Turkish Journal of Electrical Engineering & Computer Sciences

http://journals.tubitak.gov.tr/elektrik/

Research Article

Turk J Elec Eng & Comp Sci
(2016) 24: 979 – 993

doi:10.3906/elk-1312-43

A parametric study on privatization revenues of the electricity distribution companies in Turkey

Ercan İZGİ*, Selim AY
Faculty of Electrical & Electronic Engineering, Yıldız Technical University, Davutpaşa Campus, İstanbul, Turkey

Received: 05.12.2013 • **Accepted/Published Online:** 27.10.2014 • **Final Version:** 23.03.2016

Abstract: The privatization of electricity distribution companies in the state monopoly has increased significantly in recent years. Privatization is expected to improve the quality of services in the electric distribution sector and to provide additional income to the state. In this paper the privatization revenues of the 18 electricity distribution companies in Turkey are calculated through regression equations. The privatization revenues of the electricity distribution companies are identified by 5 models containing microeconomic and macroeconomic variables (parameters). The study indicates a correlation between the considered variables and the privatization revenues of the electricity distribution companies and useful parametric formulations are proposed. The proposed models and regression equations obtained can be employed for future predictions of privatization contributions after making the necessary adjustments by considering the real exchange rates, which is helpful in determining tender offer prices.

Key words: Privatization, electricity distribution company, regression model

1. Introduction

Electrical energy is one of the most important sources for economic and social development in terms of social comfort and electricity generation. It is important that electrical energy as a fundamental input is continual, reliable, and sufficient as populations grow and the economies of countries develop. Natural, economic, environmental, and financial problems in electrical energy generation are evaluated holistically.

Since electricity storage is not economical it is very important that electrical supply and demand be balanced. Demand for electricity always varies and depends on several parameters, but it is not flexible in the short term [1]. The electrical distribution sector must be reorganized through proper plans towards privatization by considering natural monopoly characteristics. The elapsed process from electricity generation to its use has four main stages: generation, transmission, distribution, and consumption. The electricity distribution sector worldwide has a natural monopoly property [2].

Reforms and deregulations in the electrical industry promote a transformation in the establishment and organization of electricity companies. These concepts, present since 1990, denote the transition from a monopolistic to a competitive stage. Activities within the framework of reformation, construction, generation, and sale of electricity face competition and the development of bulk sale markets [3].

Reform in electricity implies existing electricity companies being unbundled, a combination of companies in some activities, or the formation of new companies; deregulation describes the removal of controls on competitor suppliers in the electricity market [4].

*Correspondence: izgi@yildiz.edu.tr

Recently, increasing global competition has necessitated a decline in electricity prices, which is a basic input for several industries. This situation has placed an emphasis on electrical energy reformation in many countries. Electrical energy could give rise to various problems in the case of public ownership. For instance, in Latin American countries the electrical industry requires privatization and reformation due to a high debt stock, and in some European countries the coal industry is subsidized by the electrical industry [5].

The goal of reformation and deregulation is higher economic effectiveness. Therefore, it is necessary that cost minimization occurs not only in electricity supply, but also in electricity consumption. Factors such as competition in the electricity market, productivity rise, and cost and price drops bring forth emerging new products and services. Reforms in the electricity industry started at the generation stage. Experiences of privatization of distribution enterprises indicate that the distribution cost is approximately one-third of the total electricity cost and could be decreased considerably [6].

The following are the main factors that contribute to the rapid spread of reform and deregulation [5]:

- The growth of new production technologies like combined-cycled natural gas turbines.
- The generation of fundamental input of electric energy in all sectors on the condition of decreasing the input cost in a competitive global economy.
- The adaptation to new technologies in new companies.
- The formation of basic facilities in order to activate electricity markets because of growth in knowledge technologies.

Privatization means an extensive decrease in economic activities of government, where sometimes publicly owned enterprises devolve to the private sector.

Privatization includes social and political targets in addition to the achievement of an effectively running market economy. Some of its economic goals are as follows: gaining productivity, market economy development, capital market improvement, and hard-currency income increment. Furthermore, the economic targets are summarized as revenue generation for the government and public corporation recovery from debt.

The aims of privatization can generally be given as follows [7]:

- In terms of economic growth and its effectiveness.
- In terms of financial and budget improvements.
- In terms of income distribution.

Normally, the primary objective of privatization programs is to maximize economic efficiency. Practically, the privatization programs of political decision-makers are based on social and political grounds. Privatization was considered a solution for financial crises of countries. For this reason the expectation from privatization has overcome budgetary problems and has increased short-term revenues. Today privatization is perceived as an important strategy for economic growth.

The studies carried out so far have focused on privatization revenues related to number of years, sectoral distributions, privatization targets, and budget contributions. It is clear that privatization revenues are an important budgetary source. Therefore, revealing the variables that affect these revenues will be helpful in predicting the privatization revenues. In the current study a parametric formulation of privatization revenues from the energy distribution companies is presented. This approach is also useful for other kinds of energy

privatization such as electricity generation and natural gas distribution companies. The resulting models are for 2009, but can also be used for future years by simply updating the coefficients (k_1, k_2, k_3, k_4).

2. Privatization of the electricity distribution sector in Turkey

In Turkey the first law that allowed private sector participation in the electricity sector was enacted in 1984. This law has allowed not only private attempts to establish new production facilities with contracts of build-operate-transfer (BOT), but also private enterprises of distribution facilities by transfer agreements of operation rights. The agreements of BOT envisage operations for a period of 20 years with manufacturing facilities established by the private sector that would be transferred to the government at the end of the period. Operation rights agreements give the operation, maintenance, and repair of state-owned distribution facilities to the private sector [8].

Legal and economic issues of privatization of the distribution system and restructuring of the electricity sector are examined in various studies [9–12]. The privatization strategy document, outlining important reforms in the electric energy sector, was published on 17 March 2004 (document number 2004/3 by a decision of the Supreme Planning Council).

The strategy document shows a course of action for the work to be done during the transition period up to 2013. After the strategy document was published, Turkey's distribution network was divided into 21 distribution regions (Figure 1) [13]. Although privatization tenders for all regions were published, the entire electricity distribution system could not be privatized because of problems encountered in some regions. Another issue that is important for the sector is the rate of illegal consumption, which is higher in Turkey than in developed countries (Table 1). Turkey's average illegal consumption is 17.7%, while in the US it is 2.32% and in OECD it is 8.86% [14].

1. Dicle EDAŞ 2. Vangölü EDAŞ 3. Aras EDAŞ 4. Çoruh EDAŞ 5. Fırat EDAŞ 6. Çamlıbel EDAŞ
7. Toroslar EDAŞ 8. Meram EDAŞ 9. Başkent EDAŞ 10. Akdeniz EDAŞ 11. Gediz EDAŞ
12. Uludağ EDAŞ 13. Trakya EDAŞ 14. İstanbul AYEDAŞ 15. Sakarya EDAŞ 16. Osmangazi EDAŞ
17. İstanbul BEDAŞ 18. Kayseri EDAŞ 19. Menderes EDAŞ 20. Göksu EDAŞ 21. Yeşilırmak EDAŞ

Figure 1. Turkey's electricity distribution regions 13].

Table 1. The rates of illegal consumptions in Turkey for 2009 (Source: The Turkish Energy Market Regulatory Authority, 2010).

Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Loss-theft ratio (%)	21.6	21.4	20.9	19.9	18.6	17.8	15.1	14.8	14.4	17.7	18.6

Through privatization in Turkey and with the implementation of necessary reforms the rates of formal and illegal losses (technical and nontechnical losses) are expected to decrease down to the levels of OECD countries. In Turkey one of the structural aberrations of the electricity sector objectives is to ensure the tariffs fall by increasing the efficiency of the system. For this reason the transition period between 2006 and 2010 was rightly foreseen, but after 2010 a planned transition to a fully cost-based tariff structure took place (see Table 2). However, the transition period was extended to 2012.

Table 2. National tariffs for the transition period in TRL/kWh [7].

Sector	2006	2007	2008	2009	2010
Industry	0.1163	0.1152	0.1140	0.1130	0.1119
Industry	0.1163	0.1163	0.1163	0.1163	0.1163
Trading	0.1475	0.1450	0.1415	0.1387	0.1362
Household	0.1240	0.1240	0.1264	0.1289	0.1314
Agricultural irrigation	0.1119	0.1119	0.1119	0.1119	0.1119
Lighting	0.1197	0.1200	0.1204	0.1207	0.1210

The Prime Ministry Privatization Administration (OIB) is continuing the privatization process of TEDAŞ (Turkey Electricity Distribution Co.). TEDAŞ-owned distribution companies are state-owned enterprises that provide services such as electricity distribution and retail sale of electricity to consumers. At the end of 2009 the companies in electricity sales (with approximately 23 million customers and a total of 107 billion kWh) had a 68% share in the electricity distribution market.

For privatization of the distribution regions the stock sales model is applied, according to which an investor is the only electricity distribution license holder in the region. Ownership of the elements of the distribution facilities operated by the investor is expected to remain TEDAŞ's responsibility. The investor will only have the right to operate the distribution system as the owner of shares in the distribution company within the framework transfer of the operating rights contract that was signed by TEDAŞ.

One of the major objectives of privatization is that the investments required by the distribution system are provided by the private sector and the burden on the state budget is reduced. Continuity and quality have utmost importance in electricity distribution services.

Investment expenditures consist of the following three components:

- Expansion of investments and the cost of expropriation.
- Renovation in investments.
- Tendered and ongoing investments.

Liberalization of the electricity sector advances the objective of alignment with the European Union. With the privatization of the public sector needed reforms are carried out since the timely and successful privatization of electricity generation and distribution assets is very important in terms of liberalization.

In accordance with the High Planning Council Decision (number 2004/3), the main expected benefits from the electric power sector reform and privatization are as follows:

- Reducing costs as a result of the effective and efficient ways of electricity generation and distribution.
- Ensuring the security of electricity supply and improving its quality.

- Reduction of technical losses in the distribution sector to the averages of OECD countries and prevention of leaks.
- Provision by the private sector for the necessary renovation and expansion investments without the burden on public legal entities.
- Regulation of service quality in electric power production and trade activities through competition in order to provide better quality service to consumers.

The 2004/3 decision clarified the basic principles of privatization in Turkey. Accordingly, the following points can be mentioned.

- The privatizations will be conducted by the Privatization Administration within the framework of Law 4046.
- A solely income-oriented approach will not be employed in the privatization applications.
- A permanent increase in electricity prices will not follow privatization.
- Strong companies will be encouraged to participate, provided they have the financial capability for the aims and objectives of privatization in a free electricity market.
- The operation of investments required will continue uninterrupted regardless of the privatization process.
- Acceleration of privatization of the generation and distribution assets will be made within the scope of this document in order to facilitate the privatization administration, and if required by the necessary legal arrangements.
- In a liberalized market, distribution companies holding retail license should initiate the privatization of the distribution sector to show manufacture activity that will give investors confidence in the structure.
- Ensuring the creation of a competitive structure for electricity production and generation, the assets will be privatized by appropriate grouping.
- In the privatization applications current public obligations will be taken into account and a system of government guarantees (not required) will be established.

The Turkish electric market liberalization scheme is shown in Figure 2.

According to the Energy Market Regulatory Authority, between the 2006–2010 and the 2011–2015 periods a 2.5 times increase in investment in electricity distribution is reported based on demand forecasting. Furthermore, 8.5 billion USD in the next 5 years will be devoted to investment in electricity distribution. Furthermore, the rate of leakage loss, which is currently around 20%, is projected to fall to 10% by the end of 2015. A 1% reduction in the rate of leakage loss corresponds to savings of approximately 10 billion TRY. The privatization of the electricity distribution sector was started in February 2009. As of today, 52% of the electricity distribution market has been privatized. Additionally, according to the Turkish Electricity Market Regulatory Assembly (EMRA), the following privatization benefits are provided [15]:

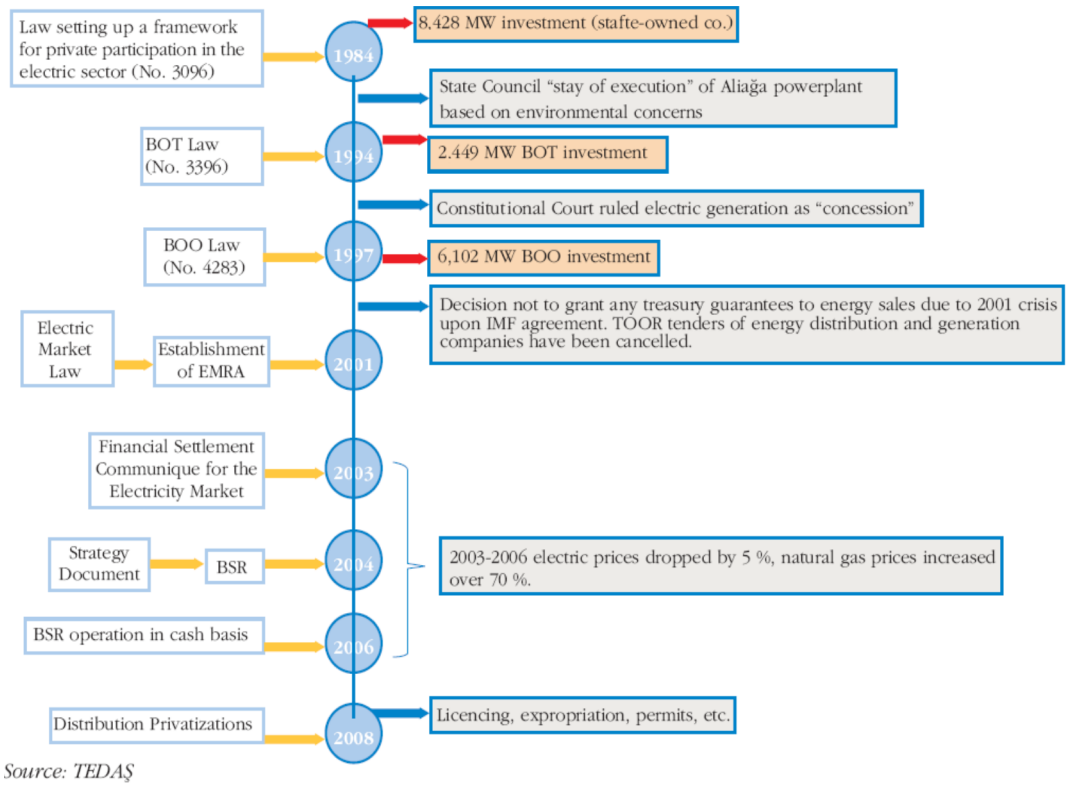

Figure 2. The Turkish electric market liberalization [14].

- Efficiency and increased services in the sector.
- Construction of new service buildings.
- The street lighting system was renewed.
- Customer service has improved.
- Staff training has been increased by 100%.
- Increased investments in the IT sector.
- The total collection rate has increased (for instance, while the payment received rate for agricultural irrigation in an area was 19% previously, it rose to 86% following privatization).
- Successful reduction in the loss and illegal rates.

Private sector shares of the electricity market, privatization revenues, and privatization methods for Turkey are given in Tables 3, 4, and 5, respectively [16].

Table 3. Development of the private sector and the public shares in the Turkish electricity sector [16].

	2001		2011	
	Private	Public	Private	Public
Generation	30%	70%	60%	40%
Transmission	0	100%	0	100%
Distribution	5%	95%	57%	43%
Wholesale	0	100%	65%	35%

Table 4. Turkey's privatization revenues based on years [7].

Year	Privatization revenue (million USD)
2001	120
2002	536
2003	187
2004	1283
2005	8222
2006	8096
2007	4259
2008	6259
2009	2275
2010	3085
2011	1358

Table 5. The share of privatization methods in Turkey [7].

Privatization method	Share (%)
Facility and asset sales	32
Block sale	47
Supply to people	16
Stock sales	3
Substituted transfer	2

In parallel with the economic developments in Turkey and the rest of the world, the electricity market narrowed during the last quarter of 2008 and in 2010 started to recover again. The need for investment has increased due to an increase in demand since 2011. An infrastructure of legislation was developed and dynamically redesigned in response to these changes. Electricity consumption in 2009 was down (–2%) due to the global crisis; it increased by 8.5% in 2010 and by 9.5% in 2011. Furthermore, the 2011–2020 generation capacity projection data seem to support the forecasts based on electricity demand and generation increase in the next 10-year period. New electricity generation, transmission, and distribution investments in Turkey between 2005 and 2020 will be 104,765 million USD according to projections of the Turkish Ministry of Energy and Natural Resources.

3. Privatization revenues of the electricity distribution companies in Turkey

The privatization revenue of an electricity distribution company depends on several factors such as book value, inventory of fixed assets, liberalization of the electricity market, growth of electricity demand, high profit expectations in the electricity sector, and variation trends of the electricity tariff.

Revenues from privatization in the electricity sector in Turkey are based on the power and distribution plants. Usually, two privatization methods are used:

- Privatization through the sale of assets.
- Privatization of assets transferred for a certain period of operation rights.

The second method is used in the privatization of electricity distribution companies in Turkey. During the operation rights (the privatization of an electric distribution company for N years) the highest tender is

registered as the privatization revenue of the company. Private institutions that offer tender and bid prices are determined by the formulation of engineering economics known as net present value [17]:

$$BasePrice\,(NPV) = -C_O + \sum_{t=1}^{N} \{[A\,(t) + B\,(t)]\,(1 - tax) - C\,(t) - D\,(t)\}\,(1 + r)^{-t} \tag{1}$$

where

A(t): The estimated revenue function based on time with the help of electricity sale revenue trends of the electricity distribution companies.

B(t): The estimated function based on time with the help of nonoperating income trends of the electricity distribution companies.

C(t): The estimated function based on time with the help of expense trends of the electricity distribution companies.

D(t): The estimated function based on time related to the planned investment expenditures of the electricity distribution companies.

C_o: Transfer costs to be paid during the privatization of electricity distribution companies.

r: Minimum Acceptable Rate of Return (MARR+ premium) foreseen for the private company.

(Between 1-N (year))

$$K = \frac{\text{The highest bid given in the tender}}{\text{The base price}} \tag{2}$$

Generally, K is greater than 1. If it has a high value, it is in accord with the goal of maximizing the state's privatization revenues. A small value indicates a special organization completed by the privatization process at a minimal cost.

Information about the electricity distribution companies in Turkey for 2009 is summarized in Table 6. As a result of the privatization of power distribution companies (Table 6) [18,19], the total expected revenue is about 16 billion USD.

4. A parametric study of the privatization of electricity distribution companies in Turkey

In the current study the privatization proceeds of the state-owned electricity distribution companies were investigated based on a number of factors, such as asset values, subscriber numbers, loss and illegal rates, and capital expenditures.

The dependent variable (y) is defined as the proceeds from the privatization of electricity distribution companies. The aforementioned factors are taken as independent variables. The independent variables (microeconomic "local" variables and macroeconomic "national" variables) are considered as follows:

x_1 : Total number of urban and rural transformers having standardized kVA and voltage levels for the jth distribution company.

x_2 : Loss-theft ratio (%) for the jth distribution company.

x_3 : Electricity sold (MWh) for the jth distribution company.

x_4 : The share (%) of total subscribers in Turkey for the jth distribution company.

x_5 : The share (%) of total electricity sold in Turkey for the jth distribution company.

Table 6. 2009 information on electricity distribution companies in Turkey [18,19].

(Region number) and Distribution Company	Number of subscribers	Share of subscribers (%)	Privatization Amount (10^6 USD)	Electricity sold (MWh)	Loss and illegal consumption (%)	Rate of loss and illegal consumption (%)	Number of total transformers	Share of electricity sold (%)
(9) Başkent EDAŞ	3,185,405	9.87	1225	11,134.2611	1,013,260	8.34	14,908	8.22
(15) Sakarya EDAŞ	1,346,637	4.17	600	8,405,333	614,556	6.81	6419	6.21
(8) Meram EDAŞ	1,582,141	4.90	440	5,574,133	520,595	8.54	13,307	4.12
(16) Osmangazi EDAŞ	1,311,267	4.06	485	4,846.,86	313,725	6.08	6929	3.58
(12) Uludağ EDAŞ	2,388,421	7.40	540	11,049,990	654,357	5.59	8751	8.16
(6) Çamlıbel EDAŞ	746,002	2.31	258	2,146,351	179,407	7.71	6132	1.58
(4) Çoruh EDAŞ	1,017,555	3.15	227	2,295,105	298,543	11.51	7600	1.69
(21) Yeşilırmak EDAŞ	1,521,182	4.71	441.5	4,049,650	481,844	10.63	11,159	2.99
(5) Fırat EDAŞ	680,237	2.11	230.25	2,032,633	320,788	13.63	6528	1.50
(13) Trakya EDAŞ	792,766	2.46	622	5,780,809	396,108	6.41	3384	4.27
(2) Vangölü EDAŞ	408,620	1.27	100.1	1,300,787	1,626,976	55.57	5419	0.96
(1)Dicle EDAŞ	1,100,754	3.41	228	4,190,977	11,337,581	73.01	11,694	3.09
(7) Toroslar EDAŞ	2,742,119	8.49	2075	14,538,958	1,316,381	8.30	14,258	10.73
(14) İstanbul AYEDAŞ	2,242,140	6.95	1813	8,582,325	693,489	7.48	3976	6.34
(17) İstanbul BEDAŞ	3,954,871	12.25	2990	18,434,621	1,975,682	9.68	7007	13.61
(10) Akdeniz EDAŞ	1,550,026	4.80	1165	5,927,658	599,040	9.18	8530	4.38
(11) Gediz EDAŞ	2,389,838	7.40	1915	12,436,056	1,032,424	7.67	11,508	9.18
(3) Aras EDAŞ	747,198	2.31	128.5	1,710,481	655,366	27.70	7342	1.26

While x_1, x_2, and x_3 are microeconomic parameters, x_4 and x_5 are related to macroeconomic parameters. The importance of the variables considered for an electricity distribution company is stated in Table 7.

Table 7. Explanation of the importance of the parameters considered.

Parameter considered	Explanation of the importance of the parameter
x_1	Installed power, book value, depreciation, corporation tax advantage, load dispatch
x_2	Much more investment requirement, loss of corporation tax, loss of company's income
x_3	Income, tax, annual growth, new investments, load factor, demography
x_4	Ability to use potential of electrical energy, tax transfer
x_5	Productivity, trade of energy, gross domestic product (GDP), balance sheet of company, corporate tax, labor effect

Because the parameters "x_i" do not involve a normal distribution (see Table 8), nonlinear regression models are used. Skewness is a measure of data symmetry. Kurtosis is a measure of whether the data are peaked or flat relative to a normal distribution. Skewness and kurtosis will be zero for a normal distribution. Jarque–Bera is a deviation measure of the distribution from normal and is calculated based on the skewness and kurtosis. The statistical parameters for the data are presented in Table 8.

Nonlinear regression models obtained using MATLAB (MATLAB R2008a) are shown below:

Proposed Model 1:

$y_1 = -8{,}3070{,}788 + 71{,}437.186 \times x_1 - 23.726387 \times x_1^2 + 0.0039562835 \times x_1^3 - 3.5143759 \times 10^{-7} \times x_1^4 + 1.5867741 \times 10^{-11} \times x_1^5 - 2.8613694 \times 10^{-16} \times x_1^6$

Table 8. Statistical values based on the sets of independent variables.

Variable	Min	Max	Mean	Variance	Standard deviation	Skewness	Kurtosis	Jarque–Bera
x_1	3384	14908	8602.833	11129179	3336.042	0.429031	2.106996	1.150294
x_2	5.2	73	15.54444	327.7569	18.10406	2.326185	7.007747	28.27993
x_3	1300787	1.11E+08	12480259	5.97E+14	24428504	3.650446	14.9158	146.467
x_4	1.27	12.25	5.112222	8.577851	2.928797	0.838121	2.870451	2.119926
x_5	0.96	13.61	5.039444	12.00517	3.464848	0.819858	2.847072	2.034039

Proposed Model 2:

$y_2 = 2{,}531{,}446.1 + 523{,}685.06 \times x_2 - 63{,}999.958 \times x_2^2 - 13{,}200.167 \times x_2^3 +$ $636.73044 \times x_2^4$ - $11.365951 \times x_2^5 + 0.067657986 \times x_2^6$

Proposed Model 3:

$y_3 = 4171.4584 + 0.085768048 \times x_3 + 4.8811338 \times 10^{-9} \times x_3^2 - 4.9872734 \times 10^{-17} \times x_3^3$

Proposed Model 4:

$y_4 = 401{,}826.8 - 825{,}155.92 \times x_4 + 756{,}977.97 \times x_4^2 - 282{,}251.5 \times x_4^3 + 51{,}937.884 \times x_4^4 - 4428.6448 \times x_4^5 + 139.09681 \times x_4^6$

Proposed Model 5:

$y_5 = -679{,}754.58 + 1{,}602{,}171 \times x_5 - 1{,}130{,}810 \times x_5^2 + 386{,}486.27 \times x_5^3 - 62{,}324.494 \times x_5^4 + 4658.6747 \times x_5^5 - 129.03308 \times x_5^6$

Error values for each model are given in Tables 9–13, respectively.

Table 9. Error values for y = f(x_1).

y_{actual} (10^3 USD) (the tender price)	y_{model} (10^3 USD)	Relative error	Absolute error (USD)
600,000	–4E+09	3.99E+09	6656.256
1,225,000	–7.9E+10	7.93E+10	64,767.93
485,000	–5.3E+09	5.29E+09	10,916.94
441,500	–2.9E+10	2.93E+10	66,378.45
440,000	–5.4E+10	5.39E+10	122,471.1
227,000	–7.4E+09	7.43E+09	32,717.62
128,500	–6.5E+09	6.55E+09	50,947.44
622,000	–3.5E+08	3.55E+08	570.869
258,500	–3.4E+09	3.37E+09	13,038.64
230,250	–4.2E+09	4.25E+09	18,458.01
228,000	–3.5E+10	3.45E+10	151,331.1
1,165,000	–1.1E+10	1.13E+10	9689.169
940,000	–1.2E+10	1.24E+10	13,166.23
1,915,000	–3.3E+10	3.26E+10	17,040.57
1,813,000	–6.6E+08	6.59E+08	363.5824
2,990,000	–5.5E+09	5.52E+09	1846.01
2,075,000	–6.8E+10	6.82E+10	32,868.26
100,100	–2.1E+09	2.12E+09	21,226.3

Pearson coefficient (r = 0.405)

Table 10. Error values for y = f(x_2).

y_{actual} (10^3 USD) (the tender price)	y_{model} (10^3 USD)	Relative error	Absolute error (USD)
600,000	–4050156	4,650,156	7.750261
1,225,000	–8401243	9,626,243	7.858158
485,000	–2971215	3,456,215	7.126217
441,500	–9317486	9,758,986	22.10416
440,000	–7753591	8,193,591	18.6218
227,000	–1.4E+07	13,799,503	60.79076
128,500	–9.5E+07	94,698,726	736.9551
622,000	–4310780	4,932,780	7.930514
258,500	–6375190	6,633,690	25.66224
230,250	–2.4E+07	23,758,775	103.1869
228,000	–6.8E+08	6.82E+08	2991.72
1,165,000	–9555904	10,720,904	9.202492
940,000	–3358326	4,298,326	4.572687
1,915,000	–6375190	8,290,190	4.329081
1,813,000	–6015649	7,828,649	4.318063
2,990,000	–1.1E+07	13,793,640	4.613258
2,075,000	–7545275	9,620,275	4.636277
100,100	–4E+08	3.96E+08	3952.988

Pearson coefficient (r = 0.560)

Table 11. Error values for y = f(x_3).

y_{actual} (10^3 USD) (the tender price)	y_{model} (10^3 USD)	Relative error	Absolute error (USD)
600,000	3,877,422	3,277,422	5.46237
1,225,000	–7.4E+07	74,958,726	61.1908
485,000	1,509,416	1,024,416	2.112198
441,500	1,118,870	677,369.7	1.534246
440,000	1,912,493	1,472,493	3.346574
227,000	452102.8	225,102.8	0.991642
128,500	291189.8	162,689.8	1.266068
622,000	2,034,800	1,412,800	2.271383
258,500	408,193.6	149,693.6	0.579086
230,250	375,986.9	145,736.9	0.632951
228,000	1,184,248	956,247.7	4.194069
1,165,000	2,123,790	958,790	0.822996
940,000	6,238,986	5,298,986	5.637219
1,915,000	7,660,525	5,745,525	3.000274
1,813,000	4,020,257	2,207,257	1.217461
2,990,000	15,048,692	12,058,692	4.033007
2,075,000	10,036,233	7,961,233	3.836739
100,100	197,230.8	97,130.79	0.970338

Pearson coefficient (r = 0.936)

Mathematically, for each model the $\partial y/\partial x_i$ partial derivatives will reveal sensitivity for the privatization proceeds of the x variables. Sensitivities for the privatization revenues are presented in Table 14.

Table 12. Error values for y = f(x_4).

y_{actual} (10^3 USD) (the tender price)	y_{model} (10^3 USD)	Relative error	Absolute error (USD) (USD)
600,000	509,349.1	90,650.94	0.151085
1,225,000	1,283,807	58,806.65	0.048005
485,000	489,744.3	4744.335	0.009782
441,500	630,196.3	188,696.3	0.427398
440,000	683,607.2	243,607.2	0.553653
227,000	367,682.4	140,682.4	0.619746
128,500	264,602.7	136,102.7	1.059165
622,000	284,924.3	337,075.7	0.541922
258,500	264,602.7	6102.707	0.023608
230,250	235,966	5715.966	0.024825
228,000	397,895.1	169,895.1	0.745154
1,165,000	654,755.8	510,244.2	0.437978
940,000	1,685,313	745,312.9	0.792886
1,915,000	1,685,313	229,687.1	0.119941
1,813,000	1,520,358	292,642.4	0.161413
2,990,000	2,987,025	2974.757	0.000995
2,075,000	1,820,980	254,019.7	0.122419
100,100	117,715.1	17,615.11	0.175975

Pearson coefficient (r = 0.941)

Table 13. Error values for y = f(x_5).

y_{actual} (10^3 USD) (the tender price)	y_{model} (10^3 USD)	Relative error	Absolute error (USD)
600,000	1,154,249	554,248.5	0.923748
1,225,000	1,228,244	3244.251	0.002648
485,000	526,610.1	41,610.12	0.085794
441,500	372,114.6	69,385.42	0.157158
440,000	696,748.4	256,748.4	0.583519
227,000	216,520.9	10,479.11	0.046163
128,500	174,016.2	45,516.21	0.354212
622,000	745,127	123,127	0.197953
258,500	208,601.5	49,898.54	0.193031
230,250	201,959.9	28,290.13	0.122867
228,000	394,773	166,773	0.731461
1,165,000	680,581.9	484,418.1	0.41581
940,000	1,217,897	277,896.8	0.295635
1,915,000	1,604,248	310,752.3	0.162273
1,813,000	1,160,844	652,155.8	0.359711
2,990,000	2,989,057	942.6897	0.000315
2,075,000	2,203,321	128,320.9	0.061841
100,100	108,875.9	8775.861	0.087671

Pearson coefficient (r = 0.943)

Table 14. Maxima and minima for the derivatives of the models.

Parameter	$\left\lvert\left(\frac{\partial y}{\partial x_i}\right)_{x_i \to x_{\max,i}}\right\rvert$	$\left\lvert\left(\frac{\partial y}{\partial x_i}\right)_{x_i \to x_{\min,i}}\right\rvert$	$\left(\frac{x_{\max}}{x_{\min}}\right)_i$
x_1	—1.8E+07-	—401,557-	4.405
x_2	—1,361,502-	—894,603-	14.038
x_3	—7.5931-	0.210223	85.333
x_4	4,142,485	102,545.4	9.646
x_5	—5,203,404-	298,163	14.177

5. Updating of the regression models

Regression equations for privatization revenues were obtained for 2009. Privatization revenues (in USD) can be updated for the following year (t) using the regression equations obtained for 2009:

$$y_t = y_{2009} \times \left(\frac{REER_t}{REER_{2009}}\right) \times k_1 \times k_2 \times k_3 \times k_4, \tag{3}$$

where REER is the abbreviation of real effective exchange rate. REER is defined as the weighted average of a country's currency relative to an index or basket of other major currencies adjusted for the effects of inflation. The weights are determined by comparing the relative trade balances in terms of one country's currency with every country within the index. A base index can be a producer price index (PPI) or a consumer price index (CPI). REER per month is announced by the Central Bank of Turkey (TCMB). For example, using TCMB's data, the average values of PPI based REER for 2009, 2010, and 2011 are calculated as 111.68, 129.39, and 110.31, respectively. Therefore, the ratio of real effective exchange rates, the multiplier in equation (3), will be 1.159 and 0.988 for 2010 and 2011, respectively.

The k_1, k_2, k_3, and k_4 in Eq. (3) are updating coefficients used to reduce the regression models for 2009 to a future year of t (e.g., 2010 and 2011). Specifically, k_1 is the ratio between the book value of the energy distribution company in year t and that in 2009; due to depreciation, k_1 is smaller than 1. The ratio between the gross domestic product (GDP) in year t and that in 2009 is expressed by k_2, which would be greater than 1 in the case of economic growth. The ratio between the GDP deflator in year t and that in 2009 is expressed by k_3; k_3 is greater than 1 due to rising asset values because of inflation. In the case of deflation k_3 will be smaller than 1. The ratio of the corporate tax multiplier in year t to that in 2009 is expressed by k_4. Any increase in corporate tax plays a role in reducing the net profit of the energy distribution company. If the privatization tender of an energy distribution company is postponed to any year t after 2009, the regression models obtained for 2009 can be adjusted for year t by using Eq. (3). For example, while k_2 for 2010 is 1.153 (1098.8/952.6), for 2011 it is 1.362 (1297.7/952.6); k_3 for 2010 is 1.075 (5.7%/5.3%), but for 2011 it is 1.622 (8.66%/5.3%). Since 2006 the corporate tax in Turkey has been 20%; for the years 2010 and 2011 k_4 is 1 [(1 – 0.20)/(1 – 0.20)].

6. Conclusion

Privatization is extremely important in all developed and developing countries, with impacts on efficient company formations, revenue increments of the countries in order to ensure financial resources for new investments, and strategic planning. To achieve the expected benefits of privatization and to ensure suitable market conditions, the current benefits should not be below market expectations. A suitable setting for privatization is achieved in countries with economic and political stability.

In the current study, with the privatization revenues of 18 electricity distribution companies in Turkey, the relationships between microeconomic variables (x_1, x_2, x_3) and macroeconomic variables (x_4, x_5) were investigated with the help of various models (Models 1–5). The private sector firms that participate in the privatization auctions for the electricity distribution companies are considered on an array of variables in addition to their price offers.

The least squares method is used for the proceeds from the privatization of electricity distribution companies, while y and x_i are the dependent and independent variables, respectively.

The results obtained from the study are summarized below:

The privatization revenues of the energy distribution companies in Turkey are expressed in nonlinear equations, depending on microeconomic and macroeconomic variables. The data of the variables are far from normal distributions (Table 8). The Pearson coefficient r values for the proposed 5 models are in the range of 0.943 to 0.405. The lowest correlation was found in model 1. Because the number of transformers (x_1) in the energy company is in the group of fixed assets, the impact over the privatization revenue in terms of business has been weak. The correlation of the leakage-loss rate in model 2 was found to be 0.560. The leakage-loss rate has a role in decreasing privatization revenues (Table 14). The obtained low correlation can be explained by the reduced goals of the targeted leakage-loss rate. For example, the loss-theft ratio of the Dicle and Vangölü (Van Lake) energy distribution companies are 36.83% and 35.45% of the targets for 2010, while they are 73.39% and 55.56% for 2009, respectively. The loss-theft rates are inversely proportional to the income levels of the region. High correlations are observed in models 3, 4, and 5. The parameters x_3, x_4, and x_5 are related to the annual sales income of the energy distribution companies, the annual profit, productivity, net profit value, and internal rate of return. All three parameters are directly related to installed power, demography, subscriber profile (household/industry), and geographical properties. Briefly, the amount of electricity sold (MWh/year) is very effective on privatization revenues.

- Due to the fact that regression equations are nonlinear and the parameters of x are not normalized, the maxima and minima for the derivatives were found in a wide range.

- If the privatization revenues of the energy distribution companies in foreign countries are expressed by the proposed parametric equations, direct economic comparison and analysis can be performed with privatization revenues in Turkey.

- The proposed methodology for privatization revenues in the current paper can also be used for power plants and natural gas distribution companies. For example, in Turkey the privatization studies of 27 hydro power plants are ongoing. By defining the microeconomic and macroeconomic variables of these plants, the equation regarding privatization revenues can be obtained.

- The resulting models for the year 2009 can be used for future years by means of Eq. (3). This equation gives the base values for renewed energy distribution tenders. The regression equations can be useful in the coming years to private sector firms interested in participating in the privatization of electricity distribution companies.

- The numerical data used in this article relate to 2009, when the floating peg model was used in Turkey. If another foreign currency model is used (managed float, sliding band, crawling band, crawling peg, etc.), the regression coefficients derived from this article need to be corrected due to the variation form of the

USD/TRL parity. In other words, for the privatization revenues on the left side of the equations, the floating peg conversion should be done.

References

[1] Joskow PL. Electricity sector restructuring and competition: lessons learned. Cuadernos de Economia 2003; 40: 548–558.

[2] Growitsch C, Jamasb T, Pollitt M. Quality of service, efficiency, and scale in network industries: an analysis of European electricity distribution. Applied Economics 2009; 41: 2555–2570.

[3] Mazer A. Electric Power Planning for Regulated and Deregulated Markets. Hoboken, NJ, USA: Wiley, 2007.

[4] Hunt S. Making Competition Work in Electricity. Hoboken, NJ, USA: Wiley, 2002.

[5] Rothwell G., Gomez T. Electricity Economics: Regulation and Deregulation. Hoboken, NJ, USA: IEEE Press, 2003.

[6] OECD/IEA. Competition in Electricity Markets. Paris, France: Publication Service, 2001.

[7] The Privatization Administration (in Turkish, ÖİB) (2010).

[8] OECD. OECD Reviews of Regulatory Reform, Regulatory Reform in Turkey: Regulatory Reform in Electricity, Gas, and Road Freight Transport. Paris, France: OECD Publications, 2011.

[9] Özkavrak O. Electricity restructuring in Turkey. Energy Policy 2005; 33: 1339–1350.

[10] Bagdadioglu N, Waddams Price C, Weyman-Jones T. Measuring potential gains from mergers among electricity distribution companies in Turkey using a non-parametric model. Energy Journal 2007; 28: 83–110.

[11] Erdoğdu E. Regulatory reform in Turkish energy industry: an analysis. Energy Policy 2007; 35: 984–993.

[12] Ulusoy A, Oğuz F. The privatization of electricity distribution in Turkey: a legal and economic analysis. Energy Policy 2007; 35: 5021–5034.

[13] IEA Statistics (2005). Electricity Information.

[14] Turkish Industrialists and Businessmen Association (TUSIAD). Liberalization of the Energy Sector: The Case of Turkey and the EU. TUSIAD Energy Strategy-4, 2009.

[15] Energy Market Regulatory Authority (EMRA), (2010) Electricity Market Report.

[16] Turkey Electricity Trading Corporation (TETAŞ), Sector Report for Year of 2011.

[17] Park CS. Contemporary Engineering Economics, 5th Edition. Upper Saddle River, NJ, USA: Prentice Hall, 2010.

[18] Turkey Electricity Distribution Company (TEDAŞ) Statistics for 2007, 2008, and 2009.

[19] The Chamber of Electrical Engineers (in Turkish, EMO), Electricity Privatization Report, 2012.