (i) "LOW" CR4 industries, (ii) "MIDDLE" CR4 industries, (iii) "HIGH" CR4 industries and (iv) "VERY HIGH" CR4 industries. An industry gets competitive as the concentration ratio gets low. For instance while low CR4 indicates competitive industries, very high CR4 states non-competitive industries. CR4≥70%, represents very high concentration ratio, 50%≤CR4<70% indicates high concentration ratio, 30%≤CR4<50% shows middle concentration ratio and CR4<30% represents low concentration ratio.

Results

Table 1 shows the descriptive statistics for the 1985-2001 period. With prices indexed to the year 2000, the average capital stock has raised 114.942 TL. Labor factor average has also rised in the same period. Similarly there has been a dramatic increase in input levels. Parallel to these increases the average of value added has also increased 1.880.304 TL.

Table 1 also shows that with the increase in value added, the wage differentials have increased. The average wage differential in 1985 was 1.36 and this number has increased to 1.87 on 2001. This situation is consistent with wage differential data explained in section 3.

Table 1. Descriptive Statistics by Four-Digit Manufacturing Industries, 1985-2001

	Mean	Max	Min	Std. Dev.	1985 Mean	2001Mean	Change
Value Added	2.518.656	39.891.727	697	4.094.509	1.390.151	3.270.455	1.880.304
Capital Stock	141.235	2.780.288	173	270.865	100.665	215.607	114.942
Labor	13362	173882	40	20838	11865	14216	2351
Input	4.218.201	42.121.635	329	6.382.332	2.972.975	5.811.914	2.838.939
Wage Differentials	1.62	5.88	0.01	0.56	1.36	1.87	0.51

Table 2 shows means of the variables according to the groups. The first of the results from the table is that as concentration ratio increases, value added per worker, capital stock per worker and input per worker also rises, consistent with expectations.

Another interesting result is that, when group 3 is ignored, as the concentration ratio gets higher in contrast to expectations the wage differentials get lower. In industries with low competition where large sized, high-tech firms dominate the industry (group 4) wage differentials are less relative to competitive

industries. This ratio is 1.59 and 1.65 respectively. On the other hand, it is possible to say that industries with high concentration ratios use less labor relative to industries with low concentration ratios.

As a result, industries with high concentration ratios produce more high-tech goods than industries with low concentration ratios but do not have a labor demand which will cause the wage differentials to rise. This situation might be a result of skilled labor settling with a wage close to the less skilled labor more than being a result of the fair wage policy.

Table 2. Means of the Variables According to the Groups

	Group 1	Group 2	Group 3	Group 4
	CR4<%30	%30≤CR4<%50	%50≤CR4<%70	CR4≥%70
Value Added (per worker)	124,9	153,3	237,8	816,6
Capital Stock (per worker)	8,45	13,52	218.2	20,23
Labor	26485	15207	8531	3218
Input (per worker)	233,5	336,2	295,2	967,2
Wage Differentials	1.65	1.61	1.65	1.59

Table 3 shows the estimated results of the logged Cobb-Douglas production function on equation (2) with the fixed/random panel data estimation methods[9]. Here, value added is the dependent variable. Wage differential has a positive effect on productivity in three models; however this positive effect is only statistically significant for the industries with low and high concentration. The effect of wage differentials on productivity is not significant for industries with middle and very high concentration ratios. But for a comparison the results from industries with low and high concentration ratios is sufficient.

Does the effect of wage differentials on productivity differ with concentration ratios? In the low concentration ratio group with 17 industries, a 1% change in wage differentials changes productivity by a 0.115%. There is no significant difference between industries with high and low concentration ratios. In industries with high concentration ratios the effect of a 1% change is also 0.112%. As expected; capital, labor and input have a positive effect on productivity.

Our expectation was, the effect of wage differentials on productivity would be higher in industries with high concentration ratios relative to the industries with low concentration ratios. As seen from table 3, in contrast to our expectation, the positive effect of wage differentials on productivity does not differ between different concentration ratios.

Conclusion

There has been an average growth in GDP of 4.5% during the last two decades (1987-2007) and 7% in the last five years in Turkey. However, this growth hasn't come with an increase in employment and unemployment rate has been 8.7% for the 1987-2007 period and 10.5% for the 2003-2007 period. There has also been a growth in manufacturing industry but this growth also didn't come with an increase in employment. The technology level which was declining in 1980's has started to rise in 2000's. This technological improvement has created differences in labor demand consistent with the SBTC hypothesis. Labor demand has changed in the favour of skilled labor for both overall Turkish economy and for manufacturing industry.

In this study the SBTC hypothesis that technological improvements will create a change in labor demand in the favour of skilled workers and cause an increase in wage differentials between these groups and therefore will raise productivity, has been empirically in-

9   To take into account endogeneity problem, we use also System Generalized Method of Moments (GMM). Since the results are not valid given the postestimation statistics, we do not report the results obtained from system GMM. The results are available upon request.

Table 3. Estimation Results: The effects of Wage Differentials on Productivity with Different Concentration Ratio: Dependent Variable: Value Added

	Model 1 CR4<30% Low	Model 2 30%≤CR4<50% Medium	Model 3 50%≤CR4<70% High	Model 4 CR4≥70% Very High
Constant	-1.222*** (0.454)	2.819*** (0.705)	-0.475 (0.355)	1.509 (0.461)
Wage Differentials	0.115** (0.052)	-0.091 (0 .088)	0.112** (0.045)	0.064 (0.084)
Capital Stock	0.115*** (0.044)	-0.021 (0.063)	0.171*** (0 .034)	0.259*** (0.043)
Labor	0.095 (0.068)	0.307*** (0.103)	0.339*** (0.061)	0.167*** (0.065)
Input	0.878*** (0.055)	0.594*** (0.074)	0.677*** (0.046)	0.576*** (0.039)
Ad. R^2	0.819	0.355	0.757	0.648
Waldstatistics (Prob. of Wald)	1278.34 (0.000)	266.58 (0.000)	1727.80 (0.000)	680.29 (0.000)
Total observations	289	374	348	273

Standard errors are reported in parentheses. Coefficients marked with ***, **, or * are statistically significant at the 1%, 5% or 10% level, respectively. All models include industry-specific effects and year-specific effects. All models are tested for the assumption of $E(u_{it}|X_{it})$. Only model 4 yields a positive correlation. Hausman test suggests random effects to be used only for model 2. However a further Breusch-Pagan LM test is executed and results suggest that random effects should be used in these models. Therefore random effects methodology is employed in all models but a robustness check is also performed using fixed effects methodology and available from the authors upon request. It is our belief that random effect results are robust and unbiased.

vestigated for industries with different concentration ratios. According to the results of the study, the wage differentials between white and blue collar workers representing the non-production and production workers respectively has increased in time. This rising wage differential has a positive effect on productivity. These results differ from Kim and Sakamoto (2008) which argues that wage differentials don't have a positive effect on productivity.

On the other hand, the effect of wage differentials on productivity does not differ between industries with high and low concentration ratios. Considering the technological innovations and improvements in Turkish manufacturing industry are caused mainly from oligopolistic markets, the main reason behind this result is that concentration does not create wage differential (Pavnick 2000) (Hanson and Harrison 1995) (Kim and Sakamoto 2008) (Sanders and Weel 2000)s. Wage differentials have declined, conflicting with expectations in industries with high concentration ratios. The low rate of employment of less skilled labor in these industries and a high rate of skilled labor employment might be the reason why wage differentials are pretty much the same in all levels of concentration.

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