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THE RELATIONSHIP BETWEEN UNIONIZATION, PRODUCTIVITY AND FIRM EFFICIENCY: EVIDENCE ON THE CHEMICAL INDUSTRY IN TURKEY

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Abstract

The purpose of this dissertation is to review the effects of unionization on productivity in the Turkish Chemical sector. The data proceed from the firms listed in the first and second five hundred firms in the review conducted by ICI (Istanbul Chamber of Industry) between 1998-2006. Both parametric and nonparametric research methods were used in the study. ANOVA analysis as a parametric method was employed in two different ways. First, by including the totality of the chemical sector firms considered, the degrees of productivity of the firms and factors that may affect the productivity were investigated in terms of unionization status (union, non-union and "nonbinding collective agreement" groups). Then, after the firms were arranged within subgroups (general chemicals, pharmaceuticals, oil and plastics), ANOVA analysis was applied again to investigate the differences between the effects of unionization on corporate productivity with regard to these subgroups. In the second parametric method, panel regression analysis was applied to unionized firms, by employing a modified Cobb-Douglas production function. Then, by means of Data Envelopment Analysis, another non-parametric research method, the relative productivity scores in union and non-union firms were computed for each year in the 1998-2006. This method enabled productivity comparisons between union and non-union firms on an annual basis. Later, another nonparametric method, Malmquist Productivity analysis was applied using the panel data set between 1998-2006 period. Malmquist Productivity Index, made it possible to determine the productivity shift in union and non-union firms within the 9 year period in a comparative manner. Finally, in-depth interviews were conducted with a number of firms as well as with labor and employer unions in order to highlight the results.

İn conclusion, nonunion firms were found more productive compared to the union and "nonbinding agrrement firms". Besides, it was detected that increase in union density in union firms has a productivity raising effect.

SENDİKALAŞMA VERİMLİLİK VE FİRMA ETKİNLİĞİ İLİŞKİSİ:
TÜRKİYE KİMYA SEKTÖRÜNDE BİR ARAŞTIRMA

Özet

Bu tez çalışmasının amacı Türkiye Kimya sektöründe sendikalaşmanın verimlilik üzerine etkilerinin incelenmesidir. Veriler 1998-2006 yılları arasında ISO'nun yaptığı değerlindirmede ilk ve ikinci beşyüze giren firma verileridir. Araştırmada parametrik ve nonparametrik sayısal araştırma yöntemleri kullanılmıştır.

Parametrik bir yöntem olan ANOVA analizi iki şekilde uygulanmıştır. İlk olarak, tüm kimya firmaları analize katılarak sendikalaşma durumuna göre (sendikalı, sendikasız ve yetkisiz sözleşmeli) firmaların verimlilik ve verimliliğe etkili faktörler incelenmiştir. Ardından, kimya alanı firmaları benzer faliyetlerine göre altgruplarına (genel kimya, ilaç, petrol ve plastik) ayrılarak ANOVA analizi tekrar uygulanmış ve sendikalılığın firma verimliliğine etkisinin kimya alt faliyet alanlarına göre nasıl farklılık gösterdiği incelenmiştir.

İkinci bir parametrik yöntem olan regresyon analizinde Cobb-Douglas üretim fonksiyonunun modifiye edilmiş bir şekli kullanılarak sendikalı firmalarda verimlilik etkisi incelenmiştir.

Nonparametrik bir araştırma yöntemi olan Veri Zarflama Analizi ile 1998-2006 yılları arasında her bir yıl için sendikalı ve sendikasız firmaların birbirlerine göre göreceli olarak etkinlik skorları tespit edilmiştir. Ayrıca bu yöntem kullanılması ile sendikalı ve sendikasız firmlarda yıl bazında verimlilik karşılaştırması yapılmıştır.

Bunu takiben yine non-parametrik bir yöntem olan Malmquist Productivity analizi, 1998-2006 yılları arası panel veri seti kullanılarak uygulanmıştır. Malmquist Productivity Index kullanılarak 9 yıllık dönem içerisinde sendikalı veya sendikasız firmalardaki etkinlik değişimleri göreceli olarak tespit edilmiştir.

Son olarak yapılan ampirik yöntemlerin sonuçlarına ve olası nedenlerine ışık tutabilmek için derinlemesine mülakat yöntemi bazı firmalara ayrıca işveren ve işçi sendikalarına uygulanmıştır. Sonuç olarak, sendikasız firmalar sendikalı ve yetkisiz sözleşmeli firmalara göre daha verimli bulunmuş, ayrıca sendikalı firmalar da sendikalaşma oranındaki artışın verimliliği arttırıcı etkisi tespit edilmiştir.

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To my family…

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List of Abbreviations

ANAP Anavatan Partisi

ANOVA Analysis of Variance

BAĞKUR Social Insurance for the Self-Employed

BCC-DEA Banker Charnes and Cooper Data Envelopment Analysis Method

CCR-DEA Charnes, Cooper and Rhodes Data Envelopment Analysis Method

CES Constant Elasticity of Substitution

CRS Constant Return to Scale

CV/IR Collective Voice / Institutional Response

DEA Data Envelopment Analysis

DEAP Data Envelopment Analysis Programming

DİSK Devrimci İşçi Sendikaları Konferasyonu

DMU Decision Making Unit

EFFCH Efficiency Change

GLS Generalized Least-Squares

HAK-İŞ Hak İşçi Sendikaları Konfederasyonu

ICI Istanbul Chamber of Commerce

IMKB Istanbul Menku Kıymetler Borsası

ISIC International Standard Industrial Classification of all Economic Activities

ISO İstanbul Sanayii Odası

ILO İnternational Labour Organization

KİPLAS Kimya Plastik Lastik İşveren Sendikası

KLEMS Capital-Labour-Energy-Materials MFP

Laspetkim-İş Lastik Petrol Kimya İşçileri Sendikası

Lastik-İş Türkiye Petrol Kimya ve Lastik İşçileri Sendikası

Lbr Labor

LP Linear Programming

LPG Liquefied Petroleum Gas

LS Least Square

LSD Least Significant Difference

MADEN-İŞ Maden İşçileri Sendikası

MESS Türkiye Metal İşçileri Sendikası

MFP Multifactor Productivity Measures

MI Malmquist Index

NGLS Non-Generalized Least-Squares

OLS Ordinal Least Square

OYAK Ordu Yardımlaşma Kurumu

PECH Pure Efficiency Cha

PETROL-İŞ Türkiye Petrol Kimya Lastik İşçileri Sendikası

QWL Quality of Working Life

R&D Research and Development

RPP Republican People's Party

SECH Scale Efficiency

SFA Stochastic Frontier Analysis

TECHCH Technical Change

TFP Total Factor Productivity

TFPC Total Factor Productivity Change

TFPCI Total Factor Productivity Change Index

TLP Turkish Labor Party

TÜRK-İŞ Türkiye İşçi Sendikaları Konfederasyonu

UK United Kingdom

US United States

USA United States of America

VRS Variable Returns to Scale

Chapter 1

Introduction

Many empirical investigations of the recent past have been studied the impact of unionization on productivity. According to a statement by Derek Bok and John Dunlop in 1970; “For more than a century and a half, economists have debated the effects of “combinations of workmen,” or collective bargaining, on the efficiency of business enterprises”.

Controversial results of the studies in the literature have directed this subject towards the question of whether the effect of unionization on productivity is an illusion or a reality. According to Freeman and Medoff (1981), a variety of different positions are available suggesting union effects are either real or illusory. One proposition is that the apparent union/nonunion differences are illusory due to the way trade unions were superimposed on various groupings of establishments or individuals. A second view suggests that the effects of unions on economic performance are real, yet all these effects take their course on price-theoretic routes; any effects seemed to be inexplicable in terms of standard price theory are taken as illusory. Finally, there is another perception that unions have certain influences on outcomes through institutional channels and thus, they have significant real nonwage effects on our economy.

Freeman and Medoff responded to the suggestion of illusory effects of unionization on corporations by asking the questions “If all union effects are illusory, why do workers join unions?” and “Why do employers oppose them (in many cases with vigor)?”

Secondly, according to the orthodox view of economics suggesting that the productivity effect only operates on price-theoretic routes, unions are claimed to exercise a negative impact on productivity. The traditional union monopoly model predicts that the managerial response to a positive union wage effect results in a substitution of labor to capital, an increase in product prices, which (according to the standard neoclassical model) subsequently induces a misallocation of resources (Machin, 1991). This condition makes the production frontier of the unionized firm lie inside that of the non-unionized firm as well as possibly triggering intrafirm allocative inefficiencies (Addison, 1982).

While the monopoly side of trade unions demonstrates the negative aspects of unionism, third alternative point of view for unions is that in some circumstances, they may be efficiency-improving in a sense that the availability of the union may result in developments in the organization and the productivity of the workplace (Booth, 1995: 183). According to Freeman (1976), unions may increase labor productivity by providing efficient collective voice for workers when negotiating workplace characteristics and establishing grievance procedures, as well as by "shocking" management into reducing existing X-inefficiency.

There are controversial results obtained from empirical studies conducted in similar manners as well as different viewpoints of managers and economists on this much debated subject of industrial relations. This subject, which started drawing attention of labor economists especially at the end of 1980s and the beginning of 1990s, has been explored in various industries, primarily in USA and UK, by employing different research methods. When the empirical studies in the existing literature are taken into account, there are certain studies which find a positive-negative and sometimes insignificant relationship between unionization and productivity. Different findings from the researches have been explained based on different management and economics theories.

In Turkey, however, not many studies researching the unionization-productivity relationship are available. The main reason for this is that insufficient and unreliable data sources hamper the access of researcher to correct data. Limitation of findings on the unionization and productivity relation in Turkey and the limited number of

studies carried out by especially using company level information aroused my interest and led me to do this study.

This thesis study is comprised of six chapters including introduction. The second chapter summarizes the fundamental characteristics of industrial relations and challenges faced in Turkey. The time period under study in this thesis is the post 1980 era. In order to comprehend better the unionization developments and activities after 1980, challenges and developments experienced in unionization activities in Turkey before 1980 are explained first. Changes realized in the unionization process are narrated within a period starting from the pre-republican period covering the post 1980 era.

The relation between trade unions and productivity is addressed in the third chapter. First, opinions of economists on unions and labor relations are given from a historical perspective and classical and contemporary approaches are reviewed. In the evolution of labor union theory section, the conventional view and modern thinking philosophy that analyze the effects of unionization on productivity are explained. In the next section, positive effects of unionization on productivity are mentioned. Positive effects, in other words, unions establishing a collective voice and increasing productivity as suggested by the modern approach and secondly, unions' tendency towards supporting technology are explained in detail. Thereafter, negative effects on productivity, restrictive work practices, union's investment prevention tendencies, strikes and the spillover effect that arises from the impact of unions on wages are discussed. And in the last section of the third chapter, articles on unionization and productivity relation collected from the 1960s up until today are presented.

In the fourth chapter, productivity and efficiency measurement methodologies targeting are classified into three groups and summarized briefly before reviewing the productivity and efficiency relationship of unions by using analytical methods in the next chapter.

The fifth chapter provides information on the analytical framework of the methodologies used including parametric and nonparametric methods, research

questions and related results. Findings of the in-depth interviews made are given in the implication section of each research methodology along with my personal comments.

The sixth chapter draws conclusions based on the findings obtained. Finally, the study concludes with limitations of this research and implications for future research.

Chapter 2

Industrial Relations in Turkey: An Overview of Basic Features and Problems

Labor unions and industrial relations in Turkey evolved in two stages, each characterized by certain political and socioeconomic developments:[1] These periods are referred to as the pre-1980 unionization movements and the post-1980 system.

2.1 Pre - 1980 Unionization Movements

When we consider the general characteristics of the unions in the pre-Republican era, we encounter workers' organizations which had the characteristics of associations but were established under legal and actual restrictions. With the Constitutional Monarchy period, employee and civil servants' organizations gained a new momentum but at the same time they caused controversies as to the direction of the unionization route (Aydoğanoğlu, 2009). Following this development's disastrous effect on the traditional power structure (Akalın, 1995: 102), a rapid increase occurred in the number of strikes even at this low level of freedom of association. Strikes which were called "1908 strikes" spread across the country to cover all work branches. The "Strike Law" was put into effect in 1909 to bring strike activity under control (Lastik-İş 25.Working Report: 118). This law remained in effect until the Labor Act 3008 was enforced in 1936.

The coverage of the 1936 Labor Act was restricted to manual workers. This act increased the already existing restrictions on work stoppages, and it laid down a full-fledged conciliation and compulsory arbitration mechanism. Based on provincial

[1] This chapter is quoted is based mainly on Dereli, T. (2006) *International Edition of Labor Law and Industrial Relations in Turkey,* Kluwer Law International pp.34-49

arbitration boards against whose pronouncements it was possible to appeal to the Supreme Arbitration Board in Ankara, the mechanism could be initiated by the elected representatives of the workers under prescribed conditions. This system created, however, the backbone on which unionism with collective bargaining could subsequently develop. The rationale for banning unions and strikes under the 1936 act was the result of the populist philosophy of the ruling Republican Peoples' Party (RPP), which supported the view that labor's interests were well protected by the classless, paternalistic state. In 1938, Turkey, being concerned about the political developments that threatened peace in Europe, passed a new Associations Act that reinforced already existing restraints on the right of association by limiting the establishment of associations based on class, race or religion.

In the period between 1923-1946, worker organizations and employee movements remained at their lowest level in the history of industrial relations in Turkey. Besides political, economic and legal factors, gradually harshening attitudes of the single party government, first by rejecting the existence of social classes and then by restricting the worker organizations and their activities, were also responsible for this situation (Makal, 1999 :449).

In 1947, it was necessary to promulgate a union act with the aim of clarifying the obscurities in union issues. In acknowledgement of the legal necessity, the government put the Labor and Employers Unions and Union Councils Act into effect in the same year. (Yücel, 1980: 198).

Within this context, the structure of Turkish unions began to take a shape. In 1952, 5 years after the enactment of the unions act, there emerged an organization representing Turkish workers, titled Türk-İş (Confederation of Turkish Trade Unions) (Ağralı, 1967: 146). Nevertheless, Türk-İş administration maintained a structure which continued with the policy of “good relations with political power” (Odaman, 2000).

Expansion of various local unions throughout industry such as the Metalworkers’ Union and Petroleum Workers Union (Petrol-İş) into national organizations which were in competition with the federations in their own branches, was among other

developments of the 1950s. The industrial unions cited were perceived as an organizational model for the other national industrial unions in the 1970s and 1980s.

Without doubt development of unionization in Turkey entered a new process with the enactment of the 1961 Constitution. This Constitution not only provided union freedom but also triggered the start of a new era in Turkey with the Trade Unions Act no 274 and the Collective Bargaining, Strike and Lockout Act no 275 adopted in 1963 (Toçoğlu, 1994: 165).

A remarkable improvement both in terms of union structure and of union-party relations was the birth of the Confederation of Reformist Trade Unions' (Devrimci İşçi Sendikaları Konfederasyonu - DİSK) in 1967. The Turkish Labor Party (TLP) played a decisive role in DİSK's foundation.

As early as 1961, TLP supporters argued that the real salvation of the Turkish working class could only be provided through political organization of the left-wing workers themselves. A general convention of the TLP held in Malatya was alleged to have adopted the idea of creating a union confederation based on TLP ideology to rival Türk-İş. Once established, DİSK frequently criticized Türk-İş harshly for its relations with foreign organizations. In particular, it denounced the financial aid the latter was receiving from external agencies that were seeking to implant a business-oriented mentality into the Turkish labor movement.

Türk-İş considered the establishment of DİSK as a setback for Turkish unionism. Splitting the movement, it worsened the so-called disease of union inflation: the fractionalization of the labor movement into too many ineffective unions. To counteract claims of political passivity, Türk-İş, during the 1960s and early 1970s, promoted the election of unionists to the Parliament, irrespective of their political party affiliations. Türk-İş also pursued a policy of penalizing its "parliamentary enemies" by issuing blacklists in the 1965 elections and afterwards, but the difficulty of convincing conservative union members to vote for rival candidates contributed to the limited achievement of this approach. Thus, Türk-İş faced the challenge of whether to support or confront the "parties" as a whole instead of treating them as individual politicians. For this reason, in spite of the existence of DİSK, left-wing

political unionism achieved little headway in these years. Certain national unions like Lastik-İş and Maden-İş affiliated with DİSK while, some Türk-İş affiliates like Petrol-İş established the social democratic fraction in Türk-İş.

But there were a number of both 1egal and practical problems remaining in the Turkish system. Most of them were various difficulties emanating from the so-called "union inflation". By 1980, there were more than 750 unions, while union density constituted approximately 40 percent of the nonagricultural and potentially unionizable work force of around 5 million. However, an evaluation in relation to the total labor force yielded a figure of around only 10 percent. Approximately 1,000 collective agreements were concluded at various levels each year, and about half of 2 million unionized workers were within the scope of these agreements.

In the late 1970s, Turkish labor relations were adversely influenced by increasing inflation and growing political instability. In 1977 and 1979, there was an unprecedented level of strike activity, and in the first nine months of the year 1980, 1,303,253 work days were lost due to strikes. Along with the effects of numerous internal problems within the unions, heightened militancy mainly on the part of the DİSK leadership and similar circumstances had located the Turkish labor movement in a very vulnerable position by September 1980.

2.2 The Post-1980 System

Turkey entered a notably challenging process in terms of both economy and politics with the political parties pushed out of the system after the declaration of martial law and military government on September 12, 1980. The initial prohibitions and restrictions imposed on labor rights were legalized after a certain period of time with new legislations (Güzel, 1996: 295). Within a few years beginning with the January 24 decisions and September 12 incident, union rights and collective bargaining conditions were reorganized in compliance with the demands of capital. Besides such modifications, the activities of various unions were suspended and strikes and lockouts were prohibited by the military National Security Council. Revitalization of

the multiparty democracy system in May 1983 speeded the pace towards a brand new industrial relations era in Turkey.

Act No. 2821 on Unions and Act No.2822 on Collective Agreements, Strikes and Lock-outs replaced Act no 274 and 275, respectively. With the new Constitutional provisions, union power was curbed and many union activities were stopped. Under Directive no 7 of the National Security Council, DİSK, one of the powerful confederations of the pre-1980 era and all its affiliated unions were shut down and their managers were arrested (Güzel, 1996: 255). Only Türk-İş was allowed to operate, due to its support for current ideology, but the right to collective bargaining was considerably curtailed. Members of DİSK started to transfer to other unions under Türk-İş and Hak-İş in the interim period when DİSK was unable to engage in any kind of union activitiy (Tartanoğlu, 2007).

Unionization in petroleum, chemical and rubber fields, which is under the research coverage of this thesis, received high level negative shocks from such adverse developments; people set their hearts in this concern, however, and continued their activities within the aim of to conserving their operations. A group of employees supporting the principles of Lastik-İş and DİSK started to be reorganized all across the nation. The Laspetkim labor union was established in 1983. Founders of Laspetkim-İş were the employees who had lost their jobs while being members of the terminated Lastik-İş union. Chemical, petroleum and rubber laborers, who became extremely impoverished under the military coup conditions and January 24 policies during the following 10 years struggled to improve their purchasing power. DİSK was acquitted by the military Court of Appeal decision in 1991 and the closed Lastik-İş union resumed its operations. Laspetkim-İş was incorporated into DİSK in 1992 and Lastik-İş and Laspetkim-İş were merged and continued their operations under the name Lastik-İş (Lastik-İş 24.Working Report: 121).

The unions suffered due to challenging sanctions regarding the exercise of their right to strike that would probably force them to commit criminal offences (Demir, 1990: 17). Strikes and lockouts were not permitted during a state of war or full or partial mobilization, and they might be prohibited in the event of major disasters adversely affecting daily life and temporarily restricted in the case of martial law or

"extraordinary emergency law" circumstances. What is more, a lawful strike or lockout deemed likely to endanger public health or national security might be suspended for sixty days by government order and taken to compulsory arbitration at the end of that period if the parties to the dispute failed to reach an agreement.[2] Extended prohibitions on strikes and long strike suspensions, starting especially with the gulf crisis appear to be the factors that broke down the most powerful and threatening weapon of unions. For the subject matter of this dissertation, the following areas in which bans on strike activity can be enforced are important: exploration, production, processing and distribution of natural gas and petroleum, petrochemical works starting from naphtha and natural gas; health institutions and pharmacies, or establishments for the production of vaccine or serrum, excluding establishments manufacturing medicines.

Legislative union restructuring attempts after 1980 mainly focused on the creation of a stable and centralized structure and on the reduction of the number of unions. To this end, with "national-industrial unionism", as exemplified by Petrol-İş, for example, having been announced the sole organizational principle, the number of industries according to which unions might be organized was cut from thirty-two to twenty-eight. The ten percent industry representation requirement for collective bargaining as a new criterion was especially effective in reducing the number of unions.

750 unions that were operative ten years before 1980 had been cut down to 69 unions by 1990 (by 2005, to 96 unions) and only 41 of these unions (by 2005, only 46) were able to satisfy the requirement of minimum 10 percent industrial representation required to obtain bargaining status; Türk-İş and its affiliates, aimed at eliminating the federations and creating a centralized structure since the beginning of the 1960s were satisfied with the current condition.

The Ministry of Labor along with the most of employers opted for unions larger in size and fewer in number because it would facilitate the process of designating the unions that received bargaining status, while the end of union inflation would

[2] This last provision has been denounced repeatedly since 1984 both by Türk-İş and the ILO.

hopefully blunt the sharp political edges within the labor movement which had dominantly characterized the pre-1980 era.

By the end of 1990, in spite of the reduction in the number of unions through forced mergers, total union membership had reached its pre-1980 level, exceeding 2 million. At that time, union density, with regard to the overall labor force, remained at around 10 percent, but in terms of the potentially unionizable work force of 3,573,426 wage earners, it reached approximately 58 percent according to the Ministry of Labor statistics. The drop in the size of the potentially unionizable work force from about 5 million in the pre-1980 period to 3.5 million was due, among many things, to the legal restrictions on union membership, the creation of the contracted workers status that disallowed union membership, and the increase in the number of civil servants who were not permitted to join unions. There were three confederations in total, Türk-İş, Hak-iş and DİSK and 32 independent unions that were not a member of these 3 confederations in 1993 (Petrol-İş Annual of 1992, 1993).

Other obstacles enforced by the new law against unions can be listed as notary approval requirement for union membership, extremely bureaucratic procedures followed in determining bargaining rights, subcontracting practices executed to weaken the unions and unjustified dismissals (Özerkmen, 2003). Act no 2822 had imposed double criteria requirement for collective bargaining. The right of collective bargaining was only entitled to the unions that reached the 10 percent threshold in the related work branch (a similar 10 percent arrangement was foreseen in Italy prior to the Second World War). The second requirement in gaining bargaining authority was the obligation to represent more than half of the employees in the establishment subject to collective bargaining (Lastik-İş 25.Working Report: 137).

Severe stabilization policies promoted by the government and based on wage restraints forced Türk-İş, contrary to its their traditional supraparty politics into conflict with the Motherland Party (Anavatan Partisi - ANAP) which was the ruling right wing conservative party. This was largely because of the pressures created by the Social Democratic fraction. Furthermore; the unions felt obliged to more strongly push for wage increases and showed an accelerating tendency to strike, as ordinary members of certain moderate Türk-İş affiliates were former DİSK members. At the

same time, due to legislation that encouraged employers to organize more effectively, the post-l983 era witnessed growth in the power of employers' associations, particularly in the metalworking, petroleum, chemicals and rubber, and food and textile industries. In this regard, MESS and KİPLAS are good examples.

In Turkey, it is especially challenging for unions to launch organizational drives within the establishment since there is not enough legal protection against acts of anti-union discrimination. Court litigations are usually considered as time-consuming. Union attempts to maintain bargaining status have been hindered by employer endeavors to expand the scope of the "non-covered" personnel in collective bargaining as well as the widespread implementation of subcontracting (factors adversely affecting Petrol-İş, particularly). Union membership was also negatively affected by the increasing number of white-collar employees, particularly in the services sector, since these workers were generally reluctant to organize.

Among the major developments of the early 2000s, however, the enactment of the new Labor Act which dealt with the individual employment relationship, combining flexibility measures and job security in conformity with ILO Convention 158 stands out as the major milestone of the recent past.

Due to the global trends which negatively affected labor unions in Turkey and elsewhere, the previously powerful Petrol-İş union lost its bargaining rights in the three big multinational corporations, BP, Mobile Oil and Shell in the mid-1990s. More frequent utilization of outsourcing and subcontracting, sale of the Batman plant as well as the enlarging scope of the so-called “non-covered employees” triggered by management pressures, led to the declining membership density of Petrol-İş in these companies. Yet the social partners went on applying the administrative clauses of expired collective agreements between themselves even in the absence fresh and binding collective agreements, i.e. the items outside wage and effort bargaining. Thus was possible due to the implicit agreement between social partners, Petrol-İş and oil companies, where the union had lost the official authorization position. This

practice, arising from the freedom of association principles of ILO, well entrenched in this sector of Turkish industrial relations, still continues.[3]

With the limited strength of collective labor agreements within framework which covered only the members at the workplace, the spread of various flexible work arrangements such as outsourcing, taking work home, part time work and work upon call added to intensive unemployment pressure. The wage increase process was curtailed and this decreased the proportion of wages in the national income, as was the case in the period between 1960 – 1980. The 1990s constituted a period when the struggle arenas of union movements were expanded in our country and association was downgraded with the spread of outsourcing and expansion of the unrecorded economy. In those years, the efforts of Lastik-İş were directed towards reaching new associations across Turkey and improving the already granted rights (Lastik-İş 25./24. Union working report: 120). Non-covered personnel phenomenon that was legitimized even within the union movement caused for this category the loss of the right of collective bargaining rights and even the freedom of association. When non-covered and outsourcing practices are considered together, it is obvious that at least 50 percent of the employees were pushed outside the collective bargaining area even at the initial stages.

Another significant development that places considerable pressure on the Turkish union movement includes privatization practices. Privatization has been continuing in Turkey since the enforcement of privatization laws in 1984. The most outstanding point both before and after privatization is the tendency towards a decrease in employment with privatization. Given the fact that the private sector does not always perceive unionization as positive, union organizing drives have been hampered through numerous ways such as contracting and subcontracting, management practices, postings to other firms, etc. For all these reasons, unions have been facing the risk of a attenuation in member density and the curtailment of bargaining power (Şenkal, 1999: 252).

[3] The sample in this thesis includes those "nonbinding agreements" referred to also as "unauthorized collective agreements."

Chapter 3

Trade Unions and Productivity

3.1 Major Views on Unions from a Historical Perspective

Since the times of mercantilism, classical economists have suggested that the effects of unions on wages entail a distorted distribution of resources, thereby shifting the high quality employees and capital from a higher marginal production use to a lower marginal use and bringing out non-productivity. The supporters of this view criticize unionism, claiming that unions have a negative effect on productivity due to their monopolistic wage increases and restrictive work practices (Turan, 2001). Moreover, criticizing the monopoly powers of unions sporadically, they consider unions as "an attack on the competitive system", "a power shaking the economic structure" and "the biggest problem" (Turan, 2000).

Adam Smith, the founder of liberal doctrines, considered unions as bargaining instruments. According to Smith, as the workers try to gain as much as possible and the employers to give as little as possible, they organize themselves to get their demands accepted by the opposing party. Therefore, organization is used by the workers to increase wages and by the employers to decrease or to maintain them at their current levels. However, in Smith's opinion, unlike employer organizations, labor organizations are generally positioned on the defensive. There seems to be an invisible agreement not to increase wages. Behind the approaches of employers and unions lie economic interests, suggests Smith after 1770s. That is to say, workers organize themselves to improve their economic conditions and to defend their rights. Adam Smith looked for neither a political nor a psychological reason for the organization of the workers (Talas, 1976:107).

David Ricardo defines labor “like all other things, purchased and sold”. According to Ricardo, wages are identified in two forms: the labor’s natural price and market price. The natural price of labor means the price required to enable all workers to earn and to maintain a lifestyle, a living without any rise and fall (Ricardo, 1821). This is the notion with an increase in wages, profits will decline, Ricardo suggests that the economy will be affected by such a condition.

Trade unions among the working class had just begun to be established when Karl Marx introduced his political theories. The presence of trade unions was considered as a curse by the capitalist leaders, so they were prohibited in most countries. Socialist thinkers of that era - the utopian socialists, the petty bourgeois socialists and others could not comprehend the significance of such a working class organization. While some were clearly opposed to trade unions, referring to them as useless and vicious entities, others were asking for prohibition of strikes for their harmful nature to the development and the interests of society (Randive, 1984). According to Karl Marx, the industrialization process would inevitably boost the poverty of the members of the labor class (proletariat) and unionization would be the natural, collective and protective reaction of that said class in order to struggle against such poverty. According to the claims of Marx, at the moment when the laborers started to unite in a workplace, they would continue their organization on a wider scale up to the point challenging the capitalist owners (bourgeoisie) to the point of taking control of both the work place and society. But the estimations of Marx concerning the laborer movement were not realized. The intellectual history of the industrial relations field developed in a non-Marxist perspective; besides, the Marxists generally considered unions to be inadequate in providing a social change among them, both in theory and in practice (Sandver, 1987).

The most important innovation in union - politics relation brought by Marxism, and later by Leninism, focuses on the necessity of maintaining a continuing link between economic struggle and political struggle. As the prominent leader of this view, Lenin argued that economic struggle is inevitably linked with political struggle (Aydoğanoğlu, 2009:37). Lenin paid great attention to the revolutionary consciousness of the struggle of the proletariat. He interpreted the spontaneous labor movement (labor unionism) as an ideological reaction to the enslavement of the

workers by the bourgeoisie. By increasing the awareness in the proletarian class, transforming the unions radically, relieving them of the burden of opportunism and developing the management of labor organizations established by the communists, deterioration of the labor class unity could be prevented (Lenin, 1982:14). When political demands and their corresponding struggle methods were in the forefront, Lenin did not underestimate the functions of economical activities on any condition and considered them to be a part of the revolutionist movements of the labor class in search of democracy and socialism (Lenin, 1998:15). However, the contributions of Lenin could not go beyond the most basic general level.

In a classic study of trade unions in nineteenth-century England Sidney and Beatrice Webbs (Kaufmann, 1989) described what is still accepted today as the basic precondition for the development of labor unions. They identified it as the divorce of capital and labor that accompanies the process of industrialization.

The Webbs observed that in a preindustrial economy most workers are self-employed as independent farmers, craftsmen, or artisans. In this situation the individual worker is, in effect, a mini business firm in which the two functions of management and labor are combined in one person, while the hallmark of industrialization is the replacement of the single producer with more complexes, specialized and large-scale forms of production. The individual shoe-maker who produces and sells shoes, for example, can no longer compete with the capitalist entrepreneur who utilizes machinery and a complex division of labor. The result of industrialization is the demise of the single producer and the creation of a wage labor force that hires itself out to owners of capital. The Webbs identify this separation of the worker from the ownership of the means of production (the divorce of capital and labor) as the necessary condition for trade unionism. (Kaufman & Hotchkiss, 2003:574). According to the Webbs, unions alternatively used mutual insurance and legal enactment methods for obtaining various benefits for their members. As for collective bargaining itself, it was exclusively a trade union method with no implicit or explicit interest on the part of employers. It substituted collective will for individual bargain (Hameed, 1970).

While Stuart Mill and W. Stanley Jevons indicated that unions might increase wages by transforming the nature of the labor market, they also suggested that there was an ambiguity here. For example, according to Mill, there is an undefined zone between the highest wage, which protects national equity and does not prevent it from increasing in parallel with the increase in population and the lowest wage that enables the number of workers to increase in parallel with the increase in employment. Wages are defined as higher or lower depending on the strict bargaining within this zone. According to the Neo-classics, unions are inclined to create or to develop this ambiguity (Biçerli, 1992).

Commons introduced an economic institution definition of "collective action in control of individual action". He acknowledged unions as a compensatory power on the labor side to match the power of corporations and accepted them as an economic institution. The negotiations of economic institution representatives over wages and employment conditions were identified as the "two sided collective action" also known as collective bargaining (Sandver, 1987).

John R. Commons encouraged Selig Perlman in his study on the theory of the labor movement; but the Commons-Perlman theory was Perlman's theory. The theory was raised from his work and his background. He had the superior qualifications necessary to develop such a labor movement theory, applicable both to USA and to all industrialized countries (Witte, 1960). Perlman underlined that collective bargaining does not only focus on wage raises and improved employment conditions, nor does it solely mean a democratic government within the industry (Perlman, 1936).

Robert F. Hoxie (1914) proposed a new concept titled "functional unionism". The presence of deeply varied structural types and diversity of unionism has been generally acknowledged and in addition, it has been underlined that the function of union has a tendency to show differences depending on distinctions in the structure. However, the general functional analysis of unionism possibly goes beyond this definition (Hoxie, 1914). The first and probably the most easily comprehensible functional type can be called business unionism. The terms friendly or uplift unionism may constitute the second functional union type. The third functional type

can be called revolutionary unionism and finally, the term dependent unionism can be given to the last functional type.

3.2 The Evolution of Labor Union Theory

The relationship between unionization and productivity which appears to provide controversial results has attracted the attention of economists and industrial relations researchers for years. It is possible to encounter studies with different opinions and different results throughout a wide range of literature. The effects of unionization on productivity are identified by Freeman and Medoff (1979, 1980a) as two faces of unionism. The suggestion of two faces of unionization is a new view of unionization arguing the non-wage effects and the monopoly face of unions. Table 3.1 illustrates how these two faces of unionization affect the three economic elements.

Table 3.1 The Two Faces of Trade Unionism

Subject: Opinion:	**Economic Efficiency (What & How)**	**Economic Equity (for Whom)**	**Social Nature of Organization**
Monopoly Unionism	Unions raise wages above competitive rates leading to too little labor in reference to capital in unionized firms. Union work rules result in a decrease in productivity. Unions lower society's output through frequent of strikes.	Unions expand the income gap by raising the wages of high-level skilled workers. Unions generate horizontal inequities by creating up differences among comparable workers.	Unions' remuneration distribution causes discrimination. Unions (individually or collectively) struggle for their own specific interests in the political environment. Union monopoly power breeds corrupt and nondemocratic elements.

Table 3.1 The Two Faces of Trade Unionism (Cont'd)

Subject: Opinion:	Economic Efficiency (What & How)	Economic Equity (for Whom)	Social Nature of Organization
Collective Voice / Institutional Response (Non-wage effects)	Unions lead to certain favorable results in productivity – by reducing quit rates, by forcing management to change their production methods and implement more efficient policies and by improving morale and cooperation between workers. Unions gather information regarding the preferences of all workers encouraging the firm to adopt a "better" combination of employee compensation and a "better" set of personnel policies. Unions develop a better communication in between workers and management leading to better decision-making.	Unions' standard wage policies decrease the rate of inequality among organized workers in a certain company or industry. Union rules restrict the coverage of arbitrary actions about promotion, dismissal and similar acts regarding individuals. Unionism fundamentally alters the distribution of power between marginal and inframarginal employees, causing union firms to select different compensation packages and personal practices than nonunion firms.	Unions play the role of a political institution representing the will of their members. Unions stand for the political interests of lower income and disadvantaged individuals.

Source: Freeman, R. B. and Medoff, J. L. (1979). *The Two Face of Unionism,* Public Interest*, 57, pp.69-93*

3.2.1 Conventional Approach of Unionism

Booth (1995: 51) noted that "The standard view of trade unions refers to organizations whose purpose is to improve the material welfare of their members, principally by raising wages above the competitive level. There is little dispute on the fact that unions are frequently able to push wages above competitive level and this is what is called "monopoly" role of trade unions."

Similarly, Freeman (1976) stated that "Standard economic analysis of the impact of trade unions on the labor market is straightforward: unions are monopolistic organizations that raise wages and create inefficiency in resource allocation".

According to Hirsch and Addison (1986:22) society suffers net welfare losses from unionism owing to the resulting inefficient factor mix and misallocation of resources between the union and non-union sectors.

Freeman and Medoff (1984:14) bring three explanations as to how unions cause a reduction in the output of society. Firstly, union-won wage increases result in a misallocation of resources by encouraging organized firms to employ fewer numbers of workers, to spend more capital per worker, and to hire workers of higher quality than the optimum social level. In regard to the monopoly model, firms respond to unionism by changing capital -and other inputs- per labor thereby enhancing the quality of labor up to the point where the contribution of the last unit of labor just equals the union wage rate. While under certain circumstances unions may use their monopoly power to pull down productivity by means of restrictive work practices, competition in product markets does not seem likely to tolerate such practices for very long. An employer who pays a higher cost of labor and receives less rather than more productivity from the work force will close down in a competitive product market. While the monopoly model foresees that unionized firms will generate higher productivity than non-union firms, it is of importance to acknowledge that the monopoly-wage induced gain in productivity is socially harmful (Freeman and Medoff, 1984). Secondly, forcing management to accept the demands of unions strike pressure lowers the rate of the gross national product. Thirdly, union contract conditions such as load limitations within the capacity of workers, constraints on performed tasks and featherbedding degrade the labor and capital productivity.

3.2.2 Latter View of Unionism

While the traditional point of view has been that unions hamper productivity within unionized firms by restricting management flexibility, by engaging in restrictive implementations and featherbedding, and by hampering production through strikes, strike threats, and other adversarial strategies (Reynolds, 1986), a new view of unionism, on the other hand, suggests that unions actually increase productivity.

The 1970s was a period when new and more positive appraisals were developed regarding the effect of unions, and these may be combined under a single “competitive” model. This model argues that unions do not depress the competitive power of organized firms, owing to the fact that the increase in cost due to union pressure for increased wage gains is compensated by way of a positive, union-promoted productivity gain. Either "shock" effects or the provision of a collective voice for the corporate employees may lead to conditions of enhanced productivity condition. The shock argument closely relates to Leibenstein's (1966) X-inefficiency suggestion (Register, 1988).

Leibenstein defined X inefficiency as the failure of an input quantity in reaching the maximum output for any reason (Leibenstein, 1973). Leibenstein (1966) argues that not only the capital and labor outputs but also X efficiency constitutes the basis of a firm’s output. The amount of X efficiency resulting from the efforts of the employees is not only defined by the decisions of a firm manager in corporate costs, amount of production and prices but also by the cooperation between managers from different departments, inspection of labor by managers and of managers by the firm owner, interaction between firms and motivational effects of market conditions (Leibenstein, 1975; 1978). When such inputs do not constitute the least cost combinations, as may be in the case when the firm is not completely competitive, then the progression of unionization will possibly “shock” management towards implementing more efficient practices rather than preferring the choice of ceasing production (Leibenstein, 1966).

According to another organization theory supporting the positive effect of unionization on productivity, unionization is connected with changes in certain procedural regulations and remediation in workers’ motivation and cooperation (Slichter, Healy and Livernash, 1960).

Union management cooperation schemes are generally set up because the employer is having trouble in holding his own in competition, and both his business and the jobs of his employees are jeopardized. In this case, union and management propose a new plan when necessary. To give an example, when management proposes a cut in wages, union may respond in return by suggesting the arrangement of a new plan to

cut down on labor costs while maintaining the wage at the same level (1960: 844). Besides, unions are asserted to be a factor increasing motivation by elevating the spirit of employees and improving productivity.

The other opinion against the monopolist effects of unions is the collective voice/institutional argument advocating the positive effects of unions. The collective voice argument deriving from the work of Hirschman (1970) was also studied by Freeman and Medoff (1984). Hirshman (1970) identified three alternative mechanisms in the labor market as exit, voice and loyalty. Hirshman asserted that people, when confronted with problems, prefer to leave the organization reffered to as "exit", to express their discontent while staying in the business called "voice" and finally, to stay in the organization or to extend their stay by showing commitment despite their content at the workplace called "loyalty".

Under the impression of dichotomy of Hirshman, Freemand and Medoff (1980b) underline that unionization has a second face besides its monopolist nature. The other side of the coin is the CV/IR (Collective Voice / Institutional Response). Voice in the labor market is interpreted as the possibility of discussing disturbing conditions between the employer and the employee rather than leaving the job. It is deemed hard for the employee to do this on his own because he fears that he will be laid off. But the collective voice strengthens communication by explaining collective discontent to the management and provides a common solution to problems. By supporting the implementation of certain work rules and conditions of employment (which may or may not be cost effective for employers after unionism has been put "in place") that are requested by workers, particularly what the industrial relations experts call the industrial jurisprudence system, union "voice" may possibly reduce the level of exit (Freeman, 1980b).

It is expected that the reduction in quitting will probably lower hiring and training costs and enhance firm-specific investments in human capital. It is certain that lower quitting levels will result in less disruption in the functioning of work groups. Interestingly enough, apart from the decrease in quits as a result of the union providing direct information about worker preferences in the manner described

earlier, the transmission mechanism between voice and performance is opaque in the voice model (Addison and Belfield, 2003).

3.3 The Effects of Unions on Efficiency and Productivity

The effect of unions on corporate productivity has been a debated question in the literature for a long time, with controversial results (Maki, 1983a). The modern approach emphasizes the positive effects of unionization on productivity while the monopolist (classical) approach has a negative view on the phenomenon. In fact, the reasons behind the relation between these two concepts can be seen as highly complex in various ways and directions. Freeman and Medoff suggest the possibility of unionism increasing productivity in some parts while decreasing it in others (Freeman & Medoff, 1979).

Ichniowski (1984) claims that the number of pages in a labor contract has a negative correlation with productivity, while Johnson (1990), with a different approach, suggests that the wage premium option for union workers plays a role of intense stimulation, as it helps to deceive the employees by making them work harder. He therefore supports unionization in productivity.

The empirical researchers have found negative, positive or no significant relations between unionization and productivity. Before discussing such empirical researches, the emphasis in the following section shall be put on the possible effects of unionization on productivity. Table 3.1 gives the main lines of the effects of unionization on productivity as asserted by Freeman and Medoff.

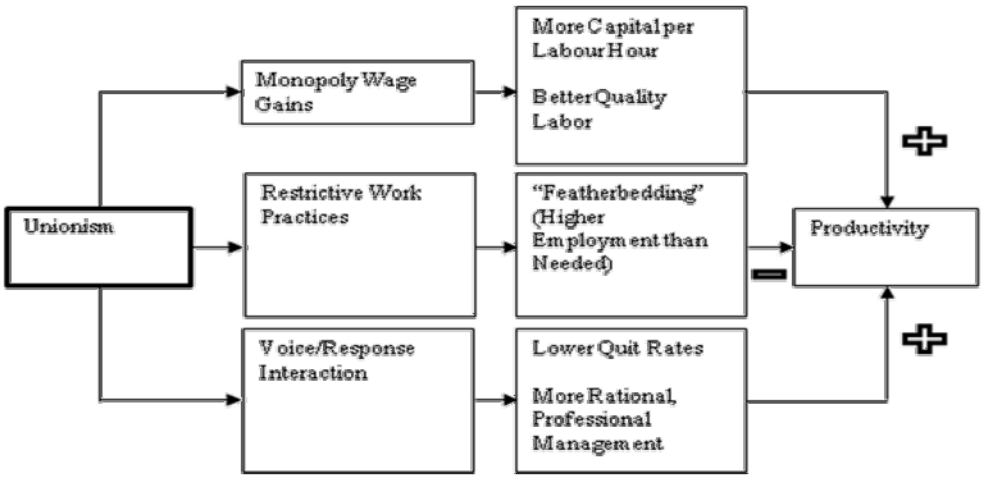

Figure 3. 1 Positive and Negative Effects of Unionism on Productivity

Source: Freeman, R. B. and Medoff, J. L. (1979). *The Two Face of Unionism,* Public Interest*, 57, pp.69-93*

It should be noted in this regard that certain dimensions of union practices which are covered under the same or similar headings may create both positive and negative consequences, depending on the groups assisted by these functions, i.e. employers (firms), workers, or the economic system in general. An example may be found in the unions' shock effect which on the one hand stimulates technological advances, thereby leading to productivity improvements, while on the other hand union practices like restrictive work practices or unions' occasional reactions to technological changes tend to affect productivity adversely. One may go even further by showing examples of how the same dimension produces diverse consequences for the same group. For example restrictive work practices by unions may be functional for workers by making work for members, thus maintaining the existing employment levels, but they may also encourage the firm to adopt labor-saving devices, thereby leading to cutoffs in employment volumes. This is the well-known principle of intended or unanticipated consequences of social action; the net balance of consequences, negative or positive (functional or dysfunctional) concequences should be evaluated for the specific group or dimension concerned, but in most cases reaching a definite conclusion on that net balance is rather speculative and difficult to estimate in numerical terms. Productivity increase or decrease caused by unions is a case in point. Analysis in Chapter 3 on the effects of unions on productivity and

efficiency should be assessed under the realities espoused by the principle of multiple consequences of social action. The net results of actual implementation are usually determined by the power relations of the actors, as implied by Dunlop's System Approach.

3.3.1 The Positive Effects of Unions on Productivity

3.3.1.1 Collective Voice / Institutional Response

The CV/IR model introduced by Freeman and Medoff (1980) is shaped around the exit, voice and loyalty conflict of Hirschman (1970). Hirschman asserted that two contrasting but mutually exclusive (1970:15) behavior options exist for employees who are dissatisfied with a firm or a product; exit and voice. Hirschman defines exit and voice options as follows:

> *Some customers stop buying the firms products, or some members leave the organization: this is the exit option. As a result, revenues drop, membership declines, and management are impelled to search for ways and means to correct whatever faults have led to exit (1970:4).*

> *The firm's or organization's members express their satisfaction directly to the management or some other authority to which management is subordinate or through general protest addressed to anyone who cares to listen: this is voice option. As a result, management once again engages in a search for the causes and possible cures of customers' and members' dissatisfaction (1970:4).*

The voice power of employees within the firm is an alternative to the exit. The decision of the dissatisfied workers to leave the firm depends on the level of effective use of the voice. If workers are convinced enough that the voice will be effective, and then they might well postpone the exit. Once you have exited, you have lost the opportunity to use voice, but another way of action is possible; in some cases, the exit will therefore be a last resort reaction after voice has proven ineffective *(1970:37).*

Hirshman asserted loyalty behavior as an alternative to exit and voice options. Defined as the commitment of employees to the firm, loyalty is in mutual interaction with exit and voice options. The loyalty concept plays a key role in the battle

between exit and voice so that it may result in longer commitment of members to the company causing them to prefer use of the voice option in a more determined and resourceful manner. Besides, it also lends an implication of disloyalty to the exit option (1970:82), by contrast.

Loyalty discourages exit and activates voice. It is true that an individual member about to become discontented with the operation of an organization can continue being loyal without raising his voice, but hardly without the expectation that someone will act or something will happen to improve matters (1970:78).

Inspired by the exit-voice theory of Hirschman, Freeman and Medoff (1984) emphasized that other aspects of unions are the *collective voice and institutional response face* (CV/IR). Unions provide the opportunity for the workers to freely express their dissatisfaction about employment terms and conditions, conveying their "true" preferences to the management without being afraid of falling into bad blood as well as efficiently "policing" or inspecting the employee service contract. It is possible, on the other hand, for the firm to minimize the costs of transactions and training as well as opportunism in a more satisfactory manner and to create a more efficient combination of remuneration and other employment terms which will very likely provoke, on the worker side, a greater worker force and motivation. Thus, it would be hardly unexpected that a firm infused by union voice proves to be more efficient in potential (Turnbull, 1991).

According to Freeman and Medoff (1979), in order for voice to be effective at the workplace, collective rather than individual bargaining with an employer is necessary for two reasons: In the first place, most of the important aspects of an industrial arena are classified as "public goods" and by limiting the stimulation for every single person to express their preferences and invest time and money in changing conditions that provide benefit for all, they affect the comfort of every employee in either a negative or a positive way. Safety measures, lighting, heating, the pace of promotions, layoffs, work sharing, cyclical-wage adjustments and promotion policies of the firm, an official grievance procedure or a pension plan all affect the workforce in the same way that defense sanitation and fire protection affect the entire citizenry.

Without a collective organization, it would be highly challenging for the individual himself to change these conditions or to make such investments.

The second benefit of collective voice is that workers not yet prepared to exit may tend to hide their true performances from the employer in fear that they will be pushed by the boss anyway. Fear of job loss limits the individual reactions and makes it risky to offer explanations. Individual protest results in layoff of the protestor. Collective voice ensures equal rights for each worker by preventing discriminations to derive from employment conditions of workers with regard to hire or tenure. Thus, the requests of all workers are also represented in this manner.

3.3.1.2 Encouragement of Technological Development and a Better Management by Unionization

It was suggested that unions resist against technology through restrictive work rules in the discussion on the negative effects of unions on productivity in the next section. As a matter of fact, there is a possibility that employers are prevented from preferring their own profit maximizing (the most efficient) production technology as a result of numerous work rules included in the negotiations of unions ranging from the infamous “make work” and “feather-bedding” practices to simple seniority systems (Maki, 1983b). But it cannot be asserted that this observation is true and effective on any condition.

Kefee (1994) underlines that the effect of unionization on technology is presented under four hypotheses in economy and industrial relations literature. One hypothesis suggests that diffusion is accelerated by unions by sustaining high wage policies or creating a positive environment in which it is possible to administrate technological change. On the other hand, negative scale effects or union rent capturing assert that unions place a hindrance against modernization by depriving the firm of the required capital by demanding high wage amounts or by establishing work rules that cause the implementation of new technology for the union labor to become to expensive to be afforded. As an alternative, bargaining models or efficient contract models reveal that since higher union wages are compensated by the increase in productivity, the

capture of economic rent or efficient bargaining, it may be possible that unions have no effect on technological diffusion. Finally, institutional and historical perspectives indicate that the union effect is not a single element, because there are different unions operating in different environments and they have different political leaderships and formulate distinct and dissimilar policies with regard to technology ranging from encouragement to opposition.

Unionization is a threat for firms in perfectly competitive markets. Firms set off the capital labor balance as a result of the rent captured with the increased wages earned by unions through collective bargaining. This is only possible through increasing the capital per capita. In a competitive market, firms tend to expect an increased production by investing in technology rather than the expensive labor so as to balance the wage increases causing cost increases in firms. This is the technology encouragement effect of unionization.

Technological change, moreover, puts a general effect on the increase of demand for qualified labor. So far, it has resulted in creation of many new professions (i.e. aircraft pilot) and in a great increase in the share of skilled craftsman (pattern makers, tool and die makers, boilermakers, welders) in the total labor force. While the development of new models and products often require an exceptionally high number of skilled men, they are also needed for the maintenance and repair of equipment and structures (Slichter, Healy and Livernash, 1960: 344). Although development or introduction of technology in the workplace result in less skilled labor pushed out of the labor market, it increases productivity by allowing a more efficient and quality production.

While there are many studies asserting that unionization places negative effects on technology, there also others suggesting the opposite in literature. Schnabel and Wagner (1992), in their study conducted with data from influence of unions on innovative activities in Germany, revealed that trade unions do not have a negative impact on innovative activity. Dowrick and Spencer (1994) suggest in their study that union power at first places a positive effect on the relative R&D performance of the firms except the condition that the union density is remained at a high level and the union only negotiates on wages. Kefee (1994), after his analysis of information

gathered by the 1983 Industry Wage Survey of the Nonelectrical Machinery Industry, found that unionized facilities are more likely to use advanced technology rather than non-union ones. Tauman and Weiss (1987) discovered that unionization can certainly encourage the adoption of labor-saving technology provided that the technological improvement is at moderate level.

Another positive influence of unionization on productivity is the shock effect of unions on management resulting from unionization. The shock effect was identified as one of the positive effects of unionization in 1960 for the first time by Slichter, Healy and Livernash (1960). Being shocked by the wage increases demanded by the union, the employer may quit the slackness and make more production with the same input. Slichter et al. denote a better management, a better balance between the interests of employer and employee and better communications.

3.3.2 The Negative Effects of Unions on Productivity

The reasons for lower labor productivity on the basis of the presence of unions are as follows: First, unions may be associated with restrictive work practices. Second, union firms may invest less than non-union firms. Third, as a result of strikes, production is cut off. Fourth, wage increases coused by unions above competitive levels create allocative inefficiency in the market by increasing lay-offs in the union sector. And finally, seniority-based practices of unions and worker appointments and promotions not based on performance are among other productivity decreasing factor.

3.3.2.1 Restrictive Work Practices

Pencavel (1977) proposed that restrictive work practices result from “union malfeasance”. Workers feel safe against the employer as a result of their rights earned by the union against the employer after collective bargaining. The rules to be applied by the union that are not appreciated by the employer cause a greater malfeasance on the part of union. In point of fact, the union may be able to validate this misconduct through work rules and operate in a conventional cartel-like fashion.

Nicknell and Nickolitsas (1997) analyzed the longitudinal data of 66 manufacturing companies in Britain and suggested that agreed reductions in restrictive work practices led to an increase in productivity. Grants of incentive shares were proposed for promoting the motivated working of the employees in order to prevent the decrease in production.

Restrictive work practices may be classified under three major categories which include rules that seek hiring of unnecessary workers; restrictions upon technological improvements in processes and rules requiring performance of unnecessary work and restriction of output.

3.3.2.1.1 Rules Requiring the Hiring of Unnecessary Employees

The articles that are included in work contracts could stipulate that the firm must hire more workers per machine than would conceivably be productive, which is described as "featherbedding" ("over manning" in the United Kingdom) (Johnson, 1990). The studies conducted in the 1950s suggested that the existence of featherbedding was higher in craft unions operating in railroad, construction, printing and entertainment industries in USA. The reason offered for this condition was that such behavior patterns were an attempt to mitigate technological change (Daykin, 1956). Similarly, Ryan (1974) asserted the detrimental effect of featherbedding applications on productivity.

The full crew rule, which specifies the minimum number of workers to be employed for a given task, can be given as an example of this situation. Full crew rule, was for many years an important subject in the American railroad industry, which necessitated the need for a fireman on diesel locomotives in freight and yard service. The long disputes on this issue were resolved in 1972 with an agreement that permitted railroads to run most diesel locomotives without a fireman. A similar application in the transportation sector is the requirement of a third seat in the USA airlines industry (Weinstein, 1964).

Likewise, concerning employment in bands of musicians, the union specifies in the collective agreement the minimum size of bands that can perform on various occasions. It sometimes stipulates that standby bands of local musicians be hired, even if they do not actually perform.

One of the rules that hurt productivity is extra work rather than extra people which is required by unions. For example, some locals of the typographers' union have demanded that advertising material received by newspapers mats be reset at a later date. The mat is used to save time; the reset material or bogus is scrapped and serves only for the purpose of giving work to local compositors. If the bogus can be set in slack periods, the cost of employer for employing more workers decreases and the productivity per capita increases (Rees, 1989: 126).

Similar to these examples, make-work requirements also cause extra work rather than extra people. For example, unions may prohibit the use of spray paint gun in painting field or restrict the scale of the width of the paint brush to be used. By doing this, the work amount requiring less numbers of employees turns into a work that can only be completed with more employees or it takes more time to complete the same work. This serves as an example for decrease in productivity.

No output generator jobs are subject to certain work rules; this is another featherbedding application. Numerous similar rules were in force in the West Coast longshore industry. When the gang was called for operation in the ship, it was obligatory to make full time payment even if they did not work full shift and it was impossible to move on to a different ship. Another example requires the presence of "witnesses" during bulk loading in the Pacific ports. During the shipment of grain and similar bulk goods by getting use of the gravity to load them in the ship, there were certain working rules requiring a team of longshoremen (Bridgman, 2010).

3.3.2.1.2 Restrictions on Technological Improvements in Processes

Since the inception of technological improvements in the production process, laborers have been exposed to job losses. Without exception, unions cannot prevent

the negative effects of technology on employment. Restrictive work policy of the unions regarding prefabricated products is in parallel with their attitude towards technological advancement. The attitude of the American Federation of Labor building trades can be given as an example. In New York, the factory-assembled toilet, lavatory, and other fixtures are not installed. Similarly, carpenters refuse to install wallboards. In many other localities, the plumbers insist that all pipes be cut and measured on the job (Randle, 1948). All these practices are designed to preserve existing employment.

3.3.2.1.3 Restriction of Output

One of the restrictive work practices is the application of limits on production by the unions which is called restriction of output. According to Furness, restriction of output has more relation with the policy of trade union regarding process intervention and production guidance which aims towards creating standard employment volume and worker remuneration (Furniss, 1969). In certain cases, unions may implement output restriction by attempting to restrict the hourly, daily or weekly production per worker.

According to Rees (1989: 129), this restriction may be caused by three reasons. First, when the workers believe they will be laid off when the seasonal orders are completed, they tend to delay the work. Second, output restriction can be used to prevent a work pace that is too rapid for the least able workers. The purpose in this kind of limitation is to prevent the discipline or discharge of these individuals. And third, it may be applied as a way of gaining income by incentive pay and labor rates for piece work. If the workers believe they will earn more money by carrying out a certain job, they hope to gain more by decreasing the production reasonably. Another example in this context is the situation which evolves when new technology brought in to the work place does not create the estimated change in time employed, because workers may generate the same amount of production while decreasing their working pace (Rees, 1989:129,130).

The following can be given as an example for output restriction; an agreed payment amount for handling a defined minimum number of tons in a shift may be taken as the basis in traditional sea port incentive schemes. For example, the minimum tonnage rate per shift bales of American cotton in Barcelona is 180 tons. It is inevitable that workers not willing to work for a higher amount than that agreed to will cause a decrease in productivity (Harding, 1990).

3.3.2.2 Union Firms may Invest Less than Non-union Firms

Unionized firms share their superficial profits with the union. Investments of unionized firms in capital equipment and research and development may be less than that of non-union firms (Grout, 1984), or their return may be at a lower level therefore causing less investment in the future.

There may be two reasons for this. First; the earnings of unions regarding wages have a certain cost for both employers and employees. This cost, generally as a high product price, will be reflected on consumers. In other words, on the employees again. On the other hand, this will be reflected as lower profit margins for the employers. Lower profit margins mean restricting new investments for capital owners.

Second; technological investments in a corporation may sometimes cause negative effects on union and non union employees. Installation of new hardware and purchase of machinery may be regarded as employment decreasing effects. The workers answer this change by slowing down the work or achieving lower production than required (Mills, 1994). Investments are reduced to prevent the union from abusing its power and to eliminate possible disputes. It is probable that capital will be kept idle due to manning disputes. This situation cuts off the return on investment and results in under-investment (Metcalf, 2002).

Many studies on the effect of unions on investment in literature suggest a negative relation. Bronars and Deere (1988) indicated that firms in industries with higher unionization rates prove to have lower capital and R&D investments as well as lower

capital-labor ratios. The same researchers Bronars and Deree (1993) also proved a significant negative relationship between unionization and both tangible and intangible capital investments. Similarly, Hirsch (1992) examined 706 U.S. firms during the 1970s in terms of differences in investment activities between union and non-union members. In parallel with a union rent seeking model, collective bargaining at firm level is deemed to have an association with significantly lower rates of physical capital and R&D investments. Kuhn (1998) also suggested that unionization may result in a decrease of investments in some Canadian companies. Another study executed in Canada reveals a negative non-linear relation through the analysis of data on 18 industries for the years 1967-87 (Odgers and Betts, 1997). Denny and Nickell (1992) uncovered the negative effects of unionization on investment. The preliminary analysis of two data sets (a cross-section of plants and a company panel for the years 1983-90) in a U.K. study of Menezes-Filho et al. (1988) points at the negative correlation.

In certain situations, however, it can be seen that the employers put in use rational operation policies to compensate for the decrease in profit rates. In this context, the unions promoting the use of new technologies may provide productivity growth. But, new technology means new investments. It is possible for the employer not to engage in new investments due to expenses brought up at higher levels. There are findings which prove that the relation between unionization and new technological investment is not linear under every condition (Lordoğlu & Özkaplan, 2007:316).

3.3.2.3 Strikes

When the union and the employer fail to agree on concluding collective work agreements, strikes happen. Workers consider the labor strike as a weapon against certain attributes of the industrial workplace such as low level of wages, insensitive management, injustice and similar behavior. Although not all of the strikes succeeded in achieving their targets, a substantially sufficient number of them provided a real threat for the management by stopping the production process in case of unfair work conditions. While the workers and the unions consider strikes as their economic well being in the long term, the work stoppage imposed costs on both the

firm and the workers (Nordlund, 2010). Similarly, it is true that strikes may become highly exhausting when they last a long time.

Numerous studies have been conducted on the effects of strikes on productivity, production loss and work-days lost, which have led to different conclusions. While the study results may contradict each other in certain cases, they have generally found the productivity effect to be negative.

For example, Maki (1983) seeks to provide an explanation for the effects of strikes in terms of productivity growth by using cross section time series data covering twenty countries. He concludes that the increase in strike activities means the decrease in productivity growth in most cases. Besides, he underlines that, given that the term normal is predefined as an average in a certain period, when the strike activity is at a higher level in a given year, it can be expected for the productivity and therefore for the growth in productivity to be lower than normal levels in the concerned year.

Another example is the time series study of Flaherty (1987) in productivity in the auto industry based on quarterly data starting from 1961 through 1981. He found the important role of the wild cats in productivity slowdown in the mid 1960's. The evidence analysis resulted in a strong and sometimes complex relation between the strikes and the productivity shift rate in the auto industry. The strike activity and associated worker behavior is in relation with the velocity of productivity change in the automobile industry in USA.

The study of McHugh (1991) investigated to what extent the strikes negatively affected productivity in nine manufacturing industries; besides other industries of suppliers or purchasers in connection with the affected sawn lumber industries are analyzed using intervention analysis of 1967 - 1981. According to the results of the analysis, the strikes were in relation with more significant productivity declines statistically in the linked industries than in the industries which experienced strikes themselves.

In his study, Bemmel (1987) suggested that the strikes had strong negative effects on productivity by investigating the data from 46 plants in 7 industries, using translog production function.

A detailed study is the Knight's (1989) practical solution based on Bemmel's (1987) estimation. The three estimation criteria for the strike activity effect on production used in the study were: the strike frequency, the number of lost days and the average duration of the strikes. The lost day variable does not possess a significant influence on labor productivity. The strike frequency and the duration impose a different and contradictory impact. The relation between the strike frequency and the labor productivity is positive. The high level of frequency is in a positive correlation with labor productivity and in general, it is not completely compensated by the negative effects of the duration of strike.

Another significant study in this context suggests a little more different results. In their study, Neumann and Reder (1984) investigated the relevance of the strikes and their results on the affected manufacturing industries. One significant result of this study is that no strike effect is observed on the industrial output in many manufacturing industries. Even if it is proved that the strikes impose considerable effects on the industrial output, they stay at a low level when the net output loss is evaluated.

Maki (1985) examined the effects of five major strikes in the British Columbia sawmills during the period 1959-1974 on production, shipment and inventory. According to the results, the prestrike effects constitute about 30 percent of the gross loss while there is no significant post strike effect.

3.3.2.4 Wages and Spillover Effect of Labor

Oswald (1982) defines the unions as the coalition of workers of similar skills. When the coalition is sufficiently large to be able to influence the wage rate paid to its own members, this is called the monopoly effect of the unions causing an increase in the price of labor. Pencavel (1977) suggest that in order to prevent firm themselves because of the increased costs, certain methods such as restricting entry into

employment through apprenticeship rules or hiring provisions can be applied. With the alteration in the capital-labor ratio, the number of workers in the firm declines. By doing this, however, the firm will settle at a different point on its production frontier, but, since it remains on the same frontier, production is technically efficient. While the firm tries to offset itself with layoffs, the displaced workers will be in the search for a new job.

Unions may indirectly cause the crowding of workers into non-union jobs, lowering wages there. On the other hand, the decline in the quantity of union labor hired implies that some workers who would have otherwise had union jobs are forced to find jobs in the non-union sector. This effect implies an increase in the supply of labor to non-union firms (Kahn, 1980). Employment rate rises in the nonunion sector as a result of the shift of laborers laid off from the union sector towards the nonunion sector. According to Borjas, as wages and the marginal product value of effort show differences in two different types of union status sector, unionization creates inefficiency in resource allocation in economy. If the marginal worker recruited by nonunion companies worked in a union sector, then the productivity would be higher; therefore it can be suggested that when certain workers are redistributed among sectors, the value of the effort will provide a higher contribution to national income (as cited in Turan, 2001).

Biçerli (2007) explains this issue by giving an easily comprehensible example: It is assumed that the labor market is comprised of two sectors as union and non-union sectors. Let's pretend to make it easier to understand by assuming that if the same demand curve is valid for a certain labor type in both markets, the employment level does not change and the market is in full competition. The following figures show the wage generation in both markets. When there is no union, the competition will provide the wage generation at Wn level in both markets. Now, let's assume that workers in this first sector are organized. Depending on the unionization given the wages, a number of workers in an amount of the unemployed in the union sector as "L1'-L2"' will transfer into the second non-union sector. The labor amount in the non-union sector will increase by "L1L2" with these new workers and the wages will regress down to Ws level. While the production increases by the "L1L2cd" filled area with the increase in employment in the non-union sector, the production

decreases in the non-union sector by “L1'L2'ab” with the decrease in employment; and when the production decrease and increase levels are compared, it can be suggested that the production decrease by “cdab” in the union sector cannot be compensated by the non-union sector and a production loss occurs for the entire economy (Biçerli, 2007: 360).

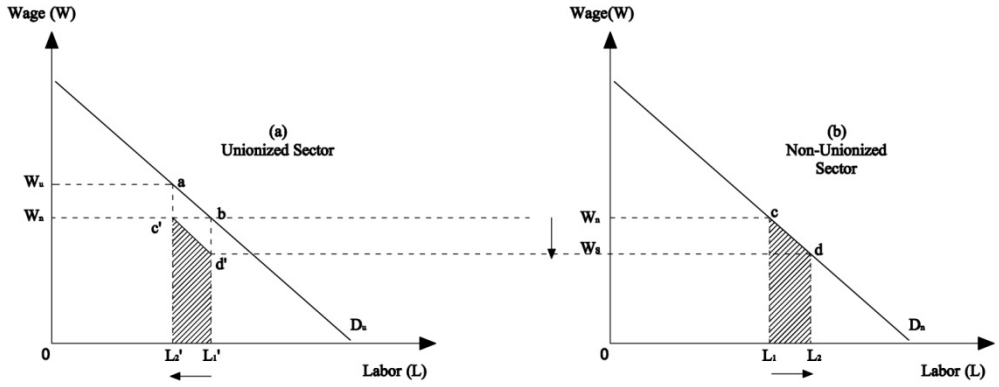

Figure 3.2 Wages Movement based on Union Status

Another negative effect of unions on productivity is the seniority-based practices by unions. While unions advocate that employee appointments should depend completely on seniority, employers suggest that they should be appointed according to the assessment of their skills. When the union has a strong bargaining power in appointment, the company is exposed to loss of productivity as it cannot recruit the more skilled and effective employee. The same works for layoffs. While employers give the layoff priority to the employee with the least contribution to the company, unions suggest the employees with the lowest seniority level should be given priority when they are laid off (Biçerli, 2007). As a result, the implementation of seniority principle in promotions and appointments decreases the average worker productivity in the business. In other words, the implementation of the seniority principle in promotions, appointments and reemployments reduces the effect of the horizontal labor liquidity on production below the optimal level (Zaim, 1965).

3.4 Review of Literature

3.4.1 Introduction

Present-day empirical studies on productivity are traced back to their beginning in the 1960s while the question is still subject to current studies. 71 articles reviewing productivity of unions, productivity increases, efficiency and firm performance will be listed on a country basis in this chapter.

USA and United Kingdom are the countries where studies on productivity of unions have been most frequently made; approximately 80 percent of the studies referred here belong to this group. However, Canada, Japan, France and some other countries contribute also with certain studies in this concern both in a theoretical and an empirical way. Of the studies to be referred to in this chapter, 63 percent are by industry, 16 percent by inter-industry and the rest are company based and other fields.

Different results have been obtained from the studies in the literature on the effects of unionization on productivity. It is possible to find some studies in which the productivity effect was shown to be positive, negative or insignificant. Even contradictory relations were observed in some studies covering two different time periods but in the same industry. In a similar sense, studies investigating different industries within the same period can yield different findings. When the totality of the investigated studies is concerned, 31 percent are found to offer a positive and 30 percent a negative result. The remaining studies are comprised of the studies with either variable or insignificant results. In order to summarize the results of the studies on a country basis, it can be concluded that studies conducted in USA resulting in a positive relation between unionization and productivity amount to 21 percent of the studies reviewed herein, and again among the same studies in USA, findings with negative relation constitute 13 percent. On the other hand, 6 percent of all the studies conducted in UK are made up by studies which resulted in negative findings. Since there have been conducted only a few studies on the effects of unionization on productivity in Turkey so far, only 6 percent of the literature screening included in this thesis is allocated to studies in Turkey.

3.4.2 Literature Review

The impact of unionization on productivity has been the subject of an ample number of studies, both theoretical and empirical in the fields of industrial relations and labor economics. These have often resulted in contradictory findings. The diversity of the findings, which are known to cause disputes, has often been explained by the variation in data, definitions, techniques and methodology.

In the orthodox view of economics, it has been claimed that unions have a negative impact on the labor market, through such means as restraints on relative wages, limitations on layoffs, and restrictions on employment. Further statements have been made on unionization with respect to its driving up unemployment and losses in productivity.

In contrast to conventional points of view, Harvard economists Freeman and Medoff have put forward controversial claims that unionization can lead to an increase in productivity, postulating two faces of unionization: the monopoly face, and the collective voice / institutional response face (Freeman & Medoff, 1979).

According to this theory, a positive impact on productivity is the outcome of workforce-related factors such as decreased labor turnover, enhanced cooperation and morale, and more effective dispute resolution. Unions, offering an effective platform to raise the collective voice of the workforce, open up communication channels between the workforce and management that lead the way to improving working conditions, more efficient policies and methods of production. Therefore, instead of exiting, employees would be able to express discontent, and to resolve outstanding issues. Subsequential improvements in working environment would result in a more satisfied, collaborative, and productive group of employees.

Apart from the theoretical analyses, empirical studies on the subject matter can also be found in abundance. These have also suggested contradictory findings, where certain studies suggesting a positive impact and others showing negative effects. Furthermore, some research has demonstrated a statistically insignificant relationship

between unionization and productivity. These studies have been carried out in a variety of sample spaces, covering industry, inter-industry, and firm levels. The distinct industries that have been subject to research were cement, coal, construction, hospital, banking, furniture and education, among others, as exemplified in the literature review.

In support of the hypotheses brought forward by Freeman (1976), a pioneering study by Brown and Medoff in 1978 employed the Cobb-Douglas productivity function modified with a unionization variable, using US manufacturing industry data from 1972. Holding the capital/labor ratio and the worker quality as constants and using gross added value as the dependent variable, they have found unionization to have a positive impact on productivity. It was concluded that the companies with higher unionization density show higher productivity levels by 20 to 25 per cent. On the other hand, Brown and Medoff (1978) also state that the realistic impact rate is actually around 10 to 15 per cent due to the high level of capital utilization in unionized companies. Additionally, they believe unions are more likely to organize in high-efficiency companies. Finally, this study also points to the effect of unionization on the quit rate. If the quit rate is also considered within the production function, we discover that the impact of unionization is decreased by 20 per cent.

The findings of the Brown-Medoff study are supportive of another study by Frantz (1976) two years earlier. In his study, Frantz found that unions had caused a 15 per cent increase in productivity levels in the wooden household furniture industry.

A similar approach to that of Brown and Medoff was assumed by Clark (1984), in that he has also kept value added as a dependent variable in the production function. The study includes inter-industry research that uses sample data from 250 large companies within 1970 – 1980 timeframe. Data was collected by means of inviting the participating companies to fill out annual statistical surveys on an individual business level. The impact of the union on economic performance was measured by sales and value added per employee. Clark also used market structure and the age of capital as control variables, but found that these have a negligible impact on the union coefficient. In conclusion, the research demonstrates that the union effect on productivity is 0.01 where control variables are used regardless of the dependent

variable. The effect is estimated to be - 0.02 and -0.03 when sales and value added variables are used, respectively. Clark concludes that unions have barely any effect on productivity.

The approach used by Brown and Medoff has been criticized for having a number of limitations. Addison and Hirsch (Addison & Hirsch, 1989) have pointed out that the usage of value added as an output measure confounds price and quantity effects, a fact also noted by Brown and Medoff themselves. Addison suggests that wage increases imposed by unions result in reflected increase in product prices, thus inflating the value added of the company. It follows that higher prices in the unionized sector may be responsible for some of the union productivity differential, resulting in an overestimation of the union effect. An alternative approach would be to replace value added with physical output in the production function.

The US cement industry has been subject to studies where the tons of cement produced per worker (instead of value added per worker) has been employed as the measure of productivity. In his study, Clark (1980a) has used data from 119 union, and 9 non-union plants for four years during the early 1970s. He has applied several controls, including ratios of capital to labor and supervisors to labor, size of the facility, average utilization, vintage, and plant-specific effects. The empirical evidence from the study suggests a positive productivity effect of unionization within a range of 6 to 8 per cent, in both cross-section and time-series data. Clark also suggests evidence that the union policies in different industries will create diverse effects of union/productivity relationships.

Another study on the same industry was performed by Clark (1980b), where he similarly used the tons of cement production per worker as the indicator of productivity. This study relies primarily on the time-series data obtained from six cement plants that changed from non-union to union status during the 1953-1976 period. The analysis incorporates not only the statistical implications of the union effect, but also data derived from interviews with union and company officials. The data measured include the worker adjustment (exit behavior, morale), management adjustment (after and before unionization) and practices procedure. The amendments to the labor contracts are found to bring major changes in both workers and

managers. Out of the 6 firms, the turnover rate has dropped in three, increased in one, and remained unchanged in the other two. Morale has escalated in three companies, and all companies have replaced their operations managers with new ones with more competent performance. In conclusion, this study empirically demonstrates that unionization has led to increased productivity, primarily due to substantial changes in procedures and management staff.

Allen (1984) has utilized the Brown-Medoff methodology to estimate the union effect on productivity in the American construction industry, using value added as an indicator of productivity. This study shows 44 to 52 per cent higher productivity levels in unionized contractors than in non-unionized ones. The estimated effect decreases to 17 to 22 per cent when value added is deflated by the construction price difference between areas.

Allen (1986a) has recorded further assessments of the effects of unions on productivity in another study, which estimates the effect of public and private ownership on productivity in the construction of hospitals and nursing homes. The sample data set contained 36 union and 8 non-union observations, where 31 of them were owned privately. In the sample of union contractors, privately owned projects have been found to have much higher productivity than the public ones. When only the private projects were taken into account, the union/non-union productivity differential was shown to be generally positive, but quite imprecise. Public projects, on the other hand, actually showed no evident differentiation between union and non-union contractors.

Another study that deflects the limitations of using value added by using physical output instead is the study conducted by Allen (1986b) on the construction industry, where he examines the difference in productivity between union and non-union contractors. The study is carried out on two separate data sets, namely the 83 commercial office buildings completed in 1973-1974, and the 68 schools completed in 1972. In the former data set, the units used are in terms of square feet of space, while in the latter the unit is student capacity. In the office building project, the study demonstrates an increased productivity in the union contractors in the order of 30 per cent. The productivity gain in the school building projects, on the other hand, was

estimated to be from 0 to 20 per cent. The fact that schools are so heterogeneous that output cannot be represented by single measures, and the restrictive regulations of the local and state authorities on school buildings have been named among the factors that affect the differential between the school and commercial projects. Allen's findings on the commercial projects are supportive of those he reached in one of his former studies.

To answer his remaining questions from previous studies Allen (1988b) examines the impact of unionization on efficiency in retail store and shopping center construction in the late seventies. The study examines profitability, cost and profit differential. As in his previous studies he used value added per hour or square feet per hour as an indicator of productivity. The productivity and price studies were analyzed using a Cobb Douglas production function, and the cost and profit comparison are obtained from a translog production function. Comparison of union and non-union contractors in 1977 shows productivity is 51 percent greater for union than non-union contractors. From his findings, he concluded that this increase in productivity was sufficiently large so as to compensate for the wage differential and, as such, there was no significant difference in unit cost.

Mandelstamm (1965) has studied the effects of unions on efficiency in the construction industry in two cities in Michigan, USA. One of the cities he chose for his work was heavily unionized, while the second was not at all. In order to estimate the efficiency of the construction workforce, he conducted interviews with contractors, sub-contractors, union leaders, and building inspectors; asking their estimation on how long it would take to get a certain construction job done. This research has provided some evidence supporting the idea that unionization brings an increase in efficiency. Furthermore, it also suggests that the costs were only slightly increased at unionized constructions.

The restrictions implied by the use of value added instead of physical output aside, Mitchell and Stone (1992) also points out that inadequate controls for output quality and input usage, important omissions if the higher cost of unionized labor results in less labor-intensive products and techniques. They criticize the Clark studies, for instance, in that they do not distinguish bulk cement from bagged cement, the latter

being more labor intensive. This study emphasizes the deficiency in the physical output measurement since unionized companies would be inclined to alter their production techniques toward less labor-intensive methods. It follows that unionized companies which have switched to bulk production techniques may register higher output volumes, thus inflating the unionization effect on productivity.

Circumventing the above problems, Mitchell and Stone (1992) studied the sawmill industry. Their study included 83 sawmills, 46 of which are unionized and 37 non-union in the year 1986. They collected data relating to quantity and quality of output, major inputs, and union status. The input variables collected were production hours, supervisory hours, capital stock and saw timber. Unionized plants were found to be significantly less productive than non-unionized plants by about 12-21 per cent. Omitting the controls for product quality and raw material usage, the estimated union effect on productivity shows an upward bias and has no statistical significance.

In his research, Boal (1990) has used the panel data referring to 83 different coal mines in the US, dating back to 1920–1925 to estimate the union effect on productivity by means of an econometric analysis. His findings reflected that the effect was not prominent across all companies, and could not yield a uniform result. He has also pointed to a variation in the results with respect to mine company size, where unionization caused a significant reduction of productivity at smaller mines. He has brought an explanation to this variation in terms of the concrete differences in management and union leadership between larger and smaller companies. Further evidence resulting from this study suggests that unionization exerted a negative impact on productivity in highly mechanized mines.

Another study on the American coal mining industry has been made by Byrnes et al (1988) who has applied two different analytical techniques to estimate the union productivity impact. They have used a mathematical programming model as well as a statistical regression analysis, using data from 84 surface mines for 1978 and 64 others for the 1975-1978 period. By both analytical methods, they deduced that unionized mines have higher productivity levels than non-unionized ones, explaining the differential by the non-unionized mines being smaller in size, a fact which increases the costs of meeting environmental safety regulations. They have also

underlined that the parametric and non-parametric methods reveal different levels of differential, where the differential found by the mathematical programming method is substantially higher.

Connerton, Freeman and Medoff (1983) have investigated the time series differential of the union effect within the American coal-mining industry, using tons of coal production as the indicator, and comparing the union impact of the 1960s to that of the 1970s. They have shown that a significant level of positive productivity effect in the 1960s has deteriorated to a considerable negative effect in the 1970s. As an explanation of the differential between the decades, they have suggested that the cooperative and compromising union climate of the 60s underwent a major change into the 70s, where the unions' approach was much more antagonistic and hostile.

Chezum et al. (1998) have contested the earlier union/productivity studies on the American coal mining industry on grounds of being biased toward more productive mines. They have used papers by Kuhn (1998) and Chezum & Garen (1996) as a starting point, both of which papers propose that unions are more likely to organize in larger firms. Chezum et al. (1998) have supported this hypothesis empirically, using data from coal mines in Eastern Kentucky, USA. In order to estimate the bias in the union/productivity effect, the thickness of the coal seams of each individual mine was taken into account. The positive association found in earlier studies was attributed to the fact that mines with wider seams are proven to be more productive, and unions are more likely to organize in such mines. This study has shown that when the seam width is taken into account, the actual union/productivity association is negative.

Freeman and Medoff (1982) gathered production per worker, non-production worker employment, and worker wage data from 1972 as well as information on the unionization and the quality of workers based on a report regarding a population survey of 1973-1975. The research has shown that unionized firms were substantially greater in terms of both employment and value added compared to non-union ones.

Eberts and Stone (1987) have used data derived from the Sustaining Effects Survey by the US Department of Education to examine the productivity differential caused

by Teacher's unions in public schools. The study has shown positive productivity effect on union schools to the order of 7 per cent for average schools, mainly due to the fact that union schools have a greater tendency to operate on standard classroom instructional techniques, which work better for the majority of the students. For the outlying students, however, productivity have been found to be lower about the same degree in union schools. This effect is also associated with the teacher's unions reducing effect on specialized instructional methods. When overall student population is considered, the average productivity effect of unions has been found to be around 3 per cent.

Union/productivity relationships have also been researched in academic fields. In their study, Meador and Walters (1994) have tested the competing hypotheses regarding the union effect by examining the research performance in a sample of 889 Ph.D-granting departments in public universities, 175 of which were unionized. As a measure of academic research productivity, the number of articles published, and the peers' survey evaluations of scholarly achievement were used. The study associates the unionized departments with a 17 per cent decrease in published article output, as well as a 9 per cent reduction in survey evaluation results.

Hoxby (1996) has researched the effect of teacher unionization on student performance in American public schools using panel data on US school districts. By studying the patterns of collective wage bargaining, she has shown that unions had an increasing effect on school inputs, all the while reducing productivity to levels that had a negative effect on student performance. Her findings also suggest that union effects are larger in areas where schools have market power.

Ehrenberg et al. (1983) have employed two different methodologies in order to estimate the effect of unions on productivity in the public sector, selecting the municipal libraries for application of the models due to the abundance of relevant data. The empirical analysis involved data from 1977 regarding 256 sample libraries. The first analytic framework was an estimation using reduced-form output equations, which is based on a model of the equilibrium level of public services, where the second involved direct estimation of public sector production functions. In

conclusion, the study found that unions did not affect productivity in municipal libraries significantly.

Graddy & Hall (1985) have used 1978 data from 30 union and 30 non-union banks in order to measure the net effect of unions on productivity within the American banking industry. The lending output per non-supervisory employee was taken as the productivity coefficient, and dummy variables indicating whether employees had union representation were also considered. The unionized banks were found less productive than non-union peers.

The effects of unions on productivity in terms of value added were analyzed by Bemmel (1987), who used survey data from 46 plants in 7 industries for estimation of their translog production functions. The study not only looked into the effects of the percentage of production workers covered by a union contract, but also the number of strikes that occurred within the previous 3 to 10 years. In conclusion, Bemmel argued that unions did not influence productivity unless they affected the success of incentive pay plans. On the other hand, his study demonstrated that strikes did induce considerable negative impacts on productivity.

Register (1988) has examined the effects of labor unions on the economic performance of hospitals, based on productivity and cost. The study relied on two data sets, the first one including 275 hospitals from 13 different urban regions in the US; and the second focusing on 114 hospitals in the state of Ohio. The productivity output measure was considered to be lodged patients days per employee, while the average hospital costs per patient day were selected as a cost variable. For the measurement of unionization, hospitals were considered as unionized if located in a city where more than 70 per cent of the healthcare workers were organized, and as non-unionized if located in a city with less than 1 per cent were organized. As a conclusion, the study attributes a 16.1 per cent increase in productivity and a 9.5 reduction of costs for the first data set. The productivity effect estimation around the second data set is also found to be positive, while cost effects have been found to be insignificant.

Lovell et al. (1998) have illustrated an overestimation of the union effect on productivity when the Cobb-Douglas production function is used for the estimation. This function relies on a first-order Taylor series approximation to what is intrinsically a nonlinear variable representing union membership. The criticism around such an approach is that it results in an upward bias in the measurement of the union effect. This study uses a comparison between the GLS estimates with the NGLS calculations in order to quantify the magnitude of the bias. The results of this study point to a 15 per cent overestimation of the union effect when linear approximation methods are used, as compared to the nonlinear model.

In his 2004 study, using company-level sets of data from 1984 to 1999 DiNardo employed a regression model to estimate the effect of unionization on productivity. In the manufacturing industry, he has shown a -3 to +3 per cent change in terms of production hours, a -4 to 4 per cent change in output, and a -2 to 0 per cent change in output per worker, concluding that the impact on productivity is statistically insignificant.

Byrne et al. (1996) have examined the effect of unionization on police productivity in large metropolitan areas of USA. The number of crimes has been included in the production function as a "productivity-determining" criterion. Results suggest that the effect of unions on police productivity varies according to the criminal categories. According to the obtained results, there occurs a negative relation between unionization and productivity regarding petty offences, while in serious crimes there seems to be an insignificant effect on police productivity.

Ruiz-Verdu (2006) has proposed a model (for U.S. and British labor markets) on the economics of union organization, which shows that those firms which benefit from unions from an efficiency point of view are more inclined to unionize. This hypothesis is supportive of the positive effect of unions on efficiency.

In his study pertaining to the efficiency effects of unionization in Britain during the pre-World War I era from 1900 to 1913, Pencavel (1977) has estimated around 22 per cent more loss in terms of output in unionized coalmines than in the non-unionized ones.

In a 1991 study by Machin, the relationship between union presence and labour productivity was examined. The sample of companies selected in the data set is specifically those highly-unionized firms in a particular sector of manufacturing in the UK. Rather than relying on a single indicator of union presence, a common presence indicator is measured that takes into account several different indicators. The study concludes that unionization does not have a significant impact on productivity levels on average. However, a certain level of variation in productivity impact is detected with respect to company size, where the effect of union presence is inclined to be more negative in relatively larger companies. Comparing the conclusions derived from earlier studies in the US, Machin asserts that some of the results indicating a positive effect of unionization in the US are not replicated in the UK. He explains this variation by the fact that the nature of American union/company management relationships is quite different from that between British unions and companies, since unions are inclined to be more cooperative in the US as compared to the antagonistic relations in the UK.

Wilson and Cable (1991) have examined fifty-two UK-based engineering firms, estimating the productivity effects of unionization by means of micro-level panel data. Their study concluded that unionization had a negative impact on productivity on the average. They asserted that union productivity effect has a non-linear relationship with union density, where a moderately unionized establishment can actually yield positive effects on productivity. This study also showed that the negative effects of unionization were higher in "closed shop" establishments.

Denny (1997) has examined unions' productivity effect in the English manufacturing industry by using panel data for the period 1973-1985. Results show differences depending on the reviewed period. The evidence points out that there was no relation in the 1970s when unions were popular but there was a negative relation in the period 1979 - 1985.

In his study made in Japan using data from 1987, Brunello (1992) investigated 979 unionized and non-unionized manufacturing companies with respect to the relation between their union status and company's performance. In this study, the companies

are separated into 3 groups as large, middle and small sized enterprises according to the number of employees. The findings show that the Japanese unions reduce both productivity and profitability. This effect is considerably less in the medium and small sized enterprises in comparison to the larger ones. This is explained by the fact that the small and middle sized enterprises consist mostly of subcontractors, where productivity is increased and costs are reduced by the imposing effect of the companies who contracted them.

Benson (1994) has conducted a survey research in 1991 for 253 Japanese manufacturing companies in order to examine the relationship between unions and economic performance. As a conclusion that relies on the managers' evaluation of productivity, Japanese unions were associated with significantly lower levels of productivity.

Tachibanaki and Noda (2000) have used 1991 company data from the second largest metropolitan area in Japan, 75 per cent of these companies being unionized. Their approach included two different methods of estimation – ordered probit estimation and a recursive model with two-stage least-square method. The obtained results are supportive of the view that unionization in Japan had a positive effect on productivity.

In his empirical analysis, Morikawa (2010) has estimated the relationship between unionization and firm performance, using data relating to around 4000 Japanese companies from manufacturing and non-manufacturing industries. It was found that unions have a statistically and economically significant positive effect on productivity.

Mefford (1986) examined the union/productivity effect using 1975-1982 data from the 31 plants of a single multinational company, where all the plants produced a similar line of product with material-intensive, labor-intensive, and low-technology methods. The areas in which unions apparently affect productivity were found to be the induced changes in management performance, and worker behavior. Although unionized plants were associated with higher absenteeism and turnover, both of which have a negative impact on productivity, it was shown that the positive effect of

management performance on productivity was sufficient to offset the negative effects. The study attributes the overall positive effect to the improved labor relations and labor quality in the unionized plants.

In the study of Yamak and Dursun (1999) which examines the "Unionization and Productivity Relations in Turkey" by means of causality analysis for the period of 1991-2005, data from 7 sectors have been used. In this study, a significant relationship could not be found between the unionization rate and productivity. In the study it is underlined that the data used at company level yield more reliable results.

Using semi-annual data from 15 business lines of 7 industries for the period of 1991-2005 again in Turkey, the presence of causality from unionization to real prices and from unionization to productivity has been researched by Dursun (2007) with panel causality analysis. In conclusion, a statistically reasonable causality relationship has been found between unionization and nominal prices per worker, while no relationship has been detected for real prices per worker. The study also fails to show a causality relationship between unionization and productivity.

Özkaplan (1994), in her study examining the productivity effect of the unions by regression analysis, has included data from 42 companies which deal in the chemical industry in Turkey during the period 1982-1992. The companies used in the analysis have union and non-union status, and only eleven of the companies have yielded results that were statistically significant. Eight of these eleven companies belonged to the chemical subsector, two to the petroleum, and the last one is included in the tire-manufacturing subsector. Since only four of the chemical companies employed union workers, the productivity effect for the non-union ones was valid. When the productivity levels of the union employees were compared to the non-union workers in the four unionized chemical companies, it was found that the productivity of the unionized workforce was higher in only one company. In the other three companies, non-unionized workers were more productive. In the petroleum industry, one of the companies showed a positive effect, where the other showed a negative impact. The single company yielding a statistically relevant result in the tire manufacturing industry has shown a negative impact. Özkaplan has underlined in her conclusion that the study should be evaluated with precaution since there is a considerable

amount of statistically insignificant results found in the study due to a restricted data base.

The Turkish hotel industry has been subject to a study by Aymankuy (2005), who researched the relationship between unionization and quality of service. The study proposed that unionization had an increasing effect on productivity by means of increased quality of service. The improved quality of service was attributed to the unions having a knowledge ability influence on the workers.

In their research covering 22 different industries from 1948 to 1976, Kendrick & Grossman (1980) have estimated the effect of unions on productivity growth. The changes in total factor productivity over several years were employed as production growth variables, while the annual rate of change of the union density was considered to be the unionization coefficient. The findings of the research signify a negative union effect for the 1948-1966 period, but a positive relation within the 1967-1976 timeline.

Mansfield (1980) examined how unionization related to the productivity growth of 22 industries for the time period of 1948 to 1966. It was estimated as a result of this study that completely unionized industries had a 5.4 to 6.1 per cent lower rate of production growth.

Link (1981) has looked into the change in average annual total factor productivity of 51 major manufacturing firms between 1973 to 1978 in an effort to estimate the relation between unionization and productivity growth. It was found that unions reduced the productivity growth by 2.5 per cent.

Link (1982) has worked out an estimation of how unionization affected the productivity growth in terms of the ratio of change in net sales from 1975 to 1979 to an index of the change in total employment and deflated tangible fixed property. The TFP and union density data from 32 chemical, 51 machinery, and 14 petroleum companies were used for the study, which showed that the TFP would fall by 10 per cent if an unorganized firm became fully organized.

In the study performed by Sveikauskus & Svekauskus in 1982, a comprehensive set of controls were employed in an estimation of the percent of workers belonging to a union on the growth in average annual TFP. These included percent of employees in large firms, percent of employees in small companies, market concentration, percent of employees in R&D, 6and a durable goods dummy variable. This study, which analyzed the TFP growth in 144 manufacturing industries from 1959 to 1969, has concluded that the percent unionized had no significant effect on productivity growth.

An empirical study on the union effect on productivity growth within a sample of 19 manufacturing industries from 1957 to 1973 has been executed by Hirsch & Link (1984). Taking into account the percentage of industry organized in 1958, they have shown that both percent organized and the change in the percent organized had negative effect on productivity growth.

Two studies by Terleckyj (1980, 1984) have used samples from two-digit United States industries in order to estimate the unionization impact on total factor productivity growth. 20 industries from 1948-1966 were considered in the first study in 1980, where measures of various levels of research and development intensity, a cyclic variation in output, and government sales were employed as controls. The resulting estimations have been found to be very sensitive to the type of measure being used as the dependent variable. The unionism impact on TFP growth has been shown to be either negative or insignificant when different measures were used. The dependency of the estimation on the type of controls employed has also manifested itself in the second study by Terleckyj (1984), which analyzed data pertaining to 27 industries from the 1969-1976 period. Again, several measures of R&D were utilized as controls. The union effect on TFP growth has been similarly shown to be either insignificant or negative, depending on the different R&D variable combinations being used.

Freeman and Medoff (1984) have considered the productivity growth in terms of the average annual value-added per worker in three different sets of industries from 1958 to 1978. According to their resulting estimation, the percent unionized in these industries had no effect on productivity growth.

In his 1985 article, Warren (1985) has estimated the effect of unions on the labor productivity over time, taking into account data from the private, domestic sector of the US economy throughout 1948-1973. In terms of productivity growth, the study has employed the ratio of total private domestic product to the quality adjusted labor input; where percent of the non-institutional labor force belonging to unions was considered as a measure of unionization. The findings from this study have demonstrated that unions not only slow the American productivity growth, but also reduce total output.

Sickles, Sykes & Warren (1988) have refined the accuracy of the results in Warren's 1985 study by fine-tuning the measurement equations with non-linear least squares. The findings in this paper are supportive of Warren's estimation that unions affect labor productivity negatively (as cited in Belman, 1989).

In an effort to evaluate the accuracy of the findings from the article by Warren (1985), Belman & Wilson (1989) have used the same set of data from the US private sector over the 1948-1973 period. Warren's definition of unionization was enhanced by the addition of the percentage of non-agricultural labor force organized, and percent of private non-agricultural labor force organized. Further controls to Warren's study were specified, including unemployment, capacity utilization, average hours of production workers, percent of women in the labor force, and percent employment in manufacturing. Belman & Wilson's study found results that ranged from positive to negative, depending on the specifications. It was indicated that the effect of unions on labor productivity was excessively sensitive to how unionization and business cycles were being measured, and the results from this model were too variable to be considered reliable (as cited in Belman, 1989).

In his paper on productivity growth under unionization, Allen (1988a) has examined how unions affect productivity change in the manufacturing and construction industries. He has found that in the manufacturing industry, unionization has no significance on production growth. On the other hand, in the construction industry, production growth has been shown to deteriorate under unionization. The variation in the results, according to Allen, may be explained by whether companies turn to more productive or less productive technologies to respond to higher wages due to union

negotiation. Allen finds a possible explanation in that the construction industry may be less likely to adopt new production technologies due to the higher density in craft unionization in this sector.

Allen (1988c) has come up with different estimations of unions effect on productivity growth when he studied the US manufacturing and construction industries. In manufacturing, he regarded the average annual change in an index of physical output per employee for 1972 to 1983, and used a measure of initial level of unionization as well as a measure of change in the unionization levels during the considered timeframe. Estimated as such, unionization was shown to bear no evident effect on productivity growth in manufacturing. For construction, on the other hand, Allen demonstrated that higher initial levels of unionization or increase in organization led to lower rates of growth in productivity, considering the change in the ratio of real value added to an index of real labor and capital input for the periods of 1972-1982, 1972-1977, and 1977-1982.

There have been some studies where the union effect on productivity has been shown to yield contradicting results. For example, Outlon (1990) studied the effect of labor market characteristics on productivity. He observed that unionization led to a decrease in productivity growth in the period 1971 - 1986. However, its effects were less detrimental in the 1980s. During the 1980s, the productivity growth rate averaged 4 percent per annum, partly due to a decline in the negative aspects of unionization.

Another such study by Nickell et al. (1992) was carried out on over one hundred UK manufacturing companies and concluded that there was a positive correlation between unionization and total factor productivity during the period 1979-84, although the correlation may have been negative during the 1975-78 period.

For an estimation of the effect of unionization on productivity growth, Maki (1983a) has looked at the time series regression of change in total factor productivity for Canada from 1926 to 1978. The percentage organized, change in the percent organized, and annual labor days lost in strikes were specified as measures of unionization within the context of this study. The growth in Canadian productivity on

average has been found to be 40 per cent lower because of unions, and a further reduction of 15 per cent was associated with strike activities. However, it must be noted that the study disregards the demographic, economic, legal and historical factors such as World War II, which likely effected the productivity growth. Also worthy of notice is that the estimations of productivity and unionization included the public sector, which might have potentially biased the results.

The effect of industrial relations on company economic performance has been examined in a study by Katz, Kochan & Gobeille (1983), which used data from 18 unionized production plants within the US automotive industry during the mid-1970s. A model of the labor climate was built by using factors such as managers' and supervisor's views on trust and cooperation, grievance levels, absenteeism, disciplinary actions, time spent in negotiations, and the number of demands made in negotiations. The analysis employs pooled time-series and cross-section data. Both qualitative and quantitative metrics were considered in the measurement of productivity. In conclusion, the authors have argued that better industrial relations had a positive effect on quality, thus improving the plant's economic performance. The productivity output in quantitative terms has been found not to be significantly affected by labor climate.

Studying 25 American durable goods plants, Kochan, Katz & Mower (1985) have analyzed the influence of conflict management systems, worker attitudes and quality of working life on the economic performance of companies. For an estimation of worker attitudes, measures were used such as workers' opinions on compensation, working environment, relations with superior and subordinates and career progress, as well as the ratio of employees submitting suggestions. The effectiveness of conflict management was assessed by grievance rates, absenteeism, and rates of disciplinary actions. Quality of working life measurement was based on the percentage of employees participating in QWL programs. The study concluded that while these three influences had insignificant individual effects on economic performance, they collectively added up to a positive overall impact.

In their study carried out in the British private sector, Machin and Stewart (1990) examined the effect of unionization on financial performance. For data, the study

relied on surveys filled out by company management in 1980 and 1984. The selected financial performance indicator was a function of the scores given to the following survey question: "How would you assess the financial performance of this establishment, compared with other establishments and companies in the same industry?" The answers received show that the unionized companies have lower financial performance levels with respect to the non-unionized ones.

Machin and Stewart (1996) conducted another study on the union effect on firm performance in the UK by consulting to data from the 1990's, relating to companies with 25 or more employees. The unions' negative effect on financial performance was found to be less negative in this study than in the first one. It was proposed that the differential can be associated with unions becoming less successful in negotiating rents than they used to be. Also, the negative effect was shown to be almost constant in companies with a closed shop, but the effect deteriorated significantly in other unionized firms.

Laroche (2004) has also investigated the impact of unionization on financial performance in his study in the French context. Using a nationally representative survey from 1998 for data, he found that union presence had no significant impact on workplace financial performance

Voos and Mishel (1986) have shown that unions cause a considerable decrease in profits for the American supermarket industry, mainly by distorting the capital investment decisions. The effect has been found to be greater in those areas where local markets are more concentrated.

In their article, Norsworthy and Zabala (1985) have suggested an estimation of the influence of improved worker attitudes on cost of production in the American automobile industry for the 1959-1976 period. The employee attitudes were measured by the number of grievances filed, unresolved grievances, unauthorized strikes, and quits. It was demonstrated by this model that improvements in employee attitudes were associated with decreased total unit costs of production.

In their study pertaining to the union effect on production costs, Eberts and Stone (1991) assert that there is little evidence that supports the unions' negative or positive effects on productivity.

Using the data from the production records of nine fabricated steel plants, Schuster (1983) has studied the effect of gainsharing plans on productivity. The productivity metrics were specified as employee output per hour and monthly average number of workers employed. The study indicates that the practice of gain sharing improved productivity per worker, but did not bear influence on employment. Furthermore, the author has brought self-criticism to the design in that the generality of the results might be inhibited by the small number of sample sites, and the short period of examination.

By means of an opinion survey filled out by 248 Irish production workers, Toner (1985) has found that workers in non-unionized plants enjoy better working conditions and higher morale than those in union plants.

In 1996, Fuchs et al (1998) collected the views of economists specializing in labor and public economics from forty leading economics faculties in US universities by requesting them to complete surveys on the subject. According to the findings, the mean and median values of the union productivity impact were 3,1% and 0%, respectively. The inter quartile range was found to be 10%, supporting the fact that the views on unionization effects on productivity vary to a considerable extent.

Doucouliagos and Laroche (2003) have researched the differences between the studies that estimate the union-productivity relationship using meta-analysis and meta-regression analysis. They point out that if all the available data on the union/productivity effect were to be pooled together, the overall result would reveal a near-zero association between unionization and productivity. On the other hand, they suggest that country -and industry-specific associations exist- such as the American studies, especially in the manufacturing fields, having a tendency to suggest more positive effects compared to those in the UK or Japan. They attribute this differential partly to the differences between the characteristics of such studies.

Using resampling methods, Doucouliagos and Laroche (2004) have evaluated the confidence limits in a meta-analysis of the union/productivity association for a sample of US-based studies. Their research has provided evidence that point to a statistically significant level of positive association between unions and productivity in the US manufacturing and education sectors, to the order of approximately 10% and 7%, respectively.

Schuster (1983b) has researched the influence of union-management cooperation programs on productivity as well as employment. Productivity and employment data from nine manufacturing plants were supplied for the study on a monthly basis for a period of four to five years. The considered periods were selected so that they ranged from two years before to at least two years after the implementation of the cooperative program. A regression analysis based on this time-series data was then supplemented with data from personal interviews. The findings from this study point out that productivity increased in six of the eight firms it could be measured in. On another note, employment was not affected by the cooperative programs in eight of the nine companies.

In an effort to estimate the influence of labor climate on productivity, Ichniowski (1984a, 1986) has examined the production functions for 10 paper plants with monthly data for the period of 1976 to 1982. While productivity was represented by the monthly output in tons, the total pages in the collective bargaining agreement or the number of secondary grievances per 1000 production hours were assigned as measures of the labor climate, assuming that longer agreement documents represented distrust between labor and management. According to the results achieved with this model, higher levels of grievances caused a decrease in productivity. Collective bargaining agreements with longer pages were similarly associated with a reduction in productivity. Studies summarizing the literature review are presented in table for clear comprehension (Table 3.2, Table 3.3, Table 3.4).

Table 3.2 Studies of the Impact of Unionism on Productivity and Efficiency

Authors	Date of study	Locale	Effect	Findings
Register	1988	United States	Productivity	Positive
Brown and Medoff	1978	United States	Productivity	Positive
Frantz	1976	United States	Productivity	Positive
Clark	1984	United States	Productivity	Positive
Clark	1980a	United States	Productivity	Positive
Clark	1980b	United States	Productivity	Positive
Allen	1986b	United States	Productivity	Positive
Allen	1986a	United States	Productivity	Positive & Negative
Allen	1988b	United States	Productivity	Positive
Mitchell & Stone	1992	United States	Productivity	Positive
DiNardo	2004	United States	Productivity	Insignificant
Byrne et al	1996	United States	Productivity	Negative & Insignificant
Boal	1990	United States	Productivity	Negative & Insignificant
Byrnes et al	1988	United States	Productivity	Positive
Connerton, Freeman & Medoff	1983	United States	Productivity	Positive & Negative
Allen	1984	United States	Productivity	Positive
Eberts and Stone	1987	United States	Productivity	Negative
Ehrenberg et al.	1983	United States	Productivity	Insignificant
Chezum et al.	1998	United States	Productivity	Negative
Lovell et al.	1988	United States	Productivity	Positive bias

Table 3.2 Studies of the Impact of Unionism on Productivity and Efficiency (cont'd)

Authors	Date of study	Locale	Effect	Findings
Graddy & Hall	1985	United States	Productivity	Negative
Warren	1985	United States	Productivity	Negative
Sickles, Sykes & Warren	1988	United States	Productivity	Negative
Belman & Wilson	1989	United States	Productivity	Insignificant
Freeman and Medoff	1982	United States	Productivity	Positive
Wilson and Cable	1991	UK	Productivity	Negative
Denny	1997	UK	Productivity	Negative & Insignificant
Machin	1991	UK	Productivity	Negative & Insignificant
Pencavel	1977	UK	Productivity	Negative
Yamak&dursun	1999	Turkey	Productivity	Insignificant
Dursun	2007	Turkey	Productivity	Insignificant
Özkaplan	1994	Turkey	Productivity	Positive & Negative& Insign.
Aymankuy	2005	Turkey	Productivity	Positive
Mefford	1986	Multinational	Productivity	Positive
Brunello	1992	Japan	Productivity	Negative
Morikawa	2010	Japan	Productivity	Positive
Tachibanaki and Noda	2000	Japan	Productivity	Positive
Benson	1994	Japan	Productivity	Negative
Meador & Walters	1994	Multinational	Productivity	Negative
Hoxby	1996	United States	Productivity	Negative
Bemmel	1987	United States	Productivity	Negative

Table 3.2 Studies of the Impact of Unionism on Productivity and Efficiency (cont'd)

Authors	Date of study	Locale	Effect	Findings
Ruiz-Verdi	2007	-	Efficiency	
Mandelstamm	1965	United States	Efficiency	
Fuchs et al	1998	United States	Meta Analysis	
Doucouliagos and Laroche	2003	UK & United States	Meta Analysis	Positive & Negative
Doucouliagos and Laroche	2004	UK & United States	Meta Analysis	Positive

Table 3.3 Studies of the Impact of Unionism on Productivity Growth

Authors	Date of study	Locale	Effect	Findings
Allen	1988a	United States	Productivity growth	Positive & Negative
Kendrick & Grossman	1980	United States	Productivity growth	Positive-Negative
Mansfield	1980	United States	Productivity growth	Negative
Link	1981	United States	Productivity growth	Negative
Link	1982	United States	Productivity growth	Negative
Hirsch & Link	1984	United States	Productivity growth	Negative
Terleckyj	1980	United States	Productivity growth	Insignificant & Negative
Terleckyj	1984	United States	Productivity growth	Insignificant & Negative
Sveikauskus & Sveikauskus	1982	United States	Productivity growth	Insignificant
Freeman and Medoff	1984	United States	Productivity growth	Insignificant
Allen	1988c	United States	Productivity growth	Insignificant & Negative
Nickell	1992	UK	Productivity growth	Positive & Negative
Maki	1983	Canada	Productivity growth	Negative
Outlon	1990	UK	Productivity growth	Negative

Table 3.4 Studies of the Impact of Unionism on Financial Issues and Labor Climate

Authors	Date of study	Locale	Effect	Findings
Voos and Mishel	1986	United States	Profitability	Negative
Eberts and Stone	1991	United States	Cost of production	Insignificant
Norsworthy & Zabala	1985	United States	Cost of production	Positive
Katz, Kochan & Gobeille	1983	United States	Financial performance	Positive
Kochan, Katz, & Mower	1985	United States	Financial performance	Positive
Machin & Stewart	1990	UK	Financial performance	Negative
Machin & Stewart	1996	UK	Financial performance	Negative
Laroche	2004	France	Financial performance	Insignificant
Shuster	1983a	United States	Gain sharing on productivity	Positive
Ichniowski	1984a, 1986		Labor climate on productivity	Negative
Shuster	1983b		Labor climate on productivity	Positive

Chapter 4

Measuring Productivity and Efficiency

4.1 Productivity and Efficiency

Technically, productivity is defined as "the proportion between the amount of the produced goods or services and the inputs used for the production of these goods and services"; and this evaluation is generally formulated as output/input ratio (Prokopenko, 2005:19).

Peter Drucker defines productivity as "the balance between all production factors that will give the greatest return for the least effort" (Drucker, 1974). Productivity is defined by the Japanese Productivity Center as "a developmentist idea or an idea consistently targeting development in everything, especially in the human factor". It is a tool supporting the idea that today should be better than yesterday and tomorrow than today (Güntürkün, 2008:6). The introducer of the total productivity evaluation concept in businesses, Davis (1955) defined productivity as "the change in the products produced by the consumed sources". If any production unit obtains more products and better quality than previous periods using the same composition of the materials, energy, machinery, work force and management sources, productivity level is held to have increased. According to this definition, productivity is the indicator of all changes in the methods applied in the current production process, input values, production capacity and output at output/input level (Akal, 2005).

While Prokopenko defines productivity as the execution of works of the highest quality, within the shortest time and for the lowest cost in order to provide the highest level satisfaction for customers and employees (Prokopenko, 2004), he defines productivity growth as a key element allowing the generation of added

value through the optimum mix of the available sources of society - human knowledge and skill, technology, hardware, raw material, energy, capital and intermediary services (Prokopenko, 2004).

Although the terms efficiency and productivity are frequently used as synonyms, efficiency differs from productivity in certain respects. On the one hand, productivity evaluates the source efficiency as a whole, while on the other efficiency, is evaluated as an output per production source. One of the main reasons for mistaking them or using one in place of the other is that the efficiency and productivity changes or sources are nested together. For this reason, it becomes harder to dissociate these two concepts. However, it is still possible to say that efficiency is one of the principle determinants of productivity. This can be expressed as "efficiency change is one of the factors causing productivity change" (Bakırcı, 2006: 97). Efficiency is a performance indicator determining to what extent the businesses have reached their determined objectives as a result of their efforts.

4.2 Productivity Measurement Methods

Productivity at business level should be monitored as an important management function so that the business can maintain competitive power in the market place of today. Productivity values can be used in many ways such as project estimation and process evaluation. A potent productivity measure should allow the formation of a baseline on which the performance growth can be evaluated. It should ease the decision making process of the organization in process investments, methods, tools and outsourcing.

Productivity calculations have numerous options in terms of the coverage and the nature of the related outputs and resources. In point of fact, productivity has many definition options such as labor versus total factor productivity and marginal versus average concepts.

As May and Denny (1979: 764) underline, "it is quite possible that an industry with relatively high productivity using one measure has relatively low productivity using

a different measure". For example, while there is an option for the outputs to be evaluated in terms of generated product or functionality, the resources can be evaluated in terms of effort or financial cost.

Differences in production technology, in production process efficiency and in the production environment cause productivity to vary at different levels. It is easy to evaluate the productivity ratio when the unit utilizes a single input for generating a single output. When the unit utilizes more than one input to generate more than one output, the outputs in the numerator and the inputs in the denominator should be combined in an economically sensible way in order for productivity to maintain the ratio of these two values (Fried et al, 1993).

While partial productivity can be calculated depending on single input or output in production process, total productivity can be calculated by using multiple inputs and outputs. These methods allow the evaluation of partial productivity evaluation and total factor productivity respectively. The input and output types frequently used in single factor and multifactor productivity measurements are given in Table 4.1.

However, in the interest of simplicity, Table 4.1 was limited to the most frequently used productivity measures. These are measures of labour and capital productivity, and multifactor productivity measures (MFP), either in the form of capital-labour MFP, based on a value-added concept of output, or in the form of capital-labour-energy-materials MFP (KLEMS), based on a concept of gross output. Among those measures, value-added[4] based labour productivity is the single most frequently computed productivity statistic, prequel to capital-labor MFP and KLEMS MFP.

[4] In this thesis, productivity measurement was performed by using the value added as the output indicator.

Table 4.1 Overview of Main Productivity Measures

	Type of input measure			
Type of output measure	***Labour***	***Capital***	***Capital and labour***	***Capital, labour and intermediateinputs (energy, materials, services)***
Gross output	Labour productivity (based on gross output)	Capital productivity (based on gross output)	Capital-labour MFP (based on gross output)	KLEMS multifactor productivity
Value added	Labour productivity (based on value added)	Capital productivity (based on value added)	Capital-labour MFP (based on value added)	-
	Single factor productivity measures		*Multifactor productivity (MFP) measures*	

Source: OECD Manual. (2001). Measuring Productivity Measurement of Aggregate and Industry-Level Productivity Growth, France p.16

Despite the variety of the evaluation methods, the most frequently applied methods can be arranged under 3 titles. These three groups of evaluation systems for efficiency analysis are ratio analysis, parametric methods and nonparametric methods.

In Total Factor Productivity evaluation, financial and non-financial approaches are utilized. In a financially based evaluation, financial data at firm or industry level are used while the nonfinancial method is classified into two as parametric methods and nonparametric methods. These two methods can also be arranged depending on whether the frontier approach is applied or not. The table (4.2) classifies these approaches. When all companies are assumed to be technically efficient, production models and TFP indices provide TFP measure by combining time series data. However, SFA (Stochastic Frontier Analysis) and DEA do not consider the companies as technically efficient. The methods used in this thesis are the production function method which is a parametric model without frontier approach, and DEA and Malmquist Index, which are nonparametric models with frontier approach. Classification of the aforementioned methods is summarized in Table 4.2 and essential points of these methods are in Table 4.3.

Table 4.2 Parametric and Non-parametric Approaches in TFP

	Methodologies Without Focusing On Frontiers	**Methodologies Focusing On Frontiers**
Parametric Methods	Production and Cost Function estimation by OLS	Sthocastic Frontier Analysis
Non-Parametric Methods	Total Factor Productivity Index . Diewert . Laspeyres . Paasche . Fisher . Tornqvist	Malmquist Total Factor Productivity Index

Source: Güntürkün, F. (2008), p.16

Tablo 4.3 Summary of the Properties of the Four Principle Methods

Attribute	**LS**	**TFP**	**DEA**	**SF**
Parametric method	yes	no	no	yes
Accounts for noise	yes	no	no	yes
Can be used to measure:				
technical efficiency	no	no	yes	yes
allocative efficiency	yes	no	yes	yes
technical change	yes	no	yes	yes
scale effects	yes	no	yes	yes
TFP change	yes	yes	yes	yes
Data used:				
cross sectional	yes	yes	yes	yes
time series	yes	yes	no	no
Panel	yes	yes	yes	yes
Basic method requires data on:				
input quantities	yes	yes	yes	yes
output quantities	yes	yes	yes	yes
input prices	no	yes	no	no
output prices	no	yes	no	no

Source:Coelli, T. J., Rao, D.S.P., O'Donnell, C. J., and Battese, G. E., (2005) "An Introduction to Efficiency and Productivity Analysis" *Springer*: USA, p.312

4.2.1 Ratio Analysis

Ratio analysis is one of the easiest ways of evaluating productivity. Being a single-dimension evaluation, this method is an incomplete and insufficient method in terms of scope and purpose. For this reason, a business may be evaluated as highly productive according to some ratios while being unproductive according to others. It is possible to obtain more accurate results by evaluating a single measure by weighting the different ratios in productivity evaluation.

4.2.2 Parametric Methods

Parametric methods assume that the production function of the companies for which productivity evaluation is conducted has an analytical structure. Estimations are made generally by applying regression techniques for productivity measurements in parameter methods. In frequently implemented methods, there are numerous inputs and single output.[5] It is more comprehensive than ratio analysis in this aspect.

In these methods, the parameters of the production function are tried to be determined. Determination of parameters related to Cobb-Douglas, CES type production function in the literature is an example of such methods. However, they remain too restrictive in terms of their characteristics including homogeneity, complete additive separability, constant substitution elasticity, etc. (Afriat, 1972).

The performance analysis in literature conducted by using parametric methods requires the prediction of production and cost functions with the OLS prediction model. However, the average function obtained from the predictions for companies through this method fails to reflect efficient production possibilities both in theory and in practice. Thus, it results in prediction errors in productivity measurements based on this method. Adopting an average performance standard in practice may actually mean the adoption of a kind of unproductiveness in reality because a business in production can achieve average standards by lowering the possible

[5] There are also other regression techniques available using more than one outcome.

performance level. In this situation, a negative average performance level is adopted. This means ignoring improvements towards a better performance level including the business performance. Moreover, an average production function is in contrast with the threshold function reflecting the behavioral maximization in theory, what is taken into account here, is the average, not maximization. For this reason, a cost curve to be drawn by the Ordinary Least Squares Method fails to provide maximization in behavior despite reflecting a satisfactory behavior level (Babacan, 2006).

4.2.3 Non-Parametric Methods

Nonparametric methods are the methods that do not require any production function approach and they use the mathematical programming as a solution technique. There are relative efficiency scores of the units for which a comparison is made by using numerous inputs and outputs.

Nonparametric methods in which the deviations from the efficiency limit are considered as inefficiency can handle the production process with numerous inputs and outputs as a whole. The ability of nonparametric methods to eliminate the weighting operation required for gathering the production factors in different measurement units constitutes another advantage of this method (Gözü, 2003).

Chapter 5

Methodology, Research Paradigms and the Analytical Frameworks

5.1 Abstract of Research models

In this dissertation, the relationship between unionization and productivity has been measured by using different statistical techniques.

The ANOVA test has been applied in two phases.

Firstly, the data set that was formed with the companies active in the Turkish Chemical Sector during the years 1998-2006 registered in ICI (Istanbul Chamber of Industry) as the top 500 and second 500, selected according to the criteria, were examined. With the ANOVA test, the criteria of productivity, per capita capital and labor were considered in relation to the firm's union status (unionized, non-union and "nonbinding union agreement" group) to determine whether there is a statistically significant difference.

Secondly, the ANOVA test was applied by considering the same criteria but for the subsectors of the Turkish Chemical Sector (general chemical, pharma, oil, plastic). Here, the aim is to answer the following questions: When the overall chemical sector is considered, are the results the same for each of the subsectors? Is there a statistically significant difference in results between the 3 groups of union status across the subsectors?

ANOVA Section 1

RQ: Is there a difference in measure of productivity among the unionized, non-unionized and the “nonbinding union agreement” groups?
RQ: Do the unionized companies tend to be in the more capital - abundant companies?
RQ: Does the number of workers display any difference among the three groups, i.e. the unionized companies, non-unionized the nonbinding union agreement groups?

ANOVA Section 2

RQ: Is there a difference in productivity in the general chemical sector, which is a subsector of the field of Chemical, among the three groups referred to as unionized, non-unionizedthe “nonbinding union agreement” groups?
RQ: Is there a difference in per capita capital in the general chemical sector, which is a subsector of the field of Chemical, among the three groups determined as unionized, non-unionizedthe “nonbinding union agreement” groups?
RQ: Does the number of working laborers display any difference in the general chemical sector, which is a subsector of the field of Chemical among the three groups, determined as unionized, non-unionized the “nonbinding union agreement” groups?

RQ: Is there a difference in productivity in the pharmaceutical sector, which is a subsector of the field of Chemical, among the three groups referred to as unionized, non-unionized the “nonbinding union agreement” groups?
RQ: Is there a difference in per capita capital in the pharmaceutical sector, which is a subsector of the field of Chemical among the three groups; i.e. unionized, non-unionized the nonbinding union agreement groups?
RQ: Does the number of working laborers display any difference in the pharmaceutical sector, which is a subsector of the field of Chemical, between the three groups that is unionized, non-unionized and the nonbinding union agreement groups?

RQ: Is there a difference in productivity in the oil sector, which is a subsector of the field of Chemical, between the two groups, referred to as unionized and non-union firms?
RQ: Is there a difference in per capita capital in the oil sector, which is a subsector of the field of Chemical, between the two groups i.e. unionized and non-union groups?
RQ: Does the number of working laborers display any difference in the oil sector, which is a subsector of the field of Chemical between the two groups, i.e. unionized and non-union groups?

RQ: Is there a difference in productivity in the plastic sector, which is a subsector of the field of Chemical, among the three groups, i.e. unionized, non-unionized and the "nonbinding union agreement" groups?
RQ: Is there a difference in per capita capital in the plastic sector, which is a subsector of the field of Chemical, among the three groups, i.e. unionized, non-unionized and the "nonbinding union agreement" groups?
RQ: Does the number of working laborers display any difference in the plastic sector, which is a subsector of the field of Chemical among the three groups, i.e. unionized, non-unionized the "nonbinding union agreement" groups?

Using data envelopment analysis, only the unionized and non-union companies active in the Chemical sector were included in the analysis. By the help of DEAthe data were used for each year in the time period of 1998-2006. The companies in the data set are companies among the first or second ICI 500. The efficiency scores of the companies have been specified by analyzing them in relation to each other. For each year, the efficiency means of the unionized and non-union companies were taken in order to find out for which years the efficiencies were more for the unionized or non-union companies.

RQ: For each single year between the years 1998-2006, what are the efficiency scores and company rankings of the unionized and non-union companies in the data set, determined relatively for each other?

RQ: For each single year between the years 1998-2006, what is the difference in the efficiency score averages of group of firms in relation to unionization status?

The Malmquist index research technique panel data analysis has been used to examine the increase in the efficiency of the companies in the given time period. In the 1998-2006 time periods the efficiency percentage increases have been determined on company basis, besides, the percentage increase difference has been determined for unionized and non-union companies as two groups.

RQ: During the years 1998-2006 what are the efficiency scores change and company rankings of the unionized and non-union companies in the data set determined relatively for each other?

Using the panel linear regression technique, the relationship between union density and the productivity of the companies have been examined. The modified form of Cobb-Douglas production function has been used.

RQ: For the years 1998-2006, what is the productivity relation between the unionized workers and the non-union workers in the unionized companies active in the chemical field?

With an aim to shed light on the results of the wide scale study conducted by employing various statistical methods, another research method, in-depth interviewing technique, was adopted. The interview questions were arranged to gather opinions on the obtained results in each research method with a view to explain the possible reasons for the findings. In determining the firms, an effort was made to select one or more firms from each of the three different statuses; the union firms group, the non-union firms group and the "nonbinding union agreement" group. By doing this, it was intended to receive the opinions of the stakeholders from each unionization status. The questions were addressed to the informants responsible for human resources of the firms. Some of the interviews were conducted with representatives of labor and employers', unions study. As a result highly useful and enlightening information was obtained interviews with these firms in order to support the findings of the study.

5.2 Data Collection and Sampling

The sample used in this thesis is from the selected companies operating in the chemical ISIC 2 in the industry coded 35 as per the chemical sub-branch classification.

Manufacture of industrial chemicals (coded 351) and other sub branches consist in chemical industries (coded 352), petroleum refineries (coded 353), manufacture of miscellaneous products of petroleum and coal (coded 354), manufacture of rubber products (coded 355), plastic products (coded 356). Manufacture of industrial chemicals coded 351 consists of main chemicals, chemical fertilizer and synthetic fibre. Other chemicals (coded 352) consist of other chemicals paints, ink, varnishes and laquers, soap and cleaning preparations, perfumes, cosmetics and other toilet preparations , petroleum refineries (coded 353) consist of petroleum refineries, manufacture of miscellaneous products of petroleum and coal consist of fuel products distribution, LPG filling, lube oil preparation and blending, manufacture of rubber products (coded 355) consists of tyre and tube industries, and data on natural rubber product sub branches, which are registered in ICI first 500 and second 500 company lists between 1998-2006, have been gathered. Companies in this study are operating in the sub sectors including battery, chemical paints, general chemical, pharmaceuticals, pesticide, petroleum, rubber and plastic.

In this study, numbers of union members were gathered the records of Lastik-İş and Petrol İş. Total numbers of employees are determined based on the documents issued by ICI. Unionization status is collected for four main groups. Firms can be classified into 3 groups, i.e. unionized, non-unionized firms, or firms have which currently do not have any legally binding collective agreement. Fourth group are firms whose union status has changed; this last group is excluded from this study. Unionized companies are those where the union represents a minimum of ten percent of workers in industryand fifty percent plus workers in the firm level. (Article 12 of Strike, Collective Labour Agreement and Lock-outs Act 2822 necessitates that the union must represent a minimum of 10 per cent of workers at the industry level in oreder to conclude collective labour agreement). Companies in the nonbinding agreements group have lost the collective bargaining authorization

status but through a tacit agreement between the company and unions still keep implementing the expired agreements. Last group is non-union firms which do not have members of any trade union nor covered by any collective agreement.

Companies selected for the study are the ones which provide data constantly between 1998-2006 or do not provide data maximum 2 years. Firms, whose data are not recorded in ICI or unions during the maximum 2 years, are selected and estimated in SPSS 15.0 for Windows program via series mean. Companies that have missing values more than two years are excluded from the sample. Data are collected to include 3 or 4 concecutive agreements covers 9 years, by taking into account the fact that duration of the collective agreement in Turkey cannot be less than 2 years and more than 3 years.

5.3 ANOVA

The analysis of variance (or ANOVA) is a powerful and common used statistical procedure in the social sciences. ANOVA measures systematic differences between means of normally distributed outcome measures in randomized experiments. The analysis of variance is used to test the hypothesis on whether there is a difference between 2 or more group's averages. The *Ho* hypothesis in the analysis of variance is that all averages in the total population are equal.

$$H_0 = \mu_1 = \mu_2 = \mu_3 ..... = \mu_n \quad (5.1)$$

That means, there is no difference between the averages. H_1 hypothesis is that there is a difference between the averages. When the difference between the averages is obtained, Post hoc tests are applied and results are analyzed.

Post Hoc tests are important for us to see from which groups the difference arises in the case of differences between groups as a result of the analysis of variance. While choosing the post hoc tests, the homogeneity of the variances is taken into account by examining the results of the Levene test applied previously. Levene test makes it possible to detect whether two or more group variances are equal to each other. W statistic, with an F value at the same time, is employed in Levene test.

$$W = \frac{\sum_{j=1}^{c} r(\overline{d_j} - \overline{\overline{d}})/(c-1)}{\sum_{j=1}^{c}\sum_{i=1}^{r}(d_{ij} - \overline{d_j})^2/(n-c)} \qquad (5.2)$$

In the formula, c is the variant number; r is the unit number in the examples; dj is the absolute difference of each example from the arithmetic average and d is the general average. Later, by comparing the W statistic with F table value with f1; c-1 and f 2; n-c degree of freedom;

$F \leq F_{\alpha;f_1-f_2}$ Ho Acceptance, main mass variances are considered equal, and

$F > F_{\alpha;f_1-f_2}$ Ho Rejection, they are considered to be different (Orhunbilge, 2010:44)

In cases when the homogeneity is not provided which is an assumption of the Brown–Forsythe and Welch tests are used to make comparisons between the averages (Kalaycıoğlu, 2006). Various procedures have been developed to determine where the significant differences in the means lie after the ANOVA procedure has been performed (Bluman, 2003). In the event that the variances are equal, the multiple comparison tests (pairwise) that the researchers can choose from are known as: LSD (Least Significant Difference), Sidak, Bonferroni, Tukey, Hochberg's GT2, Gabriel and Scheffe. In the event that the inter group variances are not equal, the post-hoc statistics to be used show differences. The statistics to be used on such condition are Games-Howell, Tamhane's T2, Tamhane's T3, Dunnet's C and Dunnet's T3, and they are processed only as "multiple range test" (Kayri, 2009). In this study, by explaining the homogeneity of variance of each researched criterion, Scheffe and Tamhane multiple comparison tests were employed. The variances have been evaluated in terms of their homogeneity and results have been provided for both cases.

5.3.1 Subset Data for ANOVA

Companies active in the chemical sector between the years 1998-2006 and registered in ICI first and second 500 have been included in the ANOVA analysis. Data including prices have been deflated using the 1994 consumer price index figures. The companies included in the study have been specified as giving data continuously as well as with missing data only for a maximum two years. The missing data have been filled in by using the SPSS 15 program. Data has been standardized based on the q/l value which shows the gross added value per capita. Based on a distribution with zero mean and 1 standard deviation, records with +3, -3 averages and with deviation below or above the standard deviation were detected as outliers and extremes.

The data set has been set in line with the normal distribution as much as possible, and the two companies creating outlier and extreme values, which are Türk Shell and Tüpraş A.Ş, have been excluded from the data set*. *603* data of *67* companies have been included in the study.

The analysis made has been carried out with the computer program of PASW 19, the latest drive of SPSS program. The data set frequency chart to be examined according to union status is below;

Table 5.1 Descriptive Statistics of Union Status

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Nonbinding union agreement	36	6.0	6.0	6.0
	Non-union Firm	396	65.7	65.7	71.6
	Union Firm	171	28.4	28.4	100.0
	Total	603	100.0	100.0	

* The resuls of the ANOVA test which contains outliers and extremes values have been presented in the Appendix A.

5.3.2 Implementation

As it is known, in the ANOVA test groups more than two can be examined from the perspective of some criteria. The per capita gross added value mentioned as productivity indicator in the literature, per capita capital and the number of workers for the differences in the unionization status have been examined. The union status has been specified, in three groups as unionized companies, non-union companies and companies with "nonbinding union agreements".

The One Way ANOVA test has been implemented in two different ways. Firstly, all chemical companies have been included in the research and subjected to the data set analyses where the ANOVA test is applied. It has been specified whether there is a significant difference from the statistical point of view among the 3 groups, unionized companies, non-union companies and companies with "nonbinding union agreements".

Secondly, taking the same criteria into consideration, the ANOVA was applied again but, this time in more detail for the subsectors of the chemical sector in Turkey. With a view to aswer the question if the results obtained for each subgroup would be the same as the ones for the entire sector. The ANOVA test aim to find out whether there was a statistically significant difference among the 3 groups (unionized, non-union companies and "companies with nonbinding union agreement").

5.3.3 ANOVA Test for the Entire Chemical Sector

Through the ANOVA test, unionized companies, non-union companies and companies with nonbinding union agreements are compared in dealing with the productivity outcomes. For the 3 groups specified according to their status, the differences between q/l (per capita productivity), c/l (per capita capital), l (number of laborers) were examined. For ANOVA test, firstly, variance homogeneity Levene’s test (Test on the absolute or squared deviation of scores from their own

group means) was applied. Its significant results were found smaller than 0.05 for q/l, c/l, and l, Welch and Brown–Forsythe tests were applied afterwards. Multiple comparison tests were applied at 95 per cent interval to determine which group is different among the mentioned three groups. Scheffe and Tamhane tests were applied by taking into consideration whether the variances were homogenous or not, and results of the two tests were provided with explanations.

5.3.3.1 Productivity

In the measurement of productivity where the per capita gross added value was taken as the criterion, there was statistically a significant difference between the unionized and non-union groups according to the "Tamhane'' test results. The difference between the unionized and non-union is specified as -298.879 (unionized - non-union). Between the unionized and the "nonbinding union agreement group" a significant result of -222.272 has been obtained.

When the Scheffe test is considered, the difference between the unionized and non-union group has been found as -298.879, thereby supporting Tamhane. No significant difference has been obtained between the "nonbinding agreement group" and the unionized and non-union groups (See table 5.1).

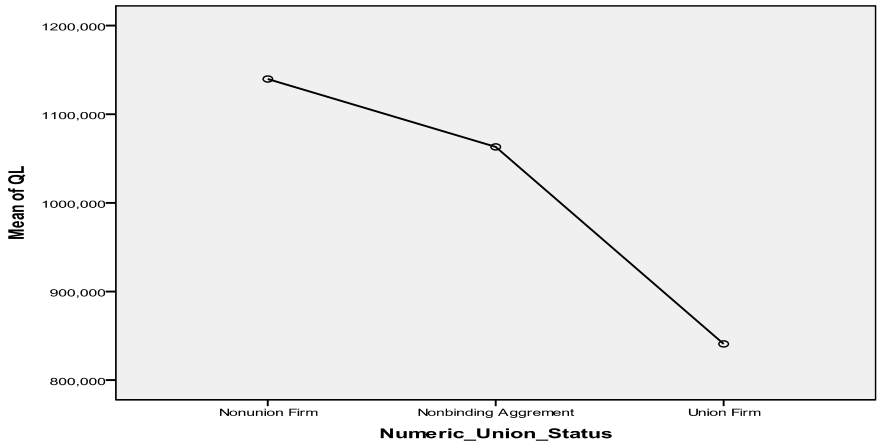

Figure 5. 1 Union Status and Productivity per Labor

Table 5.2 Multiple Comparisons for q/l

Dependent Variable		(I) Union Status	(J) Union Status	Mean Difference (I-J)	Std. Error	Sig.
q/l	Scheffe	Non-union Firm	Nonbinding union agreement	76,607.011	189,492.558	0.922
			Union Firm	298,879.542*	99,608.181	0.011
		Nonbinding union agreement	Non-union Firm	-76,607.011	189,492.558	0.922
			Union Firm	222,272.530	199,611.241	0.538
		Union Firm	Non-union Firm	-298,879.542*	99,608.181	0.011
			Nonbinding union agreement	-222,272.530	199,611.241	0.538
	Tamhane	Non-union Firm	Nonbinding union agreement	76,607.011	103,490.385	0.843
			Union Firm	298,879.542*	74,644.048	0.000
		Nonbinding union agreement	Non-union Firm	-76,607.011	103,490.385	0.843
			Union Firm	222,272.530*	88,249.822	0.044
		Union Firm	Non-union Firm	-298,879.542*	74,644.048	0.000
			Nonbinding union agreement	-222,272.530*	88,249.822	0.044

5.3.3.2 Capital

When the capital per labor is examined through ANOVA analysis; according to the Tamhane test results, no significant difference has been obtained between groups. In the same way, no significant difference has been noticed between the groups with the Scheffe test. Multiple comparison tests results are presented in Table 5.3.

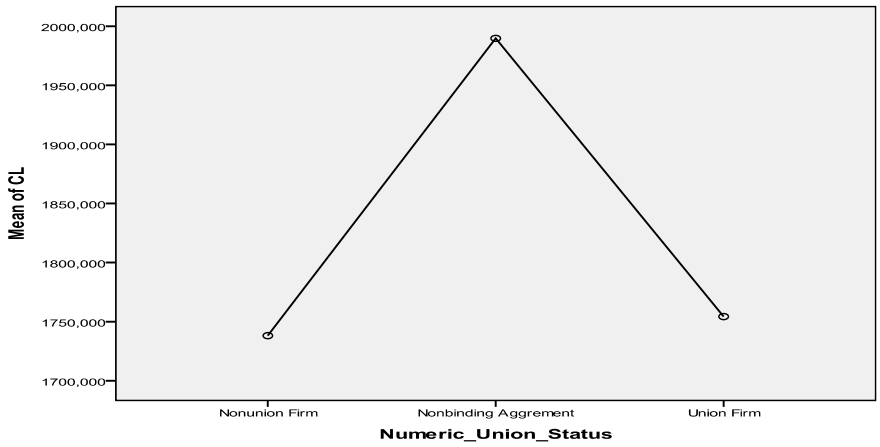

Figure 5. 2 Union Status and Capital Per Labor

Table 5.3 Multiple comparisons for c/l

Dependent Variable		(I) Union Status	(J) Union Status	Mean Difference (I-J)	Std. Error	Sig.
c/l	Scheffe	Non-union Firm	Nonbinding union agreement	-251.591	302.655	0.708
			Union Firm	-16.169	159.093	0.995
		Nonbinding union agreement	Non-union Firm	251.590	302.655	0.708
			Union Firm	235.421	318.817	0.761
		Union Firm	Non-union Firm	16.169	159.093	0.995
			Nonbinding union agreement	-235.422	318.817	0.761
	Tamhane	Non-union Firm	Nonbinding union agreement	-251.591	390.495	0.892
			Union Firm	-16.169	139.642	0.999
		Nonbinding union agreement	Non-union Firm	251.590	390.495	0.892
			Union Firm	235.421	394.027	0.911
		Union Firm	Non-union Firm	16.169	139.642	0.999
			Nonbinding union agreement	-235.422	394.027	0.911

5.3.3.3. Labour

When the number of wage workers in each of the three groups is compared, some significant differences between the 3 groups have been found. According to the Tamhane test results, the difference between the means of unionized and non-union groups is 802.463 and the difference between unionized and "nonbinding union agreement group" has been found to be 638.643. When we look at the Scheffe results for the same factor, the same results are obtained. The difference between the unionized and non-union groups is 802.463 and the difference between the unionized and nonbinding union agreement group is 638.643 (See table 5.4).

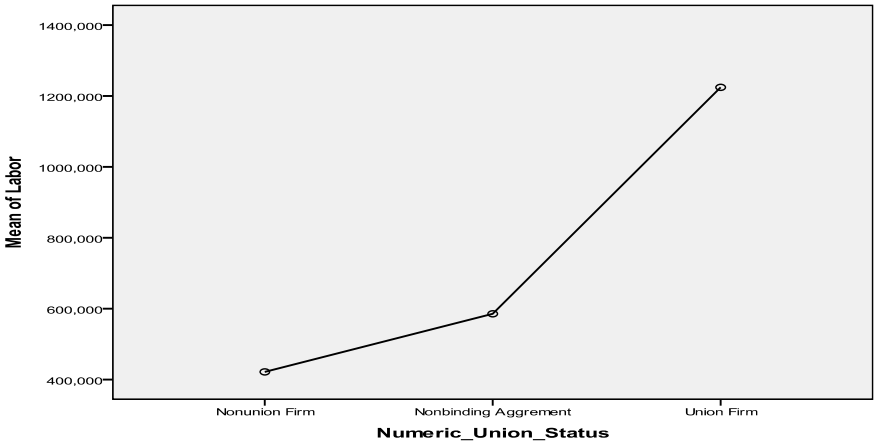

Figure 5. 3 Union Status and Labor

Table 5.4 Multiple comparisons for Labor

Dependent Variable		(I) Union Status	(J) Union Status	Mean Difference (I-J)	Std. Error	Sig.
Lbr	Scheffe	Non-union Firm	Nonbinding union agreement	-163.819	136.519	.487
			Union Firm	-802.463*	71.762	.000
		Nonbinding union agreement	Non-union Firm	163.819	136.519	.487
			Union Firm	-638.643*	143.809	.000
		Union Firm	Non-union Firm	802.463*	71.762	.000
			Nonbinding union agreement	638.643*	143.809	.000
	Tamhane	Non-union Firm	Nonbinding union agreement	-163.819	71.586	.080
			Union Firm	-802.463*	105.506	.000
		Nonbinding union agreement	Non-union Firm	163.819	71.586	.080
			Union Firm	-638.643*	125.053	.000
		Union Firm	Non-union Firm	802.463*	105.506	.000
			Nonbinding union agreement	638.643*	125.053	.000

5.3.4 ANOVA test for each sub sector

The ANOVA test has been applied for the subgroups of the chemical field where there are companies in the same study data set. The aim here is to specify whether there is a difference in the chemical sector in general according to the criteria on the number of workers, the gross added value, capital, and according to the unionization status in each subsector. The research question required a more detailed investigation on this subject. The data set comprising companies active in subfields such as power supply, dye, gas, general chemical, fertilizer, pharmaceutical, plastic,

petroleum has been put into 4 main groups. Since all the companies in the field of tyres are unionized, analysis under a separate sub-group was not deemed necessary. The groups specified as subsector have been set as general chemical, pharmaceutical, oil and plastic. The ANOVA test has been applied for four groups.

5.3.4.1. General Chemicals

Criteria such as number of workers, the gross added value and capital in the General Chemical Field were evaluated, with an attempt to find out whether there was a difference between the groups. The Levene test has been applied in the data set and the result was obtained as sig. <0.05 for each criterion. For q/l, c/l, l, Welch and Brown–Forsythe tests have been applied. The Welch and Brown–Forsythe tests have given significant results for each criterion as sig.<0.05. There are multiple comparisons in the post hoc test table. The data frequency table divided according to union status is presented below.

Table 5.5 Descriptive Statistics of Union Status (General Chemical)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Nonbinding union agreement	9	3.7	3.7	3.7
	Non-union Firm	162	66.7	66.7	70.4
	Union Firm	72	29.6	29.6	100.0
	Total	243	100.0	100.0	

5.3.4.1.1 Productivity

There is a statistically significant difference between the unionized and non-union groups according to the Tamhane test results, at which measurement for per capita gross value added was taken as the productivity criterion and the unionized and non-union difference was specified as -338.397 (union – non-union).

Between the unionized and "nonbinding union agreement" group, a significant difference of -723.580 was obtained.

When the Scheffe test considered, the difference between the unionized and non-union groups was found as -338.397 (union–non-union), supporting Tamhane. No

significant difference has been found between the nonbinding union agreement and the other two, unionized and non-union groups.

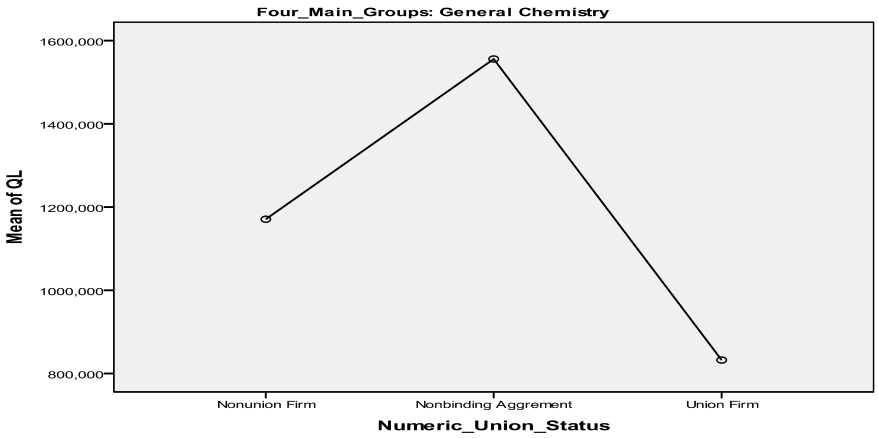

Figure 5. 4 Union Status and Productivity (General Chemical)

Table 5.6 Multiple comparisons for q/l (General Chemical)

Dependent Variable		(I) Union Status	(J) Union Status	Mean Difference (I-J)	Std. Error	Sig.
q/l	Scheffe	Non-union Firm	Nonbinding union agreement	-385.183	315.573	0.476
			Union Firm	338.397*	130.516	0.036
		Nonbinding union agreement	Non-union Firm	385.183	315.573	0.476
			Union Firm	723.580	325.788	0.087
		Union Firm	Non-union Firm	-338.397*	130.516	0.036
			Nonbinding union agreement	-723.580	325.788	0.087
	Tamhane	Non-union Firm	Nonbinding union agreement	-385.183	163.175	0.093
			Union Firm	338.397*	98.064	0.002
		Nonbinding union agreement	Non-union Firm	385.183	163.175	0.093
			Union Firm	723.580*	147.065	0.002
		Union Firm	Non-union Firm	-338.397*	98.064	0.002
			Nonbinding union agreement	-723.580*	147.065	0.002

5.3.4.1.2 Capital

The Scheffe and Tamhane tests have been applied for the per capita capital criterion in the field of general chemical. Both tests (Tamhane and Scheffe) have obtained the same results. The statistically significant difference between the nonbinding union agreement group and the non-union group has been specified as 3,322.357, and the statistically significant difference between the nonbinding union agreement group and the unionized group has been specified as 3,716.570.

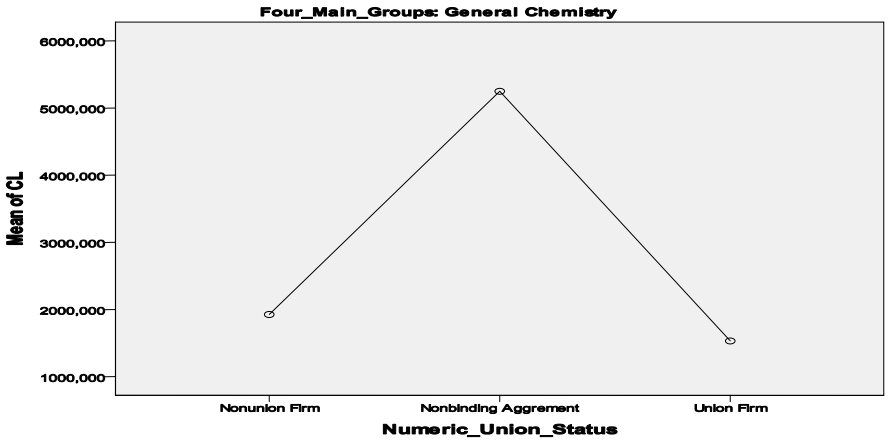

Figure 5. 5 Union Status and Capital per Labor (General Chemical)

Table 5.7 Multiple comparisons for c/l (General Chemical)

Dependent Variable		(I) Union Status	(J) Union Status	Mean Difference (I-J)	Std. Error	Sig.
c/l	Scheffe	Non-union Firm	Nonbinding union agreement	-3,322.357*	700.751	.000
			Union Firm	394.213	289.820	.398
		Nonbinding union agreement	Non-union Firm	3,322.357*	700.751	.000
			Union Firm	3,716.570*	723.435	.000
		Union Firm	Non-union Firm	-394.213	289.820	.398
			Nonbinding union agreement	-3,716.570*	723.435	.000
	Tamhane	Non-union Firm	Nonbinding union agreement	-3,322.357*	839.179	.010
			Union Firm	394.213	234.466	.257
		Nonbinding union agreement	Non-union Firm	3,322.357*	839.179	.010
			Union Firm	3716.570*	833.533	.005
		Union Firm	Non-union Firm	-394.213	234.466	.257
			Nonbinding union agreement	-3,716.570	833.533	.005

5.3.4.1.3 Labour

When the average of the workers in the field of general chemical is examined, significant differences have been found between the 3 groups. According to the Tamhane test results, the difference between the unionized and non-union group has been obtained as 493.4310, and unionized and "non-binding agreement" group difference as 602.418. The difference between the non-unionized and "non-binding group" is 108.987. When we look at the Scheffe results for the same factor the results are the similar. The difference between the unionized and non-union groups is 495.255, and the unionized nonbinding union agreement group difference has been found to be as 602.418.

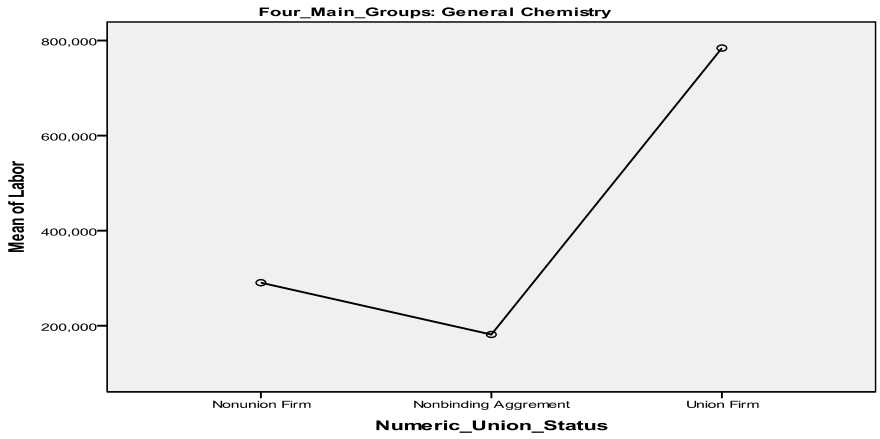

Figure 5. 6 Union Status and Labor (General Chemical)

Table 5.8 Multiple comparisons for Labor

Dependent Variable		(I) Union Status	(J) Union Status	Mean Difference (I-J)	Std. Error	Sig.
Lbr	Scheffe	Non-union Firm	Nonbinding union agreement	108.987	152.342	0.774
			Union Firm	-493.431*	63.006	0.000
		Nonbinding union agreement	Non-union Firm	-108.987	152.342	0.774
			Union Firm	-602.418*	157.273	0.001
		Union Firm	Non-union Firm	493.431*	63.006	0.000
			Nonbinding union agreement	602.418*	157.273	0.001
	Tamhane	Non-union Firm	Nonbinding union agreement	108.987*	35.921	0.025
			Union Firm	-493.431*	88.393	0.000
		Nonbinding union agreement	Non-union Firm	-108.987*	35.921	0.025
			Union Firm	-602.418*	91.598	0.000
		Union Firm	Non-union Firm	493.431*	88.393	0.000
			Nonbinding union agreement	602.418*	91.598	0.000

5.3.4.2 Pharmaceuticals

In the pharmaceuticals *subgroup*, which is a subsector of the field of Chemical, the ANOVA test and the statistical analysis were applied. For the unionized, non-union and "nonbinding union agreement" group, analysis focussed on whether there was a statistically significant difference from the q/l, c/l, l criteria. Also with multiple comparisons, effort was made to specify between which groups this difference existed and what its total was. In the data set, first the Levene's test was applied and the results for q/l, were found as sig.>0.05. For q/l, it shows the homogeneity in the variances as well as the ANOVA results. For c/l, l Welch and Brown–Forsythe tests have been applied.

Table 5.9 Descriptive Statistics of Union Status (Pharmaceuticals)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Nonbinding union agreement	18	15.4	15.4	69.2
	Non-union Firm	63	53.8	53.8	53.8
	Union Firm	36	30.8	30.8	100.0
	Total	117	100.0	100.0	

5.3.4.2.1 Productivity

Concerning productivity in the pharmaceuticals sector, for q/l groups significant difference could not be specified in ANOVA Test. In the post hoc tests table multiple comparisons have been carried out. As a result of the q/l, Tamhane and Schefe tests, no significant difference was obtained between the groups.

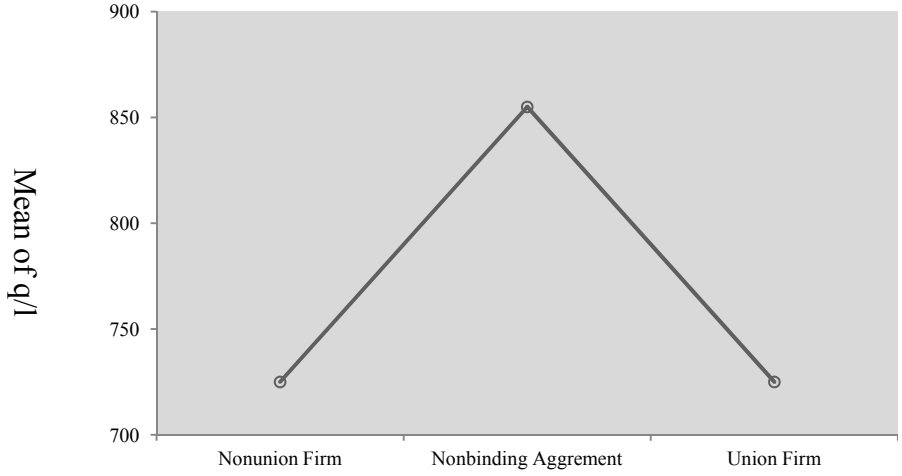

Figure 5. 7 Union Status and Productivity (Pharmaceuticals)

Table 5.10 Multiple comparisons for q/l (Pharmaceuticals)

Dependent Variable		(I) Union Status	(J) Union Status	Mean Difference (I-J)	Std. Error	Sig.
q/l	Scheffe	Non-union Firm	Nonbinding union agreement	-142.174	122.306	0.511
			Union Firm	-0.491	95.611	1.000
		Nonbinding union agreement	Non-union Firm	142.174	122.306	0.511
			Union Firm	141.683	132.106	0.564
		Union Firm	Non-union Firm	0.491	95.611	1.000
			Nonbinding union agreement	-141.683	132.106	0.564
	Tamhane	Non-union Firm	Nonbinding union agreement	-142.174	92.658	0.349
			Union Firm	-0.491	106.373	1.000
		Nonbinding union agreement	Non-union Firm	142.174	92.658	0.349
			Union Firm	141.683	118.010	0.553
		Union Firm	Non-union Firm	0.491	106.373	1.000
			Nonbinding union agreement	-141.683	118.010	0.553

5.3.4.2.2 Capital

In the pharmaceuticals, significant difference was obtained at the Tamhane and Scheffe tests. Both test gives a significant difference of 804.453 between the unionized and non-union groups.

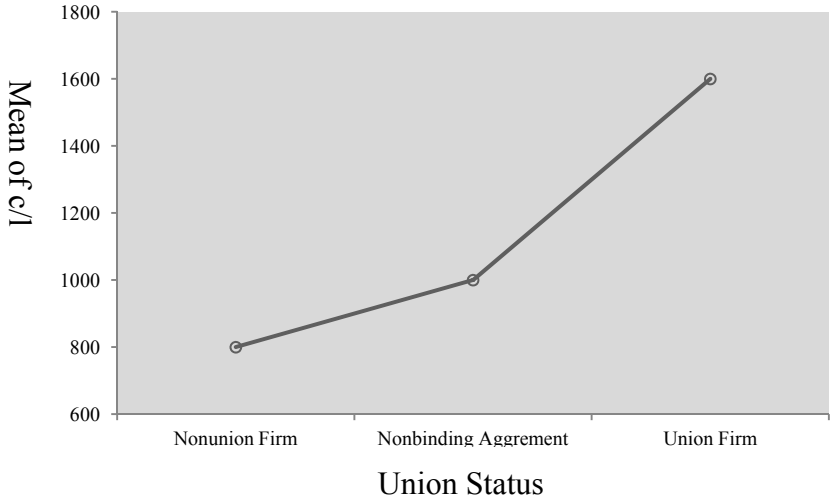

Figure 5. 8 Union Status and Capital per Labor

Table 5.11 Multiple comparisons for c/l (Pharmaceuticals)

Dependent Variable		(I) Union Status	(J) Union Status	Mean Difference (I-J)	Std. Error	Sig.
c/l	Scheffe	Non-union Firm	Nonbinding union agreement	-162.674	299.016	.863
			Union Firm	-804.453*	233.751	0.004
		Nonbinding union agreement	Non-union Firm	162.674	299.016	0.863
			Union Firm	-641.779	322.974	0.144
		Union Firm	Non-union Firm	804.453*	233.751	0.004
			Nonbinding union agreement	641.779	322.974	0.144
	Tamhane	Non-union Firm	Nonbinding union agreement	-162.674	140.455	0.583
			Union Firm	-804.453*	305.558	0.035
		Nonbinding union agreement	Non-union Firm	162.674	140.455	0.583
			Union Firm	-641.779	311.183	0.129
		Union Firm	Non-union Firm	804.453*	305.558	0.035
			Nonbinding union agreement	641.779	311.183	0.129

5.3.4.2.3 Labour

In the pharmaceuticals sector, examining the average number of workers Scheffe and Tamhane tests were applied. In the Tamhane test, a significant difference was between "the nonbinding union agreement group" and the other two groups, that is, the unionized and non-union groups. The difference between the nonbinding union agreement group and the unionized group has been found as 334.157. The difference

between the "nonbinding union agreement" group and the non-union group is 413.180.

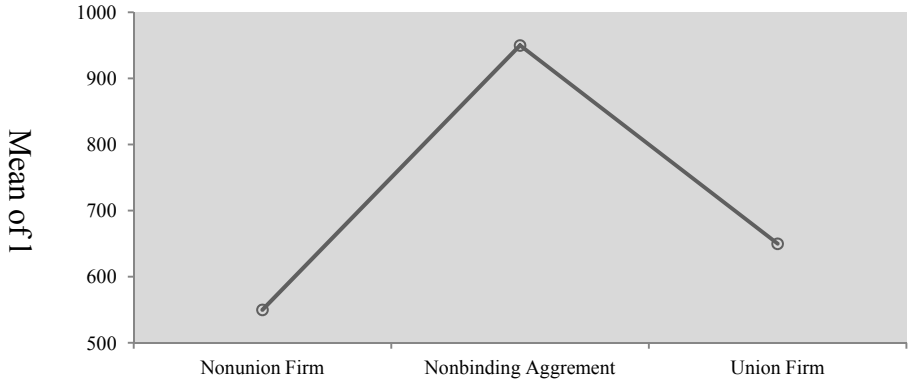

Figure 5. 9 Union Status and Labor (Pharmaceuticals)

Table 5.12 Multiple Comparisons Labor (Pharmaceuticals)

Dependent Variable		(I) Union Status	(J) Union Status	Mean Difference (I-J)	Std. Error	Sig.
Lbr	Scheffe	Non-union Firm	Nonbinding union agreement	-413.180*	77.058	.000
			Union Firm	-79.023	60.239	.426
		Nonbinding union agreement	Non-union Firm	413.180*	77.058	.000
			Union Firm	334.156*	83.232	.001
		Union Firm	Non-union Firm	79.023	60.239	.426
			Nonbinding union agreement	-334.156*	83.232	.001
	Tamhane	Non-union Firm	Nonbinding union agreement	-413.180*	58.338	.000
			Union Firm	-79.023	58.107	.443
		Nonbinding union agreement	Non-union Firm	413.180*	58.338	.000
			Union Firm	334.156*	56.623	.000
		Union Firm	Non-union Firm	79.023	58.107	.443
			Nonbinding union agreement	-334.156*	56.623	.000

5.3.4.3 Oil

For the *subgroup oil*, which is a subsector of the field of Chemical, the ANOVA analysis was made. In the oil field, there are no nonbinding union agreement group firms in our data set. For the two groups i.e. unionized and non-union firms, research was done to see whether or not there is statistically a significant difference from the

q/l, c/l, l; in the data set first the Levene's test has been carried out, the results were found to be sig. >0.05 for c/l. For q/l, and l, sig. <0.05 is was found.

Table 5.13 Descriptive Statistics of Union Status (Oil)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Non-union Firm	63	77.8	77.8	77.8
	Union Firm	18	22.2	22.2	100.0
	Total	81	100.0	100.0	

Table 5.14 Comparison of q/l, c/l, Labor (Oil)

		N	Mean	Std. Deviation	Std. Error
q/l	Non-union Firm	63	2412.168	2080.452	262.112
	Union Firm	18	863.459	339.783	80.087
	Total	81	2068.011	1949.022	216.558
c/l	Non-union Firm	63	2409.627	1508.860	190.098
	Union Firm	18	2823.929	942.138	222.064
	Total	81	2501.694	1408.214	156.468
Labor (l)	Non-union Firm	63	629.777	489.337	61.650
	Union Firm	18	4688.944	1019.082	240.200
	Total	81	1531.814	1813.755	201.528

5.3.4.3.1 Productivity

In the measurement, the per capita gross added value (q/l) was taken as the productivity criterion; according to Brown-Forsythe and Welch tests, there was a statistically significant difference between the unionized and non-union groups. Where equal variances are not assumed, the non-union and unionized difference has been specified as 1,548.708 (non-union – union)

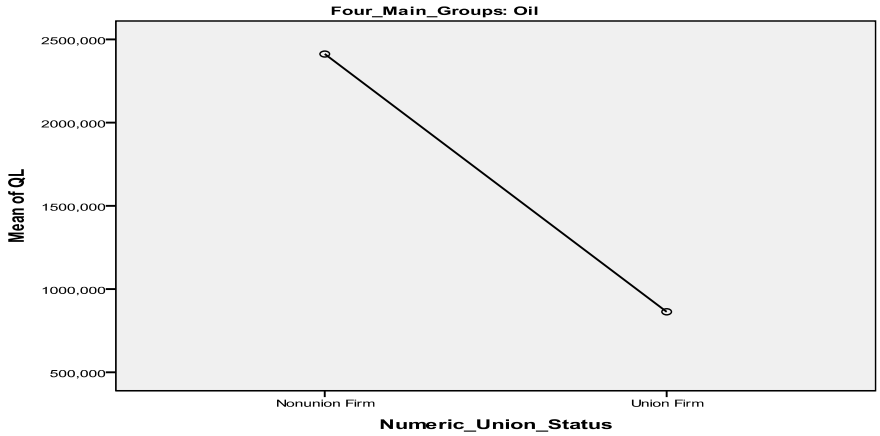

Figure 5. 10 Union Status and Productivity (Oil)

5.3.4.3.2 Capital

In the chemical sector for oil the per capita capital (c/l); has been examined; according to the ANOVA results between the unionized and non-union groups, a statistically significant difference has not been found.

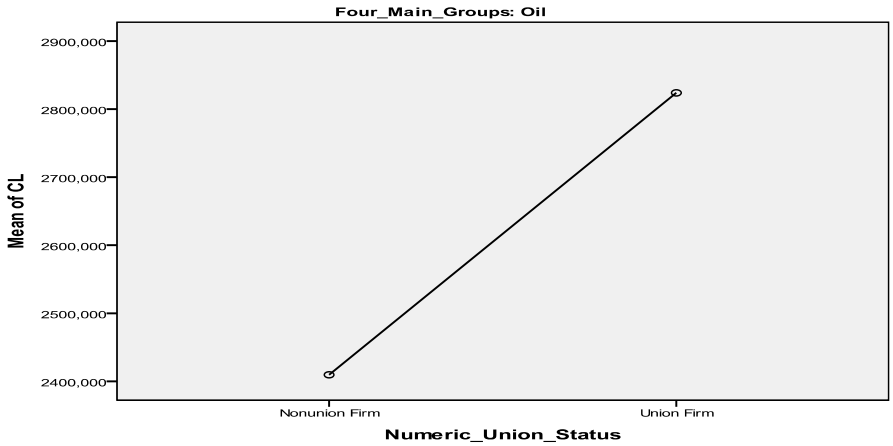

Figure 5. 11 Union Status and Capital per Labor (Oil)

5.3.4.3.3 Labour

The difference between the groups in the number of workers has been examined through the Brown-Forsythe and Welch tests; according to the results of the test, a statistically significant difference has been found between the unionized and non-union groups. The unionized non-union difference is 4,059.162 (unionized – non-union).

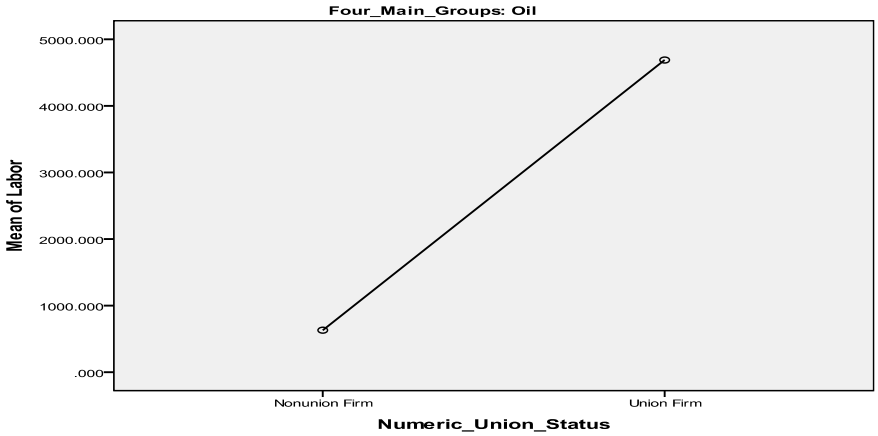

Figure 5. 12 Union Status and Labor (Oil)

Table 5.15 ANOVA Test (Oil)

		Sum of Squares	df	Mean Square	F	Sig.
q/l	Between Groups	33,578,975.939	1	33,578,975.939	9.813	0.002
	Within Groups	270,316,174.418	79	3,421,723.727		
	Total	303,895,150.357	80			
c/l	Between Groups	2,403,041.485	1	2,403,041.485	1.215	0.274
	Within Groups	156,242,455.877	79	1,977,752.606		
	Total	158,645,497.361	80			
Labor (l)	Between Groups	230,675,676.389	1	230,675,676.389	560.702	0.000
	Within Groups	32,500,989.833	79	411,404.935		
	Total	263,176,666.222	80			

5.3.4.4 Plastic

For the subgroup plastic, which is a subsector of the field of Chemical, the ANOVA test and the analysis have been applied. For the unionized, non-union and "nonbinding union agreement" groups, whether or not there is a statistically significant difference from the q/l, c/l, l criteria was examined. Also with multiple comparisons tests, the attempt was made to specify between which groups this difference exists and what its total is. In the data set first the Levene's test was applied. According to which, the significance value for q/l was obtained above 0.05. The significance value for c/l and l was below 0.05, and by assuming that the variances were not homogenous, Brown-Forsythe and Welch tests were employed.

Table 5.16 Descriptive Statistics of Union Status (Plastic)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Nonbinding union agreement	9	7.1	7.1	92.9
	Non-union Firm	108	85.7	85.7	85.7
	Union Firm	9	7.1	7.1	100.0
	Total	126	100.0	100.0	

5.3.4.4.1 Productivity

Productivity was examined in the plastic sector, the significant values of the criteria were studied according to the ANOVA test results, for q/l no significant difference was found between the groups (sig=0.175).

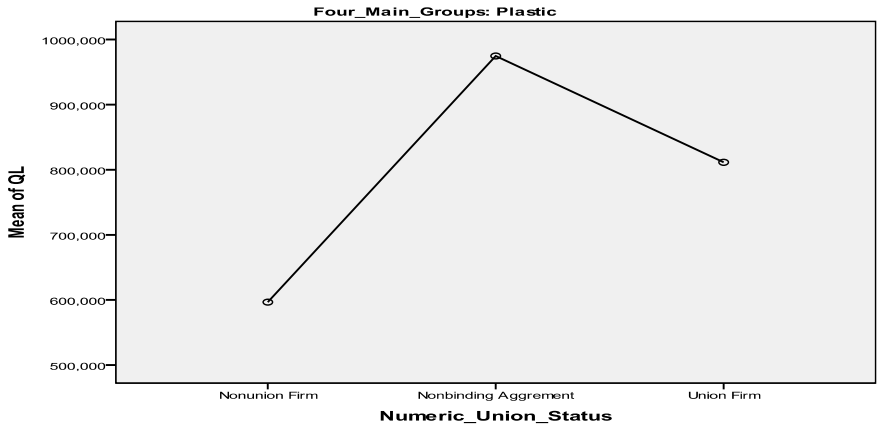

Figure 5. 13 Union Status and Productivity (Plastic)

Table 5.17 Multiple comparisons for q/l (Plastic)

Dependent Variable		(I) Union Status	(J) Union Status	Mean Difference (I-J)	Std. Error	Sig.
q/l	Scheffe	Non-union Firm	Nonbinding union agreement	-378.179	224.022	.244
			Union Firm	-214.844	224.022	.632
		Nonbinding union agreement	Non-union Firm	378.179	224.022	.244
			Union Firm	163.335	304.386	.866
		Union Firm	Non-union Firm	214.844	224.022	.632
			Nonbinding union agreement	-163.335	304.386	.866
	Tamhane	Non-union Firm	Nonbinding union agreement	-378.179	180.677	.173
			Union Firm	-214.844	118.847	.245
		Nonbinding union agreement	Non-union Firm	378.179	180.677	.173
			Union Firm	163.335	195.887	.804
		Union Firm	Non-union Firm	214.844	118.847	.245
			Nonbinding union agreement	-163.335	195.887	.804

5.3.4.4.2 Capital

For the c/l, the per capita capital changes according to unionization status in the plastic sector was examined by using the Welch and the Brown –Forsythe tests. When the Tamhane test result is considered, the difference between the non-union and the "nonbinding union agreement" groups has been found as 838.545. Besides, the difference between the union firms and non-union firms' group averages was obtained as -770.722. Scheffe test could not obtain a statistical significant difference between the groups.

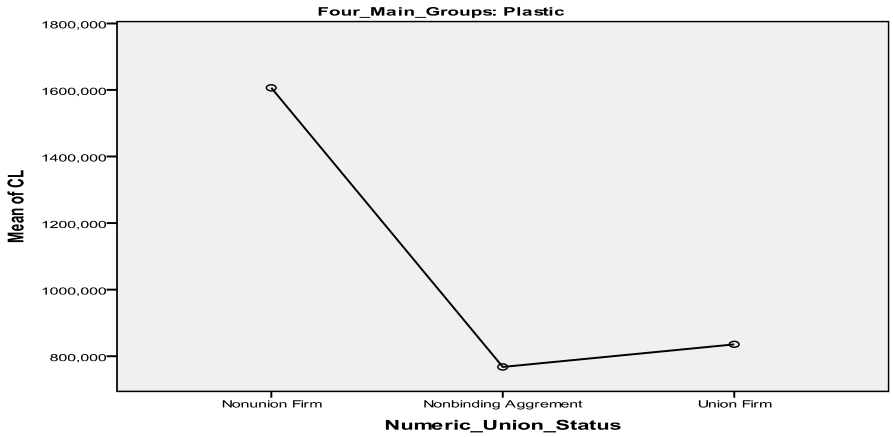

Figure 5. 14 Union Status and Capital per Labor (Plastic)

Table 5.18 Multiple comparisons for c/l (Plastic)

Dependent Variable		(I) Union Status	(J) Union Status	Mean Difference (I-J)	Std. Error	Sig.
c/l	Scheffe	Non-union Firm	Nonbinding union agreement	838.545	450.052	0.181
			Union Firm	770.722	450.052	0.235
		Nonbinding union agreement	Non-union Firm	-838.545	450.052	0.181
			Union Firm	-67.823	611.501	0.994
		Union Firm	Non-union Firm	-770.722	450.052	0.235
			Nonbinding union agreement	67.823	611.501	0.994
	Tamhane	Non-union Firm	Nonbinding union agreement	838.545*	212.277	0.002
			Union Firm	770.722*	136.624	0.000
		Nonbinding union agreement	Non-union Firm	-838.545*	212.277	0.002
			Union Firm	-67.823	168.104	0.972
		Union Firm	Non-union Firm	-770.722*	136.624	0.000
			Nonbinding union agreement	67.823	168.104	0.972

5.3.4.4.3 Labour

When the number of employees in the Plastic subgroup is considered; according to Tamhane test, differences were obtained between all group averages. The difference between the non-union group and the unionized group has been found to be 300.334. The difference between the non-union group and the "nonbinding union agreement" group was 204.556. Additionally, the difference between the nonbinding union agreement group and unionized group was obtained as 95.778. According to the results of the Scheffe test, the difference between the non-union and unionized groups has been found to be 300.334, giving the same results as Tamhane.

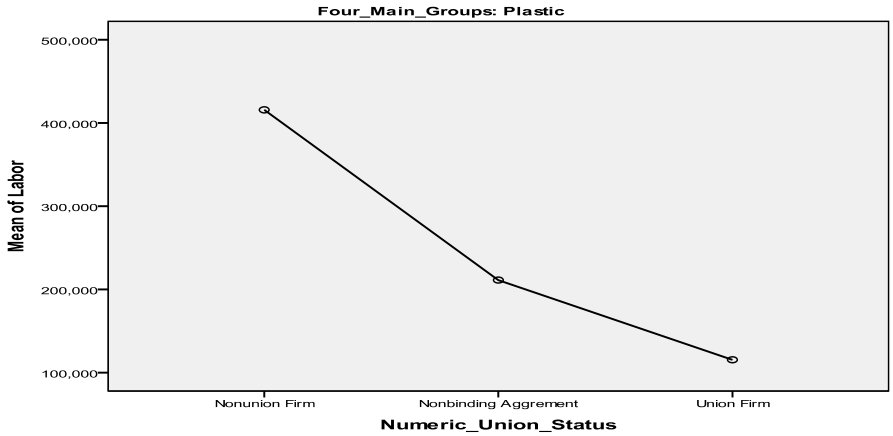

Figure 5. 15 Union Status and Labor (Plastic)

Table 5.19 Multiple comparisons for Labor (Plastic)

Dependent Variable		(I) Union Status	(J) Union Status	Mean Difference (I-J)	Std. Error	Sig.
Lbr(l)	Scheffe	Non-union Firm	Nonbinding union agreement	204.556	101.447883	0.135
			Union Firm	300.334*	101.447	0.015
		Nonbinding Aggrement	Non-union Firm	-204.556	101.447	0.135
			Union Firm	95.777	137.840	0.786
		Union Firm	Non-union Firm	-300.334*	101.447	0.015
			Nonbinding union agreement	-95.777	137.840	0.786
	Tamhane	Non-union Firm	Nonbinding union agreement	204.556*	39.640	0.000
			Union Firm	300.334*	31.205	0.000
		Nonbinding Aggrement	Non-union Firm	-204.556*	39.640	0.000
			Union Firm	95.777*	27.096	0.017
		Union Firm	Non-union Firm	-300.334*	31.205	0.000
			Nonbinding union agreement	-95.777*	27.096	0.017

5.3.5 ANOVA Interpretations

Companies active in the Chemical Sector in Turkey between the years 1998-2006 and registered in the ICI first and second 500 groups have been subject to the ANOVA analysis. The ANOVA test was applied in two different ways.

First, *all the chemical companies* were included in the scope of the research and all the data set was subjected to analysis, applying the ANOVA test. Tamhane's test results revealed statistically significant differences between the mean values relating to unionized firms and the other two groups, that is, non-union firms and firms with non-binding agreements. Considering the groups' mean values, there is a tendency towards productivity increase successively from the unionized to non-unionized firms, meaning non-union firms are more productive.

The reason for this tendency was probed by in-depth interviews conducted with informants. An informant representing one of the largest non-union firms (AYGAZ) in the petroleum industry attributed this difference to low productivity possibly resulting from lack of discipline in unionized firms due to the fact that workers see their union as a powerful force shielding them against disciplinary actions by the employer. It is in fact conceivable that those who violate work discipline in non-union settings can be terminated more readily than similar workers in unionized setting. Union members have a stronger feeling of job security as they view their union as a protective force against dismissals and other disciplinary actions by the employers. Similar views were also supported by respondents representing union as well as unionized firms and firms with non-binding agreements. Likewise, in an interview with a representative from a firm in the "non-binding agreements" group (ALKİM), the higher productivity compared to that of the unionized group was attributed to the absence of union power behind workers, resulting in the workers increased commitment to work since they lack the support and protection of the union.

Union pressures forcing employers to accept job descriptions, thereby limiting the scope of worker's activities and effort, may also be the cause of lower productivity.

Strict adherence by the union to working time rule and avoiding undertaking longer hours are also seen as factors resulting in lower productivity in union settings. Non-union firms tend to employ workers at lower labor costs and/or keep them working longer hours, refraining from paying the legally mandated overtime premiums. Certainly work along these lines is apt to increase production. It was common practice for some firms, while progressive employers kept paying the time and a half or even the union-negotiated "higher" rates for all overtime hours worked. The flexibility brought in the overtime work rules in the Labor Act of 2003 paved the way for abusing these rules in non-union work places.

Differently from the previous regulations in Act no 1475, the obligation of dividing weekly work hours equally into work days in a week was abolished, thereby, distributing normal weekly working time days in a week in different proportions through agreements was made possible. In the case of balancing (63/II), on the other hand, working over 45 hours in some weeks is not considered as overtime work as long as weekly average 45 hour work is not exceeded within the equalization period (two or four months) (Labor Act Article 41/I) (Topçuoğlu, İ. 2009; 8). A simple example can be given to better understand. Accordingly, in case 55 hour work is exceeded in five work days in the first two weeks and 30 hour work is exceeded in the third and fourth weeks of the equalization period, total work hours will be 110+60=170 in the four week equalization period and as weekly average work period is 170÷4=42.5 hours, no overtime payment will be made to the worker as the weekly average work does not exceed 45 hours in average. If they worked for 45 hours in a week in the third and the fourth weeks, the average work period would be 50 hours and they would earn overtime payment for 5 hours for each week (Topçuoğlu, İ. 2009; 76).

But this flexibility measure has not been used properly by non-unionized firms; that is, while no overtime pay was granted daily the weekly working time was not reduced adequately in the following weeks so as to balance out the average weekly working time at 45 hours within the given period of adjustment. Thus the non-union firms took advantage of the new flexibility measures illegally.

Furthermore, some firms did not respect the legally mandated rest breaks. As it is possible for union firms to implement the labor law on a wider scale when compared to non-union firms, one is likely to find their productivity at a lower level. Collective agreements regulate working time in a more orderly fashion. They foresee the application of rest periods, tea or meal breaks along legal lines. It is difficult to estimate how these adjustments are implemented even at legal minimums at non-union firms.

The hypothesis that unions tend to be organized in firms with high per capita capital was tested and confirmed for this sector; when the three groups were examined in terms of per capita capital, no statistically significant difference was found between them.

According to the results of the Tamhane's test, it was found that compared to the other two groups, more workers were employed on average in the "unionized firms" group. When the groups' mean values are considered, the number of workers employed in respective groups tends to increase as the rate of unionization rises, whereas the trend of the gross value added per capita tends to decrease. While the number of workers employed is the highest in unionized firms, it tends to fall in firms with "nonbinding union agreements" and reaches the lowest level in non-union firms, in that order. Common views of respondents indicate that the reason accounting for this difference could be attributed to the larger volume of employment (overmanning) prevailing in the unionized firms. Furthermore, the respondents also made reference to the difficulties involved in terminating workers in unionized firms, due to the additional protection provided by the labor union. This leads to continued employment of unproductive workers. To offset lower productivity, unionized firms have to hire additional workers. On the other hand, this may be given as a reason for the high number of employees in union firms.

Besides, unions are also opposed to the employer's use of subcontractors in establishments where they are active and try to restrict subcontracting of employment. As the subcontracting applications are welcomed by the non-union firms, the required labor force is met by contract labor. The number of employees in

the non-union firms is higher than unionized firms because contracted employees are not included in the workforce of the firm. Concerning the results obtained for the unionized group, (i.e. the large volume of employment and lower added value per capita), the same interviewee noted the probability of the unionized group supplying correct information reflecting the real figures. Likewise; the KİPLAS representative from the employers' union active in the chemicals, petroleum and tire sector made the following remarks on the aforementioned topics; data on workers are recorded and documented more correctly in unionized firms. This may be one reason why the number of workers appears to be higher in such firms. This may also explain the lower productivity computed as a ratio of production per worker. Numerical data reflect the real situation more correctly in unionized firms. Further, employment of subcontractors and their workers is hardly acceptable in unionized firms; and if there is such employment, it is easily observable. Non-union firms, on the other hand, rarely state the number of contractor's employees correctly.

As a further step in the analysis, the ANOVA test was applied again, taking the same criteria into account but this time for the subsectors of Turkey's chemical sector and in a more detailed fashion, in order to find out whether the results obtained for the whole sector also applied in the case of subsector comparisons. The purpose is to test if there is a statistically significant difference between the three groups (unionized, non-unionized and nonbinding union agreements group) in terms of each subsector of the chemicals sector.

According to the ANOVA test results, in which the *General Chemical* field groups are taken into consideration in terms of per capita productivity, the unionized firms are less productive than the other two groups. The difference (in terms of the q/l mean) between unionized and non-union, as well as between the unionized and nonbinding union agreement group, were found to be statistically significant. Unionized firms give lower rates of productivity when compared to the other two groups. As for the q/l between the non-union and the nonbinding union agreement groups, no statistically significant difference was found. When statistical relevance is ignored and only the group averages are considered, the nonbinding group can be suggested as the most productive. Considering the results obtained for the general

chemicals sector, the findings concerning the comparison between the unionized and non-unionized firms reflect the real situation. But the nonbinding union agreement group's appearance of having the highest productivity may be misleading since the sample includes only one firm representing this category. Therefore the comparison involving the non-union group may not be considered reliable.

Concerning the interview question as to why the non-unionized firms' per capita productivity (in the general chemical sub group) has been found to be higher than unionized firms, a human resources manager representing the "nonbinding union agreements" group in the general chemicals sector (ALKİM) responded by saying that this finding was quite natural. According to him workers' stronger commitment led to this finding. Thus, its reflection to the worker's total productivity in the firm is only natural. Similarly, a respondent from the non-union general chemicals sector representing KAYALAR repeated his earlier statements with a further remark pointing also to the possible effects of lower unionization in this sector.

In terms of per capita capital comparisons, no significant difference was found between the unionized and non-union groups, but the "nonbinding union agreements" group is characterized by statistically significant higher rates of per capita capital in comparison to the other two groups.[6]

In a group comparison of the number of laborers, the Tamhane test results showed clearly that the unionized group had more workers than the non-union group and nonbinding union agreement group. The companies in the "nonbinding union agreement group" are the companies that provide the least amount of employment among the three groups. On account of the insufficiency of data on the "nonbinding agreements firms" ; it may be deceptive to conclude that the nonbinding agreement firms employ the lowest number of workers possible.

Including the companies in the area of *pharmaceuticals*, when the per capita productivity is examined, the ANOVA test results showed no significant difference

[6] The result is conceived as unreliable when it is taken into account that the data of nonbinding firms is at insufficient.

between the three groups, i.e. unionized, non-union and "nonbinding union agreement" as a result of the Scheffe's test.

The Tamhane's test was applied in examining per capita capital for these groups in order to disclose the differences between averages of unionized and non-union firms, referring to the situation when variances are not homogenous. Per capita capital was found higher in unionized firms, meaning they are mostly capital intensive organizations. The same result was obtained by applying the Scheffe's test (with homogeneity of variances under the same assumption)

As a result of the Tamhane's test result, in the comparison of the average of number of workers, the "nonbinding union agreement" group companies were found having more workers than the other two groups,. No significant difference was found between the unionized and non-union groups.

Concerning the particular findings for the *oil-field* which is a subsector of the chemicals industry, non-unionized companies were found to be more productive than unionized.

When analyzed in terms of per capita capital, no difference was found between union and non-union group averages.

The number of employees was again analyzed by using the ANOVA analysis. It was discovered that union firms had more workers than non-union firms. Findings in the petroleum field support the general chemical field. Moreover, certain possible reasons for the higher number of employees in the union firms than the non-union ones have been detected as a result of the interview conducted with the employers' union. Concerning the higher number of workers employed in oil sector firms, the representative of KİPLAS refers to the uniqueness of the petroleum sector where the number of workers employed is overstated since some of them, though seemingly employed and paid wages, work only for temporary periods as they are also land owners. The interviewee from AYGAZ, representing the non-union group in the petroleum sector, referred to the higher number of workers employed in this sector

as a factor arising from the predominance of public ownership and a result of politically motivated recruitments in this sector. Unions are organized more easily in the public sector and the performance of Petrol-İş is noteworthy in this respect.

In the *plastic industry,* the application of the Tamhane's and Scheffe's tests showed that there was no difference in productivity between the "unionized" and "non-union" groups. Here, in terms of per capita capital; the non-union group represents more per capita capital; the "unionized" and "nonbinding union agreements" groups seem to have lower per capita capital than the "non-union" group.

On the other hand, the situation is somewhat different in the plastic industry which is also subsector of the chemical industry. Here, in terms of the number of workers employed, statistically significant differences were found. Non-union firms tend to employ the highest number of workers, followed by companies in the "nonbinding union agreements" group, while the unionized firms employ the least number of workers. (However, one must interpret these findings for the plastic sector with some caution as the "unionized" and "nonbinding union agreement" firms are under-represented in the sample with the inclusion of only one firm from each.)

Table 5.20 ANOVA Findings

ANOVA Criteria	ANOVA Test for All Turkish Chemical Sectors	ANOVA Test for General Chemical Sectors	ANOVA Test for Pharmaceuticals Sectors	ANOVA Test for Oil Sectors	ANOVA Test for Plastic Sectors
Productivity per labor	union < non-union union < nonbinding	union < non-union union < nonbinding	no significant relationship	union < non-union	no significant relationship
Capital per labor	no significant relationship	nonbinding > union nonbinding > non-union	union > non-union	no significant relationship	non-union >union non-union > nonbinding
Labor	union > non-union union > nonbinding	union > non-union > nonbinding	nonbinding > non-union nonbinding > union	union>non-union	non-union > nonbinding > union

5.4 Data Envelopment Analysis (DEA)

5.4.1 Introduction

The first application of data envelopment analysis method was by ‘’Farrell’’ in his work ‘’Frontier Production Function’’ in 1957. After that Data Envelopment Analysis (DEA) has been introduced by Charnes, Cooper and Rhodes in 1978. They proposed a model that had an input orientation and constant returns to scale (CRS). The following papers have considered alternative sets of assumptions, such as Färe, Grosskopf and Logan (1983) and Banker, Charnes and Cooper (1984), in which variable returns to scale (VRS) models were proposed (Coelli et al., 2005:162).

Data Envelopment Analysis develops a set of nonparametric and semiparametric techniques for the evaluation of economic efficiency between firms and nonprofit organizations (Sengupta, 1995). A great variety of DEA applications in performance evaluations in different independent units within various contexts in many countries have been observed in recent years. It has been extensively applied in performance evaluation and benchmarking of the entities such as health care (hospitals, doctors), business firms, education (schools and universities), banks, manufacturing, benchmarking management, fast food restaurants, retail firms etc, including performance of countries' regions ,cities and even people .

Here by comparing its performance with the best performing unit in the sample, the unit performance is evaluated. The best performing units form the efficient frontier. If the unit is not on the efficient frontier it is considered to be inefficient. Hence, DEA is called "the frontier analysis". It is generally utilized for the evaluation of the performance of a set of peer entities called decision making units (DMU’s in this context are chemical firms) that convert multiple inputs into multiple outputs. The aim of DEA is to quantify the distance to the efficient frontier for each DMU. The performance measurement is expressed in the efficiency score form. Following the evaluation of the relative efficiency of the present set of units, the analysis shows how inputs and outputs need to be changed in order to elevate the efficiency of the target DMU to the maximum level (Mantri, 2008:15).

DEA is a methodology directed to frontiers rather than central to tendencies[7]. Instead of trying to fit a regression plane through the *center* of the data as in statistical regression, for example, one 'floats' a piecewise linear surface to rest on top of the observations. The focus of DEA is on the individual observers as represented by the *n* optimizations (one for each n observation) required in DEA analysis, in contrast to the focus on the averages and estimation of the parameters that are associated with single-optimization statistical approaches (Charnes et al., 1997: 4-5). DEA proves particularly adept at uncovering relationships that remain hidden from other methodologies in this perspective. For instance, consider what somebody wants to mean by "efficiency", or more generally, what one somebody would mean by saying that one DMU is more efficient than another DMU (Cook & Zhu, 2005).

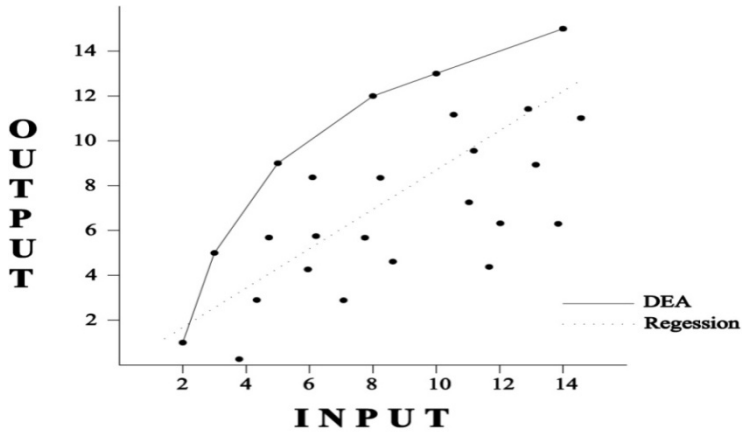

Figure 5. 16 Comparison of DEA and Regression

Source: Charnes et al, 1997:5

The significant superiority of DEA over other methods that determine efficiency, such as cost–benefit analysis or regression is that the relative weights of the variables are not necessarily known before the instance (Wagner & Shimshak, 2007). Due to the fact that it requires very few assumptions, DEA has created many possibilities for use on conditions that have been resistant to other approaches because of the complex (often unknown) nature of the relations between the multiple measures (Cook & Zhu, 2005).

[7] A comparison of regression analysis and DEA can be found in Thanassoulis' study.

5.4.2 DEA in Mathematical Terms

This technique is based on the ratio comparison between outputs produced by a decision making unit (DMU) and inputs spent by a DMU for the production purpose (Banker et al., 1984):

The efficiency score in the presence of multiple input and output factors is defined as:

$$Efficiency = \frac{\text{weighted sum of outputs}}{\text{weighted sum of inputs}}$$

$$Efficiency = \frac{u_1 y_{1j} + u_2 y_{2j} + \ldots\ldots}{v_1 x_{1j} + v_2 x_{2j} + \ldots\ldots}$$

u_1 = weight of the output number one

y_{1j} = output number one of unit j

v_1 = weight of the input number one

x_{1j} = input number one of unit j

The mathematical statement of the ratio of output-input for the decision unit having m inputs and t outputs is given below.

$$\frac{\sum_{i=1}^{t} u_i y_i}{\sum_{k=1}^{m} v_k x_k} \qquad (5.3)$$

For efficiency calculations, each type of input and output is multiplied by a particular weight coefficient. The objective of all rational units is to increase the efficiency value as possible, i.e. to maximize the value of this equation. This problem can be solved by assigning the most proper weight coefficients for each unit.

For each input and output, weight coefficients which belong to DMU are determined by Data Envelopment Analysis. The limitations for the weight coefficients are as follows: They have to be positive numbers and the ratio of weighted outputs to weighted inputs should be greater than one. Decision unit chooses the weight coefficient which maximizes the performance of ‘’r’’ compared to the performances of other units. DEA is formulated as the following fractional mathematical programming model:

$$\max_{u,v} \theta \frac{\sum_{i=1}^{t} u_i y_{ir}}{\sum_{k=1}^{m} v_k x_{kr}}, i = 1,....,n \qquad (5.4)$$

Provided that it is smaller than 1, Z many efficiency values of DMU can be defined as; efficiency score of DMU for the number Z below <1 limit:

$$0 \leq \frac{\sum_{i=1}^{t} u_i y_{ic}}{\sum_{k=1}^{m} v_k x_{kc}} \leq 1 \qquad (5.5)$$

C=1,2,...r,...Z and for all inputs and outputs $u_i, v_k > 0$

This equation is calculated for each DMU, thus weight sets equalling to the number of Z many DMUs are obtained. The weight coefficients maximize the efficiency value of the unit. “Charnes and Cooper” used a transformation mechanism in order for the fractional model to be transformed into a linear program. Linear program for a ‘’r’’ DMU is obtained by simplifying the denominator of the objective function of fractional function to 1. The equation producing "r" decision unit's performance, the denominator of which is equalized to 1 is in the form below with some limitations:

$$Max.u_i v_k \sum_{i=1}^{t} u_i y_{ir} \qquad (5.6)$$

Subjected to ;

$$\sum_{i=1}^{t} u_i y_{ic} - \sum_{k=1}^{m} v_k x_{kc} \leq 0$$

c=1,2,...r,...Z

$u_i \geq 0$

$v_k \geq 0$

Another possible way is to minimize the linear program weighted inputs for ‘’r’’ decision units and making the weighted outputs equal to 1 (Bakırcı, 2006:127-129).

$$Min.u_i v_k \sum_{k=1}^{m} v_k x_{ir} \qquad (5.7)$$

Subjected to ;

$$\sum_{k=1}^{m} v_k x_{kc} - \sum_{i=1}^{t} u_k y_{ic} \geq 0$$

c=1,2,...r,...Z

$$\sum_{i=1}^{t} u_i y_{ic} = 1$$

for all i and k ;

u_i , $v_k > 0$

Contrary to classical efficiency approaches, the most important feature of DEA is that the determination of weights for inputs and outputs by the analyzer is not required.

Assuming that there are n DMUs: DMUi, DMU2, ..., and DMU. DMUs have each with “m” inputs and “t” outputs of the same type. DMUs are selected as follows; all inputs and outputs are assumed to be nonnegative, but at least one input and one output are positive, the items (inputs, outputs and choice of DMUs) should reflect an analyst's interest and the measurement units of the different inputs and outputs need not be congruent (Cooper et.al, 2007:22).

Charnes and Cooper developed a transformation from a linear fractional programming problem into an equivalent linear programming problem. By using

this transformation, the fractional programming problem and solved by a standard LP solver.

$$\max_{\mu} \theta = \sum_{k=1}^{s} \mu_k y_{ki}, i = 1, ..., n$$

According to Cooper et al (2004:8), DEA really encompasses a variety of alternate (but related) approaches to evaluating performance. Characteristics such as isotonicity, nonconcavity, economies of scale, piecewise linearity, Cobb-Douglas log linear forms, discretionary and nondiscretionary inputs, categorical variables, and ordinal relationships can also be treated through DEA.

5.4.3 Data Envelopment Analysis Models

In identification of the efficient border, DEA emerges as a whole of integrated concepts and methods that can be expressed by many models. There are many DEA model variants depending on various assumptions on the utilized production technology. These include the assumption of constant or variable returns to scale (Podinovski, 2004). Each model can also differ as input oriented and output oriented with its own methodological approach. Input oriented models determine how much the inefficient decision units for any output level should decrease their input amount. Output oriented analyses, on the other hand, determine how much output should be decreased in order for DMU's to reach the efficient border (to relatively efficient firm values). Apart from these models, they can be classified into DEA, CCR and BCC models. The CCR-DEA model is preferred in this thesis.[8]

The CCR ratio model (1978) evaluates the overall efficiency in an objective manner and by identifying the source; it can estimate the amounts of the thus identified inefficiencies. Another model, the BCC model (1984) distinguishes between the technical and scale inefficiencies by estimating pure technical efficiency at the given scale of operation and identifying whether increasing, decreasing or constant returns to scale possibilities are present for further exploitation. (Charnes et al., 1997:23).

[8] Sample of DEA Application-Two Inputs and One Output Case is presented in Appendix B

5.4.4 Characteristics and Limitations of DEA

5.4.4.1 Characteristics of DEA

Some of the main characteristics of DEA can be listed as:

1) DEA is used to evaluate the efficiency of homogeneous units (DMU's), which utilize the same type of outputs.

2) DEA nonparametric and deterministic method. It is a nonparametric method in that it requires no estimation of the parameters of the efficient production frontier which is automatically calculated by the model keeping away from making any subjective hypothesis. It is deterministic since it is not possible to make random deviations from the efficient frontier, in other words, properties of DEA implicitly assumes that input and output variables explain the production process completely (Lupi, 2008:88).

3) DEA is a fractional mathematical programming technique; however it can be transformed into a linear programming model and solved by a standard LP solver.

4) DEA expands the concept of the single-input, single-output technical efficiency measure of Farrell to the multiple-input and multiple-output case by calculating a relative efficiency score as a ratio of a virtual output to a virtual input. More specifically, efficiency is defined as a ratio of a weighted sum of outputs to a weighted sum of inputs.

5) DEA is an approach focusing on frontiers instead of central tendencies. It evaluates the efficiency of each DMU that is relative to similar DMU's. By doing so, it provides an efficient frontier or envelope for all considered DMU's rather than fitting a regression plane through the center of data.

6) DEA requires few assumptions. One reason is that DEA has created many possibilities for utilization in cases which have been resistant to other approaches

because of the complex (often unknown) nature of the relations between the multiple inputs and multiple outputs involved in many of these efficiencies (which are often reported in non-commeasurable units) (Cooper et al., 1999).

Findings of the data envelopment analysis method are as follows (Giokas& Pentzaropoulos):

(a) the efficiency frontier which consists of the best-practice units;

(b) the most and the least efficient units which are ranked accordingly. The efficiency rating of any unit reflects its distance from the frontier: it is equal to 1 for all efficient units and is less than 1 for all inefficient units;

(c) an efficiency reference set, or peer group, for each inefficient unit. This is a subset of all the efficient units that are the closest to the unit under evaluation;

(d) input/output target levels for each inefficient unit that would, if reached, make that unit relatively efficient, i.e. increase its rating from less than 1 to actually 1; and

(e) critical inputs and outputs for any inefficient unit which need to be given priority during the implementation of an improvement procedure.

5.4.4.2 Limitations of DEA

Despite the fact that DEA provides much superiority to regression analysis or other statistical approaches, it is necessary to consider the certain limitations brought by DEA.

• Sensitivity of DEA method against slight changes in data. Since DEA is a methodology focusing on frontiers or boundaries, minor changes in data can make a significant shift in efficient frontiers. For this reason, it is necessary to obtain the accurate evaluations of inputs and outputs in order to implement DEA in a completely successful way (Lertworasirikul, 2002).

• Since DEA is a nonparametric technique, statistical hypothesis tests are difficult and are the focus of ongoing research (www.emp.pdx.edu).

• DEA shows a good performance at estimating the "relative" efficiency of a DMU, but it stays really slow on "absolute" efficiency. In other words, it can tell you how well you are doing compared to your peers but not compared to a "theoretical maximum" (www.emp.pdx.edu).

5.4.5 Subset Data for DEA

The companies which are actively involved in chemical sector between the years 1998 and 2006 in Turkey and certified by ICI first and second 500 are included in the research. DEA (Data Envelopment Analysis) is applied for each year between 1998 and 2006. Among the companies of the chemical sector, unionized or non-union firms are selected as samples of the study.

By definition, multiple input and output might be included in the research where data envelopment analysis is used. As the gross value added might be considered as an output factor, gross value added per person is taken as an output. Inputs are the capital per labourer and labour values. In order to remove the effect of inflation, the variables which involve prices are deflated by using the consumer price indexes of 1994. The inputs and outputs are put into operation as logarithmic values. As a consequence of non-availability of negative values in DEA, companies with negative values are excluded from the data set. DEAP 2.1 which is programmed by Coelli is utilized for this research. CRS input oriented DEA model has been used.

5.4.6 DEA Applications

The reason for using data envelopment analysis in this study is that the companies active in the chemical field and included in the data set can be put into efficiency order with the multiple input and output technique. After this stage, the companies have been put into different groups according to their union status and efficiency

comparison has been made. Thus, it has been attempted to find out the efficiency difference relatively between the unionized and non-union companies.

5.4.7 Research Findings

For the database of 1998, 63 companies in the Turkish chemical sector are included in DEA. Of these 63 companies, 20 are unionized and 43 are non-unionized. The average efficiency value of all companies for this year is found to be 0.695. For unionized companies, the average efficiency score is 0.660 and for non-unionized ones it is calculated as 0.71. Two non-unionized companies are observed to be the most efficient ones compared to others and they are considered as reference points. One of those companies is Nobel (Nobel İlaç Sanayi) and it performs in the pharmaceutical field. The other company is EÖS (Eczacıbaşı Özgün Kimyasal Ürünler Sanayi ve Ticaret Anonim Şirketi) in the general chemical field. 30% of unionized companies are above the score 0.70. For non-unionized companies this ratio is observed to be 45%. Unionized companies are found to be less efficient. An efficiency difference for this year between the unionized and non-unionized firms can be seen in Table 7.21.

Table 5.21 Comparison of the efficiency scores of unionized and non-union companies of the year 1998

Efficiency scores	**Number of unionized firms**	**Percentage of number of unionized firms**	**Number of non-unionized firms**	**Percentage of number of non-unionized firms**
0-10				
11-20				
21-30				
31-40				
41-50	1	5%	2	5%
51-60	3	15%	2	5%
61-70	10	50%	20	47%
71-80	5	25%	11	26%
81-90	1	5%	4	9%
91-99,9			2	5%
100			2	5%
Number of firms	20		43	
Average efficiency scores	0.66		0.71	

64 companies in Turkish chemical sector, 20 of which are unionized and 44 non-union, are included in the study for 1999. The average efficiency value of unionized companies of the chemical sector is found to be 0.70 and for the non-unionized ones

it calculated as 0.76. The four reference companies which are observed to be the most efficient are all non-unionized companies. These are Fako, Nobel and Sanovel, which are companies in the pharmaceutical field and EÖS, which operates in the general chemical field. While 20% of companies within the efficiency range of % 91-99 are unionized, only 2% of non-unionized companies are in this interval. Non-unionized companies are found to be relatively efficient compared to unionized companies for the year 1999. Average efficiency value of all companies for the same year is calculated to be 0.740.

Table 5. 22 Comparison of the efficiency scores of unionized and non-union companies of the year 1999

Efficiency scores	Number of unionized firms	Percentage of number of unionized firms	Number of non-unionized firms	Percentage of number of non-unionized firms
0-10				
11-20				
21-30				
31-40				
41-50			1	2%
51-60			1	2%
61-70	3	15%	10	23%
71-80	8	40%	21	48%
81-90	5	25%	6	14%
91-99,9	4	20%	1	2%
100			4	9%
Number of firms	20		44	
Average efficiency scores	0.70		0.76	

For 2000, 65 companies in Turkish chemical sector, 20 of which are unionized and 45 are non-unionized, are included in the study. For unionized companies average efficiency score is 0. 74 and for non-unionized ones it is calculated as being 0. 81. Four non-unionized companies have the top score of '1' and they are considered to be most efficient. One of those companies is Fako and Sanovel which is in the pharmaceutical field. The other companies are EÖS (Eczacıbaşı Özgün Kimyasal Ürünler Sanayi) operating in chemical sector and The Shell Company in the oil industry. This year the difference of average efficiency score between unionized and non-unionized companies is higher compared to previous years. The average efficiency value of all companies for this year is found to be 0.789.

Table 5.23 Comparison of the efficiency scores of unionized and non-union companies of the year 2000

Efficiency scores	Number of unionized firms	Percentage of number of unionized firms	Number of non-unionized firms	Percentage of number of non-unionized firms
0-10				
11-20				
21-30				
31-40				
41-50				
51-60	2	10%	2	4%
61-70	6	30%	5	11%
71-80	7	35%	17	38%
81-90	4	20%	13	29%
91-99,9	1	5%	4	9%
100			4	9%
Number of firms	20		45	
Average efficiency scores	0.74		0.81	

For the year 2001, 56 companies in Turkish chemical sector, 18 of which are unionized and 38 are non-unionized, are included in the DEA study. The reason for the decrease in the number of companies this year compared to previous years is assumed to be the economic recession in 2001. As a result of the gross value added per person being a negative value this year, some companies had to be excluded from the research. For unionized companies average efficiency score is 0. 66 and for non-unionized companies, it is calculated as being 0. 71. Complete efficiency is observed for 2 companies of the chemical sector which have the score of "1" and which comprise 2% of 56 non-unionized companies. The two companies are Debant Plastik San. A.Ş. in the field of plastic and EÖS in the field of general chemical. 34% of unionized companies are above the efficiency score of 0.70 in the results and non-unionized companies form 42% of the number of companies whose score is in the score range between 0.70 and 1. According to the relative efficiency analysis, non-unionized companies are found to be relatively more efficient. The average efficiency value of all companies for this year is found to be 0.693.

Table 5.24 Comparison of the efficiency scores of unionized and non-union companies of the year 2001

Efficiency scores	Number of unionized firms	Percentage of number of unionized firms	Number of non-unionized firms	Percentage of number of non-unionized firms
0-10				
11-20				
21-30				
31-40				
41-50	1	6%	1	3%
51-60	4	22%	7	18%
61-70	7	39%	14	37%
71-80	5	28%	8	21%
81-90	1	6%	6	16%
91-99,9				
100			2	5%
Number of firms	18		38	
Average efficiency scores	0.66		0.71	

For the database of 2002, 64 companies in Turkish chemical sector are included in DEA. Of these 64 companies, 20 are unionized and 44 are non-unionized. Average efficiency value of all companies for this year is 0.802. The most efficient companies which are reference points are respectively: Dalan Kimya, Nobel İlaç, Dow Turkey and The Shell Company of Turkey. Relative efficiency score of unionized companies is 0.78 and it is 0.81 for non-unionized companies. The number of the most efficient companies is 9% of the non-unionized companies. The percentages of companies, whose score is above 70% for the study including all companies are 80 for unionized and 82 for non-unionized companies. Despite the efficiency values of unionized and non-unionized companies being very close, non-unionized ones are more efficient.

Table 5.25 Comparison of the efficiency scores of unionized and non-union companies of the year 2002

Efficiency scores	Number of unionized firms	Percentage of number of unionized firms	Number of non-unionized firms	Percentage of number of non-unionized firms
0-10				
11-20				
21-30				
31-40				
41-50			1	2%
51-60	1	5%		0%
61-70	3	15%	7	16%
71-80	8	40%	12	27%
81-90	6	30%	14	32%
91-99,9	2	10%	6	14%
100			4	9%
Number of firms	20		44	
Average efficiency scores	0.78		0.81	

65 companies in Turkish chemical sector, 20 of which are unionized and 45 are non-unionized, are included in the DEA study for the year 2003 and their relative efficiency scores are established. Out of 3 companies which are observed to be the most efficient, 1 of them is unionized and 2 are non-unionized. These companies are EÖS and Dow Turkey Corporation. In the data set where all companies are included, the efficiency average of unionized companies is 0.68 while it is 0.74 for non-unionized companies. The number of companies which have an efficiency score above 0.70 is 7 for unionized and 28 for non-unionized companies. General efficiency average of all companies is found to be 0.721.

Table 5.26 Comparison of the efficiency scores of unionized and non-union companies of the year 2003

Efficiency scores	**Number of unionized firms**	**Percentage of number of unionized firms**	**Number of non-unionized firms**	**Percentage of number of non-unionized firms**
0-10				
11-20				
21-30				
31-40				
41-50	2	10%		
51-60	2	10%	7	16%
61-70	9	45%	10	22%
71-80	4	20%	17	38%
81-90	2	10%	7	16%
91-99,9		0%	2	4%
100	1	5%	2	4%
Number of firms	20		45	
Average efficiency scores	0.68		0.74	

For 2004, 64 companies in Turkish chemical sector are included in DEA. Of these 64 companies, 19 are unionized and 45 are non-unionized and their relative efficiency scores are established. The arithmetic mean of relative efficiency score of unionized companies is found to be 0.77 and it is 0.81 for non-unionized companies. 4 companies, which are efficient, are non-unionized and these companies are respectively: The Shell Company of Turkey, EÖS, Milangaz LPG Distribution and Trade Co. Inc, Dow Turkey A.Ş. This means that 9% of non-unionized companies are found to be completely efficient. There are no companies of efficiency score below 0.50 in neither group. The average efficiency score of the year 2004 including all companies is 0.804.

Table 5.27 Comparison of the efficiency scores of unionized and non-union companies of the year 2004

Efficiency scores	Number of unionized firms	Percentage of number of unionized firms	Number of non-unionized firms	Percentage of number of non-unionized firms
0-10				
11-20				
21-30				
31-40				
41-50				
51-60	1	5%	1	2%
61-70	6	32%	4	9%
71-80	5	26%	17	38%
81-90	6	32%	14	31%
91-99,9	1	5%	5	11%
100		0%	4	9%
Number of firms	19		45	
Average efficiency scores	0.77		0.81	

64 companies in Turkish chemical sector, 19 of which are unionized and 45 are non-unionized, are included in the DEA study for the year 2005 and their relative efficiency scores are established. The average efficiency score of the year 2005 including all companies is 0.699.

For the whole database, the arithmetic mean of relative efficiency score of unionized companies is found to be 0.68 and it is 0.71 for non-unionized companies. The completely efficient 2 reference firms are non-unionized and these companies are respectively: Milangaz LPG Distribution and Trade Co. Inc. and The Shell Company. Only one non-unionized company exists below the score of 50% in 2005. Despite the efficiency values of unionized and non-unionized companies being very close, non-unionized ones are more efficient for this year.

Table 5.28 Comparison of the efficiency scores of unionized and non-union companies of the year 2005

Efficiency scores	Number of unionized firms	Percentage of number of unionized firms	Number of non-unionized firms	Percentage of number of non-unionized firms
0-10				
11-20				
21-30				
31-40				
41-50			1	2%
51-60	4	21%	4	9%
61-70	9	47%	19	42%
71-80	4	21%	17	38%
81-90		0%	1	2%
91-99,9	2	11%	1	2%
100		0%	2	4%
Number of firms	19		45	
Average efficiency scores	0.68		0.71	

For the year 2006, 64 companies in Turkish chemical sector, 20 of which are unionized and 44 are non-unionized, are included in the database. The average efficiency score of the year 2006 including all companies is 0.791. For unionized companies average efficiency score is 0.78 and for non-unionized companies it is calculated as 0.80. Top efficiency value belongs to two non-unionized companies of chemical. These are Milangaz LPG and The Shell Company.

Table 5.29 Comparison of the efficiency scores of unionized and non-union companies of the year 2006

Efficiency scores	Number of unionized firms	Percentage of number of unionized firms	Number of non-unionized firms	Percentage of number of non-unionized firms
0-10				
11-20				
21-30				
31-40				
41-50				
51-60				
61-70	5	25%	8	18%
71-80	8	40%	15	34%
81-90	6	30%	15	34%
91-99,9	1	5%	4	9%
100			2	5%
Number of firms	20		44	
Average efficiency scores	0.78		0.80	

5.4.8 DEA Interpretation

The companies which are actively involved in chemical sector between the years 1998 and 2006 in Turkey and certified by ICI first 500 and second 500 are included in the research. DEA (Data Envelopment Analysis) is applied for each year between 1998 and 2006. Among the companies of the chemical sector, unionized or non-union firms are selected as samples of the study.

The aim of the DEA study is to specify the efficiency scores of the companies in the field of chemicals in relation to each other which rank in the ICI 1,000 in regard to years, and to put them into order according to their efficiency. Besides, the aim is also to compare the efficiency values of the unionized and non-union companies, which is the research question in this thesis.

For each year, relative efficiency evaluations were made for unionized and non-union companies. In the data set formed for the unionized and non-union companies in the chemical field the relative efficiency score for each company has been obtained. The efficiency scores and the ranking of all the companies obtained by years are presented in the appendix. They also categorized according to the subgroup mentioned with their score evaluation has been made. For the 1998-2006 period, evaluation has been made for each single year and the average efficiency difference between unionized and non-union companies has been calculated. For the year 1998, unionized companies' average efficiency score is 0. 660 and for non-unionized ones it is calculated as being 0.71. Efficiency differences between union and non-union firms is found to be *5 percent.* For the year 1999, the average efficiency value of unionized companies of chemical sector is found to be 0.70 and for the non-unionized ones 0.76. Efficiency differences between union and non-union is found to be *6 percent*. For the year 2000, for unionized companies average efficiency score is 0.74 and for non-unionized ones it 0.81. Efficiency differences between firms with union and non-union is found to be *7 percent*. For the year 2001, for unionized companies' average efficiency score is 0.66 and for non-unionized companies it is calculated as 0.71. Efficiency differences between firms with union and non-union is found to be *5 percent*. For the year 2002, relative efficiency score of unionized companies is 0.78 and 0.81 for non-unionized companies. Efficiency differences between union and non-union firms is found to be *3 percent*. For the year 2003, in the data set where all companies are included, the efficiency average of unionized companies is 0.68 while it is 0.74 in non-unionized companies. Efficiency differences between union and non-union firms is found to be *6 percent*. For the year 2004, the arithmetic mean of relative efficiency score of unionized companies is found to be 0.77 and 0.81 for non-unionized companies. Efficiency differences between union and non-union firms is found to be *4 percent.* For the year 2005, the arithmetic mean of relative efficiency score of unionized companies is 0. 68 and it is 0.71 for non-unionized companies. Efficiency differences between union and non-union firms is found to be *3 percent*. For the year 2006, for unionized companies' average efficiency score is 0.78 and for non-unionized companies it is calculated as

being 0.80. Efficiency differences between union and non-union firms is found to be *2 percent*.

The efficiency differences fluctuate between 7 per cent and 2 per cent. For all years, the companies without unions seem more efficient in the time mentioned.

Thus the results of the DEA method the related in-depth interviews have been discussed and the possible reasons for the decrease in productivity difference between union and non-union firms since 2004 have been investigated.

According to a non-union firm operating in the oil field (AYGAZ), deviation of unions from their aggressive behaviors may have resulted in an increase in productivity. It has been underlined that the absence of strikes and lockouts for a long time is an indicator in this context.

An nonbinding union agreement firm operating in the chemical field (ALKIM) has interpreted this result as the possibility of a more positive interaction of the unions in terms of employees of the firms starting from 2004.

A non-union firm operating in the general chemical field (KAYALAR) has commented as follows: “Within the framework of EU harmonization rules, a serious burden has been put on firms' legal responsibilities starting from 2003. Rights and liabilities of employers and workers (operational capability, health and safety of the employee and the workplace, provisions against dismissals etc.) in both non-unionized and unionized firms have been modified and increased”. For this reason, productivity differences of union and nonunion firms were minimized.

A significant point in the study conducted by using DEA indicates that the crisis in 2001 did not cause a major shift in the general performances of the firms. Besides, the productivity difference between union and non-union firms were discovered similar to other years. With an aim to prove the results, the interviewees were asked how the productivity, capital and number of workers were affected by the crisis.

A non-union firm operating in the petroleum field (AYGAZ) has underlined that the firm was not affected by the crisis, by taking some precautions like entry into natural gas market as a substitution product to contributed to stability.

An "nonbinding agreement firm" operating in the general chemical field (ALKIM) stated that the crises in 2001 and 2008 did not have any effect on corporate productivity: “In such crises, our company does not suffer from any effects in terms of capital per capita, productivity and number of workers. We have not preferred practices such as collective dismissals to use the crisis as an excuse layoffs”.

Similarly, a union firm operating in the general chemical field (COGNİS) has commented as follows: "The crisis in 2001 did not have an effect on our productivity”.

A non-union firm operating in the general chemical field (KAYALAR) suggested that the number of employees and the capital had slightly declined but there was not an effect on productivity. They underlined that the decrease in production had no relation with productivity but it was caused by the supply-demand balance.

When the entire chemical field is considered, employers' union in the chemical field has stated that firms had to lay off certain amount of employees even if union and non-union firms consider dismissal as the last resort. The common suggestion of the interviewees in this regard shows that the crisis in 2001 did not cause an extreme effect on productivity in the chemical field and it is supported by the findings of DEA.

Table 5.30 Year: 1998 Efficiency Scores of Firms

Firms	Efficiency Scores	Firms	Efficiency Scores	Firms	Efficiency Scores	Firms	Efficiency Scores
Adeka	0.744	**Fako**	0.856	**Pilsa**	0.666	**Mutlu**	0.695
Akkim	0.677	**Firat Pl.**	0.416	**Polinas**	0.650	**Petkim**	0.533
Aksa	0.646	**Glaxo**	0.706	**Sonovel**	0.959	**Petlas**	0.481
Akzo	0.740	**Habaş**	0.636	**Siko**	0.802	**Soda**	0.650
Ali Raif	0.727	**Hayat Kimya**	0.607	**Süperfilm**	0.615	**Toros**	0.675
Aygaz	0.665	**İba**	0.633	**Vatan Plastik**	0.814	**Tüpraş**	0.817
Bak Amb.	0.488	**İpragaz**	0.656	**Verim**	0.668	**Türk Pirelli**	0.733
Bio Farma	0.689	**İstanbul Asf.**	0.821	**Sasa**	0.645	**Tpao**	0.608
Birleşik Oksijen	0.693	**Kayalar**	0.616	**Arili**	0.738	**Eös**	1000
Bizim Gaz	0.737	**Kopaş**	0.837	**Bayer İlaç**	0.676	**Roche**	0.769
Bakim	0.720	**Korozo**	0.722	**Bayertürk**	0.729	**Santa Farma**	0.697
Dalan Kimya	0.548	**Marshall**	0.654	**Brisa**	0.661	**The Shell**	0.781
Debant	0.695	**Milangaz**	0.652	**Cognisr**	0.669		
Dow	0.919	**Mogaz**	0.765	**Dyo Matbaa**	0.714		
Eczacibaşi Baxter	0.794	**Naksan**	0.550	**Eis**	0.524		
Ege Güb.	0.652	**Nobel**	1000	**Goodyear**	0.666		
Elif Pl.	0.611	**Novaplast**	0.695	**Gübre Fab.**	0.586		

Table 5.31 Year:1999 Efficiency Scores of Firms

Firms	Efficiency Scores	Firms	Efficiency Scores	Firms	Efficiency Scores	Firms	Efficiency Scores
Adeka	0.768	**Fako**	1.000	**Novaplast**	0.731	**Gübre Fab.**	0.689
Akkim	0.755	**Firat Pl.**	0.478	**Pilsa**	0.701	**Mutlu**	0.684
Aksa	0.745	**Glaxo**	0.715	**Polinas**	0.713	**Petkim**	0.557
Akzo	0.762	**Habaş**	0.668	**Sonovel**	1.000	**Petlas**	0.549
Ali Raif	0.780	**Hayat Kimya**	0.700	**Siko**	0.889	**Soda**	0.584
Aygaz	0.721	**İba**	0.710	**Süperfilm**	0.706	**Toros**	0.671
Bak Amb.	0.617	**İpragaz**	0.727	**Vatan Plastik**	0.743	**Tüpraş**	0.842
Başer	0.710	**İstanbul Asf.**	0.879	**Verim**	0.772	**Türk Pirelli**	0.637
Bio Farma	0.682	**Jotun**	0.738	**Sasa**	0.652	**Tpao**	0.649
Birleşik Oksijen	0.722	**Kayalar**	0.653	**Arili**	0.821	**Eös**	1.000
Bizim Gaz	0.796	**Kopaş**	0.853	**Bayer İlaç**	0.752	**Roche**	0.833
Bakim	0.875	**Korozo**	0.777	**Bayertürk**	0.720	**Santa Farma**	0.753
Dalan Kimya	0.513	**Marshall**	0.717	**Brisa**	0.666	**The Shell**	0.943
Debant	0.696	**Milangaz**	0.703	**Cognisr**	0.757		
Eczacibaşi Baxter	0.854	**Mogaz**	0.821	**Dyo Matbaa**	0.812		
Ege Güb.	0.766	**Naksan**	0.613	**Eis**	0.617		
Elif Pl.	0.682	**Nobel**	1.000	**Goodyear**	0.746		

Table 5.32 Year: 2000 Efficiency Scores of Firms

Firms	Efficiency Scores	Firms	Efficiency Scores	Firms	Efficiency Scores	Firms	Efficiency Scores
Fako	1.000	**Hayat Kimya**	0.761	**Eczacibaşi Baxter**	0.864	**Türk Pirelli**	0.705
Sonovel	1.000	**İba**	0.763	**Birleşik Oksijen**	0.879	**Gübre Fab.**	0.710
Eös	1.000	**Bio Farma**	0.771	**Kayalar**	0.880	**Brisa**	0.738
The Shell	1.000	**Polinas**	0.771	**İstanbul Asf.**	0.885	**Toros**	0.769
Naksan	0.594	**Marshall**	0.773	**Mogaz**	0.886	**Goodyear**	0.774
Dow	0.597	**Vatan Plastik**	0.773	**Bizim Gaz**	0.902	**Mutlu**	0.788
Habaş	0.662	**İpragaz**	0.780	**Kopaş**	0.905	**Bayertürk**	0.797
Firat Pl.	0.667	**Aygaz**	0.782	**Bakim**	0.922	**Bayer İlaç**	0.819
Pilsa	0.672	**Aksa**	0.795	**Dalan Kimya**	0.940	**Roche**	0.850
Verim	0.678	**Akzo**	0.798	**Petkim**	0.558	**Arili**	0.875
Süperfilm	0.700	**Ege Güb.**	0.801	**Petlas**	0.585	**Siko**	0.958
Glaxo	0.706	**Adeka**	0.808	**Cognis**	0.621	**Tüpraş**	0.896
Elif Pl.	0.713	**Akkim**	0.810	**Tpao**	0.669	**Dyo Matbaa**	0.908
Bak Amb.	0.720	**Ali Raif**	0.822	**Santa Farma**	0.677	**Nobel**	0.978
Debant	0.723	**Korozo**	0.852	**Sasa**	0.682		
Milangaz	0.743	**Jotun**	0.859	**Eis**	0.689		
Başer	0.751	**Novaplast**	0.859	**Soda**	0.691		

Table 5.33 Year: 2001 Efficiency Scores of Firms

Firms	Efficiency Scores	Firms	Efficiency Scores	Firms	Efficiency Scores	Firms	Efficiency Scores
Akkim	0.721	**Habaş**	0.636	**Verim**	0.593	**Tpao**	0.581
Aksa	0.651	**İba**	0.687	**Sasa**	0.584	**Eös**	1.000
Akzo	0.600	**İpragaz**	0.678	**Arili**	0.749	**Santa Farma**	0.769
Ali Raif	0.803	**İstanbul Asf.**	0.709	**Bayer İlaç**	0.697	**The Shell**	0.857
Aygaz	0.668	**Jotun**	0.799	**Bayertürk**	0.680	**Adeka**	0.693
Bak Amb.	0.594	**Kayalar**	0.730	**Brisa**	0.604		
Başer	0.676	**Kopaş**	0.721	**Cognisr**	0.741		
Bio Farma	0.646	**Korozo**	0.691	**Dyo Matbaa**	0.734		
Birleşik Oksijen	0.777	**Marshall**	0.570	**Goodyear**	0.748		
Bizim Gaz	0.845	**Milangaz**	0.675	**Gübre Fab.**	0.682		
Bakim	0.861	**Mogaz**	0.817	**Mutlu**	0.671		
Dalan Kimya	0.740	**Naksan**	0.512	**Petkim**	0.514		
Debant	1.000	**Polinas**	0.700	**Petlas**	0.484		
Dow	0.853	**Sonovel**	0.675	**Soda**	0.611		
Ege Güb.	0.570	**Siko**	0.809	**Toros**	0.645		
Elif Pl.	0.585	**Süperfilm**	0.623	**Tüpraş**	0.808		
Glaxo	0.642	**Vatan Plastik**	0.464	**Türk Pirelli**	0.615		

Table 5.34 Year: 2002 Efficiency Scores of Firms

Firms	Efficiency Scores	Firms	Efficiency Scores	Firms	Efficiency Scores	Firms	Efficiency Scores
Akkim	0.825	**Firat Pl.**	0.659	**Pilsa**	0.770	**Mutlu**	0.824
Aksa	0.788	**Glaxo**	0.671	**Polinas**	0.775	**Petkim**	0.573
Akzo	0.816	**Habaş Hayat**	0.709	**Sonovel**	0.636	**Petlas**	0.606
Ali Raif	0.832	**Kimya**	0.429	**Siko**	0.938	**Soda**	0.737
Aygaz	0.870	**İba**	0.888	**Süperfilm Vatan**	0.754	**Toros**	0.782
Bak Amb.	0.770	**İpragaz İstanbul**	0.892	**Plastik**	0.650	**Tüpraş Türk**	0.950
Başer	0.797	**Asf.**	0.864	**Verim**	0.723	**Pirelli**	0.729
Bio Farma	0.760	**Jotun**	0.928	**Sasa**	0.636	**Tpao**	0.640
Birleşik Oksijen	0.939	**Kayalar**	0.798	**Arili**	0.953	**Eös**	0.967
Bizim Gaz	0.953	**Kopaş**	0.898	**Bayer İlaç**	0.869	**Roche Santa**	0.840
Bakim	0.925	**Korozo**	0.847	**Bayertürk**	0.751	**Farma**	0.858
Dalan Kimya	1.000	**Marshall**	0.801	**Brisa**	0.765	**The Shell**	1.000
Debant	0.811	**Milangaz**	0.658	**Cognisr Dyo**	0.890	**Adeka**	0.832
Dow Eczacibaşi	1.000	**Mogaz**	0.887	**Matbaa**	0.818		
Baxter	0.807	**Naksan**	0.627	**Eis**	0.776		
Ege Güb.	0.701	**Nobel**	1.000	**Goodyear**	0.781		
Elif Pl.	0.713	**Novaplast**	0.808	**Gübre Fab.**	0.802		

Table 5.35 Year: 2003 Efficiency Scores of Firms

Firms	Efficiency Scores	Firms	Efficiency Scores	Firms	Efficiency Scores	Firms	Efficiency Scores
Akkim	0.736	**Fako**	0.695	**Novaplast**	0.736	**Gübre Fab.**	0.709
Aksa	0.698	**Firat Pl.**	0.781	**Pilsa**	0.686	**Mutlu**	0.683
Akzo	0.759	**Glaxo**	0.545	**Polinas**	0.732	**Petkim**	0.503
Ali Raif	0.747	**Habaş Hayat**	0.593	**Sonovel**	0.662	**Petlas**	0.557
Aygaz	0.795	**Kimya**	0.538	**Siko**	0.884	**Soda**	0.607
Bak Amb.	0.682	**İba**	0.762	**Süperfilm Vatan**	0.626	**Toros**	0.686
Başer	0.598	**İpragaz İstanbul**	0.842	**Plastik**	0.656	**Tüpraş Türk**	0.843
Bio Farma	0.668	**Asf.**	0.771	**Verim**	0.584	**Pirelli**	0.630
Birleşik Oksijen	0.835	**Jotun**	0.828	**Sasa**	0.485	**Tpao**	0.567
Bizim Gaz	0.888	**Kayalar**	0.710	**Arili**	1.000	**Eös**	1.000
Bakim	0.934	**Kopaş**	0.771	**Bayer İlaç**	0.768	**Roche Santa**	0.629
Dalan Kimya	0.843	**Korozo**	0.793	**Bayertürk**	0.687	**Farma**	0.736
Debant	0.550	**Marshall**	0.743	**Brisa**	0.701	**The Shell**	0.909
Dow Eczacibaşi	1.000	**Milangaz**	0.637	**Cognisr Dyo**	0.808	**Adeka**	0.768
Baxter	0.719	**Mogaz**	0.848	**Matbaa**	0.767		
Ege Güb.	0.719	**Naksan**	0.542	**Eis**	0.640		
Elif Pl.	0.643	**Nobel**	0.736	**Goodyear**	0.662		

Table 5.36 Year: 2004 Efficiency Scores of Firms

Firms	Efficiency Scores	Firms	Efficiency Scores	Firms	Efficiency Scores	Firms	Efficiency Scores
Akkim	0.820	**Fako**	0.799	**Novaplast**	0.747	**Gübre Fab.**	0.785
Aksa	0.841	**Firat Pl.**	0.828	**Pilsa**	0.802	**Mutlu**	0.735
Akzo	0.861	**Glaxo**	0.731	**Polinas**	0.795	**Petkim**	0.697
Ali Raif	0.788	**Habaş**	0.765	**Sonovel**	0.756	**Petlas**	0.590
Aygaz	0.908	**Hayat Kimya**	0.544	**Siko**	0.991	**Soda**	0.699
Bak Amb.	0.778	**Iba**	0.805	**Süperfilm**	0.605	**Toros**	0.687
Başer	0.747	**Ipragaz**	0.973	**Vatan Plastik**	0.792	**Tüpraş**	0.948
Bio Farma	0.738	**Istanbul Asf.**	0.874	**Verim**	0.747	**Türk Pirelli**	0.740
Birleşik Oksijen	0.895	**Jotun**	0.867	**Sasa**	0.652	**Tpao**	0.671
Bizim Gaz	0.909	**Kayalar**	0.783	**Arili**	0.887	**Eös**	1.000
Bakim	0.969	**Kopaş**	0.877	**Bayer İlaç**	0.862	**Santa Farma**	0.866
Dalan Kimya	0.829	**Korozo**	0.653	**Bayertürk**	0.769	**The Shell**	1.000
Debant	0.774	**Marshall**	0.759	**Brisa**	0.786	**Adeka**	0.832
Dow	1.000	**Milangaz**	1.000	**Cognisr**	0.853		
Eczacibaşi Baxter	0.859	**Mogaz**	0.871	**Dyo Matbaa**	0.837		
Ege Güb.	0.777	**Naksan**	0.642	**Eis**	0.679		
Elif Pl.	0.702	**Nobel**	0.865	**Goodyear**	0.833		

Table 5.37 Year: 2005 Efficiency Scores of Firms

Firms	Efficiency Scores	Firms	Efficiency Scores	Firms	Efficiency Scores	Firms	Efficiency Scores
Akkim	0.643	**Fako**	0.750	**Novaplast**	0.750	**Mutlu**	0.750
Aksa	0.665	**Firat Pl.**	0.752	**Pilsa**	0.684	**Petkim**	0.643
Akzo	0.750	**Glaxo**	0.643	**Polinas**	0.643	**Petlas**	0.536
Ali Raif	0.643	**Habaş**	0.643	**Sonovel**	0.643	**Soda**	0.643
Aygaz	0.750	**Hayat Kimya**	0.524	**Siko**	0.750	**Toros**	0.570
Bak Amb.	0.625	**İba**	0.650	**Süperfilm**	0.559	**Tüpraş**	0.998
Başer	0.500	**İpragaz**	0.857	**Vatan Plastik**	0.653	**Türk Pirelli**	0.681
Bio Farma	0.763	**İstanbul Asf.**	0.790	**Verim**	0.625	**Tpao**	0.679
Birleşik Oksijen	0.797	**Jotun**	0.769	**Sasa**	0.536	**Eös**	0.762
Bizim Gaz	0.670	**Kayalar**	0.625	**Arili**	0.750	**Roche**	0.643
Bakim	0.750	**Kopaş**	0.750	**Bayer İlaç**	0.643	**Santa Farma**	0.924
Dalan Kimya	0.562	**Korozo**	0.643	**Bayertürk**	0.643	**The Shell**	1.000
Debant	0.750	**Marshall**	0.784	**Brisa**	0.756		
Dow	0.667	**Milangaz**	1.000	**Cognisr**	0.643		
Eczacibaşi Baxter	0.799	**Mogaz**	0.656	**Dyo Matbaa**	0.625		
Ege Güb.	0.562	**Naksan**	0.627	**Goodyear**	0.788		
Elif Pl.	0.643	**Nobel**	0.930	**Gübre Fab.**	0.536		

Table 5.38 Year: 2006 Efficiency Scores of Firms

Firms	Efficiency Scores	Firms	Efficiency Scores	Firms	Efficiency Scores	Firms	Efficiency Scores
Akkim	0.769	**Firat Pl.**	0.725	**Pilsa**	0.761	**Petkim**	0.705
Aksa	0.768	**Glaxo**	0.740	**Polinas**	0.721	**Petlas**	0.644
Akzo	0.807	**Habaş**	0.756	**Sonovel**	0.724	**Soda**	0.752
Ali Raif	0.783	**Hayat Kimya**	0.704	**Siko**	0.888	**Toros**	0.697
Aygaz	0.875	**İba**	0.741	**Süperfilm**	0.686	**Tüpraş**	0.979
Bak Amb.	0.826	**İpragaz**	0.959	**Vatan Plastik**	0.656	**Türk Pirelli**	0.750
Başer	0.766	**İstanbul Asf.**	0.865	**Verim**	0.638	**Tpao**	0.721
Bio Farma	0.782	**Jotun**	0.844	**Sasa**	0.757	**Eös**	0.879
Birleşik Oksijen	0.832	**Kayalar**	0.814	**Arili**	0.878	**Roche**	0.690
Bizim Gaz	0.827	**Kopaş**	0.931	**Bayer İlaç**	0.854	**Santa Farma**	0.898
Bakim	0.964	**Korozo**	0.618	**Bayertürk**	0.799	**The Shell**	1.000
Dalan Kimya	0.698	**Marshall**	0.804	**Brisa**	0.786	**Mutlu**	0.762
Dow	0.905	**Milangaz**	1.000	**Cognisr**	0.814		
Eczacibaşi Baxter	0.805	**Mogaz**	0.866	**Dyo Matbaa**	0.739		
Ege Güb.	0.698	**Naksan**	0.617	**Eis**	0.651		
Elif Pl.	0.742	**Nobel**	0.851	**Goodyear**	0.842		
Fako	0.825	**Novaplast**	0.831	**Gübre Fab.**	0.825		

5.5 Malmquist Productivity Change Index

5.5.1 Introduction

The Data Envelopment Analysis, a nonparametric method which is the most frequently used efficiency evaluation method by employing the data obtained from decision units in a single period. A decision unit of which efficiency has been evaluated with DEA may lose its effectiveness in further periods and may not qualify as a reference anymore. But in efficiency evaluation process, it is also important to investigate how efficiency develops in time. To do this, the Malmquist Total Factor Productivity (TFP) index which includes the time factor has also been developed (Kılıçkaplan et al, 2004).

Malmquist primarily put forward the comparison of the inputs within a firm at different points in time in terms of the maximum factor by which the input in one period could be decreased such that the firm could still produce the same output level of the other time period. This approach led to the Malmquist input index. Caves, Christensen and Diewert (1982) advanced the Malmquist input index to define the Malmquist productivity index. DEA based Malmquist productivity measures were developed by Fare Grasskopf and Lovell (1994) (as cited in Zhu, 2003:278).

Malmquist index is a popular method widely preferred in evaluating productivity changes. There are three reasons for that; first, different from Tornqvist index and Fisher's ideal index, it does not require the minimization of cost or the maximization of return to evaluate the total factor productivity. Second, there is not an obligation such as determining the prices necessary for the evaluation of Tornqvist index and Fisher's ideal index. Occasionally, related price data may not be accurate. This causes Malmquist TFP index to be preferred. Third, it is possible to make evaluation by using panel data (Kılıçkaplan et al., 2004).

Malmquist TFP index evaluates the total factor productivity change between two data points by calculating the ratio of the distance of each point according to a common technology. Distance functions can be evaluated as both input oriented and output oriented (Yavuz, 2003:32).

The Malmquist productivity index is comprised of two components. Technical efficiency change is the first component of this index. Technical efficiency change is an evaluation of the process in which decision units approach to the efficient border. The second component is technical change and this component aims at identifying the change of the efficient border in time (Tarım, 2001:151-152).

The Malmquist productivity index is expressed in the equity in 7.16. The index components technical change and efficiency change are given in equities 7.17 and 7.18. In this index, *t* refers to the base year and *t+1* refers to the next year. As it is seen, the index is obtained from the multiplication of the change in TP with technological change. Separation of the index in this way allows us to identify the contribution of these two changes to TFP (Karabulut et al., 2008).

$$m_i(y_{t+1}, x_{t+1}, y_t, x_t) = \frac{D_1^{t+1}(x^{t+1}, y^{t+1})}{D_0^t(x^t, y^t)} \left[\left(\frac{D_0^t(x^{t+1}, y^{t+1})}{D_0^{t+1}(x^{t+1}, y^{t+1})} \right) \left(\frac{D_0^t(x^t, y^t)}{D_1^{t+1}(x^t, y^t)} \right) \right]^{1/2} \quad (7.16)$$

$$\text{Efficiency Change} = \frac{D_1^{t+1}(x^{t+1}, y^{t+1})}{D_0^t(x^t, y^t)} \quad (7.17)$$

$$\text{Technical Change} = \left[\left(\frac{D_0^t(x^{t+1}, y^{t+1})}{D_0^{t+1}(x^{t+1}, y^{t+1})} \right) \left(\frac{D_0^t(x^t, y^t)}{D_1^{t+1}(x^t, y^t)} \right) \right]^{1/2} \quad (7.18)$$

A value greater than 1 will indicate positive total factor productivity growth from period t to period t+1. One needs to solve four linear programming problems to determine the Malmquist index. In addition to these, five indices with components in MI evaluation are shown per firm and per year. These indices are technical

efficiency, technological change, pure technical efficiency change, scale efficiency change, and total factor productivity change. The indices of total factor productivity change (TFP) is consideredas a combination of technological change and technical efficiency change (related to CRS technology). Technical efficiency change evaluates the capability to get the best use from available technology; on the other hand, technological change refers to the improvement or deterioration of the technological condition (Coto-Millan et al., 2010: 291). Technical efficiency is comprised of pure technical efficiency and scale efficiency and it is obtained from the multiplication of these two indexes. While technical efficiency examines the administrative efficiency, scale efficiency searches whether DMU's operate with the convenient scales. Direction of the change in the amount of outputs with the same input is being investigated by means of technological change. To give an example, if the technological change index is over 1 (meaning a positive contribution to MI), this means greater output amounts have been generated with an input amount at the same level. Malmquist method makes evaluation for the previous, current and next DEA frontier periods. MI value is identified as the change in the total factor productivity; a value greater than 1 indicates the increase in the total factor productivity while a value below 1 displays the level of decrease (Büyükılıç & Yavuz, 2005:41).

5.5.2 Subset Data for Malmquist Index

The ICI first 500 and second 500 companies that were active in the sector of chemical between the years of 1998-2006 have been included in the Output oriented-Malmquist index analysis. 53 chemical companies have been included in the study that provided continuous data. Data including prices have been deflated using the 1994 consumer price index figures. Between the years 1998 and 2006, TPFC change was observed for a unionized and a non-unionized group. Both unionized and non-unionized firms have been included in the study.

5.5.3 Results and Implications

It is the aim of this section to examine the change in the efficiency of the companies with and without trade unions between the years of 1998-2006, and to study how much they increased or decreased their efficiency. The increased or decreased efficiency during the years will be specified as percentage in the flow of the years according to companies' situations regarding the presence of trade unions. The reasons for inefficiency and sub components of technical productivity change have not been the focal point.

Gross added value was included as the output and capital and labor as the input in the Malmquist index method. Malmquist productivity index calculations were made in two phases in this thesis. To begin with, productivity differences of all chemistry firms in the data set without distinguishing union and nonunion firms between 1998-2006 were analyzed. This analysis found the productivity average in the entire chemistry sector as 0.959. This result indicates 4 percent productivity decrease when considered in terms of productivity in the chemistry sector.

In the study made on 53 companies, while increase has been observed in TFPC index in 14 companies, (Santa Farma, Bayer İlaç, Goodyear, Petkim, Kayalar, Bakim Coates, Gübre Fabrics, Petlas, Debant Pl., Aygaz, Shell, İpragaz, Milangaz, Bak Ambalaj) there is a decrease in the other 39 companies.[9] Six of the said companies with efficiency increase are unionized ans eight are non-union firms. Summary of results are given in Table 5.39.

Table 5.39 Malmquist Index Results

Productivity Change For All Chemistry Sector	-% 4
Productivity Change For Unionised Firms	-% 3.9
Productivity Change For Non-unionized Firms	-% 3.8

[9] Details of MI findings (Both unionized and nonunionized firms included) have been presented in Appendix D1,D2,D3.

Secondly, union and nonunion firms' data were put through Malmquist analysis separately. TFPCH differences between unionized and nonunionized establishments have been found one per thousand. Results found the average productivity of union firms between 1998-2006 as 0.961. This result indicates -4 percent of productivity change (decrease in productivity). Productivity analysis results of non-union firms, on the other hand, obtained the average productivity 0.962. This means about 4 percent productivity change in nonunion firms between 1998-2006. Summary of results are given in Table 5.40 and 5.41.

Table 5. 40 Malmquist Index Summary of Unionised Firms

firm	tfpch	firm	tfpch	firm	tfpch
Dyo Matbaa Mürekkepleri San Ve Tic. A.Ş.	0.878	**Soda Sanayii A.Ş.**	0.936	**Sasa Sun Sentetik Elyaf Sanayii A.Ş.**	0.926
Goodyear Lastikleri T.A.Ş.	1.014	**Toros Gübre Ve Kimya Endüstrisi A.Ş**	0.837	**Arılı Plastik Sanayi A.Ş.**	0.949
Gübre Fab.T.A.Ş.	1.076	**Tüpraş-Türkiye Petrol Rafinerileri A.Ş.**	0.991	**Bayer İlaç Fabrikaları Anonim Şirketi.**	1.017
Mutlu Akü Ve Malzemeleri San. A.Ş.	0.899	**Türk Pirelli Lastikleri A.Ş.**	0.849	**Bayer Türk Kimya San.Ltd.Şti.**	0.900
Petkim Petrokimya Holding A.Ş. Genel Müdürlüğü	1.052	**Türkiye Petrolleri Anonim Ortaklığı**	0.941	**Brisa Bridgestone Sabancı Lastik San. Ve Tic. A.Ş.**	0.973
Petlas Lastik Sanayi Ve Ticaret A.Ş.	1.100	**Santa Farma İlaç San.A.Ş.**	1.037	**Cognis Kimya Sanayi Ve Ticaret A.Ş**	0.970
		mean	**0.961**		

Table 5. 41 Malmquist Index Summary of Non-Unionised Firms

firm	tfpch	Firm	tfpch	firm	tfpch	Firm	tfpch
Adeka	0.869	**Bizimgaz**	0.957	**İpragaz A.Ş.**	1.187	**Polinas Plastik**	0.905
Ak-Kim Kimya	0.927	**Bakim Coates**	1.085	**İstanbul Asfalt Fabrikaları**	0.889	**Sanovel İlaç San Ve Tic.A.Ş.**	0.830
Aksa Akrilik	0.989	**Dalan Kimya Endüstri A.Ş.**	0.924	**Kayalar Kimya**	1.081	**Sika Deteks Yapı Kimyasalları**	0.922
Akzo Nobel Kemipol Kimya	0.901	**Debant**	1.407	**Kopaş**	0.925	**Süper Film Sanayii**	0.951
Ali Raif	0.904	**Ege Gübre Sanayii A.Ş.**	0.887	**Korozo**	0.777	**Vatan Plastik**	0.758
Aygaz A.Ş.	1.095	**Elif Plastik**	0.970	**Marshall Boya Ve Vernik San.**	0.982	**Verim Plastik**	0.802
Bak Ambalaj	1.223	**Glaxo Wellcome**	0.891	**Milangaz Lpg Dağıtım**	1.227	**Eös Eczacıbaşı**	0.776
Biofarma	0.982	**Habaş Sınai Ve Tıbbi Gazlar**	0.964	**Mogaz Petrol Gazları.**	0.955	**The Shell Company Of Turkey Ltd.**	1.123
Birleşik Oksijen	0.966	**İba Kimya Sanayi Ve Tic. A.Ş.**	1.001	**Naksan Plastik.**	0.938	**Mean**	**0.962**

5.6 Production Function Approach

5.6.1 Introduction

As explained above, the relationship between unionization and productivity has been evaluated by various statistical methods in the literature. [10] In studies measuring this relation by using the production function approach rather than Translog and Cobb-Douglas production function. One of the most important studies analyzing the relation between unionization and productivity by production function method is the study of Brown and Medoff (1978). In the article of Brown and Medoff titled "Trade Unions in the Production Process" (Brown & Medoff, 1978), the effect of unionization on worker productivity was measured by setting off from Griliches 1967.

Brown and Medoff applied an econometric analysis of the union effect in the United States manufacturing. In this analysis, a modified version of Cobb-Douglas production function was employed. Using added value per man-hour as an indicator of productivity, the study resulted in positive union effects on productivity. Using of gross added value as a dependent variable in production function was criticized by many researchers, including Brown and Medoff themselves. Brown and Medoff noted that the use of added value as an output measure confounds price and quantity effects (as cited in Addison and Hirsch; 1989). That is, part of the measured union productivity differential may result from higher prices in the unionized sector. Similarly, what appears to be an output effect can possibly be a difference in prices indeed; as added value was used to measure output in the concerned studies. Furthermore, potential technology differences between union and nonunion firms are not controlled in the analysis (Clark, 1980). (Other criticism besides the main concerns listed here is given in Ch.3 literature review chapter of the thesis).

In this dissertation modified Cobb-Douglas production function is used, as in Brown and Medoff's study. Main function (some variant of the Cobb- Douglas production function) is defined as follows;

[10] Details on studies analyzing productivity relation of unions are given in the literature chapter of the thesis.

$$Q=AK^{\alpha}(L_n + cL_u)^{1-\alpha} \quad (7.17)$$

The inside of parenthesis derived in this way is divided by $L^{1-\alpha}$ and the outside is multiplied by $L^{1-\alpha}$, forming the equation as below.

Here P denotes union density $P = \frac{L_u}{L}$ (7.18)

L denotes amount of worker per unit $L = L_u + L_n$ (7.19)

$$Q = AK^{\alpha}L^{1-\alpha}\left(\frac{L_n}{L} + cP\right)^{1-\alpha}$$

$$Q = AK^{\alpha}L^{1-\alpha}\left(\frac{L_n}{L} + (c-1)P + \frac{L_u}{L}\right)^{1-\alpha}$$

$$Q = AK^{\alpha}L^{1-\alpha}\left(\frac{L}{L} + (c-1)P\right)^{1-\alpha}$$

$$Q = AK^{\alpha}L^{1-\alpha}\left[1 + (c-1)P\right]^{1-\alpha} \quad (7.20)$$

Where Q is output, K is capital, L*n* is non-union labor, *Lu* is union labor, all on a per establishment basis, α = elasticity of output with respect to capital ($0 < \alpha < 1$), and A is a constant of proportionality which depends on the units in which Q, K, L*n* and *Lu* are measured.

The parameter c shows differences in the productivity of union and non-union labor. If c is greater than 1, union labor is more productive than non-union labor; if c is less than 1; union labor is less productive than non-union labor. With the Cobb-Douglas production function, c gives the ratio of the marginal products of union to non-union labor.

Dividing both sides of (2) by L and taking natural logarithms gives us this equation.

$$\ln \frac{Q}{L} = \ln A + \alpha \ln\left(K / L\right) + \left(1-\alpha\right) \ln\left[1 + \left(c-1\right) P\right]$$

If using first order Taylor series approximation here: that is ln (1+x) ≈x the error approximation is smaller and closer to zero. The $\left(1-\alpha\right) \ln\left[1 + \left(c-1\right) P\right]$ part of equation turns out to be $\left(1-\alpha\right)(c-1)P$ if the Taylor Series approach is used. [11]

Turns to be this equation[12];

$$\ln \frac{Q}{L} = \ln A + \alpha \ln\left(K / L\right) + \left(1-\alpha\right)\left(c-1\right) P \quad (7.21)$$

Equation can be estimated given data on (Q/L), (K/L), and P. The coefficient of P identifies the union-productivity parameter c. If union labor is more productive than non-union labor, this coefficient should be positive, while if union labor is less productive, the coefficient should be negative. Thus, it can be interpreted (c - 1) as the productivity differential of union workers or $\left(1-\alpha\right)(c-1)$ as the productivity differential of unionized establishments. The coefficient on P measures the logarithmic productivity differential of unionized establishments.

Here in order to find the coefficient of the P, the α, which is the $\alpha \ln(K / L)$ coefficient of the equation is used and c can be calculated by putting the $\left(1-\alpha\right)(c-1)$ which is the coefficient of P in its place.

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[11] We can describe this as follows: The values obtained by $\ln\left[1 + \left(c-1\right) P\right]$ part of the equation, which is ln (1 + x), are approximately equal to x and $\left(c-1\right) P$ with a small error. (As an example, c=1.50 and p=0.70 ln (1+ (0.5*0.70) =0.30 or only from the x part, we find 0.35 and the relative difference is negligibly small.)

[12] This equity has been based upon some assumptions in the article of Hirsch and Addison 1986: 192-194.

According to Hirsch and Addison (1986), equation (722) relies upon some assumptions. First, in order to production elasticities equal to 1, it assumes whole firms operate under constant returns to scale. This assumption may be relaxed by including in In L variable as a measure of establishment size (as cited in Özkaplan, 1998: 261).

Secondly, coefficient of P (Union density), i.e. (1-a)(c-1), measures productivity difference in the union firm. The union productivity effect is obtained by dividing the P coefficient by (1-α).

$$\ln \frac{Q}{L} = \ln A + \alpha \ln \left(K / L \right) + \ln L + \left(1 - \alpha \right) \left(c - 1 \right) P \quad (7.22)$$

Third, to anticipate what follows, c > 1 implies that unions have higher total factor productivity (TFP), as obtains after subtracting a ln (K/L) from both sides of (7.21),

In Q - a lnK- (1 - α) ln L = TFP ≈ lnA + (1 - α) (c - 1) P

The method of production function, does not investigate the reasons of the productivity effect; it only determines whether the unionized employees at a specific period and at a specific sector or employment place to be more productive or not with respect to the non-unionized ones (Özkaplan, 1998: 261).

5.6.2 Subset Data for OLS Approach

Linear regression is a statistical prediction model that explains a continual dependent variable again with a continual independent variable. The purpose of OLS employment in this thesis is to determine the relation between the unionization density and productivity in unionized chemistry companies. Logarithmic indications of the gross added value per capita, capital per labor and labor data and union density data of 18 union chemistry companies operating in the chemistry industry have been added in the study. Implementing a modified version of the Cobb-

Douglas production function (equation no 7.22), the relation between unionization rate and productivity has been researched by using statistic program E-Views 6.

5.6.3 Results and Implications

The purpose of the panel regression analysis employed in this thesis is to study the effect of the unionization rate of companies operating in the chemistry industry in Turkey on productivity. In order to identify the effect of unionization rate on productivity on a company basis, the company variant has been defined as a fixed effect. [13] In terms of overall results, the effect of unionization rate in union firms on productivity has been obtained positive. Results are given in Table 5.42.

Table 5.42 OLS Results

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	5.045	1.010	4.994	0.0000
LNKL	0.266	0.039	6.717	0.0000
LNL	-0.052	0.145	-0.356	0.7223
P	0.340	0.190	1.787	0.0760
Effects Specification				
Cross-section fixed (dummy variables)				
Weighted Statistics				
R-squared	0.979	Mean dependent var		10.568
Adjusted R-squared	0.977	S.D. dependent var		7.003
S.E. of regression	0.357	Sum squared resid		18.070
F-statistic	344.796	Durbin-Watson stat		1.944
Prob(F-statistic)	0.000			

The union density coefficient, i.e. the (1 - α) (c - 1) multiplication indicates a productivity effect and this figure was found to be positive (0.347). Therefore, the c value is over 1 (1.46). In other words, increase in the union density also increased productivity in labor force. When results of 18 companies are evaluated all together, it can be concluded that union member in union firms work more productively than non-union member.

[13] Firm fixed effect results have been presented in Appendix E.

Chapter 6

Conclusions and Implications for Further Research

6.1 Discussion of Results

By using different parametric and nonparametric statistical methods, this thesis explores the relationship between unionization and productivity in the chemical sector of Turkey, during the 1998-2006 period. The data used belong to firms which fall into the first and second 500 rankings of the ICI in the chemicals sector of Turkey within the 1998-2006 time span. ANOVA method, the first technique used in the study, was applied in two ways. The first ANOVA approach dealt with variations of per capita productivity, per capita capital and number of workers employed by 3 different types of union status, i.e. unionized firm, non union firm and the firm with "non binding collective agreement". The study reached meaningful findings between union and non union firms as well as firms with non binding agreements. The major finding of the study revealed that union firms have lower productivity in relation to non union firms and the one with non binding collective agreements. When the groups' mean values were considered, productivity tended to decline in relation to unionization. No difference was detected, however, in terms of per capita capital used by the groups. In terms of the number of workers employed, on the other hand, a negative relationship was found between unionization and employment volume, that is, an increasing employment volume was found to prevail in relation to the union status of the firm.

ANOVA analysis was applied to the subsectors of the chemical industry to see if the results are consistent with those of the general chemical sector. In other words, the same parameters were used for each group (i.e. union, non union, non binding agreements groups) in the general chemicals, oil, pharmaceuticals and plastics

subsectors. The productivity differential for the general chemicals and oil subsectors in relation to unionization status is consistent with the findings obtained for the entire chemical sector. On the other hand, no relationship between unionization status and productivity in pharmaceuticals-plastics subsectors was found in the study.

Data envelopment analysis (DEA), which is another research method used in this study is a non parametric technique applied to productivity research frequently. For this approach, relative productivity scores of union and non union firms listed in the first and the second 500 rankings of the ICI in the chemicals sector were determined with a view to compare their relative efficiency scores. DEA technique found that non union firms are more productive, with a difference varying between 2 and 7 percent according to the years under study. This analysis was made for each relevant year in order to uncover also the impact of the 2001 economic crisis. This analysis showed that the 2001 crisis accounted for no significant difference between the union and non union firms in terms of productivity. Those findings were also probed through in depth interviews made with the relevant informants.

Following this DEA-base study, the productivity changes were studied for the 1998-2006 period in union and non union firms by using DEA-based malmquist productivity index which is a non parametric method in measuring productivity changes. Malmquist index was applied using two approaches; in the first data for the entire chemicals sector were applied with a view to determine the general change in productivity. The results showed a 4 percent reduction in productivity in the entire chemicals sector. On the other hand analysis of union and non union firms in terms of productivity change revealed only a negligible difference (about 0.1%). Suffice it to say that, as a result of applying malmquist index, no significant difference was found in terms of productivity change (whether in the "increase or decrease" dimension) between union and non union firms.

Still from a somewhat different perspective, the topic has been analyzed by panel regression analysis, whereby productivity relationship to union density was measured in unionized firms, using a modified version of Cobb-Douglas production

function. The effect of unionization density in union firms on productivity was found positive.

To make a general overview of the results of parametric and nonparametric analysis applied in this thesis; according to the ANOVA test results, it is possible to conclude that union firms in Turkey are less productive compared to nonunion and "nonbinding contracted" firms. However, the panel regression analysis (which includes only union firms in the data set) indicates that the effect of union density on productivity in union firms is positive. In other words, if the firm is not a union firm, it should maintain its nonunion status, but if a union firm, then pressure on employees to diminish the number of union member personnel may result in a decrease in productivity. But, it would not be wrong to say that this study has been executed and concluded based on data obtained for a certain period of time in the chemistry sector and its results are valid under the aforementioned conditions.

Literature studies on unions' negative effects on productivity are dealt with in chapter 3 of the thesis. Among the factors accounting for such effects were cited such variables as unions' restrictive work practices, union strike threats and drops in production due to strike practices, the implementations which hinder research and development efforts and technological investments as well as wages spillover effects. In an effort to shed light on unions' possible negative effects on productivity and to further clarify the research findings of this study on this matter, in-depth interviews were conducted with selected informants of the leading chemical firms of Turkey, and with the representatives of labor and employers' unions.

A somewhat commonly shared opinion obtained from the interview respondents is the relatively higher sense of job security enjoyed by union members as opposed to feelings of relative insecurity among nonmembers. Due to fear of reprisal by the management and easier layoff procedures, in non union firms, non members observe work discipline more and show higher loyalty to the company than in unionized firms.

Another cited reason was related to the power demonstration effects on union leaders during collective bargaining negotiations. Demands of workers concerning structure of jobs, wages and working conditions proceed as a natural process from workers to shop-stewards, then to union's branch management and then to top union leadership. In this process the shop-steward has a decisive role in impacting workplace working conditions. His/her main task is to struggle for members' interests in the best possible way. The steward's performance in this endeavor is likely to determine his/her feature career as a union leader. To achieve this objective he usually must engage in aggressive behavior, specially at the negotiations stage. Among the likely reasons which seem to lead to tension and unfavorable consequences for workplace productivity is cited the power motives of the shop-stewards and union administrations vested in their positions and conflicts of interests with management during bargaining rounds.

Working time arrangements are cited yet as another factor accounting for higher productivity in non union firms. Respondents in interviews referred to the strict application of working time arrangements which are jointly determined with the labor union in collective agreements, while non union firms are quite free and flexible in the application of working time and overtime work. Responses to interview questions indicate the extent of restrictions of workers' rights in non union plants where violations of working time rules extend from rest breaks to overtime regulation violations. In contrast to the previous labor act no.1475, act no.4857 which came into force in the year 2003 loosened the regulation of overtime work, thus paving the way for making workers do overtime in excessive hours more easily. Obviously this makes it possible for non union firms to reach higher production volumes. Unlike the regulations under the previous system, the 45-hour weekly working time may be exceeded under act no.4857, provided the employer, engaging in a balancing act (equalizing act), turns the average weekly time into 45 hours which he must realize within 2 months (this equalizing period may be extended up to 4 months by collective agreement). In this process no overtime premium pay is required, provided the daily working time does not exceed 11 hours.

In other words, working over 45 hours in some weeks is not considered as overtime work as long as weekly average is equaled to 45 hours in a balancing process of 2-4 months. The only limitation in act no.4857 is the ceiling on the maximum overtime done in a year, which must not be more than 270 hours and in practice it is hand to monitor such limits. Therefore, one can safely argue that the new legislation on flexible working time has made the implementation of overtime easier for the employer.

One reason accounting for the lower per capita productivity in unionized firms may be the higher volume of employment in unionized firms. Self-evidently, job security is stronger in union firms where layoffs are usually a difficult process. This charging on unproductive workers is harder in the unionized firm; the firm, rather than laying off workers with low productivity, are tempted to hire new workers in order offset for the low productivity. As one interviewee said "while one worker is engaged in one job in the non union firm, employing two workers for the same job in the union firm (overmanning) is an important reason for the reduction of per worker productivity due to unionization". Further reason for the seemingly higher number of workers in union firms is because of the more precise designation of worker numbers in union firms. In other words, official employment volume may have been understated in non union firms. Still another factor leading to differences in numbers is the relative ease of the subcontracting practice in non union firms which employ short-term, temporary and flexible laborers. Labor unions try to oppose labor displacement and layoffs through a variety of ways in order to ward off the risk of increasing unemployment in times of economic crisis. Unions accept flexibility measures readily in such times by adopting milder approaches to employer practices. As cited in the Petrol-İş report on 2008 economic crisis, "layoffs must never be conceived of as being a solution; on the contrary, employment must be pursued as a sustainable goal. Reliable financial documentation or reports of independent auditors must take precedence before taking any action. The union is ready and willing to share information and policy with the employer to implement flexible measures, provided that the employer insures that benefits lost during the crisis shall be compensated once the crisis over".

In order to prevent layoffs, some of the mild applications of unions are listed as follows:

1) Putting workers on annual leave;
2) Paying half-wages in the case of work stoppage until 1 week ;
3) Deferring the payment of social benefits foreseen in the collective agreement to a future date;
4) Reducing or deferring the payment of the second year wage increases envisaged in collective agreement by concluding protocols with the union;
5) Lastly, putting the workers on unpaid leave after taking their consent.

Generally one could argue that unions in Turkey still followed their traditional, employment-wage policies. On the other hand, firms have to adapt themselves to new production and marketing policies dictated by the 21st century competitive economic production systems. It is unfortunate that most union policies in Turkey at present still favor Fordist working methods, thereby resisting firms' demands for more flexibility. As exemplified by many success stories in the West, unions must choose to take a more collaborative approach in defending the employability of workers.

6.2 Limitations of the Study

In this study, the effects of unions in the chemical sector on productivity and efficiency are investigated by implementing parametric and nonparametric evaluation methods. Unions are studied in terms of their effects on productivity and certain economic parameters and ideological orientation. In the study, union relations with the political power are ignored. Gross added value is used as the productivity indicator by considering the similar studies in literature. Indication of productivity by a single parameter is the main limitation in the study. Apart from this, use of gross added value as the indicator of productivity may constitute an upwards bias, as the prices are higher in the union sector.

In the regression analysis, one of the methods used in investigating the productivity effect of unionization, a modified Cobb Douglas production function was

implemented. While using the Cobb Douglas function, it is assumed to represent the production function of all firms in the chemical sector without considering the sub-productions of the selected firms.

ANOVA analysis was used against possible criticism regarding production comparisons throughout the entire chemical sector by ignoring the difference in provided goods and services. Through this analysis method, productivity of groups divided according to their unionization conditions in the entire chemical sector has been investigated and the related data have been investigated separately in sub chemical sectors based on the production of the firms. However, as an extreme decrease would occur in the data set for other methods (DEA, Malmquist), such division could not be practiced.

A limitation that we may face in evaluating the unionization rate which is one of the data used in the regression analysis is about creating the data set including the number of union workers. There is a considerable difference between the number of union member employees registered in the records of the Ministry of Labor and the actual number of the registered members in unions. One of the reasons for this situation is the lack of regular updating of the number of resigned or retired employees in the Ministry records. Another reason is that unions tend to inflate their membership status in order to get authorization for collective bargaining. With a view to overcome this limitation, real membership figures in the firms concerned were gathered directly from the records of Petrol-İş and Lastik-İş.

ISO determines the first and second 500 firms as well as making a list of companies with the biggest sales and production figures. Production is determined by adding the interim consumption to the added value. If the interim consumption amount in a year is over the production amount, the added value within the concerned year will be negative. If the units comprising the value added such as wages, earnings and leasing amounts (highest in the agriculture sector) are over the added value, negative gross added value will occur. As programs used for DEA and Malmquist Productivity analyses cannot make any evaluation with negative data in this thesis, firms with negative gross added values are not included in the scope of research.

It is considered that identification of certain factors such as age, education and gender of the employees as variables may facilitate obtaining more detailed information; however, as it is not possible to reach such data in our country, they remain outside the research. As there are a few companies among the firms listed in Istanbul Stock Exchange which operate in the union chemical sector and take part in the defined time period; union, non-union and non-binding agreement groups have made it impossible to make a comparison between such firms. Firms are selected among ICI first and second 500 because the number of accessible firms is higher in the 1998-2006 period. For this reason, only productivity and some other indicators issued by ICI could be obtained and other financial rates that could have been investigated in more detail have been left outside the scope of the study.

6.3 Implications for Further Research

The main reasons behind the limited number of researches on the effects of unionization on productivity in Turkey can be summarized as the unreliability of data, limited data sources and difficulties in accessing to data. Especially unaccountable information furnished by the Ministry of Labor, bureaucratic procedures followed up in information provision and in addition, retraction of companies from sharing their confidential information are examples to challenges in the way. A similar study can be made by industry, inter industry and company basis, when it is possible to overcome the aforementioned restrictions to a certain extent.

It is suggested that it may be easier to collect data for studies to be executed in industry based studies (when data accuracy is compensated). In industry based studies, it is possible for the effects of unionization of productivity to show differences in different industry structures. It may be determined how this relation differs based on industry by conducting a research on productivity and unionization relation in two different industries with similar union structures in Turkey.

Alterations in productivity rates of companies before and after unionization can be investigated in companies in which the unionization status has changed in a certain period of time, again based on industry. Conducting a questionnaire with

management can be implemented as a method to easily access the numeric data of the company.

It has been observed in company based studies that data resources are limited in Turkey and companies are not eager to share their productivity figures. When it is possible to overcome such restrictions, the productivity effect can be investigated in more detail by identifying certain financial ratios as productivity indicators. Widespread availability of company based studies in foreign countries is a result of easy access to accurate data. A similar study can be executed by making comparisons between industries and company groups in different countries.

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Appendix A : ANOVA Findings Without Outliers

Table A.1 Test of Homogeneity of Variances

Test of Homogeneity of Variances				
	Levene Statistic	df1	df2	Sig.
Q/L	9.720	2	618	.000
C/L	2.551	2	618	.079
lbr	132.620	2	617	.000

Table A.2 Results of Welch and Brown -Forsythe

		Statistic[a]	df1	df2	Sig.
q/l	Welch	5.456	2	304.172	0.005
	Brown-Forsythe	2.638	2	227.848	0.074
c/l	Welch	0.162	2	92.432	0.851
	Brown-Forsythe	0.16	2	89.265	0.853
Lbr	Welch	38.04	2	86.533	0
	Brown-Forsythe	64.589	2	215.371	0

a. Asymptotically F distributed.

Table A.3 Multiple Comparisons For Productivity per Capita

Dependent Variable		(I) Numeric_Union_Status	(J) Numeric_Union_Status	Mean Difference (I-J)	Std. Error	Sig.
q/l	**Scheffe**	Non-union Firm	Nonbinding Aggrement	390.699	660.294464	.839
			Union Firm	-666.604	340.103	.147
		Nonbinding Aggrement	Non-union Firm	-390.699	660.294	.839
			Union Firm	-1057.303	693.164	.313
		Union Firm	Non-union Firm	666.604	340.103	.147
			Nonbinding Aggrement	1057.303	693.164	.313
	Tamhane	Non-union Firm	Nonbinding Aggrement	390.699*	161.531	.048
			Union Firm	-666.604	442.912	.350
		Nonbinding Aggrement	Non-union Firm	-390.699*	161.531	.048
			Union Firm	-1057.303*	427.791	.042
		Union Firm	Non-union Firm	666.604	442.912	.350
			Nonbinding Aggrement	1057.303	427.791	.042

Table A.4 Multiple Comparisons For Capital per Capita

Dependent Variable		(I) Numeric_Union_Status	(J) Numeric_Union_Status	Mean Difference (I-J)	Std. Error	Sig.
c/l	**Scheffe**	Non-union Firm	Nonbinding Aggrement	-161.149	330.329	.888
			Union Firm	-69.424	170.145	.920
		Nonbinding Aggrement	Non-union Firm	161.149	330.329	.888
			Union Firm	91.725	346.773	.966
		Union Firm	Non-union Firm	69.424	170.145	.920
			Nonbinding Aggrement	-91.725	346.773	.966
	Tamhane	Non-union Firm	Nonbinding Aggrement	-161.149	392.616	.968
			Union Firm	-69.424	150.572	.955
		Nonbinding Aggrement	Non-union Firm	161.149	392.616	.968
			Union Firm	91.725	395.940	.994
		Union Firm	Non-union Firm	69.424	150.572	.955
			Nonbinding Aggrement	-91.725	395.940	.994

Table A.5 Multiple Comparisons For Labor

Dependent Variable		(I) Numeric_Union_Status	(J) Numeric_Union_Status	Mean Difference (I-J)	Std. Error	Sig.
Lbr	Scheffe	Non-union Firm	Nonbinding Aggrement	-168.077	151.641	.541
			Union Firm	-977.236*	78.129	.000
		Nonbinding Aggrement	Non-union Firm	168.077	151.641	.541
			Union Firm	-809.158*	159.174	.000
		Union Firm	Non-union Firm	977.236*	78.129	.000
			Nonbinding Aggrement	809.158*	159.174	.000
	Tamhane	Non-union Firm	Nonbinding Aggrement	-168.077	71.478	.070
			Union Firm	-977.236	114.792	.000
		Nonbinding Aggrement	Non-union Firm	168.077	71.478	.070
			Union Firm	-809.158	133.039	.000
		Union Firm	Non-union Firm	977.236	114.792	.000
			Nonbinding Aggrement	809.158	133.039	.000

Appendix B: Sample of DEA Application-Two Inputs and One Output Case

The DEA method used in this thesis constitutes an example of *"Two Inputs and One Output Cases". A simple explanation can be given as follows to comprehend the operation of the applied method.*[14] *(Cooper et al. 2007)*

The table below demonstrates the sales performance of nine firms (A to I). Note the input and output variables for each:

- **Input 1 (x_1) :** Number of employees, with a unit of 10.
- **Input 2 (x_2) :** Floor area in 1000m^2 units.
- **Output (y) :** Sales in $100,000 units.

Please also note that the sales are unitized to 1 under the constant return-to-scales assumption. That is, input values are normalized so that the figues on the table represent the values for getting 1 unit of sales.

Table B.1 Two Inputs and One Output Case

Firms		A	B	C	D	E	F	G	H	I
Employee	x_1	4	7	8	4	2	5	6	5.5	6
Floor Area	x_2	3	3	1	2	4	2	4	2.5	2.5
Sale	y	1	1	1	1	1	1	1	1	1

The firms are then plotted such as in chart below, where the "unitized" axes are:

- Input 1 (x_1) / Output (y)
- Input 2 (x_2) / Output (y)

[14] This example is quoted is based mainly on Cooper, W. W., Seiford, L. M. and Tone K. (2007) "DEA a Comprehensive Text with Models Applications References and DEA Solver Software" USA:Springer, pp.6-8

Figure B.1 Efficient Frontier

It would be a safe assumption that the firms using less input to get one unit of output are *more efficient.* Hence we can specify the line connecting firms *C, D and E* as the *efficient frontier.* The tradeoffs among these three firms are irrelevant in this context – we can simply conclude that no point on this frontier can improve one of its input values without damaging the other.

As a next step, we can then envelop all points that fall within the area enclosed by the following:

- The frontier line
- The vertical line passing through E.
- The horizontal line passing through C.

The region thus enveloped is the so called *"Production Possibility Set".* Please note that this requires the assumption that the true frontier line consists of *linear segments* such as the ones connecting E to D, and D to C. In reality, these segments may not be linear.

The Production Possibility Set should be interpreted as the area where production is possible at the rates specified by any given data point in it, and the nine data points represented in the chart are assumed to serve as empirical evidence for this.

Let's now try estimating the efficiency of the firms that are *not* on the frontier line. Taking firm A as an example, we can use the following in calculating its efficiency:

Efficiency of firms A = OP / OA = 0.8571

Where;

- OA is the length of the line connecting the origin to point A.
- OP is the length of the line connecting the origin to point P.
- Point P is the point where OA intersects the frontier line.

Note that point P in this case is on the line that connects D to E. Points D and E, then, would be the *reference set* for point A, which means that the efficiency of firms A is to be calculated with a combination of D and E. It follows that the reference set for any inefficient firms may differ – the reference set for firms B, for instance, will be composed of C and D.

Furthermore, since many firms notably gather around point D, it can be considered as being *"representative"*. Firms C and E are surely efficient as well, although their efficiency should be attributed to their specific characteristics since they are set far apart from the other observations.
Consequently, the next part of the analysis deals with identifying possible improvements by referring inefficient behaviors to those on the efficient frontier. Following the example of firms A, improving its efficiency would imply moving to point P so that:

- **Input 1 (x_1) :** 3.4
- **Input 2 (x_2) :** 2.6

which are the coordinates of P.

Efficiency improvement would not be limited to opportunities in changing both inputs. It can also be achieved by reaching any point on the OA_1 segment, which implies that either floor area could be reduced to attain D, or by reducing employees to achieve A_1 .

Figure B.2 Improvement of Store A

Appendix C: Malmquist Index Results

Table C.1 Malmquist Index Summary of Firms Means

firm	effch	techch	pech	sech	tfpch
1	0.939	0.941	0.970	0.968	0.883
2	1.064	0.958	1.046	1.018	1.019
3	1.137	0.960	1.125	1.011	1.092
4	0.951	0.952	0.936	1.016	0.905
5	1.089	0.969	1.068	1.019	1.055
6	1.143	0.958	1.140	1.003	1.094
7	0.972	0.965	0.969	1.003	0.938
8	0.856	0.981	0.859	0.996	0.839
9	1.000	0.991	1.000	1.000	0.991
10	0.884	0.963	0.876	1.009	0.851
11	0.972	0.972	0.961	1.012	0.945
12	1.102	0.924	1.079	1.021	1.018
13	0.973	0.955	0.956	1.018	0.929
14	1.000	0.956	1.209	0.827	0.956
15	1.061	0.959	1.081	0.982	1.018
16	0.948	0.966	0.932	1.018	0.916
17	1.007	0.965	1.005	1.002	0.972
18	1.006	0.963	1.017	0.990	0.969
19	0.953	0.922	0.935	1.020	0.879
20	0.953	0.966	0.958	0.994	0.920
21	0.976	1.017	0.972	1.004	0.993
22	0.948	0.945	0.937	1.012	0.897
23	0.949	0.945	0.938	1.012	0.897
24	1.129	0.992	1.124	1.004	1.119
25	1.300	0.948	1.326	0.980	1.232

Table C.1 Malmquist Index Summary of Firms Means (cont'd)

firm	effch	techch	pech	sech	tfpch
26	1.021	0.948	0.994	1.028	0.968
27	1.008	0.963	1.030	0.979	0.971
28	0.982	0.964	1.067	0.921	0.947
29	1.124	0.946	1.277	0.880	1.064
30	1.008	0.937	1.052	0.959	0.945
31	1.240	1.142	1.176	1.055	1.416
32	0.868	0.979	0.904	0.961	0.850
33	0.987	0.964	0.987	1.001	0.952
34	0.911	0.958	0.895	1.018	0.873
35	0.976	0.961	0.961	1.016	0.939
36	0.996	0.983	1.023	0.974	0.979
37	1.225	0.968	1.228	0.998	1.186
38	0.931	0.935	0.905	1.028	0.871
39	1.118	0.947	1.182	0.946	1.059
40	0.977	0.947	1.080	0.904	0.924
41	0.823	0.985	0.807	1.020	0.810
42	1.013	0.961	1.012	1.001	0.974
43	1.295	0.936	1.250	1.036	1.212
44	0.970	0.979	1.037	0.935	0.949
45	0.987	0.947	0.975	1.012	0.934
46	0.935	0.967	0.940	0.994	0.904
47	0.887	0.958	0.802	1.106	0.850
48	0.932	0.960	0.972	0.959	0.895
49	0.952	0.995	0.953	1.000	0.948
50	0.830	0.949	0.856	0.970	0.787
51	0.859	0.922	0.864	0.994	0.793
52	0.780	0.947	1.000	0.780	0.738
53	1.139	1.015	1.139	1.000	1.157
MEAN	0.996	0.964	1.008	0.988	0.959

Table C.2 Malmquist Index Summary of Unionised Firms Means

firm	effch	techch	pech	sech	tfpch
Dyo Matbaa Mürekkepleri San Ve Tic. A.Ş.	0.906	0.968	0.807	1.123	0.878
Goodyear Lastikleri T.A.Ş.	1.048	0.968	1.049	0.998	1.014
Gübre Fab.T.A.Ş.	1.111	0.968	1.105	1.006	1.076
Mutlu Akü Ve Malzemeleri San. A.Ş.	0.928	0.969	0.919	1.010	0.899
Petkim Petrokimya Holding A.Ş. Genel Müdürlüğü	1.087	0.968	1.069	1.017	1.052
Petlas Lastik Sanayi Ve Ticaret A.Ş.	1.144	0.961	1.129	1.013	1.100
Soda Sanayii A.Ş.	0.967	0.968	0.967	1.000	0.936
Toros Gübre Ve Kimya Endüstrisi A.Ş	0.851	0.984	0.860	0.989	0.837
Tüpraş-Türkiye Petrol Rafinerileri A.Ş.	1.000	0.991	1.000	1.000	0.991
Türk Pirelli Lastikleri A.Ş.	0.877	0.968	0.877	1.000	0.849
Türkiye Petrolleri Anonim Ortaklığı	0.960	0.979	0.959	1.001	0.941
Santa Farma İlaç San.A.Ş.	1.070	0.969	1.069	1.001	1.037
Sasa Sun'i Ve Sentetik Elyaf Sanayii A.Ş.	0.957	0.968	0.957	1.000	0.926
Arılı Plastik Sanayi A.Ş.	0.980	0.968	1.000	0.980	0.949
Bayer İlaç Fabrikaları Anonim Şirketi.	1.050	0.968	1.055	0.995	1.017
Bayer Türk Kimya San.Ltd.Şti.	0.929	0.968	0.917	1.013	0.900
Brisa Bridgestone Sabancı Lastik San. Ve Tic. A.Ş.	1.006	0.968	1.006	0.999	0.973
Cognis Kimya Sanayi Ve Ticaret A.Ş	1.002	0.968	0.999	1.002	0.970
mean	0.990	0.971	0.982	1.008	0.961

Table C.3 Malmquist Index Summary of Non-Unionised Firms Means

firm	effch	techch	pech	sech	Tfpch
Adeka	0.944	0.921	0.989	0.954	0.869
Ak-Kim Kimya	0.910	1.018	0.992	0.918	0.927
Aksa Akrilik	0.888	1.115	0.903	0.983	0.989
Akzo Nobel Kemipol Kimya	0.913	0.986	0.919	0.994	0.901
Ali Raif	0.936	0.965	1.011	0.926	0.904
Aygaz A.Ş.	1.025	1.068	1.000	1.025	1.095
Bak Ambalaj	1.225	0.998	1.154	1.062	1.223
Biofarma	1.010	0.973	1.078	0.937	0.982
Birleşik Oksijen	0.958	1.008	1.031	0.929	0.966
Bizimgaz	0.932	1.027	1.082	0.861	0.957
Bakim Coates	1.138	0.953	1.047	1.087	1.085
Dalan Kimya Endüstri A.Ş.	1.018	0.908	1.245	0.818	0.924
Debant	1.240	1.135	1.087	1.140	1.407
Ege Gübre Sanayii A.Ş.	0.873	1.016	1.060	0.824	0.887
Elif Plastik Ambalaj Sanayi	0.975	0.994	1.111	0.878	0.970
Glaxo Wellcome	0.901	0.989	0.896	1.005	0.891
Habaş Sınai Ve Tıbbi Gazlar	0.978	0.986	0.928	1.053	0.964
İba Kimya Sanayi Ve Tic. A.Ş.	0.946	1.058	1.079	0.877	1.001
İpragaz A.Ş.	1.151	1.032	1.148	1.002	1.187
İstanbul Asfalt Fabrikaları	0.952	0.933	0.901	1.057	0.889
Kayalat Kimya	1.099	0.984	1.054	1.042	1.081
Kopaş	0.946	0.978	1.038	0.911	0.925
Korozo Ambalaj San.Ve Tic.A.Ş.	0.749	1.037	0.943	0.794	0.777
Marshall Boya Ve Vernik San. A.Ş.	0.972	1.010	0.994	0.978	0.982
Milangaz Lpg Dağıtım Ticaret Ve Sanayi A.Ş.	1.273	0.964	1.159	1.098	1.227
Mogaz Petrol Gazları Anonim Şirketi.	0.940	1.016	1.028	0.914	0.955
Naksan Plastik.	0.946	0.992	0.962	0.983	0.938
Polinas Plastik	0.882	1.026	0.989	0.892	0.905
Sanovel İlaç San Ve Tic.A.Ş.	0.817	1.016	0.808	1.011	0.830
Sika Deteks Yapı Kimyasalları	0.937	0.984	1.045	0.897	0.922
Süper Film Sanayii	0.907	1.049	0.992	0.915	0.951

Table C.3 Malmquist Index Summary of Non-Unionised Firms (cont'd)

firm	effch	techch	pech	sech	Tfpch
Vatan Plastik	0.770	0.985	0.978	0.787	0.758
Verim Plastik	0.872	0.920	1.018	0.856	0.802
Eös Eczacıbaşı	0.839	0.924	1.000	0.839	0.776
The Shell	1.000	1.123	1.000	1.000	1.123
mean	0.960	1.001	1.015	0.946	0.962

Appendix D: In-Depth Interview Questions

In-Depth Interview Questions

1 - Contrary to the previous study, the logarithmic functions have been taken out from the results set and data containing negative values have been added to the research.

Question 1-In your opinion, why is company performance in the non-union group in total chemical sector higher than
(a) to the "nonbinding union agreements" group and then
(b) to the union group, in that order?

Question 2- Even though total performance increases; can employing more workers in the union group be a reason for low performance per worker? Does increasing employment cause a fall in (productivity performance per hour worked), in other words, does it cause a type of disguised employment?

Question 3- How do you explain the "nonbinding union agreements" group is better performance than that of the "union group"? In the companies in this groups there used to be unions and collective labor agreements. As the unions in that group lost their bargaining rights, the parties in these companies continued implementing the expired contracts with some through employer's initiative amendments. How or why did this kind of implementation generate a more productive environment?

Question 4- How do you explain the fact that the capital per person is not significantly different among the three groups while productivity is higher in the non-union group?

Question 5- The Chemical sectors included in the data set were examined in terms of their gross added value capital per person and workers' wages between the years

1998-2006. Taking consideration that the 2001 Crisis happened during these years, could you please explain how the criteria below and your company were affected by the crisis?
Productivity
Capital per person
Number of wage earners (workers)

Question 6- There are two groups of workers at the unionized companies. Members and non-members of the union; How do you think the presence of that difference impacts workers' psychology, work performance (i.e. production) and morale?
In the research the input (number of workers and capital) and the output (productivity) variables were specified and applied to the companies in the field of chemical, and relative efficiency scores have been obtained for the companies among themselves for each year.

Question 7- When Data Envelopment method was used, parallel to the findings above, the "efficiency" scores of the non-unionized companies were found to be higher than the unionized companies between years 1998 and 2006 (The difference varies between 2% and 7 % according to years; from 2004 onwards it has a significant decrease).
In your opinion, what reasons could explain the lower performance of that unionized companies?

Question 8-In the period 1998-2006 it has been found that the non-union companies increased their efficiencies by 3 %. In your opinion what could be the reasons for this activity increase at the non-union companies, taking the crisis into account as well?

Question 9- According to some literature, the impact of the unions on productivity is positive. Among the reasons put forth to explain this difference, the following factors are cited: the unions make a positive impact on productivity by keeping the workers' morale high, by providing opportunities for the workers to have a right to voice their requests and to participate in management, by cooperating with the

employer on occupational health and safety measures, by creating a more fair and transparent environment. However, our research findings do not support this hypothesis generally. Does this result emanate from reasons specific for Turkey or from the chemical sector's special characteristics? If yes, what can these factors be in your opinion?

GENERAL CHEMICAL

ANOVA results display the following for the subsectors:

Question 10 – When the productivity per person is examined in the general chemical sector, the unionized companies were more productive than the non-union companies. How would you explain these results from the general chemical perspective? Why?

Question 11 – From the point of view of capital usage per person, a statistically significant difference was found in the "nonbinding union agreements" group compared to the other two groups meaning there is a more intensive capital usage. In your opinion, why is the capital intensiveness per person higher in the "nonbinding union agreements" group? Can higher productivity be explained by this factor?

Question 12- From the point of view of the number of workers, the number of workers in the union group is higher than "the non-union" and the "nonbinding union agreements" group, does the increase in the number of workers make a negative impact on productivity? Explain it by taking into consideration labor and capital intensiveness ratios of the sector. Does productivity fall (respectively) because the union and "nonbinding union agreements" group have more workers than the non-union group?

PHARMACEUTICALS

Question 10- No significant relationship has been found between unionization and productivity in the medicine sector. How is the union status for the companies in the sector? What do you think about the impact of unionization on productivity? How do you explain this result from the perspective of the medicine sector? Why?

Question 11- In the companies in the medicine sector the capital per person is higher at the unionized companies than the non-union ones. Can this result be explained by the status of unionization?

Question 12- The number of workers in the medicine sector was found to be higher in the "nonbinding union agreements" group compared to the other two groups. Can there be a relation between the number of workers in this sector and the unionization structure?

OIL

Question 10- When the gross added value per person is taken into consideration in the oil sector, non-union companies are more productive than the unionized ones. This result supports the research results for the whole chemical sector. How would you explain the results for the field of oil? Why?

Questions 11- In terms of the capital per person, in the field of oil, the unionized companies are more capital intensive than the others. Have the unions been organized at richer companies in the field of oil? The unionized companies have been found to have intensive capital and yet unproductive. Is there a special factor to explain this in the oil field?

Question 12- It has been determined that in oil the unionized companies employ more workers. It has also been found that at the unionized companies productivity (i.e. gross added value) is less compared to the non-union ones, while the number of workers employed is much higher. Does employing too many workers cause a fall in productivity?

PLASTIC

Question 10- No statistically significant difference among the three groups has been found in the subsector except for the plastic sector. However, when the averages are considered, the unionized companies have been found to be more productive than the non-union ones. This is contrary to the result found for the chemical sector taken as a whole. In your opinion, which characteristics of the plastic sector could help to explain this difference?

Question 11- When the capital per person is examined, the non-union group seem to be more capital intensive than the unionized and "nonbinding union agreements" groups. Are the companies in the sector capital intensive or labor intensive? The number of unionized firms is fewer in the plastic sector. Can this sector have a general negative attitude towards unionization?

Question 12- In the plastic sector, the number of workers employed at non-union companies is higher than the other two groups, i.e. the unionized and "nonbinding union agreements" groups. The non-union group having more workers has also been found unproductive. Does this result emanate from employing too many workers? In the other subsectors of chemical, in general chemical, oil and medicine, this relationship entirely in the opposite direction is completely to the contrary. Does this finding reflect a special feature of the plastic sector?

Appendix E: OLS Results

Table E.1 Firms Fixed Effect

Firms	Productivity Effect
1	-0.427
2	-0.119
3	0.058
4	0.156
5	0.357
6	0.118
7	-0.197
8	0.171
9	-0.454
10	-0.280
11	-0.585
12	-1.394
13	-0.220
14	-0.233
15	3.061
16	-0.020
17	0.002
18	0.007