BENCHMARK REGULATION IN UKRAINE'S ENERGY SECTOR – BACK TO THE USSR?

by

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Abstract

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The focus of this paper is the usefulness of applying benchmarking methods of regulation to Ukrainian electricity distribution sector. It will be argued that despite serious limitations on its way, benchmark methods in Ukrainian regulation can be highly useful at reaching a number of important goals. Most important, the company benchmarking will aid the national regulator in assessing the company efficiency and will increase transparency in the sector. This may considerably improve implementation of the existing methods of regulation and increase efficiency of the regulated companies.

A benchmarking study of Ukrainian electricity distributors was conducted to explore several methodologies that can be applied in practice. The results on the company efficiency and trends in the sector are provided. Finally, some comments are made with regard to the observed efficiency differences for the existing company ownership groups.

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INTRODUCTION

Ukraine's electricity sector has undergone significant restructuring in the mid 90' with reforms being modeled after the UK example. The vertically integrated electricity sector was split into generating companies, one electricity transmission company and regional electricity distributing and supplying companies. Electricity distributing companies are in the process of privatization with half of them being already privatized. Transmission and distributing companies were by law announced to be natural monopolists and consequently regulated by a regulatory body, the National Electricity Regulatory Commission of Ukraine (NERC).

New economic and institutional environment brought by the reforms lead to a number of challenges that are faced by NERC, a major player in the sector. The fact that most regulators in Ukraine have an experience of command regulation does not necessarily imply an advantage in guiding natural monopoly activities in the market-oriented economy. NERC is a comparatively new establishment and some methods left by the western consultants are still not fully appropriated by the commission's personnel. Lack of transparency, elements of legal and illegal regulatory capture further complicate effective regulatory practice in the country.

In this paper I will discuss the relevance of benchmark regulation schemes in the Ukrainian electricity distributing sector. I will show that benchmarking can reduce information asymmetry – one of the major obstacles to regulation. Besides the analysis of the company performance, which is one of the benchmarking outcomes, there is a high likelihood that sector transparency will be improved if benchmarking is practiced officially (and the results are made freely available). All else being equal, this will stimulate Ukrainian regulators to exercise their discretion within reasonable bounds.

Despite certain similarities the benchmarking method has with the command economy practice, it may yield very good results in practice by enhancing technical efficiency in the sector through competitive environment simulation. Finally, the development of relevant benchmarks for particular companies and for the industry as a whole will first, enable a good functioning of current regulatory methods (including cost of service and the rate of return regulation (RORR) and, second, will prepare the way for future methods such as a price cap regulation (PCR).

A number of methods from the international regulatory practice were used to illustrate the applicability of various benchmarking approaches to Ukrainian electricity distributing companies. First, an overview of the industry trends with some analysis of company labour dynamics is provided. Second, an econometric estimation of an average-cost function was conducted to identify the importance of some environmental variables. Finally, DEA model was constructed to assess the company input oriented inefficiency.

The Application of a number of benchmarking methods enabled us to comment on the industry trends and estimate company individual efficiency scores. We also show that some important environmental variables such as the customer density are very significant in explaining costs in the sector. Another result obtained is that the state owned companies seem to be more efficient than the privatized ones. The explanation of this result needs however further research, since such a result can be attributed to several factors. These factors include corporate governance issues, the type of regulation exercised toward different ownership groups and to some extent the model specification. Finally, different profit maximizing strategies of the privatized companies are noted. Overall, the results obtained indicate that benchmarking is a method, which is quite useful for the regulatory practice in Ukraine.

The paper is structured in the following manner. In the first chapter I review relevant literature on the benchmarking theory and methods in regulation. The second chapter introduces the reader to regulatory specifics in the Ukrainian power sector and provides a descriptive analysis of the industry. The third chapter presents empirical estimation of the average cost function and input oriented DEA model. In the fourth chapter the obtained results are discussed. Concluding discussion of the relevant policy implications is found in chapter five.

Chapter 1

LITERATURE REVIEW

Incentive vs Command Regulation

During the past century and especially during the last several decades many regulatory methods have been developed and applied in practice. They can be divided into two broad categories – incentive and command regulatory methods. Lewis and Garmon (1997) coined the definition of the former one as "… the use of rewards and penalties to induce the utility to achieve the desired goals where the utility is afforded some discretion in achieving the goals." Command regulation, which is very similar to one practiced in the former Soviet Union (fSU), differs from the incentive regulation in that companies are often given direction with regard to both targets and tactics.

Some of the most widely employed methods of incentive regulation toward public utilities are modifications of price cap regulation (PCR), rate of return (RORR) regulation and yardstick regulation. The cost of service of regulation is basically the only main method of direct or command type. Hybrids methods of these exist as well.

Price cap regulation was first widely and successfully used in the course of recent regulatory reforms in the power, water and gas sectors in UK. Under PCR a firm is allowed to raise its prices at the inflation rate minus some X-factor (expected periodic productivity gains by the firm) for a predetermined period; this practice has proven to stimulate companies for cost-reducing activities. (Viscusi et all., 2000). One potential drawback of the method is that companies tend to decrease their expenditures (avoid investments) at a price of neglecting long-term goals.

RORR is a more traditional method of regulating utilities used in many countries. Under this methodology, a company receives a stipulated return on its capital by allowing owners a return they could have earned in a competitive market. This method, however, has one serious pitfall, the so-called Averch-Johnson (A-J) effect (Averch and Johnson, 1962). It is the tendency of firms to increase the rate base (gross value of assets) by making excessive (e.g. at the expense of labour) investments.

Yardstick competition method is applied by setting certain performance targets for companies that later serve as a basis for company compensation. The regulator determines the performance benchmarks or yardsticks either from international practice or from the local industry participants. Since the compensation is linked to the company compliance with the benchmarks, this stimulates competition among the companies and leads to efficiency improvements in the desired areas.

Benchmarking in Regulation

According to Spendolini (1999), “the essence of the benchmarking process – understanding the processes that drive the numbers”; simple comparisons of companies (though very useful) are of course not the ultimate goal per se. It is the “how to” that is important - before Rome became the key sea power in the region, its engineers had spent considerable effort dismantling Greek galleys to appropriate the know-hows of their more skilful rivals. The example of competitive markets today shows that it is those survive who can match (and outperform) the best.

However, the companies in regulated industries do not usually have the incentives to fight the efficiency battle. That is one of the main reasons why regulators started to apply such methods as yardstick competition to learn more about the firms and then stimulate monopolists to achieve superior but at the same time feasible levels of efficiency. Yardstick competition as a method of monopoly regulation was first articulated in Shleifer (1985). Here, the regulator estimates an average cost for a firm in the industry (all firms are to be homogeneous, otherwise heterogeneity is to be accounted for) and then assigns prices (tariffs) dependent on the benchmarked cost.

In practice yardstick competition in it original form has not been widely applied as a main approach to regulation of natural monopolies[1]; however, some of its elements and modifications are becoming extensively used by utility regulators in many countries. While regulators in countries like Chile, Netherlands, Norway and the UK extensively (and officially) apply benchmarking methods, it is certain that regulators in the rest of the world do also use some form of benchmarking to aid their decision- making[2].

Some of the large scale benchmarking analyses of electricity utilities were studies of New Zealand and Dutch electricity utilities conducted in 1999 and 2000 respectively to aid national regulators with setting price and revenue caps[3]. The price cap regulation requires that a so-called price path for each company is set – expected changes in price over the designated period. Since the price path is in part determined by the X-factor dynamics (a percentage of company efficiency

[1] Shleifer mentions Medicare – a public organization that receives financing based on the performance of private hospitals.

[2] Jamasb and Pollit (2001) mention about 20 countries in which utility regulators use benchmarking of some form.

[3] DTe (2000), IPART (1999).

improvement over time), benchmarking the "right" X-factor is often the main goal of such studies.

Benchmark Regulation Criticized

There are of course potential drawbacks of benchmarking as a method and its application. The most focused and consistent criticism of utility benchmarking comes from the National Economic Research Associates (NERA) representatives. Williamson and Toft (2001), for example, point that accurate control for heterogeneity among firms is not possible and thus may result in unreasonable benchmarks. Since there is no two identical companies indeed, it is hardly feasible to completely account for the differences that exit. The problem is worsened if some relevant parameters are not available.

Unreasonable targets can also be the result of possible subjective approach taken by the regulator in assigning the targets as suggested in Lieb-Doczy and Shuttleworth (2002). It is needless to say that the misspecified targets may distort incentives and lead to either excessive or less than fair profits for the companies.

Further, the nature of benchmarks presupposes that they will change from time to time reflecting exogenous shocks or industry trends. Therefore, the element of uncertainty created may harm the industry environment (which, for example, is not good at all for attracting investment to industries that are being privatized).

In Ukraine the regulator is known to often act at his "discretion" (whether because of regulatory capture or technical limitations). Therefore, it may seem that the benchmarking may be undesirable in the transitional economies like

Ukraine due to a high probability of the unreasonable targeting or, using the Soviet terminology, "norming" of the performance measures[4].

A number of articles in the Economist[5] criticise the idea of benchmarking public service sector activities by the British government by referring to the fact that the people will always find a loophole; the success in the targeted area may come at a price of a complete failure in a still important but untargeted area. The idea of benchmarking in the public sector is therefore discredited to a great extent by the notorious Soviet planning/targeting experience.

Nevertheless, benchmarking is greatly admired by regulators for a number of reasons. First, benchmarking enables regulators to conduct both static and dynamic descriptive analysis of the industry and the companies. Moreover, regulators can analyse the efficiency of the companies with respect to their past performance, relative to other local utilities performance and/or relative to the international peers[6].

Second, besides the productivity measurement, benchmarking is often used to overcome such regulatory "impediments" as the problem of asymmetric information. It is argued that international benchmarking (by using few but key often readily available qualitative variables) can considerably improve regulator practice otherwise hindered by scarce local information. The problem of asymmetric information is thus partially resolved in a process of learning by benchmarking (Estache et all, 2001). Companies that are being benchmarked become very interested in disclosing information to be treated fairly.

[4] I am grateful to Andrej Juris of NERA for his critical comments on the issue. Mr. Juris has however pointed to potential usefulness of financial indicators' benchmarking in Ukraine.

[5] For example, "Missing the Point" article in the April 26, 2001 issue.

[6] Most of the studies include all types of comparisons that are feasible in terms of data available. International benchmarking, however, is often complicated by a high degree of heterogeneity.

Third, yardstick competition can be used to stimulate cost minimization by making rewards (tariffs) dependent on the company's performance as compared to other companies. Agrell et all (2002) provide some examples of different yardstick models discussed in the context of Norwegian regulatory practice. This is more of an extension to the yardstick competition; these methods are more known as sliding scale and partial cost adjustment methods[7].

Methodology

The way benchmarks are set often determines mathematical or econometric methods that are used for the estimation. As Yatchew (2001) notes, there are four possible ways cost benchmarks can be set: on the basis of sample (1) average costs, (2) median costs, (3) percentile (25% lowest costs companies), (4) company/s with the lowest costs. Accordingly, the first three benchmarks can be estimated by econometric methods – OLS, Least absolute deviations regression and by the quintile regression method. The fourth one, the best practice cost benchmark, is usually estimated by the Data Envelopment Analysis (DEA).

Some of the first econometric estimations of the electricity distributors' cost functions are Neuberg (1977) and Huettner and Landon (1977). Authors of the modern benchmarking studies employ mainly efficiency and productivity analysis methods such as DEA, Stochastic Frontier Analysis (SFA) and Malmquist and Tornqvist productivity indices[8]. As a result of research done by both individual researchers and country regulators, models were constructed to assist regulators in assessing efficiency and making well-considered tariff setting decisions.

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[7] Discussion of these methods can be found in Joskow and Schmalensee (1986).

[8] For example, in IPART (1999) study DEA and productivity indices were employed.

Chapter 2

BENCHMARK REGULATION IN UKRAINE'S ENERGY SECTOR

Ukraine's Regulatory Context

In 1994 the National Electricity Regulatory Commission of Ukraine (NERC) was established to regulate natural monopolies in the energy sector including power, gas, oil industries. Electricity distributing companies in Ukraine are officially regarded as natural monopolies. These companies are region-based, i.e. each of the 25 regions of Ukraine and the two major cities Kyiv and Sevastopol has its own electricity distributor (henceforth denoted as oblenergo). Oblenergos purchase electricity from the wholesale electricity market (WEM) and distribute power to consumers[9]. There are about 40 companies that distribute and supply electricity but oblenergos are by far the most important ones (financially and politically). For this reason I do not include them in my analysis (these are often large factories, railroads or military bases).

As part of the electricity reforms, privatization of state owned oblenergos was performed; at the moment there have been two waives with 7 companies sold in 1997 and 7 - in 2001[10]. The rest of the companies are expected to be sold in the next several years.

[9] There were a number of studies that discussed extensively the history and outcomes of the reforms; to avoid duplication, I would recommend Ryding (1998) - though somewhat outdated, still is a must reading on the history of the electricity reforms in Ukraine and, in particular, on the role of the Western advisors. Tsaplin (2001) is another paper that provides a good analysis of the country's national regulator activities.

[10] The process of Ukrainian privatisation in the power sector was very painful; some of the companies were resold several times, taken back by the state etc. Thus, I will talk about the current ownership state of the companies. A brief summary of the indeed troublesome privatisation process in Ukraine can be found at www.imepower.com.

The owners of the companies can be classified into 4 broad groups: the first one – companies owned by the U.S. investor, the second group - by a Slovak financial group, the third - by the Ukrainian investors and, finally, the state owned companies group. The companies owned by the Ukrainian investors can further be divided: one company, Odessaoblenergo, is owned by an offshore entity whose founder cannot be exactly specified; the rest of the companies in this group belong to a large Ukrainian financial establishment.

Current Regulatory Approaches

In Ukraine, several regulatory approaches are officially in place to distinguish between state owned and the first waive of privatization company groups and the second waive group companies. The former are regulated via the cost of service approach and the latter (second waive group) - via RORR.

The rate of return was accepted to be 17%, the rate base is fixed for a period of 7 years - unless a company files for tariff reconsideration due to cost increases (more than 5% from what is stipulated in tariffs) that have happened for a number of reasons, including inflation and local exchange rate fluctuations with respect to the U.S. dollar. NERC has also the right to file for the tariff change on the basis of considerable cost structure discrepancies[11].

The application of RORR is new to NERC – in fact, the first tariff resetting process started at the beginning of the year 2003. Since the cost of service regulation is very similar to the command regulation practiced in the Soviet Union, it is natural that NERC staff is more accustomed (and inclined) to the cost of service regulation. Though the western advisers assisted NERC in drafting the rules and decrees on RORR, some time yet has to pass for NERC to fully appropriate the method.

[11] NERC decree # 348 (10/04/2001).

Corporate Governance Issue

Historically, both individual economic agents and the state enterprises in the fSU indulged and excelled in finding ways of not following the state commands[12]. The state was always considered as an enemy that prevented an agent from profits (ones that were due to some extra effort the company undertook). It was also seen as a sure source of funding in difficult circumstances (soft budget constraint). Therefore, the corporate governance problem will be quite relevant in the post communist countries (there is a hope that this will change with time).

The corporate governance problem is indeed quite considerable in Ukraine. Moreover, the problem is real both for the state owned oblenergos and for the most privatised oblenergos. While evidence from many studies seem to indicate that privatised companies are more efficient than the public ones, in particular in the regulated sector[13], evidence is mixed for Ukraine (the empirical results will be presented in the next chapter).

This strong inclination to trick the state on the side of the companies may be explained by a number of factors. First, as it was mentioned, patterns of dealing with the "planner"-regulator persist, second, investors are very uncertain about the future – uncertainty coming from regional authorities (who have a potential to influence business activities), NERC and general economic and political situation in the country. Therefore, the owners of privatized companies tend to get the most from the company, sometimes, illegally[14]. One should say though

[12] Of course, shrewdness or even dishonesty is possible in other countries as well, Enron being one notable example. However, firms in the former command economies are in a more "favourable" environment for these kinds of problems to occur.

[13] See a literature review in Viscusi et all (2000).

[14] The most recent example is the so-called "Software Case" – a number of privatized companies acquired specialized software systems at prices that allegedly were several times higher than market ones. The "unjustified" costs (e.g. for one companies it was estimated to be about USD 15 millions) were hidden by the companies by distorting the financial reports. As soon as it was discovered, a number of financial audits followed and the companies' top managers were fired.

that the situation is probably worse for the state owned companies – some of them are at the edge of bankruptcy.

Regulatory Lag Issue

The opportunity is taken here to comment on a very important issue in regulation – the regulatory lag. The period of 7 years mentioned earlier can hardly be called the regulatory lag in its usual meaning – a period during which the company's tariffs are fixed. For example, during the period of 1999-2002 the companies came for a tariff resetting on average 2 times a year (some companies as often as 3 times a year). It is very likely that ROR regulated companies will follow suit.

In international practice[15], the regulatory lag or more precisely its duration is very important; its correct definition directly influences whether the company will have incentives for pursuing efficient use of resources, i.e. reduction of costs. This is generally true for all methods of regulation (though extremely so for PCR). It is crucial that the company owners know the period they can enjoy a certain price or return and have no incentives to press on the regulator without serious reasons.

The longer is the interval between the tariff settings, the more the company has incentives to reduce their costs since it is the only way left to maximize profits. In a sense, a competitive environment is simulated, when a company cannot influence its prices. However, as the regulatory lag increases, the regulator price path forecast accuracy worsens. Long-term forecasts of key economic indicators, exogenous shocks (price shocks, ecological catastrophes, etc) are not very robust and hence a risk that a company will either earn excessive profits or go bankrupt rises as the forecast horizon expands. It is therefore considered (in the most

[15] The following regulatory lag discussion is drawn from Baldwin and Cave (2000).

countries) that duration of 4-6 years is optimal for the regulatory lag. It is argued that this period allows the commission to make a robust forecast, which balances disadvantages and benefits of the lag increase.

Regulatory practice in Ukraine is plagued by frequent tariff reconsiderations (some companies have their tariff changed up to three times a year) [16] due to the absence of the fixed regulatory lag notion. Such frequency may indicate one of the three: first, the companies were unlucky enough to experience an exogenous (e.g. ecological) shock which resulted in losses under existing tariffs. Second, it may indicate that there was managerial inefficiency in controlling the expenditures. Third, it may indicate the presence of strategic behaviour: since it would be impossible to get a high price increase immediately at the first time of the price setting, companies apply several times so that their revenue increases are not that obvious[17].

It is quite challenging to distinguish between reasonable and unreasonable tariff filing – it is always possible to find good reasons that unfavourably influence the company's operations. The most frequent exogenous cost driving shock in Ukraine is ecological disasters (incidents of assets thefts, e.g. copper lines, are quite widespread in the country as well). At the moment, a law on obligatory insurance is being discussed to somehow hedge against losses from ecological disasters. However, one thing is obvious - regulated companies have less motivation to take precautionary measures to keep the costs down, as opposed to

[16] Almost exclusively, tariffs are being raised during the consideration. Exceptions include several cases when some companies were found to cheat the regulator and a recent case with privatised companies (to be discussed in the conclusion part).

[17] Though we focus on the companies when discussing this issue, one should remember than the regulator has his word to say as well. Data observation makes it possible to say that under different NERC chairmen tariff reconsiderations differed in number. Overall, there is a tendency for the regulatory lag increase (see also a discussion on the issue in Tsaplin et all (2003).

the competitive firms that cannot come to a friendly regulator for additional funding.

The Future of Ukraine's Regulation Methods

As soon as the privatisation process is completed, it is expected that RORR will likely to be the main method. It was suggested that NERC should adopt PCR as a method yielding superior incentives and thus results (Kutsak, 2001). This method is most likely the future of Ukrainian regulation, though a very distant one. Application of PCR methodology requires both a mature regulator and the sector because of considerable technical complexity of its implementation.

The national regulator should first excel in applying more simple methods and then proceed with more advanced. In this respect, benchmarking (that can be both simple and complex in its design) can be used to improve the practice of RORR and cost of service regulation. Moreover, benchmarks developed can further be used to prepare for and foster PCR in Ukraine.

The Potential Advantages of Applying Benchmarking Methods in Ukrainian Electricity Distribution

Despite the potential shortcomings of benchmarking discussed in the previous chapter, its advantages are likely to be of more value to society in Ukraine. While technical difficulties (data, skills in application) are indeed real in Ukraine, these should and will be eventually resolved. Moreover, other methods of regulation – for instance, RORR, which is currently practiced in Ukraine, also require much expertise. Introducing benchmarking in itself will create (almost absent) demand and respect for good quality data and economists.

NERC has recently started developing benchmarks for the companies[18]. While the work has begun, final benchmarks are not yet approved and practiced officially. Among the benchmarks that are likely to be considered in the nearest future are ones related to the quality of service, the level of customer bill payments, levels of investments and other indicators. Though most of the benchmarks are partial, econometric and mathematical approaches to benchmarking are considered as well.

The second set of problems regarding the regulatory discretion is a more serious one. One cannot probably approach regulatory issues without taking into account both positive and normative theories of regulation. Regulatory capture and opportunistic behaviour do indeed happen and can distort the results of any good regulatory scheme.

Despite this potential danger, the benchmarking (if used officially) can in fact constrain extreme regulatory discretion. The regulator may publish the benchmark study results, which will draw public attention and (likely) criticism of the regulatory decisions. In the west it is not uncommon for various interest groups (for the most part, companies) to initiate public discussions of allegedly unfair regulatory decisions, especially related to the benchmarking results. Hence, while potentially burdensome for a regulatory body, public attention will increase transparency in Ukraine's energy sector[19] and will help to avoid to some extent regulator's unreasonable behaviour.

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[18] The author of this paper had a privilege to participate in the implementation of benchmarking methods at NERC. The author again expresses his gratitude to his former NERC colleagues for their support and encouragement. However, the conclusions and opinions presented in this study do not necessarily represent the views of NERC or its stuff.

[19] The issue of transparency in Ukrainian electricity sector is quite a burning one as, for example, specified by this year's IMF country report.

The problem with regulatory uncertainty on the side of the investors can be dealt in two ways (assuming gradual implementation). First, NERC can benchmark companies (in addition to the official financial analysis used) but not use obtained results directly in setting the tariffs. The main objective of benchmarking in this case will be therefore to define the problem areas and initiate further investigation.

There are very strong reasons to believe that benchmarking has a future in Ukrainian utility regulation. In several years NERC will have a sufficiently extensive database to implement reasonable benchmarking using sophisticated econometric and mathematical methods. For the large scale studies or inquires, NERC will have to contract economic consulting agencies capable of doing such studies (and such agencies do already exist in Ukraine).

Trends in Ukrainian Electricity Distribution

The data to be used in the research are taken from NERC databases and queries. All of the NERC licensees provide their quarterly and yearly financial and technical information. The relevant variables' description for the year 2001 is provided in Appenices D and E.

Since natural monopolies are characterized by increasing returns to scale it is of interest whether Ukrainian companies exhibit this property. Graphs of average distribution costs plotted against electricity distributed for years 1999-2002 are presented in Appendix A. Besides, the analogous graph is given for 14 UK electricity distributors. Data for total of 26 Ukrainian electricity distributors are plotted for each of the four years[20].

[20] Cost data for each year are presented at historical values. The exchange rate was taken to be 5,4 UAH/USD for all years; though the exchange rate yearly fluctuations are not accounted, the average cost trend is not affected by this simplification.

The graphs presented in Appendix A indicate that all (especially small) companies could greatly benefit from the economies of scale. Thus we can conclude that Ukrainian electricity distribution exhibits increasing returns to scale (IRS). If we look at a graph picturing average costs for the British distributors, one may notice that increasing returns are present as well, though the companies are less dispersed. It can be also argued that the minimum efficiency scale is yet to be achieved in Ukraine, since average cost curve is L-shaped and not U-shaped.

One can observe some of the trends in electricity distribution during the last five years by simple descriptive data analysis[21]. The table with the aggregated data is presented in Appendix B. By looking at the trends one can see for instance that the oblenergos' share of electricity supplied increased over the period, which may imply that the share of small companies in the sector decreased. This trend is desirable, since economies of scale can be better exploited by oblenergos. We also see that the total line length goes down which is likely to be explained by a steady decrease in the total electricity consumption demand and by the low levels of capital investments.

Labour Dynamics

A phenomenon worthy of a special attention is the growth of the (average) number of employees in the sector with time. From the first glance it may seem surprising since as capital requirements decrease labour requirements should probably reflect the trend. One conclusion is that this labour hoarding is profitable for the companies.

The labour trend however is not unanimous for the different ownership groups. For example, there was a positive growth of 6,2% a year (2001-2002) in the

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21 One should of course remember that one region (Lugansk) is missing from the analysis. Besides, some small electricity distributors and or suppliers that operate within some regions are not taken into account. These are often large factories, railroads or military bases.

average number of employees in the Slovak group companies (total 4) after the privatisation. A year before, the growth rate for the same group of companies was 7,7% respectively. Opposite to that, a negative growth of approximately 17% in the average number of employees was observed in the two companies owned by the U.S. investor (also for the after-privatisation period - 2001 to 2002). For the year prior to privatization the average growth amounted to positive 0,6%[22].

One should note that this difference is not explained neither by differences in labour to capital ratios (U.S. owned companies were already more "efficient" in this sense before the privatization) nor by the different market trends for the companies (electricity demand fluctuations, customer number growth or capital growth) nor by the different regulatory conditions – the companies in both groups are regulated by the RORR method. These different profit maximizing strategies are therefore somewhat surprising; this compels us to conclude that the nationality of ownership makes the difference. That is, the Slovak group seems to know how to do business in Ukraine better than the Americans. Of course, for a definite conclusion, one has to investigate this issue more thoroughly – partial benchmarking has its flaws. Nevertheless, this is one example how the regulator can identify possible "areas of interest" by benchmarking.

Partial performance indicators

One could also observe a high degree of correspondence between various variables plotted on graphs in Appendix C. One reason is that some normalization does take place or was taken place in the past. It should be remembered as well that these are aggregate figures (e.g. we could discriminate between employees who work on distribution and supply activities, different categories of transformer capacity etc). However, some of the ratios, for example,

[22] It is necessary to note that during the discussed period some new (small) electricity distributing companies were founded (thus reducing the labour requirements for the oblenergos). However, no new companies were created in regions where U.S. owned companies operate.

number of employees per line ratio, could be benchmarked and be set as a yardstick for the companies under the cost of service regulation. On the other hand, these simple plots could be used by the regulator to identify the outlining companies and investigate the underlying reasons.

Legal "Constraints" in the Sector

Before one starts estimating efficiency of input allocation one has to check whether the companies can freely dispose inputs, i.e. that there are no legal constraints binding companies to certain quantity or price requirements. In the electricity distribution sector companies and the regulator are not bounded. It is indeed so, even though one can find formal constraints on labour price and quantity.

The average wage in the industry, for example, is stipulated by the state ruling[23]. This wage setting is an inheritance from the old times, since wages in different sectors of the economy used to be officially set and fixed. It is not known whether this ruling holds in other monopolized sectors, but this is quite a formality for the electricity distributors, as indicated by the fact that often real wages are much higher that the official standard (see Appendix B). Intuitively, this seems to be reasonable, since NERC is the official regulator and has to have the sole right (and superior potential) to determine the "right" wages in its dominion sector.

Labour input in the energy sector (i.e. not only in the electricity distribution) also seems to be regulated by a special institute called "Ukrenergopratzya" (the Institute of the Ukrainian Energy Labour). The institute sets normative amounts of labour that correspond to the capital requirements of a given company. This

[23] Cabinet of Ministers of Ukraine decree #1006 (21/06/2000).

practice can be traced to the recent Soviet past, when a certain amount of workers was assigned to each piece of the equipment. While thinking about the efficiency of such norms, a reader is reminded of the labour hoarding phenomenon observed in the former Soviet Union.

Since NERC compensates for the company labour expenditures, companies can get an advantage by increasing a number of employees before the tariff setting and afterward laying-off a considerable amount (one can refer to the labour dynamics issues discussed before). However, again, NERC does not always follow norms set by Ukrenergoprayzya – in fact, NERC labour quantity allowances are as a rule lower.

Chapter 3

EMPIRICAL ESTIMATION

For the empirical illustration of the benchmarking methods econometric estimation (OLS) and linear programming (DEA) are employed. It should be emphasized that the main objective of the current empirical study is to explore the main benchmarking methods which can be potentially used in Ukrainian regulation, rather then to develop the final model that should be applied in practice. This does not of course mean that the results of the modelling cannot be used for practical purposes; some of the policy implications of the obtained results are discussed later in the text.

While every effort was made to avoid an oversimplifying approach, the author admits that the DEA model, for instance, presented in this study does not encompass all the aspects (heterogeneity) of the industry. The present attempt is rather the first step toward a large-scale (and regular) analysis the problem certainly deserves.

Most of the assumptions made are simplifying; some are due to the data limitations and some to the relative unimportance of certain factors (either in general or for the purposes and the scope of the present study). Though the author doubts that these assumptions seriously affect the frontier estimation (i.e. determining the leaders and outsiders), some distortions in efficiency scores may in fact be present. Further research in the area is therefore encouraged to achieve more comprehensive and robust results by relaxing some of the assumptions.

Similarly, the major goal of the average-cost function estimation was not to define a yardstick average cost for the companies but rather to test for the direction in which major variables influence the costs. A recorded sector history of 4-5 years for the 27 major electricity distributing companies somewhat weakens the reliability of econometric estimation. Stochastic Frontier Estimation (SFA) using panel data is in principle possible; one has however, to overcome a difficulty of quantitative data across time comparisons (to be discussed further in the text).

The small sample problem could have been alleviated by including peer companies from the other countries. This, however, would come at a price of the increased comparability problems. Nonetheless, it is not reasonable to completely denounce a company cost function estimation as a method of benchmarking in Ukraine. It may be used in addition to DEA (e.g. as a sensitivity test) given all disclaimers mentioned[24].

The Average Cost Function Estimation

When considering the cost function variables, it is important to remember that electricity cannot be stored and thus, fluctuations in its demand should be met instantaneously. As was argued by Huettner and Landon (1977) in this regard, the firm accumulates enough capacity (required inputs) in order to meet peak demand at any time. The load factor (LF) variable is thus an important cost determinant: the companies that experience lower fluctuations of electricity demand will have lower costs as shown, for example, in Fillipini and Wild (1997). One should note however that some companies in Ukraine often do not meet peak demands and customers incur power shortages. This is usually to be blamed

[24] In fact, the author calculated the company ratings (not presented in this study) by estimating a number of cost function specifications. However, the results were not robust enough (likely because of the cross section nature of the analysis).

for electricity generation failure to produce enough power because of the fuel shortages[25].

Capacity utilization information, which is another factor influencing costs as mentioned by Huettner and Landon (1977), is unavailable for Ukrainian companies. It is known though that the electricity consumption (hence distribution) plummeted during the years of transition; while in 1990 it was 268.3 GWh, in 2001 – 161.56 GWh. However, it is not clear whether capital requirements were fully adjusted by the companies to the demand changes during these 10 years (a previous discussion of the trends may imply some adjustment).

A proxy for capacity utilization was constructed (electricity distributed per line length); however it had a very high degree of correlation (about 70%) with the customer density variable. Customer density (CD) is an environmental variable defined as the total number of customers divided by the total amount of energy distributed. It is assumed that as the density increases, it becomes cheaper for the company to distribute the output. Hence, it was decided that the customer density variable will be viewed as a factor capturing the effect of the capacity utilization as well.

The price of labour (PL) is usually defined as the total labour costs divided by the total number of employees (Fillipini and Wild, 1999). However, since the exact number of employees involved in the distribution business for all the companies is not currently available, data for the total number of employees and total employee costs were used[26]. Another (simplifying) assumption made is that

[25] One exception is the companies serving the city of Kiev and its region: for obvious political reasons electricity supply in the area equals its demand at all times.

[26] For the sample of 20 oblenergos the average share of total personnel devoted to the distribution activity in year 2002 was 73% (arithmetic mean). The rest of the personnel is mainly working in the electricity supply department. Some companies also generate electricity; however, only for several of the companies this could be considered as an important activity (one outlier has 30% share). Overall, the generation share among the companies is on average 6% of the distribution activity output.

different salaries in different companies are attributed to labour heterogeneity inherent to various regions in Ukraine.

The price of capital (PK) variable is defined in the literature in several ways. In some papers, for example, Neuberg (1977), it is collapsed to the residual because of certain difficulties in defining it. Still in other papers, price of capital is defined as the residual capital costs divided by the capital stock, where residual capital stock is total distribution costs minus labour costs (Fillipini and Wild, 1999). Capital stock is sometimes approximated either by the total distribution line length or the transformer capacity.

I have decided to follow Neuberg (1977) and collapse PK to the intercept since PL and PK have a high degree of correlation (about 0.7 if defined as mentioned above). This could be in part explained by a high degree of correlation that exist between transformer capacity and the number of employees.

The total quantity of electricity distributed (Q) includes electricity supplied by oblenergos to its own customers and electricity distributed to the small companies-suppliers (excluding electricity losses). Total costs (TC) of electricity distribution include labour and other costs relevant to the company distribution activity (in Ukraine the price of purchased electricity is not included into distribution costs).

I have further added a dummy IOU which equals 1 if the company is privatized and 0 otherwise. All of the 6 companies were privatized in year 1998.

A total number of companies considered in the model is 26 (of total 27 oblenergos.) One regional company (Lugansk Energy Union) is excluded because it was created in 2002. Its predecessor Luganskoblenergo (stripped of its assets) still exits. Hence, there is a certain financial and technical confusion that lead to the exclusion of this region from the sample. Besides this confusion, there are no other reasons to consider this company an outlier with respect to any of the factors considered in this study.

The average-cost function was estimated for a year 2001 cross-section. One should note of course that in a cross section it is assumed that the firms are identical, which certainly is not true in reality. Oblenergos differ in size and consumer structure; moreover, two of the companies are city-companies (which means, for example, that they have high customer density and high share of underground cables). For the detailed statistical description of all the variables used in the model see Appendix D.

Empirical Results

The average-cost function model has therefore the following specification:

LOG(AC) = a*LOG(Q) + b*LOG(PL) + c*LOG(LF) + d*LOG(CD) + e*IOU + constant

Table 1. OLS Estimation Results.

Variable	Coefficient	t-Statistic
LOG(Q)	-0.383219	-5.145126
LOG(PL)	0.119209	2.670927
LOG(LF)	-0.026080	-0.102714
LOG(CD)	-0.415142	-4.902255
IOU	0.285292	3.914014
Constant	7.222538	11.82925
R-squared	0.846171	

The model was estimated by OLS method with White Heteroskedasticity-Consistent Standard Errors and Covariance. As is suggested by most of the previous empirical studies, customer density (CD) variable in the equation has an expected sign and is significant at conventional levels. The negative sign of quantity distributed (Q) confirms our suggestion that there is an economy of scale in the sector. On the other hand, while having the right influence on the cost, the load factor variable (LF) is insignificant at conventional levels. One possible explanation could be due to the fact that peak demands are often not met by the companies as already mentioned.

Privatized companies seem to be less efficient that the state owned. The choice of companies to be privatized in 1998 was likely not random; these companies were by far not the worst companies (rather the opposite was true). The DEA results (as will be discussed later) presented in this and other studies provide however mixed results as for the privatisation influence. One should also note that the second waive of privatized companies (6 total) is not included, since they were privatized in the middle of the year 2001.

Potential weakness of the model

The author admits that the model could be extended to test the influence of other relevant variables: for example, Filippini and Wild (1999) have 12 explanatory variables, including the time trend and squared output. However, the small sample limitations do not allow such an extensive investigation.

There are two reasons why the panel data was not used in the current study. The major challenge is the comparability of the Ukrainian quantitative data across time periods. The comparison will often be inadequate due to first, changes in accounting rules that were implemented in 2000 and, second, due to certain difficulties calculating an inflation index for labour and capital costs in the energy sector. The second major difficulty is missing data for some of the companies (which in principle could be made available in the future).

DEA Estimation

Some of the main advantages of DEA is that no functional representation of the efficiency frontier is necessary and estimation of a model with several outputs is possible. Furthermore, input qualitative information is often readily available to regulators. An economic qualitative analysis of efficiency thus provides a very useful dimension for the overall company performance. One of the possible weaknesses of DEA, stemming from its deterministic nature, is that it does not capture the data noise. Hence researches implicitly assume good data quality.

There is no generally accepted DEA model specification for the electricity distribution activity in the empirical literature at the moment. Jamasb and Pollit (2001) mention about a dozen of electricity distribution and generation models that were estimated by DEA. A considerable diversity in models is further complicated by the fact that inputs and outputs are sometimes used interchangeably. One explanation is that the DEA modelling in the electricity distribution does not have a long enough history to come up with one generally accepted set of input/output variables. Another explanations is that the authors consciously want to emphasize various aspects of the activity despite a danger of some misrepresentation or bias. Finally, data limitations can indeed narrow considerably a researcher's choice of a model.

Ukrainian DEA Model Specification

The variables that are used for the efficiency analysis are divided into three categories: inputs variables (ones used in the activity), outputs (results of the activity) and the environmental (exogenous) variables that help to account for the heterogeneity present across companies. Most of the models applied toward electricity distribution activity are input-oriented models because the main output (electricity distributed) is exogenous to the companies. Hence the company managers are left with inputs (cost) minimization as the major feasible area of the efficiency enhancement. The resulting efficiency scores can therefore be interpreted as the inputs utilization efficiency given the outputs.

The model specification used in the study directly follows the one used by the London Economics in an international benchmarking study of the New Zealand electricity distributors.

Table 2. DEA Model Specification

Inputs	Outputs
Operating costs of electricity distribution (mln UAH)	Total electricity distributed (GWh)
Total line length (pole kilometres)	Peak demand (MW)
Total transformer capacity (MVA)	Total number of customers

The specification is quite parsimonious and at the same time is capable to serve as good illustration of a DEA applied in electricity distribution. The following output variables were taken: total amount of electricity distributed (Q), peak demand (PEAK) and the total number of customers (CUST) (for statistical description of the variables see Appendix E). Indeed, it is in the nature of electricity distribution business that the output is exogenous to the companies, though a certain degree of demand side management is possible. Ultimately, companies in Ukraine cannot manipulate output without the consent of the three groups – the state as represented by NERC, consumers and, to some extent, electricity generating companies. Finally, the peak demand is considered to be another output variable for which the company requires resources.

Some of the major input variables in the business are the number of employees, the network size (TL) and the transformer capacity (TC). However, it should be noted that managers cannot and have no sense to decrease some of these inputs in the short run. While labour lay offs are quite possible and desirable, it is difficult and not reasonable to react to a demand fall in electricity consumption by getting rid of, say, electricity lines. Hence, it should be noted that the management efficiency is not necessarily estimated here, because of the existence of non-discretionary inputs.

Operating costs (OPEX) can be influenced by firms to some extent and thus it is possible to capture possible manager inefficiency. It is assumed that all oblenerogos face the same price (i.e., labour heterogeneity is assumed). In international benchmarking studies (for example, in the one done for the Dutch regulator) labour cost normalizations are usually performed.

Another set of variables that has to be included in estimation of efficiency is the control or environmental variables – factors that influence efficiency but are exogenous to the firms. In electricity distribution business, the most often considered environmental variables are the customer number and structure (residential, commercial and industrial), line structure (cable/overhead), other activities performed by the companies (electricity supply[27], generation) and customer or line density. All of these factors may have different and sometimes significant cost implications for the companies.

It is also very possible that a rich diversity in DEA model specifications found in the literature is attributable to bringing environmental forces into play. This has to do with a practice of including environmental variables as inputs or outputs. Coelli et all (2002) has a discussion on a number of alternative methods for adjusting for various environments. One of such methods is to include the

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[27] The challenge of incorporation of both distribution and supply activities of one company has not been tackled to my knowledge in any research yet. The main difficulty is the problem of discrimination between the different activities with the same good.

environmental variable as a (non)-discretionary input/output when a direction of its influence is known. Due to the limiting nature of the software available to the author, however, some of these inputs will be included as discretionary inputs, i.e. inputs that companies may minimize. However, in reality, some of them are often non-discretionary (the network length) - at least in the short run.

Another simplifying assumption of the model is that of identical quality of provided service. As it was noted by Pardina et all (1999), the omission of the quality of service variables may for example cause some firms to appear with lower costs and thus more efficient. Instead I have assumed that the quality is the same across the companies and thus outputs are comparable in that sense. One reason is that the indicators of service quality are not yet developed by NERC and those available have very questionable usefulness[28].

The DEA Model Setup

Total number of companies is K, inputs are represented by the N x K matrix X, $X \in {}_{+}R^{N}$ and outputs by the M x K matrix $Y \in {}_{+}R^{M}$; all X and Y belong to the technology set: $(x^k,y^k) \in T$, for all k=1…K.

The DEA linear programming problem is then represented by[29]:

Min $_{\theta,z}\ \theta$, subject to : $Yz \geq y^k$, $Xz \leq \theta x^k$, $z \geq 0$ (alternatively, for the variable returns to scale (VRS), another condition $\Sigma^k z=1$ is added).

Both constant returns to scale (CRS) and variable returns to scale (VRS) DEA models were estimated to check for the scale efficiencies. CRS assumption applies

[28] Regional offices of NERC do receive some feedback from the customers on the company operation. However, it is very likely that different regions have varying levels of awareness of these offices existence. Further, it is impossible yet to classify the customer reaction and thus the pure number of such calls is meaningless as a proxy of service quality.

[29] Coelli et all (2002).

to cases when it is known that companies are operating at an optimal scale[30]. On the other hand, by assuming VRS it is possible to determine the scale efficiencies of the firms. In general, the efficiency scores under CRS and VRS are and internally consistent (as can be seen in Table 3 and Appendix F Table) – the score rankings of the companies is preserved with minor exceptions for the individual scores.

The companies were further grouped according to the ownership status to enable comparisons of ownership form effect. The first group "SOE" includes 14 state owned companies, the second group "UA" includes companies owned by the Ukrainian financial group, the group "US" includes companies owned by the U.S. investor, the "SLOVAK" group - companies owned by Slovak investors and "OD" is an offshore company. In all cases the owners have a control share of the company stocks - 51% being the minimum and 100% the maximum. The U.S. and Slovak investors bought the companies in April 2001. The companies belonging to the UA group and the offshore owner were privatized in 1998.

Parallel to this work, another benchmarking study of Ukrainian electricity distributors (with the same data set used) was conducted. In the unpublished paper by Tsaplin et all (2003) two DEA models were estimated[31]:

	Model 1	Model 2
Inputs	Operating costs (distribution), thousand UAH	Electricity input, MWh
		Operating costs (distribution), thousand UAH
		Transformer capacity, MVA
		Network length, thou. km
Outputs	Electricity delivered, MWh	Electricity delivered, MWh
	Number of customers	Number of customers
	Network length, thou. km	

[30] Op. cit.

[31] Two city-based companies were omitted from the sample on the grounds of preserving homogeneity.

The results of these models and their comparability with the findings of the current research will be discussed later in the text.

Empirical Results of DEA Benchmarking

The calculated individual efficiency scores of the companies for the time period of the study are provided in the Appendix. F. However, the companies presented differ both in size, in particular, in the amount and proportions of inputs they use. Hence, in order to enable reasonable comparisons between the efficiency scores of different ownership groups, these individual scores were aggregated.

The aggregation methodology of technical efficiency scores was taken from Fare et all (2002). The company individual input weight ω was calculated in the following manner:

$$\omega^k = \frac{1}{N}\sum_{n=1}^{N}\frac{x_{kn}}{\sum_{k=1}^{K} x_{kn}}$$

where, as specified before, k stands for the company, x for the input and N for the total number of inputs. The next step is to calculate the aggregate technical efficiency (TE) scores: $TE=\Sigma^K F_i(y^k,x^k)*\omega^k$ (both for a given ownership group and for the industry), where F(.) is an input oriented efficiency score for a given company. The obtained scores are presented in the Table 3 below.

Table 3. DEA Model Aggregated Efficiency Scores (CRS and VRS) for the Years 1999-2002.

YEAR	**1999**		**2000**		**2001**		**2002**	
Ownership Group (# of companies)	CRS	VRS	CRS	VRS	CRS	VRS	CRS	VRS
SOE (14)	0.856	0.898	0.883	0.908	0.862	0.874	0.849	0.876
UA (5)	0.827	0.866	0.808	0.840	0.845	0.861	0.858	0.885
SLOVAK (4)	0.704	0.725	0.680	0.694	0.702	0.707	0.698	0.712
US (2)	0.721	0.751	0.727	0.750	0.752	0.763	0.762	0.781
OD (1)	0.962	1.000	0.939	1.000	0.891	0.915	0.870	0.930
AVERAGE (26)	0.830	0.857	0.835	0.847	0.841	0.868	0.832	0.870

Once the aggregation was conducted it is now possible to compare the scores and draw the conclusions.

C h a p t e r 4

DISCUSSION OF THE RESULTS

A regulator can draw several conclusions from the presented DEA model results. First, the year 2000 was a trough year in the industry – average efficiency plummeted and then picked up the next year (similar results that are not presented in the paper were obtained by calculating Malmquist indices for the same model specification). There is also an indication of an overall positive trend for efficiency change with OD being one exception: its relative efficiency scores were steadily declining over the study period. Finally, the regulator can identify scale factor importance for each individual company.

Also, we may note that the state owned companies are on average more efficient than the privatized ones (as also was seen in the previous econometric estimation results). While this model results suggest that the ownership form may be not the reason, since for example the Slovak group companies were the least efficient prior to their privatization as well, some results of DEA modelling in Tsaplin et all (2003) suggest that the change of ownership of oblenergos has in fact an influence on the efficiency. This implication, however, is sensitive to the model specification and thus has to be further studied. It was however also found that the privatized companies do sometimes maximize profits by being truly efficient in Ukraine – the electricity losses were sufficiently reduced after the ownership change took place[32].

[32] Op cit.

Besides the efficiency scores for the ownership groups, individual performance is of course also of interest for the regulatory body. Individual performance can be benchmarked to the industry trend and sources of inefficiency identified and addressed. The DEA modelling is therefore a useful tool for diagnosis. Further enquiry and research has to follow: for instance, the financial information (debts, receivables) has to be taken into account as well. Odessaoblenergo (OD) that has very good relative efficiency scores was nearly bankrupt in 2002, while its drop in efficiency in 2001 is explained by severe losses brought about by the climate cataclysms in the region. Finally, though the state-owned companies were shown to be the most efficient in the sample, it is always possible to find a superior benchmark (western counterparts?) and strive for further improvement.

Chapter 5

CONCLUSIONS AND IMPLICATIONS

Though ownership efficiency estimation is not the primal goal of the benchmarking study (neither the main goal of this paper), it is a good illustration of the results that could be obtained from benchmarking and of possible research questions that interested parties can pursue. Within the scope of this study, it is possible to note that one the one hand, managers in privatized companies are not passive and indifferent as it relates to enhancing their company's efficiency; rather they are concerned that the resulting profits of investors are maximized. Therefore, when the profit maximization is not conditioned on cost minimization, it is natural that efficiency is not likely to be sufficiently improved.

NERC can be partially blamed for the lack of providing due incentives. Recently, one of the companies of the U.S. group (regulated via RORR) came for a tariff resetting. After one year of operations, the company managed to reduce operational expenses. The regulator responded by exact reduction of the cost without any reward for efficient operation[33]. It is therefore very likely that this company will not have any incentives to economize on costs in the future (as it is the case with other companies that have a longer experience of cooperation with the regulator). A good regulatory framework and a good will of the regulatory commission are indeed crucial to effective regulation.

[33] The reasons mentioned by NERC for its decision were: an allegedly insufficient level of investments by the owner and presumably high existing tariffs. Some observers say though that the political reasons were key.

NERC is advised not to destroy incentives to minimize costs for the privatized companies regulated by the ROR method. This is of course a complex issue, since there is often the conflict of interest - NERC has obligations before the society to ensure fair tariffs and the quality of service, and before the strategic investors – to grant fair returns; some environmental factors such as the regulatory capture may of course complicate things. Finally, an issue of the regulatory lag ought to be resolved - the companies should have a sufficient time to reap the benefits of the cost minimization.

In the future, NERC should continue the development of the benchmarking approaches of assessing the company efficiency (at the initial stage this could be simple partial or weighted average performance indicators). One of the potential spillover effects of such benchmarking practice will be a greater degree of transparency so vital in the electricity sector. Regular accounting audits are to be conducted - not only in the state owned companies but also in the privatized companies due to existing corporate governance problems.

The potential of economic research and its results in electricity regulation is immense: the current research could be further enhanced in a number of ways. First, while stochastic frontiers have certain computational difficulties, as it was outlined before, the work in this direction should be attempted with a considerable effort spent on composing industry price indices and cost data decomposition and verification. The models developed in this paper can also be used as a background for financial benchmarking. For instance, in RORR it is crucial to determine the rate base for the company, therefore, the regulator can benchmark financial figures to set reasonable targets.

Finally, the learning by benchmarking process will create the ground for further regulatory reforms, in particular, price cap method application. This will mean nothing but a big leap into the "capitalist" future of Ukrainian regulation.

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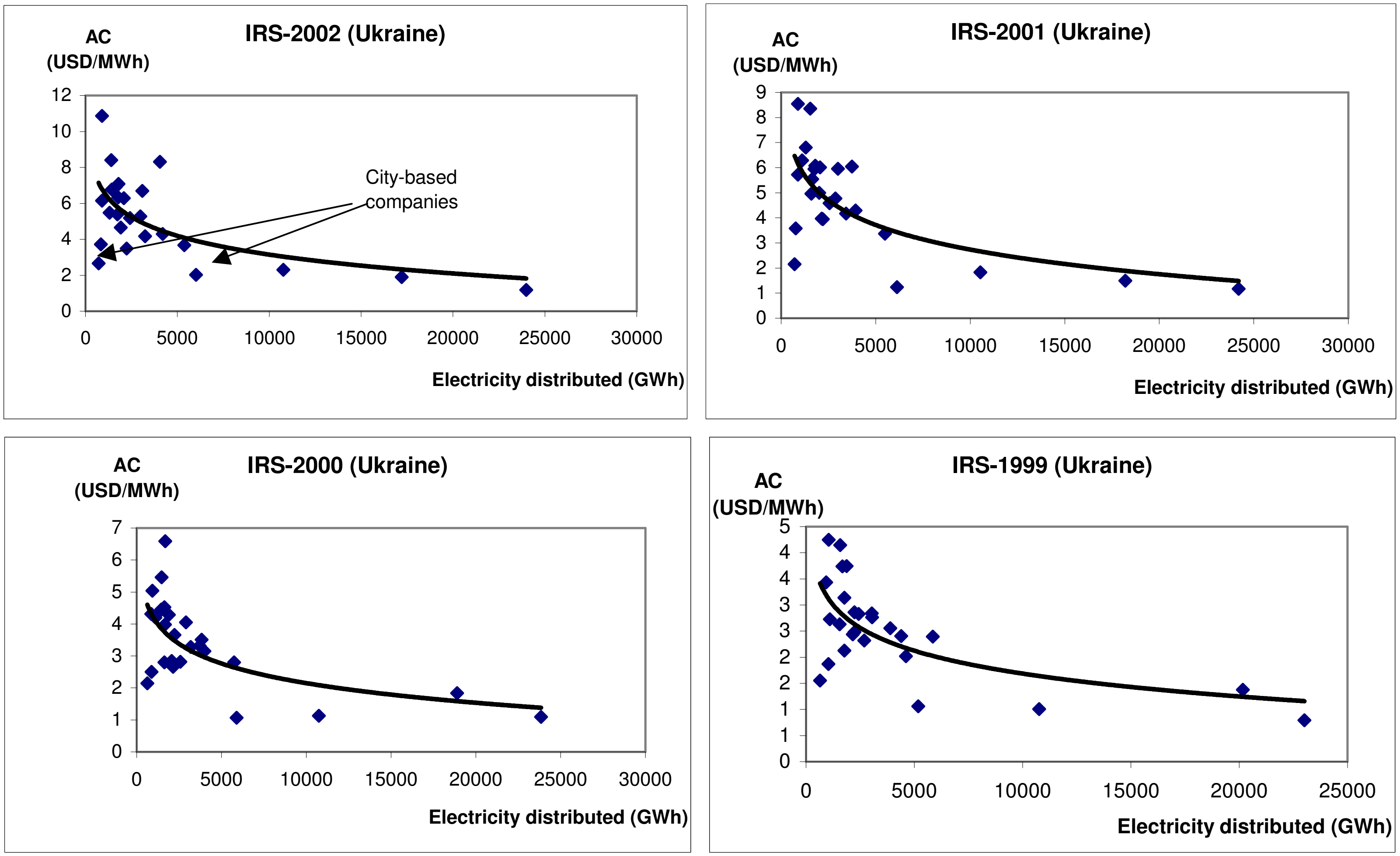
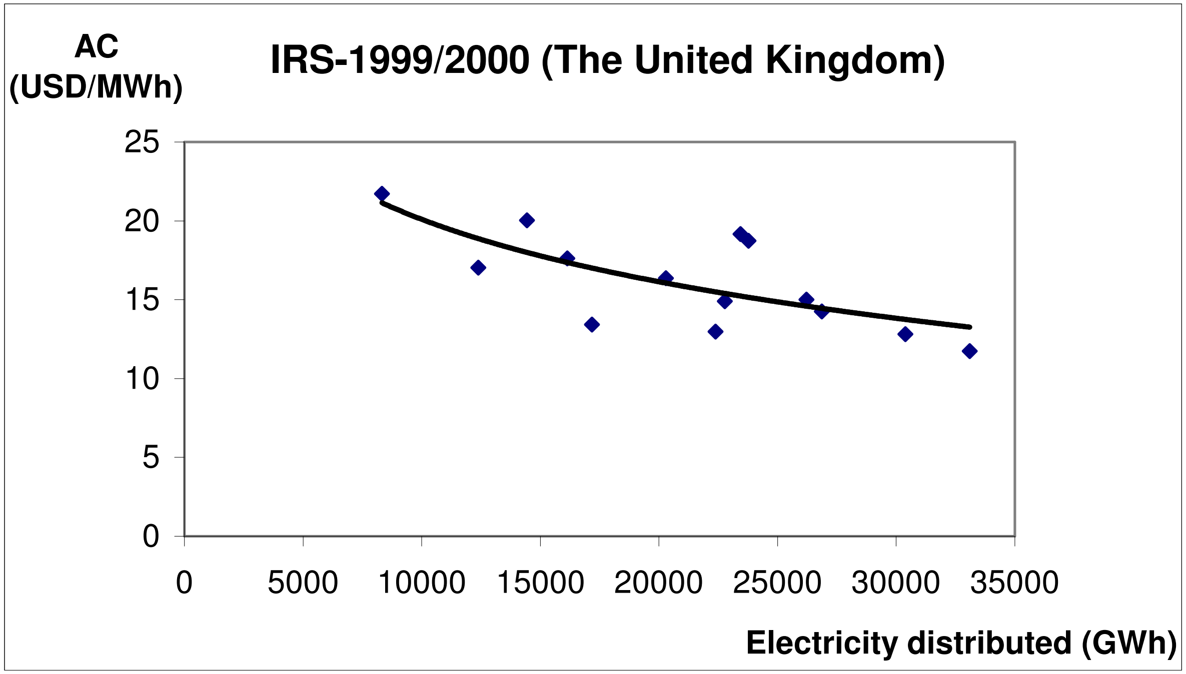
Appendix A. The Decreasing Average Cost Curve of Electricity Distribution[34]



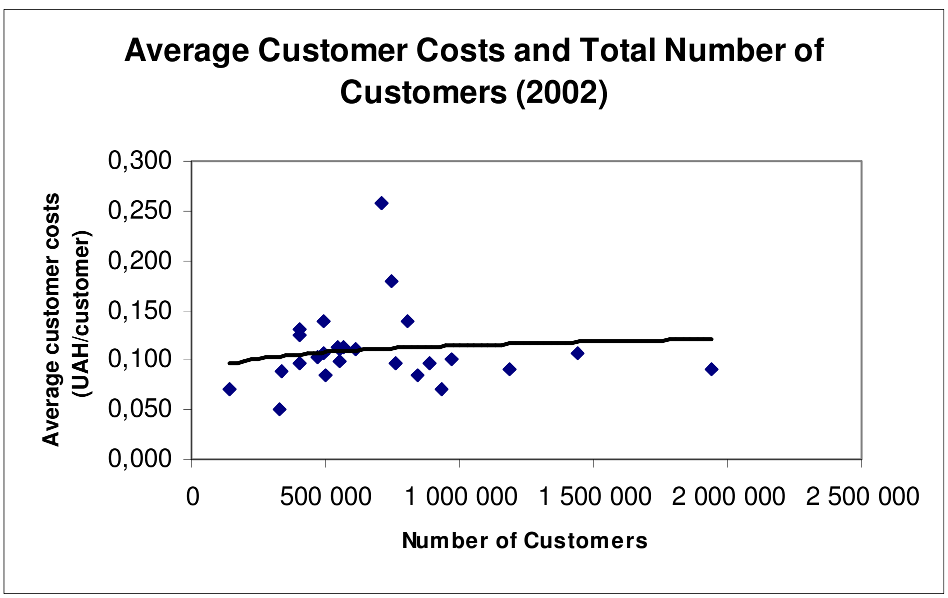
[34] There are total 26 Ukrainian electricity distributors represented on the graphs. One regional company (Luganskoblenergo) is omitted from the graph on the grounds discussed before; if included, it fits the trend well. The data for the UK distributors were taken from the unidentified magazine printout.


AC
(USD/MWh)
IRS-1999/2000 (The United Kingdom)
25
20
15
10
5
0
0
5000
10000
15000
20000
25000
30000
35000
Electricity distributed (GWh)

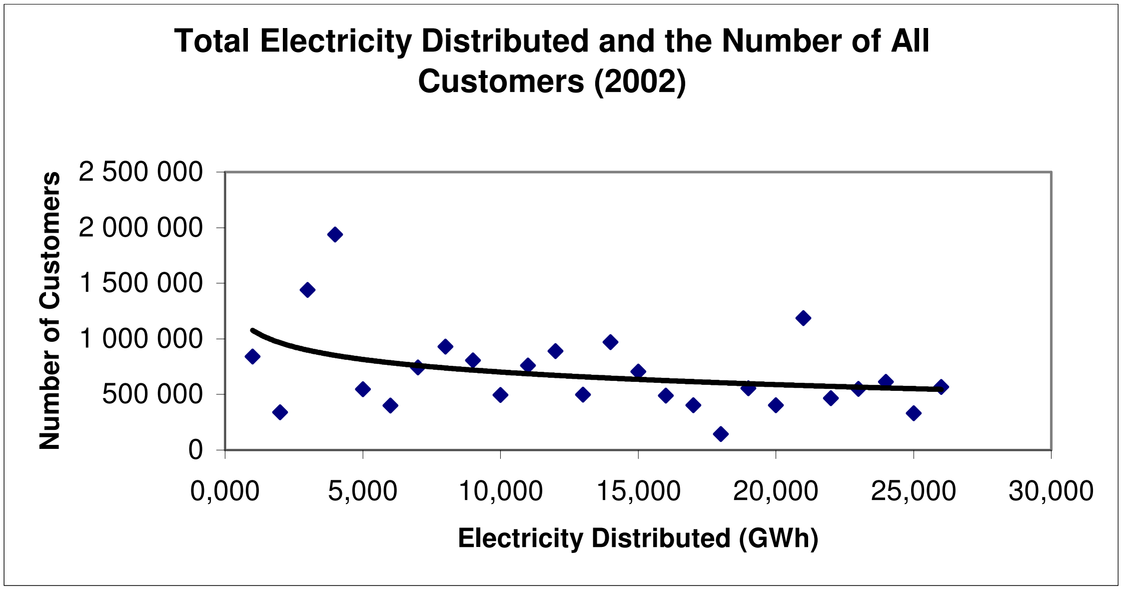
Appendix B. Industry Trends

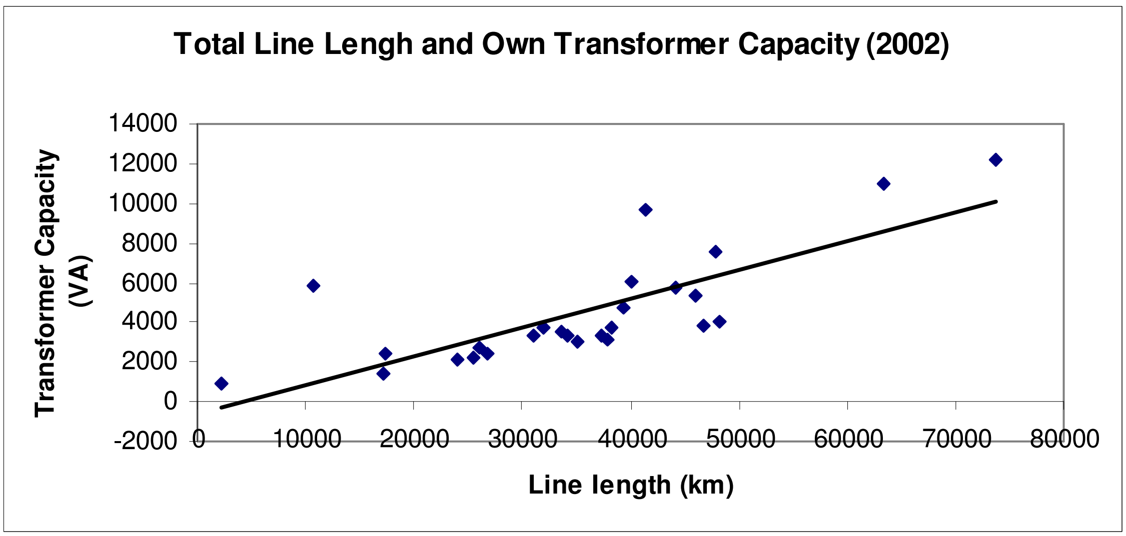
Total 26 companies	Sum for the year				
Variable	**2002**	**2001**	**2000**	**1999**	**1998**
Number of residential customers	17432722	17291349	17278119	16996855	15676417
Number of non-residential customers	585608	597087	639509	588550	na
Number of customers	18018330	17888436	17917628	17585405	na
Electricity distributed (GWh)	105503	106591	107570	110672	115079
Electricity supplied (GWh)	100106	99692	82897	80067	86760
Total transformer capacity (MVA)	117448	116441	116238	118225	117977
Total line length (pole km)	919775	923945	933189	936281	937247
Average number of employees	101416	98421	91934	88344	88387
Normative[35] number of employees	117926	110514	104276	104686	108834
Max (peak) demand a day (MW)	24428	24246	22296	22050	na
Min demand a day (MW)	11698	10962	10457	11354	na
Difference in a peak demand volatility	12730	13284	11839	10696	na

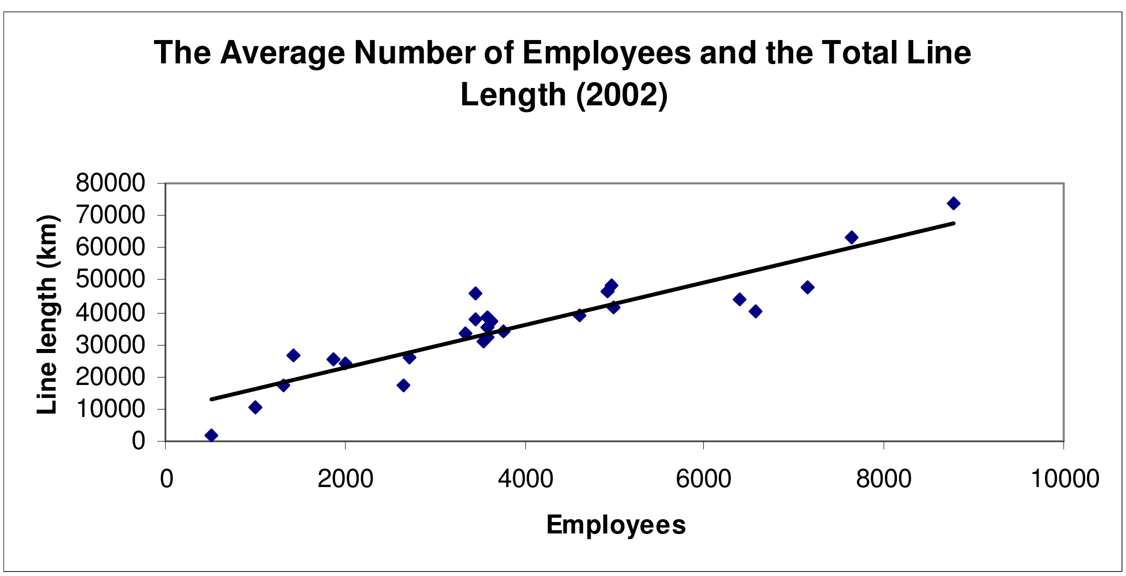
Appendix C. Partial Benchmarks



[35] "Normative" -as set by the Ukrenergopratzya institute.


Total Electricity Distributed and the Number of All Customers (2002)
Number of Customers
2 500 000
2 000 000
1 500 000
1 000 000
500 000
0
0,000
5,000
10,000
15,000
20,000
25,000
30,000
Electricity Distributed (GWh)


Total Line Lengh and Own Transformer Capacity (2002)
Transformer Capacity (VA)
14000
12000
10000
8000
6000
4000
2000
0
-2000
0
10000
20000
30000
40000
50000
60000
70000
80000
Line length (km)


The Average Number of Employees and the Total Line Length (2002)
Line length (km)
80000
70000
60000
50000
40000
30000
20000
10000
0
0
2000
4000
6000
8000
10000
Employees

Appendix D. Econometric Model Data Description (year 2001).

Statistic	Q	AC	PL	LF	CD	IOU
Mean	4099.653	25.30496	46.58356	0.434720	77.42256	Total of 6 privatized companies (the first 1998 waive).
Median	2102.146	26.27463	6.064908	0.402390	28.57260	
Maximum	24199.45	46.15754	847.7439	0.741609	1145.626	
Minimum	715.9420	6.350309	4.406026	0.283419	16.44619	
Std. Dev.	5519.316	10.77356	165.7744	0.107757	219.6606	
Skewness	2.645630	-0.138845	4.595550	1.014430	4.681481	
Kurtosis	9.208345	2.508382	22.69866	3.808890	23.26859	
Jarque-Bera	72.08607	0.345366	511.8897	5.168127	540.0207	
Probability	0.000000	0.841404	0.000000	0.075467	0.000000	
Observations	26	26	26	26	26	26

Q	Electricity Distributed, GWh
AC	Average distribution costs, UAH
PL	Price of Labour -total labour costs divided by the total number of employees)
LF	Load factor (average demand divided by the peak demand)
CD	Customer density (number of customers per sq.km)
IOU	Dummy: 1 if privatized, 0 otherwise

Appendix E. DEA Model Data Description (Year 2001).

Statistic	Q	CUST	PEAK	OPEX	TL	TC
Mean	4057790.	518223.7	939.5385	75898.65	35376.04	4517.192
Median	1999674.	496327.0	617.5000	64507.00	36212.00	3658.000
Maximum	23990337	1938162.	4106.000	181695.0	73658.00	12222.00
Minimum	712883.0	1.000000	204.0000	10266.00	2148.000	877.0000
Std. Dev.	5400473.	455775.4	931.6325	44561.52	15203.31	2837.180
Skewness	2.645355	1.254155	2.195908	1.003497	0.211724	1.373751
Kurtosis	9.320036	5.104924	7.304232	3.338683	3.664095	4.194926
Jarque-Bera	73.59567	11.61585	40.96566	4.487958	0.672025	9.724668
Probability	0.000000	0.003004	0.000000	0.106036	0.714614	0.007732
Observations	26	26	26	26	26	26

Q	Electricity Distributed, GWh
CUST	Total number of customers
PEAK	Peak Demand, MW
OPEX	Operating costs, UAH
TL	Total line length, pole km
TC	Own transformer capacity, VA

Appendix F. Oblenergo Individual Efficiency Scores as Calculated by DEA.

Company	2002		2001		2000		1999	
	CRS	VRS	CRS	VRS	CRS	VRS	CRS	VRS
Vinnitsaoblenergo	0.96	1.00	0.98	1.00	0.94	1.00	0.90	1.00
Volynoblenergo	0.67	0.67	0.67	0.67	0.65	0.65	0.67	0.67
Dniprooblenergo	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Donetskoblenrgo	0.97	1.00	1.00	1.00	1.00	1.00	0.90	1.00
Zhytomiroblenergo	0.74	0.76	0.72	0.73	0.69	0.72	0.71	0.76
Zakarpattyaoblenergo	0.85	0.85	0.84	0.84	0.82	0.82	0.83	0.83
Zaporizhyaoblenergo	0.64	0.64	0.66	0.67	0.95	0.96	0.84	0.85
Kyivenergo	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Kyivoblenergo	0.74	0.77	0.74	0.75	0.72	0.75	0.71	0.75
Kirovogradoblenergo	0.66	0.67	0.68	0.68	0.66	0.67	0.68	0.69
Krymoblenergo	0.67	0.73	0.68	0.68	0.66	0.67	0.68	0.69
Lvivoblenergo	0.92	0.97	0.93	0.96	0.90	0.95	0.92	0.96
Mykolaivoblenergo	0.76	0.79	0.81	0.81	0.72	0.73	0.72	0.73
Odesaoblenergo	0.87	0.93	0.89	0.92	0.94	1.00	0.96	1.00
Poltavaoblenergo	0.90	0.93	0.87	0.88	0.84	0.87	0.90	0.94
Prykarpatyaoblenergo	0.85	0.86	0.84	0.85	0.79	0.81	0.80	0.81
Ryvneoblenergo	0.81	0.81	0.78	0.78	0.74	0.74	0.75	0.75
Sevastopolmiskenergo	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Sumyoblenergo	0.77	0.79	0.77	0.78	0.74	0.77	0.74	0.78
Ternopiloblenergo	0.84	0.85	0.83	0.84	0.82	0.83	0.83	0.87
Kharkivoblenergo	0.82	0.92	0.84	0.91	0.84	1.00	0.84	0.90
Khersonoblenergo	0.65	0.65	0.66	0.66	0.63	0.64	0.68	0.68
Khmelnitskoblenergo	0.79	0.82	0.82	0.83	0.77	0.80	0.81	0.87
Cherkasyoblenergo	0.77	0.80	0.77	0.78	0.74	0.77	0.77	0.81
Chernivtsyoblenergo	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Chernigivoblenergo	0.80	0.82	0.79	0.80	0.73	0.76	0.73	0.79