Estimation of Production Technology for Turkish Textile Industry

Nesrin Dağ

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Approval of the Institute of Graduate Studies and Research

Prof. Dr. Elvan Yılmaz
Director (a)

I certify that this thesis satisfies the requirements as a thesis for the degree of Master of Science in Economics.

Asst. Prof. Dr. Gülcay Tuna Payaslıoğlu
Chair, Department of Economics

We certify that we have read this thesis and that in our opinion it is fully adequate in scope and quality as a thesis for the degree of Master of Science in Economics.

Assoc. Prof. Dr Sevin Uğural
Co-Supervisor

Assoc. Prof. Dr. Mehmet Balcılar
Supervisor

Examining Committee

1. Assoc. Prof. Dr. Mehmet Balcılar
2. Assoc. Prof. Dr. Sevin Uğural
3. Asst. Prof. Dr. Çağay Coşkuner
4. Asst. Prof. Dr. Hasan Güngör
5. Dr. Yenal Süreç

ABSTRACT

This study examines the production technology in Turkish textile manufacturing industry, for the period 1988-2008. It is analyzed whether the production technology can be represented by a cost function or a profit function. A translog cost function is estimated and endogeneity of the output level is analyzed. The estimated translog cost function is also evaluated with hypothesis testing to verify the statistically significance of the independent variables.

It is illustrated that the data in Turkish textile industry can be explained by the estimated translog cost function and the output is not an endogeneous variable in textile manufacturing. It is presented that the shares of labor and capital costs are approximately 13.2 % and 2.3 % respectively. It is demonstrated that the contribution of oil price in total cost of input is less than 1 %.

Turkish textile industry within the examined period demonstrates an increasing return to scale with a factor of 1.15.

Keywords: Production technology, Translog cost function, Textile industry.

ÖZ

Bu çalışma, 1988-2008 yılları arasında Türkiye textil sanayinde üretim teknolojisini araştırmaktadır. Üretim teknolojisinin maliyet fonksiyonu ile mi yoksa kar fonksiyonu ile mi temsil edildiği incelenmiştir. Bir translog maliyet fonksiyonu tahmin edilmiş ve çıktı seviyesinin içsel bir değişken olup olmadığı araştırılmıştır. Tahmin edilen fonksiyon ayrıca varsayım testlerine tabi tutularak, bağımsız değişkenlerin istatistiki önemliliği değerlendirilmiştir.

Türkiye tekstil sanayisinin çalışmada tahmin edilen translog maliyet fonksiyonu ile temsil edilebileceği gösterilmiş ve çıktı seviyesinin içsel bir değişken olmadığı bulunmuştur. İşgücü maliyetinin toplam girdi maliyetleri içinde yaklaşık % 13.2, sermaye maliyetinin ise yaklaşık % 2.3 oranında yer tuttuğu görülmüştür. Yakıt maliyetin toplam girdi maliyeti içindeki oranının ise % 1'den az olduğu bulunmuştur.

İncelenen zaman aralığında Türkiye tekstil sanayisinin 1.15 oranında ölçeğe göre artan getiri gösterdiği izlenmiştir.

Anahtar Kelimeler: Üretim teknolojisi, translog maliyet fonksiyonu, tekstil endüstrisi.

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INTRODUCTION

1.1 Production Technology

Production is one of the key elements in an economy. Firms, household or government are producing goods and services but the aim of each differs. Theory of the firm says that firms try to maximize their profit with the given output level. On the other hand, given level of output enforces firms to minimize their costs. This level of output is determined by different combination of input. Production technology specifies how different inputs are used to produce a certain amount of output. It is the method of transformation from input to output.

The importance of the production function is that it will give the relationship between inputs and outputs mathematically. Firms can decide their level of output with respect to their available inputs or can choose the amount of inputs with respect to the required level of output. Thus they can develop their plans accordingly, whether they require more labor, capital or they need more materials, etc. That's why, once the production function is known, firms can pursue the right policies to get maximum output in the efficient manner obtaining maximum profit.

A production function for a given technology can be written in the form of $Q = f(X_a, X_b, X_c, ..., X_n)$

where each term corresponds to the level of input to be able to have the maximum value of output product. As Hyman (1989) indicated, properties of production function affect the relationship between output and cost. We can express the cost function in terms of output and the output function in terms of input prices so that knowing the input prices and the function associated with it will reveal the cost of the output.

Normally, firms try to maximize their profits. Profits are the difference between total revenue (TR) and total cost (TC) per sales period: Profit = TR – TC. A firm maximizes profits by continuing to produce up to the point at which marginal revenue equals marginal cost: MR = MC. On the other hand, for a competitive firm marginal revenue is equal to the market price, P=MR. Therefore, the competitive firm maximizes profits at the point where its marginal cost equals the competitive market price. MC=P.

On the other hand, firms try to minimize their cost, as well. A cost function describes the relationship between output produced and the minimum possible cost of that output. Technology and input prices are usually taken as given in specifying cost functions. A change in either input prices or adoption of improved technology will affect the minimum possible cost of producing a given amount of output.

Production technology can be identified by estimating either a cost function or a profit function. In the literature, estimating cost function is a more commonly used approach than estimating profit function. As Kumbhakar and Tsionas (2008) state “In practice, researchers using a dual approach have to decide whether the cost or the profit function should be used. Most often the decision is in favor of a cost function without much justification from either theoretical or empirical viewpoints.” It is seen in the literature that usually a translog cost function is chosen to represent the underlying production technology.

Actually, the choice between the two approaches depends on the decision whether output is going to be kept constant as in cost minimization or to be left as a variable as in the profit function. Thus, instead of using a profit function explicitly one can use a cost function along with the optimal output decision rule as an additional equation. The advantage of doing this is that one can test econometrically whether the data support profit maximizing behavior. To test the reliability of the decision, a test based on the work of Schankerman and Nadiri (1986) is commonly applied. The mentioned test searches the deviations of output level from the profit maximizing level to decide whether output is going to be considered as endogenous or exogenous.

1.2 Textile Industry

Textile industry in Turkey is quite important for the economy. This can be identified from the input-output table of the country. Input-output tables indicate how products relate to industries, final uses and the value added so that the Gross Domestic Product (GDP) can be determined. As Kula (2008)defines: ‘Input-output tables provide summary information of the industrial structure of an economy for a given period. They contain information on the flows of goods and services between industries and sectors of the economy'.

2002 Input-Output Tables in Turkey were prepared at basic prices and derived to symmetric I-O tables according to European System of Accounts (ESA'95) and the Eurostat Input-Output Manual published in 2002. Statistical Classification of Economic Activities in the European Community (NACE Rev. 1.1) and Statistical Classification of Products by Activity in the European Community (CPA 2002) were used in 2002 Supply Use and Input-Output Tables.

The manufacture of textiles in the Input-Output Tables includes the activities of spinning of textile fibres, weaving and finishing of textiles, manufacture of made-up textile articles except apparel, manufacture of carpets, rugs, cordage, rope, twine and netting and manufacture of knitted and crocheted fabrics and articles. Manufacture of wearing apparel; dressing and dyeing of fur is separated from this classification.

When the input-output table of 2002 is examined, it is seen that there are 21 sub industries within the manufacturing sectors. Among these, textile industry has the second largest share (15.06 %) in value added. (See Table_1)

Table 1: Value Added Shares in Industries

	Manufacture of food products and beverages	Manufacture of textiles	Manufacture of wearing apparel; dressing and dyeing of fur	Manufacture of chemicals and chemical products	Manufacture of machinery and equipment n.e.c.
Value added at basic prices	11 493 140	9 000 940	5 425 526	4 713 424	4 284 388
Output at basic prices	46 447 641	34 726 107	20 011 320	16 375 114	11 582 398
VA manuf. / Tot.VA manuf. (%)	19.23	15.06	9.08	7.89	7.17

Turkstat, The Supply-Use and Input - Output Tables of the Turkish Economy, 2002

The share of textile goods within the export goods is approximately 14.5 % between 1997 and 2007. (See Table.5) This is quite high proportion when only one industry is considered.

Moreover, Turkey is the second largest textile supplier (after China) of the European Union, as it is seen in (Table.2).

Table 2: Top 10 Suppliers of EU in textiles (million €)

	2005	2006	2007	2008	Share	% growth 2005/2008
Extra-E27	18,074	19,868	20,930	19,885	100.0	10.0
China	4,081	4,885	5,451	5,613	28.2	37.5
Turkey	3,328	3,677	3,815	3,418	17.2	2.7
India	2,028	2,210	2,398	2,225	11.2	9.7
Pakistan	1,246	1,394	1,546	1,472	7.4	18.1
USA	894	987	954	924	4.6	3.4
Switzerland	935	943	982	902	4.5	-3.6
South Korea	803	737	799	676	3.4	-15.8
Japan	522	549	568	571	2.9	9.5
Taiwan	487	522	411	426	2.1	-12.6
Indonesia	387	438	459	395	2.0	2.0

Source : Eurostat http://ec.europa.eu/enterprise/sectors/textiles/statistics/ dated 24.2.2010

In the world market, Turkey ranks as the seventh largest apparel and the fifteenth largest textile exporter. Although the share of Turkey in the world's export markets is 0.82% in 2008, the share of the Turkish textile and apparel sector is 4.1%.

The employment in textile industry in Turkey is also highly important considering the opportunity given to women labor. The sector employs about 2 million people with 62 % of unregistered employment, in accordance with the research done by Ministry of Labour and Social Security. Total employment in textile sector is 13.6 % of total employment and 23.6 % of manufacturing industry.

Recently, Turkey has emerged as a machine maker and the Turkish machinery industry has recorded a substantial export performance between 2002 and 2008 and reached to 8 % share in Turkey's total export in 2009. Textile machinery exports have an upward trend between 2002 and 2008 with a share of 3.2 % in total machinery exports.

As more capital intensive industry as compared to clothing industry, most of the companies in the sector is medium scale. The industry has also large scale companies having integrated production facilities. There are nearly 7500 textile manufacturers producing for the textile export of Turkey. The production facilities mainly concentrated in İstanbul, İzmir, Denizli, Bursa, Kahramanmaraş, Gaziantep.

The products of textile industry are used as raw material input in manufacturing of wearing apparel and dressing such as furring, tela, label, ekstrafor, sewing cotton, etc. So, 53 % of total cost (45 % from fabric, 8 % from accessories) of wearing apparel and dressing comes from the textile industry. This enforces the importance of textile industry for the other manufacturing industries.

1.3 Problem Statement

Estimation of the production technology is not elaborated much in Turkey. The applications are usually in terms of the productivity measures, such as Saracoglu and Suiçmez (2006), efficiencies, such as Çakmak, Dudu and Ocal (2008) and business management, such as Yılmaz and Baral (2009). There are very few studies especially when manufacturing industry is considered. The only relevant study on this issue that the author could find is the one performed by IŞIK and ACAR (2005) who estimated the production function for manufacturing and textiles industries. Therefore an estimation of the production technology for manufacturing industry will be of utmost importance.

When the input-output table of 2002 is examined, it is seen that there are 21 sub industries within the manufacturing sectors. Among these, textile industry has the second largest share (15.06 %) in value added (Table.1). Besides, Turkey is the second largest textile supplier (after China) of the European Union (Table.2). In addition, the share of Turkish textile and apparel sector in the world's export markets is 4.1%. Furthermore, the employment in textile industry in Turkey gives the opportunity to women labor, so that there is probability of increasing the contribution of woman labor force.

Therefore, the study will concentrate on the textile manufacturing industry.

1.4 Purpose of the Study

The main objective of this study is to investigate whether the production technology for textile manufacturing industry in Turkey can be represented by a cost function or a profit function. This is performed by estimating a translog cost function and testing whether it exhibit the characteristics of it.

This is going to be a determination of the technique and will shed light on the future manufacturing industries studies.

Chapter 2

LITERATURE REVIEW

Estimation of production technology was rarely studied in Turkey. The existing studies of the estimation of production and profit function are mostly on general manufacturing industries, agricultural, iron and steel industries. On the other hand, estimation of a cost function is also found for a service industry.

The recent research on estimation of production function for textile manufacturing has been performed by IŞIK and ACAR (2005). They estimated the production function for manufacturing and textiles industries based on 1985-2001 data. They used Cobb-Douglas, CES and Translog Functional Forms in order to select the appropriate one. Supply elasticities, return to scale and substitution elasticities were obtained for these sectors. It reveals that Cobb-Douglas production function has better explanatory power in explaining the production structure of Turkish manufacturing and textile industries. The increasing return to scale factor for the textile industry was found to be higher (2.25) than for the manufacturing industry (1.62). Higher increase in output than increase in inputs indicated that there were still investment opportunities for entrepreneurs for textile industry. On the other hand, estimated production function showed that the effect of capital to output is higher than the effect of labor, although the textile industry is relatively labor intensive. So, IŞIK and ACAR (2005) concluded that more capital intensive investment is required in textile industry.

Çiçek, Günlü and Tandoğan (2009) showed the factors affecting profits in commercial egg production, by multiple regression analysis and estimated the production function. They used the profit function model to estimate factors affecting profit per kg egg in laying period and evaluate whether the established model could be used as a practical decision support tool in the field by the producers. It has been reported that higher egg production cost and less Feed Conversion Rate value (FCR-kg feed consumed per kg eggs) depends on poor quality feed usage in production. According to the results of their multiple regression model the most important factors affecting profit are the economic items such as feed prices, labor costs, veterinary and medicine expenditures, other costs and egg sale prices. While egg price has a positive effect on profit, the mentioned costs have negative sides. Some technical factors such as FCR, mortality rate and laying percentage have a negligible effect on profit per egg/kg.

Hanedar et all. (2006) studied the relationship between the real wage and labor productivity on long run profit maximization in the Turkish manufacturing sector, over the period 1950 to 2001. They used the annual data of real wage and labor productivity in the Turkish manufacturing sector, to get the regression analysis for profit maximization. They investigated whether the long-run equilibrium implied by profit maximization or not for the Turkish manufacturing industry. They recognized that the co-integration relationship between real wage and productivity in Turkish manufacturing sector failed. In the studied period, Turkey faced with increasing labor productivity and decreasing real wages, for this reason, a rupture occurred between wage and productivity in Turkish manufacturing sector. They showed how policy implementations and the 1980s as a period affect the long run relationship and parameters.

Efficiency and technical progress in manufacturing industries in Turkey is measured by Saatçi and Yardımcı (1998). Cement industry and iron and steel industry were taken as sample. The Cobb-Douglas and translog production functions were estimated, using the panel data between 1987-1992, in iron and steel industry. It was shown that constant return to scale exists in both industries and elasticity of capital is too low. They also found out the rate of technical progress around 2 % in those manufacturing sectors. The efficiency was changing according the firms, 20 % of enterprises were working with 80 % efficiency whereas the efficiency of 20-30 % the firms were very low.

Çalışkan (2006) estimated a translog cost function for 84 hospitals governed by Ministry of Health in order to see whether there is ‘economies of scope’ or not. The dependent variable, the total variable cost, was defined as the total expenditure on labor, drugs-supplies. Hospital outputs were represented by the number of outpatient visits of discharged and of total patient days. The study used personnel, drugs-supplies as variable inputs. Calculation carried out the output pairs revealed that economies of scope were present for outpatient visits and discharges. Hospitals do not seem to gain efficiencies from the joint production of outpatient visits an inpatient days.

As it is seen from the above examples, the research on estimation of production technology is very limited in Turkey. But there are good researches from other countries. For example, Kumbhakar and Tsionas (2008) estimated both translog cost and profit functions. They stated that the dual cost and profit function formulations explicitly assume that producers either minimize cost or maximize profit. They used 23 US airlines over the period 1971-1986, with the inputs labor, capital, materials and fuel. They found that the profit maximizing model was rejected by the data. Mean technical inefficiency was realized as 3.25%. Evidence of technical progress (cost diminution) was found with the increasing returns to scale for the airline industry.

Asche, Kumbhakar, and Tveteras (2007) studied to see whether the production technology should be represented by a cost or profit function. The data of Norwegian salmon aquaculture farms for the period 1985-1995 is used with three inputs; feed, capital and labor. The data failed to reject the cost function specification, thereby meaning that for the farmed salmon industry in Norway, endogeneity of output was not an issue. This does not, however, mean that the salmon farmers are not profit maximizers It also showed how to derive elasticities associated with the long run profit function from an estimated cost function. There might be high adjustment cost in producing output consistent with the P=MC rule.

The empirical literature on estimation of production technology mostly focuses on estimation of dual cost functions, as indicated by Asche, Kumbhakar and Tveteras (2007). For example, Filippini and Zola (2005) estimated a Cobb-Douglas cost function for a sample of 47 Swiss postal offices for the year 2001 and figured out the existence of economies of scale, suggesting that efficiency gains could result from merging smaller postal offices operating in the same service area or in small adjacent service area. The merger would generate cost advantages only if the two postal offices integrate some collecting, processing and distributing functions so as to act as a single postal office. The outcome of the analysis showed that approximately 50% of the postal offices operate close to the regional standard for efficiency, achieving scores of 12% or lower, in terms of cost difference in relation to the best-practice technology.

Truett and Truett (1998) examined the data of the Mexican nonelectrical machinery industry for the period 1970-1992, and estimated the translog cost function. The translog approach allowed the researchers to determine the nature of input substitution in the industry, to assess the impact of technological change on cost, and to determine input direct and cross price elasticities of demand. There was evidence that the industry exhibited economies of scale but that technological change has not significantly affected cost. Direct demand elasticities were negative and less than one for all inputs (capital, labor, and intermediate goods), but capital displays a higher price elasticity of demand than labor or intermediate goods.

A number of translog and Cobb-Douglas frontier production models were estimated for the Bangladesh handloom textile industry to investigate its production technology and technical efficiency in production by Jaforullah (1999). He used the data of 1990 census report on the Bangladesh handloom textile industry for 64 regions on value added, denoted by Q, number of persons engaged, denoted by L, and value of capital stock, denoted by K including factory house and related structures, and other assets used in weaving which were expected to have a productive life of more than a year. It was found that the technical efficiency of the industry in producing cloth was only 41%. It was concluded that the industry might improve its technical efficiency by increasing its male/female labour ratio and yarn/capital ratio and decreasing its hired/family labour ratio and labour/capital ratio. The production technology of the industry was found to be characterized by a linearly homogeneous Cobb-Douglas function. The elasticity of substitution between labour and capital for the industry was found to be unity.

Another translog cost function estimation was performed by Azeez (2001), for the Indian non-electrical machinery manufacturing sector over the period 1974-1996. A translog short-run variable cost function was used to estimate the output where the short run average total cost is minimized. He found out that optimal output and input prices had a positive relation in the case of all the three variable inputs (price of labor, price of fuel, price of material). The potential output elasticities with respect to input prices, averaged through the whole period, were 0.017, 0.010 and 0.053 respectively for labor, fuel and material prices. Therefore he suggested the possibility of complementarity between these inputs and capital.

On the other hand, there are also some studies on profit function estimations, not common though. Kam and Lin (2002) developed the translog profit function for the Taiwan's hog production. They used the data of 149 hog farm samples to analyze the effect of pollution on the hog industry.

In Taiwan, the current stage of hog production release substantial amount of polluted water and animal excrement to the nearby rivers and the sewage system which damages the environment, and becomes a public concern. Duality theory was utilized to develop a translog profit function including one output (hog), three variable inputs (labor, fodder, and piglet), and four fixed inputs (capital, farm size, location, and pollution cost). The factors of corn and soybean imports are introduced to examine the impacts of pollution costs internalization on Taiwan's hog production, input demand, and cereal imports, respectively. If the government adopts a policy to internalize the pollution cost, Taiwan's hog supply will decrease by 1.60%. The demands for labor, fodder and piglets will decrease by 4.18%, 1.44%, and 1.39%, respectively. The low demand for fodder induces importation of corn and soybean decreased by 1.58% and 1.43%, respectively.

Kumbhakar and Lozano-Vivas (2004) demonstrated the profitability relation with mark-ups using a panel data on Spanish savings banks covering the period 1986-1999. They investigated competitiveness in the output markets in the Spanish banking industry and found out that the pricing behavior does not strongly influence profitability unless the other influences are controlled for. The empirical results showed that the mark-ups on outputs (deposit services and loans) have declined over time. The mark-up in the deposit market appears to be higher than the loan market, suggesting that the loan market has a more competitive environment than the deposit service market.

Another profit function approach is applied in the study of Kumbhakar (2002). An analytical framework is provided to measure and decompose total factor productivity growth into technical change and economies of scale. As he stated, producers take output(s) as given. While this is the case for some industries (e.g. electricity, telecommunication, etc.), for majority of the producers' output is not given. The producers choose input and output quantities based on some behavioral assumptions. The most popular approach for input and output choice is based on the assumption that producers are profit maximizers. Thus, he used a profit function approach to analyse productivity growth and decompose total factor productivity.

Chapter 3

METHODOLOGY

A translog cost function is estimated to find out whether the data for textile industry in Turkey is appropriate for cost minimization or profit maximization. The following variables are used and the estimation is done with the Ordinary Least Square (OLS) method, using E-views program. The estimated system is a cost system with;

- a translog cost function
- three input share functions, and an output share function, and
- a function implying profit maximization condition.

The variables in the estimated system are:

COST: total cost of input (TL) q: output (TL)

w: labor cost (TL) t: time trend

v: total power capacity (TL) (approximated as capital cost)

p: price of oil (TL)

After the estimation is done, the results are tested by using the Schankerman and Nadiri test (1986), in order to verify the decision whether data fit for the production technology where producers are in fact profit maximizers.

The quarterly data of the variables are collected from the Turkish Statistical Institute, for the period of 1988 to 2008.

The logarithm forms of the variables are considered. The advantage of this functional form is that it will give the elasticities directly. On the other hand, some loglikelihood tests are performed in order to test the redundancy.

3.1 Data Description

It is not easy to find a detailed data for all the variables. There are missing data for the year 2002 due to the overall change in the collection of data in accordance with EU regulations. Therefore, the data for 2002 are estimated from the growth trend of previous 14 years. Data covers the total amount of values from the government as well as from the private companies. 1987 based Consumer Price Index (CPI) is used to get the real values of data. In addition, the data is deseasonalized before the estimation in the E-views, in order to remove the seasonal effects.

Total Power Capacity in the Turkish textile industry is used for the price of capital (v) values, for the years 1988-2001. Due to the major change in collecting data after year 2002, this data is no more collected, instead the gross investment in tangible goods are used. Price of labor (w) is taken from the cost of labor data in the textile industry. This covers the wages as well as social security costs. The third input data is taken as price of oil (p), since it is one of the major effects to all kind of costs. Time dummy variable (t) is also used to be able to reflect the technological changes, if any.

In order to visualize how the data changes per time, graphical representations of each variable are given in Figure.1, below.

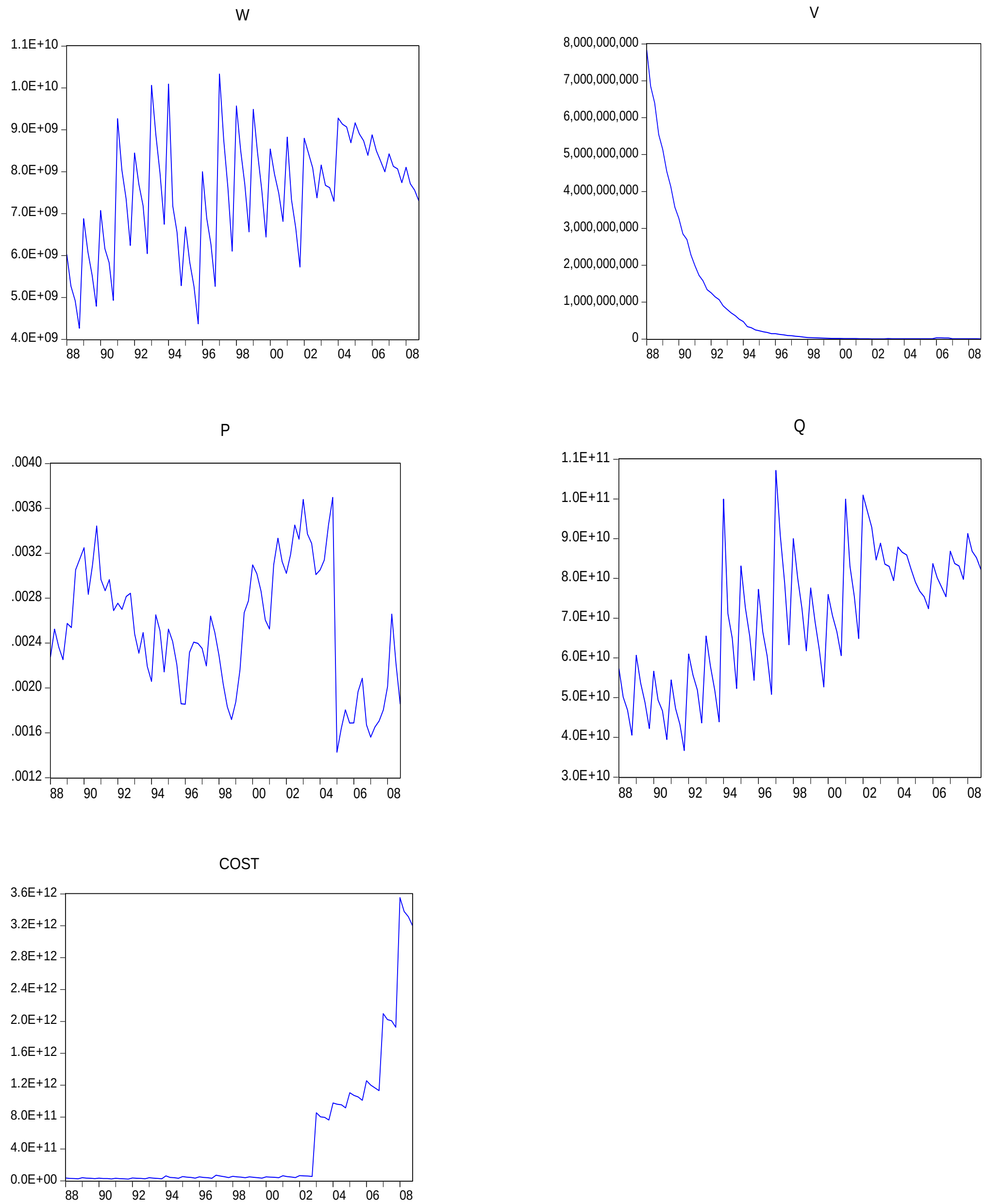

Figure 1: The change of the dependent/independent variables per time

3.2 Difficulties in the Data

The data is obtained from TURKSAT for the whole textile industry as private and public, for the period 1988.Q1-2008Q4. Nevertheless, there are some missing data for the year 2002 except for price of oil and consumer price index. This is because of the procedural change in collecting data, in accordance with EU regulations. So this data is calculated from the trend between 1988 and 2001, using the general growth equation. $Y_t = Y_0(1+r)^n$,

where Y_t is the value at 2002, Y_0 is the value at 1988, r is the growth rate between these years and n is the number of variables.

Moreover, for the data price of capital (v), total power capacity is not a collected data any more, after 2002. So the most convenient data of gross investment in tangible goods is used in the estimations.

1987 based monthly Consumer Price Index (CPI) is used to find the real values of costs, for the years 1988-2005. It is converted to quarterly by taking averages of each three months. Data for the rest of the years (2005-2008) is taken from the 2003 based year CPI and conversion is performed between the base years. The same change in the quarterly data of 2003 based CPI is used to calculate the change in quarterly data of 1987 based CPI.

Data for the price of oil input (p) is a complete quarterly data including value added tax in it. For the data of cost of capital (v), it can be told that the real value of capital cost decreases although the nominal capital investment increases each year.

3.3 Model Specification

It is assumed the data of Turkish textile industry is represented by translog cost function as indicated in eq.1. This is derived from a cost function with the imputed output value giving the profit maximization condition, theoretically. In the following steps, this condition is going to be tested. The translog cost function specification that also incorporates technical change is specified as follows:

$$\begin{aligned} \ln COST = {} & \beta_1 \ln w + \beta_2 \ln v + \beta_3 \ln p + \beta_4 t + \beta_5 \ln q \\ & + 0.5\beta_{11}(\ln w)^2 + 0.5\beta_{22}(\ln v)^2 + 0.5\beta_{33}(\ln p)^2 + 0.5\beta_{44}(t)^2\, 0.5\beta_{55}(\ln q)^2 \\ & + \beta_{12}\ln w * \ln v + \beta_{13}\ln w * \ln p + \beta_{14}\ln w * t + \beta_{23}\ln v * \ln p + \beta_{24}\ln v * t + \beta_{34}\ln p * t \\ & + \beta_{1q}\ln w * \ln q + \beta_{2q}\ln v * \ln q + \beta_{3q}\ln p * \ln q + \beta_{4q} t * \ln q + \varepsilon_0 \end{aligned} \quad \text{(eq.1)}$$

where, COST: total cost of input (TL) q: output (TL)

w: labor cost (TL) t: time trend

v: total power capacity (TL)

p: price of oil (TL)

Then, some Likelihood Ratio Tests are performed in order to check whether the data corresponds to this model. So, it is examined if the contribution of some of the included variables is jointly statistically significant or not.

3.4 Methodology Steps

3.4.1 Hypothesis Testing

The representation of the data for Turkish textile industry is assumed to be a translog cost function and it is estimated. In order to check whether this assumption is correct, a number of hypothesis tests are executed. All tests are performed at the 5 % significance level and the results are given in the Table 3, as a summary.

The null hypothesis, H_0: the additional variables are not jointly significant (β coefficients are zero)

The alternative hypothesis, H_1: unrestricted model

Firstly, the model is tested for a Cobb-Douglas function, by taking all cross terms as zero (all $\beta_{ij} = 0$). Second, Hicks-neutral technical change is also tested. Then, with the third hypothesis 'No technical change' is analyzed. Lastly, the Cobb-Douglas function with no technical change is tested. For all tests, it is checked for the statistically significance of the variables.

3.4.2 Schankerman And Nadiri Test

In the main model it is assumed that the producers in the textile industry are profit maximizer, the input prices and output are taken as exogenously given and they try to minimize their cost. Now it is tested whether the output is exogenous or not.

In our context, the Schankerman and Nadiri test is equivalent to Hausman test and can be performed as a two stage test. Here, we use the version of the Hausman (1978) test proposed by Davidson and MacKinnon (1989, 1993), which carries out the test by running an auxiliary regression. To carry out the Hausman test by artificial regression, we run two OLS regressions. In the first regression, we regress the log of the output variable q on all exogenous variables and instruments and retrieve the residuals from this regression. That is, the output is regressed against all inputs and their cross terms. Then in the second regression, we re-estimate the translog cost function including the residuals from the first regression as additional regressors. If the OLS estimates are consistent, then the coefficient on the first stage residuals should not be significantly different from zero.

3.4.3 Cost Shares

Since the cost of all three inputs and the total cost are known so that cost shares can be calculated. The genaral equation can be given;

$$S_i = \frac{c_i}{C} \quad \text{where } i = w, v, p, q \qquad \text{(eq.2)}$$

3.4.4 Input Demand Elasticities

In this study, it is tried to be found also the long-run input and output elasticities (derived from the shares) with the following equations:

$$e_{ip} = \frac{\beta_{iq} S_q}{S_i(\beta_{qq} + S_q^2 - S_q)} \qquad \text{(eq.3)} \quad \text{and} \quad e_{qp} = \frac{S_q}{(\beta_{qq} + S_q^2 - S_q)} \qquad \text{(eq.4)}$$

$$e_{qi} = -\frac{\beta_{iq}}{(\beta_{qq} + S_q^2 - S_q)} \qquad \text{(eq.5)} \quad \text{and} \quad e_{qj} = -\frac{\beta_{jq}}{(\beta_{qq} + S_q^2 - S_q)} \qquad \text{(eq.6)}$$

where β_{iq} is the coefficients of three inputs in the main model: $\beta_{wq}, \beta_{vq}, \beta_{pq}$. All β_{ii} and β_{qq} values are twice of their estimated values because they are in the form of multiplication with 0.5, as it is seen in eq.01.

The short-run input demand elasticities from the main model of translog cost function (eq.1) can be calculated;

$$\eta_{ii} = \frac{\beta_{ii}}{S_i} + S_i - 1 \quad \text{(eq.7)} \quad \text{and} \quad \eta_{ij} = \frac{\beta_{ij}}{S_i} + S_j \quad \text{(eq.8)}$$

Then, the price elasticities associated with the long run factor demand functions are to be found as follows:

$$e_{ii} = \eta_{ii} + \frac{e_{qi} e_{ip}}{e_{qp}} \quad \text{(eq.9)} \quad \text{and} \quad e_{ij} = \eta_{ij} + \frac{e_{qj} e_{ip}}{e_{qp}} \quad \text{(eq.10)}$$

Chapter 4

RESULTS AND DISCUSSION

In this chapter, first the results are presented and evaluated and then, all findings are summarized.

4.1 Estimation Results

In this study, translog cost function (eq.1) is estimated in order to find out the representation of Turkish textile industry. The coefficients of the estimated function are given in Table.6. Estimated translog cost function with technical change under profit maximization assumption can be represented as follows:

LNCOST = 520.826907305*LNW + 42.4772877081*LNV + 229.324634368*LNP + 1.26185310392*T + 85.3494427558*LNQ - 2.4978506961*LNWSQ - 0.395516901512*LNVSQ + 1.12579396666*LNPSQ - 0.00580561499641*TSQ + 3.08195590641*LNQSQ - 3.50953376609*LNWLNV - 3.30849710292*LNWLNP - 0.177855463539*LNWT + 0.111202768297*LNVLNP - 0.0914227597838*LNVT + 0.0815443972768*LNPT - 14.2889277155*LNWLNQ + 2.31882524869*LNVLNQ - 5.85880060227*LNPLNQ + 0.226245235612*TLNQ - 6710.24855492.

This functional form is tested whether the data confirms this hypothesis and the results are summarized in Table.3. The details corresponding to hypothesis tests can be found through Tables 7-10 and the summary is given below Table 4.

Testing of the model for a Cobb-Douglas function, by taking all cross terms as zero (all $\beta_{ij} = 0$) reveals that null hypothesis is rejected, saying that all cross terms jointly statistically significant, and the results are shown in Table 7. The results of Hicks-neutral technical changes are given in Table.8. Rejection of null hypothesis shows that the interaction terms of technical change are statistically significant.

Then, with the third hypothesis 'No technical change', it is observed that the null hypothesis is rejected, indicated in Table.9. This reveals that the model requires 'T' term as it captures the technological change in the production function. Lastly, the Cobb-Douglas function with no technical change, given in Table.10 shows that again 'T' term and all interaction terms are required for better explanation of the dependent variable, which is the total cost of inputs.

Therefore the results support the representation of the translog cost function for the Turkish textile industry.

It is found that time trend 't' indicating the technology change in the textile industry and all interaction terms are required for better explanation of the total cost of inputs. Therefore the results reveals that the textile industry can be explained better by a translog cost function than a Cobb-Douglas function with or without technological term.

Table 3: Summary of Hypothesis Test Results

Null Hypothesis	Log Likelihood	Test Statistic	Critical Value	Decision
Translog cost fn. with Hicks-neutral technical change $(\beta_{14} = \beta_{24} = \beta_{34} = \beta_{4q} = 0)$	-25.89696	167.5248	2.53	Reject H_0
Translog cost fn. with Hicks-neutral no technical change $(\beta_{14} = \beta_{24} = \beta_{34} = \beta_{4q} = \beta_4 = \beta_{44} = 0)$	-99.41034	314.5515	2.37	Reject H_0
Cobb-Douglas cost fn. with technical change (all $\beta_{ij} = 0$)	-47.61879	210.9684	1.84	Reject H_0
Cobb-Douglas cost fn. with no technical change (all $\beta_{ij} = 0$) and $\beta_4 = 0$)	-131.0860	377.9029	1.86	Reject H_0

The producers in the textile industry are taken as profit maximize and the input prices and output are taken as exogenously given. Then, it is tested whether the output is exogenous or not, with the Schankerman and Nadiri (1986) Test. The result of the regression of output is given in Table.11 and that of the main model with an additional regressor of the residual is given in Table.12.

Table 4: Translog Cost Function Estimation Results

		Translog with Hicks-neutral technical change		Translog with Hicks-neutral no technical change		Cobb-Douglas cost fn. with technical change		Cobb-Douglas cost fn. with no technical change	
Variable	Parameter	Coefficient	t-ratio	Coefficient	t-ratio	Coefficient	t-ratio	Coefficient	t-ratio
Constant	c	-5480.408	-1.230	-16336.30	-1.566	-14.93311	-0.886	-17.27434	-0.650
LNW	β_1	174.1985	0.673	-324.1409	-0.538	-0.466477	-1.107	1.120587	0.993
LNV	β_2	13.53138	0.605	122.9189	2.487	0.953560	13.198	-0.383243	-4.995
LNP	β_3	-142.1084	-1.230	414.6623	1.698	0.341313	1.447	-1.737593	-2.935
T	β_4	-0.078794	-0.912			0.140141	22.160		
LNQ	β_5	235.6882	1.122	1606.598	3.518	0.632202	1.269	2.462116	1.868
LNWSQ	β_{11}	1.379687	0.426	11.70456	1.569				
LNVSQ	β_{22}	-0.085021	-1.186	-0.070056	-0.772				
LNPSQ	β_{33}	3.844004	3.224	3.026014	1.189				
TSQ	β_{44}	0.001739	2.515						
LNQSQ	β_{55}	-0.602649	-0.151	-30.77811	-3.666				
LNWLNV	β_{12}	-0.937797	-1.295	-0.225171	-0.132				
LNWLNP	β_{13}	2.502179	0.906	10.40074	1.849				
LNWT	β_{14}								

LNVLNP	β_{23}	0.499605	1.384	-0.594313	-0.751				
LNVT	β_{24}								
LNPT	β_{34}								
LNWLNQ	β_{1q}	-8.164601	-1.285	-5.473846	-0.365				
LNVLNQ	β_{2q}	0.572852	0.927	-4.768001	-3.842				
LNPLNQ	β_{3q}	4.951411	1.395	-24.20734	-3.251				
TLNQ	β_{4q}								
Log-likelihood		-25.89696		-99.41034		-47.61879		-131.0860	

4.1.1 Schankerman and Nadiri Test Results

The result of output regression against the inputs and their cross terms is given in Table.11. That is the first stage of Schankerman and Nadiri test. Then the second regression's results can be seen in Table 12, which is the re-estimation of the translog cost function including the residuals from the first regression as additional regressors.

In Table.12, it is seen that t-statistics of variable 'resid01test' is not statistically significant. This result reveals that the output is not an endogenous variable. Hence the producers are not profit maximizers but cost minimizers in the Turkish textile industry.

4.1.2 Results of Cost Shares

After realizing the output is not an endogenous variable for the Turkish textile industry, corresponding input and output cost shares are evaluated. The input and output cost shares are calculated in accordance with eq.2, can be examined through the Table.13.

Hence, the input shares are found as 13.17 % for labor cost, 2.79 % for capital cost, 4.94×10^{-12} % for the input oil price. The output share 115.37 % indicates that the textile industry shows an increasing return to scale.

4.1.3 Results of Elasticities

Price elasticities of demand are aimed to be found through eq.9 and 10. Firstly, it is necessary to find e_{ip} and e_{qp} by using eq.3 and eq.4.

The coefficients of three inputs in the main model $\beta_{wq}, \beta_{vq}, \beta_{pq}$ can be found from the Table.6, as the following:

$\beta_{wq} = \beta_{1q} = -14.28893$, $\beta_{vq} = \beta_{2q} = 2.318825$, $\beta_{pq} = \beta_{3q} = -5.858801$

All β_{ii} and β_{qq} values are found to be form the results of eq.1 therefore;

$\beta_{11} = \beta_{ww} = -4.995702$, $\beta_{22} = \beta_{vv} = -0.791034$, $\beta_{33} = \beta_{pp} = 2.251588$, $\beta_{55} = \beta_{qq} = 6.163912$

If those values are substituted into the elasticity equations, price elasticities of inputs are found to be (from eq.3);

$$e_{ip} = e_{wp} = \frac{\beta_{wq} S_q}{S_w(\beta_{qq} + S_q^2 - S_q)} = \frac{-14.28893 * 1.1537}{0.1317(6.163912 + (1.1537)^2 - 1.1537)} = -19.7393537$$

$$e_{ip} = e_{vp} = \frac{\beta_{vq} S_q}{S_v(\beta_{qq} + S_q^2 - S_q)} = \frac{2.318825 * 1.1537}{0.0279(6.163912 + (1.1537)^2 - 1.1537)} = 15.1210785$$

$$e_{ip} = e_{pp} = \frac{\beta_{pq} S_q}{S_p(\beta_{qq} + S_q^2 - S_q)} = \frac{-5.858801 * 1.1537}{4.94 * 10^{-12}(6.163912 + (1.1537)^2 - 1.1537)} = -2.1577484 * 10^{11}$$

Then, the elasticity of output is (from eq.4);

$$e_{qp} = \frac{S_q}{(\beta_{qq} + S_q^2 - S_q)} = \frac{1.1537}{6.163912 + (1.1537)^2 - 1.1537} = 0.181936$$

From eq.5 and 6;

$$e_{qw} = -\frac{\beta_{wq}}{(\beta_{qq} + S_q^2 - S_q)} = -\frac{-14.28893}{(6.163912 + (1.1537)^2 - 1.1537)} = 2.25334$$

$$e_{qv} = -\ \frac{\beta_{vq}}{(\beta_{qq} + S_q^2 - S_q)} = -\ \frac{2.318825}{(6.163912 + (1.1537)^2 - 1.1537)} = -\ 0.36567$$

$$e_{qp} = -\ \frac{\beta_{pq}}{(\beta_{qq} + S_q^2 - S_q)} = -\ \frac{-5.858801}{(6.163912 + (1.1537)^2 - 1.1537)} = 0.92392$$

The short-run input demand elasticities from the main model of translog cost function (eq.1);

$$\eta_{ii} = \frac{\beta_{ii}}{S_i} + S_i - 1 \quad \text{(eq.7)} \quad \text{and} \quad \eta_{ij} = \frac{\beta_{ij}}{S_i} + S_j \quad \text{(eq.8)}$$

$$\eta_{ww} = \frac{\beta_{ww}}{S_w} + S_w - 1 = \frac{-4.995702}{0.1317} + 0.1317 - 1 = -38.80074$$

$$\eta_{vv} = \frac{\beta_{vv}}{S_v} + S_v - 1 = \frac{-0.791034}{0.0279} + 0.0279 - 1 = -29.32457$$

$$\eta_{pp} = \frac{\beta_{pp}}{S_p} + S_p - 1 = \frac{2.251588}{4.94 * 10^{-12}} + 4.94 * 10^{-12} - 1 = 4.55787 * 10^{11}$$

$$\eta_{wv} = \frac{\beta_{wv}}{S_w} + S_v = \frac{-3.509534}{0.1317} + 0.0279 = -26.62004$$

$$\eta_{wp} = \frac{\beta_{wp}}{S_w} + S_p = \frac{-3.308497}{0.1317} + 4.94 * 10^{-12} = -25.12147$$

$$\eta_{vp} = \frac{\beta_{vp}}{S_v} + S_p = \frac{0.111203}{0.0279} + 4.94*10^{-12} = 3.98578$$

Then, the price elasticities associated with the long run factor demand functions are as follows;

$$e_{ii} = \eta_{ii} + \frac{e_{qi}e_{ip}}{e_{qp}} \quad \text{(eq.9)} \quad \text{and} \quad e_{ij} = \eta_{ij} + \frac{e_{qj}e_{ip}}{e_{qp}} \quad \text{(eq.10)}$$

$$e_{ww} = \eta_{ww} + \frac{e_{qw}e_{wp}}{e_{qp}} = -38.80074 + \frac{2.25334*(-19.7393537)}{0.181936} = -283.27943$$

$$e_{vv} = \eta_{vv} + \frac{e_{qv}e_{vp}}{e_{qp}} = -29.32457 + \frac{-0.36567*15.1210785}{0.181936} = -59.71616$$

$$e_{pp} = \eta_{pp} + \frac{e_{qp}e_{pp}}{e_{qp}} = 4.55787*10^{11} + \frac{[0.92392*(-2.1577484*10^{11})]}{0.181936} = -6.39976*10^{11}$$

From eq.10;

$$e_{wv} = \eta_{wv} + \frac{e_{qv}e_{wp}}{e_{qp}} = -26.62004 + \frac{(-0.36567)(-19.7393537)}{0.181936} = 13.05374$$

$$e_{wp} = \eta_{wp} + \frac{e_{qp}e_{wp}}{e_{qp}} = -25.12147 + \frac{(0.92392)(-19.7393537)}{0.181936} = -125.36322$$

$$e_{vp} = \eta_{vp} + \frac{e_{qp}e_{vp}}{e_{qp}} = 3.98578 + \frac{(0.92392)(15.1210785)}{0.181936} = 80.77469$$

4.2 Discussion of Findings

In the estimated model (eq.1), positive value of coefficients of input as it is expected. As the labor cost, capital cost and price of oil increase total cost of inputs increases. The individual significance of t-statistics demonstrate that the coefficients of labor cost and oil price are significant within 1 % significant and cost of capital is found to be significant within 10 %.

The study uses the translog cost function to be estimated and the results are checked with some hypothesis tests. It is tested by omitting some of the independent variables and analyzed if those are jointly statistically significant. Cobb-Douglas function is found to be not appropriate when taking all cross terms as zero, showing the all cross terms are jointly statistically significant. The interaction terms of technical change are found also statistically significant, leading the technical change term as significant. This is expected because one of the important factors in the manufacturing industry is the technical change. Hence, the data in the Turkish textile industry can be explained by the estimated translog cost function.

Since the OLS method is used for the estimation, it is necessary to check the violations of the classical assumptions of OLS method.

The data used in this study is a time series data, so normally autocorrelation problem in the data is expected. Firstly, Durbin-Watson statistics (DW) in the OLS regression result can be checked. For the estimated translog cost function DW value can be seen as 1.380718 in Table.1.

The null hypothesis is H_0: no autocorrelation

The alternative one is H_1: autocorrelation exists

At 5 % level of significance, k'=20 (# of explanatory variable), n=84

d_L= 1.121 d_U= 2.241

It can be seen that it is in the 'indeterminate zone'. Therefore, Breusch-Godfrey Serial Correlation LM Test is performed for this indefinite case and the result is given in Table.14. 'Obs*R-squared' value of the estimation of translog cost function shows that there is no autocorrelation (the p-value indicates it is insignificant, 0.0103).

Since the data is time series data, normally Heteroscedasticity problem is not expected. Yet, it is also checked. The White test is used to find out if the error variance is heteroscedastic or not.

The null hypothesis is H_0: Homoscedasticity

The alternative one is H_1: Heteroscedasticity

As it is seen on the Table.15, probability value of Obs*R-squared variable is quite high, indicating that they are significant (19.06 %) . This means that, one can not reject the null hypothesis; hence there is no Heteroscedasticity in the data. So the error variance is homoscedastic.

It is known that the multicollinearity is a feature of the sample, not of the population; we do not ‘test for multicollinearity’ but can, measure its degree in any particular sample, as expressed by Gujarati (2003).

As it is seen in the Table.1 there is high R^2 with several insignificant β values. Hence the multicollinearity is expected. There seems to be multicollinearity assumption is violated, nevertheless, is not corrected. Assumption on the homoscedastic error term, on the other hand, is found to be hold in this study.

Chapter 5

CONCLUSION

In this study, production technology for Turkish textile industry is examined. Textile industry has the second largest share in value added within the manufacturing sector. Total employment and opportunity given to women labor in the textile industry are also very important factors to be considered. As the production technology is well determined and applied by producers or policy makers, contribution to the economics and welfare of the society will increase.

In order to determine the production technology, the data in Turkish textile industry is examined whether it can be represented by a cost function or profit function. A translog cost function is estimated considering input and output share functions and profit maximizing condition. OLS method is used to find out the coefficients of the function. Hypothesis testing such as Likelihood Ratio Tests are performed in order to check whether the data fits to the model which is estimated. By checking the jointly statistically significance of the variables, it is understood that data corresponds to the estimated translog cost function.

On the other hand, in order to confirm production technology comes from the profit maximization condition, Schankerman and Nadiri test (1986) is performed. This test allows the user to find out the endogeneity of the variable. Hence, the study demonstrates the output is not an endogeneous variable. However, this result does not imply that producers in Turkish textile industry are not profit maximizer. It can be concluded that the related production technology has the cost minimization specifications.

In this study, input and output cost shares are also calculated. 13.17 % for labor cost, 2.79 % for capital cost, 4.94×10^{-12} % for the input oil price are recognized. The output share is found to be greater than 1, (1.15) illustrates that textile industry exhibits an increasing return to scale. This reveals that the firms in the textile industry can still increase their inputs to get more output. This result is compatible with the previous study of Işık and Acar (2005) who found also Turkish textile industry exhibits an increasing return to scale having a factor of 2.25 for the period 1985-2001. With the cost share result of oil price, it can be concluded that it has not much significance on the cost of inputs.

When the price elasticicities of demand are considered, it can be concluded that all inputs demonstrate very much elastic demands which might be predictable due to the high competitive characteristics of textile industry.

For the future studies, it can be suggested that some other inputs can be included in the analysis. Because total amount of input cost shares sum up to approximately 16 %, one can add some other inputs to examine their contributions to the cost. Moreover, if the true value of real labor cost can be identified and used in the studies it can generate better result. By this way, the high unregistered employment such as 62 % in the textile manufacturing can be taken into account.

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APPENDICES

Appendix A: Textile Manufacturing Tables

Table 5: Export Shares of Textile Manufacturing

Year	Economic Activity		Value 000 $	% share of textile in total export
2007		Toplam	107 271 750	
	D	İmalat	101 081 873	
	17	Tekstil Ürünleri	10 804 633	10.1
2006		Toplam	85 534 676	
	D	İmalat	80 246 109	
	17	Tekstil Ürünleri	9 265 791	10.8
2005		Toplam	73 476 408	
	D	İmalat	68 813 408	
	17	Tekstil Ürünleri	8 742 704	11.9
2004		Toplam	63 167 153	
	D	İmalat	59 579 116	
	17	Tekstil Ürünleri	7 998 061	12.7
2003		Toplam	47 252 836	
	D	İmalat	44 378 429	
	17	Tekstil Ürünleri	6 841 165	14.5
2002		Toplam	36 059 089	
	D	İmalat	33 701 646	
	17	Tekstil Ürünleri	5 532 758	15.3
2001		Toplam	31 334 216	
	D	İmalat	28 826 014	
	17	Tekstil Ürünleri	4 943 497	15.8
2000		Toplam	27 774 906	
	D	İmalat	25 517 540	
	17	Tekstil Ürünleri	4 614 078	16.6
1999		Toplam	26 587 225	
	D	İmalat	23 957 813	
	17	Tekstil Ürünleri	4 557 626	17.1
1998		Toplam	26 973 952	
	D	İmalat	24 064 586	
	17	Tekstil Ürünleri	4 794 000	17.8
1997		Toplam	26 261 072	
	D	İmalat	23 312 800	
	17	Tekstil Ürünleri	4 450 117	16.9

(data is taken from TurkStat -foreign trade statistics)

Appendix B: E-Views Outputs of Estimations

Table 6: Estimation Results for the main model

Dependent Variable: LNCOST
Method: Least Squares
Date: 06/16/10 Time: 08:26
Sample: 1988Q1 2008Q4
Included observations: 84

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNW	520.8269	107.8139	4.830796	0.0000
LNV	42.47729	23.73222	1.789857	0.0783
LNP	229.3246	49.75908	4.608699	0.0000
T	1.261853	2.877057	0.438592	0.6625
LNQ	85.34944	80.51387	1.060059	0.2932
LNWSQ	-2.497851	1.581455	-1.579463	0.1192
LNVSQ	-0.395517	0.047154	-8.387825	0.0000
LNPSQ	1.125794	0.487072	2.311348	0.0241
TSQ	-0.005806	0.000621	-9.355300	0.0000
LNQSQ	3.081956	1.561414	1.973824	0.0528
LNWLNV	-3.509534	0.585846	-5.990544	0.0000
LNWLNP	-3.308497	1.291610	-2.561529	0.0128
LNWT	-0.177855	0.064114	-2.774061	0.0073
LNVLNP	0.111203	0.200108	0.555715	0.5804
LNVT	-0.091423	0.006194	-14.76002	0.0000
LNPT	0.081544	0.015430	5.284902	0.0000
LNWLNQ	-14.28893	2.538003	-5.629989	0.0000
LNVLNQ	2.318825	0.694138	3.340581	0.0014
LNPLNQ	-5.858801	1.462690	-4.005497	0.0002
TLNQ	0.226245	0.086815	2.606056	0.0114
C	-6710.249	1710.589	-3.922770	0.0002

R-squared	0.994488	Mean dependent var	25.41308
Adjusted R-squared	0.992738	S.D. dependent var	1.646333
S.E. of regression	0.140300	Akaike info criterion	-0.877748
Sum squared resid	1.240100	Schwarz criterion	-0.270044
Log likelihood	57.86542	Hannan-Quinn criter.	-0.633456
F-statistic	568.2860	Durbin-Watson stat	1.380718
Prob(F-statistic)	0.000000		

Table 7: Translog Cobb-Douglas

Redundant Variables: LNWSQ LNVSQ LNPSQ TSQ LNQSQ LNWLNV LNWLNP LNWT LNVLNP LNVT LNPT LNWLNQ LNVLNQ LNPLNQ TLNQ

F-statistic	47.55977	Prob. F(15,63)	0.0000
Log likelihood ratio	210.9684	Prob. Chi-Square(15)	0.0000

Test Equation:
Dependent Variable: LNCOST
Method: Least Squares
Date: 06/01/10 Time: 18:08
Sample: 1988Q1 2008Q4
Included observations: 84

	Coefficient	Std. Error	t-Statistic	Prob.
LNW	-0.466477	0.421417	-1.106926	0.2717
LNV	0.953560	0.072249	13.19831	0.0000
LNP	0.341313	0.235796	1.447492	0.1518
T	0.140141	0.006324	22.16036	0.0000
LNQ	0.632202	0.498012	1.269450	0.2081
C	-14.93311	16.85426	-0.886014	0.3783

R-squared	0.932066	Mean dependent var	11.59757
Adjusted R-squared	0.927711	S.D. dependent var	1.646333
S.E. of regression	0.442642	Akaike info criterion	1.276638
Sum squared resid	15.28268	Schwarz criterion	1.450268
Log likelihood	-47.61879	Hannan-Quinn criter.	1.346436
F-statistic	214.0353	Durbin-Watson stat	0.479990
Prob(F-statistic)	0.000000		

Table 8: Hicks Neutral Technical Change

Redundant Variables: LNWT LNVT LNPT TLNQ

F-statistic	99.97107	Prob. F(4,63)	0.0000
Log likelihood ratio	167.5248	Prob. Chi-Square(4)	0.0000

Test Equation:
Dependent Variable: LNCOST
Method: Least Squares
Date: 06/01/10 Time: 18:13
Sample: 1988Q1 2008Q4
Included observations: 84

	Coefficient	Std. Error	t-Statistic	Prob.
LNW	174.1985	258.8937	0.672857	0.5034
LNV	13.53138	22.35912	0.605184	0.5471
LNP	-142.1084	115.5177	-1.230187	0.2229
T	-0.078794	0.086372	-0.912268	0.3649
LNQ	235.6882	209.9814	1.122424	0.2657
LNWSQ	1.379687	3.240144	0.425811	0.6716
LNVSQ	-0.085021	0.071681	-1.186107	0.2398
LNPSQ	3.844004	1.192186	3.224333	0.0020
TSQ	0.001739	0.000692	2.514552	0.0143
LNQSQ	-0.602649	3.992845	-0.150932	0.8805
LNWLNV	-0.937797	0.724188	-1.294963	0.1998
LNWLNP	2.502179	2.760982	0.906264	0.3680
LNVLNP	0.499605	0.361018	1.383880	0.1710
LNWLNQ	-8.164601	6.352183	-1.285322	0.2031
LNVLNQ	0.572852	0.618147	0.926726	0.3574
LNPLNQ	4.951411	3.549174	1.395088	0.1676
C	-5480.408	4456.537	-1.229746	0.2231

R-squared	0.959498	Mean dependent var	11.59757
Adjusted R-squared	0.949826	S.D. dependent var	1.646333
S.E. of regression	0.368771	Akaike info criterion	1.021356
Sum squared resid	9.111470	Schwarz criterion	1.513307
Log likelihood	-25.89696	Hannan-Quinn criter.	1.219116
F-statistic	99.20284	Durbin-Watson stat	0.745922
Prob(F-statistic)	0.000000		

Table 9: Hicks-Neutral No Technical Change

Redundant Variables: LNWT LNVT LNPT TLNQ T TSQ

F-statistic	433.5940	Prob. F(6,63)	0.0000
Log likelihood ratio	314.5515	Prob. Chi-Square(6)	0.0000

Test Equation:
Dependent Variable: LNCOST
Method: Least Squares
Date: 06/01/10 Time: 18:16
Sample: 1988Q1 2008Q4
Included observations: 84

	Coefficient	Std. Error	t-Statistic	Prob.
LNW	-324.1409	602.9515	-0.537590	0.5926
LNV	122.9189	49.42801	2.486827	0.0153
LNP	414.6623	244.2289	1.697842	0.0940
LNQ	1606.598	456.7294	3.517615	0.0008
LNWSQ	11.70456	7.461756	1.568606	0.1213
LNVSQ	-0.070056	0.090775	-0.771760	0.4429
LNPSQ	3.026014	2.545250	1.188887	0.2386
LNQSQ	-30.77811	8.396150	-3.665741	0.0005
LNWLNV	-0.225171	1.708654	-0.131783	0.8955
LNWLNP	10.40074	5.624649	1.849136	0.0687
LNVLNP	-0.594313	0.790842	-0.751494	0.4549
LNWLNQ	-5.473846	14.99888	-0.364950	0.7163
LNVLNQ	-4.768001	1.240991	-3.842091	0.0003
LNPLNQ	-24.20734	7.445654	-3.251204	0.0018
C	-16336.30	10434.75	-1.565566	0.1220

R-squared	0.766854	Mean dependent var	11.59757
Adjusted R-squared	0.719549	S.D. dependent var	1.646333
S.E. of regression	0.871860	Akaike info criterion	2.724056
Sum squared resid	52.44960	Schwarz criterion	3.158130
Log likelihood	-99.41034	Hannan-Quinn criter.	2.898550
F-statistic	16.21082	Durbin-Watson stat	0.529303
Prob(F-statistic)	0.000000		

Table 10: Cobb-Douglas No Technical Change

Redundant Variables: T LNWSQ LNVSQ LNPSQ TSQ LNQSQ LNWLNV LNWLNP LNWT LNVLNP LNVT LNPT LNWLNQ LNVLNQ LNPLNQ TLNQ

F-statistic	350.0953	Prob. F(16,63)	0.0000
Log likelihood ratio	377.9029	Prob. Chi-Square(16)	0.0000

Test Equation:
Dependent Variable: LNCOST
Method: Least Squares
Date: 06/05/10 Time: 09:33
Sample: 1988Q1 2008Q4
Included observations: 84

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNW	1.217535	1.112518	1.094395	0.2771
LNV	-0.166215	0.138595	-1.199284	0.2340
LNP	-1.660881	0.584563	-2.841237	0.0057
LNQ	2.462116	1.318136	1.867877	0.0655
C	-84.39200	44.44680	-1.898719	0.0613

R-squared	0.504361	Mean dependent var	11.59757
Adjusted R-squared	0.479265	S.D. dependent var	1.646333
S.E. of regression	1.188027	Akaike info criterion	3.240143
Sum squared resid	111.5012	Schwarz criterion	3.384835
Log likelihood	-131.0860	Hannan-Quinn criter.	3.298308
F-statistic	20.09751	Durbin-Watson stat	0.148634
Prob(F-statistic)	0.000000		

Table 11: Regression of Output as Endogenous Variable.

Dependent Variable: LNQ
Method: Least Squares
Date: 06/15/10 Time: 12:23
Sample: 1988Q1 2008Q4
Included observations: 84

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNW	-14.99997	35.62492	-0.421053	0.6750
LNV	23.50487	6.544470	3.591562	0.0006
LNP	20.03748	14.08192	1.422923	0.1593
T	2.130086	0.769175	2.769313	0.0072
LNWSQ	0.733906	0.838613	0.875143	0.3845
LNVSQ	-0.059682	0.022029	-2.709202	0.0085
LNPSQ	0.107312	0.279068	0.384535	0.7018
TSQ	-0.000256	0.000250	-1.025529	0.3087
LNWLNV	-0.992104	0.289675	-3.424887	0.0010
LNWLNP	-0.595583	0.571110	-1.042852	0.3007
LNVLNP	-0.250909	0.089443	-2.805238	0.0065
LNWT	-0.091243	0.033468	-2.726305	0.0081
LNVT	-0.005868	0.003185	-1.842550	0.0697
LNPT	-0.013912	0.008198	-1.697050	0.0942
C	-3.958442	397.6072	-0.009956	0.9921

R-squared	0.886490	Mean dependent var	24.93954
Adjusted R-squared	0.863459	S.D. dependent var	0.223733
S.E. of regression	0.082672	Akaike info criterion	-1.987427
Sum squared resid	0.471597	Schwarz criterion	-1.553353
Log likelihood	98.47194	Hannan-Quinn criter.	-1.812933
F-statistic	38.49113	Durbin-Watson stat	0.918989
Prob(F-statistic)	0.000000		

Table 12: Shankerman-Nadiri Test, results with residuals included in main model

Dependent Variable: LNCOST
Method: Least Squares
Date: 06/16/10 Time: 09:09
Sample: 1988Q1 2008Q4
Included observations: 84

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNW	746.3395	42575.02	0.017530	0.9861
LNV	-310.8990	66714.47	-0.004660	0.9963
LNP	-71.92219	56872.88	-0.001265	0.9990
T	-30.76223	6045.879	-0.005088	0.9960
LNQ	100.3838	2839.528	0.035352	0.9719
LNWSQ	-13.53152	2083.065	-0.006496	0.9948
LNVSQ	0.501757	169.3978	0.002962	0.9976
LNPSQ	-0.487547	304.5856	-0.001601	0.9987
TSQ	-0.001955	0.727057	-0.002688	0.9979
LNQSQ	3.081955	1.573956	1.958095	0.0547
LNWLNV	11.40594	2815.915	0.004051	0.9968
LNWLNP	5.645597	1690.458	0.003340	0.9973
LNWT	1.193902	258.9763	0.004610	0.9963
LNVLNP	3.883404	712.1598	0.005453	0.9957
LNVT	-0.003204	16.65503	-0.000192	0.9998
LNPT	0.290699	39.48655	0.007362	0.9941
LNWLNQ	-14.28894	2.558389	-5.585130	0.0000
LNVLNQ	2.318826	0.699714	3.313963	0.0015
LNPLNQ	-5.858805	1.474439	-3.973583	0.0002
TLNQ	0.226245	0.087512	2.585292	0.0121
C	-6650.744	11365.49	-0.585170	0.5606
RESID01TEST	-15.03417	2838.325	-0.005297	0.9958

R-squared	0.994488	Mean dependent var	25.41308
Adjusted R-squared	0.992620	S.D. dependent var	1.646333
S.E. of regression	0.141427	Akaike info criterion	-0.853938
Sum squared resid	1.240100	Schwarz criterion	-0.217296
Log likelihood	57.86542	Hannan-Quinn criter.	-0.598014
F-statistic	532.6339	Durbin-Watson stat	1.380718
Prob(F-statistic)	0.000000		

Table 13: Cost Shares

LABOR COST

Date: 06/16/10
Time: 09:29
Sample: 1988Q1 2008Q4

	SIW
Mean	0.131687
Median	0.158899
Maximum	0.295332
Minimum	0.001925
Std. Dev.	0.088720

CAPITAL COST

Date: 06/16/10
Time: 09:35
Sample: 1988Q1 2008Q4

	SIV
Mean	0.027887
Median	0.000740
Maximum	0.260092
Minimum	1.98E-06
Std. Dev.	0.056289

COST OF INPUT PRICE OIL

Date: 06/16/10
Time: 09:37
Sample: 1988Q1 2008Q4

	SIP
Mean	4.94E-14
Median	5.39E-14
Maximum	1.16E-13
Minimum	4.93E-16
Std. Dev.	3.55E-14

OUTPUT SHARE

Date: 06/16/10
Time: 09:39
Sample: 1988Q1 2008Q4

	SIQ
Mean	1.153651
Median	1.549043
Maximum	1.732830
Minimum	0.022387
Std. Dev.	0.695310

Table 14: Breusch-Godfrey Serial Correlation Test

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	3.728000	Prob. F(2,61)	0.0297
Obs*R-squared	9.149001	Prob. Chi-Square(2)	0.0103

Test Equation:
Dependent Variable: RESID
Method: Least Squares
Date: 06/21/10 Time: 08:56
Sample: 1988Q1 2008Q4
Included observations: 84
Presample missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNW	-13.30751	103.6219	-0.128424	0.8982
LNV	2.269390	22.78645	0.099594	0.9210
LNP	-28.58882	49.38226	-0.578929	0.5648
T	0.942519	2.789576	0.337872	0.7366
LNQ	-30.02655	78.20916	-0.383926	0.7024
LNWSQ	0.267133	1.520343	0.175706	0.8611
LNVSQ	0.009167	0.045402	0.201914	0.8407
LNPSQ	0.143359	0.470508	0.304691	0.7616
TSQ	0.000203	0.000601	0.338388	0.7362
LNQSQ	0.680241	1.533435	0.443606	0.6589
LNWLNV	-0.022604	0.562390	-0.040193	0.9681
LNWLNP	0.333488	1.246810	0.267473	0.7900
LNWT	-0.011833	0.061729	-0.191689	0.8486
LNVLNP	0.072685	0.194251	0.374179	0.7096
LNVT	0.001657	0.005975	0.277310	0.7825
LNPT	-0.000523	0.014811	-0.035283	0.9720
LNWLNQ	0.157604	2.440594	0.064576	0.9487
LNVLNQ	-0.068422	0.666375	-0.102677	0.9186
LNPLNQ	0.861843	1.455724	0.592037	0.5560
TLNQ	-0.028922	0.084174	-0.343600	0.7323
C	402.8724	1647.628	0.244517	0.8077
RESID(-1)	0.349593	0.132487	2.638701	0.0105
RESID(-2)	0.035661	0.142377	0.250468	0.8031

R-squared	0.108917	Mean dependent var	-1.08E-14
Adjusted R-squared	-0.212458	S.D. dependent var	0.122233
S.E. of regression	0.134593	Akaike info criterion	-0.945446
Sum squared resid	1.105032	Schwarz criterion	-0.279866
Log likelihood	62.70875	Hannan-Quinn criter.	-0.677888
F-statistic	0.338909	Durbin-Watson stat	1.958647
Prob(F-statistic)	0.996759		

Table 15: Heteroskedasticity Test:White

Heteroskedasticity Test: White

F-statistic	1.356722	Prob. F(20,63)	0.1791
Obs*R-squared	25.28770	Prob. Chi-Square(20)	0.1906
Scaled explained SS	25.32510	Prob. Chi-Square(20)	0.1893

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 06/21/10 Time: 11:22
Sample: 1988Q1 2008Q4
Included observations: 84

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-68.79561	85.79279	-0.801881	0.4256
LNW^2	0.083020	0.223593	0.371298	0.7117
LNV^2	0.060951	0.031443	1.938472	0.0570
LNP^2	0.227513	0.447165	0.508791	0.6127
T^2	0.002912	0.001489	1.955961	0.0549
LNQ^2	0.096781	0.160831	0.601759	0.5495
LNWSQ^2	-5.34E-05	0.000132	-0.404368	0.6873
LNVSQ^2	-1.57E-06	4.02E-06	-0.391546	0.6967
LNPSQ^2	0.000753	0.000678	1.110454	0.2710
TSQ^2	1.64E-08	7.06E-09	2.315063	0.0239
LNQSQ^2	-2.30E-05	0.000124	-0.184930	0.8539
LNWLNV^2	-2.23E-05	3.87E-05	-0.575439	0.5670
LNWLNP^2	4.47E-05	0.000452	0.098900	0.9215
LNWT^2	-7.66E-07	1.54E-06	-0.496944	0.6210
LNVLNP^2	-2.26E-05	7.31E-05	-0.309533	0.7579
LNVT^2	2.75E-07	2.09E-07	1.312837	0.1940
LNPT^2	-2.28E-07	1.55E-06	-0.146690	0.8838
LNWLNQ^2	-3.15E-05	0.000219	-0.143546	0.8863
LNVLNQ^2	-7.77E-05	4.11E-05	-1.889778	0.0634
LNPLNQ^2	-0.000486	0.000488	-0.995086	0.3235
TLNQ^2	-4.31E-06	2.04E-06	-2.109590	0.0389

R-squared	0.301044	Mean dependent var	0.014763
Adjusted R-squared	0.079153	S.D. dependent var	0.028025
S.E. of regression	0.026893	Akaike info criterion	-4.181552
Sum squared resid	0.045565	Schwarz criterion	-3.573848
Log likelihood	196.6252	Hannan-Quinn criter.	-3.937260
F-statistic	1.356722	Durbin-Watson stat	2.070925
Prob(F-statistic)	0.179097		