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Loss Per Consumer approach for efficiency analysis of Turkish Electricity Distribution Companies by Using DEA

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ABSTRACT

The performance evaluation of electricity distribution companies has been extensively studied in the last two decades. These evaluations have been conducted in structures managed through a tariff system and have been approached from various perspectives. With liberalization, privatization, and increasing transparency in the markets, access to data, which is one of the major challenges in this field, has been improved. Energy losses have been a crucial factor in the performance evaluation of electricity distribution companies in Turkey. This article proposes using the Loss Per Consumer (LPC) index, rather than the conventional percentage representation, as a more effective tool for monitoring, evaluation, and setting targets. A data envelopment analysis (DEA) method was applied to the 2020 data of electricity distribution companies to perform an output-oriented efficiency assessment. The analysis makes use of energy losses, interruption time, interruption frequency, and loss rate (with both percentage and LPC options) as outputs and line length, transformer capacity, number of transformers and consumers, and energy invoiced as inputs. The results suggest that the LPC method offers better scalability for efficiency evaluations and the follow-up studies could further elucidate this issue by focusing on provinces and additional consumer groups.

Keywords: Energy losses, loss & theft, electricity distribution, DEA

JEL Classification: C30, C38, Q40

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1. INTRODUCTION

The COVID-19 pandemic in 2020 resulted in an energy crisis, characterized by a rise in the costs and a decrease in the supplies of energy. The reference prices in the Turkish spot electricity market (Market Clearing Price-MCP) increased more than tenfold between August 2020 and August 2022 (Figure 1) (EPİAŞ, Enerji Piyasaları İşletme A.Ş., 2022). The situation in the European Union and the rest of the world is even more dire. Energy losses and efficiency concerns become more pressing in the light of these cost increases, which disrupt the balance between energy demand and supply. The lost energy, which must be replaced at higher costs, cannot be fully reflected in the tariffs, causing distortions in the pricing method.

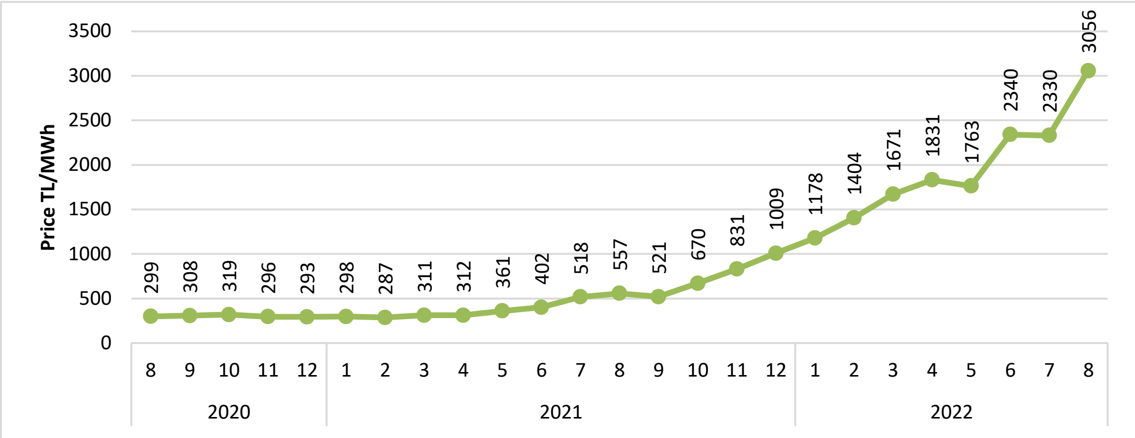

Figure 1-Monthly averages of MCP

Source: EPİAŞ, Enerji Piyasaları İşletme A.Ş., 2022

The total energy invoiced within the Turkish electricity distribution network in 2021 was 253,033 TWh (EMRA, 2022). Using data from the EMRA annual report, actual consumption was calculated to be 285,554 TWh, with an average distribution network loss rate of 11%. This equates to a loss of 32,551 TWh, or a financial loss of 16.5 billion TL (based on an annual MCP average of 508.10 TL/MWh) (EPİAŞ, Enerji Piyasaları İşletme A.Ş., 2022). In USD, this loss is equivalent to 1.81 billion USD, the cost of building a new 1,500 MW wind power plant from scratch. This energy loss is equivalent to the energy generated by a power plant with a capacity of 3,700 MW operating at 100% capacity for 8,760 hours annually. If a 60% efficient natural gas combined power plant were used, it would mean the annual energy generated by a 6,200 MW power plant is being lost. There is no power plant of this size in Turkey. Thus, efforts to reduce energy losses would be equivalent to building a virtual power plant, reducing costs and increasing energy security.

The issue of loss in the electrical network has been widely discussed in academic literature. Losses, which represent the difference between the energy drawn from the system and the energy invoiced, are divided into technical and non-technical losses (NTL). Technical losses are associated with the age of the network and technology advancements, while NTL is more related to the country's development (Smith, 2004). The reduction of NTL requires both technical measures, such as increased measurement and field scanning efficiency, and changes to the definition of electricity theft in criminal laws. NTL is a common problem in underdeveloped and developing countries (Depuru, 2011) and is an important factor in the evaluation of grid privatization (Ulusoy, 2007), which is seen as a method to combat losses. The privatization of Electricity Distribution Companies (DisCo) in Turkey was completed in 2013 (Ölmez, 2015). The regions with high loss rates had low privatization costs, as indicated in Figure-2 (TEDAŞ, Türkiye Electricity Distribution Corp., 2022), since high NTL indicates a need for improvement work in the field after privatization.

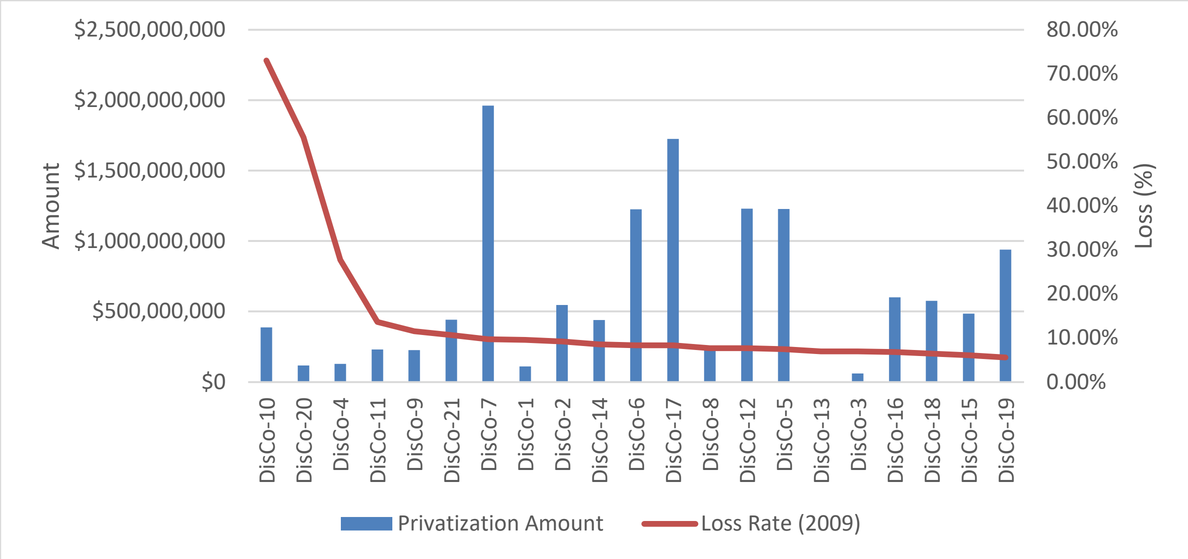

Figure 2-Privatization cost of distribution companies and loss rates

Source: TEDAŞ, Türkiye Electricity Distribution Corp., 2022

Figure-3 shows the loss rates of distribution companies according to 2021 values (EMRA, 2022). These loss rates show the official figures 8 years after 2013, the year of completion of privatizations. It can be evaluated that a completely homogeneous structure has not been formed despite the operation period after privatizations, improvements and three tariff periods (five-year periods). Since the geographical, cultural, social, political and economic characteristics of the provinces are very different from each other besides their technical characteristics, a homogeneous level should not be expected (Yurtseven, 2015). Homogenization in the field corresponds to a period that requires knowledge and determination change as well as legal, social, technical, and economic struggle. For this reason, periodic developments are observed, and precautions are taken while monitoring and evaluating the loss issue. In Türkiye, this structure is shaped on the basis of 5-year tariff applications issued by the Energy Markets Regulatory Authority (EMRA), which is the regulatory body that inspects private electricity distribution companies.

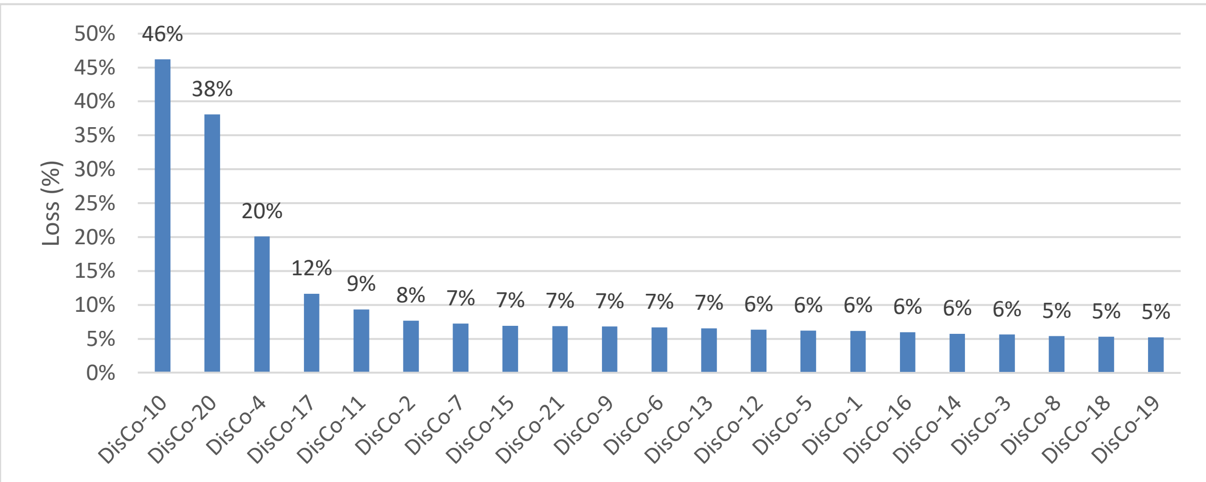

Figure 3-Loss rates of electricity distribution companies in 2021

Source: EMRA, 2022.

The issue of loss has been discussed in a very wide literature and has been the subject of much field research in the worldwide scale. Smith focused on the causes of electricity theft, evaluated the data of 102 countries for a period of 20 years and offered solutions by grouping them (Smith, 2004). Berktay et al. (2004) drew attention to the misconception between the percentage loss approach and the amount of kWh loss and mentioned that the two are different from each other. According to Bhattacharyya (2005), especially the NTL rate differs in developed and developing countries. Criminalizing electricity theft and improving tariff regulations are some reforms in the energy sector. Ulusoy and Oğuz (2007), in their study on the legal and economic analysis of privatization, referred to the issue of loss and theft through the traditional percentage approach. Taşdöven et al. (2012) focused on illegal electricity use and stated that privatization and free market formation are appropriate tools to reduce these rates by describing the lost energy in percentage. Depuru (2011) studied the factors that push the consumer to steal electricity, described the technical methods and suggested a method for diagnosis with smart measurement systems. According to him, socio-economic reasons such as unemployment, low literacy level, and insufficient punishments are among the causes of electricity theft (Depuru, 2011). Yurtseven (2015) focused on socio-economic and natural causes in his study and investigated the relationship between variables such as theft, education, income, rurality, energy price, regional temperature, migration rate, agricultural product potential and loss rates, and concluded that the electricity price is not directly effective in this relationship. Terciyanlı et al. (2017) showed that NTL can be calculated with an algorithm. Ahmad et al. made a comprehensive review on the general modeling mechanism of theft detection studies in the smart grid environment. Accordingly, since the theft detection is made in terms of kWh consumption, not percentage, the actual loss size can be expressed more meaningfully in terms of consumption (Ahmad, 2018). Savian et al., (2021) examined NTL and made applications and evaluations on percentage by conducting one of the most comprehensive review studies to date. Emre and Sözen (2022) stated in their studies that the problem of energy poverty and inability to pay is a situation that can turn into energy theft if not resolved. In their study, they argued that there is a level of vulnerability independent of energy price at each consumption level and that energy poverty can be diagnosed from the energy cut job order. In his study, Emre and Sözen (2022) stated that measures to reduce energy poverty should be taken to prevent energy theft and suggested an efficiency-based method over the energy cut job order.

The issue of loss, which is very important for electricity distribution companies, is always handled as percentage in the World Bank (World Bank Database, 2022), International Energy Agency and other international sources and common terminology. Losses in the electrical network are expressed as a percentage term obtained by dividing the difference between the energy drawn from the system and the energy invoiced by the energy drawn from the system. While there is no problem in this representation for technical losses, there are some problematic aspects of the percentage representation in the representation of NTL:

1. Percentage representation can cause semantic confusion in showing annual progress. For example, suppose a target of reducing NTL by 20% per year is accepted. The performance of the region, which had 80% technical loss at first, by reducing 20% loss annually is shown in the figure below. Accordingly, the rate taken with respect to the first year does not reveal an accurate result in evaluating the performance. Although the distribution company achieves a 20% loss reduction performance every year, it fell behind the target (Figure-4).

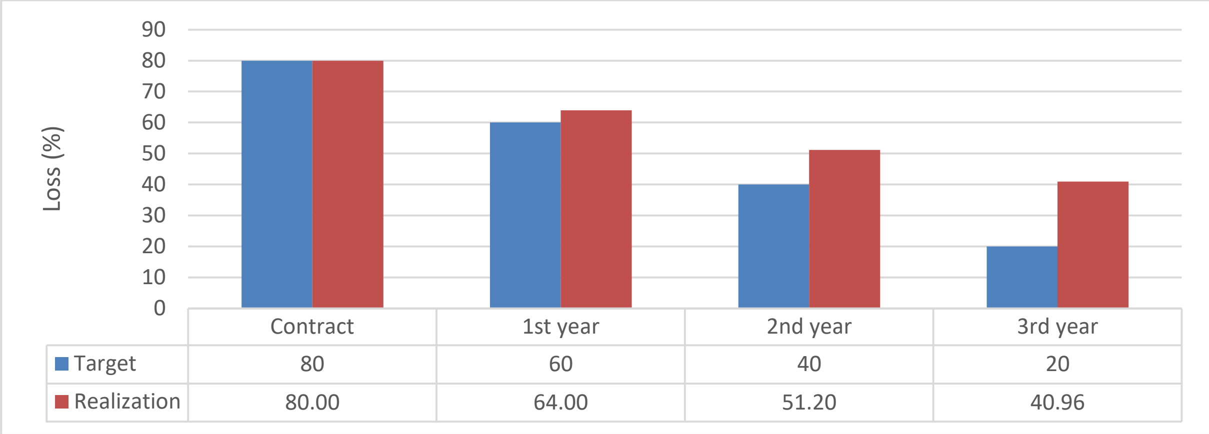

Figure 4-Loss & theft mitigation scenarios

Source: Source: Author calculation.

2. Loss representation in percentage is not suitable for performance targeting because of decreasing benefit. As the ratio decreases, the technical nature of the illegal activity becomes professional, and the effort required to detect it increases in the fight against NTL. However, it is not possible to go below a certain level.

3. Percentage representation does not represent regional differences. The performance of the distribution companies, whose technical equipment and information-methods application is exactly the same, is different as a natural result of the heterogeneity of the field.

4. Percentage representation creates a perception independent of the size of the lost energy, which is the main problem. Figure-5 shows the invoiced energy amount and loss rates of Turkish Electricity Distribution Companies. There is no-correlation between these two parameters. The ratio of the energy drawn by the region with the highest loss rate is 6.32 times the second one! The lost energy is 11,866,130 MWh for the first company and 1,343,872 MWh in the second region. In other words, the lost energy of the first company is 8.83 times the second one.

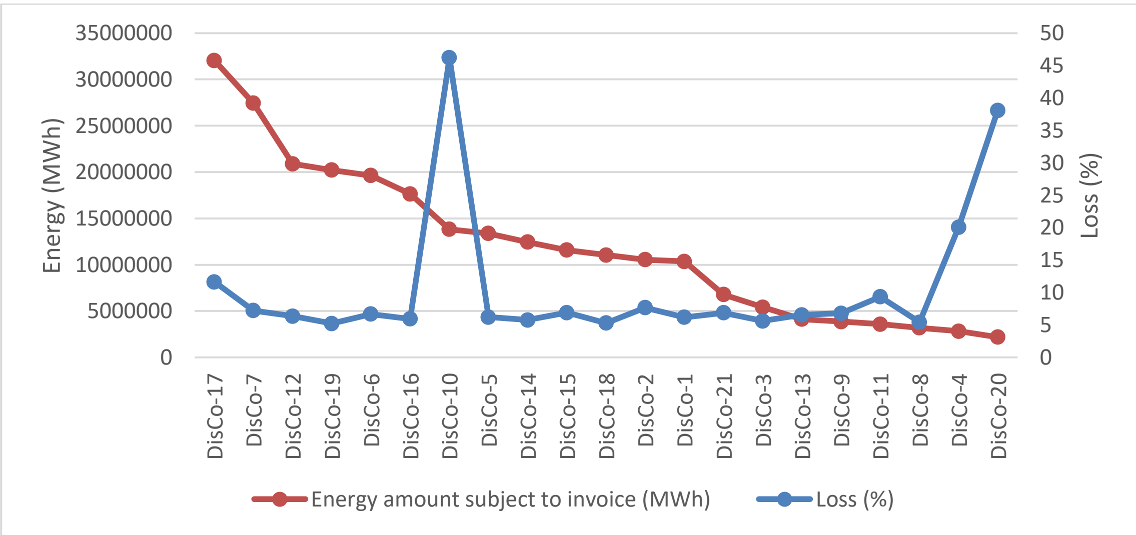

Figure 5-Energy invoiced and loss (%)

Source: EMRA, 2022.

5. In energy consumption, connection from low voltage level causes more loss than connection from high voltage level. On the other hand, there is no homogeneity in the consumption

type. For example, while low-consumption dwellings are generally connected at low voltage level, industrial consumers with high consumption make high-voltage connections. In this case, a distribution region with more industrial consumption will face fewer losses than another consumption region with less industrial consumption. In other words, among the distribution companies on equal terms, those with many residential consumers have to struggle more with lost energy. The percentage representation reflects a ratio over the total without reflecting these differences.

6. One of the methods to combat lost energy is to increase the number of registered consumer and to decrease the number of unregistered consumers (PwC Türkiye, 2015). Percentage rating is an impression that does not reflect the situation regarding the number of consumers.
7. Line lengths and transformer sizes vary depending on the geographical characteristics of the distribution companies. Longer lines mean more losses, and small transformers for small settlements have an increasing effect on losses. In the percentage representation, an evaluation and target situation is formed that is not dependent on all these effects.
8. Percentage representation is not successful in local and distinctive representation of the loss problem.

As an alternative method, an index can be obtained by dividing the difference between the energy drawn from the grid and the energy billed (lost energy) by the number of consumers. Figure-6 shows the values of the loss rates of distribution companies calculated by the Loss Per Consumer (LPC) method according to the year 2021 values.

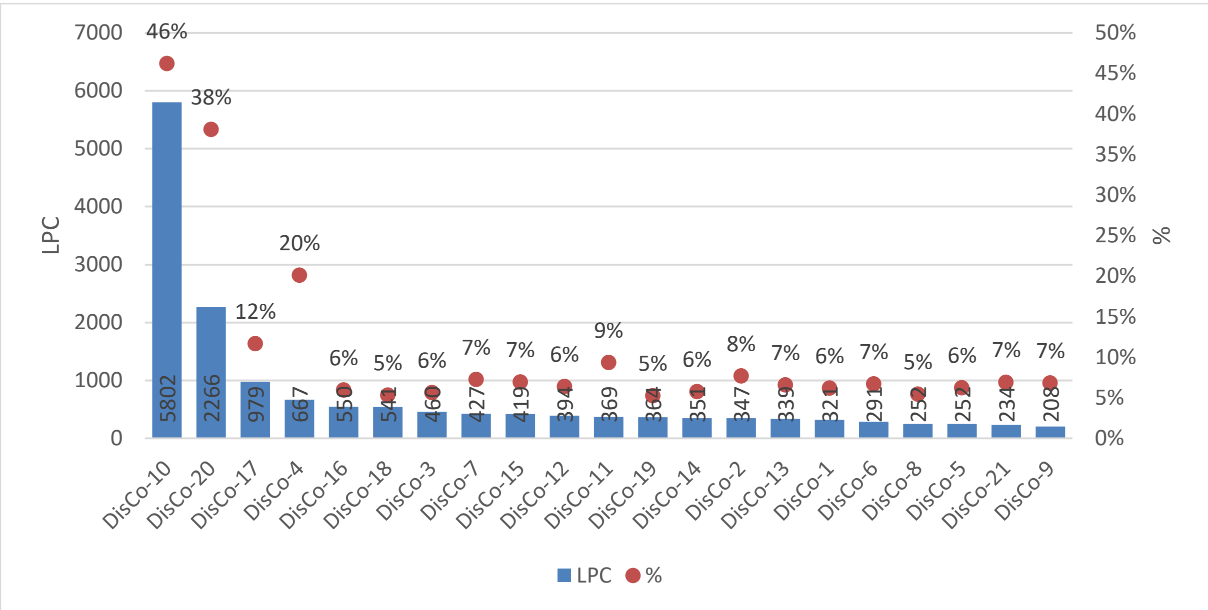

Figure 6-LPC and percentage representation for loss-2021

Source: EMRA, 2022

This index is more powerful than the percentage approach considering the advantages below.

1. It will not cause any inconsistency in showing annual developments and may be more successful in showing a clear target
2. Targets can be determined without being attached to the principle of diminishing utility.
3. It is more successful in showing regional differences.
4. It is directly related to the lost energy and does not cause a percent perception error.
5. Increasing the number of registered consumers in the fight against lost energy has a positive effect.

6. Geographical differences are directly reflected in the number of consumer and lost energy.
7. It is simple to calculate and understand.
8. This representation is more successful in distinguishing the problem area.

As illustrated in Figure-6, there is a discrepancy between the LPC ranking and the percentage ranking. This discrepancy is a result of the aforementioned misunderstandings. For instance, DisCo-4 has the third highest loss rate as per the percentage representation, while its rank is fourth when evaluated through the LPC approach, which is more aligned with the average. This disparity in evaluation affects the perceived quality and service quality of the company. Therefore, it is imperative to examine the performance measurements of distribution companies in detail and to evaluate their performance through both the percentage representation and LPC method using current data, in order to determine if the percentage representation of loss may result in a misleading assessment of the company's performance.

In Figure-7, the loss performances of the electricity distribution regions (company activity areas) are shown by percentage and LPC method. Accordingly, regions in percentage representation seem more problematic than they actually are. Basically, this is due to the scalability of the percentage representation being lower than the LPC method. Therefore, the loss representation in terms of percentage is weak in target setting.

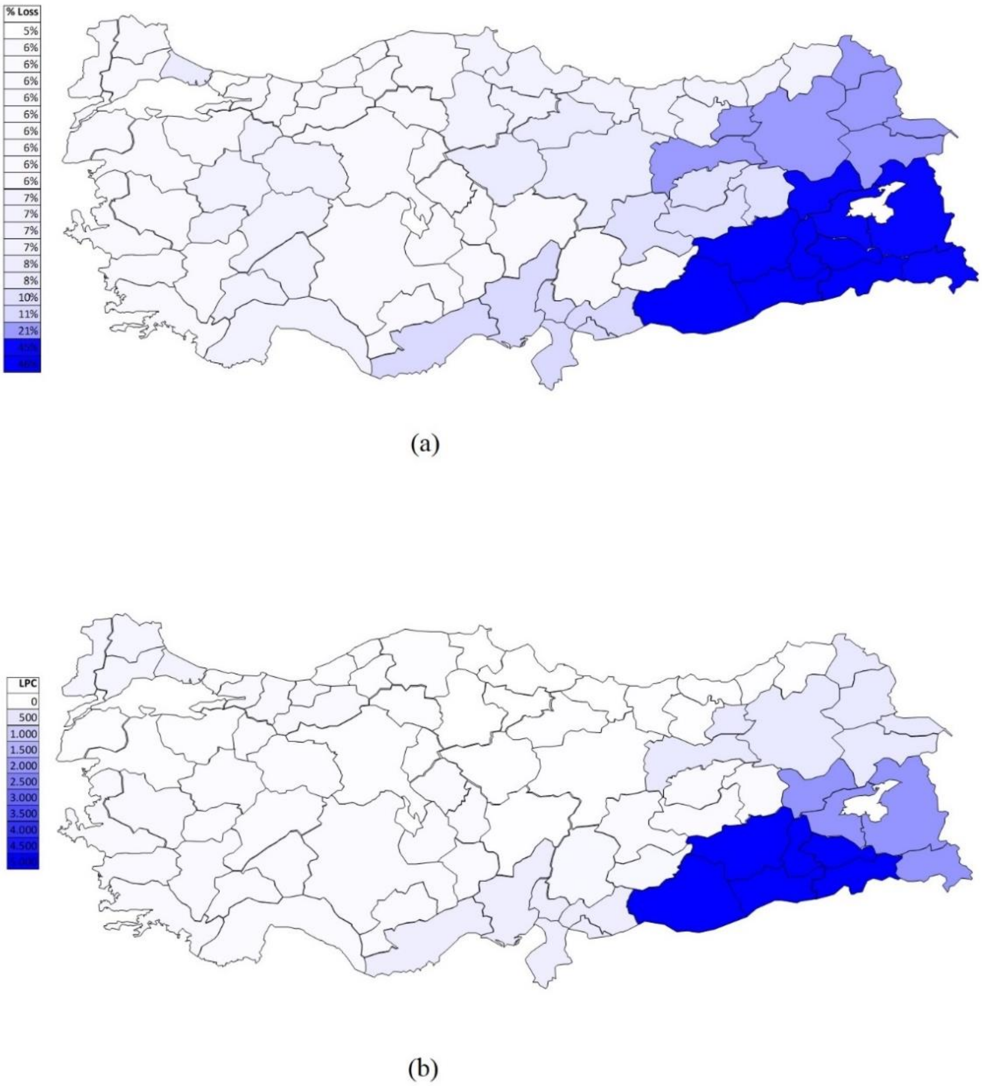

Figure 7-Loss representation of distribution regions (DisCo's') (a) in percentage (b) in LPC

2. LITERATURE REVIEW

Academic studies on the performance of Turkish Electricity Distribution Companies took place in Bağdadioğlu's studies before the privatizations started (Bağdadioğlu, 1996). According to his study, the pioneers of this subject are Thomas's study in 1985 (Thomas, 1985) and the studies in which Weyman-Jones and Doble investigated the productivity of 12 regions with the same method using the DEA method (Weyman-Jones, 1991; Weyman-Jones, 1994). Bağdadioğlu (1996) stated that DEA is an effective method in efficiency analysis and argued that privatization will improve inefficiency in distribution companies.

Bağdadioğlu (2006), used the number of personnel, number of transformers, transformer power, line length, amount of loss as the inputs where the outputs were selected as the number of consumers, the electricity consumed, and the area served, in his study. This is the first study conducted for 81 provinces (82 when Istanbul is considered as Asia and Europe). In this study, Bağdadioğlu (2006) even made technical comments that the same service can be provided with less transformers in the provinces that are inefficient.

Bağdadioğlu (2009) suggested a reward/punishment application as per System Average Interruption Duration Index (SAIDI) and System Average Interruption Frequency Index (SAIFI) data that would increase the service quality of 13 distribution companies that seems inactive with DEA analysis. The regulation has implemented as the Service Quality Criterias into the 4th Tariff Implementation Period, which started in 2020 (Official Gazette of Turkish Republic, 2020) and has become compatible with the literature, albeit late. In this study, total expenditures, number of interruptions, duration of interruption and number of consumers as output, distributed electricity and network length were used as inputs.

Ertürk and Türt-Aşık (2011) analyzed and interpreted the performance of 38 companies in the Turkish gas distribution sector in their study. While determining the inputs and outputs, it was stated that they were chosen as a result of a very detailed literature review and while the network length, number of personnel, CAPEX and OPEX were included in the inputs, total consumption, number of consumer and peak consumption were used in the outputs.

Tovar et al. (2011) made a productivity analysis using 8 years of data from 17 distribution companies in Brazil. They used the number of personnel and investment amount as well as network losses as inputs where the outputs were distributed energy and number of consumers. Input distance function parameters include losses vs consumers variable. They concluded that; although the size of the firm is not important in productivity, it provides an advantage in technical efficiency in performing some purchases and services.

Santos et al. (2011) stated that they did not use the "service region" variable, which is traditionally used in outputs in their efficiency analysis with DEA for 14 distribution companies in Portugal.

Çelen (2013) compared the efficiency of 21 distribution companies between 2002 and 2009. In another article, he reviewed 19 studies conducted with DEA applications in the Turkish electricity sector and found that 16 of them were conducted on measuring the performance of electricity distribution companies. According to Çelen (2013), the motivation for such a number of analyses is the privatization of electricity distribution companies. Çelen (2013) tabulated the publications in the details of the method used, input and output details. Accordingly, the input-oriented approach was generally used in industry studies that started with Bağdadioğlu's studies and mostly measured the performance measurements of electricity distribution companies with DEA. While the preferred inputs are transformer power, line length, number of personnel and number of transformers, the outputs are.

Agrel et al. (2015) used personnel cost, CAPEX, Energy loss cost and OPEX as inputs, while they used the number of consumers, distributed energy and line lengths as outputs in their efficiency analysis using DEA for Norwegian Electricity Distribution Companies.

Ömürgönülşen et al. (2016) analyzed the relative efficiency of wind farms in the Marmara Region and Türkiye with DEA as an example of Turkish energy sector with DEA application.

In his proposal to measure the efficiency of Turkish Electricity Distribution Companies with DEA, Koçak (2019) used consumption amounts on the basis of consumption group as input and number of consumers as output. He chosed input-oriented model to minimize electricity consumption. As a result, out of 81 provinces, 15 provinces with CCR and 26 provinces with BCC appeared to be active.

Karabiber (2019) showed that it is possible to detect with software by using AMR data in NTL detection and the consumed energy is used, not percentage, in calculations in his analysis.

Çiçek and Lecuna (2019) used the electricity consumption as input in the provinces according to geographical regions and number of consumers as output for their analysis.

Güler et al. (2020) evaluated the efficiency of electricity distribution companies with DEA. Their inputs were the loss & theft rate, the population of the region served and the maximum demand and outputs as the number of consumers and the amount of electricity consumption. As a result, 3 distribution companies were found effective in the CCR model and 6 distribution companies in the BCC model. Çamlıbel, Toroslar and Akedaş regions are marked as the least active regions (Güler, 2020).

Briseno and Rojas (2020) presented the approaches in tables according to the methods used in electricity theft calculations. Even in the software algorithm, in which the loss rates in 141 countries from 2005 to 2010 were compared, an evaluation was made on percentage rates representation. They calculated the loss per capita (divided by population) over an average loss (Briseno, Factors associated with electricity theft in Mexico, 2020) .

Arif et al (2022) investigated the amount of loss and theft in the distribution company using similar consumer consumption patterns with the help of big data, and they used an approach from the number of people in the household.

All these analyses show that the DEA method is used successfully in the energy sector in efficiency measurement, and the chosen method is generally input-oriented approaches. The reason for this is the search for effective uses of the input in problems where the output cannot be interfered with. In the literature, while the loss and theft rate, the population of the region and the amount of consumption are used as inputs, the number of consumer and the size of the serviced region are chosen as outputs.

3. METHODOLOGY AND DATA

DEA (Data Envelopment Analysis) was used as a method in this study. This method, which is frequently used in similar studies in the literature, is a mathematical technique used to measure the effectiveness of units under similar or same conditions relative to each other (Ulucan, 2010). After the input and output variables are selected, they are scored relative to the weight coefficients assigned (Cooper, 2004), (Charnes, 1994) (Tarım, 2001).

The data subject to analysis are publicly available data. Since EMRA's 2020 data have been officially agreed and corrected, these data have been used. Although publicly available data were used, the results of the efficiency analysis were used anonymously. The aim is to avoid the distraction of well-known companies' names.

4. EFFICIENCY ANALYSIS OF ELECTRICITY DISTRIBUTION COMPANIES

In accordance with the literature, performance measurements of 21 distribution companies in Türkiye were made based on the data of 2020. This study has some features that distinguish it from other studies in the literature. In the literature, the number of consumer and the energy consumed have been used as output variables. However, the general approach on the regulation side in the evaluation of a distribution company is considering data such as line length, number of transformers, transformer power which reflect the situation in the field and should be considered as inputs. The number of consumer and the energy consumed are also an element of the network. Since there is no energy access problem today, it would not be correct to say that more consumers are accessed when more lines are built. For this reason, it is more appropriate to evaluate it among the characteristics of the region and the network as using it in input part. Likewise, the investment amount is another parameter that shows the need for improvement in the region as well as showing the performance in terms of improvements made to the region. Invoiced energy amount is more suitable as an input in terms of showing the consumption scale in the region. Lost energy, the number of outages and downtime and loss rates have been chosen as outputs in accordance with the general regulatory approach because these data are outputs used in the quality assessments of distribution companies in the legislation.

Another feature that distinguishes this study from previous studies in the literature is the use of output-oriented method instead of input-oriented method. The main reason for this is that intervention on the output side is not very possible and there are question marks about the performance on the main input side. However, if we consider that we are in the 4th tariff period (5 years each), it can be said that tariff-based applications have been made for a period of approximately 20 years, investments are made in this way and quality service is tried to be provided. The parameters that are selected as outputs and that show service quality are the parameters that actually show performance, and even when all inputs are equal, the status of these outputs affects the service quality. For this reason, an output-oriented method was chosen with a different perspective from other studies in the literature.

Finally, the term LPC was used instead of the percentage loss expression, which was found to be an inadequate form of expression in defining and targeting. In order to understand whether the percentage approach and the LPC approach make a difference in the performance evaluation of companies (by using DEA), the loss rate in outputs was subjected to two different analyzes as percentage and LPC (Table-1).

Table 6. Input and outputs of DEA

2020		Input							Output				
		A	B	C	D	E	F	G	H	I	J	K	L
DisCo	No	Line Length (km)	Power of Transformer (MVA)	# of transformer	Investment Amount (million TL)	# of Personnel	Energy Invoiced (MWh)	# of Consumer	Energy Loss (MWh)	SAIDI	SAIFI	Percen-tage Loss	LPC
DisCo-1	1	70892	8844	22609	340,9	2240	9868312	2021430	571527	1079,1	17,5	6%	283
DisCo-2	2	55015	8661	20650	405,1	2142	9854829	2261144	628519	1592,7	24,1	7%	278
DisCo-3	3	27003	4031	12966	107,3	1131	6375911	758253	231141	1087,6	31,9	6%	305
DisCo-4	4	57744	3110	13817	246	1895	2968664	1059724	621092	1493,7	17,2	21%	586
DisCo-5	5	25749	9514	8251	330,6	2869	13116132	2986408	652846	522,3	7,8	5%	219
DisCo-6	6	116911	18145	36129	956,3	5520	23098293	4364706	973561	1815,5	20,7	6%	223
DisCo-7	7	38844	19109	15502	823,5	4540	26146989	5206272	1981498	1045,4	22,4	8%	381
DisCo-8	8	48464	2967	13284	219,2	1289	2909211	1017047	194883	1881,5	44,4	8%	192
DisCo-9	9	60714	3486	12803	275,1	1271	3662366	1431113	289101	2097,8	33,6	7%	202
DisCo-10	10	78978	14715	68770	861,1	6648	12660435	2006712	9937469	2826,2	57,5	46%	4952

DisCo-11	11	46029	3361	13455	195,2	1100	3744266	1012106	279017	1538,7	40,8	10%	276
DisCo-12	12	60233	17807	35899	629,3	2513	25257839	3524259	1051858	1208,8	17,2	6%	298
DisCo-13	13	26557	3874	9730	166,6	911	3910631	770138	152558	677,8	28,9	6%	198
DisCo-14	14	92397	13726	60300	706,3	2041	13213403	2227229	617383	1689,3	17	6%	277
DisCo-15	15	51354	9552	28764	540,6	1536	10744601	1888481	443325	1783	46,1	7%	235
DisCo-16	16	38760	11164	19797	241,1	2143	20779508	1964034	570110	1668	37,9	6%	290
DisCo-17	17	95974	20763	52113	1016,8	5965	32924394	4095586	2069562	3850,6	35,5	11%	505
DisCo-18	18	29360	6426	12549	228,4	1073	11285934	1168994	400148	1233,6	13,8	6%	342
DisCo-19	19	52441	13526	29289	512,2	2306	21492837	3380216	743405	725,1	13	6%	220
DisCo-20	20	39316	2875	12445	163,5	2033	2121296	745993	1612538	4478	115,9	45%	2162
DisCo-21	21	81820	5172	20912	426,5	2028	6566254	2207040	393830	1277,1	22,3	7%	178

Source: Author calculation.

5. RESULT & DISCUSSIONS

Data Envelopment Analysis with BCC method was used to examine efficiency using loss calculation with percentage and LPC method. In the approach that keeps the inputs equal, the performance parameters are calculated according to the change in the output and the ranking of the companies. As a result of the analysis made with this method, the performance ranking of the distribution companies is shown in Table-2. Accordingly, when all inputs and outputs are evaluated relatively, DisCo-10 and DisCo-20 are the most efficient companies, while DisCo-1 and DisCo-6 are the most inefficient companies.

Table 7. DEA scores of DisCo's'

No	DisCo	DEA Score (percentage)	DEA Score (LPC)	DisCo	No
1	DisCo-20	100%	100%	DisCo-10	1
2	DisCo-10	100%	100%	DisCo-20	2
3	DisCo-7	89%	89%	DisCo-7	3
4	DisCo-9	75%	75%	DisCo-9	4
5	DisCo-8	66%	66%	DisCo-8	5
6	DisCo-11	65%	65%	DisCo-11	6
7	DisCo-5	56%	56%	DisCo-5	7
8	DisCo-13	56%	56%	DisCo-13	8
9	DisCo-15	53%	53%	DisCo-15	9
10	DisCo-18	52%	52%	DisCo-18	10
11	DisCo-4	49%	49%	DisCo-3	11
12	DisCo-3	49%	40%	DisCo-17	12
13	DisCo-17	40%	38%	DisCo-4	13
14	DisCo-14	38%	38%	DisCo-14	14
15	DisCo-16	38%	38%	DisCo-16	15
16	DisCo-12	37%	37%	DisCo-12	16
17	DisCo-2	35%	35%	DisCo-2	17
18	DisCo-21	29%	29%	DisCo-21	18
19	DisCo-19	27%	27%	DisCo-19	19
20	DisCo-1	27%	27%	DisCo-1	20
21	DisCo-6	20%	20%	DisCo-6	21

Source: Author calculation.

According to Table-2, the order of 16 distribution companies does not change, 3 distribution companies are in a better position with percentage approach and 2 distribution companies are in worse position with percentage approach.

The results may not reflect the same results as the percentage and LPC approaches and should not be expected. Because performance evaluation is obtained by evaluating all input and output parameters.

6. CONCLUSIONS AND POLICY IMPLICATIONS

In this study, the relative efficiency analysis of 21 Electricity Distribution Companies in Türkiye was investigated by DEA (Data Envelopment Analysis). In the literature, the subject has been subject to research many times before and after electricity distribution company privatization. In previous studies, it was not possible to reach all the data desired to be analyzed due to the fact that the liberalization and privatization studies were not completed, the electricity market was not developed, the measurement systems were not developed, and the data transparency was not provided. The accuracy of the obtained data has been the subject of debate. On the other hand, there were difficulties in data supply due to the concern that such activities could be a commercial consideration. Today, as a result of the strengthening of both the legislation and the electricity market structure, technical and operational data are transparently subject to annual reports. The opportunity to evaluate the data obtained from EMRA sources has increased. On the other hand, in the previous studies, only few of them made use of input and output variables, depending on the literature. The original aspect of this study is that it reflects the different perspective made by considering the field realities.

DEA has been frequently used in the literature in the performance evaluation of electricity distribution companies. As summarized in the literature section of this study, the input and output data used in each study are presented and comments are made in this context. In many of the studies, the high amount of loss was emphasized especially in the eastern and southeastern Anatolia regions, and this data was presented as an important reason for the low performance. In the literature, measures regarding the illegal use of electricity, which is a socio-economic phenomenon, have been suggested, and it has been agreed that privatization is the pertinent method to eliminate all these disorders.

After the electricity distribution company privatizations completed in 2013, the Regulatory Authority (EMRA) focused primarily on infrastructure and prioritized the improvement of grid and metering systems. Electricity distribution companies that are managed by the tariff system, use percentage loss rates for the definition as the world terminology. On the other hand, the main characteristics of distribution companies are the conditions of the region they serve, the voltage level to which the consumer is connected, the profile of the consumer, etc. These parameters are different for each of them. In addition, the percentage indicator carries the percentage information, not the information that the lost energy is large or small. It is thought that such a representation may cause an erroneous perception both in the loss evaluation and in the performance evaluations of the distribution companies. For this purpose, it is recommended to representation the amount of Loss Per Consumer (LPC), which is a more useful and simple method for issues such as the percentage representation not showing the amount of loss, which are its weaknesses, and the difficulty in defining future targets. This method also allows the parameter to be positively affected in case the number of registered consumers, which is one of the loss prevention methods, is increased. The LPC representation shows a different loss performance with respect to percentage representation.

In the second stage, it was examined how using the LPC approach instead of percentage in the relative performance measurements of the companies would change the result. In the relative efficiency analysis done for this purpose, percentage and LPC loss representations were used as alternatives in the outputs section and electricity distribution companies were ranked according to their efficiency scores. The results showed that percentage representation gives different results compared to LPC approach. This showed that companies might have been evaluated differently in terms of performance.

Electricity distribution companies are subjected to different analyzes and evaluations by regulatory institutions. These assessments and many of their data may not be public. In this respect, although it is underlined that the actual evaluation results are the evaluation made by the experts of the Regulatory Authority, the LPC method has strong features in terms of monitoring and assessing the realistic targets that can be followed for improvement studies. If there is more data availability in the follow-up studies, examining percentage and LPC approaches over residential consumer can yield additional insights in terms of loss assessment on household consumer and improving targets of the distribution companies.

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