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MASTER'S THESİS

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ABSTRACT

Efficiency Analysis of Turkey Sugar Factories and the Comparison With EU

The purpose of the study is to determine whether Turkey, the candidate country for EU membership, is capable of competing with the sugar industry in the process of integration with the sugar industry of the Union and to show how to compete under the current competitive conditions. In addition, by using input sets per factory, the efficiencies of all sugar factories belonging to the state and private sector in Turkey are analyzed and are revealed the improvement potentials. For doing this, Turkish and European Union's sugar factories 2016 data was used as an input for the Data Envelopment Analysis (DEA) method (CCR total activity analysis, BCC technical activity analysis) and thus efficiencies of sugar factories in Turkey and EU were compared.

In the study, three models were created. With the first model; state-owned sugar factories operating in Turkey is aimed to measure the production performance. For this purpose, efficiency measurements were made by using non-parametric DEA with 2016 data of 21 sugar factories operating in public sector. In the second model, comparison of public and private sugar factories in Turkey was made using input and output sets to measure the adequacy of production efficiency. The purpose of the third model created in our study is to reveal whether Turkish sugar industry can compete with the European Union sugar industry or not, and to make suggestions on how they can compete in the current competitive conditions.

As a result of the analyses, it has emerged that the sugar industry of Turkey does not have an efficient structure in production if we compare it with EU countries. With the findings, potential improvements in how inefficient factories will direct their inputs are illustrated by graphs. In addition, efficient factories which are taken as a reference by inefficient factories have been determined. In the first model built by taking the basic inputs that reflects cost of production and solved with the DEA-SOLVER-LVS software, 76% of the factories analyzed according to CCR method and 57% of the factories analyzed according to the BCC method were found inefficient. In the analysis of the second model; Afyon, Erciş, Çumra, Kayseri, Boğazlayan, Keskinkılıç, Ereğli, Kars and Kırşehir Sugar Factories were found efficient. In the third model which is made according to the CCR approach, Belgium, UK, Croatia and Denmark were in top five and Greece, Italy, Turkey, Hungary and Finland were found last five in terms of efficiency.

For the inefficient sugar factories to be efficient in Turkey, it is recommended that inefficient factories should be closed, capacity of existing efficient beet processing factories

should be increased and number of workers in the factories should be decreased and hereby the amount of sugar per factory would be increased.

Key Words: Data Envelopment Analysis, Efficiency Measurement, European Union (EU), Sugar Factories, Sugar Industry.

ÖZET

Türkiye Şeker Fabrikalarının Verimlilik Analizi ve AB ile Karşılaştırılması

Araştırmanın amacı, AB'ye aday ülke olan Türkiye'nin, Birliğe entegrasyon sürecinde şeker sanayiinin, Birliğin şeker sanayiiyle rekabet edebilecek kapasitede olup, olmadığını belirlemek ve mevcut rekabet koşulları altında nasıl rekabet edebilir hale dönüştürüleceğini göstermektir. Ayrıca, Türkiye'deki devlete ve özel sektöre ait tüm şeker fabrikalarının etkinlikleri analiz edilerek, her fabrika için girdi setleri kullanılarak iyileştirme potansiyellerini ortaya çıkarmaktır. Bu amaçla, Türkiye ve AB şeker fabrikaları 2016 yılı verileri esas alınarak, Veri Zarflama Analizi (VZA) yöntemi (CCR toplam etkinlik analizi, BCC teknik etkinlik analizi) kullanılmış ve böylece Türkiye ve AB'deki şeker fabriklarının üretim etkinlikleri ölçülmüştür.

Çalışmada üç model oluşturulmuş ve ilk model ile Türkiye'de faaliyet gösteren devlete ait şeker fabrikalarının üretim performansının ölçülmesi hedeflenmiştir. Bu amaçla kamu sektöründe faaliyet gösteren 21 şeker fabrikasının 2016 yılı verileri ile parametrik olmayan DEA kullanılarak verimlilik ölçümü yapılmıştır. Araştırmada oluşturulan ikinci modelle, bazı girdi faktörleri çerçevesinde, kamuya ait pancar şekeri fabrikaları ve özel sektör pancar şekeri üretim fabrikaları da dahil olmak üzere, Türkiye'deki tüm pancar şekeri üretim fabrikalarının nispi etkinliklerini ölçmek amaçlanmıştır. Çalışmada oluşturulan üçüncü modelin amacı; Türkiye'deki şeker endüstrisinin Avrupa Birliği şeker endüstrisi ile rekabet edip edemediği ve mevcut rekabet koşullarında nasıl rekabet edebileceği konusunda önerilerde bulunulması olarak özetlenebilir.

Yapılan analizler sonucunda, Türkiye şeker sanayiinin, AB ülkeleri arasında, üretimde etkin bir yapıya sahip olmadığı ortaya çıkmıştır. Elde edilen bulgularla, etkin olmayan fabrikaların, girdilerinin nasıl yönlendirileceği konusunda potansiyel iyileştirmeler grafiklerle gösterilmiştir. Bu fabrikaların referans alacakları etkin fabrikalar belirlenmiştir. Üretim maliyetini yansıtan temel girdiler alınarak kurulan birinci modelde, CCR yöntemine göre analiz edilen fabrikaların %76'sı, BCC yöntemine göre analiz edilen fabrikaların %57'si DEA-Solver-LVS programı ile çözülerek etkisiz bulunmuştur. İkinci modelin analizinde, Afyon, Erciş, Çumra, Kayseri, Boğazlayan, Keskinkılıç, Ereğli, Kars ve Kırşehir şeker fabrikaları etkin bulunmuştur. Üçüncü modelde CCR analizi kullanılmış ve yüksek verimliliğe sahip ülkeler Belçika, İngiltere, Hırvatistan ve Danimarka olarak belirlenmiştir.

Verimliliği son sırada olan beş ülke ise Yunanistan, İtalya, Türkiye, Macaristan ve Finlandiya’dır.

Türkiye şeker fabrikalarını verimli hele getirebilmek için, verimsiz şeker fabrikalarının kapatılması, mevcut verimli pancar işleme fabrikalarının kapasitelerinin artırılması, fabrikalardaki işçi sayısının azaltılması ve böylece fabrika başına şeker miktarının artırılması ihtiyacı bulunmaktadır.

Anahtar Kelimeler: Avrupa Birliği (AB), Etkinlik Ölçümü, Şeker Fabrikaları, Şeker Sanayii, Veri Zarflama Analizi.

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ABBREVIATIONS

BIOSAD	Journal of Biotechnology and Strategic Health Research
CAP	The Common Agricultural Policy
CMO	Common Market Organization
DEA	Data Envelopment Analysis
DMU	Decision Making Units
ECSC	European Coal and Steel Community
EP	European Parliament
etc.	Et cetera
EU	European Union
HFCS	High fructose corn syrup
HIS	High-intensity sweeteners
IP	Improvement Potential
ISO	International Sugar Organization
IMF	International Money Fund
SBC	Starch-based candies
SBS	Starch Based Sugar
TBMM	Turkish Grand National Assembly
TEL QUEL	The same
TL	Turkish Lira
TSFI	Turkey Sugar Factories Inc.
USA	United States of America
VAT	Value-Added Tax
WSE	White Sugar Equivalent

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1. INTRODUCTION

There are many factors determining the performance of an economy. Those factors are industrial structure, existing technology, capital accumulation, labor force, raw material scarcity and in addition to them, there are lots of tangible and intangible factors such as business relations, quality of labor force, intellectual capital, information technology, production, productivity, development, income distribution and other economic indicators.

In the contemporary world, the main concerns of managers include determining organizations success in utilizing the extent of the facilities, comparing their performance, identifying inefficient organizations, distinguishing the source of inefficiency, analyzing their strengths and weaknesses and providing appropriate solutions to improve their status. Nowadays, it is seen that only capacity increases are not sufficient in the measurement of successfulness of economic enterprises. Besides that, efficiency increase and productivity improvement in existing capacity are the major parts of development plans.

In globalized world economy, various concepts are used to evaluate the outputs obtained from the inputs of all small and large businesses. Efficiency and productivity, being used more frequently in recent years, are the most important ones. Efficiency researches are carried out to determine the components of productivity, technological progress and the effects of them.

The technological development mentioned here can be embodied by tangible assets such as capital and intermediate goods. But, capacity increase as a singular factor is not sufficient in the analysis of economic enterprises. Form of new business structures, organizational structures, developments in science and technology, methods and techniques are also important. The unexplained portion of those developments on total is considered as a surplus resulting from the composition of all production factors and is analyzed by total factor productivity. Total factor productivity includes knowledge of the capacity of an economy.

Another aim of efficiency research is to focus on the "efficiency" that expresses acquiring the highest output by using the present technology and the present inputs. Efficiency analysis can be divided by three bases which are technological development, efficiency change and scale effects. By doing this, the information obtained through this decomposition can be used to create policies of the units analyzed, and may be a source of analysis for the determination of other variables related to production. The determination of those values enables the determination of inefficient factors causing the bussiness' getting away from the effective situation and also it enables taking action to fix it. Efficient use of resource usage without wasting them will directly affect productivity. Productivity increases will be the basis for high economic growth (Mülga Devlet Planlama Teşkilatı, 2008: 16-17).

The most widely used method in production-based productivity measurement is efficiency measurement. There is no absolute criterion in the literature about efficiency measurement. Therefore, in practice, the relative efficiency of enterprises operating in the same sector is generally measured. Parametric and non-parametric methods are used to measure efficiency, which is a relative performance indicator. The most preferred technique among the non-parametric methods in recent years is Data Envelopment Analysis (DEA) developed by Charnes et al. (1978).

In literature, DEA based on the logic of linear programming comes at the beginning of efficiency measurement methods. "DEA is a nonparametric technique which aims to measure the relative performances' of the decision making units (DMUs), in circumstances where inputs and outputs having different unit of measures or measured at different scales which are causing difficulty for comparison" (Ramanathan 2003: 26-27).

"The relative efficiency of a decision unit in DEA, is defined as the ratio of the weighted sum of the outputs to weighted sum of the inputs and is also referred to as technical efficiency" (Cooper , Seiford , and Tone, 2004: 3-4. In later years, BCC multiple input-multiple output efficiency measurement method that is based on variable return assumption instead of constant returns assumption in CCR is developed by Banker, Charnes and Cooper (1984).

DEA which is a mathematical programming technique that can be applied in two ways: one is input oriented model aiming at obtaining a certain output level with minimum amount of input and the other one is output oriented model aiming at providing maximum output with a certain input level. DEA helps making relative comparisons and separates the Decision Making Units (DMU) as efficient and inefficient. This method gives an idea about how to make inefficient DMU more efficient by changing their inputs and outputs. DEA can measure the efficiency of the units to which it is applied for only one period. In other words, DEA cannot measure how the efficiency of units changes over time. (Cooper, Seiford and Tone, 2002: 2)

Let us briefly explain why the DEA method used in the analysis of our thesis. One reason is that it is one of the most suitable tools for the efficiency analysis of sugar factories. Sugar; from the agricultural sector to the industrial sector; from employees (civil servants, workers) to consumers; from farmers to merchants; has a multidimensional structure. It is a basic and strategic food item and also it is related with the health concerns. Efficiency of production factors of table sugar, starch based sugar, sugar alcohols and high intensity sweeteners, that we consume in our daily lives directly or in other food products, has been among the priority policies for all countries. DEA is a model in production systems that helps to calculate both efficiency comparison of production factors and total factor productivity. Therefore, it is aimed to inform decision makers correctly in order to ensure efficient and productive use of production factors by comparing the efficiency of sugar factories in our country among themselves and with the EU.

DEA identifies alternative ways to increase the performance of an inefficient decision-making unit to the level of relatively efficient units in its cluster, and allows decision makers in particular to choose the optimal improvement path and to better recognize the production process (about all inputs and outputs). Since the objectives determined in DEA efficiency analysis are based on the best performing units, the meaning and validity of the efficiency analysis are strengthened. DEA is a more advantageous efficiency analysis method for deterministic situations than the other parametric methods as DEA is not parametric and does not carry the assumption that the data conform to a specific functional distribution rule.

In our country, when we look at the distribution of 33 sugar factories which have been included efficiency analysis, we see 25 of which are state-owned enterprise (Turkey Sugar Factories Inc.), six of which are owned by beet growers cooperative and two of which are owned by private companies. Due to this different distribution, each company's production, management and technology accumulation and the legal regulations they are subject to differ. Therefore it was preferred the use of DEA as it was a method to analyze where the productivity differences in these factories stem from and how others can reach the best sampling by applying improvement alternatives.

In Turkey, in many areas such as energy, manufacturing industry, health and agriculture, efficiency measurement using DEA analysis was made. Also by using DEA, Turkish and the EU sugar industry efficiency analysis was carried out. (See Emre Güneşer

Bozdağ Ph. D. Thesis, 2007). However, after this study conducted using the 1990-2005 data, major changes have occurred in the sugar sector in both the EU and Turkey.

With the 2006 reform in the EU, many factories were closed, production factors began to be used more productively and efficiently, and the economies of scale began to be used. Finally, in 2017, the quota application was abolished and thus the market was opened to competition. In Turkey due to the economic crisis in 2000, Sugar Law No. 4634 came into force in 2001 to ensure the stability, efficiency and privatization of sugar production. The purpose of this law is to produce beet sugar to meet the domestic demand, to direct the sector according to the rules of competition in the domestic market, to prepare the legal infrastructure to ensure privatization, to be harmonized to international commitments.

In Turkey, Turkish Sugar Factories Inc. has the largest share (%59 for 2017, after privatization of 15 factories %43 for 2018) in sugar industry (in terms of sugar quota). Besides that big advantage, it has big inefficiency problems as well. These problems caused by their production process also have affected the company's income statement and the company's cumulative loss has reached a billion TL in the last five years. The need for efficiency analyses in sugar factories started especially from the start of the quota application in terms of analyzing the effects of quotas. And also, privatization of the sugar factories made it an important tool for determining the values of state owned sugar factories especially whose privatization made in 2018. Due to the data unavailability of 2017/2018 marketing year, this thesis's analysis is based on the data of 2016 therefore does not cover the privatization effects which were made in 2018 and the EU quota abolition which was made in 2017. Production efficiency of 18 EU-28 countries' sugar factories have been analyzed, but Romania is not included in the analysis due to lack of the data.

The problems stemming from the inefficiency of the sugar industry in Turkey has affected the sugar consumer prices and resulted in the consumption of all confectionery at prices higher than the world price levels.

The purpose of the study is to determine whether Turkey, the candidate country for EU membership, is capable of competing with the sugar industry in the process of integration with the sugar industry of the Union and to show how to compete under the current competitive conditions. In addition, by using input sets per factory, the activities of all sugar factories belonging to the state and private sector in Turkey are analyzed and this study revealed the improvement potentials. The production efficiency of Turkey's sugar factories (including the private sugar factories) and the EU sugar factories, based on the data of 2016, were compared for each country. As a result of all these analyses, this study will come to a conclusion about whether the sugar industry in Turkey can compete with the EU and what should be done for the increasing competition.

Turkish sugar sector has a very important role in the economy as it employs nearly 19 thousand employees in the factories, as the number of sugar beet producer is nearly 110 thousands and as it generate nearly 9.5 billion revenue per year. Having been aware of the importance of this sector in Turkish economy, we will make three analysis for determining the inefficiency factors in the sector.

These analyzes can be summarized as follows:

1- In the first analysis, taking the inputs as the number of employees of state-owned sugar factories in Turkey (officials, workers, temporary employees) and energy consumption and taking the ouputs as sugar production in the factory, comparison of the sugar factories will be conducted. Thus, the relative ranking of public sector plants was made and the development potential of inefficient factories was determined.
2- The public and private sugar factories in Turkey by using the number of employees, their capacities and processed beet data, as inputs, and the amount of sugar produced, as output, were compared. By doing this, their efficiencies will be measured and we get the chance of comparing public and private sugar factories.
3- The sugar factories in Turkey and EU countries by using the number of employees, their capacities and processed beet as inputs, and the amount of sugar produced as output, were compared. By this analysis, we will determine the relative efficiency of Turkey and EU sugar factories.

The input-output sets used in the analyzes are the basic production factors.

This thesis consists of six chapters. In the introduction chapter, general information about the subject and study was explained. In the second chapter, information about issues such as the history of sugar, sugar types, sugar market in the world, import and export figures, the quota system for sugar sector in Turkey, the share of public and private sector sugar market, starch-based sugar, high intensity sweeteners were given.

In the third chapter of the study, the European Union (EU) 2006 reform on sugar sector and the objectives of this reform, new regulations introduced, closure of sugar beet processing factories, the place where the market has arrived as of today and market expectations and the realization of quotas removed in 2017 was examined.

In the fourth chapter of the study, general information about performance measurement in enterprises, three basic elements of performance control which is consisting of productivity, efficiency and effectiveness concepts were explained, the methods of efficiency measurement were mentioned and detailed information about DEA used in the measurement of sugar factories in this study was given.

In the fifth chapter of the study, three different models was set. In the first model, efficiency analysis was carried out with DEA according to the data of 2016 in Turkish public sugar factories using input and output sets reflecting production costs. In the second model, comparison of public and private sugar factories in Turkey was made using input and output sets to measure the adequacy of production efficiency. In the third model, efficiency analysis of all sugar beet factories between Turkey and EU was performed within the framework of the selected data.

In the conclusion and evaluation chapter of the study, various recommendations were made by making general evaluations about sugar factories in Turkey and EU data according to the results of the analysis.

2. OVERVIEW OF SUGAR AND SUGAR SECTOR IN TURKEY

Sugar has a strategic importance in the world. Sugar has been a protected product all over the world owing to the fact that, contribution to agricultural production, by-products and its contribution to employment, being the main ingredient of nutrition (Erdinç, 2017: 9-26).

In this chapter, general information about the concept of sugar, such as; history of sugar, classification of sugar, raw material of sugar, etc. will be given. In addition, the state of the sugar market in the world and in Turkey, sugar production, sale, import and export figures will be given and thus one who will read this thesis will get the knowledge about sugar market.

2.1. Overview of Sugar Term

There are two types of sugar used in the world for sweetening:

1. Crystal sugar (sucrose) is known as white sugar or table sugar which is obtained from beet or cane,

2. Starch-based sugar, which two main types of glucose and isoglucose, obtained from agricultural products such as starch-containing corn, rice, potatoes.

Crystal sugar can be consumed directly, but is also used as an input in some industries such as pastry, beverage, yeast, medicine, animal feed, alcohol, biofuels, chemistry and fertilizers (Leblebici J. and Leblebici F., 2011: 6-7).

Starch-based sugar (SBS), which are carbohydrate pattern sweeteners have two basic types that are glucose and isoglucose syrup and are produced from starch that is included in wheat, potatoes, mostly corn plants. SBS, which is also presented to the market with liquid forms (commercial basis), is used to sweeten foods, extend the shelf life of foods and color the foods in food industry. The most common species of SBS are isoglucose (HFCS: High Fructose Corn Syrup) syrups which contain 42% and 55% fructose in the market. HFCS is generally used in drink industry (Hannah and Spence, 1996: 110-111).

There are two types of sweeteners as an alternative to crystal sugar which is known sugar in public (Republic of Turkey Ministry of Agriculture and Forestry, 2019a):

1. High-intensity sweeteners (HIS): High-intensity sweeteners are aspartame, saccharin, sucralose etc. which have the degree of sweetness about 30-20 000 times of the sugar.

2. Sugar alcohols: Sugar alcohols has about the degree of sweetness of half of the sugar. Its examples are orbitol, xylitol etc. which are used in sugar-free chewing gum.

High-intensity sweeteners, which are called alternative sweeteners, provides the same taste as sugar due to their high sweetness by using much less than sugar. The majority of HIS are artificial sweeteners. These are high intensity sweeteners that can cause health problems when food usage limits are exceeded and they are not produced in Turkey. HIS are used directly in the products or in beverages such as tea and coffee, and they can only be imported (Gültekin, Öner, Savaş and Doğan, 2017: 34-38).

2.1.1. White Sugar (Table Sugar)

In the world sweetener market, the share of sucrose, which is known as table sugar or white sugar, is % 77; the share of High Fructose Syrup based on starch which is known as izoglucose, is %8; the share of Glucose Syrup based on starch which is known as glucose, is %5; the share of High-intensity sweeteners like aspartame, saccharin, sucralose is %9; the share of sugar alcohols is %1 (Figure 1) (Abolished Sugar Authority, 2017: 6-7).

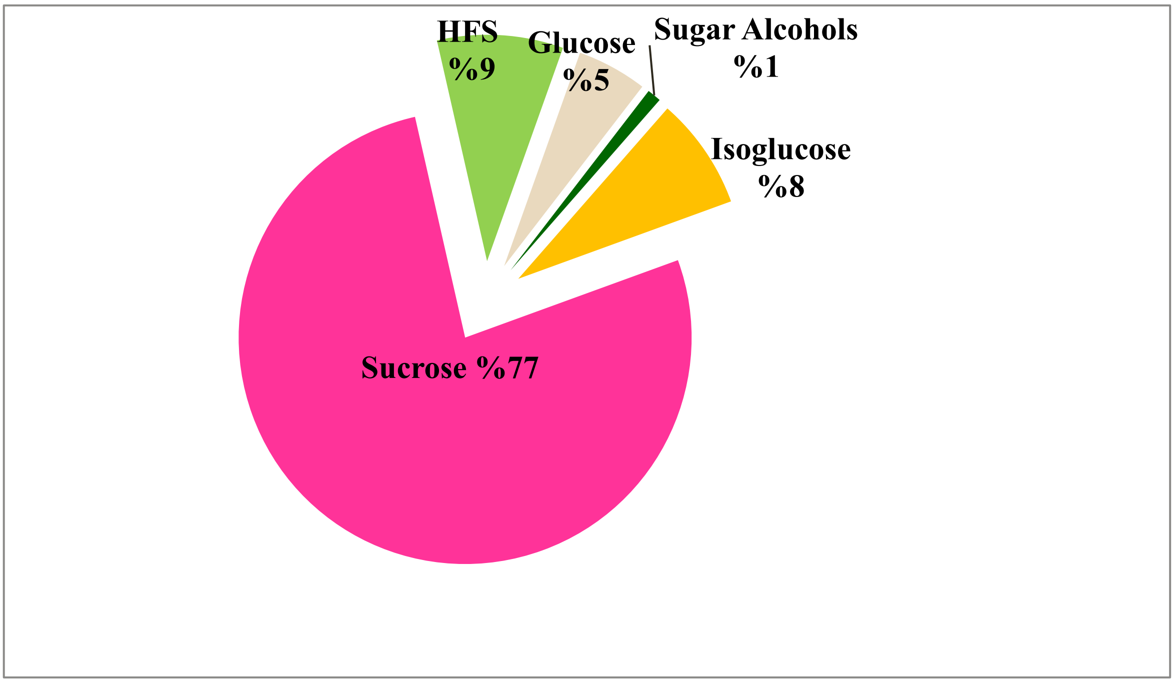


Figure 1. Distribution of Sweeteners in the World Sweetener Market

Source: Abolished Sugar Authority 2017 Year's Annual Activity Report p:6-7

We can classify the sweeteners in general as in Figure 2.

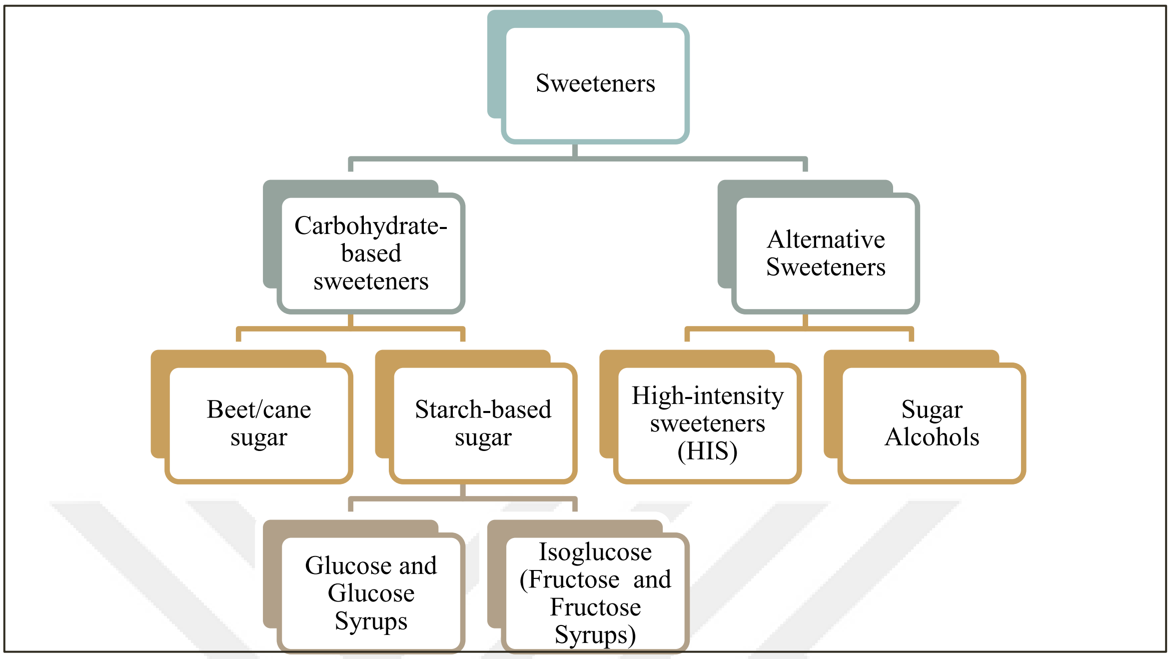


Figure 2. Classification of Sugars

In the last completed period of 2017/2018 world sugar production approximately 78% of white sugar is produced from cane and the remaining 22% from beet. There is no difference between the sugars obtained from both raw materials in quality. In this respect, they are seen as being identical. Sugar is produced in 113 countries across the globe; 71 of these are sugar cane grower; 36 of these are sugar beet grower, and six of these are from both. The production cost of sugar obtained from sugar cane which can be widely grown in the region of tropical and similar climatic zones is lower than beet sugar. For this reason, the world sugar stock market prices are determined by cane sugar which is low cost. As the climate is not suitable for growing sugarcane economically in Turkey like in the European Union (EU) and Ukraine and so on sugar is produced from beet (TSFI, 2018: 2-8).

Although the world sugar production amount has shown significant fluctuations from year to year, mainly depending on climatic conditions, annual sugar production in 2017/2018 marketing year has exceeded 184 million tons. Brazil is the world's largest sugar producer and has more than one- fifth of world sugar production alone. The other major sugar producing countries following Brazil are respectively Thailand, China and US (Figure 2.3.). While the world white sugar production increased about 4 million tons between from 2015/16 period to 2016/17 period, also white sugar consumption increased about 2 million tons. In the period of 2017/2018, production increased about 20 million tons, consumption increased about 2 million tons compared to the previous year (FO Licht's, 2017a).

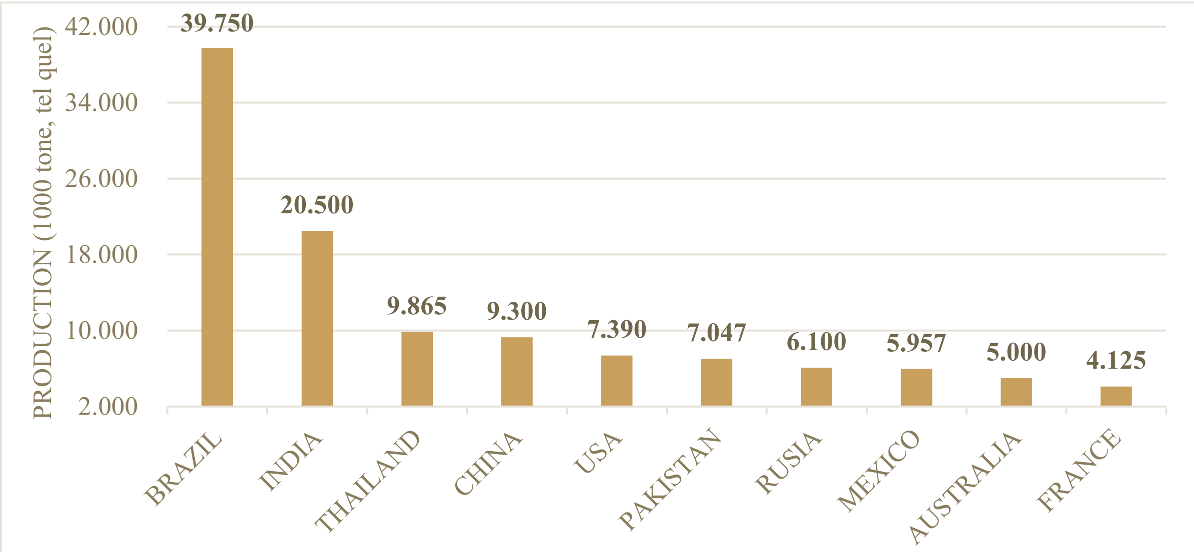


Figure 3. 2016/17 PY World's 10th Largest Producer (one thousand tons, tel quel)
Source: ISO World Sugar Balances November 2017- F. O. Licht Balances 19/06/2017

Note: Tel quel, literally means “as is” or “as it comes”, shows the amount of sugar converted by the ISO close to the White Sugar Equivalent (WSE). The industry standard conversion of 96-polarization raws to whites is to multiply the raws by 0.92. The formula as provided by the ISO is (2P - 100) /0.92, where P is the degree of polarization tested by polariscope. Refined sugar has about 99.9 polarization, and in real world raw sugar has not 96 polarization but its polarization level ranges between 97 and 99.5 for most countries. For example, 100 tonnes actual or tel quel of raw sugar will commonly equal to about 106 tonnes raw sugar with the 96 degrees polarisation level (Pairault, 2004: 4-5).

Distribution of the top 10 countries in World sugar production, consumption, import and export is shown in the Figure 4.

PRODUCTION %77 of World Sugar Production	CONSUMPTION %61 of World Sugar Consumption	IMPORT %46 of World Sugar Import	EXPORT %83 of World Sugar Export
• Brazil	• India	• China	• Brazil
• EU	• EU	• Indonesia	• Thailand
• India	• China	• USA	• Australia
• Thailand	• Brazil	• Bangladesh	• EU
• China	• USA	• UAE	• India
• USA	• Indonesia	• Korea	• Guatemala
• Pakistan	• Rusia	• Malaysia	• UAE
• Rusia	• Pakistan	• Algeria	• Pakistan
• Mexico	• Mexico	• Saudi Arabia	• Mexico
• Australia	• Egypt	• Nigeria	• Cuba

Figure 4. Top 10 Countries in World Sugar Production, Consumption, Import and Export.
Source: ISO Quarterly Market Outlook, Feb. 2018.

The world sugar consumption reached 175.5, million tonnes as tel quel in 2017/18 marketing year. India ranks first with its consumption of around 24 million tons, followed by EU, China, Brazil and US. World consumption of crystal sugar is growing at around 2% every year. White sugar consumption quantities of 2016/17 PY countries and consumption per capita is below (Figure 5).

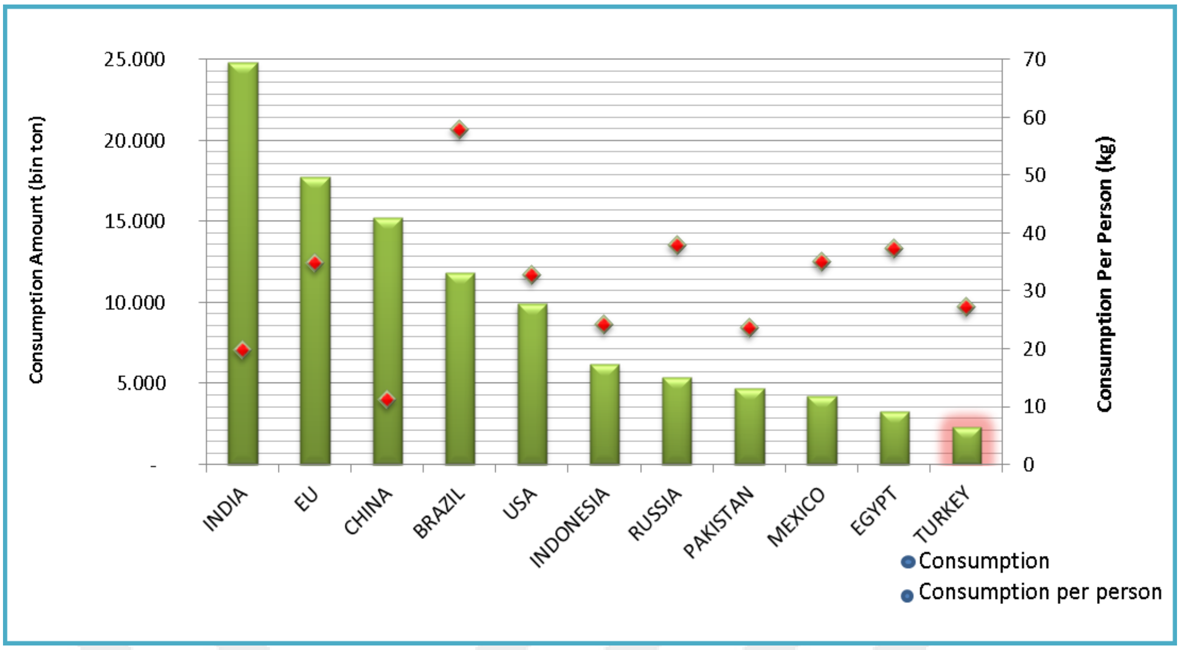


Figure 5. White Sugar Consumption Quantities of 2016/17 PY Countries and Consumption Per Capita. Source: F.O.Licht Balances 25/09/2017

International sugar trade is made on the basis of world stock exchange prices. The international stock exchanges which determine the world market price for sugar are the London stock exchange for white sugar and the New York stock exchange for raw sugar. World sugar prices are determined by cane sugar which constitutes four-fifths of sugar production and the entire of sugar exports. The main determinant in the formation of world sugar prices is the supply / demand situation of sugar. Foreign factors such as oil and commodity prices, energy policies, freight prices, exchange rate changes, interest rates, trade policies and preferential agreements, inflation, political and financial turmoil, speculative transactions, countries' economic conditions, are increasingly playing an increasing role on prices. It is a fact that sugar produced below the demand leads to a decrease in stocks, thus increasing the prices, and the opposite situation causes the prices to fall (Abolished Sugar Authority, 2017: 14).

In 2016/17 marketing year, the amount of sugar traded around the world is around 60 million tons and Brazil realizes about half of the world sugar exports. The second and third largest exporters are Thailand and Australia; the largest importers are China, Indonesia, EU and USA (Table 1). The EU was a net exporter before the sugar reform but it is now a net importer.

Table 1. World Sugar Market thousand tons, tel quel

Source: ISO 2018 August Balance

Period	Production	Consumption	Import	Export	Stock at the end of period	Balance
2008/09	142 961	151 520	48 395	48 390	69 490	-8 559
2009/10	148 391	151 960	53 993	53 997	65 917	-3 569
2010/11	156 177	153 096	53 870	53 865	69 013	3 081
2011/12	163 597	157 962	54 325	54 321	74 652	5 635
2012/13	171 804	163 572	60 655	60 579	82 960	8 232
2013/14	174 146	165 344	58 361	57 917	92 206	8 802
2014/15	169 393	166 920	58 278	58 257	94 700	2 473
2015/16	164 141	169 989	66 228	66 283	88 797	-5 848
2016/17	169 594	172 441	65 324	65 317	85 957	-2 847
2017/18	184 170	175 573	58 604	59 045	94 113	8 597

Between 2008/09 and 2017/18 marketing years, the change in world sugar production and consumption has been shown in the Figure 6.

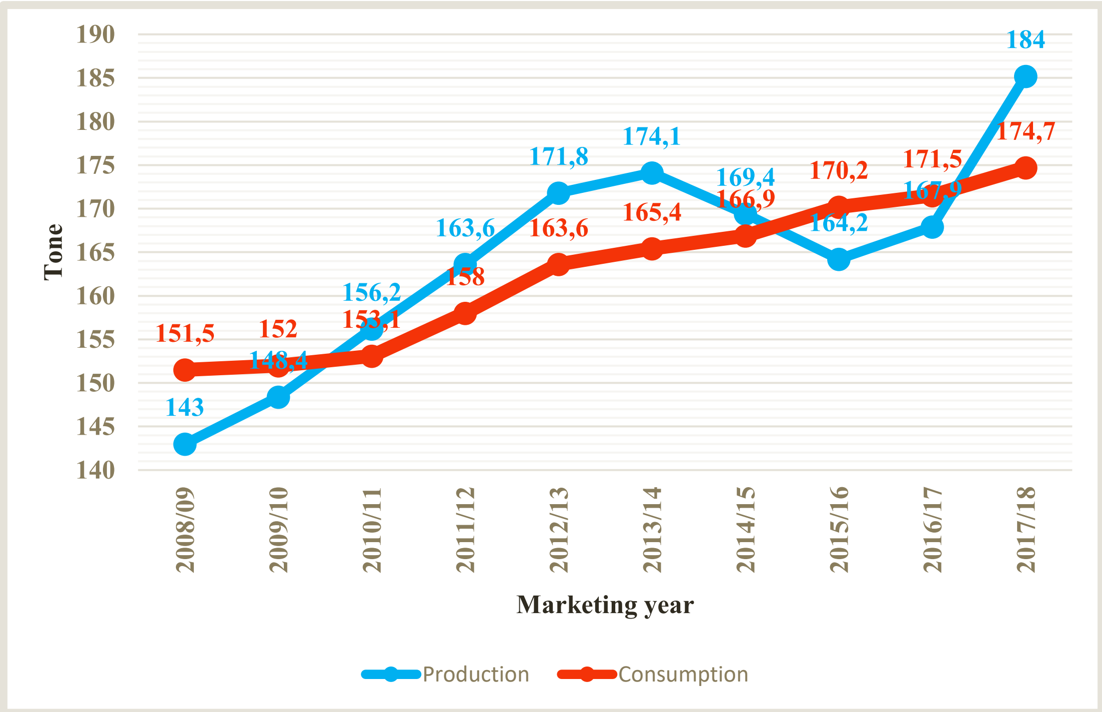


Figure 6. World Sugar Production and Consumption

Source: ISO 2018 August Balance Report

If we look at world sugar prices, its prices is one of the most volatile in the world stock market in recent years. As shown in the table above (Table1); because of the continuation of world sugar supply surplus since 2010 prices showed an overall downward trend due to the completion of the recovery process of stocks and the world price of white sugar decreased to $290/ton in 2015. Finally, the average price of the world white sugar market was $499/ton in 2016. Average world price of white sugar was $391/ton in 2017 and was $343/ton in 2018. The sugar stock market price as of March 31, 2019 is $334 /ton. World Sugar Prices are given in detail (Figure 7).

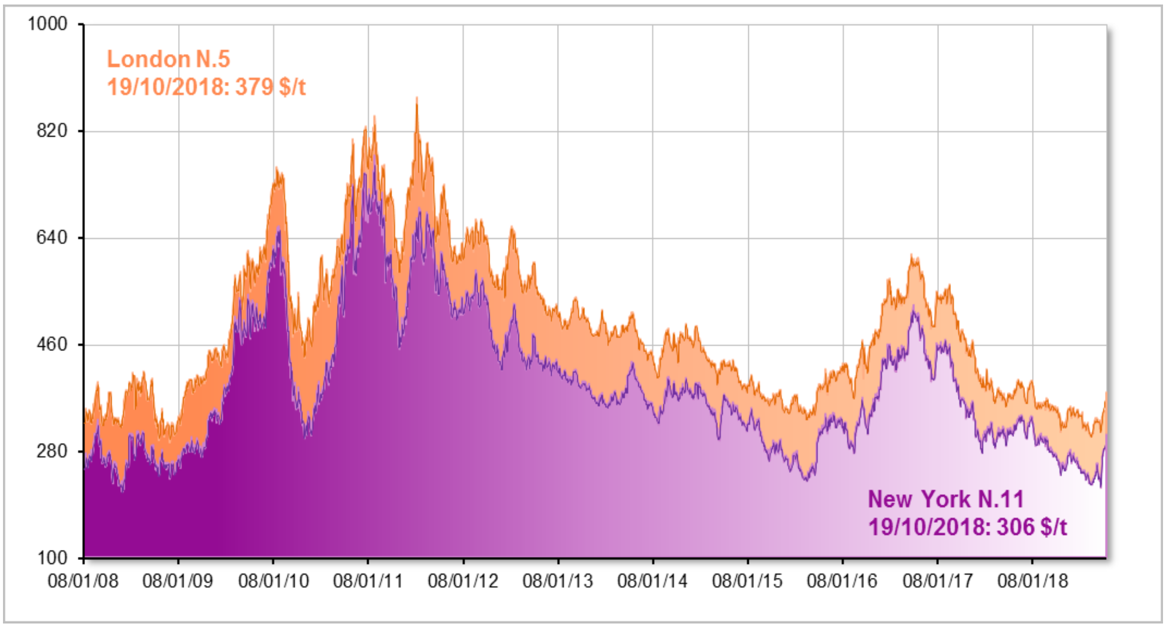


Figure 7. European Commission Sugar Market Situation

Source: European Commission Sugar Market Situation

According to the projections for 2018/19 marketing year, international sugar prices are expected to remain on a downward trend as the world's sugar production will give over 4 million tons of surplus. Moreover, a significant increase is expected in the sugar imports of China and the US in 2018/19 period.

Another important issue in the sugar markets in the world is the production of ethanol which is directly related to the sugar industry and which is used as an alternative fuel. Sugar crops are major feed stocks for renewable bio-ethanol production for using as a transportation fuel. Brazil is the world’s leader in fuel ethanol production from sugarcane as it is in the production of sugar. Brazil's ethanol production was 30.7 billion liters in 2018.

Between the years 2011 and 2017, the raw sugar and white sugar stock market prices and the white sugar premium are shown in the graph below (Figure 8). In the world sugar trade, the white sugar premium (raw sugar and white sugar price difference) is taken into consideration in evaluating the cost of processing the raw sugar into white sugar.

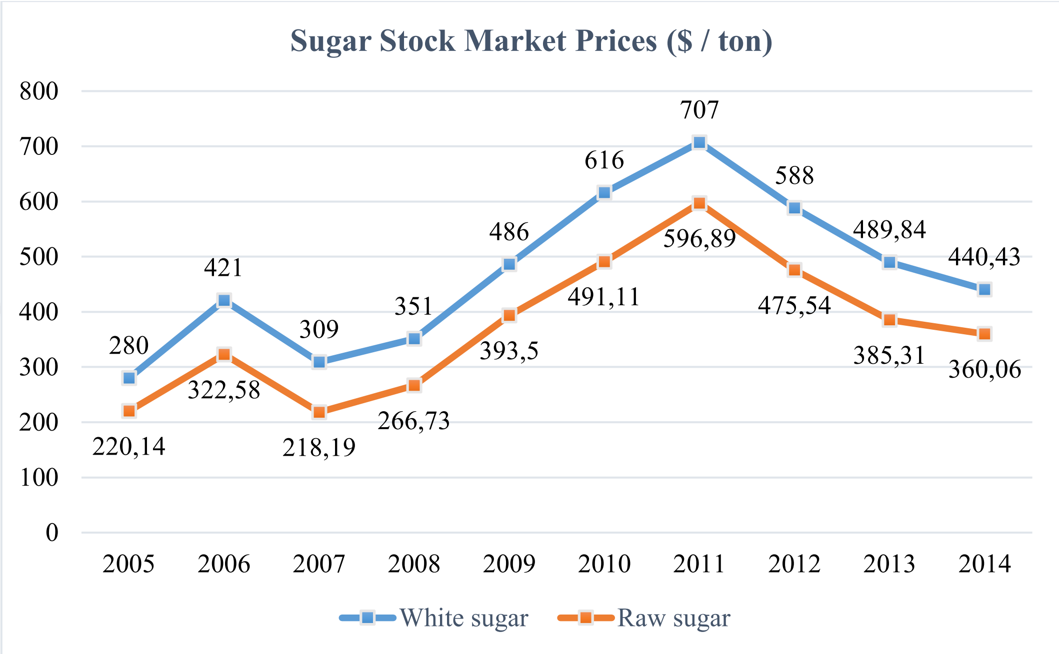


Figure 8. Sugar Stock Market Prices ($ / ton)
Source: ISO 2018 August Balance Report

2.1.2. Starch Based Sugar

Starch based sugar (SBS) have the second largest share after sucrose in the World. SBSs are carbohydrate-type sugars produced from starch derived from plants such as corn, potatoes, wheat, cassava (tapioka) and found in two main variety, generally glucose syrup and isoglucose (LMC, 2017b).

In the world, starch based sugar which is only produces from corn are called corn syrup, and syrups including fructose and glucose are called high fructose corn syrup (High Fructose Corn Syrup= HFCS). Starch-based syrups including about 42% fructose and 53% glucose are called HFCS-42; syrups containing about 55% fructose and 41% glucose are named HFCS-55. The HFCS-55 is accepted to be a substitute for sucrose produced from beet (Hannah and Spence, 1996: 110-111).

In 2016, total HFCS production reached to 14.1 million tons on a dry weight basis (approximately 19 million tons on a commercial basis) in the world. The United States ranks the first in the HFCS production with 7.7 million tons. It is followed by China with 2.7 million tons, by Japan with 0.9 million tons and by EU with 0.7 million tons respectively. The US alone has more than half of the total HFCS production without significant change over the years (Figure 9) (FO Licht's, 2017a).

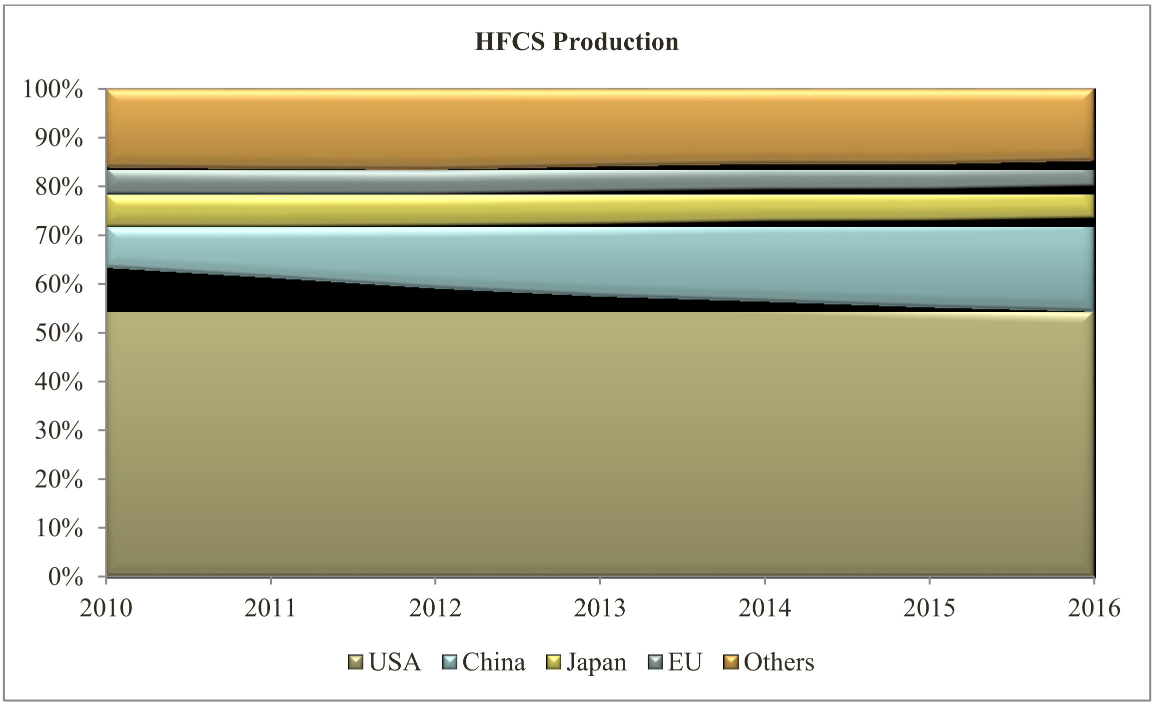
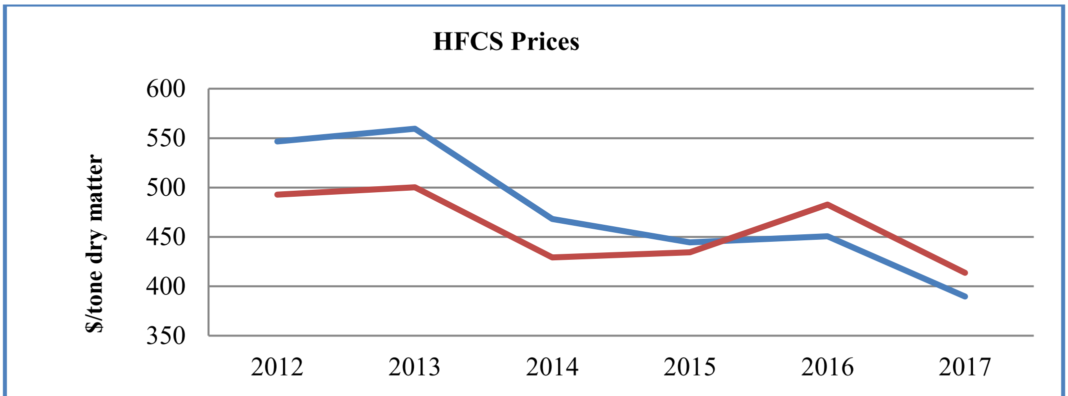


Figure 9. HFCS Major Producing Countries

Source: FOLicht's International Sugar and Sweetener Report, Vol.149, No.23 /16.08.2017

The USA dominated world HFCS production as of 2012-2017. In USA the prices of HFCS-55 and HFCS-42 which are the most widely used types of starch-based sugars are given in the chart below (Figure 10) (SSQ, 2017).



	2012	2013	2014	2015	2016	2017
HFCS-55	546,46	559,46	468,05	444,48	450,65	389,64
HFCS-42	492,72	500,21	429,23	434,35	482,59	413,65

Figure 10. HFCS World Prices

Source:. SSQ Sugar and Sweetener 2nd Quarterly Report, Q2 2017.

HFCS's prices have been declining since 2012. For the first six months of 2017, the average price was $ 500 ($ 375 in commercial base) for both types of HFCS.

2.2. The Historical Development of Sugar Sector In Turkey

Turkey Sugar Factories are first industrial enterprises in Turkey. The study of establishing a sugar factory was first initiated by a farmer named Nuri Şeker in Uşak. While this study was continuing, a Sugar Factory was inaugurated on November 22, 1926 in Alpullu and this factory has been the first sugar factory to operate in Turkey (Damlıbağ, 2017: 167-168). The construction of factory was completed 11 months and the factory was established with 600 000 Turkish Lira capital. Alpullu Sugar Factory's partners are "private individuals, Türkiye İş Bankası, Ziraat Bankası and Trakya City Administrations. After 21 days from opening of Alpullu Sugar Factory, Uşak Sugar Factory was started to operate (Veldet, 1958: 407). Until 1933, sugar needs of Turkey were met by Uşak and Alpullu Sugar Factories. In the light of the experiences obtained from these two factories about beet farming and sugar factory management, Eskişehir Sugar Factory opened on December 5, 1933 and Turhal Sugar Factory opened on October 19, 1934. In 1935, these four factories were assembled under a single company and in this way Turkey Sugar Factories Inc. which has 22 million TL capital has been established (Damlıbağ, 2018:147-152). Between 1951-1956, 11 new sugar factory were built and started to operate. The number of sugar factories in Turkey were also reached 15. In Ankara in 1962, in Kastamonu in 1963, in Afyon in 1977, in Muş and Ilgin in 1982, in Ağrı in 1984, in Elbistan in 1985, in Erciş, Ereğli and Çarşamba in 1989, in Çorum in 1991, in Kars in 1993, in Yozgat in 1998 and in Kırşehir in 2001 sugar factories were established and started to operate (TSFI, 2017: 5-6).

Prior to the entry into force of the Sugar Law No. 4634, Çumra, Boğazlıyan and Aksaray Sugar Factories that were allowed to operate with decision of the Council of Ministers were started to operate by giving quota as much as its own installed capacity (Sugar Law, 2001).

From the date of their establishment until the early 1990s, management of Amasya, Kayseri and Konya Sugar Factories, which are owned by Limited Liability Sugar Beet Growers Cooperative Association, have been transferred to Turkey Sugar Factories Corporation as a result of the decisions taken at their management boards. After again as a result of the decisions taken by their management boards, Amasya Sugar Factory in 1991, Kayseri and Konya Sugar factories in 1992 removed management powers given to Turkey Sugar Factories Corporation and these factories began to be governed by its own Sugar Beet Growers Cooperative (Erdinç, 2017: 9-26).

In today, beet sugar production in Turkey are scheduled at 33 sugar factories. Turkish Sugar Factories Corporation which have 15 of these factories and private sector has 18 of these factories. In 2018, 14 factories of Turkey Sugar Factories Corporation has been started to be privatized and no demand was received for a factory, for three factories the buyer firms could not fulfill the obligation due to the economic crisis and the remaining 10 factories were sold (TSFI, 2018: 2-8).

In Turkey, annual sugar production installed capacity is 4 700 thousand tons of sugar and 3 500 thousand tons belong to the facilities of production beet sugar, 1 200 thousand tons belong to the facilities of starch-based (TSFI, 2018: 33-34).

2.3. Developments and Policies Implemented in the Sugar Sector in Turkey

Supply and demand are important in sugar production. Many policies are followed to ensure stability in production and supply. But Turkey has been following an unstable production process with its exporter and importer identity in sugar. Especially in the 1990s, the instabilities in the amount of sugar production have left the sugar sector sometimes with the risk of import and sometimes with the stock problem. For these reasons, planning and control of production is very important.

The need for establishing a new legal infrastructure has been brought on the agenda in the sugar sector for the loss of the functioning of many substances of No. 6747 dated June 22, 1956 Sugar Law that is regulate the sugar regime in Turkey. In this reason, in 1996, study on the reorganization of the sugar regime was initiated and The Draft Law on Sugar was consigned to Turkish Grand National Assembly (TBMM) on December 14, 2000 by The Council of Ministers and it was adopted in the General Assembly of TBMM on April 4, 2001 (Bozdağ, 2007: 63).

The sugar policy of Turkey is based on to meet the domestic demand with domestic production. In accordance with this aim, with the Sugar Law No. 4634 entered into force in 2001, new important regulations have been introduced. The purposes of the sugar law are to supply the domestic demand with domestic production and to regulate the sugar regime, and to determine pricing, marketing terms and methods with procedures and principles in sugar production in Turkey. In other words, the essence of the law is based on self-sufficiency to provide planning of sugar production and supply and to provide income guarantee for producers and industrialists (Turkish Court Accounts, 2014).

Since 2002/2003 marketing year, sugar industry in Turkey has been organized within the framework of Sugar Law No. 4634 and the "regulations" were issued based on this Law. The principles of this law are as follows (Sugar Law, 2001):

- In this context, the Sugar Authority, in cooperation with all relevant institutions and organizations, in the light of all the developments in the sector, determines the policies and strategies that will take care of the interests of the country and the sector and ensures their implementation. Also this Authority directs the activities of the companies operating in the sector towards the production and supply of sugar.

In accordance with the demand for domestic sugar, the power of the allocation of sugar quotas to all companies within the scope of the Law belongs to the Sugar Board.

Quota A: It is the amount of sugar which is produced according to domestic demand and given to the domestic market at the marketing year.

Quota B: It is the amount of sugar which is produced for the safety margin and corresponds to a certain ratio of quota A.

Quota C: It is the amount of sugar which is produced outside of A and B quotas and which cannot be marketed domestically. According to Sugar Law, C Sugar is produced only for export and cannot be marketed domestically (Sugar Law, 2001).

Table 2 below shows quotas and the increases of quotas over the years.

Table 2. Sugar Quatos and Increases in Turkey

MARKETING YEAR	BEET SUGAR QUOTA (A + B)	SBS QUOTA (A)	THE INCREASE OF SBS QUOTA %	TOTAL QUOTA
2004/2005	2 149	234	50	2 500
2005/2006	2 191	234	50	2 542
2006/2007	2 191	234	50	2 542
2007/2008	2 191	234	35	2 507
2008/2009	2 520	267	25	2 854
2009/2010	2 560	271	50	2 966
2010/2011	2 288	244	50	2 655
2011/2012	2 288	244	35	2 617
2012/2013	2 288	244	38	2 625
2013/2014	2 266	244	25	2 571
2014/2015	2 318	250	30	2 568
2015/2016	2 363	250	25	2 613
2016/2017	2 505	265	0	2 770
2017/2018	2 656	267	-	2 923

After the Sugar Authority has charged its regulatory and supervisory duties for a period of 16 years, with the Decree Law No. 696 prepared in the state of emergency, the Sugar Authority was closed and the duties of the Authority were transferred to the Ministry of Agriculture and Forestry.

2.4. Sugar Sector in Turkey

Turkey is the World's 5 th, and the Europe's 4 th largest sugar producer country which is producing sugar from beet. It is following USA, France, Russia and Germany as of 2017/18 marketing year. Some data of Turkey's sugar sector are given below (Table 3) (Republic of Turkey Ministry of Agriculture and Forestry, 2019b: 4).

The economic size of the sugar sector is approximately 9.5 billion TL. The market value of sugar is 8.5 billion TL, the value of by-products like molasses, pulp and etc. is 1 billion TL. Total established sugar production capacity of Turkey is, totaling 4.7 million tons with 3.5 million tons of beet sugar and 1.2 million tons of SBS. Sugar production in Turkey directly or indirectly concerns about 2 million people (Abolished Sugar Authority, 2016a: 27-32).

Table 3. Production quotas, capacities and quantities of sugar factories in Turkey

Factory/ Company Name	Beet processing capacity (Tone/Day)	Sugar production capacity (Tone/Year)	2018/2019 A Quota, (Tone/year)	Sugar Quota, (Tone/year)	Amount of processed beet (Tone)	Amount of sugar produced (Tone)	Capacity utilization rate (%)	C Sales of sugar		
								Direct export (Tone)	Manufacturer-Exporter Sales (Tone)	Total (Tone)
Adapazarı Sugar Factory	6 000	99 000	63 000	55 500	497 200	65 870	67	0	14 689	14 689
Amasya Sugar Factory	5 800-6 000	99 070	74 300	69 100	654 500	82 885	84	850	3 722	4 572
Kayseri	12 960	241 056	328 800	328 800	1 385 000	196 676	82	4 999	11 085	16 084
Boğazlıyan	15 000	288 000			1 450 000	202 928	70	0	4 464	4 464
Kayseri Sugar Factory	27 960	529 056	328 800	328 800	2 835 000	399 604	76	4 999	15 549	20 548
Konya	9 284	278 505	435 500	435 500	1 404 000	207 100	74	0	5 820	5 820
Çumra	14 850	325 215			2 388 000	329 700	101	1 000	11 252	12 252
Konya Sugar Factory	24 134	603 720	435 500	435 500	3 792 000	536 800	89	1 000	17 071	18 071
Kütahya Sugar Factory	3 500	45 400	43 800	40 500	334 300	49 080	108	0	5 650	5 650
Keskinkılıç Sugar Factory	6 333	107 016	107 000	107 000	744 586	110 299	103	78	122	200
Private Total	73 827	1 483 262	1 052 400	1 036 400	8 857 586	1 244 538	84	6 927	57 899	64 825
Türkiye Şeker Fabrikaları AŞ. Total	47 311	842 842	636 850	624 350	4 452 700	561 869	67	0	8 454	8454
Privatization Total	57 281	1 193 360	875 750	875 750	7 157 300	963 181	81	0	8 711	8 711
Grand Total	178 419	3 519 464	2 565 000	2 536 500	20 467 586	2 769 588	79	6 927	75 063	81 990

Source: Abolished Sugar Authority (2016)

Within the scope of privatization TSFI's loss are 936.8 million TL in last five years (2013-2017). Furthermore TSFI made lose 1.4 billion TL in 2018. It is foreseen that the privatization activities will be accelerated due to the factors that hamper the competitive conditions such as the inefficiency of some factories, the high cost of production and the energy consumption, the high number of public factories in the sector and the high domestic sugar prices.

In this context, the privatization of 14 factories of TSFI in 2018 has been started and no demand was received for a factory (Kastamonu Sugar Factory), for three factories (Bor Sugar Factory, Ilgın Sugar Factory, Yozgat Sugar Factory) buyer companies were unable to fulfill the obligation due to the economic crisis and the remaining 10 factories were sold. The following table shows the factories', which are sold, capacity, quotas, amount of beet processed, amount of produced sugar, number of farmers and total number of employees in 2017/2018 marketing year (Table 4).

Table 4. Situation of Sugar Factories which produce beet sugar and are privatized in 2018 in Turkey.

Factory/ Company Name	**Beet processing capacity (Tone/Day)**	**Sugar production capacity (Tone/Year)**	**2018/2019 A Quota, (Tone/year)**	**2017/2018 Marketing year**					
				Sugar Quota, (Tone/year)	**Amount of processed beet (Tone)**	**Amount of sugar produced (Tone)**	**Capacity utilization rate (%)**	**Number of Farmer**	**Number of Worker**
Afyon	6 500	151 000	115 000	115 000	987 500	135 150	90	3 973	299
Alpullu	4 000	48 000	25 000	25 000	115 000	11 000	23	793	194
Bor	3 655	83 360	62 000	62 000	446 000	59 765	72	2 169	298
Burdur	5 319	110 000	74 000	74 000	595 500	78 900	72	5 020	286
Çorum	6 700	131 000	95 750	95 750	844 000	113 170	86	2 678	282
Elbistan	3 557	69 000	50 000	50 000	415 500	51 720	75	2 710	270
Erzincan	1 854	41 000	26 500	26 500	194 000	28 080	68	1 939	224
Erzurum	2 815	72 000	50 500	50 500	317 500	46 500	65	2 617	321
Ilgın	5 400	162 000	107 500	107 500	1 073 000	140 300	87	6 621	344
Kırşehir	3 600	72 000	70 250	70 250	641 800	90 220	125	3 307	270
Muş	3 681	58 000	40 500	40 500	314 500	43 100	74	4 037	348
Turhal	7 200	135 000	100 750	100 750	848 000	113 026	84	7 027	414
Yozgat	3 000	61 000	58 000	58 000	365 000	52 250	86	2 721	272
TOPLAM	57 281	1 193 360	875 750	875 750	7 157 300	963 181	81	45 612	3 822

Table 5. Situation of Sugar Factories of TSFI which produce beet sugar

Factory/ Company Name	Beet processing capacity (Tone/Day)	Sugar production capacity (Tone/Year)	2018/2019 A Quota, (Tone/year)	2017/2018 Marketing year			
				Sugar Quota (Tone/year)	Amount of processed beet (Tone)	Amount of sugar produced (Tone)	Capacity utilization rate (%)
Ağrı	3 600	50 000	22 000	490 850 + 133 500	142 000	19 948	40
Ankara	3 603	70000	74 000		454 000	57 640	82
Çarşamba	3 000	43 000	-		0	0	0
Elazığ	1 800	29 000	27 000		154 000	20 400	70
Erciş	2 100	36 000	31 000		159 000	24 300	68
Ereğli	8 500	193 842	158 000		1 142 000	149 930	77
Eskişehir	7 200	147 000	139 300		970 000	127 100	86
Kars	1 754	26 000	14 700		74 700	10 400	40
Kastamonu	3 504	67 000	31 750		267 200	34 750	52
Malatya	3 500	60 000	52 100		369 000	45 161	75
Susurluk	7 000	84 000	59 000		533 000	47 780	57
Uşak	1 750	37 000	28 000		187 800	24 460	66
TOTAL	**47 311**	**842 842**	**636 850**	**624 350**	**4 452 700**	**561 869**	**67**

The sales prices of the factories sold and the companies selling the factories are given below (Figure 11).

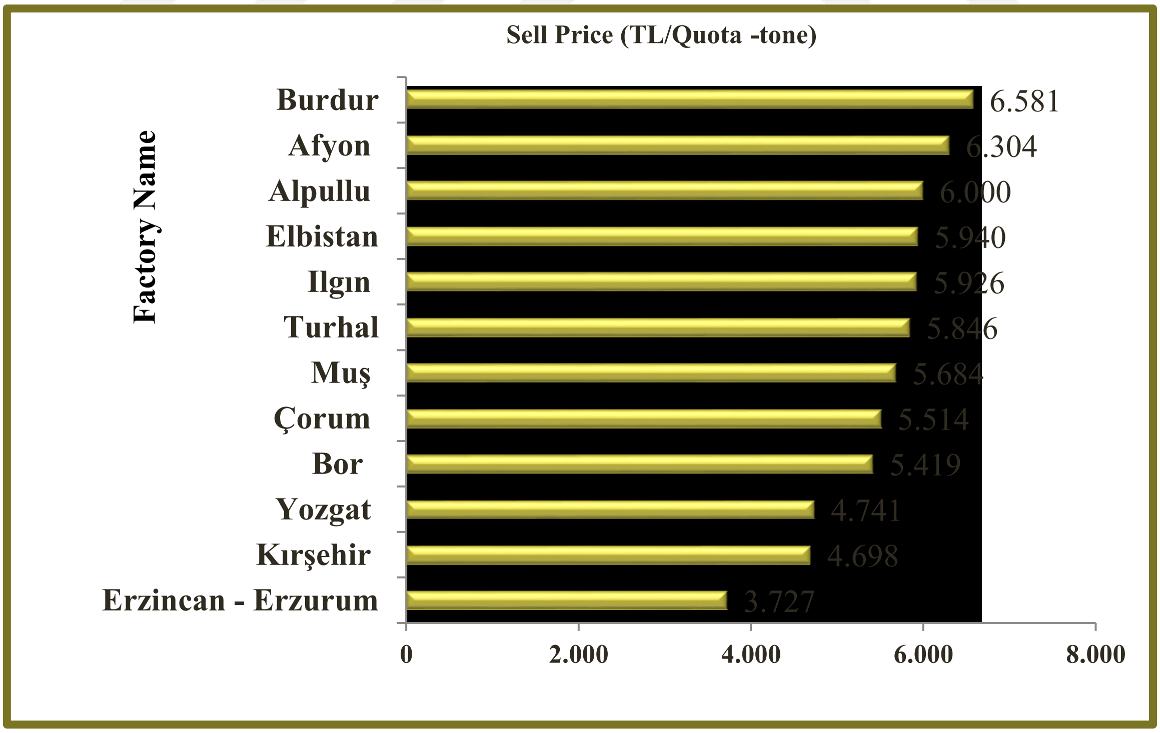


Figure 11. The Sales Prices of Privatized Sugar Factories

The sales prices of privatized sugar factories are given below (Table 6).

Table 6. The sales prices of privatized sugar factories.

Sugar Factory	First company in the tender / Company that sign contract	Amount of the sales Million TL
Afyon	Doğuş	725
Bor	Doğuş	336
Çorum	Çorum Sugar	528
Elbistan	Mutlucan Sugar	297
Erzincan-Erzurum	Albayrak	287
Kırşehir	Tutgu Gıda	330
Muş	Muş Sugar	230
Turhal	Kayseri Sugar	589
Alpullu	Binbirgıda	150
Burdur	Eser Grup .-Sterk Plast Joint Venture Group	487
Ilgın	Alteks Textile	637
Yozgat	Doğuş	275
TOTAL		**4.871**

Source: Minister of Agriculture and Forestry – Department of Sugar –November 2018

The production capacity of 33 sugar factories of 14 companies, whose quota is allocated under the Sugar Law, is 3.1 million tons/year. Thirteen of the fourteen companies are private companies and one of them which is state-owned Turkey Sugar Factories Incorporated Company within the scope of privatization. In Turkey, 2 million 536 thousand tons of beet sugar A-quota was designated for in 2017/18 marketing year and 2 million 565 thousand tons of A-quota was designated in 2018/2019 marketing year. In the 2017/2018 marketing year, 2 million 769 thousand tons of sugar was produced and 2 million 364 thousand tons of domestic sales and 56 thousand tons C-sugar were sold and a total of 2 million 420 thousand tons of sugar was sold.

On the other hand, the C-sugar demand of the the manufacturer exporters was met from within the country until the 2014/15 marketing year. However, beet production decreased due to adverse climate conditions in 2014/15 marketing year. Sugar production has been realized below the total A quota of the country which can be supplied to the domestic market and there has not been sufficient C-sugar production. In order to avoid any disruption in meeting the sugar demands of exporters, C-sugar was met by imports (Abolished Sugar Authority, 2016a: 33-34).

As for sugar prices; average sales factory prices of beet sugar excluding VAT determined by companies are given in the figure below (Figure 12).

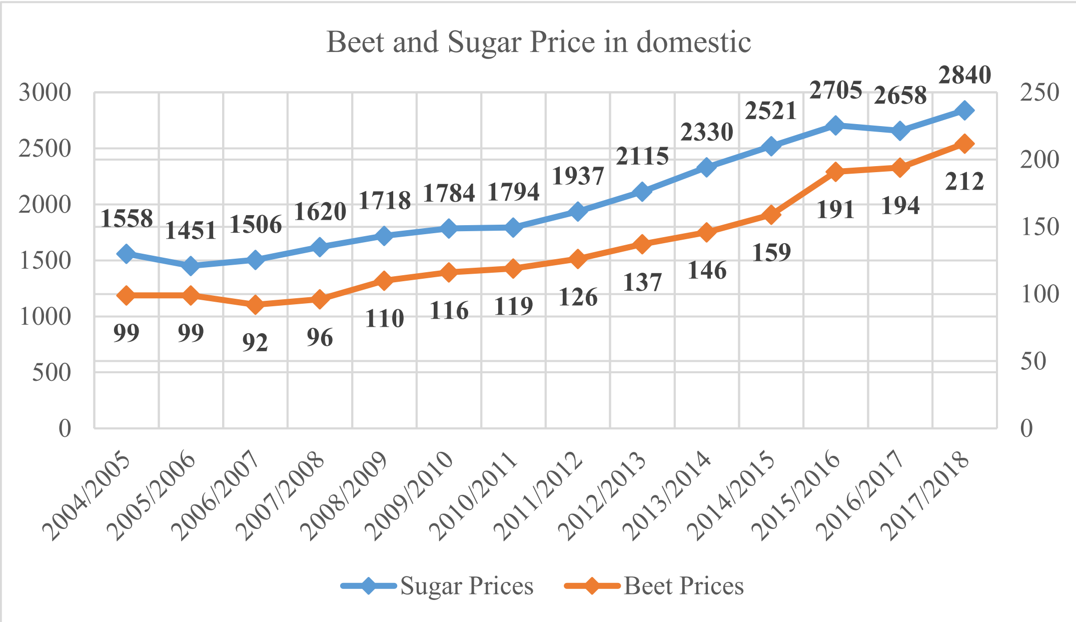


Figure 12. Beet and Sugar Price in Domestic.
Source: Abolished Sugar Authority

2.4.1. Starch-Based Sugar in Turkey

SBS is produced from corn in Turkey and in the first marketing year (2002/2003) which is immediately after the entry into force of Sugar Lawand corn production has shown a significant increase in Turkey.

SBS sugar production capacity of five factories of five companies which are allocated the quota under the Sugar Law are 1 million 53 thousand tons/year. In addition, the production capacity of five factories, which do not have a quota right and which produce starch based sugar only for export to abroad, is 350 thousand tons and the total production capacity of SBS is 1 million 403 thousand tons in the country. In the 2001/02 marketing year before the quota application, the domestic sales of SBS was 461 thousand tons, whereas in the 2017/18 marketing year in our country, the domestic sales of SBS is 281 thousand tons (Figure12) (Abolished Sugar Authority, 2017).

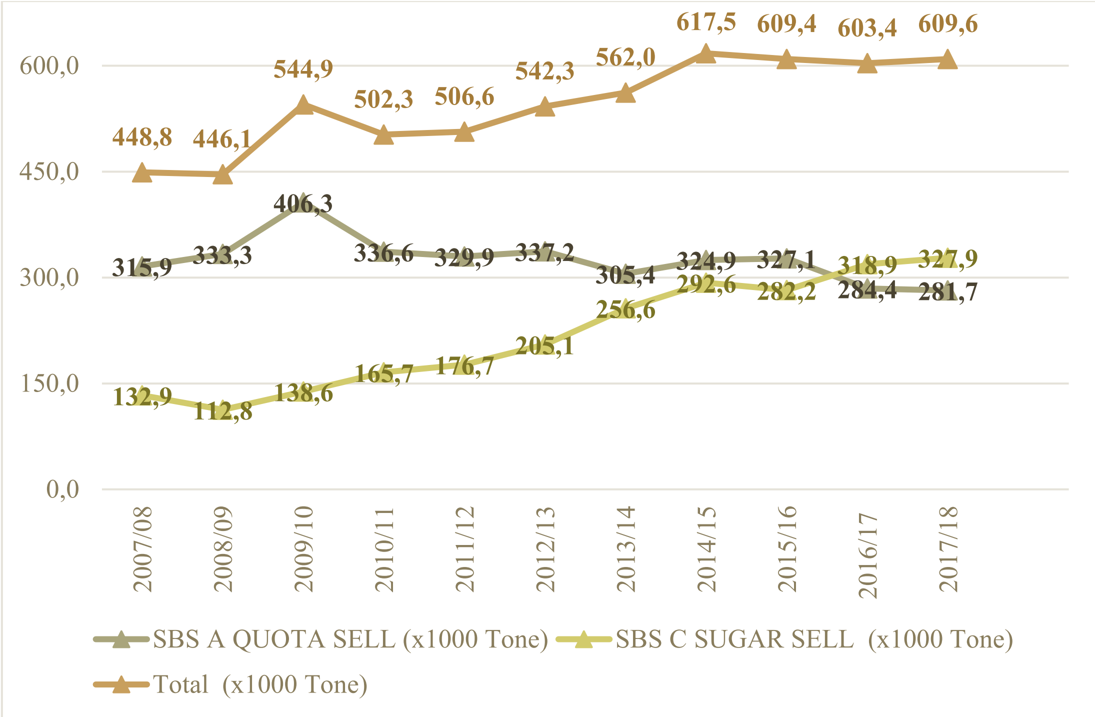


Figure 12. SBS Sell (A and C)
Source: Abolished Sugar Authority

The table below shows the increased quotas of the SBS and the prices of glucose / isoglucose with TL / Kg. In the 2018/2019 marketing year, the SBS Quota was reduced by 50% with the Law No 7103 (Table 7).

Table 7. Increase of quotas and Isoglucose and Glucose Prices

Years	Amount of SBS Quotas (Increased) (x1000 Tone)	Isoglucose TL/Kg	Glucose TL/Kg
2012/2013	336	1.49	1.42
2013/2014	308	1.61	1.43
2014/2015	330	1.79	1.59
2015/2016	330	1.93	1.71
2016/2017	318	1.96	1.84
2017/2018	260	2.14	2.08
2018/2019	135	2.33	3.02

The following figure shows the average prices of crystal sugar, glucose and isoglucose by years. It is seen that the price of glucose used in sugary products has a sudden rise in the 2017/2018 marketing year (Figure13). The reason for this is that due to the lack of glucose in the market as a result of the fall in the SBS quota, and the fact that imports cannot be realized in a short period of time, the average sold price has reached and even exceeded the price of crystal sugar.

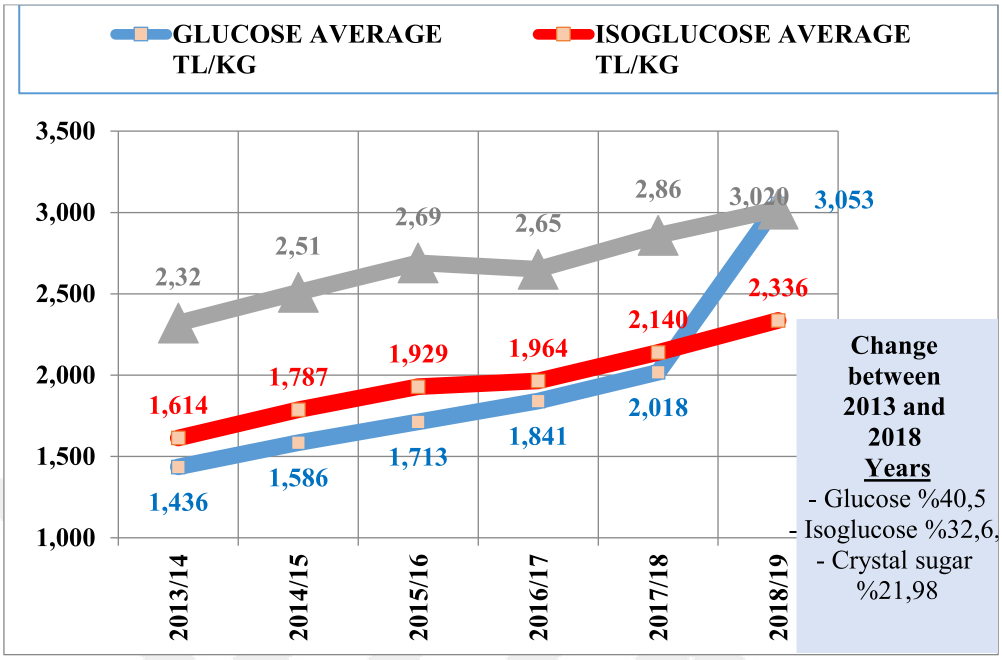


Figure 13. Average Prices for Glucose, Isoglucose and Crystal Sugar

In this chapter, general information about the concept of the sugar and sugar sector in Turkey was given. In the next chapter the sugar market, market regulations, competition potential, market forecasts after the sugar quota abolished in 2017 will be discussed.

3. SUGAR SECTOR IN EUROPEAN UNION

In this chapter general information about sugar sector in European Union (EU), such as; sugar production, consumption, export, import, abolished quota etc. is given. The EU is the world's leading producer of beet sugar, with around 50% of the total. However, beet sugar represents only 20% of the world's sugar production; the other 80% is produced from sugar cane. In order to support European growers and processors, the sugar sector was originally subject to production quotas and a minimum price. However, as part of the process of making European agriculture more market-orientated, the quota system ended on September 30, 2017. Sugar is a part of the common market organization (CMO) between EU countries. Beet farmers can get income support in the form of direct payments. EU countries also have the option to grant additional support to specific sectors in difficulty – including sugar beet and sugar cane production.

3.1. The History of Sugar Sector in European Union

Sugar was only discovered by western Europeans as a result of the Crusades in the 11th Century AD. The subsequent centuries saw a major expansion of Western European trade with the East, including the importation of sugar. Sugar cane could not be grown in Europe due to climate, so the countries in Europe turned to the refining process by importing sugar. By 1750 there were 120 sugar refineries operating in Britain. Their combined output was only 30,000 tons per annum. At this stage sugar was still a luxury and vast profits were made to the extent that sugar was called "white gold". Sugar beet was first identified as a source of sugar in 1747. Also in this process; as a result of the desire of countries to establish dominance against each other in Europe, wars emerged. During the war, countries have tried to prevent mutual damage by preventing the entry of imported products by sea, to harm each other's economy and to win the war. Because sugar is the top of these products, there has been a crisis against sugar throughout the war period on the whole continent. Thus, sugar inflow stopped to the European continent. Due to the failure to meet sugar needs, beet farming started to do domestic production to meet the need for sugar. By 1880 sugar beet had replaced sugar cane as the main source of sugar on continental Europe (Sucrose.com, 2019). Thus, the birth of beet sugar has started in Europe and after that day it has achieved until today continuously developing. Beet sugar has been competing for cane sugar. France is the world's largest beet sugar producer.

Factories has been started to establish in country like Germany, France, Australia, Hungary, Russia, Belgium and Holland. And this situation has affected the supply of metal and iron in the world. In order to make coal and steel more efficient in Europe, France, the Federal Republic of Germany, Italy, Belgium, Luxembourg and the Netherlands have established a European Coal and Steel Community (ECSC) by signing the treaty of Paris in 1951. First time in history of Europe with the treaty, states left their management of national sovereignty to the supranational organization. This treaty emerged the Treaty of Rome, which constituted the idea of the unification of Europe over the years. With the Treaty of Rome, the foundation of today's European Union and Europe's The Common Agricultural Policy (CAP) has been established (Economic Development Foundation).

The Treaty of Rome enabled the creation of the European Economic Community (EEC). With this treaty;

1. To remove all barriers to trade in the domestic market and establish a common market within 12 years,
2. To create common customs tariff for third countries,
3. To remove barriers to the free movement of goods, capital, service and persons among the member states,
4. To create common policy in agricultural field,
5. To create common fund in the field of transport,
6. To establish a system that will not distort competition for a common market,
7. To establish of European Social Fund and European Investment Bank,

were targeted (Roma Treaty, 1958).

3.2. EU Common Agricultural Policy

Common Agricultural Policy is a program that is an implementation of EU subsidies to agriculture and planning of agriculture. The purpose of the Common Agricultural Policy; to provide farmers with a reasonable standard of living, to produce quality goods at a fair price to consumers, to carry out the use of technical innovations and inventions and modernization, to ensure food safety and sustainable production in agriculture, to keep the rural economy alive and to preserve biodiversity (Treaty of Amsterdam, 1997).

There are three main dimensions to achieve the goals and objectives of the EU common agricultural policy; these are market support, income support and rural development. The agricultural sector is more dependent on weather and climate than other sectors. At the same time, minor delays in meeting the demand can show great effects on price and consumption. That's why; the first dimension is market support is of great importance for ensuring stability and security in agriculture. The second dimension is income support aiming to prevent inequality in income distribution by providing direct income support to farmers. Rural development dimension is also very important to reduce the difficulties in rural areas for ensuring regional development. Although the three dimensions are interrelated, a general sustainability can be achieved when applied together. The budget of the first two dimension is provided from the EU budget, the third dimension is financed by the member states (European Commission, 2019).

All EU member states are obliged to implement CAP as part of the European agricultural market. The collective implementation of this policy also contributes to national policies by making better use of budgetary resources. CAP has been established on the basis of three principles to achieve its goals and objectives in the Stresa Conference in 1958 (JRC Scientific and policy reports, 2014).

1. **Community Preference Principle,** is aimed to prevent the importation of the products produced in the third party countries by preferring the agricultural products produced in the EU.
2. **Common Financial Responsibility Principle,** is aimed to cover all expenditures with the participation of all members of the community.
3. **Single Market Principle,** allows the implementation of European agricultural reforms and establish a common commercial policy with other countries of the EU and establishes a common commercial policy and enables the EU to act as a single trade partner with other countries. In this context, the same price applies to the same products within the community (Keskin, 2005: 1-10).

3.3. The EU Sugar Common Market Organization (CMO)

The Sugar CMO is one of the most important elements of the EU's CAP. In 1968, the sugar common market system was established because of the necessity of quota management to prevent overproduction, to stabilize the sugar markets, to create an intervention price for refined sugar and raw cane sugar, and because of the need for special interventions for the establishment of the balance between producers and manufacturers. The EU Sugar Sector has become an active sector with this system that has been going on for about 50 years. It was characterized by a system of supply quotas, which were defined by EU legislation for each Member State. The arrangements for transferring quota (owned by factories) and delivery rights (issued to growers) within national boundaries were a matter of national competence (Benesova, Rezbova, Smutka, Tomsik and Laputkova, 2015: 1825–1838)

Since 1977, the production of isoglucose for supply into the EU market has also been subject to quota under CAP sugar sector regulations. From 1994 onwards, insulin syrup was also included within the sugar regime and subject to supply quotas.

The main products included in the EU sugar regime are white sugar, raw sugar, isoglucose and insulin syrup. The tools used by the Sugar CMO are as follows; intervention price, quota system, production taxes, minimum stock system, storage regulation.

With the **price system** is intended to provide price stability by avoiding the excessive fall and excessive rise in the prices that may occur in the common market order and to realize a fair income distribution. There are four institutional prices used in the EU sugar regime (European Commission, 2003);

1. Target Price: It is the price which is determined by the opinion that the producers will increase their income levels to the most reasonable levels and which is expected to be the result of the supply-demand movements of the community.
2. Intervention Price: The base price, which represents the lowest level of guarantee available to manufacturers. This price is determined on the basis of the highest rate of agricultural production in the community, for ensuring self-sufficiency in the EU region.
3. Basic Beet Price: It is calculated by taking into consideration the intervention price for white sugar and the process margins, the income from beet growers' sales of molasses, and the expenses incurred during the transportation of beet to the processors.
4. Minimum Beet Price: It is the price that sugar producers should pay for beet suitable for processing as sugar.

There is also a reference price described in the Council Regulation as follows.

‘***Reference price***: It should be fixed for standard qualities of white sugar and raw sugar. Such standard qualities should be average qualities representative of sugar produced in the Community and defined on the basis of criteria used by the sugar trade. It should also be possible to review the standard qualities to take into account, in particular, of commercial requirements and developments in technical analysis (Official Journal of the EU, 2006).

Reference Prices:

1. For white sugar, the reference price shall be:

(a) EUR 631.9 per tonne for each of the marketing years

2006/2007 and 2007/2008;

(b) EUR 541.5 per tonne for the marketing year 2008/2009;

(c) EUR 404.4 per tonne as from the marketing year 2009/2010.

2. For raw sugar, the reference price shall be:

(a) EUR 496.8 per tonne for each of the marketing years 2006/2007 and 2007/2008;

(b) EUR 448,8 per tonne for the marketing year 2008/2009;

(c) EUR 335.2 per tonne as from marketing year 2009/2010.’

The above mentioned reference prices are the prices applied to the unpackaged sugar from the factory. Since January 1, 2009, the reference price has been applied as 404 euro (European Commission, 2009).

In a given marketing year, a temporary and limited purchasing intervention system is implemented to contribute to the balancing of the market when market prices fall below the reference price for the next marketing year.

Also, new market instruments to be managed by the Commission were introduced. First, if market prices fall below the reference price for white sugar, operators can benefit from a special storage program under the conditions set by the Commission. Second, it is possible for the Commission to decide to attract sugar from the market as long as it needs to re-balance the market, in order to keep the structural balance of the sugar in the market close to the reference price (Official Journal of the EU, 2006).

The quota system was put into practice in 1968 and the practice was continued for five years. Quotas which are shared between member states by the Council of Ministers reduce the possible costs and enable each country to produce in a certain share. The quota system have three elements. These are A-quota B-quota and C-quota. Quotas-A and B are the quantities that can be produced within the borders of the EU. Apart from these, it is forbidden to put into C-sugar to the country. The total quota was 17.4 million tons. 82% of this amount is allocated as quota-A and 18% of this amount is as quota B. The quota system has three main objectives:

1. To limit the total amount of sugar to be transported to the EU sugar market.
2. Limit the potential cost of intervention purchases.
3. To guarantee a share in the EU sugar market for each member state.

Production taxes are the taxes collected at certain rates of quotas given for financing of sugar costs and for supplying source to intervention purchases within EU.

Minimum stock system was put into practice in the EU due to sugar shortage in 1970s. According to this system, if 5% of the quota A or the actual production is below the quota, it is obligatory to have a quota B of 5%.

Stock regulation: due to seasonality of sugar production (sugar is not produced in every period, only produce in a short period of year) there is a restriction on sugar sales by the community for. A resource is paid for storage costs. These benefits are paid to traders and intervention agencies that store sugar. The chart below shows the EU market price, world market price and the EU reference price for white sugar over the years.

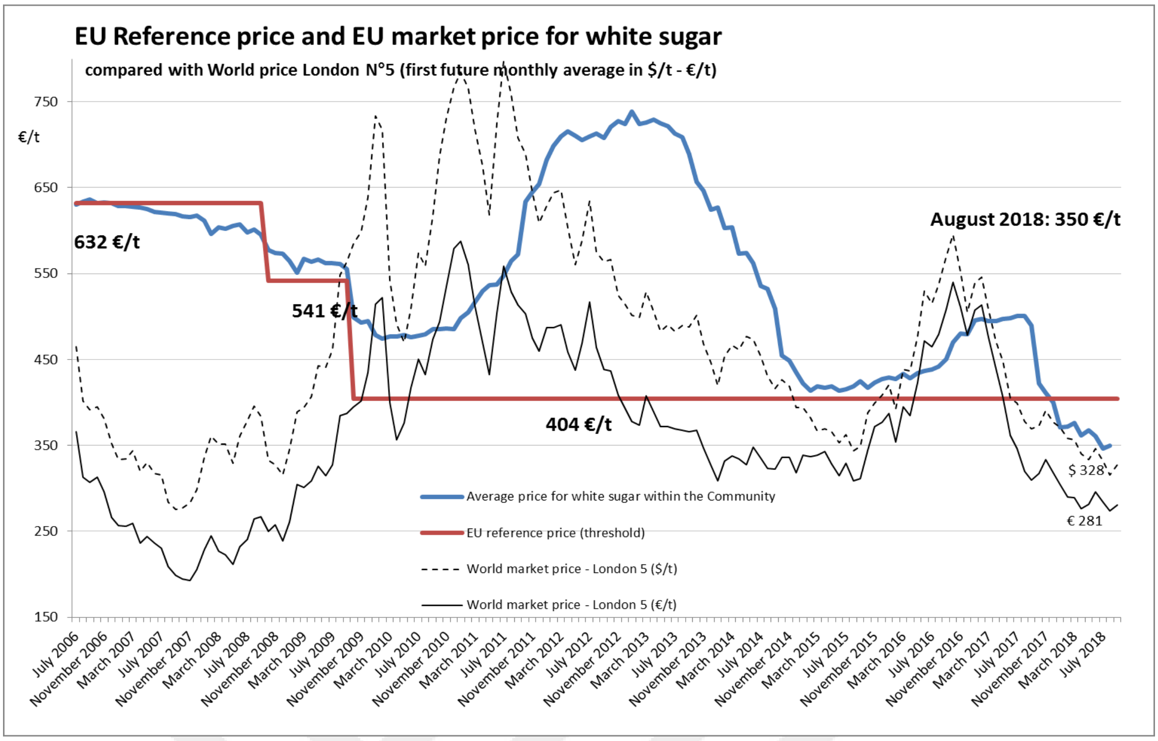


Figure 14. EU Reference Price and EU Market Price for White Sugar

As can be seen from the figure, before 2017 the EU market price was above world price and reference price, after 2017, world price and EU market price fell below the reference price (Figure 14).

3.4. The EU Sugar Regime

The EU is the world's leading producer of beet sugar, with around 50% of the total. However, beet sugar represents only 20% of the world's sugar production; the other 80% is produced from sugar cane. While the EU countries have a common market organisation for sugar, the EU has agreements with other countries worldwide on sugar import and export. The EU also has an important refining industry that processes imported raw cane sugar. For the period from 2014/2015 marketing year until 2018/2019 marketing year in the European Union; the figure below shows the production, export and import balance sheets (Abolished Sugar Authority, 2016b).

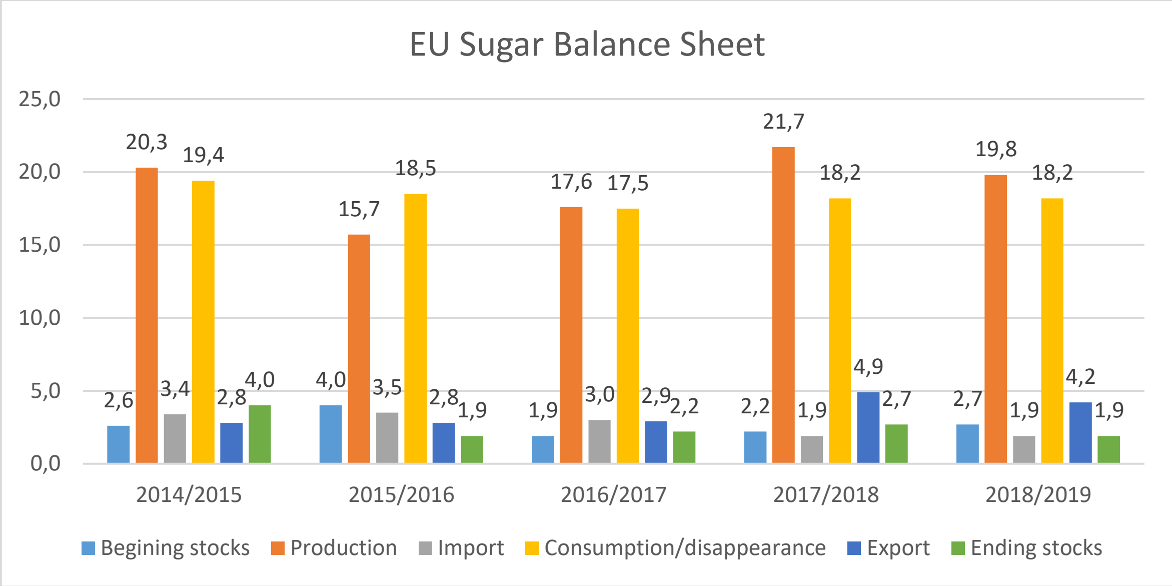


Figure 15. EU Sugar Balance Sheet 2014/2015 to 2018/2019

Source: European Commission EU Sugar Market Observatory (https://ec.europa.eu/agriculture/market-observatory/sugar/balance-sheets_en)

Most of the EU's sugar beet is grown in the northern half of Europe, where the climate is more suited for growing beet. The most competitive producing areas are in northern France, Germany, the United Kingdom and Poland. The EU also has an important refining industry that processes imported raw cane sugar. In the European Union for 2015/2016 and 2016/2017; sugar quota amount, beet cultivated agricultural land, sugar produced during the campaign, stock amount transferred from the previous year, isoglucose production, quota excess isoglucose and total sugar production is given below for 28 member countries separately.

Table 8. Final production of Marketing Year 2015/2016 (EU 28)

		SUCRE								ISOGLUCOSE	ISOGLUCOSE	SUCRE+
tons	*QUOTA*			Production	*carry forward*	*carry forward*	Total	PRODUCTION	OUT OF	QUOTA	OUT OF	**ISOGLUCOSE**
white sugar		Superficie		of the	*from 14/15*	*from 15/16*	Production	under Quota	QUOTA		QUOTA	available
equivalent	*R 183/2009*	'000 ha	t/ha	campaign	*to 15/16*	*to 16/17*			*(indust. + carry f.)*		(export / release EU market)	QUOTA PRODUCTION
		(a)	(b)	(c)	(d)	(e)	(f) = (c) + (d) - (e)	(h)	(g)= (f) - (h)			
BE	*676 235*	53.7	*13.6*	749 371	87 605	34 750	802 226	676 235	125 991	114 580	0	**790 815**
BG					0	0	0	0		89 198	23 210	**89 198**
CZ	*372 459*	53.6	*9.3*	455 877	65 300	14 669	506 508	372 459	134 049			**372 459**
DK	*372 383*	24.8	*12.5*	310 901	65 000	3 135	372 766	372 383	383			**372 383**
DE	*2 898 256*	282.7	*11.8*	2 953 158	921 094	220 594	3 653 657	2 898 256	755 402	56 638	0	**2 954 894**
EL	*158 702*	4.9	*5.1*	150 719	6 180	0	156 899	156 899	0	0		**156 899**
ES(**)	*498 480*	37.0	*15.2*	552 207	80 535	120 762	511 980	498 480	13 500	53 810	0	**552 290**
FR (met.)	*3 004 811*	349.6	*13.0*	4 011 772	197 310	60 798	4 148 284	3 004 811	1 143 473			**3 004 811**
FR (Dom)	*432 220*			554 717			554 717	432 220	122 497			**432 220**
HR	*192 877*	16.2	*6.7*	119 576	74 413	3 613	190 376	190 376	0			**190 376**
IT	*508 379*	38.1	*7.3*	480 398	194 118	166 137	508 379	508 379	0	29 712	0	**538 091**
LT	*90 252*	12.3	*8.1*	128 018	6 000	0	134 018	90 252	43 766			**90 252**
HU	*105 420*	15.0	*7.5*	128 834	0	4 584	124 250	105 420	18 830	250 266	37 793	**355 686**
NL	*804 888*	56.9	*13.4*	765 336	189 000	25 000	929 336	804 888	124 448	0		**804 888**
AT (*)	*351 027*	45.4	*9.4*	408 248	91	80	408 258	351 027	57 231			**351 027**
PL	*1 405 608*	171.6	*8.5*	1 423 780	321 716	90 160	1 655 336	1 405 608	249 728	42 861	0	**1 448 470**
PT (continen	*0*			0			0	0		6 438	0	**6 438**
PT (Açores)	*9 953*	0.1		9 859			9 859	9 859	0			**9 859**
RO	*104 689*	23.6	*6.0*	176 884	34 593	13 612	197 865	104 689	93 176			**104 689**
SK	*112 320*	21.7	*7.7*	200 189	0	0	200 189	112 320	87 869	68 095	0	**180 414**
FI	*80 999*	12.5	*4.8*	120 208	11 229	0	131 437	80 999	50 438	0		**80 999**
SE	*293 186*	19.0	*10.3*	257 764	83 000	0	340 764	293 186	47 578			**293 186**
UK	*1 056 474*	74.2	*13.2*	977 611	360 759	168 949	1 169 421	1 056 474	112 947			**1 056 474**
TOTAL	*13 529 618*	1 313	*10.9*	14 935 427	2 697 944	926 845	16 706 525	13 525 219	3 181 306	711 598	61 003	**14 236 817**

Source: European Commission, 2017

Table 9. Final production of Marketing Year 2016/2017 (EU 28)

		SUCRE								ISOGLUCOSE	ISOGLUCOSE	SUCRE+
tonnes	*QUOTA*			Production	*carry forward*	*carry forward*	Total	PRODUCTION	OUT OF		OUT OF	**ISOGLUCOSE**
white sugar		areas yield		of the	*from 15/16*	*from 16/17*	Production	under Quota	QUOTA	QUOTA	QUOTA	available
equivalent	*R 183/2009*	'000 ha	t/ha	campaign	*to 16/17*	*to 17/18*			*(indust. + carry f.)*		*(export / release*	QUOTA PRODUCTION
		(a)	(b)	(c)	(d)	(e)	(f) = (c) + (d) - (e)	(h)	(g)= (f) -(h)		EU market)	
BE	*676 235*	*56.4*	*11.4*	729 058	34 750	29 786	734 022	676 235	57 787	114 580		**790 815**
BG					0	0	0	0		89 198	11 581	**89 198**
CZ	*372 459*	*52.3*	*11.9*	593 684	14 669	47 872	560 481	372 459	188 022			**372 459**
DK	*372 383*	*32.7*	*12.2*	400 284	3 135	8 600	394 819	372 383	22 436			**372 383**
DE	*2 898 256*	*310.4*	*12.3*	3 567 861	220 594	233 312	3 555 144	2 898 256	656 888	56 638		**2 954 894**
EL	*158 702*	*5.3*	*6.0*	221 421	0	13 519	207 902	158 702	49 200	0		**158 702**
ES	*498 480*	*32.8*	*14.6*	468 244	120 762	90 526	498 480	498 480	0	53 810		**552 290**
FR (Met.)	*3 004 811*	*375.0*	*12.4*	4 132 626	60 798	351 619	3 841 805	3 004 811	836 994			**3 004 811**
FR (Dom)1	*432 220*			547 674			547 674	432 220	115 454			**432 220**
HR	*192 877*	*18.8*	*11.0*	362 990	3 613	60 213	306 390	192 877	113 513			**192 877**
IT	*508 379*	*32.4*	*7.8*	377 838	166 137	35 785	508 190	508 190	0	30 256		**538 446**
LT	*90 252*	*14.7*	*9.7*	163 229	0	38 076	125 153	90 252	34 901			**90 252**
HU	*105 420*	*13.7*	*10.5*	158 250	4 584	22 582	140 253	105 420	34 833	225 239	37 701	**330 659**
NL	*804 888*	*66.8*	*13.1*	872 805	25 000	27 500	870 305	804 888	65 417	0		**804 888**
AT	*351 027*	*43.6*	*12.0*	486 518	80	81 270	405 328	351 027	54 301			**351 027**
PL	*1 405 608*	*202.9*	*10.3*	1 960 739	90 160	265 840	1 785 060	1 405 608	379 452	42 861		**1 448 470**
PT (Contine)	*0*			0		0				3 740		**3 740**
PT (Açores)	*9 953*	*0.1*		9 937		0	9 937	9 937	0			**9 937**
RO	*104 689*	*23.7*	*7.0*	170 995	13 612	21 320	163 287	104 689	58 598			**104 689**
SK	*112 320*	*21.7*	*9.5*	221 046	0	52 127	168 919	112 320	56 599	68 095		**180 414**
FI	*80 999*	*11.6*	*6.1*	137 953	0	27 842	110 111	80 999	29 112	0		**80 999**
SE	*293 186*	*30.1*	*10.8*	336 477	0	27 000	309 477	293 186	16 291			**293 186**
UK	*1 056 474*	*70.6*	*12.7*	917 064	168 949	22 510	1 063 503	1 056 474	7 029			**1 056 474**
TOTAL	*13 529 618*	1 416	*11.5*	16 836 694	926 845	1 457 299	16 306 240	13 529 413	2 776 827	684 417	49 282	**14 213 830**

Source: European Commission, 2017.

With regard to employment, there are roughly 145 000 sugar beet growers in 20 different Member States in the EU and 28 000 direct jobs in the sugar beet processing in 2017.

The EU was one of the largest importers of cane sugar through economic partnership agreements with the African, Caribbean and Pacific countries until 2017. Moreover, the EU was a sugar exporter, which exports predominantly to neighbouring countries in Middle East and North Africa until the same year.

The following figure shows the import (Figure 16) and export (Figure 17) figures for the EU 2015/2016, 2016/2017 and 2017/2018 period, and the countries in which they are made.

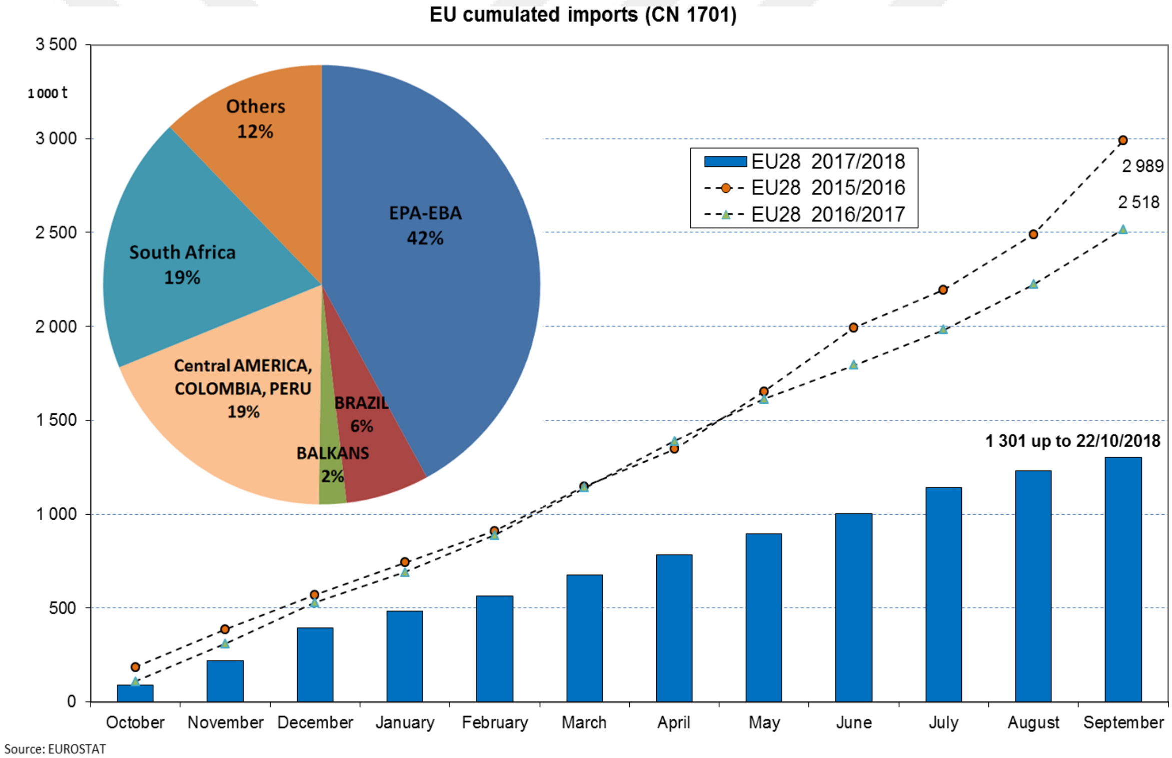


Figure 16. EU Cumulated Imports Last Three Marketing Years.

Source: EU Sugar Market Situation 25 October 2018

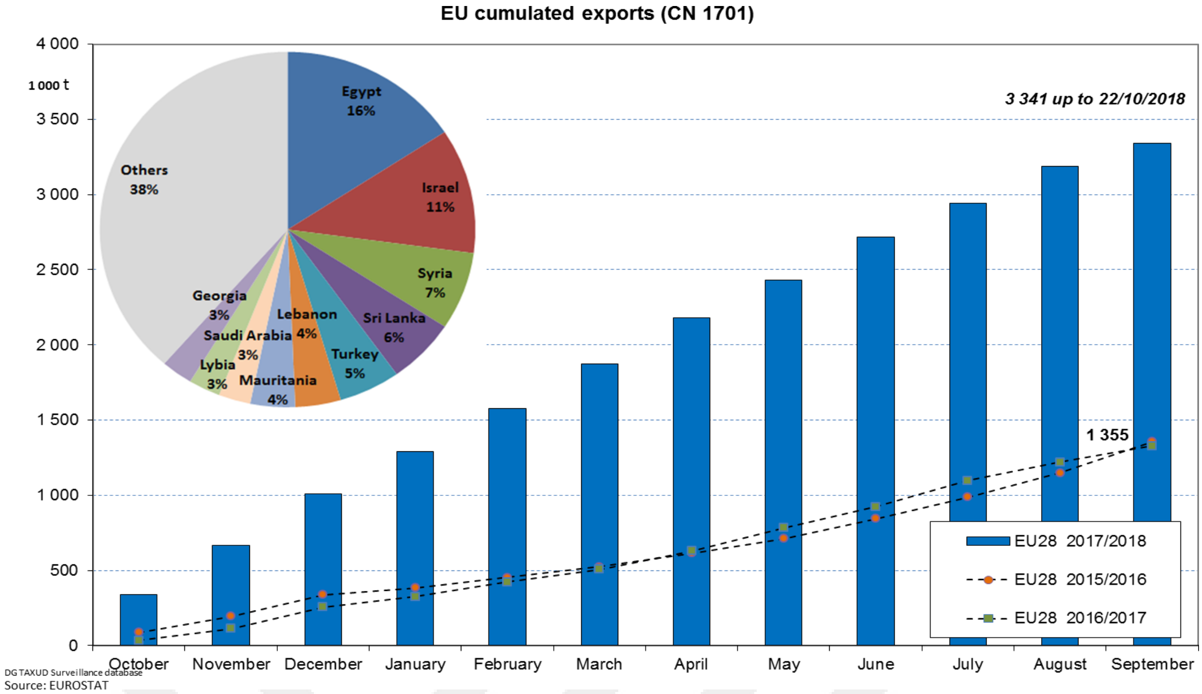


Figure 17. EU Cumulated Exports Last Three Marketing Years.

Source: EU Sugar Market Situation 25 October 2018

The volume of sugar imported and the sugar produced is used for the domestic market in the drink and food industry. Only a minor part of the sugar is consumed in the market. Before the abolishment of quotas, out-of-quota sugar was used for exports, specified chemical uses and bioethanol production. The remaining volume of out-of-quota sugar would be carried to the next marketing year as quota sugar.

Sugar is the only agricultural sector in the EU where its production is dependent on a quota system until 2017. It was declared with the first rules on the Sugar Common Market Organisation (CMO) in 1968, together with a support price for producers at a level importantly over the world market price. At the time, one of its basic objective of the recently announced Common Agricultural Policy (CAP) had the self-sufficiency of the continent for its food production by encouraging agricultural production with remunerative and stable prices for farmers. Together with a support prices, quotas gave a welcome encouraging to achieve these aims in the sugar sector.

The CAP is a dynamic policy which has constantly adapted over time to fit with the realities and evolving challenges of food production, market demands, environmental concerns and farmers' needs. The shift from product support (through prices) to producer support (through income support via direct payments) started in 1992. After, in 2003 an additional reform consolidated this transition by decoupling the direct payments from the production of any specific product.

The quota system works are below:

-The total EU production quota of 13.5 million tonnes of sugar is shared between 20 Member Countries.

-In surplus of the quota production is known as "out-of-quota" sugar and strict rules govern its use.

-There is also a small quota of 0.72 million tonnes for an alternative sweetener named Glucose Fructose Syrup (also known as isoglucose) and excess production of isoglucose is subject to similar restrictions.

3.4.1. The 2006 Reform of the EU Sugar Regime

In the case of sugar, the way for the transition was paved with a significant reform in 2006. The 2006 Reform of the EU Sugar Regime, operational since July 1, 2006, had the main objective of encouraging sugar production to migrate to more cost efficient regions by offering higher cost producers an opportunity to leave the industry above compensation and surrender production quotas. With the Reform, the European Commission targeted a cut in overall EU sugar production of as much as 6 mln tonnes. In September 2007, new elements were agreed to speed up the Reform. “The European Commission, in a 2011 full impact assessment study, considered the 2006 Reform to be relatively successful, as it eliminated some key market control measures of domestic support, such as price intervention, production and export refunds” (European Commission, 2011).

The reform included the gradually reduction of support prices for sugar and beet, the phasing out of public intervention until 2008/2009, ceasing paying export refunds as from 2008, and also a mechanism to support the restructuring of the whole industry that took place between 2006 and 2010. In 2015, Member Countries agreed on the principle of the end of quotas. A system of voluntary compensation (value €5.4 billion) for ceasing the activity resulted in the decreased the quota production by about 6 million tonnes and led to the creation of a more competitive EU sugar sector ready to compete on a deregulated EU market closer to international prices and to led to benefiting advantages from market opportunities, both in the world and the domestic markets.

After this important transition, and following initially agreeing the end of the quota system for sugar in 2015, the European Parliament (EP) and Member States decided to postpone 2013 CAP reform which is landmark for two years until the end of the 2016/17 sugar marketing year.

There is also a long established and wide consensus among EP, agricultural stakeholders and Member States about the CAP needs to be simplified. The quota and price management required administrative resources and complex monitoring both for the authorities and the operators.

Key Policy Changes of the 2006 EU Sugar Reform are summarized below (ISO-MECAS, 2014: 2-6);

1- Reference sugar prices, which have changed intervention prices, were decreased by 36% over four years starting from 2006/07. The 2006/07 white sugar support price of EUR 631.9/tonne was reduced to EUR 404.4/tonne by the end of the transition period in 2009/10. The reference price for raw sugar was set at initially EUR 523.7/tonne in 2006/07, and was reduced to EUR 335.2/tonne by 2009/10; (European Commission, 2011: 98).

2- The Sugar price intervention (an obligation of the Commission to buy from the industry any unsold quota sugar at a guaranteed price) was abolished after 2009/10 and replaced with a system of private storage. Producers taking advantage of the scheme are paid a private storage aid. Intervention up to 2009/10 was limited to 600 thousand tonnes per marketing year and the buying- in took place at 80% of the reference price of the following marketing year; (European Commission, 2011: 100).

3- For sugar, export refunds were suspended from 2008,

4- Direct payments to compensate farmers leaving the sector comprised 64.2% of the revenue loss,

5- A restructuring fund paid a basic EUR 730/tonne up to 2007/08 for producers to renounce their quotas and quit the industry, with at least EUR 73/tonne going to ex-growers (the fund was paid for by a levy on continuing processors). To qualify for the restructuring money, which fell to EUR 625/tonne in 2008/09 and EUR 520/tonne in 2009/10, sugar firms had to give up their rights to the quota, stop production altogether in at least one factory, close the factory (or factories) and restore good environmental conditions of the site and help the redeployment of factory staff;

6- The quota system was simplified: the “A” and “B” quotas were merged into a single quota.

After the 2006 Reform of the EU Sugar Regime, sugar production quotas were significantly reduced in Italy, Spain and Greece and production stopped altogether in five Member States - Ireland, Latvia, Slovenia, Bulgaria and continental Portugal. As a result, there has been a further concentration of production in the leading Member States: the market share of France and Germany increased from 43% of EU production to 52% on average. Table 8-9 shows that the largest seven sugar producers in the EU-28 (Germany, France, Poland, United Kingdom, Netherlands, Belgium and Italy) today account for a massive 85% of overall production quotas in the bloc. This is significantly up from the 76% of EU production quotas held by the seven largest producers prior to the 2006 Reform.

A major result of the Reform is a leaner industry, with importantly higher sugar beet/sugar products from a much-reduced number of factories and on a reduced product fields. The number of beet sugar factories decreased from 191 prior in 2006 to 108 in 2012/2013. Sugar beet fields declined from 2.2 mln ha in 2002/2003 to 1.7 mln ha in 2012/2013. Contrary on them, average sugar beet areas increased from approximately 60 tonnes/ha to over 70 tonnes/ha in recent years. Average sugar areas per ha also rose importantly from 9 tonnes/ha to over 11 tonnes/ha. Sugar production dropped by 20% over the period while the use of sugar beet for ethanol production has risen from less than 5 mln tonnes to nearly 9 mln tonnes (ISO, 2013).

Table 10. Provisional productions of the 2017/2018 MY (EU 28)

Tonnes white sugar equivalent		SUGAR			ISOGLUCOSE
		areas '000 ha (a)	yield t/ha (b)	Production of the Campaign (c) = (a) * (b)	Production of the campaign
BE		64.7	*15.0*	972 109	
BG					
CZ		58.1	*11.3*	655 468	
DK		34.4	*11.5*	396 893	
DE		384.8	*13.4*	5 161 378	
EL		6.2	*5.9*	36 514	
ES		36.8	*14.6*	536 390	
FR (Met.)		442.9	*13.8*	6 096 118	
FR (Dom.)				233 836	
HR		22.3	*10.3*	229 143	
IT		38.0	*8.0*	305 254	
LT		15.2	*9.3*	140 615	
HU		15.3	*9.3*	142 000	
NL		86.2	*15.4*	1 325 501	
AT		42.8	*10.9*	467 735	
PL		231.7	*10.0*	2 312 844	
PT (Continent)					
PT (Açores)		0.1		0	
RO		27.6	*7.9*	218 477	
SK		22.5	*8.0*	179 591	
FI		10.5	*6.1*	64 181	
SE		30.8	*10.0*	306 906	
UK		107.0	*12.7*	1 363 546	
TOTAL		**1 678**	***12.6***	**21 144 497**	**600 000**

Source: European Commission EU Sugar Market Observatory (https://ec.europa.eu/agriculture/market-observatory/sugar/balance-sheets_en)

One of the most notable consequences of the 2006 Reform of the EU Sugar Regime was concentration of the EU sugar industry on the most efficient producing groups. The EU hosts many of the world's largest sugar companies, such as EU Sugar Südzucker, Tereos, Nordzucker, Pfeifer und Langen and Cristal Union, which have maintained offensive consolidation/expansion over the past few years. These top producing companies dominate sugar production in the EU. They have expanded to reach 80% of the bloc's total production. This situation makes the EU one of the world's most concentrated producers today. For example, Südzucker, the world's largest sugar conglomerate, has stakes in 32 plants in Europe, including nine in Germany, five in France and other 18 factories in other nine European countries (For full details about location and production capacity, see ISO paper on "FDI and M&A in the World Sugar Industry in 2017).

3.4.2. The EU Sugar Sector After The Quotas End

Removal of the sugar quotas means that there are no more limits to exports or to production, allowing production to better adjust to market demand, both outside and within the EU. The Commission is continuously providing market transparency and information to make possible the sector to respond to market developments. A Sugar Market Observatory is operational. The goal of the organization is to provide the sugar sector with greater transparency by means of disseminating short-term analysis and market data timely. The Commission is confident that, after one or two marketing years, sugar and beet producers will have competely adapted to the new market environment. The Commission will pursue vigilant to these probable developments and will not hesitate to make use existing safety net measures to support producers. Member States have the option of providing voluntary coupled support linked to production to address sectors in difficulties, including sugar beet production.

The 2017/2018 marketing year (now coming to a close) has been characterised by significant shifts resulting from the abolition of EU production quotas. Beet production reached 142 million ton, a level never reached in the past 15 years and 27 % above the last five-year average. The driving forces behind the exceptional harvest are 1.75 million hectares, an 17% increase in the area, and an unprecedented high yield of 81.6 tons / hectares (over 13% of the five-year average). EU sugar production reached 21.1 million t, 26 % more than in 2016/2017 (European Commission, 2016).

The average EU sugar beet efficiency is predicted to reach 78.4 t/ha by 2030. Yield prospects will result in a loss in profitability for producer in the short term and the sugar beet field is predicted to reduce by 0.1 million ha over the outlook period as compared with 2018/2019 (Figure 18).

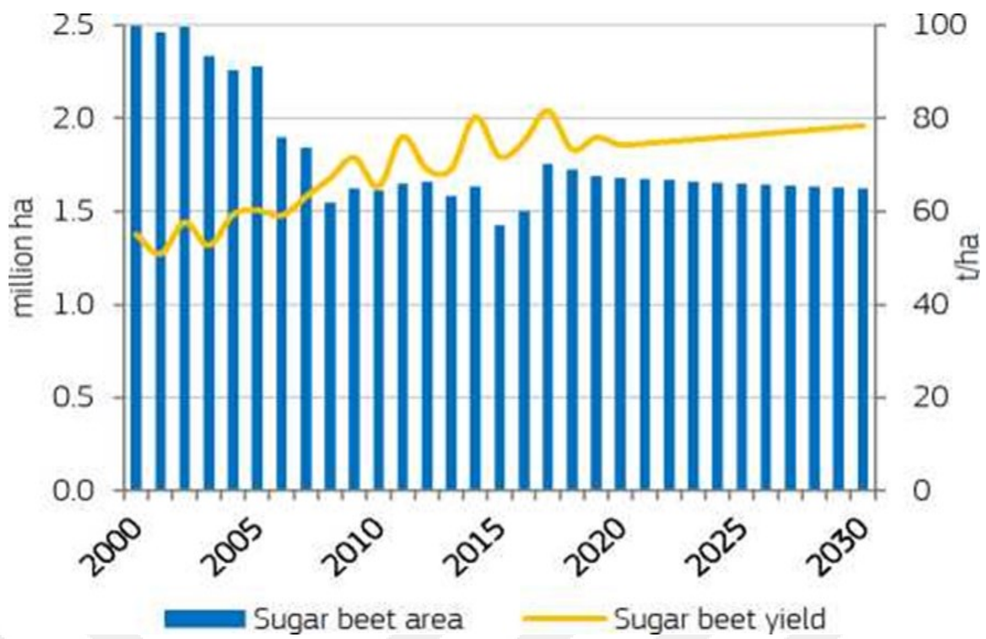


Figure 18. EU sugar beet area (ha)

Source: European Commission, 2018.

The lower beet production will automatically convert into lower sugar production. Estimated sugar production levels for 2019 is 18.8 million t and for 2020 this is 18.4 million t. This, together with some reduction in stocks over the coming years, will make it possible to maintain exports and to satisfy domestic demand, so that the EU remains a net exporter. Accounting for predicted efficiency developments, production could reach 19.3 million t by 2030. This is 13 % more than average production over the sugar quota regime from last years, but is 12 % below the especially high 2017/2018 level (European Commission, 2018).

In the next chapter, after explaining the efficiency measurement methods and basic concepts in this subject, detailed information will be given about the DEA method which is one of the efficiency measurement methods.

4. BASIC CONCEPTS, EVENT MEASUREMENT METHODS AND DATA ENVELOPMENT ANALYSIS

Businesses felt the need to improve their performance in order to sustain their lives in under increasing competition conditions. Productivity and efficiency approaches have gained more importance in each time period.

In this chapter, the basic concepts such as productivity, efficiency and effectiveness which are prominent in the production and service sector and are used in the analysis chapter of thesis are given. After explaining the concepts, brief explanations are given about the methods of efficiency measurement. And DEA's, one of the efficiency measurement, basic methodology how it works was explained.

There are three basic concepts used in performance measurement: productivity, efficiency, effectiveness. These concepts are explained below and the differences between them are given.

4.1. Basic Concepts

Basic concepts are outlined on three titles: Productivity, Efficiency and Effectiveness.

4.1.1. Productivity

Productivity; which is one of the performance criteria widely used and production-oriented concept, is defined between relationship the output that produces a production or service system and the input or inputs that uses to produce this output (Prokopenko, 2003: 19). Briefly, productivity is expressed mathematically as the ratio of output to input. Productivity=outputs/inputs.

Productivity in a firm consists of depending on many factors as well as hardware such as labor force, raw material, machine etc., the amount of capital, technological level, management and organizational structure of the company, innovation and openness to information (Bakırcı, 2006: 40). It is not enough for decision-makers to explain this relationship with a single and simple ratio such as output / input. There is a necessity to monitor this ratio for determined time periods or to compare it for different units (Akal, 2006: 45-48).

When the production involves a single output and a single input, the calculation is a insignificant issue. However, when there is more than one input a method must be used for aggregating these inputs into a single index of inputs. The same problem occurs with multiple outputs. The productivity means total factor productivity that describes a productivity measure involving all factors of production (Coelli at all, 2005: 61-82). However, the measurement or calculation of productivity varies according to many factors such as the structure of the production system, the purposes of efficiency measurement. It is essential that productivity should be measured by a model or an approach which is in a good way take something in hand the inputs and outputs of the production process and representing of the main function of the production activity efficiency. The DEA that will be mentioned in the future provides new expansions in this regard.

4.1.2. Efficiency

When we mean the efficiency we are referring to a level of performance which is described as using the least amount of input to get the highest amount of output. Efficiency requires reducing the number of unneeded resources used to produce a specific output, including energy and personal time. It is a measurable concept that can be determined by using the ratio of useful output to total input.

In terms of input or resource utilization coefficient, the efficiency rate can be defined as the relationship between the amount of resources to be consumed in order to achieve the goals set in a production unit and the amount of resources actually consumed (Debreu, 1951: 273-292).

Efficiency which is one of the dimensions of performance is defined as the capacity to achieve maximum results with minimum effort or cost in the economic sense (Kök and Deliktaş, 2003: 43-44). In addition, efficiency, as a result of the organization's activities to be implemented to achieve their defined goals and strategic objectives, determines the degree of reach these goals and objectives (Kubalı, 1998: 36-37). Measuring efficiency is important for all organizations. Information obtained as a result of efficiency measurement will help managers to ensure resource utilization, increase efficiency and make the right decisions (İlkay and Doğan, 2009: 191-218).

4.1.2.1. Technical Efficiency

Production is the process of converting inputs into outputs. Technical activity is the success of producing the maximum amount of output possible by a production unit using its inputs in the most efficient way. In DEA, the efficiency limit is the set of all possible production facilities of active decision-making units. The decision units which are given below limits the units that do not use some of their resources efficiently. As the measure of inefficiency, the efficiency score of the decision units on the efficiency limit is 1, the efficiency scores of the other decision units are calculated based on radial distances (Charnes et al. 1978: 429-431). What we call technical efficiency is defined as: "an input output vector is technically efficient if, and only if, increasing any output or decreasing any input is possible only by decreasing some other output or increasing some other input." (Koopmans 1951: 60).

While all the decision units on the production frontier are defined as technically efficient, it is thought that the decision units that fall below this limit have relatively wasted resources.

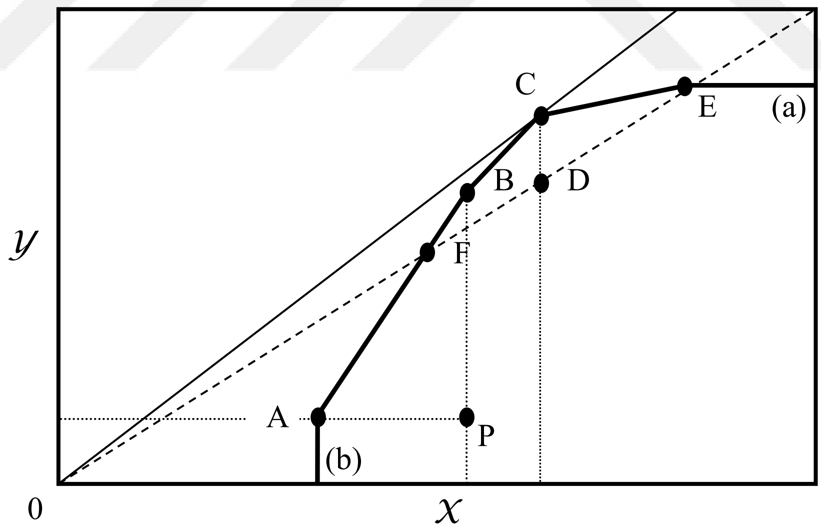


Figure 19. Technical Efficiency and Scale Efficiency

Based on the above figure; While the decision units A, B, C and E are defined as technically efficient, it is concluded that the decision-making units D and P wasted resources, they are not technically efficient.

The reason for this is examined on the figure; It appears that P decision unit uses the same amount of input as the B decision unit. However, when looking at the amount of output, it is seen that the output amount is higher. The same applies to the D decision-making unit. The decision-making unit D used the same amount of input as the C unit, but the C decision-making unit produced more output. Similarly, the decision-making unit D and the decision-making unit B produced the same amount of output, but the decision-making unit B produced the same output amount using more inputs than the decision-making unit B. As a result of all these investigations; P and D decision making units are interpreted as technical inefficiency.

When the above figure, which explains the difference between technical efficiency and productivity, is examined; the slope of the ray, which starts from the point of origin and passes through the point representing the decision unit, gives the productivity value for this decision unit. The increase in the slope of this ray indicates that the efficiency has increased. For example; when the decision units A and D are compared, the productivity of the decision-making unit D is higher than the productivity of the decision-making unit A, although the decision-making unit D is technically inefficient. Thereby, a technically efficient unit can be found to be unproductive when compared to a technically inefficient unit. Although the decision units D and E have the same productivity level, the D decision unit is not technically efficient. The decision making unit P has the lowest productivity. The decision making unit P may increase its technical efficiency and productivity by shifting towards decision making unit B (Tarım, 2001: 5-40).

4.1.2.2. Scale Efficiency

The scale efficiency can be defined as the success of production in the appropriate scale (Dikmen, 2008:4). In a production process; when the inputs are increased at the same rate, if the increase in the output level is more than the increase rate in the inputs, the increasing return according to the scale and if it is lesser, decreasing return according to the scale are mentioned. If the amount of output increases at the same rate as the increase in inputs, the scale refers to the fixed return according to the scale (Aktaş, 2001: 165). For example; in the above-mentioned figure, it appears that the C unit which is the most efficient scale size with D decision-making unit are in the same input scale. While the decision-making unit D is at the optimum scale, it has no technical efficiency by wasting its resources. Both C and D decision units are said to be efficient in scale but only C is technically efficient, and D is technical inefficient. The decision units (A, F, B), which pass through the C point and remain to the left of the line parallel to the Y axis, can be made the comment to is going to increase their productivity when they increase their scale, provided that they are technical efficiency. This situation is called increasing returns according to the scale. It is seen when the input units in this section are increased by 1 unit, an increase in output amounts by more than 1 unit. The decision units (E) that pass through point C and to the right of the line parallel to the Y axis will see an increase in efficiency when they decrease their scale while maintaining their technical efficiency. This situation is also referred to as decreasing returns by scale. The E decision unit in this section can reduce the amount of input to C level and end the inefficiency due to excessive production. Another decision unit D, has at the same scale with E decision unit which is the most efficient scale size. As a result, although D unit produces at an optimum scale it produces less output than E, for this reason it can be concluded it does not use its resources well (Tarım, 2001: 165).

4.1.2.3. Allocation Efficiency

Allocation efficiency means the use of resources to obtain the highest value (Çetin, 2010:187). In other words, the allocation efficiency is defined as the success of selecting the most appropriate input combination by taking into account the input prices of a company using multiple inputs (Bakırcı, 2006: 202).

4.1.3. Effectiveness

"Effectiveness is a performance dimension that determines the extent to which organizations achieve the objectives as a result of their activities. Effectiveness is a performance dimension that determines the extent to which organizations achieve the objectives as a result of their activities" (Horngren, Foster and Datar, 2000: 229). Organizational effectiveness is generally described in the literature as the level of obtaining the 'result' that the organization aims to achieve.

Effectiveness, which is often used in the same sense as efficiency, actually refers to a concept quite different from the efficiency. Although the efficiency is a concept related to the use of available resources, Effectiveness is a concept related to objectives and outputs. Effectiveness is defined as achievement of defined objectives and efficiency as a measure of achievement of results with minimum resources. Effectiveness seems to be more of an answer to the following questions:

• Are there really needed, useful goods and services produced?

• What is intended to be achieved in output production, but what has happened?

• In conclusion, how many of our plans at the beginning of the period have realized effectiveness.

Briefly; the most important problem in measuring the effectiveness that we define as the degree of accomplishing the objectives is the measurement of objectives. In cases where the objectives can be measured quantitatively, there is no significant problem.

4.2. Efficiency Measurement Methods

Efficiency measurement methods are outlined on three titles: Rate Analysis, Parametric Methods and Non-parametric Methods.

4.2.1. Rate Analysis

In enterprises, the most simple and widely used method for performance measurement is ratio analysis. Ratio analysis is widely used because it requires very little information and allows it to compare with a similar asset in another organization or an associated unit within the same organization. The reason for the widespread use of this analysis, which is limited to single input and single output, is that it evaluates single output by a single input. Ratio analysis is insufficient in cases where more than one input and output are required. For this reason, it was seen that in the cases where multiple inputs and outputs will be used, they are insufficient to measure performance because they are one-dimensional and can not interpret proper (Baysal, 2004: 438).

4.2.2. Parametric Methods

Parametric methods are the approaches where parameters of this function are determined by assuming that the production function of the sector or production units to be measured for efficiency has an analytical structure. The relationship between inputs and outputs is studied on a parametric basis. Regression techniques and ordinary least-squares methods are frequently used by these methods. Econometric methods allow statistical tests related to parameter values and are used frequently in recent years. Econometric methods allow statistical tests related to parameter values and are used frequently in recent years. There are different approaches to estimating variables such as econometrics, production function, productivity and technological development. Stochastic boundary approach, which enables the simultaneous estimation of technical activity, is a method which is widely used in recent years (Taymaz, Voyvoda and Yılmaz, 2008: 24-27). At the beginning of the missing aspects of the parametric method is that this analysis take into account only one output and all outputs of the decision units are reduced to a single value through a common unit. The outputs of decision-making units may not always be evaluated on the same unit and in this case analysis is impossible. Another problem is that the units are not ranked according to the most efficient unit, but all units above the average value are evaluated to be effective. This situation causes the decision units to not be fully compared in terms of efficiency. The most important deficiency of this analysis is that the production function can be determined parametrically and the production function is to be different in different decision units (Tarım and Cingi, 2000: 7-8).

4.2.3. Non-parametric Methods

Unlike parametric methods, these methods can be expressed as deterministic models. The deterministic methods do not require a complete definition of the production function and therefore parameter estimation and assume that there are deterministic relations between inputs and outputs. Therefore, they have the flexibility to measure efficiency in the production areas where there are multiple inputs and outputs. In this case, it can be said that these techniques are more sensitive to measurement errors.

The majority of non-parametric efficiency measurement methods are independent of input and output units. With these features, it allows different dimensions of the enterprise to be measured at the same time (Bakırcı, 2006: 104). Being extremely sensitive to data sets is one of the biggest disadvantages of non-parametric methods. Because of the sensitivity to these data sets, the fact that the data sets correctly represent the production process and that the data is correct prevents the measurement of errors that may occur and allows the specified input and output components to represent the production process (Yolalan, 1993:5).

Measurement techniques based on the boundary production function can be classified as follows (Figure 20) (Yavuz, 2003:23-33):

	Deterministic	Stochastic
Parametric (Econometric)	• Cobb-Douglas type production function	• Stochastic Production Limit
		• Malmquist Total Factor Productivity Index (Stochastic determination of distance functions)
Nonparametric (Linear programming)	• Data Envelopment Alysis	
	• Malmquist Total Factor Productivity Index	

Figure 20. Classification of measurement techniques based on the boundary production function approach

4.3. Data Envelopment Analysis

DEA is a non-parametric method of measuring the efficiency of a DMU such as a firm or a public sector agency, first introduced into the Operations Research (OR) literature by Charnes, Cooper, and Rhodes (CCR) (1978). “The original CCR model was applicable only to technologies characterized by constant returns to scale globally. In what turned out to be a major breakthrough, BCC extended the CCR model to accommodate technologies that exhibit variable returns to scale” (Banker at all, 1984: 1078-1092). “In subsequent years, methodological contributions from a large number of researchers accumulated into a significant volume of literature around the CCR–BCC models, and the generic approach of DEA emerged as a valid alternative to regression analysis for efficiency measurement” (Ray, 2004: 10)

DEA is a methodology based on the interesting linear programming application. It was essentially developed for performance measurement. It has been successfully employed for assessing the concerned performance of a set of firms that use a variety of identical inputs to produce a diversity of identical outputs. In today's increasingly complex management systems, performance measurement, the need to analyze enterprises and production systems in detail, and the need to improve the systems at every level are becoming more and more important (Ramanathan, 2003: 26-27).

Data envelopment analysis method is an important tool in cases where production or service systems use more than one input and produce more than one output. This method, which enables the analysis of inputs and outputs with different units, can be easily applied in a wide range of systems producing goods or services.

Under the conditions of today's intense competition, businesses have to use their scarce resources effectively during the production process. The measurement of whether companies use their resources effectively can be realized by comparing them with the enterprises producing similar products using the same production factors.

DEA provides information on the extent to which rate of efficiency of the enterprises or other decision-makers with the increase or decrease of their inputs and outputs will vary. In cases where it is difficult to convert a large number of inputs and multiple outputs into a weighted input or output set, DEA produces very valid and meaningful results. While any statistical method is evaluated according to an average manufacturer with an average trend approach, DEA compares each producer with only the best producers (Aydemir, 2002: 45). DEA is a method for measuring the relative efficiency of decision-making units with multiple outputs and inputs, as well as for determining the amount of inefficiency in the DMUs and providing information about where the inefficiency comes from. With this feature, DEA can provide support to managers by determining the amount of input reduction and / or output increase required in inactive units (Ramanathan, 2003: 27).

4.3.1. Objectives in Implementation of Data Envelopment Analysis

The objectives of the implementation of DEA can be listed as follows;

• Define the relative inefficiencies and resources of each of the decision-units to be compared, in each of the input-output dimensions,

• Classification of decision-making units according to the efficiency values,

• Evaluation of the management of the decision-making units,

• Establishing a quantitative basis for the use of resources for decision-making units and replacing limited resources with units that can be used more effectively to achieve the desired output level,

• Providing that standards which determined for specific input-output relationships with realized performance are compared and investigated,

• To determine the adequate standards for the sector in which the decision making units are compared,

• Determining reference input and output amounts for inefficient decision-making units by using efficient decision-making units according to the determined standard,

• Showing inefficient decision units how much they need to reduce input amounts or increase output amounts in order to become efficient, based on reference decision units (Başkaya and Avcı, 2011: 89-90).

4.3.2. Application Steps of Data Envelopment Analysis

1- Selection of observation set (selection of decision-making units): The first stage in the DEA includes the selection of decision making units (DMU) to be compared with each other. The fact that these units are similar to each other in terms of production technology, in other words, ”homogeneous” observation cluster is very important for the results to be meaningful (Keçek, 2010: 78).

The homogeneous group of decision-making units must have the following characteristics.

• All decision-making units must have similar objectives in carrying out similar tasks.

• All decision-makers should operate under the same market conditions.

• All factors (inputs and outputs) that characterize the performance of the decision-making units within the group should be the same except for their density or size (Çekin, 1991: 29-30).

The number of DMU within the observation set should be above a certain value. Otherwise, the decision unit, which is advantageous at any output / input ratio, maximizes all weights for itself and reaches the efficiency limit (Yolalan, 1993: 3-6). The number of decision-making units to be analyzed and measured by DEA is very important. There are many opinions that the number of decision-making units should be above a certain value in order to obtain meaningful and accurate results, but there is no consensus or theoretical acceptance of what the number should be. In short, Vassiloglou and Giokas (1990) stated that the number of decision-making units should be more than three times the sum of the input and output. Another point of view is that the number of inputs and outputs depends on the number of the decision making unit should be at least 20 based on their experience (Norman and Stoker, 1991: 262). Bowlin (1998) stated that there should be at least three decision units per input and output variable. Another view (Boussofiane at all, 1991: 1-15) is that there should be at least one more decision making unit than the sum of the number of inputs and outputs.

2- Selecting input and output sets: Since DEA is a data-based activity measurement technique, getting healthy measurement results is directly proportional of meaningful inputs and outputs.

3- The aim at this stage is; the selection of the inputs and outputs that can best express the production technology. For this reason, the list of all candidate inputs and outputs to be associated with production should be made and work should be started. Then, the variables, that is determined with some preliminary statistical analysis, have very high correlation between them and have no direct effect on production should be eliminated. (Yolalan, 1993: 3-6).

4- Relative efficiency measurement with DEA: After the observation set consisting of the decision units which will be made comparative analysis and the related input output sets are selected, the analyst who will measure the activity chooses the DEA model which is most suitable for the present production environment (Yolalan, 1993: 65-70). For each of the decision units, efficiency values ranging from 0 to 1 are calculated. Decision units with an efficiency value equal to 1 are considered efficient (Keçek, 2010: 80).

5- Detail analysis for each decision unit: After the measurement of the relative efficiency, the measures to be taken in order to improve the decision-making units which are not efficient according to the results are determined (Yolalan, 1993: 65-70).

6- Evaluation of the results: In the final stage of DEA, common findings for the efficient and inefficient decision-making units of the observation cluster are investigated. In addition, information and comments can be made about the preventions that need to be taken in order to convert the company into an efficient state (Yolalan, 1993: 65-70).

4.3.3. Models in Data Envelopment Analysis

If there are multiple decision-making units (DMU) for a decision-maker, it is important to measure the efficiency of the decision-making units and to shape the decision as a result of this activity measurement. Decision makers want to increase the efficiency of inefficient decision-making units because there are many costs involved (Yücel, 2015: 37) The decision-maker wants to know how much, to what extent, or what input or input sets, and what output or output sets should be set.

DEA mathematically, is based on the ratio of the sum of the weighted outputs of "a" decision unit to the sum of the weighted inputs, and in this respect uses linear programming as a solution technique.

The Efficiency of any decision-making unit (for any "j" DMU) is as follows:

$$E = \frac{u_1 y_1 + u_2 y_2 + \ldots + u_s y_s}{v_1 x_1 + v_2 x_2 + \ldots + v_m x_m}$$

In formula, there are "*s*" output and "*m*" input for "*j*" decision making unit. Here, "u_s *s*." the weight of the output, "y_s *s*." the amount of output, "v_m *m*" the weight of the input and "x_m *m*." indicates the amount of input.

There are two ways to increase the efficiency of "a" decision unit, as the overall efficiency formula is the ratio of outputs to inputs:

I. Decreasing the amount of input while keeping the outputs fixed (for input)

II. Increasing the amount of output while keeping inputs fixed (for output)

The first approach is known as input oriented, and the second is known as output oriented. For input-DEA models focus on how to use the most appropriate input composition to be used to provide the most efficient output composition. Output-oriented DEA models with the same thought emphasizes the maximum output that can be achieved with the combination of a particular input composition.

Models can also be classified according to efficient limit types. This distinction is referred to as constant return to scale models and variable return to scale models. One unit increase in inputs in constant income model leads to an increase in output at the same rate; in the variable-return to scale model, a one-unit increase in the input leads to a different rate of output increase (Çiftçi, 2004: 126).

4.3.3.1. The CCR Model

These models, named after the initials of Charnes, Cooper and Rhodes, are based on the constant returns to scale. This model measures the total efficiency under the assumption of constant return to scale. There are many researches and publications on health sector, banking, energy and education institutions where data envelopment analysis is used.

Although various models have been developed, the CCR model is widely used today (Tarım, 2001: 5-40). (See Özden, 2008, Baysal, Uygur, and Toklu, 2004: 437-442, Cingi, Selçuk and Armağan 2000, National Productivity Center 2001)

Once the CCR model is solved "n" times, the input and output weights and their efficiency limits are obtained. This limit is considered to be a relative efficiency criterion and it is thought that at least one decision unit will be on this boundary (Yıldırım, 2009: 69). Like all linear programming models, DEA models can be expressed in two different forms: primal and dual. In the data envelopment analysis, the dual model is more used to achieve the best solution according to the primal model, both because it requires less mathematical processing and provides important managerial information.

The optimal weights may vary from one DMU to another DMU. This generally will happen. Thus, the weights in DEA are derived from the data instead of being fixed in advance. Each DMU is appointed a best weights group with variables values.

The total value of dual variables in the optimal solution of the CCR model established for any "k" decision-unit indicates the direction of return to scale for the decision-unit "k" (Banker at all, 1984: 1078-1092):

$$\sum_{i=1}^{n} \lambda_{ki} = 1 \quad \Rightarrow \quad \textbf{CSR (constant returns to scale)}$$

$$\sum_{i=1}^{n} \lambda_{ki} < 1 \quad \Rightarrow \quad \textbf{IRS (increasing returns to scale)}$$

$$\sum_{i=1}^{n} \lambda_{ki} > 1 \quad \Rightarrow \quad \textbf{DSR (diminishing returns to scale)}$$

Figure 21. Returns to Scale.

The CCR primal and dual model for input can be defined as follows (Norman and Stoker 1991: 6-195).

Input-oriented CCR model

Table 11. Input-oriented CCR model

Primal Model	***Dual Model***
$Max\ e_0 = \sum_{r=1}^{s} u_r y_{rj0}$	$Min\ \theta$
s.t. $\sum_{r=1}^{s} u_r y_{rj} - \sum_{i=1}^{m} v_i x_{ij} \leq 0$ $\quad$ ***j* = 1,2,…..,*n***	s.t. $\sum_{j=1}^{n} \lambda_j y_{rj} \geq y_{rj0}$ $\quad$ *r* = 1,2,…..,*s*
$\sum_{i=1}^{m} v_i x_{ij0} = 1$	$-\sum_{j=1}^{n} \lambda_j x_{ij} + \theta x_{i\,j0} \geq 0$
$u_r \geq 0, v_i \geq 0$	$\lambda_j \geq 0,\ \theta : free$
r* =1,2,…..,*s*; *i* =1,2,…..,*m	*j = 1,2,…..,n*

In the primal model, the weighted sum of the inputs is limited to 1 and it is aimed to maximize the weighted output sum of the decision unit by selecting the appropriate values for "u_r" and "v_i". A decision-making unit in the dual model; only if the efficiency rate value "θ" is equal to 1 and all slack variables are equal to zero is determined as efficiency. In the dual model, weights (λ_j) are calculated on the decision units instead of the weights on the input or output. In addition, weights should be equal to or greater than zero in the dual model (Norman and Stoker, 1991: 255-275).

Output-oriented CCR model

Table 12. Output-oriented CCR model

Primal Model	***Dual Model***
$Min\ e_0 = \sum_{i=1}^{m} v_i x_{i\,j0}$	$Max\ \theta$
s.t. $-\sum_{r=1}^{s} u_r y_{rj} + \sum_{i=1}^{m} v_i x_{ij} \geq 0$ $\quad$ ***j* = 1,2,…..,*n***	s.t. $\sum_{j=1}^{n} \lambda_j x_{ij} \leq x_{ij0}$ $\quad$ *i* =1,2,…..,*m*
$\sum_{r=1}^{s} u_r y_{rj0} = 1$	$-\sum_{j=1}^{n} \lambda_j y_{rj} + \theta y_{i\,j0} \leq 0$
$u_r \geq 0, v_i \geq 0$	$\lambda_j \geq 0,\quad \theta$ free
r* =1,2,…..,*s*; *i* =1,2,…..,*m	*r* =1,2,…..,*s*; *j = 1,2,…..,n*

The objective function of the CCR primal model for the output refers to the minimization of the weighted input sum of the “n” decision-making unit. The output efficiency for the n decision-making unit of the dual model is calculated for a given set of inputs (Yavuz, 2001: 54-57).

4.3.3.2. The BCC Model

The BCC model, which is a model obtained by modifying the assumptions of the CCR model, was established under the assumption of variable return to scale. It was developed by Banker-Charnes-Cooper in 1984. Using the BCC model, can also be determined direction of return to scale for all decision units. The BCC limit is always below the CCR limit, so a DMU's CCR efficiency score will be less than or equal to the BCC efficiency score (Yıldız, 2006: 216).

This approach, which allows the efficiencies of units to be divided into two parts as “scale efficiency” and “technical efficiency”, may reveal whether causing of the inefficient decision-making units have “activity inefficiency” or “scale inefficiency”.

The BCC models for input and output are defined as follows (Norman and Stoker, 1991: 6-195).

BCC model for input:

Table 13. BBC model for input

Primal Model	***Dual Model***
$Max\ e_0 = \sum_{r=1}^{s} u_r y_{rj0} + c_0$	$Min\ \theta$
s.t. $\sum_{r=1}^{s} u_r y_{rj} - \sum_{i=1}^{m} v_i x_{ij} + c_0 \leq 0$ ***j* = 1,2,….,*n***	s.t. $\sum_{j=1}^{n} \lambda_j y_{rj} \geq y_{rj0}$ *r*= 1,2,….,*s*
$\sum_{i=1}^{m} v_i x_{ij0} = 1$	$-\sum_{j=1}^{n} \lambda_j x_{ij} + \theta x_{ij0} \geq 0$ $\sum_{j=1}^{n} \lambda_j = 1$
$u_r \geq 0, v_i \geq 0$	$\lambda_j \geq 0$, θ: free
r **=1,2,….,*s*; *i* =1,2,….,*m*; c_0 :free**	*i* =1,2,….,*m*; *j = 1,2,…..,n*

The above-mentioned input-oriented BCC models are very similar to the input-side CCR models. However, the difference between the BCC model is that the sum of "λ_j s" equal to 1, ie convexity constraint.

BCC model for input

Table 14. BCC model for input

Primal Model	***Dual Model***
$Min\ e_0 = \sum_{i=1}^{m} v_i x_{ij0} - c_0$	$Max\ \theta$
s.t. $-\sum_{r=1}^{s} u_r y_{rj} - \sum_{i=1}^{m} v_i x_{ij} - c_0 \geq 0 \quad \boldsymbol{j = 1,2,\ldots,n}$	s.t. $\sum_{j=1}^{n} \lambda_j x_{ij} \leq x_{ij0} \quad i = 1,2,\ldots,m$
$\sum_{r=1}^{s} u_r y_{rj0} = 1$	$-\sum_{j=1}^{n} \lambda_j y_{rj} + \theta y_{ij0} \leq 0 \mid \sum_{j=1}^{n} \lambda_j = 1$
$u_r \geq 0, v_i \geq 0$	$\lambda_j \geq 0, \quad \theta$ *:free*
r* =1,2,….,*s*; *i* =1,2,….,*m*;** c_0 ***:serbest	*r* =1,2,….,*s*; *j* = *1,2,…..,n*

As in the input-oriented BCC model, the output-oriented BCC model is similar to the CCR model. Similarly, difference from the output-oriented CCR model is that the sum of " λ_j " in the dual model is equal to 1. The aim is to add variable return to scale assumption to the model.

4.3.4. Strengths and Weaknesses of Data Envelopment Analysis

As in every method, DEA also has strengths and weaknesses. These are briefly summarized below (Yavuz, 2001: 51-54):

-Strengths Aspects

• DEA provides the ability to include multiple inputs and multiple outputs as a result of the use of linear programming.

• DEA allows decision makers to better understand the production process by identifying all relevant inputs and outputs.

• DEA enables simultaneous measurement of different dimensions of enterprises.

• DEA provides the opportunity to reduce the different dimensions of the enterprise to a single efficiency criterion in production environments where there are many inputs and many outputs.

• DEA does not require any assumptions about the analytical structure of the production function. In this respect, it has a more flexible structure than the parameters.

•DEA calculates the relative efficiency for each decision unit, maximizes the objective functions separately, and determines the optimal solution for each decision unit (Yolalan, 1993: 86).

• Since efficiency analysis is performed according to the boundary function generated by the best observations, instead of the average function generated by the statistical limit estimation methods, the determined targets are made by taking the best performing units as examples. This strengthens the meaning and validity of efficiency analysis with DEA.

• DEA determines the decision units which are compared, which are efficient and which are not efficient. DEA establishes alternative ways to determine the performance of an inefficient decision-making unit and to reach the level of relatively efficient decision-makers within the observation set.

-Weaknesses Aspects

• Qualitative input and output measurements may weaken the results.

• The fact that the relevant inputs and outputs accurately reflect the production process is of vital importance in terms of giving the method healthy results. The results of the method may be biased and misleading when a critical output or input is excluded from the review.

• The difference between observed performance and best performance in DEA is only based on measurement errors which are ignored for end-observation points and inefficiency. Ignoring externalities may have misleading consequences.

•Although DEA can determine the efficient and inefficient decision-making units separately, it is insufficient to compare the decision units that make up the efficiency limit (Yolalan, 1993: 86-87).

• DEA models are static and single time section models. In real life, the production process is a dynamic feature, since it will take longer than a period for decision-making units to convert certain inputs into outputs.

• Some decision units with extremely large or small input/output values in the observation set in DEA can create problems in determining the efficiency limit..

• The fact that the decision-making units in the reference group are superior to others makes it difficult to make a comment about whether these units are really efficient when evaluated on their own. For this reason, the efficiency results of DEA should be evaluated within the framework of relativism (Aydemir, 2002: 90- 93).

In the previous chapters, Turkey and EU sugar markets were mentioned, in this chapter, information about the efficiency measurement methods and the DEA is given. In the next chapter the application of the thesis and analysis will be made within the framework of the established models and the results of the analysis will be evaluated.

5. AN APPLICATION ON EFFICIENCY BY DATA ENVELOPMENT ANALYSIS METHOD: TURKEY SUGAR FACTORIES AND THE COMPARISON WITH EU

This section constitutes the application part of the thesis. In the light of theoretical knowledge in the previous sections, DEA method was used to make efficiency analysis of the sugar factories in Turkey and compared with the EU.

5.1. The Purpose and The Method of The Research

In this study, three models were set up in various combinations using “number of civil servant (actual average)”, “temporary workers”, “permanent workers”, “fuel consumed for 1 ton sugar”, “electricity consumed for 1 ton sugar” and “beet processing capacity” as input and “the amount of sugar produced ” as output. Here it is aimed to measure relative efficiency in sugar factories and countries which have sugar factories.

Model 1 (civil servant-permanent worker-temporary worker-electricity consumption-fuel consumption model);

- Variable cost items reflecting the production costs of factories; “civil servant” “permanent worker” “temporary worker” “consumed electricity” “consumed fuel” was used as input. The output was based on the amount of sugar produced.
- It is aimed to measure relative efficiency with DEA in 21 sugar factories of TSFI. Thus, a comparison of efficiency measurement results will be made between public factories with the data of 2016. In addition, the model, in terms of the “civil servant” “temporary worker” “permanent worker” in the factories provides the opportunity to compare the level of efficiency according to the distinction.

Model 2 (number of employees- processed beets, daily capacity model)

- “*Number of employees (actual average)*” “*processed beet*”, and “*daily capacity*” which reflect the production capacity of the factories is used as input. In the same way, the output is based on the “the *amount of sugar produced*”.
- Based on the 2016 year for the selected beet sugar production data; It is aimed to measure relative efficiency in 29 factories, that are 21 sugar factories connected to TFSI and eight private sugar factories, (public and private). In the second model, which measures

productivity in all sugar factories in Turkey including public and private factories; three inputs were used in parallel to the production data used in the model. Thus, it is aimed to provide ease of interpretation between the second and third models.

Model 3 will be in the form of two analyzes. First, Analysis of Model 3 will be explained.

Model 3.1 (Turkey-EU efficiency model)

The "*daily capacity", "processed beet*" and "*number of employees (actual average*)" which reflect the production capacity of the factories are used as inputs. In the same way, output is also based on the "amount of sugar produced". Based on the 2016 year for the selected sugar beet production data; it is aimed relative efficiency measurement in some EU countries (EU 28) and Turkey.

Model 3.2 (Turkey-EU efficiency model (employees per factory-capacity per factory)

Reflecting the capacity of production between countries "capacity per factory" and "*employees per factory (actual average*)" used as input. The output is based on *"the amount of produced sugar per factory"*

It is intended to measure relative efficiency between EU countries (E.U. 28) and Turkey with selected production data for 2016 year.

The data are provided from 2016 Annual Reports of TSFI, Sugar Industry Cost and Analysis Book, Turkish Sugar Authority, European Commission Reports, CEFS Sugar Statistics 2016 and Market Evaluation, Consumption and Statistics Committee (MECAS).

In this study using data envelopment analysis; The results obtained by dissolving the Model 1 and 2, that both to ensure the see their own situation of factories belonging to TSFI and to evaluate the data of all beet sugar producers operating in Turkey and thus it is thought to be able to facilitate making decisions which are concerning the sugar sector.

The purpose of the third model established in the study; can be summarized as determining whether the sugar industry in Turkey is capable of competing with the sugar industry of the European Union and making recommendations on how to compete under the current competitive conditions. Therefore, on third model; relative production efficiency in the sugar sector of EU countries and Turkey are based on the data of 2016 year were analysed on the basis of country.

As the data used in previous studies in this field are not up-to-date, the diversity of inputs is not kept much and no detailed comparative analysis is made with the EU, the analyzes conducted in the research reveal the superiority of this study.

5.2. Limitations of Research

In the first model, 2016 year data were taken (civil servant-permanent worker-temporary worker-fuel consumption-electricity consumption). Since the privatizations were made in 2018 and the data related to private sector factories have not been published yet, the most recent data is based on 2016 data. In addition, the scope of the study was determined as the public sugar factories and the Susurluk, Alpullu, Çarşamba, Ağrı Factories, which are belonging to the TSFI, did not produce sugar in 2016, and so the data of 21 sugar factories were taken as basis.

In the second model (capacity-worker-processed beet), 2016 data were taken due to the fact that it is easy to compare with the third model and the 2017-2018 data is not yet available. Member countries of the E.U. 28 from which have sugar factories and Turkey on the third Model is based on the data of 2016. Because, in 2006, the EU was reformed, many sugar factories were closed, market regulation were renewed, and also in 2017 sugar quotas were abolished in the EU and thus the market was opened to competition. Although, in Turkey, the state-owned sugar factory was included in the scope of privatization in 2000 and the quota of the production was started in 2003, it was possible to privatize 10 factories in 2018. For this reason, our analysis is based on the data of 2016 in order to obtain meaningful results in comparison of factories.

It is possible to evaluate the units analyzed in their fields and in relative terms in this study. For this reason, only a factory that is efficient in an analysis of the public sugar factories, may not be efficient in a study where all sugar factories, including the public and private are evaluated, or by taking other production data are analyzed. Therefore, the analyzes performed in this study should be evaluated within the framework specified.

5.3. Data Collection

The Data Collection is a process by which the researcher collects the information from all the relevant sources to find answers to the research problem and evaluate the outcomes. The data collection component of research is common to all fields of study including physical and social sciences, humanities, business, etc. While collecting the data, the researcher must identify the type of data to be collected, source of data, and the data is to be collected should be well addressed by the researcher (Reponsible Conduct of Research.com, 2019).

The data collection methods can be classified into two categories. First is the primary data are the first-hand data, collected by the researcher for the first time and is original in nature but however it is costly and time-consuming. Second is secondary data are collected by someone else for his research work and has already passed through the statistical analysis. One of the advantages of the secondary data is that it is less expensive than the primary data. The secondary data are readily available from the other sources and as such, there are no specific collection methods.

The secondary data can be both qualitative and quantitative. The qualitative data can be obtained through newspapers, diaries, interviews, transcripts, etc., while the quantitative data can be obtained through a survey, financial statements and statistics.

In this study, three models were set up in various combinations using “number of workers”, “fuel consumed for 1 ton sugar”, “electricity consumed for 1 ton sugar” and “beet processing capacity” as inputs and “the amount of sugar produced ” as output.

In the first model, 2016 year data were taken (civil servant-permanent worker-temporary worker-fuel consumption-electricity consumption). Since the privatizations were made in 2018 and the data related to private sector factories have not been published yet, the most recent data is based on 2016 data. In addition, the scope of the study was determined as the public sugar factories and the Susurluk, Alpullu, Çarşamba, Ağrı Factories, which are belonging to the TSFI, did not produce sugar in 2016, and so the data of 21 sugar factories were taken as basis. In the second model, which measures relative efficiency in all sugar factories in Turkey including public and private factories, 3 inputs were used in parallel to the production data used in the model. In the third model, relative production efficiency in the sugar sector of EU countries and Turkey were analysed on the basis of country. Because, in 2006, the EU was reformed, many sugar factories were closed, market regulation were renewed, and also in 2017 sugar quotas were abolished in the EU and thus the market was opened to competition. For this reason, our analysis is based on the data of 2016 in order to obtain meaningful results in comparison of factories. Thus, it is aimed to provide ease of interpretation between the second and third models.

The data are provided from Turkish Statistical Institute, 2016 Annual Reports of TSFI, Sugar Industry Cost and Analysis Book, Abolished Turkish Sugar Authority, European Commission Reports, (CEFS) Sugar Statistics 2016, International Sugar Organization Reports and Market Evaluation, Consumption and Statistics Committee (MECAS) Reports. Since Turkish Sugar Authority (TSA) is a member of ISO on behalf of Turkey, to the reports of ISO and MECAS (their non-public data are only given to its members) have been reached through the TSA. In addition, some unpublished information and reports of the TSA has also been provided through bilateral relations.

5.4. Reliability of Research Data

- On Model 1 *"Civil servant (actual average)"*, *"permanent worker"* "*temporary worker"* "*fuel consumed for 1 ton of sugar",* "*electricity consumed for 1 ton of sugar "* are used as input and "*the amount of sugar produced*" is used as output. These data were obtained from the 2016 Annual Report of TSFI, Sugar Industry Cost and Analysis Book and Turkish Sugar Authority for the relevant years.
- On Model 2 "Number of employees (actual average)" "processed beets" and "daily capacity" used as input and "the amount of sugar produced" as output. It was taken from 2016 Annual Report of TSFI, Capacity Reports of the Turkish Sugar Authority.
- The data which are belonging to Turkey and the countries of the EU members, on Model 3.1 "Number of employees", "daily capacity" and "processed beet" used as input, "the amount of sugar produced" used as output; and on Model 3-2 "the capacity per factory", "number of employees per factory (actual avarage)" used as input, "the amount of sugar produced per factory" used as output; were obtained from CEFS Reports, European Commission Reports, 2016 Annual Report of TSFI, and Abolished Turkish Sugar Authority.

That's why they are considered reliable data. The data are presented in Appendix-1, Appendix-2 and Appendix-3 and Appendix-4.

5.5. Data Envelopment Analysis

For three different models were set up, five application steps of DEA described below have been carried out. Decision making units for each model were selected in step 1. Input and output sets were determined in step 2. Appropriate data envelopment analysis was selected in step 3. Return on scale type was chosen in step 4. DEA application was realized step 5.

5.6. Selection of Decision Making Units to Be Evaluated

Charnes at all. (1978) named the responsible units for converting the input into output and producing similar outputs using similar inputs, as "decision making unit - DMU". These DMU can be institution, company, factory, department, business, university as well as yearly values that show the inputs and outputs of a single institution (Kaynar and Bircan, 2007: 362). However, these DMU should do the same for the same purpose and work under the same market conditions. Homogeneity is necessary for to make comparisons and to make comparisons meaningful (Baysal at all, 2005: 69). Data envelopment analysis can measure the relative efficiency of these decision units that have multiple inputs and outputs (Kaynar and Bircan, 2007: 363). Ahn has attracted attention to two points at DMU choices. First, each DMU that responsible for the outputs produced with the sources it uses, must be defined as any unit. The other, the number of DMU studied should be large enough to make the results of the efficiency limit measurement meaningful (Ahn, 1987). According to Boussofiane, for reliability of the work, be on the point of being "m" the number of inputs and "n" being the number of outputs, there must be at least "m + n + 1" DMU (Keçek, 2010: 78).

5.6.1. Determining The Input and Output Set

-Input and output set for the first model (permanent worker- temporary worker- civil servant-fuel consumed- electricity consumed)

In the first model, taking into account the studies in the literature, five inputs and one output representing the important cost items that were not taken into account before, were determined. The input and output variables are shown in Appendix-1, Appendix -2, Appendix-3 and Appendix-4 of the study for the evaluation of the efficiency analysis of 25 public sugar factories analyzed for 2016 year. Table 15 shows the explanatory information about the input and output factors used in the model (Figure 22).

Table 15. Model 1 output-input elements

TYPE	UNIT	DESCRIPTION
INPUT		
Permanent Worker	Piece	The number of permanent workers working at the factory during the relevant campaign period.
Temporary Worker	Piece	The number of temporary workers working at the factory during the relevant campaign period.
Civil Servant	Piece	The number of civil servant working in the factory during the relevant campaign.
Total Fuel Consumption (7000 Kcal/kg)	7000 kcal/kg	The total fuel consumed during the campaign period
Total Electricity Consumption	Kwh	The total electricity consumption during the campaign period.
OUTPUT		
Produced Sugar	Tone	The total amount of sugar produced in each factory during the relevant campaign period.

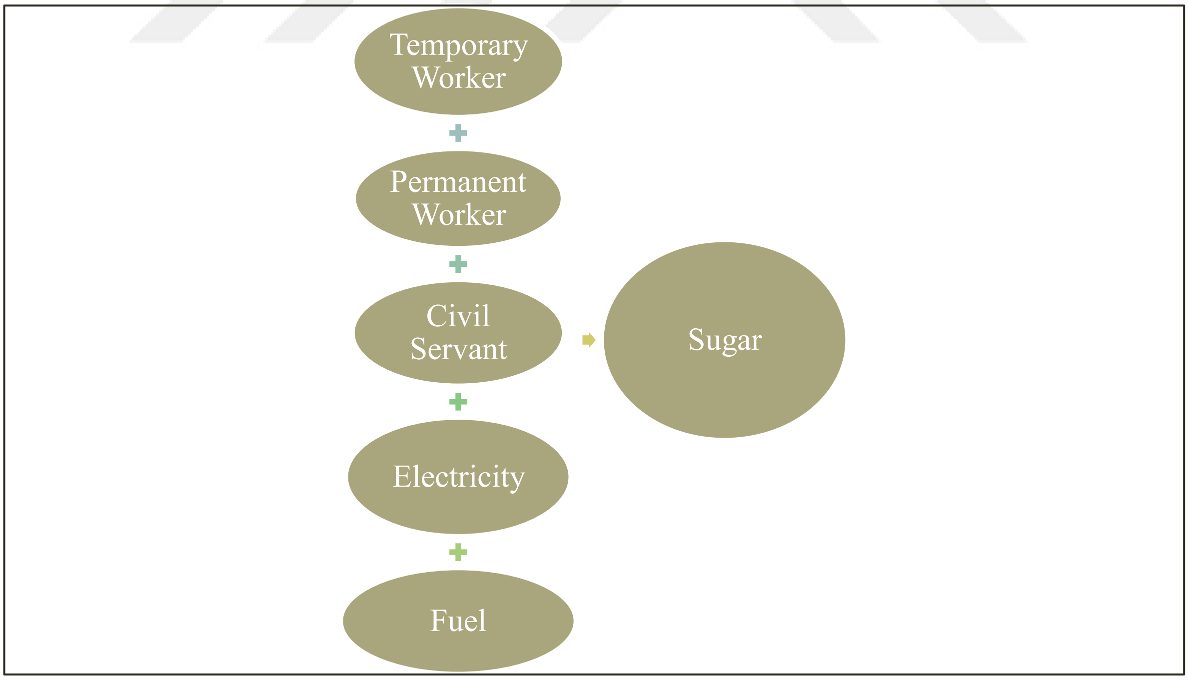


Figure 22. Model 1 Sugar Factories Efficiency Analysis Model

-Input and output output for the second model (daily capacity-processed beet-employee)

Three inputs and one output were determined to be used for analysis taking into account the studies in the literature. The data on the efficiency study for input and output variables of 33 factories of Turkey analyzed for 2016 marketing year, are given in Appendix-2 of the study. Table 16 shows the explanatory information about the input and output factors used in the model (Figure 23).

Table 16. Model 2 output-input elements

	UNIT	DESCRIPTION
INPUT		
Employees (Actual Average)	Piece	The number of actual employees (permanent and temporary) working at the factory during the relevant campaign period.
Processed Beet	Tone	The amount of beet processed in the relevant campaign period.
Daily Capacity	Tone/Year	It shows the beet processing capacity in the relevant campaign period.
OUTPUT		
Produced Sugar	Tone	The total amount of sugar produced in each factory during the relevant campaign period.

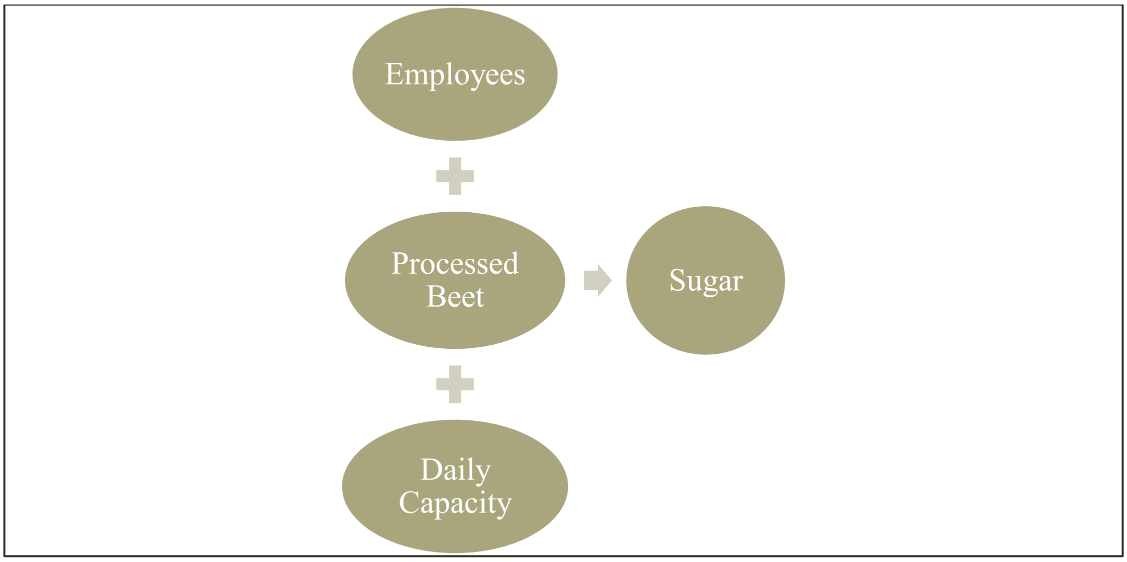


Figure 23. Model 2 Sugar Factories Efficiency Analysis Model

-Input and Output Set for The Third Model (Turkey-EU efficiency)

a. Input and Output Set for 1st Application to belong Third Model (Turkey- EU efficiency (country-based)

Three inputs and one output were determined to be used for analysis taking into account the studies in the literature. The data on the efficiency study for input and output variables of Turkey and some of the EU member states (EU-28) analyzed for 2016 marketing year, are given in Appendix-3 of the study. Table 17 shows the explanatory information about the input and output factors used in the model.

Table 17. Model 2 output-inputs elements

TYPE	UNIT	DESCRIPTION
INPUT		
Employees	Number	The number of actual employees (permanent and temporary) working at the factory during the relevant campaign period.
Daily Capacity	Tone/Year	The number of beet processing capacity during the relevant campaign period
Processed Beet	Tone	The number of beet during the relevant campaign period
OUTPUT		
Produced Sugar	Tone	Total amount of sugar produced in each factory during the relevant campaign period.

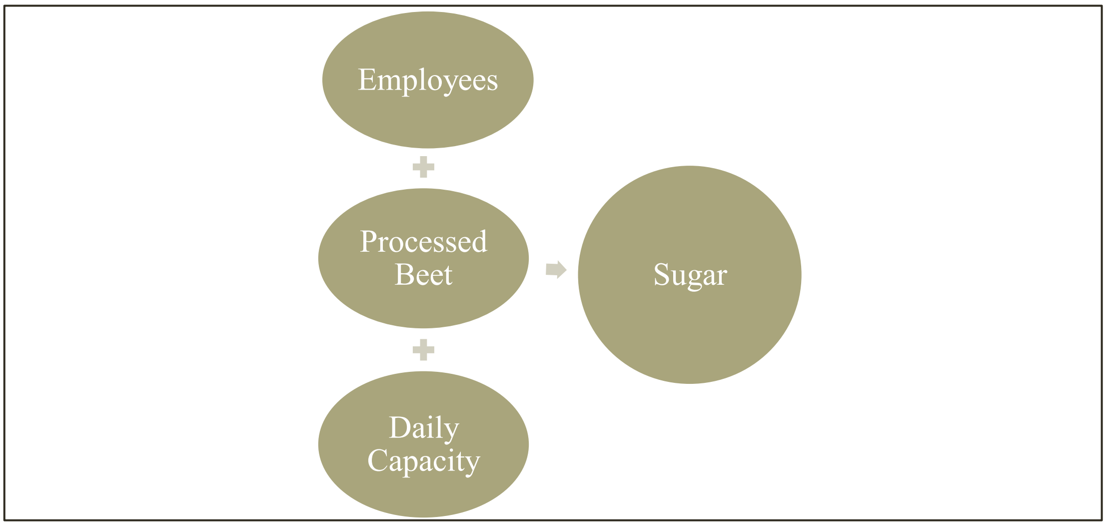


Figure 24. Model 3 Sugar Factories Efficiency Analysis Model

b. Input and Output Set for 2st Application to belong Third Model (Turkey- EU efficiency (factory-based)

Two inputs and one output were determined to be used for analysis taking into account the studies in the literature. The data on the efficiency study for input and output variables of Turkey and some of the EU member states (EU-28) are analyzed for 2016 marketing year, are given in Appendix-4 of the study. Table 16 shows the explanatory information about the input and output factors used in the model (Figure 25).

Table 18. Model 3 output-inputs elements

TYPE	UNIT	DESCRIPTION
INPUT		
Employees per factory	Number	The actual average number of employees in the factory (permanent and temporary) during the relevant campaign period.
Capacity per Factory	Tone/day	The number of beet processing capacity in a factory during the relevant campaign period
OUTPUT		
Produced Sugar per Factory	Tone	Total amount of sugar produced in a factory during the relevant campaign period.

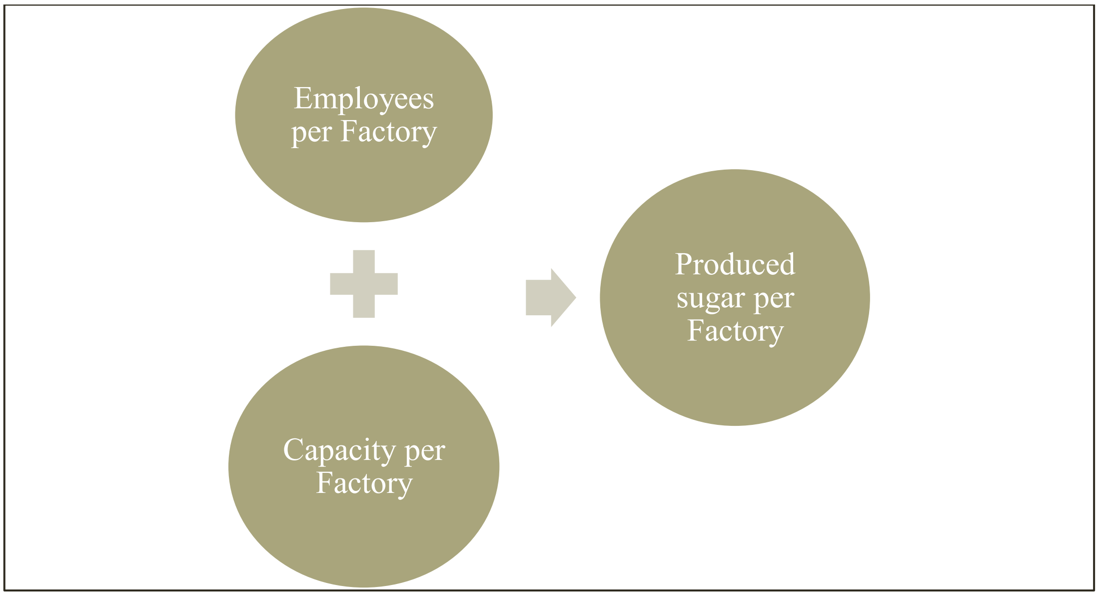


Figure 25. Model 3 Output-Inputs Elements

5.6.2. Choosing The Appropriate Data Envelopment Analysis Model

Selection of input minimization or output maximization model should be done carefully (Baysal at all, 2005: 69). Many researchers have preferred to use the input-oriented approach in their studies on account of the fact that, most decision making units have to produce a certain amount of output. However, this is not the same for all sectors. Some industries that have limited resources and want to benefit from them, may want to produce as many output as possible. In such cases, it would be better to use the output-oriented approach. In many studies, it is observed that the difference between them is not much looking at the results of different approaches (Erken and Emiral, 2002: 16).

In this study input oriented models that aims to minimize input factors used in sugar production were used. The reason of not using output oriented model is the quota system in the sugar sector.

5.6.3. Choosing The Type of Return on Scale

Return on scale, can be fixed or variable. Return on scale, are related to the direction of the change in output when change in inputs. It can be modeled with constant return on the scale, if the process produces twice the output, when inputs are doubled. On the other hand, it can be modeled with variable returns on the scale, if the process produces more or less than twice the output when inputs are doubled (Cooper at all, 2002: 130-140).

5.6.4. Measurement of Efficiency with Data Envelopment Analysis

In Model 1, the input-oriented dual CCR-DEA and dual BCC-DEA models were installed and solved separately for each of the 21 sugar factories in Turkey for 2016 marketing year.

In the Model 2, the input-oriented dual CCR-DEA and dual BCC-DEA models were installed and resolved separately for each of the 29 sugar factories and the factories producing special beet sugar for 2016 marketing year.

In the Model 3, dual CCR-DEA and dual BCC-DEA models were installed and resolved separately for each country by taking the total of all beet sugar producer factory data from some EU member countries and in Turkey for the 2016 marketing year.

5.7. Empirical Results (Comparison Parameters)

5.7.1. Empirical Results for The First Model

In the Analysis 1 study, is obtained the efficiency measurements among the public sugar factories in Turkey. Analysis results are shown in Table 19. The table are included the results of Model-1 that is used "permanent worker", "temporary worker", "civil servant (actual average)", "fuel consumed for 1 ton sugar" and "electricity consumed for 1 ton sugar" data as inputs and "the amount of sugar produced" as output. In addition, efficiency scores and reference sets obtained from DEA models are shown.

Table 19. Empirical results for Model 1 (CCR)

Model = CCR-I			*Improvement Potential (IP)																						
			Civil Servant	Projected Civil Servant			Permanent Worker	Projected Permanent Worker			Temporary Worker	Projected Temporary Worker			Electricity Consumption MWH	Projected Electricity Consumption			Fuel Consumption	Projected Fuel Consumption			Sugar		
DMU	Score	Rank	Data	Projection	IP	Diff. %	Data	Projection	IP	Diff. %	Data	Projection	IP	Diff. %	Data	Projection	IP	Diff. %	Data	Projection	IP	Diff. %	Data	Projection	Diff %
Afyon	1	1	61	61	0,0	0	207	207	0,0	0	48	48	0,0	0	31860,673	31860,673	0,0	0	49129	49129	0,0	0	137310	137310	0
Ankara	1	1	110	110	0,0	0	483	483	0,0	0	20	20	0,0	0	15203,157	15203,157	0,0	0	19557	19557	0,0	0	63110	63110	0
Bor	0,716	18	55	30,79142995	24,2	-44,016	229	162,3343198	66,7	-29,112	54	38,6869714	15,3	-28,357	16280,054	11663,44414	4616,5	-28,357	29151	17053,53477	12097,4	-41,499	68145	68145	0
Burdur	0,822	10	56	28,91211098	27,1	-48,371	201	165,3117304	35,7	-17,755	56	40,8031732	15,2	-27,137	18969,002	15061,65277	3907,4	-20,599	22655	18632,52365	4022,4	-17,755	80315	80315	0
Çorum	1	1	38	38	0,0	0	219	219	0,0	0	52	52	0,0	0	19465	19465	0,0	0	23395	23395	0,0	0	103018	103018	0
Elazığ	0,684	20	66	5,603363983	60,4	-91,51	156	30,0376263	126,0	-80,745	66	6,48237107	59,5	-90,178	2912	1991,936387	920,1	-31,596	3992	2730,704004	1261,3	-31,596	11480	11480	0
Elbistan	0,564	21	33	18,60854838	14,4	-43,61	180	98,96643575	81,0	-45,019	101	26,4008673	74,6	-73,861	14896,2	8399,898739	6496,2	-43,61	21717	12246,11652	9470,8	-43,61	48050	48050	0
Erciş	0,934	6	26	9,359645887	16,6	-64,001	256	53,94111709	202,1	-78,929	107	12,8079365	94,2	-88,03	5759,601	4794,355452	965,3	-16,759	6167	5762,339882	404,7	-6,562	25374	25374	0
Ereğli	1	1	42	42	0,0	0	215	215	0,0	0	83	83	0,0	0	26700,739	26700,739	0,0	0	43007	43007	0,0	0	153705	153705	0
Erzincan	0,685	19	67	14,14058492	52,9	-78,895	141	74,94510005	66,1	-46,847	41	15,908158	25,1	-61,2	6851,883	4692,897781	2159,0	-31,509	9663	6617,79374	3045,2	-31,514	27560	27560	0
Erzurum	0,916	7	48	15,34120251	32,7	-68,039	247	88,41377235	158,6	-64,205	53	20,9932245	32,0	-60,39	8665,6	7858,329127	807,3	-9,316	10309	9444,932439	864,1	-8,382	41590	41590	0
Eskişehir	0,797	12	87	50,07413646	36,9	-42,444	296	236,0437624	60,0	-20,255	67	53,4288246	13,6	-20,255	31026,5	24741,93173	6284,4	-20,255	42042	33526,18871	8515,6	-20,255	120300	120300	0
Ilgın	0,913	8	48	43,83181301	4,2	-8,684	267	196,7426722	70,3	-26,314	74	67,5740451	6,4	-8,684	29629,365	26048,83947	3580,4	-12,084	49446	41382,26931	8063,7	-16,308	137850	137850	0
Kars	0,735	17	27	4,154186647	22,8	-84,614	131	23,94123357	107,1	-81,724	35	5,68467646	29,3	-83,758	2960	2127,92745	832,1	-28,111	3479	2557,557805	921,4	-26,486	11262	11262	0
Kastamonu	0,757	15	46	12,21139046	33,8	-73,453	146	64,72036942	81,3	-55,671	48	13,7378143	34,3	-71,38	5350,7	4052,647576	1298,0	-24,259	7679	5714,930734	1964,1	-25,577	23800	23800	0
Kırşehir	1	1	40	40	0,0	0	212	212	0,0	0	45	45	0,0	0	13274,975	13274,975	0,0	0	18720	18720	0,0	0	77960	77960	0
Malatya	0,754	16	77	19,7207281	57,3	-74,389	209	108,9723143	100,0	-47,86	60	24,525888	35,5	-59,124	10974,2	8278,674849	2695,5	-24,562	14116	10648,77387	3467,2	-24,562	45761	45761	0
Muş	0,792	13	41	14,97602361	26,0	-63,473	237	86,30918869	150,7	-63,583	96	20,493506	75,5	-78,653	9758,883	7671,27104	2087,6	-21,392	11639	9220,107166	2418,9	-20,783	40600	40600	0
Turhal	0,872	9	75	46,08349063	28,9	-38,555	287	250,2178481	36,8	-12,816	66	57,1482573	8,9	-13,412	21192,905	18476,80517	2716,1	-12,816	28532	24875,31582	3656,7	-12,816	104240	104240	0
Uşak	0,779	14	39	13,46844536	25,5	-65,466	167	71,38276039	95,6	-57,256	37	15,152001	21,8	-59,049	5739,33	4469,831885	1269,5	-22,119	9149	6303,232427	2845,8	-31,105	26250	26250	0
Yozgat	0,808	11	29	23,43739519	5,6	-19,181	211	129,0476065	82,0	-38,84	46	30,1751003	15,8	-34,402	12572,905	10161,24631	2411,6	-19,181	16496	13331,83693	3164,1	-19,181	56320	56320	0

Table 19 shows that five of the 21 sugar factories (Afyon, Ankara, Çorum Ereğli, Kırşehir Sugar Factories) examined according to CCR-DEA model are total efficient (CCR / CRS). The other 16 factory total efficiency values are less than 1, so they are inefficient. Among these DMUs, the Elbistan sugar factory has the lowest efficiency score with a score of 0.5639. The decision unit that should be taken as reference for the Elbistan Sugar Factory to be efficient is Çorum (0.077), Ereğli (0.133), Kırşehir (0.253) as seen in Table 20.

Table 20. Reference Data for Model 1

No	DMU	Score	Rank		Reference(Lambda)						
1	**Afyon**	1	1	Afyon	1						
2	**Ankara**	1	1	Ankara	1						
3	**Bor**	0.7164	18	Ereğli	0.113	Kırşehir	0.651				
4	**Burdur**	0.8224	10	Çorum	0.707	Ereğli	0.049				
5	**Çorum**	1	1	Çorum	1						
6	**Elazığ**	0.684	20	Çorum	0.019	Kırşehir	0.122				
7	**Elbistan**	0.5639	21	Çorum	0.077	Ereğli	0.133	Kırşehir	0.253		
8	**Erciş**	0.9344	6	Çorum	0.246						
9	**Ereğli**	1	1	Ereğli	1						
10	**Erzincan**	0.6849	19	Kırşehir	0.354						
11	**Erzurum**	0.9162	7	Çorum	0.404						
12	**Eskişehir**	0.7974	12	Afyon	0.33	Ankara	0.029	Çorum	0.686	Ereğli	0.016
13	**Ilgın**	0.9132	8	Afyon	0.263	Ereğli	0.662				
14	**Kars**	0.7351	17	Çorum	0.109						
15	**Kastamonu**	0.7574	15	Kırşehir	0.305						
16	**Kırşehir**	1	1	Kırşehir	1						
17	**Malatya**	0.7544	16	Çorum	0.253	Kırşehir	0.253				
18	**Muş**	0.7922	13	Çorum	0.394						
19	**Turhal**	0.8718	9	Çorum	0.363	Ereğli	0.054	Kırşehir	0.75		
20	**Uşak**	0.7788	14	Kırşehir	0.337						
21	**Yozgat**	0.8082	11	Çorum	0.288	Ereğli	0.032	Kırşehir	0.279		

Among the efficient factories according to CCR-I model, Afyon, Ereğli, Çorum and Kırşehir factories are the most referenced decision units for inefficient factories and these DMVs are the best performing decision units. In 2016, the average total activity score of 21 factories was 0.8348. The tables below show improvable potential graphs of the one by one inputs.

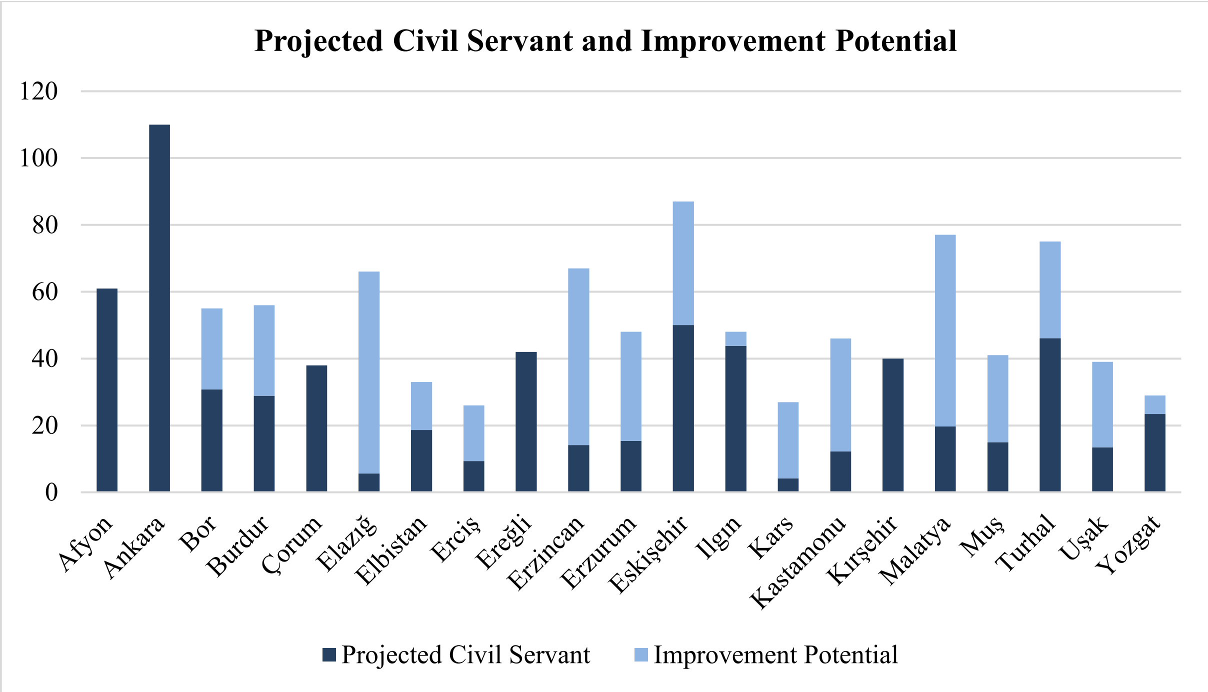


Figure 26. Improvement Potential of Civil Servants

As shown in Figure 26, 67 civil servants are employed in Erzincan, but 15 civil servants are sufficient for the efficient operation of the factory. Furthermore, employing more staff than the number of civil servants required is an extra cost for the factory.

It is seen that Ankara is efficient in terms of the civil servant in the chart. However, we know that it is efficient in fuel consumption and electricity consumption, but it is not efficient in terms of number of civil servants. It's a constraint of the DEA and the reason why it appears to be efficient in the analysis.

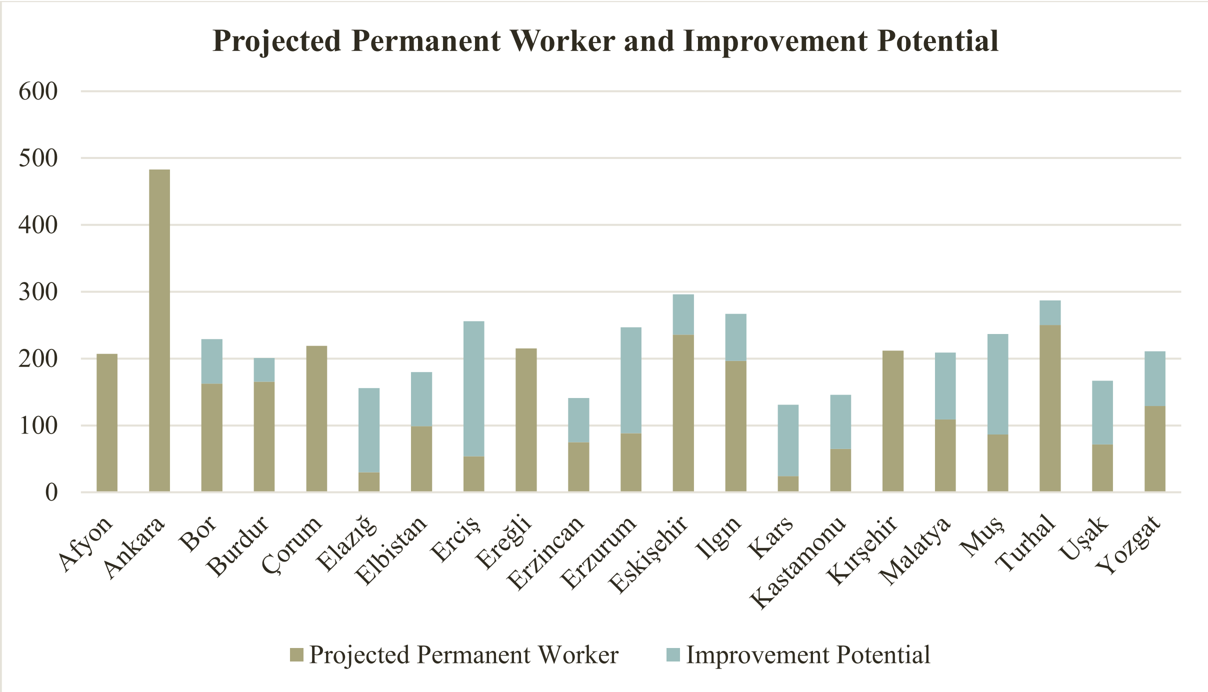


Figure 27. Improment Potential Permanent Workers

In terms of permanent workers, the efficiency status and improvement figures of the factories are shown in the Figure 27. As can be seen in the figure, Erciş Sugar Factory will be efficient if it reduces the number of its workers below 100. In terms of permanent workers, the most efficient sugar factory is Afyon Sugar Factory.

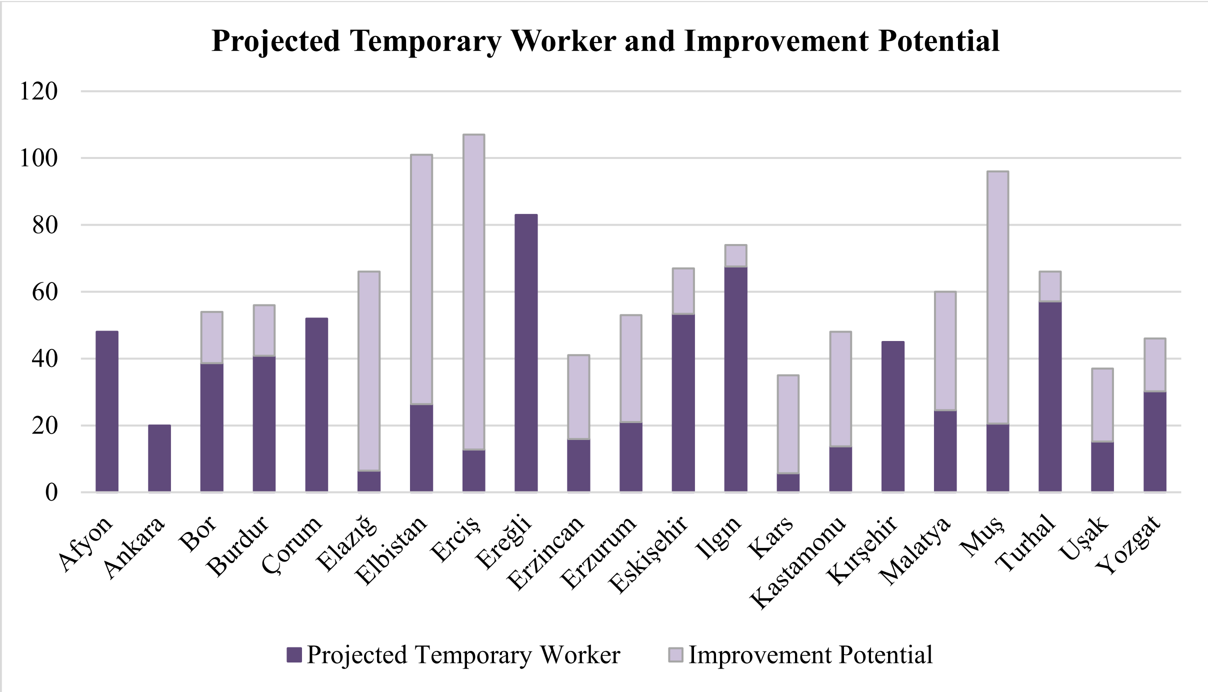


Figure 28. Improment Potential Temporary Workers

In terms of temporary workers (Figure 28), we can say that Muş and Elbistan Sugar Factories will be more efficient if they reduce the number of their workers.

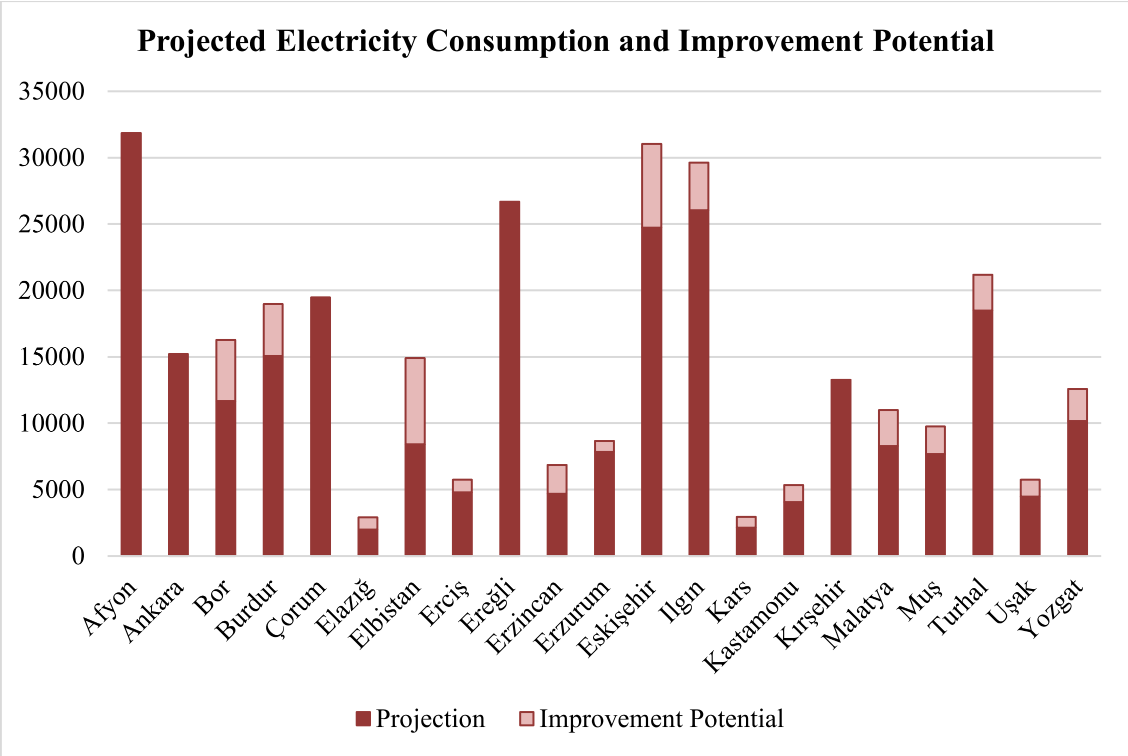


Figure 29. Improment Potential of Electricity Consumption

In terms of electricity consumption, Eskişehir and Turhal Sugar Factories need to decrease the amount of electricity they currently use to be efficient. In terms of this output, as can be seen in the figure above, Çorum and Afyon Sugar Factories is efficient.

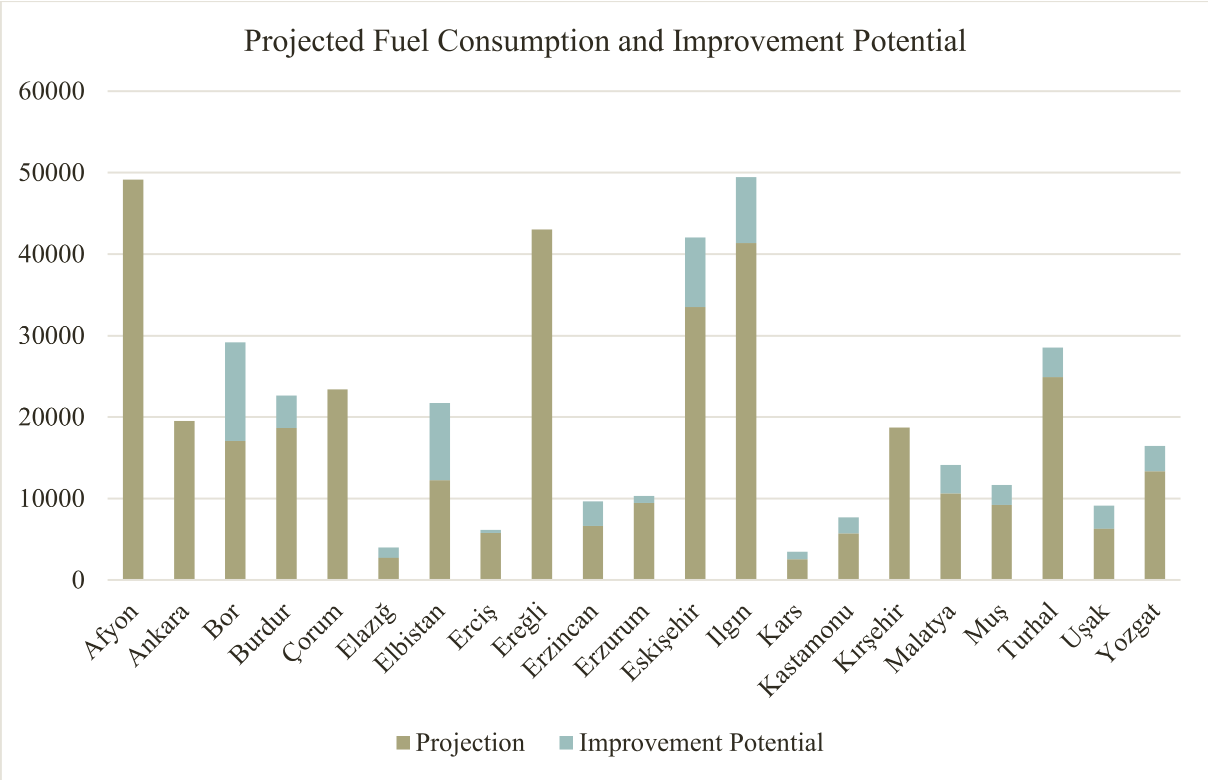


Figure 30. Improment Potential of Fuel Consumption

In terms of fuel consumption (Figure 30), Ilgın and Elbistan Sugar Factories need to decrease the amount of fuel they currently use to be efficient. In terms of this output, as can be seen in the figure above, Çorum and Afyon Sugar Factories are efficient. The Ilgın and the Elbistan sugar factories can become more efficient, if they reduce their fuel consumption from 49 000 to 40 000 and from 21 000 to 15 000 respectively.

Table 21. Empirical results for Model 1 (BCC)

Model = BCC-I																					
				Civil Servant			Permanent Worker			Temporary Worker			Electricity Consumption MWH			Fuel Consumption			Sugar		
No	DMU	Score	Rank	Data	Projection	Diff.(%)	Data	Projection	Diff.(%)	Data	Projection	Diff.(%)	Data	Projection	Diff.(%)	Data	Projection	Diff.(%)	Data	Projection	Diff .(%
1	Afyon	1	1	61	61	0	207	207	0	48	48	0	31860,67	31860,67	0	49129	49129	0	137310	137310	0
2	Ankara	1	1	110	110	0	483	483	0	20	20	0	15203,16	15203,16	0	19557	19557	0	63110	63110	0
3	Bor	0,8098	20	55	38,94526	-29,19	229	185,4373	-19,023	54	43,72757	-19,023	16280,05	13183,1	-19,023	29151	19185,48	-34,186	68145	68145	0
4	Burdur	0,9213	15	56	35,62404	-36,386	201	185,1856	-7,868	56	51,594	-7,868	18969	15261,89	-19,543	22655	20872,54	-7,868	80315	80315	0
5	Çorum	1	1	38	38	0	219	219	0	52	52	0	19465	19465	0	23395	23395	0	103018	103018	0
6	Elazığ	1	1	66	65,99923	-0,001	156	155,9985	-0,001	66	65,99926	-0,001	2912	2911,989	0	3992	3991,985	0	11480	11480	0
7	Elbistan	0,9165	16	33	30,24332	-8,354	180	164,9636	-8,354	101	46,4356	-54,024	14896,2	9574,402	-35,726	21717	13805,59	-36,43	48050	48050	0
8	Erciş	1	1	26	25,99978	-0,001	256	255,9973	-0,001	107	106,9988	-0,001	5759,601	5759,588	0	6167	6166,995	0	25374	25374	0
9	Ereğli	1	1	42	42	0	215	215	0	83	83	0	26700,74	26700,74	0	43007	43007	0	153705	153705	0
10	Erzincan	0,9972	10	67	28,71601	-57,14	141	140,6098	-0,277	41	40,49174	-1,24	6851,883	5676,35	-17,156	9663	8001,699	-17,192	27560	27560	0
11	Erzurum	0,9718	12	48	30,31548	-36,843	247	178,0107	-27,931	53	51,50697	-2,817	8665,6	8421,486	-2,817	10309	10018,59	-2,817	41590	41590	0
12	Eskişehir	0,8123	19	87	45,98563	-47,143	296	214,606	-27,498	67	54,4213	-18,774	31026,5	24379,35	-21,424	42042	34148,96	-18,774	120300	120300	0
13	Ilgın	0,9277	14	48	44,5298	-7,23	267	214,5172	-19,656	74	68,6501	-7,23	29629,37	25834,87	-12,807	49446	39195,18	-20,731	137850	137850	0
14	Kars	1	1	27	26,99974	-0,001	131	130,9992	-0,001	35	34,99989	0	2960	2959,991	0	3479	3478,989	0	11262	11262	0
15	Kastamonu	0,9479	13	46	28,32006	-38,435	146	138,3925	-5,211	48	39,2247	-18,282	5350,7	5049,677	-5,626	7679	6958,297	-9,385	23800	23800	0
16	Kırşehir	1	1	40	40	0	212	212	0	45	45	0	13274,98	13274,98	0	18720	18720	0	77960	77960	0
17	Malatya	0,7988	21	77	32,19723	-58,185	209	166,9505	-20,119	60	41,23041	-31,283	10974,2	8766,258	-20,119	14116	11275,95	-20,119	45761	45761	0
18	Muş	0,84	18	41	29,973	-26,895	237	199,0709	-16,004	96	64,28776	-33,034	9758,883	8197,089	-16,004	11639	9776,315	-16,004	40600	40600	0
19	Turhal	0,8895	17	75	39,29533	-47,606	287	216,2005	-24,669	66	55,25609	-16,279	21192,91	18852,1	-11,045	28532	25380,58	-11,045	104240	104240	0
20	Uşak	0,9743	11	39	33,64786	-13,723	167	162,7114	-2,568	37	36,04983	-2,568	5739,33	5591,942	-2,568	9149	7300,488	-20,205	26250	26250	0
21	Yozgat	1	1	29	28,99985	-0,001	211	210,9975	-0,001	46	45,99976	-0,001	12572,91	12572,84	-0,001	16496	16495,91	-0,001	56320	56320	0

Table 22. Reference Data for Model 1

No.	DMU	Score	Rank		Reference(Lambda)						
1	Afyon	1	1	Afyon	1						
2	Ankara	1	1	Ankara	1						
3	Bor	0.8098	20	Afyon	0.144	Ereğli	0.039	Kars	0.32	Kırşehir	0.496
4	Burdur	0.9213	15	Afyon	0.04	Çorum	0.395	Ereğli	0.195	Kars	0.37
5	Çorum	1	1	Çorum	1						
6	Elazığ	1	1	Elazığ	1						
7	Elbistan	0.9165	16	Ereğli	0.186	Kars	0.585	Yozgat	0.23		
8	Erciş	1	1	Erciş	1						
9	Ereğli	1	1	Ereğli	1						
10	Erzincan	0.9972	10	Ereğli	0.114	Kars	0.886				
11	Erzurum	0.9718	12	Çorum	0.291	Erciş	0.158	Kars	0.53	Kırşehir	0.021
12	Eskişehir	0.8123	19	Afyon	0.326	Çorum	0.554	Ereğli	0.12		
13	Ilgın	0.9277	14	Afyon	0.186	Çorum	0.253	Ereğli	0.561		
14	Kars	1	1	Kars	1						
15	Kastamonu	0.9479	13	Ereğli	0.088	Kars	0.912				
16	Kırşehir	1	1	Kırşehir	1						
17	Malatya	0.7988	21	Çorum	0.191	Ereğli	0.016	Kars	0.573	Kırşehir	0.219
18	Muş	0.84	18	Çorum	0.21	Erciş	0.346	Kars	0.366	Kırşehir	0.078
19	Turhal	0.8895	17	Çorum	0.526	Ereğli	0.173	Kırşehir	0.301		
20	Uşak	0.9743	11	Afyon	0.011	Ankara	0.05	Kars	0.774	Kırşehir	0.165
21	Yozgat	1	1	Yozgat	1						

Table 21 shows efficient companies and reference factories in terms of BCC (techinical efficiency). For example, the reference factory is still itself because the efficieny score of Afyon is one. Muş factory is not efficient in terms of technical efficiency and the reference of the Muş factory is determined as Çorum (0.526) Eregli (0.173) and Kırşehir (0.301).

5.7.2. Empirical Results for the Second Model

As can be seen in the table below (Table 23), Analysis 2 results that are used “capacity” “processed beet” and “employees” as input and “the amount of sugar produced” as output, and efficiency scores and reference sets obtained from DEA models are available.

Table 23. Empirical Results for Model 2 (CCR)

Model = CCR-I

				Daily Capacity				Processed Beet				Employee			Sugar Produced		
No.	DMU	Score	Rank	Data	Projection	Improvement Potential	Diff.(%)	Data	Projection	Improvement Potential	Diff.(%)	Data	Projection	Diff.(%)	Data	Projection	Diff .(%)
1	Afyon	0,9237	12	7500	6927,6415	572,358504	-7,631	1027000	948625,042	78374,95781	-7,631	652	602,243	-7,631	137310	137310	0
2	Ankara	0,8147	26	3800	2128,41541	1671,584592	-43,989	503000	409773,176	93226,82357	-18,534	783	294,0761	-62,442	63110	63110	0
3	Bor	0,9264	11	3800	2298,22323	1501,776771	-39,52	477600	442465,427	35134,57284	-7,356	508	317,5378	-37,493	68145	68145	0
4	Burdur	0,8438	23	5200	2708,66239	2491,337609	-47,91	618000	521485,227	96514,77317	-15,617	546	374,2469	-31,457	80315	80315	0
5	Çorum	0,9101	14	7500	3474,33209	4025,667905	-53,676	735000	668895,787	66104,21344	-8,994	645	480,0369	-25,576	103018	103018	0
6	Elazığ	0,8874	18	1800	387,168577	1412,831423	-78,491	84000	74539,6303	9460,369744	-11,262	369	53,49379	-85,503	11480	11480	0
7	Elbistan	0,7591	28	3800	1620,50959	2179,490408	-57,355	411000	311988,609	99011,39078	-24,09	484	223,9004	-53,74	48050	48050	0
8	Erciş	0,9663	7	2000	855,750476	1144,249524	-57,212	170500	164753,36	5746,639536	-3,37	478	118,2362	-75,264	25374	25374	0
9	Ereğli	0,9074	15	8500	7713,06602	786,9339785	-9,258	1209700	1097705,41	111994,5922	-9,258	720	653,3421	-9,258	153705	153705	0
10	Erzincan	0,8793	19	1850	929,474388	920,5256117	-49,758	203500	178947,057	24552,94339	-12,065	332	128,4224	-61,319	27560	27560	0
11	Erzurum	0,9442	8	3300	1402,64295	1897,357046	-57,496	286000	270043,835	15956,1653	-5,579	496	193,7985	-60,928	41590	41590	0
12	Eskişehir	0,7749	27	7500	4057,17594	3442,82406	-45,904	1008000	781107,798	226892,2021	-22,509	786	560,5665	-28,681	120300	120300	0
13	Ilgın	0,8426	24	8000	5822,75343	2177,246572	-27,216	1084000	913411,065	170588,9353	-15,737	747	629,4447	-15,737	137850	137850	0
14	Kars	0,9935	6	1750	379,816421	1370,183579	-78,296	73600	73124,1564	475,8435587	-0,647	271	52,47797	-80,635	11262	11262	0
15	Kastamon	0,8538	20	3800	802,666562	2997,333438	-78,877	181000	154533,38	26466,6202	-14,622	410	110,9018	-72,951	23800	23800	0
16	Kırşehir	0,9339	10	4000	2629,23887	1370,761128	-34,269	542000	506194,214	35805,78617	-6,606	477	363,2732	-23,842	77960	77960	0
17	Malatya	0,8208	25	3600	1543,31196	2056,688045	-57,13	362000	297126,134	64873,86584	-17,921	507	213,2343	-57,942	45761	45761	0
18	Muş	0,8504	22	3800	1369,25472	2430,745277	-63,967	310000	263615,766	46384,23446	-14,963	544	189,1854	-65,223	40600	40600	0
19	Turhal	0,9134	13	7500	3515,54464	3984,455362	-53,126	741000	676830,232	64169,76847	-8,66	764	485,7311	-36,423	104240	104240	0
20	Uşak	0,8518	21	1800	885,294002	914,7059981	-50,817	200100	170441,228	29658,77228	-14,822	324	122,3181	-62,247	26250	26250	0
21	Yozgat	0,9377	9	3800	1899,41936	1900,58064	-50,015	390000	365685,712	24314,2878	-6,234	456	262,4364	-42,448	56320	56320	0
22	Adapazarı	0,8954	17	6000	3380,78956	2619,210441	-43,654	474700	425047,253	49652,74719	-10,46	309	276,6792	-10,46	62388	62388	0
23	Amasya	0,733	29	6000	2592,7479	3407,252104	-56,788	681000	499168,789	181831,2113	-26,701	672	358,2313	-46,692	76878	76878	0
24	Kayseri	1	1	6000	6000	0	0	1155150	1155150	0	0	829	829	0	177907	177907	0
25	Boğazlıyan	1	1	14400	14400	0	0	1411850	1411850	0	0	1015	1015	0	217441	217441	0
26	Keskinkılıç	1	1	6960	6960	7,27596E-12	0	766414	766414	0	0	478	478	0	110229	110229	0
27	Konya	0,997	5	16500	8814,4173	7685,582701	-46,579	1496836	1492416,05	4419,947624	-0,295	563	561,3375	-0,295	170188	170188	0
28	Çumra	1	1	10315	10315	0	0	1757164	1757164	0	0	656	656	0	199787	199787	0
29	Kütahya	0,8964	16	3000	1655,24684	1344,753158	-44,825	355500	318676,398	36823,60166	-10,358	283	228,6999	-19,187	49080	49080	0

Efficient factories are Çumra, Kayseri, Boğazlıyan and Keskinkılıç factories, inefficient factories are Eskişehir, Elbistan and Amasya according to CCR (total efficiency) in Turkey.

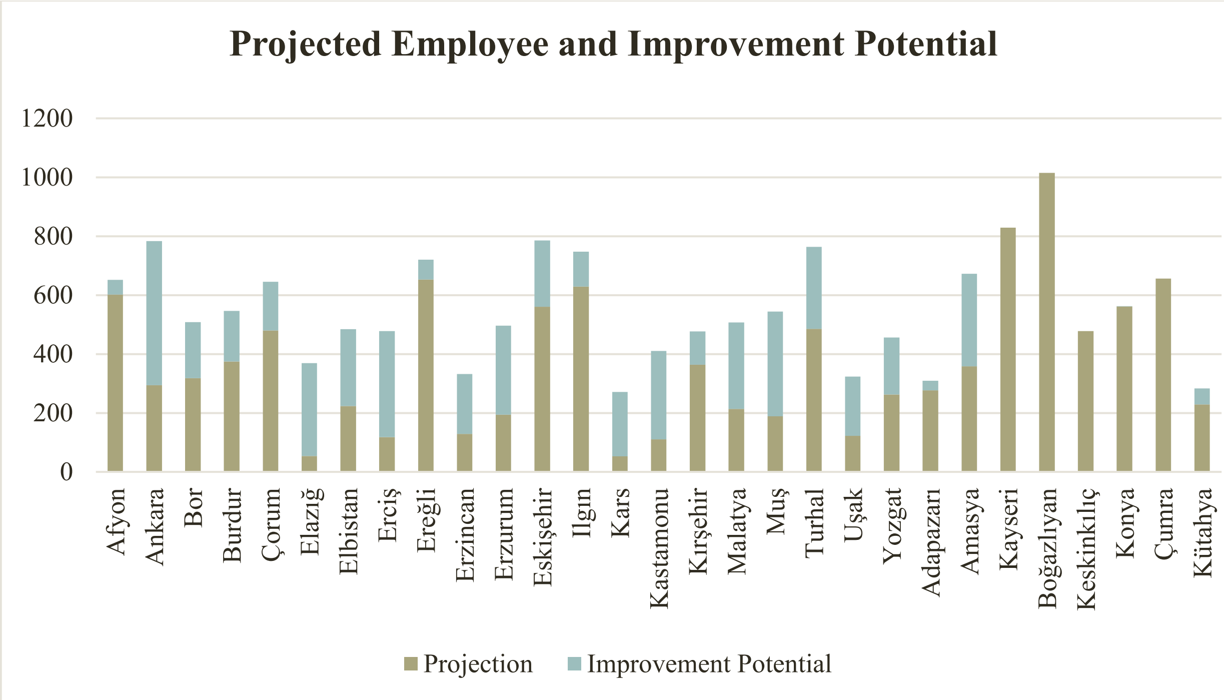


Figure 31. Improvement Potential of Employee

As can be seen in the figure above (Figure 31), Ankara is the worst in terms of employees. The number of workers is too high as it should be in there. It is thought to be more efficient if the number of workers are reduced. The most efficient factories are Boğazlıyan, Kayseri, Konya, Çumra and Keskinkılıç. Considering this, it can be said that private sugar factories are more efficient than public sugar factories in terms of workers.

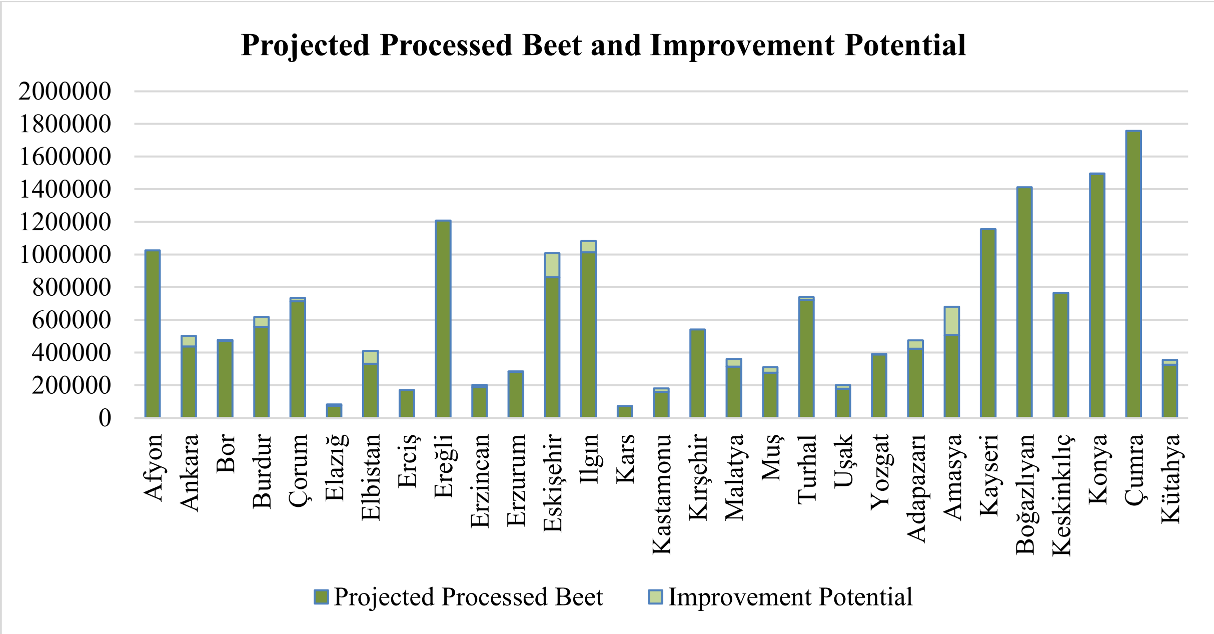


Figure 32. Improvement Potential of Processed Beet

In terms of processed beets, Afyon, Bor, Çorum, Ereğli, Erciş, Erzurum, Kırşehir, Uşak, Yozgat, Keskinkılıç, Kütahya, Boğazlıyan, Çumra and Kayseri Sugar Factories are more efficient than other sugar factories (Figure 32). In terms of this output, Amasya, Elbistan and Eskişehir sugar factories can be developed according to the current situation.

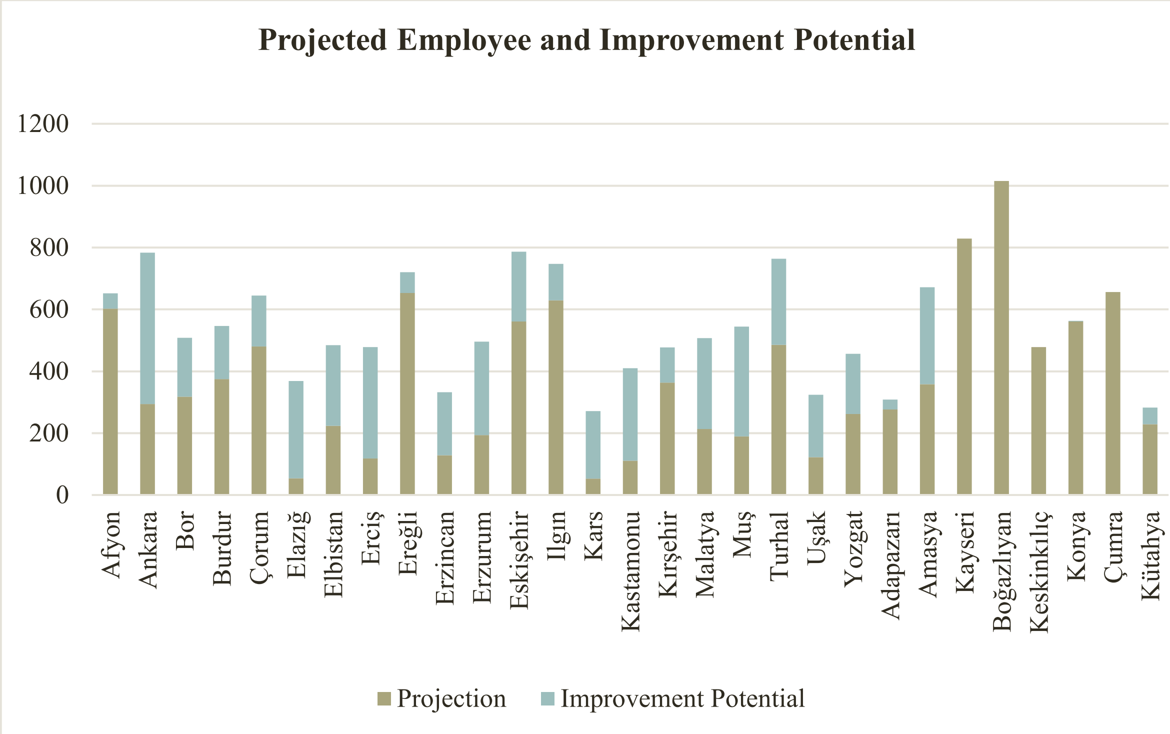


Figure 33. Improvement Potential of Capacity

In terms of capacity, Çumra, Keskinkılıç, Kayseri and Bağazlıyan Sugar factories are more efficient than others factories (Figure 33). If Adapazarı and Amasya sugar factories will rise their current capacity, the efficiency score of they can be increased.

The results of the BCC (technical analysis) are shown in Table below (Table 24). Accordingly, inactive factories are Amasya, Elbistan and Eskişehir.

The technical efficiency score of 11 (Erciş, Erzincan, Kars, Uşak, Kayseri, Boğazlıyan, Keskinkılıç, Konya, Çumra, Adapazarı and Kütahya Sugar Factories) of the 29 sugar factories which are examined according to the BCC-DEA model was one. In other words, BCC is active in these 14 factory. Amasya sugar factory is the lowest efficiency score decision unit with activity score of 0.7334 from 18 factories which are not efficient. Reference point of Amasya Sugar Factory is Kars and Kayseri Sugar Factories.

Table 24. Empirical Results for Model 2 (BCC)

Model = BCC-I															
				Daily Capacity			Processed Beet			Employee			Sugar Produced		
No.	DMU	Score	Rank	Data	Projection	Diff.(%)	Data	Projection	Diff.(%)	Data	Projection	Diff.(%)	Data	Projection	Diff. (%)
1	Afyon	0,9238	17	7500	6928,591	-7,619	1027000	948755,0583	-7,619	652	602,32551	-7,619	137310	137310	0
2	Ankara	0,8153	26	3800	3072,2813	-19,15	503000	410100,9664	-18,469	783	444,60734	-43,217	63110	63110	0
3	Bor	0,9271	16	3800	3200,6905	-15,771	477600	442778,8401	-7,291	508	461,46671	-9,16	68145	68145	0
4	Burdur	0,8608	21	5200	3591,2556	-30,937	618000	532002,8339	-13,915	546	470,02192	-13,915	80315	80315	0
5	Çorum	0,9104	19	7500	4090,0676	-45,466	735000	669109,622	-8,965	645	578,2367	-10,351	103018	103018	0
6	Elazığ	0,9726	12	1800	1750,7101	-2,738	84000	75440,15314	-10,19	369	271,76857	-26,35	11480	11480	0
7	Elbistan	0,7748	28	3800	2735,9327	-28,002	411000	318453,934	-22,517	484	375,01631	-22,517	48050	48050	0
8	Erciş	1	1	2000	1999,9947	0	170500	170499,5456	0	478	477,98415	-0,003	25374	25374	0
9	Ereğli	0,9081	20	8500	7718,9394	-9,189	1209700	1098541,294	-9,189	720	653,83957	-9,189	153705	153705	0
10	Erzincan	1	1	1850	1849,9938	0	203500	203499,3212	0	332	331,99889	0	27560	27560	0
11	Erzurum	0,9456	14	3300	2523,4499	-23,532	286000	270433,0736	-5,443	496	372,54901	-24,889	41590	41590	0
12	Eskişehir	0,7819	27	7500	4584,499	-38,873	1008000	788126,7555	-21,813	786	614,55122	-21,813	120300	120300	0
13	Ilgın	0,8479	24	8000	6088,4289	-23,895	1084000	919134,7977	-15,209	747	633,38902	-15,209	137850	137850	0
14	Kars	1	1	1750	1749,9854	-0,001	73600	73599,99492	0	271	270,99767	-0,001	11262	11262	0
15	Kastamonu	0,8562	22	3800	2069,7459	-45,533	181000	154973,4169	-14,379	410	312,98035	-23,663	23800	23800	0
16	Kırşehir	0,9567	13	4000	3545,5687	-11,361	542000	518553,796	-4,326	477	456,36561	-4,326	77960	77960	0
17	Malatya	0,8218	25	3600	2629,8243	-26,949	362000	297503,4631	-17,817	507	386,51534	-23,764	45761	45761	0
18	Muş	0,8516	23	3800	2498,2016	-34,258	310000	264007,8313	-14,836	544	369,23406	-32,126	40600	40600	0
19	Turhal	0,9137	18	7500	4121,2326	-45,05	741000	677040,5776	-8,632	764	582,32848	-23,779	104240	104240	0
20	Uşak	1	1	1800	1799,9911	0	200100	200099,0093	0	324	323,99812	-0,001	26250	26250	0
21	Yozgat	0,9385	15	3800	2899,1138	-23,708	390000	366032,8906	-6,145	456	421,87146	-7,484	56320	56320	0
22	Adapazarı	1	1	6000	5999,9363	-0,001	474700	474698,8307	0	309	308,99924	0	62388	62388	0
23	Amasya	0,7334	29	6000	3423,4109	-42,943	681000	499457,2652	-26,658	672	490,7086	-26,978	76878	76878	0
24	Kayseri	1	1	6000	6000	0	1155150	1155150	0	829	829	0	177907	177907	0
25	Boğazlıyan	1	1	14400	14400	0	1411850	1411850	0	1015	1015	0	217441	217441	0
26	Keskinkılıç	1	1	6960	6960	0	766414	766414	0	478	478	0	110229	110229	0
27	Konya	1	1	16500	16499,445	-0,003	1496836	1496835,681	0	563	562,99988	0	170188	170188	0
28	Çumra	1	1	10315	10315	0	1757164	1757164	0	656	656	0	199787	199787	0
29	Kütahya	1	1	3000	2999,9807	-0,001	355500	355499,4039	0	283	282,99953	0	49080	49080	0

Table 25. Reference Data for Model 2

No.	DMU	Score	Rank		Reference(Lambda)						
1	Afyon	0,9238	17	Kayseri	0,31	Boğazlıya	0,011	Keskinkılı	0,624	Çumra	0,056
2	Ankara	0,8153	26	Kars	0,689	Kayseri	0,311				
3	Bor	0,9271	16	Kars	0,659	Kayseri	0,341				
4	Burdur	0,8608	21	Kars	0,368	Kayseri	0,351	Kütahya	0,281		
5	Çorum	0,9104	19	Kars	0,449	Kayseri	0,551				
6	Elazığ	0,9726	12	Kars	0,985	Uşak	0,015				
7	Elbistan	0,7748	28	Kars	0,65	Kayseri	0,183	Kütahya	0,167		
8	Erciş	1	1	Erciş	1						
9	Ereğli	0,9081	20	Kayseri	0,314	Boğazlıya	0,066	Keskinkılı	0,451	Çumra	0,169
10	Erzincan	1	1	Erzincan	1						
11	Erzurum	0,9456	14	Kars	0,818	Kayseri	0,182				
12	Eskişehir	0,7819	27	Kars	0,2	Kayseri	0,612	Kütahya	0,188		
13	Ilgın	0,8479	24	Kayseri	0,498	Keskinkılı	0,403	Kütahya	0,099		
14	Kars	1	1	Kars	1						
15	Kastamor	0,8562	22	Kars	0,925	Kayseri	0,075				
16	Kırşehir	0,9567	13	Kars	0,344	Kayseri	0,325	Kütahya	0,331		
17	Malatya	0,8218	25	Kars	0,793	Kayseri	0,207				
18	Muş	0,8516	23	Kars	0,824	Kayseri	0,176				
19	Turhal	0,9137	18	Kars	0,442	Kayseri	0,558				
20	Uşak	1	1	Uşak	1						
21	Yozgat	0,9385	15	Kars	0,73	Kayseri	0,27				
22	Adapazar	1	1	Adapazar	1						
23	Amasya	0,7334	29	Kars	0,606	Kayseri	0,394				
24	Kayseri	1	1	Kayseri	1						
25	Boğazlıya	1	1	Boğazlıya	1						
26	Keskinkılı	1	1	Keskinkılı	1						
27	Konya	1	1	Konya	1						
28	Çumra	1	1	Çumra	1						
29	Kütahya	1	1	Kütahya	1						

For example in the reference table above (Table 25); In order for the Elbistan Factory to be effective; Kars (0,65), Kayseri (0,183) and Kütahya (0,167) Factories are shown as reference (Table 22). It is stated that if Elbistan Factory's input are increased as much as the reference factories' specified rates, it will be efficient.

5.7.3. Empirical Results for the Third Model

Sugar factories in the EU and sugar factories in Turkey will be compared in terms of efficiency in Model 3. The analysis here will be two-way that are factory-based and country-based format. First, country-based comparison will be made.

5.7.3.1. Empirical Results for 3/1 Model

Analysis, that is used “daily capacity”, “processed beet”, “employees” as inputs and “the amount sugar produced” as output of sugar factories in Turkey and sugar factories in EU (EU-28) results are shown in the table below. Efficiency scores and reference sets obtained from DEA models are appeared in the table as well.

As can be seen in the figure below (Table 26), efficiency score of Belgium, UK and Croatia is number 1. That’s why they are the most efficient countries among EU countries.

Table 26. Empirical Results for Model 3.1 (CCR)

Model = CCR-I																		
				Employees	Projected Employees			Daily Capacity	Projected Daily Capacity			Projected Processed Beets	Projected Processed Beets			Sugar Produced		
No	DMU	Score	Rank	Data	Projection	Improvement Potential	Diff.(%)	Data	Projection	Improvement Potential	Diff.(%)	Data	Projection	Improvement Potential	Diff.(%)	Data	Projection	Diff.(%)
1	Austria	0,9557	12	777	343,56213	433,4	-55,784	24700	23606,45	1093,5	-4,427	2557011	2443803,823	113198,9	-4,427	402985	402985	0
2	Belgium	1	1	657	657	0,0	0	46040	46040	0,0	0	4441830	4441830	0,0	0	740009	740009	0
3	Croatia	1	1	603	603	0,0	0	21000	21000	0,0	0	706296	706296	0,0	0	119576	119576	0
4	Czechia	0,9947	5	1372	719,72864	652,3	-47,542	35186	31691,51	3494,3	-9,931	2707108	2692715,923	14401,8	-0,532	455877	455877	0
5	Denmark	1	1	491	491	0,0	0	21620	21620	0,0	0	1836975	1836975	0,0	0	311000	311000	0
6	Finland	0,928	15	272	97,186628	174,8	-64,27	7000	6495,849	504,1	-7,202	795553	738256,0398	57295,7	-7,202	120208	120208	0
7	France	0,988	6	6450	6265,1256	184,9	-2,866	296725	293168,4	3557,7	-1,199	25753975	25445281,46	308790,2	-1,199	4295763	4295763	0
8	Germany	0,9841	7	5164	4645,2089	518,8	-10,046	247000	204540,6	42459,3	-17,19	17660750	17379088,87	281689,0	-1,595	2942281	2942281	0
9	Greece	0,7523	19	578	212,27333	365,7	-63,275	14000	10532,76	3467,2	-24,766	1238350	931660,3356	306689,8	-24,766	156899	156899	0
10	Hungary	0,8808	16	279	96,734167	182,3	-65,328	7035	6196,586	838,4	-11,918	913069	804251,6539	108819,6	-11,918	128834	128834	0
11	Italy	0,8466	17	1000	399,90813	600,1	-60,009	32065	27146,46	4918,5	-15,339	3461081	2930176,512	530895,2	-15,339	480398	480398	0
12	Lithuania	0,9713	9	265	180,74584	84,3	-31,794	8930	8673,709	256,3	-2,87	781551	759120,52	22430,5	-2,87	128018	128018	0
13	Netherlan	0,9302	13	744	692,04196	52,0	-6,984	53700	48227,31	5472,6	-10,191	5104460	4747984,56	356495,5	-6,984	788639	788639	0
14	Poland	0,9657	11	4682	2305,6018	2376,4	-50,756	123000	101521,6	21478,3	-17,462	8931933	8625932,533	306008,0	-3,426	1460371	1460371	0
15	Slovakia	0,9297	14	492	154,42225	337,6	-68,613	10812	10052,34	759,7	-7,026	1336375	1242480,219	93893,7	-7,026	200189	200189	0
16	Spain	0,9676	10	1814	592,45927	1221,5	-67,34	36621	35435,85	1185,1	-3,236	3410791	3300408,66	110373,2	-3,236	552207	552207	0
17	Sweden	0,9808	8	416	256,54228	159,5	-38,331	16650	16329,57	320,5	-1,925	1573651	1543365,973	30292,8	-1,925	257764	257764	0
18	Turkey	0,8304	18	18468	2138,831	16329,2	-88,419	178419	148157,8	30261,6	-16,961	17949200	14904883,56	3044363,8	-16,961	2467898	2467898	0
19	UK	1	1	730	730	0,0	0	46600	46600	0,0	0	6111125	6111125	0,0	0	977780	977780	0

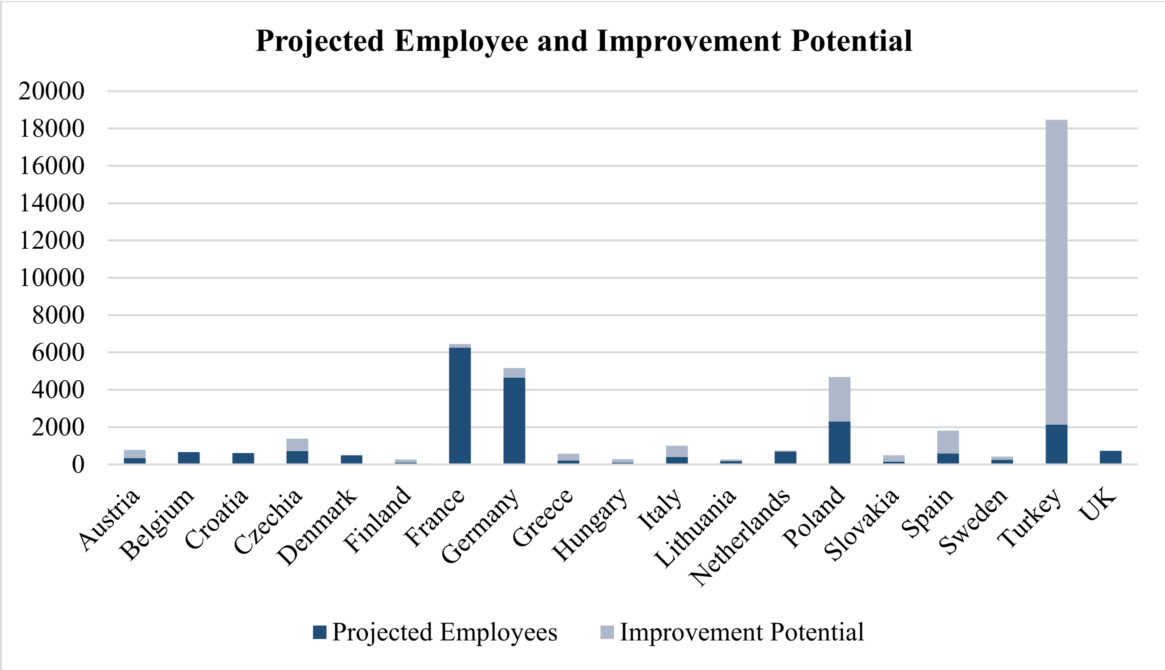


Figure 34. Improment Potential of Employee

Turkey is the most inefficient country in terms of the number of personnel employed and Poland is the country following it (Figure 34). It is inevitable that Turkey should go to reduction in the number of employees in order to be more efficient.

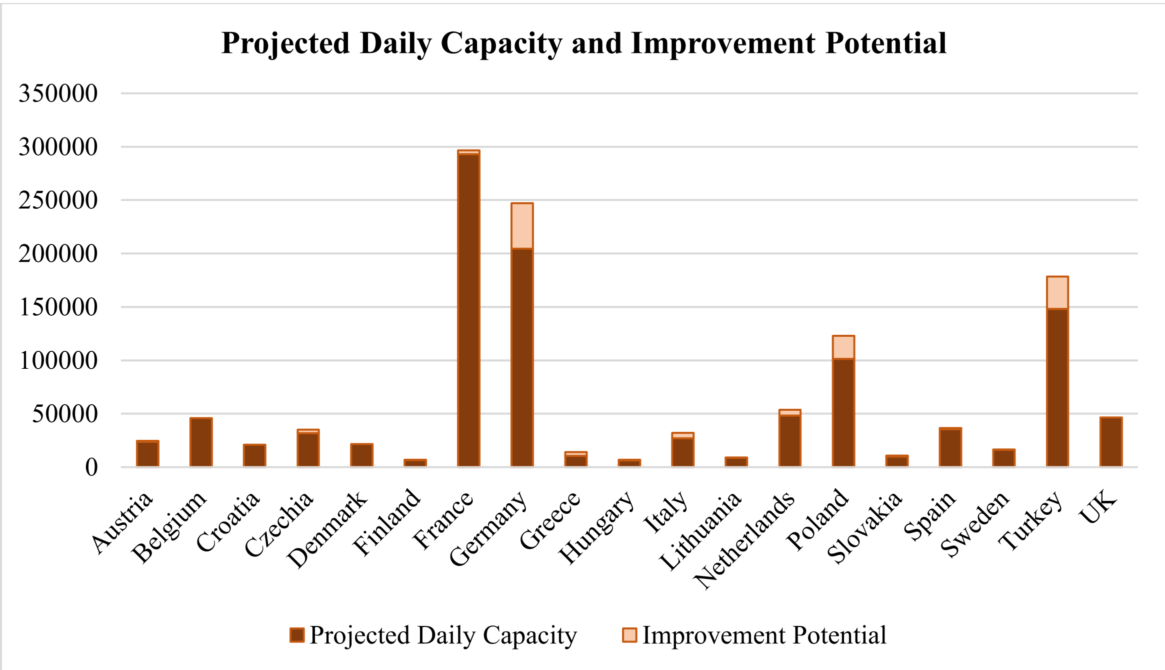


Figure 35. Improment Potential of Capacity

In Figure 35 the comparison of capacities of the factories is shown. It is thought that they will be more efficient if Germany increased its capacity from 200 000 to 250 000, and Turkey rises capacities of the factories from 150 000 to 180 000.

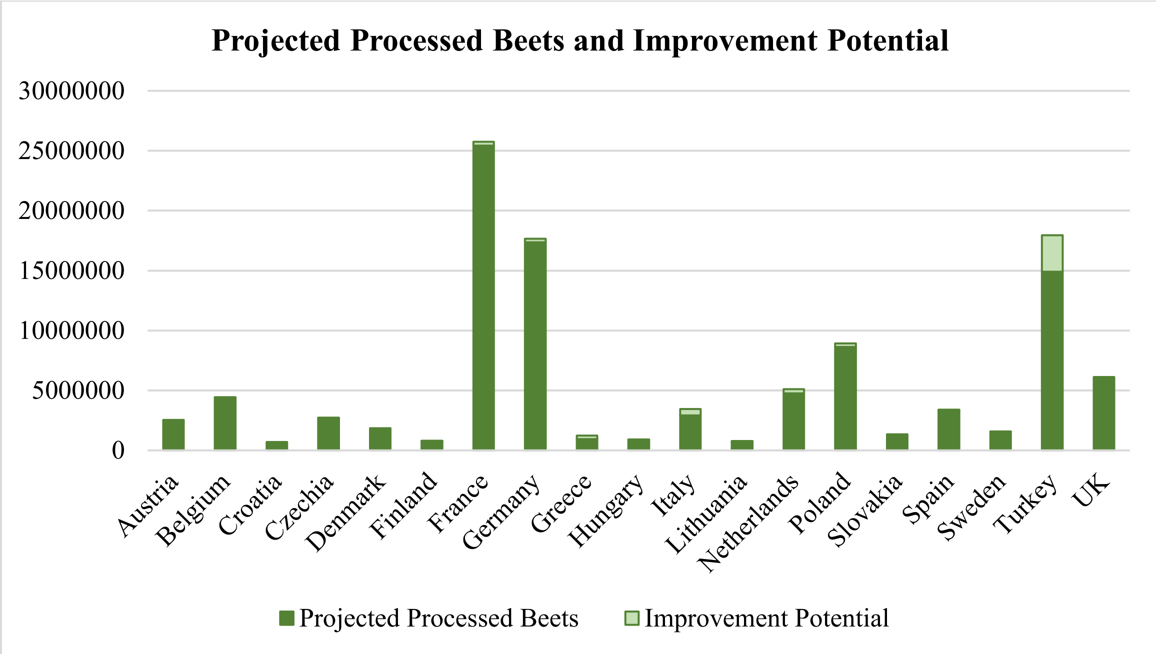


Figure 36. Improment Potential of Processed Beets

Figure 36 shows efficiency level of the countries in terms of beet processed. It is thought that Turkey will be more efficient if it raises the level of beet processed.

Table 27. Reference Data for Model 3.128

Model = CCR-I							
No.	DMU	Score	Rank		Reference(Lambda)		
1	Austria	0.9557	12	Belgium	0.409	UK	0.103
2	Belgium	1	1	Belgium	1		
3	Croatia	1	1	Croatia	1		
4	Czechia	0.9947	5	Denmark	1.466		
5	Denmark	1	1	Denmark	1		
6	Finland	0.928	15	Belgium	0.071	UK	0.069
7	France	0.988	6	Belgium	1.011	Denmark	11.407
8	Germany	0.9841	7	Denmark	9.461		
9	Greece	0.7523	19	Belgium	0.069	Denmark	0.34
10	Hungary	0.8808	16	Belgium	0.005	UK	0.128
11	Italy	0.8466	17	Belgium	0.395	UK	0.193
12	Lithuania	0.9713	9	Belgium	0.042	Denmark	0.312
13	Netherlands	0.9302	13	Belgium	0.988	UK	0.059
14	Poland	0.9657	11	Denmark	4.696		
15	Slovakia	0.9297	14	Belgium	0.047	UK	0.169
16	Spain	0.9676	10	Belgium	0.546	Denmark	0.476
17	Sweden	0.9808	8	Belgium	0.294	Denmark	0.129
18	Turkey	0.8304	18	Belgium	2.835	UK	0.378
19	UK	1	1	UK	1		

In Table 27 the efficiency measures and reference numbers is shown. Most efficient countries are Belgium, Croatia, and Denmark. The lowest ones are Italy, Turkey and Greece.

Table 29. Empirical Results for Model 3.1 (BCC)

Model = BCC-I															
				Employees			Daily Capacity			Processed Beets			Sugar Produced		
No	DMU	Score	Rank	Data	Projection	Diff.(%)	Data	Projection	Diff.(%)	Data	Projection	Diff.(%)	Data	Projection	Diff.(%)
1	Austria	0,9597	15	777	486,554549	-37,38	24700	23705,144	-4,028	2557011	2454020,793	-4,028	402985	402985	0
2	Belgium	1	1	657	657	0	46040	46040	0	4441830	4441830	0	740009	740009	0
3	Croatia	1	1	603	603	0	21000	21000	0	706296	706296	0	119576	119576	0
4	Czechia	0,9998	9	1372	707,656066	-48,422	35186	31622,199	-10,128	2707108	2706542,908	-0,021	455877	455877	0
5	Denmark	1	1	491	491	0	21620	21620	0	1836975	1836975	0	311000	311000	0
6	Finland	1	1	272	271,997869	-0,001	7000	6999,993	0	795553	795552,1993	0	120208	120208	0
7	France	1	1	6450	6449,99984	0	296725	296725	0	25753975	25753974,73	0	4295763	4295763	0
8	Germany	0,9983	10	5164	4425,9403	-14,292	247000	203281,64	-17,7	17660750	17630222,05	-0,173	2942281	2942281	0
9	Greece	0,7685	19	578	295,879067	-48,81	14000	10758,674	-23,152	1238350	951643,1547	-23,152	156899	156899	0
10	Hungary	1	1	279	278,997892	-0,001	7035	7034,99	0	913069	913067,7027	0	128834	128834	0
11	Italy	0,8488	18	1000	531,14873	-46,885	32065	27218,085	-15,116	3461081	2937907,234	-15,116	480398	480398	0
12	Lithuania	1	1	265	264,998833	0	8930	8929,9959	0	781551	781550,6407	0	128018	128018	0
13	Netherlan	0,9336	16	744	694,612545	-6,638	53700	47323,82	-11,874	5104460	4765620,905	-6,638	788639	788639	0
14	Poland	0,978	13	4682	2209,82313	-52,802	123000	100971,7	-17,909	8931933	8735629,957	-2,198	1460371	1460371	0
15	Slovakia	0,9796	12	492	315,380591	-35,898	10812	10591,914	-2,036	1336375	1309172,147	-2,036	200189	200189	0
16	Spain	0,9678	14	1814	592,774058	-67,322	36621	35442,235	-3,219	3410791	3301003,68	-3,219	552207	552207	0
17	Sweden	0,9906	11	416	385,796356	-7,26	16650	16493,031	-0,943	1573651	1558815,281	-0,943	257764	257764	0
18	Turkey	0,8908	17	18468	3298,86285	-82,137	178419	158931,76	-10,922	17949200	14932802,22	-16,805	2467898	2467898	0
19	UK	1	1	730	730	0	46600	46600	0	6111125	6111125	0	977780	977780	0

As can be seen in the Table above (Table 29), the most efficient countries are Belgium, Croatia, Denmark, Finland, Hungary, UK and Lithuania in terms of technical efficiency. Inefficient countries are Greece, Turkey and Italy.

Table 30. Reference Data for Model 3.1

No.	DMU	Score	Rank		Reference(Lambda)				
1	Austria	0.9597	15	Denmark	0.565	Lithuania	0.233	UK	0.202
2	Belgium	1	1	Belgium	1				
3	Croatia	1	1	Croatia	1				
4	Czechia	0.9998	9	Denmark	0.964	France	0.036		
5	Denmark	1	1	Denmark	1				
6	Finland	1	1	Finland	1				
7	France	1	1	France	1				
8	Germany	0.9983	10	Denmark	0.34	France	0.66		
9	Greece	0.7685	19	Denmark	0.12	Lithuania	0.872	UK	0.008
10	Hungary	1	1	Hungary	1				
11	Italy	0.8488	18	Denmark	0.583	Lithuania	0.128	UK	0.289
12	Lithuania	1	1	Lithuania	1				
13	Netherlands	0.9336	16	Belgium	0.863	France	0.005	UK	0.132
14	Poland	0.978	13	Denmark	0.712	France	0.288		
15	Slovakia	0.9796	12	Finland	0.631	Hungary	0.279	UK	0.09
16	Spain	0.9678	14	Belgium	0.544	Denmark	0.454	France	0.002
17	Sweden	0.9906	11	Denmark	0.396	Lithuania	0.537	UK	0.067
18	Turkey	0.8908	17	France	0.449	UK	0.551		
19	UK	1	1	UK	1				

In Table 30 reference numbers is shown. For instance, as reference countries for Austria; Denmark 0.565, Lithuania 0.233 and UK 0.022 rates are specified. Since the activity number of the Belgian country is 1, it is also referred to as reference. Turkey's reference countries appear as France 0.449 and UK 0.551.

5.7.3.2. Empirical Results for the 3/2 Model

In the analysis 3-2, factory-based comparisons of sugar factories in the EU and sugar factories in Turkey were made. In the table below, efficience scores and reference sets obtained by DEA models are shown. With the established model, “employees per factory” and “capacity per factory” data were entered as input and the “sugar produced per factory” data were taken as output.

Table 31. Empirical Results for Model 3.2 (CCR)

Model = CCR-I															
				Employeers Per Factory (piece)	Projected Employers per factory			Capacity Per Factory (tone/day	Projected Capacity per Factory			Sugar Produced Per Factory (tone)		
No	DMU	Score	Rank	Data	Projection	Improvement Potential	Diff.(%)	Data	Projection	Improvement Potential	Diff.(%)	Data	Projection	Diff. (%)
1	Germany	0,5677	16	258	110,13468	147,9	-57,312	12350	7011,3059	5338,7	-43,228	147114,05	147114,05	0
2	Austria	0,7776	7	389	150,84427	238,2	-61,223	12350	9602,9276	2747,1	-22,244	201492,5	201492,5	0
3	Belgium	0,8432	4	219	184,66541	34,3	-15,678	15346,6	11756,022	3590,6	-23,397	246669,6	246669,6	0
4	Czechia	0,6175	15	196	48,755042	147,2	-75,125	5026,57	3103,8046	1922,8	-38,252	65125,28	65125,28	0
5	Denmark	0,6856	12	246	116,41269	129,6	-52,678	10810	7410,9718	3399,0	-31,443	155500	155500	0
6	Finland	0,8184	5	272	89,991875	182,0	-66,915	7000	5728,991	1271,0	-18,157	120208	120208	0
7	France	0,69	11	258	128,63828	129,4	-50,14	11869	8189,2678	3679,7	-31,003	171830,52	171830,52	0
8	Netherlan	0,7936	6	372	295,20125	76,8	-20,645	26850	18792,866	8057,1	-30,008	394319,5	394319,5	0
9	UK	1	1	183	183	0,0	0	11650	11650	0,0	0	244445	244445	0
10	Spain	0,7186	9	363	82,68026	280,3	-77,223	7324,2	5263,5248	2060,7	-28,135	110441,4	110441,4	0
11	Sweden	0,7378	8	416	192,97107	223,0	-53,613	16650	12284,77	4365,3	-26,218	257764	257764	0
12	Italy	0,714	10	333	119,88081	213,1	-64	10688,33	7631,7568	3056,5	-28,597	160132,6	160132,6	0
13	Lithuania	0,6832	13	133	47,919356	85,1	-63,97	4465	3050,6038	1414,4	-31,677	64009	64009	0
14	Hungary	0,8728	3	279	96,449598	182,5	-65,43	7035	6140,0974	894,9	-12,721	128834	128834	0
15	Poland	0,5659	17	260	60,738003	199,3	-76,639	6833,3	3866,6543	2966,7	-43,415	81131,7	81131,7	0
16	Slovakia	0,8824	2	246	74,934212	171,1	-69,539	5406	4770,402	635,6	-11,757	100094,5	100094,5	0
17	Turkey	0,6592	14	560	55,986643	504,0	-90,002	5407	3564,177	1842,8	-34,082	74785	74785	0
18	Greece	0,5341	18	289	58,730015	230,3	-79,678	7000	3738,8234	3261,2	-46,588	78449,5	78449,5	0
19	Croatia	0,2714	19	201	29,839829	171,2	-85,154	7000	1899,6394	5100,3	-72,862	39859	39859	0

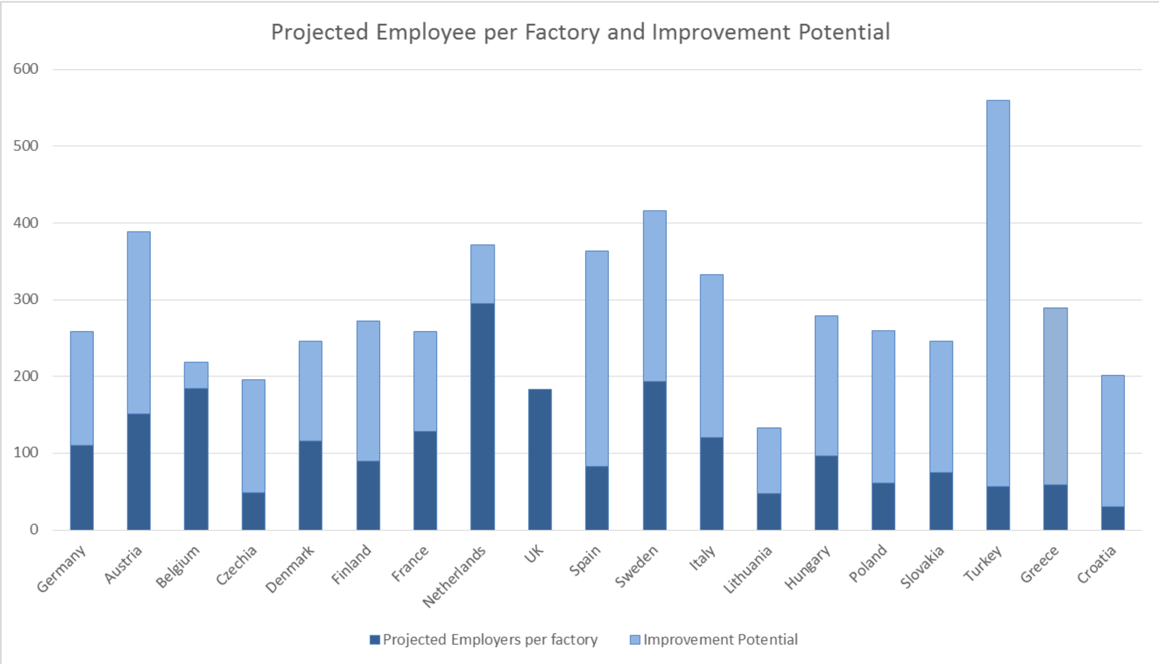


Figure 37. Improment Potential of Processed Beets

When we evaluate on factory basis, the most efficient countries are UK and Slovakia. Inefficient countries are Croatia, Greece and Poland. Turkey ranks 14th in the efficiency rankings (Table 31).

As can be seen from the examination of the Figure 37, in Turkey, the number of workers is so high than it should be. In order to make the country efficient, the number of workers per factory should be decreased below 100 in Turkey. Belgium is the most efficient country in terms of number of employees.

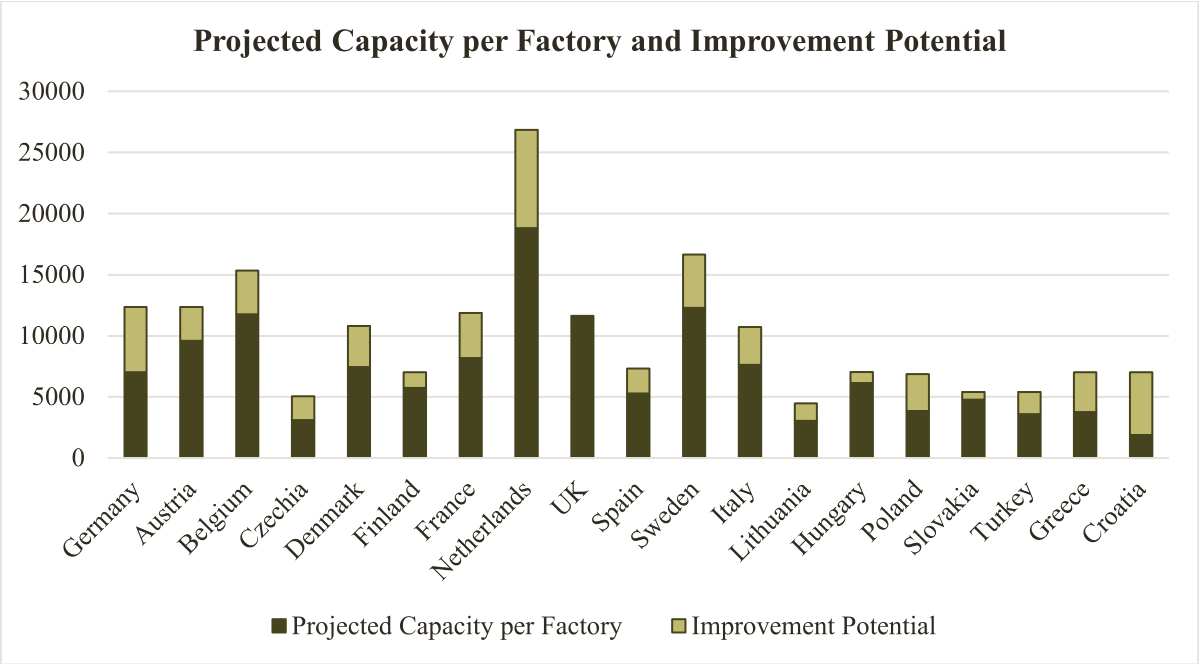


Figure 38. Improment Potential of Capacity

In terms of improvement potential of capacity (Figure 38); UK is the most efficient country, but Netherland, Croatia and Germany are the inefficient countries.

Table 32. Empirical Results for Model 3.2 (BCC)

Model = BCC-I												
				Employeers per Factory (Piece)			Capacity per Factory (tone/day)			Sugar Produced per Factory (tone)		
No	DMU	Score	Rank	Data	Projection	Diff.(%)	Data	Projection	Diff.(%)	Data	Projection	Diff. (%)
1	Germany	0,6272	19	258	161,82604	-37,277	12350	7746,324	-37,277	147114,05	147114,05	0
2	Austria	0,7929	11	389	201,74319	-48,138	12350	9792,0434	-20,712	201492,5	201492,5	0
3	Belgium	0,8484	9	219	185,80409	-15,158	15346,6	11875,483	-22,618	246669,6	246669,6	0
4	Czechia	0,8941	7	196	136,49625	-30,359	5026,57	4494,0812	-10,593	65125,28	65125,28	0
5	Denmark	0,7396	14	246	181,93162	-26,044	10810	7994,6376	-26,044	155500	155500	0
6	Finland	0,8966	6	272	237,21881	-12,787	7000	6276,0153	-10,343	120208	120208	0
7	France	0,7278	15	258	187,7789	-27,217	11869	8638,5572	-27,217	171830,52	171830,52	0
8	Netherland	1	1	372	371,99875	0	26850	26849,869	0	394319,5	394319,5	0
9	UK	1	1	183	183	0	11650	11650	0	244445	244445	0
10	Spain	0,7992	10	363	241,48133	-33,476	7324,2	5853,5529	-20,079	110441,4	110441,4	0
11	Sweden	0,7808	12	416	199,79474	-51,972	16650	13000,657	-21,918	257764	257764	0
12	Italy	0,7488	13	333	219,79421	-33,996	10688,33	8002,9868	-25,124	160132,6	160132,6	0
13	Lithuania	1	1	133	132,99936	0	4465	4464,9784	0	64009	64009	0
14	Hungary	0,9452	5	279	233,4541	-16,325	7035	6649,14	-5,485	128834	128834	0
15	Poland	0,7188	16	260	186,61958	-28,223	6833,3	4911,4799	-28,124	81131,7	81131,7	0
16	Slovakia	1	1	246	245,9971	-0,001	5406	5405,9892	0	100094,5	100094,5	0
17	Turkey	0,8777	8	560	166,7452	-70,224	5407	4745,9773	-12,225	74785	74785	0
18	Greece	0,6916	17	289	178,2204	-38,332	7000	4841,5363	-30,835	78449,5	78449,5	0
19	Croatia	0,6617	18	201	132,99867	-33,832	7000	4464,9554	-36,215	39859	64008,36	60,6

Table 32 shows the BCC (technical activity) rates. According to this analysis, countries that have taken the best technical efficiency, are Netherlands, UK, Lithuania and Slovakia. Turkey, technical efficiencies have taken place in the rankings 8th, Greece, Croatia and Germany are the countries located in the last ranks. Although this result means that Turkey is in the middle of technical efficiency, it should be taken into consideration that four factories belonging to TSFI did not campaign in 2016 and therefore would not affect the results of the analysis as it did not produce sugar and therefore it was not included in the analysis.

Table 33. Reference Data for Model 3.1

No.	**DMU**	**Score**	**Rank**		**Reference(Lambda)**				
1	Germany	0.6272	19	UK	0.449	Lithuania	0.494	Slovakia	0.056
2	Austria	0.7929	11	UK	0.702	Slovakia	0.298		
3	Belgium	0.8484	9	Netherlands	0.015	UK	0.985		
4	Czechia	0.8941	7	Lithuania	0.969	Slovakia	0.031		
5	Denmark	0.7396	14	UK	0.461	Lithuania	0.31	Slovakia	0.229
6	Finland	0.8966	6	UK	0.139	Slovakia	0.861		
7	France	0.7278	15	UK	0.549	Lithuania	0.209	Slovakia	0.242
8	Netherlands	1	1	Netherlands	1				
9	UK	1	1	UK	1				
10	Spain	0.7992	10	UK	0.072	Slovakia	0.928		
11	Sweden	0.7808	12	Netherlands	0.089	UK	0.911		
12	Italy	0.7488	13	UK	0.416	Slovakia	0.584		
13	Lithuania	1	1	Lithuania	1				
14	Hungary	0.9452	5	UK	0.199	Slovakia	0.801		
15	Poland	0.7188	16	Lithuania	0.525	Slovakia	0.475		
16	Slovakia	1	1	Slovakia	1				
17	Turkey	0.8777	8	Lithuania	0.701	Slovakia	0.299		
18	Greece	0.6916	17	Lithuania	0.6	Slovakia	0.4		
19	Croatia	0.6617	18	Lithuania	1				

6. CONCLUSION AND EVALUATION

With the phenomenon of globalization, the intense competition in all areas of the economic system makes it essential for the efficient use of scarce resources in both public and private enterprises.

Before the accession of EU, it is very important to analyze the level of efficiencies of the goods which have big economic impact for the Turkey's economy in terms of production, income and employment. In EU, there is free flow of goods between countries and there is no custom tariff for the trade between the community countries. This requires competitiveness for the EU candidate countries. Sugar is such a good which its economic influence is relatively high for Turkey too. The purpose of the study is to determine whether Turkey has a capability to compete with the EU sugar industry and to show how can compete under the current competitive conditions.

In Turkey, the need for efficiency analysis in sugar factories started especially from the start of the quota application in terms of analyzing the effects of quotas. And also, privatization of the sugar factories made it an important tool for determining the values of state owned sugar factories especially whose privatization process ended in 2018.

Due to the data unavailability of 2017/2018 marketing year, this thesis's analysis is based on the data of 2016 therefore does not cover the privatization effects which were made in 2018 and the EU quota abolishion which was made in 2017.

In addition to EU-Turkey comparative analysis, by using input sets per factory, the activities of all sugar factories belonging to the state and private sector in Turkey are analyzed and are revealed the improvement potentials.

The research data sources are; abolished Turkey Sugar Authority, Department of Sugar of Ministry of Agriculture and Forest, Turkish Sugar Factories Inc. (Türkşeker) Annual Reports, International Sugar Organization Sugar Yearbooks, European Commission Reports, Annual Statistics, Association of Beet Cultivators Cooperatives (Pankobirlik), Amasya, Kütahya, Konya, Kayseri Sugar Factories Annual Reports, CEFs Statistics, FAOStat, EuroStat, IMF World Economic Outlook Database and Barten's Sugar Industry Europe.

In this study, 3 models were set up. First model compares the sugar factories within the Turkish Sugar Factory's Co, second model compares to the public and private sugar factory and the last model compares the relative efficiency of sugar industries of Turkey with EU countries.

Subsequently, some suggestions were made by considering the analysis results of the established models.

Production efficiency of 18 countries which have sugar factories and which are member of in EU-28 have been analyzed based on the data of 2016, but Romania are not included in the analysis due to lack of the data. As a result of all these analyses, we came to conclusion about whether the sugar industry in Turkey can compete with the EU and what should be done for increasing competitiveness of Turkish Sugar Industry.

With the first model established in the study; the production performance of the state-owned sugar factories operating in Turkey is aimed to be measured. For this purpose, efficiency measurement was carried out by using DEA which is non-parametric method with 2016 data of 21 sugar factories operating in public sector. The aim of the second model established in the study is to measure the relative efficiency of state owned sugar factories and private sugar factories all together.

The purpose of the third model established in the study can be summarized as determining whether the sugar industry in Turkey is capable of competing with the sugar industry of the European Union and making recommendations on how to compete under the current competitive conditions.

6.1. Evaluation of The Result of Analysis of The Established Models

In the models, 21 factories from 25 public sugar factories were included in the analysis. Four factories (Ağrı, Alpullu, Çarşamba and Susurluk sugar factories) were not included in the analysis on the grounds that they were not operated in 2016.

6.1.1. Model 1 (civil servant-worker-temporary worker-fuel-electricity)

- In the first model established by taking the basic inputs that reflects cost of production 76% of the factories analyzed according to CCR method and 57% of the factories analyzed according to the BCC method were found ineffective by solving with DEA-SOLVER-LVS program.

- The inefficiency of decision units analyzed by DEA technique shows that waste was made in the use of input factors and therefore the potential output amount could not be reached.

- When the data of 21 public sugar factories analyzed in the model, it is examined the dimensions of waste made in ineffective decision units, from another perspective, the potential improvements are observed. For instance, Malatya Sugar Factory, which was ineffective under both CCR and BCC, produced 45 746 tons of sugar in the marketing year of 2016 with 346 employees, while Afyon Sugar Factory produced 137 310 tons of sugar with 316 employees. The comparative data shows that proportion of the wastage is high resulting from the incorrect personnel policies in state-owned sugar factories in Turkey. In addition, it is observed that the employment policies of the factories in the eastern Anatolia region are governed for social purposes rather than production efficiency.

- According to the results of the analysis, Malatya, Muş, Turhal and Bor sugar factories are in the last ranks and the most inefficient ones. In the analysis, the reason for the inefficiency of these factories is due to the inefficient employment policies, inefficient fuel and electricity consumption.

- As a result of the analysis, it is seen that the factories with high efficiency have high production capacities and the factories with low efficiency have low production capacities.

- Potential improvement analysis was carried out along with efficiency analysis of Turkish sugar factories. The analysis revealed how inefficient factories could be effective. In the analysis, it was calculated how much a sugar factory should reduce its input by using minimum inputs in order to obtain a constant output. It has been shown that inactive sugar factories should take effective sugar factories as good reference.

- Studies with DEA technique have strong features such as obtaining the important administrative information with the ease of implementation and interpretation, but also have some limitations arising from the structure of the technique. First of all, since DEA is a relative efficiency measurement technique, it cannot be claimed that the results obtained reflect the absolute effectiveness or inefficiency of the decision units. Different conclusions can be made by joining other decision-making units or subtracting one or more of the existing decision-making units. DEA, on the other hand, is a cross-sectional analysis whose results are valid only for the period in which it is applied. When the effectiveness of the same decision units is examined in another period, different results can be obtained.

6.1.2. Model 2 (Capacity-Processed Beet-Worker)

- The model compares relative efficiency of public and private sugar factories in Turkey are compared in terms of production capacity with the 2016 data.

- In the second model the inputs representing the production capacity (number of employees, processed beet and daily beet processing capacity) were solved by using DEA-solver-LVS program and 86% of the factories were inefficient according to CCR method, 62% of the factories were inefficient according to BCC method.

- In the analysis of the second model according to BCC method; Adapazarı, Erciş, Erzincan, Çumra, Konya, Kayseri, Boğazlıyan, Keskinkılıç, Kars, Kütahya and Uşak Sugar Factories are found effective. The most referenced factories are the Kayseri Sugar Factory, which is a private factory, and Kars Sugar Factory, which belong to the State. In the efficiency analysis based on production factors, it is seen that some state and private factories do not have significant advantages over each other.

6.1.3. Model 3 Efficiency Comparison Between Turkey and EU Member Countries

In this comparison inputs are "beet processing capacity per factory", "the number of employee (actual average) per factory", "processed beet"; and output is "the amount of sugar produced per factory".

- In this analysis, CCR and BCC input-oriented efficiency analysis was performed and technical efficiency results were obtained. According to the CCR analysis, the countries with high efficiency are the Belgium, UK, Croatia and Denmark. Five countries whose efficiency are in the last place are Greece, Italy, Turkey, Hungary and Finland. France, Finland, Hungary and Lithuania's BCC are effective which means that they do not have problems in terms of technical effectiveness, but they are inefficient because of the wrong scale and therefore they are not fully efficient.

- Looking at the data of EU countries; France, Germany and Turkey is seen to take place the first three rank in sugar production. This can be interpreted as they are efficient countries in terms of producing sugar. However, within the scope of the third model analysis, which is made with DEA with the input sets of actual number of employees per factory, the capacity of beet processing per factory and processed beet per factory and output sets of the amount of sugar produced per factory; these countries are not fully efficient. As mentioned earlier, the results of the efficiency analysis should be evaluated within the framework of the identified constraints (inputs and outputs). Different results can be obtained by using different sets of inputs and outputs, or using different marketing year data.

• Taking the number of employees per factory (actual average), the capacity of daily beet processing per factory, processed beet per factory, as input; and the amount of sugar per factory as output; Turkey, which is a candidate country to the EU; is one of the last six countries with inefficient sugar production.

• When the data used in the analysis of the third model is examined; the number of workers per factory in Turkey is quite high, while the beet processing capacity per factory, amount of sugar produced per factory seems to be quite low. It is necessary reducing the number of inefficient sugar factories and the number of idle people working in the factories to have Turkey's competitive production structure within the EU market. Under the current circumstances, one way to ensure that the sugar industry can compete with the EU is to increase the beet processing capacities of the factories. When comparing Belgium which is an efficient country with Turkey, it is seen that Turkey’s number of workers per factory is 2.6 times more than that it was in Belgium and beet processing capacity per factory in Belgium is greater than Turkey roughly 3 times, and also the amount of sugar produced per factory in Belgium is more 3.3 times than Turkey.

• For the sugar factories to be efficient in Turkey, it is required that closure of some inefficient sugar factory, increasing the capacity of existing efficient beet processing factory, reducing the number of workers in the factories and also increasing the sugar production per sugar factory is needed.

6.2. General Evaluation

1- Glucose, known as table sugar, is obtained from cane and beet. World sugar exchange prices are determined by low-cost cane sugar, which is dominant in trade. There is no difference in quality between the sugars obtained from cane and beet. However, the production of sugar cane at a lower cost than sugar beets results in it being predominantly internationally tradable. Due to the geography, sugar are produced, in the countries such as European Union, Russia, Ukraine and Turkey from beet; countries such as USA, Japan and

China both from beet and cane; many countries, particularly Brazil, India, Mexico, Pakistan, Thailand and Australia from cane.

Although the main determinant in the formation of world sugar prices is the supply / demand situation; speculation, oil and commodity prices, energy policies, freight cost, exchange rate changes, interest rates, trade policies and preference agreements, inflation, political and financial turmoil, and economic conditions of countries play an increasing role in prices. The fact that the sugar produced is below the demand causes the stocks to decrease and therefore the prices to increase, and in the situation vice versa, the prices to decrease.

In 2018, world white sugar prices decreased by 21%. Like all other commodities, sugar prices are affected by sugar supply and demand worldwide. Demand can change prices, while prices can change supply, and increases in sugar prices result in producers wanting to take advantage of this, making production in more areas, which can lower prices by creating production surplus.

When there is a surplus in the amount of sugar, prices fall; in cases of shortage of supply caused by problems in sugar beet / cane production or harvest, sugar prices increase. Developments in the world, especially in the last 25-30 years, have caused the interaction of sugar with other agricultural products and fuel markets. On the one hand, the competitiveness of the starch-based sugar produced from corn with the sugar of beets and cane has increased, on the other hand, the use of ethanol as a fuel has affected the prices of oil and sugar.

2- If we look at the EU, EU Ministers of Agriculture have reached a political decision on a comprehensive reform of the Common Market Order for Sugar, based on a European Commission Reform Proposal prepared in June 2005. The aim of the reform is to increase the competitiveness and market focus of the EU Sugar sector in order to guarantee the sustainability of the sector in the long term and to strengthen the bargaining power in the current negotiations with the World Trade Organization. As a result of the reform implemented in the EU, quotas were abolished in 2017 and as a result, in 2018, the EU moved from a net importer position to a net exporter position in sugar.

3- In Turkey, the sugar sector, before the Sugar Law No. 4634 came into force, has followed an unstable production course with the position of importer and exporter changing periodically. Particularly in the 1990s, instability in the amount of production has left the sector at times facing import risks and at times stock problems. Therefore, production planning and control of sugar is of strategic importance. Production planning is carried out on the basis of "annual domestic sugar need and security stock" due to the high sugar prices in our country which produces sugar from beets due to its geographical location and the inability to apply subsidies to sugar exports within the scope of our commitments to the World Trade Organization.

The privatization of TSFI entered agenda for the first time on June 22, 2000 with a letter of intent given to the IMF. Looking at the privatization process as of today, the sales and transfer operations of 10 factories belonging to TSFI (Afyon, Alpullu, Bor, Corum, Elbistan, Erzincan, Erzurum, Kırşehir, Muş, Turhal) were completed in 2018.

Total capacity is 4.7 million tons against the quota of 2 million 500 thousand tons determined according to sugar demand in our country. There is a capacity surplus of 40% in sugar beet and 70% in SBS. Pursuant to the provisions of the Sugar Law No. 4634, it is necessary to supply quota first for the establishment of a new factory or for additional capacity. For this reason, there is no need to establish a new factory to meet the domestic production in the sector or to increase the capacity in the existing factories. Under current conditions, only maintenance, renovation, modernization and environmental investments are made.

4-We can partition sugar factories in Turkey under three headings according to their ownership: TSFI, Sugar Beet Growers Cooperatives and private companies. TSFI is a state-owned enterprise which operates according to market conditions and whose capital is all owned by the Treasury. As of today, the number of factories belonging to TSFI are 15, the number of factories belonging to Sugar Beet Growers Cooperatives are six, and number of factories belonging to private companies are 12. According to the analysis results, in terms of working personnel, fuel and electricity used and daily beet processing capacities; Erciş, Erzincan, Uşak and Kars factories from TSFI, Boğazlıyan, Kayseri, Konya and Çumra Factories from Sugar Beet Growers Cooperatives, Keskinkılıç, Adapazarı and Kütahya Factories from private companies, because of having high capacity utilization rate, are efficient, the others are inefficient. In addition, it is seen that these factories are far from competing with the EU factories and are in need of improvement to a large extent.

5- In Turkey seven sugar factories (Kars, Erzincan, Erzurum, Elazığ, Erciş, Uşak and Yozgat Sugar Factories) which are small scale (1 750-3 000 tons/day beet processing capacity) must be shut down. Five of them are located in the Eastern Anatolia region. Especially the factories located in eastern Anatolia were established for socio-economic purposes, beets are inadequate, campaign times are short, production costs are high and they can not be run efficiently.

6- Turkey needs to follow the World Trade in sugar sector and maintain a cautious approach. It is an opportunity for Turkey to have countries that import large quantities of sugar around the country. Approximately half of Turkey's total beet production capacity have been being used. Due to the low-cost cane sugar that dominates the world stock exchanges, domestic sugar has no competitiveness with imported sugar. Protection rates in imports are of great importance in order to ensure domestic production preference. In the case of beet sugar being exported, the difference between world prices and domestic prices, which are lower than domestic prices, must be subsidized. On the other hand, the fact that world sugar exchange prices are quite low compared to the production costs of beet sugar produced in our country is the weakest aspect of the sector in international competition. In order to increase the efficiency of state-owned factories, there is a need to either restructure them in management, technology, legislation and agriculture areas by increasing their daily beet processing capacity, or by privatizing these factories to establish competition in the market.

7- Other sugar factories which are competitors of TSFI, are able to produce sugar at lower cost such reasons as their proximity to raw materials and the market, high beet yields, capacity sizes and optimal capacity utilization, modern technologies, having been industrial automation, lower labor costs and using the advantages of being private sector better (like tender, wages, management and marketing flexibility, etc.). One of the most important problems of TSFI is the stock problem. In order to sell the sugar produced within the market conditions; despite the use of all marketing methods taking into account the sales procedures and the legislation in force and the cost of production, the last marketing year (2017) was entered with significant quantities of sugar stock. In order to dissolve the stock remaining in the hands of TSFI, the State must support it.

8- The Çarşamba Sugar Factory is a factory established to import and process raw sugar and export it as sugar. However, in recent years, the Çarşamba Sugar Factory has not campaigned at all, increasing TSFI's costs and reducing its productivity in general due to its average of 200-300 employees and mandatory operating expenses. It is inevitable for this factory to carry out the necessary work which are to import raw sugar from the international market and to produce sugar and to export it to our neighboring countries.

9- The abolition of sugar quota in Turkey as in the EU is impossible as of today. The most basic element that determines the market values of factories today is the amount of quota that the factory has. While the state-owned TSFI operates as a player in the market, if the quotas are abolished; the TSFI will have to sell the sugar produced by it below its cost, or the inventory will increase and face stock costs. In addition, the market value of the factories will decrease significantly and even the possibility of privatizing the factories will be eliminated. Because for the investors, the possibility of establishing a new factory in places with high technology, high beet polar value and close to raw material and market network will become more profitable and more efficient than buying one of TSFI's factories. Therefore, as a market regulator, the State is obliged to determine quotas and carry out market controls until ensuring competition in the market by completing privatizations or restructuring the sector. Once the market is fully open to competition, it is considered that it would be more appropriate to abolish quotas and thus liberalise the market.

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APPENDIX-I

DMU	(I) Civil Servant	(I) Permanent Worker	(I) Temporary Worker	(I) Electricity Consumption MWH	(I) Fuel Consumption	(O) Sugar
Afyon	61	207	48	31.861	49.129	137.310
Ankara	110	483	20	15.203	19.557	63.110
Bor	55	229	54	16.280	29.151	68.145
Burdur	56	201	56	18.969	22.655	80.315
Çorum	38	219	52	19.465	23.395	103.018
Elazığ	66	156	66	2.912	3.992	11.480
Elbistan	33	180	101	14.896	21.717	48.050
Erciş	26	256	107	5.760	6.167	25.374
Ereğli	42	215	83	26.701	43.007	153.705
Erzincan	67	141	41	6.852	9.663	27.560
Erzurum	48	247	53	8.666	10.309	41.590
Eskişehir	87	296	67	31.027	42.042	120.300
Ilgın	48	267	74	29.629	49.446	137.850
Kars	27	131	35	2.960	3.479	11.262
Kastamonu	46	146	48	5.351	7.679	23.800
Kırşehir	40	212	45	13.275	18.720	77.960
Malatya	77	209	60	10.974	14.116	45.761
Muş	41	237	96	9.759	11.639	40.600
Turhal	75	287	66	21.193	28.532	104.240
Uşak	39	167	37	5.739	9.149	26.250
Yozgat	29	211	46	12.573	16.496	56.320

APPENDIX-II

DMU	(I) Daily Capacity	(I) Processed Beet	(I) Employee	(O) Sugar Produced
Afyon	7.500	1027000	652	137.310
Ankara	3.800	503.000	783	63.110
Bor	3.800	477.600	508	68.145
Burdur	5.200	618000	546	80.315
Çorum	7.500	735.000	645	103.018
Elazığ	1.800	84000	369	11.480
Elbistan	3.800	411000	484	48.050
Erciş	2.000	170.500	478	25.374
Ereğli	8.500	1.209.700	720	153.705
Erzincan	1.850	203.500	332	27.560
Erzurum	3.300	286000	496	41.590
Eskişehir	7.500	1.008.000	786	120.300
Ilgın	8.000	1.084.000	747	137.850
Kars	1.750	73.600	271	11.262
Kastamonu	3.800	181.000	410	23.800
Kırşehir	4.000	542000	477	77.960
Malatya	3.600	362.000	507	45.761
Muş	3.800	310.000	544	40.600
Turhal	7.500	741.000	764	104.240
Uşak	1.800	200.100	324	26.250
Yozgat	3.800	390.000	456	56.320
Adapazarı	6.000	474.700	309	62.388
Amasya	6.000	681.000	672	76.878
Kayseri	6.000	1.155.150	829	177.907
Boğazlıyan	14.400	1.411.850	1.015	217.441
Keskinkılıç	6.960	766414	478	110.229
Konya	16.500	1.496.836	563	170.188
Çumra	10.315	1.757.164	656	199.787
Kütahya	3.000	355.500	283	49.080

APPENDIX-III

DMU	(I) Employees	(I) Daily Capacity	(I) Processed Beets	(O) Sugar Produced
Austria	777	24.700	2.557.011	402.985
Belgium	657	46.040	4.441.830	740.009
Croatia	603	21.000	706.296	119.576
Czechia	1.372	35.186	2.707.108	455.877
Denmark	491	21.620	1.836.975	311.000
Finland	272	7.000	795.553	120.208
France	6.450	296.725	25.753.975	4.295.763
Germany	5.164	247.000	17.660.750	2.942.281
Greece	578	14.000	1.238.350	156.899
Hungary	279	7.035	913.069	128.834
Italy	1.000	32.065	3.461.081	480.398
Lithuania	265	8.930	781.551	128.018
Netherlands	744	53.700	5.104.460	788.639
Poland	4.682	123.000	8.931.933	1.460.371
Slovakia	492	10.812	1.336.375	200.189
Spain	1.814	36.621	3.410.791	552.207
Sweden	416	16.650	1.573.651	257.764
Turkey	18.468	178.419	17.949.200	2.467.898
UK	730	46.600	6.111.125	977.780

APPENDIX-IV

DMU	(I) EMPLOYEERS PER FACTORY (PİECE)	(I) CAPACITY PER FACTORY (tone/day)	(O) SUGAR PRODUCED PER FACTORY (tone)
Germany	258	12.350	147.114
Austria	389	12.350	201.493
Belgium	219	15.347	246.670
Czechia	196	5.027	65.125
Denmark	246	10.810	155.500
Finland	272	7.000	120.208
France	258	11.869	171.831
Netherlands	372	26.850	394.320
UK	183	11.650	244.445
Spain	363	7.324	110.441
Sweden	416	16.650	257.764
Italy	333	10.688	160.133
Lithuania	133	4.465	64.009
Hungary	279	7.035	128.834
Poland	260	6.833	81.132
Slovakia	246	5.406	100.095
Turkey	560	5.407	74.785
Greece	289	7.000	78.450
Croatia	201	7.000	39.859

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