

DEREGULATION OF ELECTRICITY DISTRIBUTION MARKET IN SLOVENIA

Štefan Bojnec and Drago Papler
University of Primorska, Slovenia

E-mails: stefan.bojnec@fm-kp.si; drago.papler@elektro-gorenjska.si

Abstract

Deregulation and liberalization of electricity distribution markets are expected to encourage greater competition to reduce sources of economic inefficiency. The electricity market in Slovenia was regulated by government control of prices, but has been gradually deregulated. We analyze factors of production, market structures and costs, and pricing to explain main development patterns in electricity distribution. We apply four analytical models, which are econometrically tested using time series data: production function, cost function, price function and demand function. The estimated production functions indicate increasing returns to scale in the Slovenian electricity distribution output that is explained by labor and capital. Labor productivity is associated with capital intensity and particularly with human capital. The estimated cost functions show that real cost changes are caused by internal factors in electricity distribution enterprises, particularly by wages and amortization. Yet, the estimated price functions suggest the crucial role of purchase electricity price on consumer price determination. These mean that both cost-push factors inside enterprises as part of margin and input-output price transmission are crucial factors for consumer price determination within gradually deregulated electricity markets. Greater economic impacts on household demands are expected with further and complete liberalization and deregulation of the Slovenian electricity markets.

Key Words: *Electricity market, deregulation, competition, Slovenia.*

1 Introduction

Market structures and market mechanisms in the electricity distribution system differ between countries. In Europe there is a tendency to create a Single European electricity market (e.g. Bowen 2004). Its deregulation should encourage a greater competition to reduce sources of economic inefficiencies, which are caused by different regulative intervention policies and persistent market power. The changes of the agreements on trade and distribution of electricity energy, deregulation and liberalization of electricity market to improve mechanisms for allocation of resources and reduction of impediments in lines for distribution of electrical energy are questions, which are also important for the Slovenian market of electrical energy. The deregulation of distribution markets for electrical energy is expected to lead to an increase in the number of competitors and thus to a further increase in competitive market pressures.

Electricity consumption is often used as an approximation of the level of economic development of a certain country. As a part of energetic it represents a significant component of economic infrastructure. The European electricity sector has entered into restructuring during the last fifteen years. Deregulation and liberalization of previous

monopolistic structures aim to increase efficiency of electro-energetic enterprises and to reduce prices of electrical energy for final consumers. In the European Union (EU), the Directive 96/92 EC (OJ 1997) introduced gradual liberalization and deregulation of certain activities of electricity market. The aim is to create competitive market with electrical energy with free choice of suppliers and with removed barriers for cross-border trade to improve economic efficiency of the sector with gains for consumers in the commercial sector and for households through lower prices and better quality of services (EU-Commission 2003).

In 1999, Slovenia introduced the first step towards liberalization of energy markets. On 15 April 2001 the electricity distribution market was liberalized, while for households it is still under the government control. In 2003 the deregulation has continued in direction of small- and medium-sized industrial users. Since 1 July 2004 all non-households' consumers of electricity energy can freely choose suppliers. This increases liberalization of electricity market up to 75%. Electricity prices for households remain under the government control, which should be abolished on 1 July 2007. At that time the electricity markets in Slovenia should be completely liberalized and deregulated.

We first compare electricity prices in selected EU countries and after then we briefly present market structures and price formation in the Slovenian electrical energy distribution system to provide theoretical basis for econometrically applied four analytical time series models: production function, cost function, price function and demand function. Final section derives main conclusions and policy implications.

2 Levels and dynamics in electricity prices

2.1 *Cross-country's electricity price comparisons*

With liberalization of internal electricity market there is increasing window of opportunities for large non-households' users to choose suppliers. We aim to compare Slovenian prices across EU countries to see possible similarities and differences in price levels. Prior to November 2001 electricity prices in Slovenia were fixed by tariff structures. After then electricity prices are set by bilateral negotiations and contracts. With the introduction of this approach in electricity price formation, the evidence for about two-third of electricity transactions is hidden. For this reason the Statistical Office of the Republic of Slovenia (SORS) has introduced EU comparable questionnaire for electricity distribution enterprises to collect electricity prices for a large users (Suvorov 2004). Electricity prices are recorded for different users depending on use, connected power and hours of use. The Statistical Office of the EU (Eurostat) publishes electricity prices for its members twice a year in the publication *Statistics in Focus, Environment and Energy*. This data allows comparisons of electricity prices across EU countries (Table 1).

In January 2004 the Slovenian Ig price for users in industry with annual consumption 24,000 MWh was at 89% of the average EU weighted price with taxes. After the EU enlargement (in June 2004) this Slovenian price was 85% of the average EU-25 weighted price. For Slovenia relevant is particularly comparison of electricity prices with neighboring countries. In Austria basic Ig price is 24 percentage points less, but in

Italy 31.6 percentage points greater than the average EU weighed price. Taxes can be important factors for electricity prices. Due to higher taxes the final price in Austria is 4 percentage points and in Italy 29.7 percentage points, greater than the average EU weighed average. In Germany, basic Ig price is 13.8 percentage points greater and with taxes 21 percentage points greater than the final average EU price.

Table 1: Electricity prices for industry (Ig prices) and households (Dc prices) in selected European Union countries (1 January 2004, in SIT/kWh)

	Industry (Ig) prices			Household (Dc) prices		
	Ig without tax	Ig with tax	% of tax	Dc without tax	Dc with tax	% of tax
Slovenia	12.43	14.91	20	19.97	23.96	20
Belgium (Brussels)	13.73	17.00	24	27.10	33.66	24
Denmark	...	...	...	21.66	53.54	147
Germany	14.61	20.31	39	29.80	40.19	35
Greece (Athens)	12.50	13.49	8	14.70	15.88	8
Spain (Madrid)	11.48	14.01	22	20.95	25.54	22
France (Paris)	10.77	14.16	31	21.42	27.67	29
Ireland (Dublin)	15.79	18.39	16	24.97	29.73	19
Italy	16.90	21.78	29	33.94	46.16	36
Luxemburg	9.82	10.82	10	28.76	32.31	12
Netherlands	...	...	...	24.40	43.25	77
Austria	9.75	17.52	80	23.22	33.52	44
Portugal (Lisbon)	14.46	15.20	5	30.37	31.96	5
Finland	12.02	16.00	33	19.17	25.54	33
Sweden	10.53	13.18	25	21.26	34.09	60
United Kingdom	9.07	11.15	23	19.81	20.78	5
Average EU, simple	12.42	15.62	26	24.10	32.92	37
Average EU, weighted	12.84	16.79	31	24.32	32.10	32

Source: Eurostat (2004). Exchange rate 1 Euro is 236.71 SIT.

In January 2004, the retail electricity price for households with an annual consumption 3.500 kWh (consumer group Dc, which is close to an average Slovenian household) was 23.96 SIT/kWh. This is less than 75% of the average EU weighted retail price. After Slovenia entered into the EU, in June 2004, it was 79% of the average EU-25 weighted retail price. The Slovenian price is less than similar price in Austria and particularly less than in Italy or in Germany (Papler 2005, 67-69).

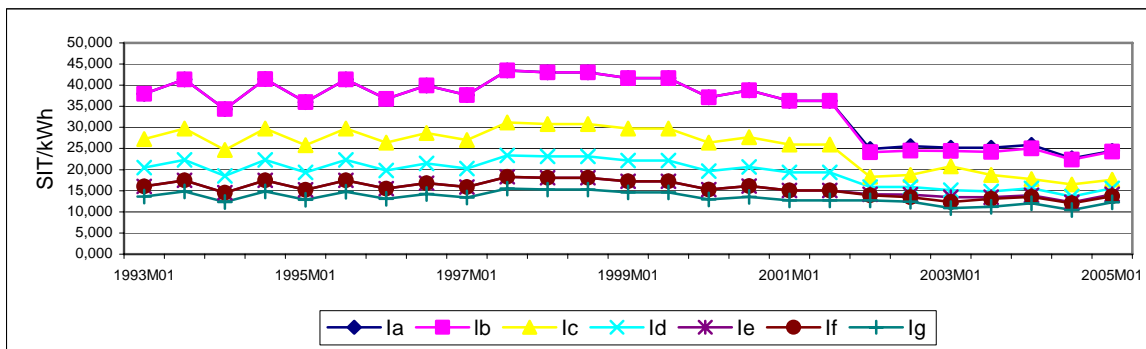
2.2 Dynamics of electricity prices in Slovenia

In 2004, electricity supply in Slovenia was from three main sources: thermo-energy (34%), hydro-energy (27%) and nuclear power (39%). In the structure of demands are two main groups: large enterprises on 110 kV network (aluminum, fertilizer and some other heavy industry factories) (32%), and the distribution enterprises of electrical energy (78%). In Slovenia are five regional distribution enterprises with the headquarters in Celje (market share 19%), Kranj (10%), Ljubljana (37%), Maribor (20%) and Koper (14%). They are suppliers to commercial users and households. Annual electricity consumption is more than 12.43 billion kWh. The dynamics in

electricity prices in Slovenia are analyzed by industrial users (Figure 1) and by households (Figure 2), respectively.

Between the period January 2001 and January 2005, real electricity prices for industrial users more rapidly declined for the smaller users with annual consumption 50 MWh (prices Ib) by 19.3%. During the same period, electricity prices for medium-sized users with annual consumption 24,000 MWh (prices Ig) increased by 16.6%. After price liberalization real electricity prices for industrial users have declined by 33.1% for Ib users and by 3.4 for Ig users.

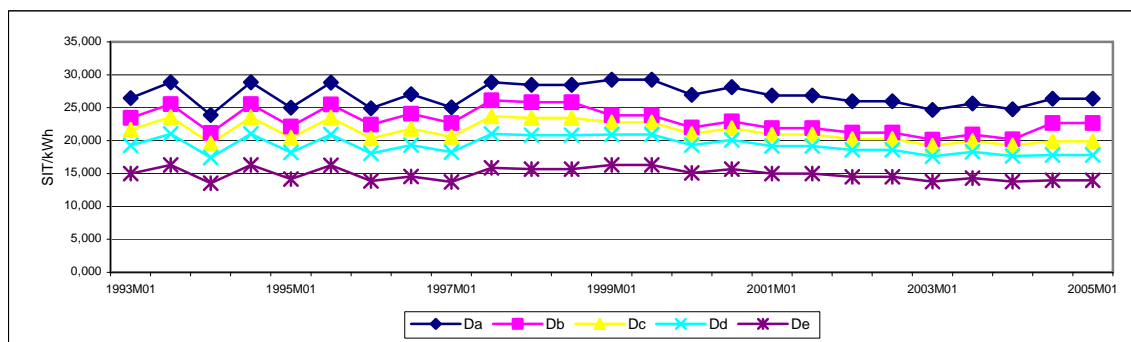
Figure 1: Real electricity prices for industry in Slovenia, 1993-2005.



Source: Own calculations.

Figure 2 presents real electricity prices for different household users' groups from different distribution enterprises. So far these prices for households explore rather stable development patterns in comparison to real electricity prices for industrial users. This market segmentation between industrial and households' users is less likely to continue in a present form when also electricity prices for households are completely liberalized.

Figure 2: Real electricity prices for households in Slovenia, 1993-2005.



Source: Own calculations.

3 Regression analysis

The previous studies underlined possible economic effects of electricity prices in the Slovenian economy (e.g. Žižmond and Novak 2004). As illustrated in the previous section, liberalization of electricity prices for industrial users causes their declines in real terms. To evaluate causalities between different variables in the electricity markets in

Slovenia, we apply four analytical approaches: production function, cost function, price function, and demand function. The econometric methods are used to empirically estimate the each type of model by using statistical package SPSS.

Data on electricity prices are collected from different sources: from the SORS, from electricity distribution enterprises and from the Agency of Energy of Slovenia. The Electro of Gorenjska is the main source of data obtained from electricity distribution enterprises. The SORS and the Electro of Gorenjska are sources of data for variables, which are used in the regressions.

3.1 Production function

We use Cobb-Douglas type of production function to specify relation between output (Q) and production factors (X_1, X_2, \dots, X_n):

$$Q = \beta_0 x_1^{\beta_1} x_2^{\beta_2} \quad (1)$$

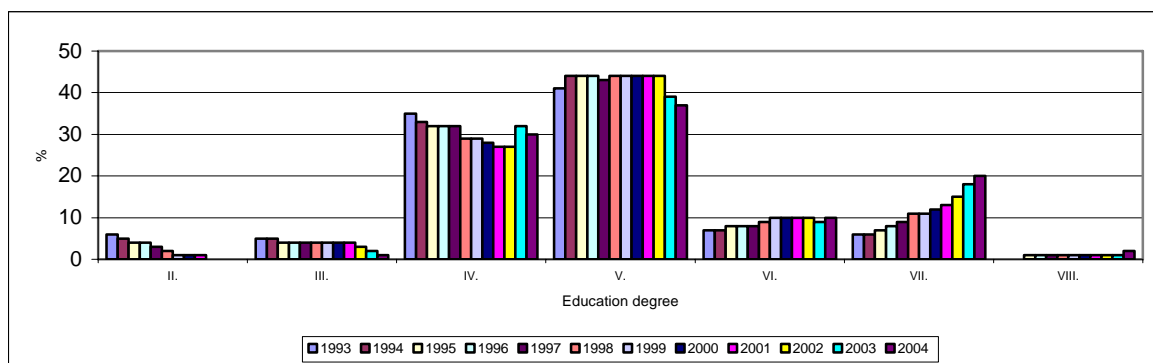
Symbols: Q – variable, which measures level of production,
 β_0 – constant,
 x_1 – variable, which measures use of labor,
 β_1 – coefficient of elasticity of labor,
 x_2 – variable, which measures use of capital,
 β_2 – coefficient of elasticity of capital.

In natural logarithm form, equation (1) is:

$$\ln(y) = \ln(\beta_0) + \beta_1 \ln(x_1) + \beta_2 \ln(x_2) \quad (2)$$

Output (Q) as dependent variable is in empirical estimations measured by total real revenues. Explanatory variables are capital (K) and employment (L). Instead of use of the number of employees, we use also variable of human capital (H), which is expressed by the number of schooling years of all employees in the electrical distribution system. Besides this, we specify production function with labor productivity (Q/L) as dependent variable, which is explained by capital intensity of labor (K/L) and average years of schooling per employee (H/L). In the structure of human capital, the IV and V education degrees prevail (Figure 3).

Figure 3: Human capital by degree of education of employees 1993 – 2004



Source: Own calculations on the basis of data obtained from Electro Gorenjska.

Moreover, intensity in development of electricity infrastructure is included by infrastructure per employee (I/L). The intensity of infrastructure development is measured by investments in automatization and reconstruction of electricity transmission networks (from 10 to 20 kW), transformation stations and distribution centers per employee in the sector.

The impact of human capital is in diffusion of knowledge and in providing basis for introduction of advanced technologies, new organization methods and incentives for research and development. Some of these effects are internalized by the electricity sector, but there are also some other positive spillover effects with positive externalities for society, which can be expressed through higher growth of output. The estimated production function shows the significant role that human capital plays in the increase in labor productivity in the electricity distribution sector (Table 2). The contribution of capital and the contribution of labor to the growth of output in the electricity distribution sector are found significant. The increase in capital and the increase in labor, respectively, lead to the increase in output by the increasing return to scale, which can be explained not only by the increase in these factors of production, but also by some changes in compositions and structures of physical capital and labor over time. This is consistent with the positive and significant role of human capital that is associated to labor, then significant role of physical capital intensity per employee and infrastructure per employee, respectively, play in the increasing labor productivity and efficiency by the increasing returns to scale in the electricity distribution system.

Table 2: Estimated production functions, 1993-2003.

Dependent variable	Constant	ln(K)	ln(L)		R ²	F-test
Q	4.81 (2.36)	0.40 (6.46)	1.57 (3.33)		0.95	80.9
Q/L	Constant	ln(K/L)	Ln(H/L)	ln(I/L)	0.92	43.2
	1.85 (0.95)	0.12 (2.13)	5.39 (9.28)			
Q/L	7.52 (1.37)	0.10 (1.58)	3.01 (1.34)	0.60 (1.10)	0.93	30.0

Q= output, K = capital, L = labor, I = infrastructure, ln = natural logarithm. In the brackets are t-statistics.
Source: Own estimations.

3.2 Cost function

For empirical estimations we use cost function in the following form:

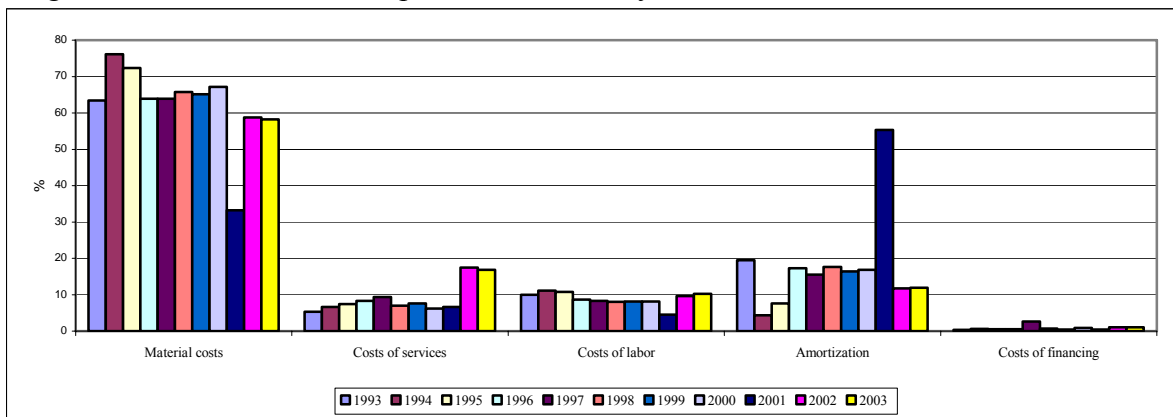
$$C = \beta_0 \prod x_i^{\beta_i} \quad (3)$$

Symbols: C – total costs,
 β_0 – regression constant,
 x – vector of explanatory variables,
 β_i – coefficient of elasticity.

As dependent variable for total costs are used total real expenses. As explanatory variables are used real costs of services (Cs), real costs of labor (Cd), real material costs

(*Cm*), real costs of amortization (*Am*), and real costs of financing (*Cf*). As can be seen from Figure 4, material costs or costs of purchase of electricity energy represent the most significant component in the costs of electricity distribution enterprises. Among costs of amortization, in 2001 there is besides regular amortization included also additional amortization from valuation of some immobile assets, machinery, equipment and similar.

Figure 4: Structure of total expenses in electricity distribution, 1993-2003.



Source: Own calculations on the basis of data obtained from Electro Gorenjska.

The explanatory variables include costs of factors that are arising from economic environment of enterprise. Costs of services measures impacts of prices of services from external suppliers, costs of labor captures impact of wage increases on prices, and costs of financing are used for investigation of impacts of interests rates on electricity prices (see also Žižmond and Novak 2004). Data used are obtained from Electro Gorenjska and from Agency for Public Evidence and Services (AJ PES). The estimated regression results of costs functions are presented in Table 3.

Table 3: Estimated costs functions, 1993-2003.

	Constant	ln(<i>Am</i>)	ln(<i>Cd</i>)	ln(<i>Cs</i>)	ln(<i>Cm</i>)	ln(<i>Cf</i>)	R ²	F-test
ln (total real expenses)	4.64 (0.38)	0.26 (5.74)	0.60 (1.08)			0.03 (0.59)	0.85	13.1
ln (total real expenses)	17.47 (9.52)	0.24 (5.31)		0.04 (0.35)		0.02 (0.24)	0.83	11.1
ln (total real expenses)	17.34 (1.88)	0.89 (5.15)			0.01 (0.06)	0.06 (0.48)	0.82	10.9

ln = natural logarithm. In the brackets are t-statistics.

Source: Own estimations.

The costs of amortization have significant impact on total costs of electricity distribution in Slovenia. The increase of amortization by 1% increases total costs by between 0.24% and 0.89%. As expected, there are also positive impacts of other groups of costs (labor, services, material costs, and financing) on total costs, but association is not significant. While material costs are the most significant in the structure of total

costs, costs of amortization are found as the significant factor in creation of the upward pressures on the total costs increases in the electricity distribution enterprises.

3.3 Price function

In this section, we shift from concepts of production function and cost function to concept of price function. Our initial hypothesis of price formation is described by three explanatory variables:

$$P = f(C_{pur}, C_{tax}, C_w) \quad (4)$$

Symbols: $P = P_{sale}$ – real selling price,

C_{pur} – real purchase price,

C_{tax} – real costs of taxes,

C_w – real costs of wages.

The regression results of price function are presented in Table 4. The selling price (P_{sale}) as dependent variable is expressed by real value of sales (total real value of revenues from sales). The explanatory variables are measured by three variables: real purchase costs of electricity (C_{pur}), real costs of taxes (C_{tax}), and real costs of labor or real costs for wages (C_w). The annual time series data for the period 1993-2004 are obtained from Electro Gorenjska. There is significant and strong association in vertical electricity price transmission through the electricity distribution enterprises, but the coefficient of elasticity is less than one: the increase in the purchase electricity price by 1% increases the sale electricity price for distributors by 0.77%. This is consistent with the increased competitive pressures in the electricity distribution markets, which are creating pressures to reduce operational and marketing costs in the electricity distribution system. The increases in taxes and wages are partly passed through into sale price to consumers, but more likely they are additional costs of electricity distributors. The simultaneous increases in purchase electricity price, taxes and wages by 1% increase the sale electricity price by 0.992%. These results suggest that price policies by electricity distribution enterprises are adjusting towards the increasing competitive pressures in the markets. It seems that in transmission of purchase electricity price into sale or consumer price there is less monopoly market power with ongoing rationalizations in distribution of electricity energy. This can also be a result of overall technological progress in the electricity distribution system with associated positive externalities on costs reductions.

Table 4: Estimated price function, 1993-2003.

	ln(Constant)	ln(C_{pur})	ln(C_{tax})	ln(C_w)	R ²	F-test
ln(P_{sale})	0.59 (0.13)	0.77 (2.95)	0.07 (0.21)	0.15 (0.59)	0.96	54.3

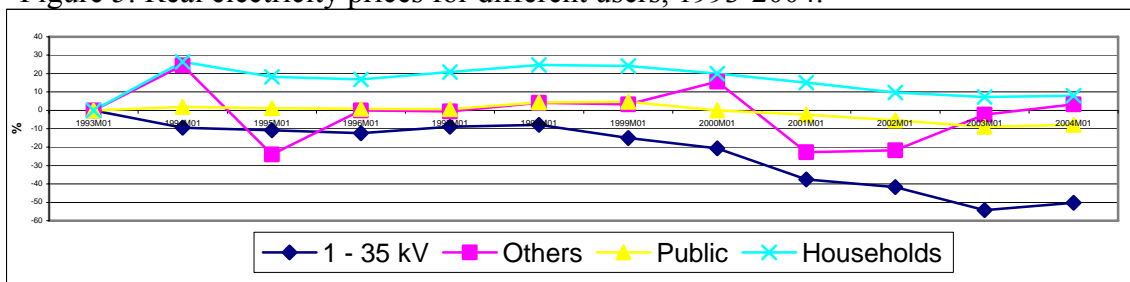
ln = natural logarithm. In the brackets are t-statistics.

Source: Own estimations.

In the structure of the electricity sales, there are four main purchase groups: medium-sized purchases of power between 1 and 35 kV, other purchases, public electricity lighting, and households' users. Between 1993 and 2001, real sale prices of electricity

increased by 6.1%, but this general increase varies by different users: for medium-sized power (1-35 KV) declined by 20.6%, for low power buyers increased by 16.7%, for public electricity lighting increased by 0.1%, and for households increased by 20%. During the same time, taxes increased by 49.5%. Demonopolization and price deregulation for greater industrial users (greater than 41 kW connection power) in 2002, and for other users, except of households in July 2004, is likely to have some additional impacts on selling electricity price formation. This is confirmed in Figure 5, which clearly indicates that since 2001 the deregulation of electricity distribution markets leads to the decline in real electricity prices by more than 20 percentage points. The greatest real price declines are recorded for the medium and low power buyers, but less for public lighting and for households. With these changes are also associated changes in market structures by different distribution enterprises.

Figure 5: Real electricity prices for different users, 1993-2004.



Source: Own calculations on the basis of data obtained from Electro Gorenjska.

3.4 Demand function

Demand function explains expenditures for electricity consumption as dependent variable in association with real consumer incomes, electricity consumption, real price, and some other explanatory variables:

$$D_t = f(Y_t, D_{pc}, P_{sale}). \quad (5)$$

Symbols: D_t – real expenditures or consumption in period t ,

Y_t – real income in period t ,

D_{pc} – electricity consumption per capita in the Gorenjska region,

P_{sale} – average real consumer price of electricity.

Table 5 indicates that estimated parameters are less significant. We also experimented with consumption of other energy in households, which are substitutes to electricity consumption. This is an issue for future research.

Table 5: Estimated demand function, 1993-2003.

	$\ln(\text{Constant})$	$\ln(Y_t)$	$\ln(D_{pc})$	$\ln(P_{sale})$	R^2	F-test
$\ln(D_t)$	7.98 (1.83)	0.47 (0.78)	0.002 (0.04)	0.16 (0.26)	0.53	3.0

\ln = natural logarithm. In the brackets are t-statistics.

Source: Own estimations.

4 Conclusion

The Slovenian electricity market is adjusting to gradual deregulation and liberalization of electricity-trading arrangements. The Slovenian electricity distribution market is becoming more competitive in terms of the greater number of competitors that have entered into markets, thus changing market structures, and due to the increasing competitive pressures in vertical price transmission and in determination of distribution/marketing margin.

The electricity market in Slovenia was regulated by the government control of prices, but has been gradually deregulated since 2001 for larger industrial electricity users, since 2003 for medium and smaller industrial users, and since 1 July 2004 for all users, except of household's electricity consumption. By 1 July 2007 also electricity markets for household's consumption should be completely liberalized. With electricity markets deregulation these markets are becoming more competitive. The increasing competitive pressures and gradual electricity price liberalization cause the decline in real electricity sale or consumer price.

We apply four analytical models that have been econometrically tested using time series data: production function, cost function, price function and demand function. The increasing returns to scale in the Slovenian electricity distribution system are pertained to labor and capital. The increase in labor productivity is associated with capital intensity and particularly with human capital. The real cost changes are caused by internal factors in electricity distribution enterprises, particularly by wages and amortization. The pass-through of purchase electricity price to consumer price is found as significant, but it is less than one. Both the cost-push factors inside enterprises as part of margin and input-price transmission seem that are significant factors in the increasingly competitive consumer price determination. Greater economic impacts on household electricity demands are expected with complete liberalization and deregulation of the Slovenian electricity market in the enlarged EU electricity and energy markets, which is also an issue for future research.

References

- Bower, J. 2004. Seeking in the Single European electricity market: Evidence from an empirical analysis of wholesale market prices. Economic Working Paper Achieve at WUSTL, <http://ideas.repec.org/p/wpa/wuwpot/0401005.html>.
- EU-Commission. 2003. Draft – Strategy paper. Brussels: European Commission, Directorate-General for Energy and Transport.
- Eurostat. 2004. IEA statistics in focus, environment and energy, 2/2004, Luxembourg.
- OJ. 1997. Directive 96/92/EC of European Parliament on of the Council of 19 December 1996 concerning common rules for internal market in electricity, OJ No. L 027, 30.01.1997.
- Papler, D. 2005. Ekonomska analiza standardnih cen električne energije v Sloveniji in EU, 1., 2. in 3. del. *Naš stik*, št. 5, 31. maj, 67-69, št. 6, 30. junij, 68 – 69, št. 7-8, 3. avgust, 66 – 67. Ljubljana: Elektro-Slovenija.
- Suvorov, M. 2004. Statistično spremljanje cen energentov. *Učinkovito z energijo, bilten Agencije za učinkovito rabo in obnovljive vire energije*, št. 7, 8. december.

Žižmond, E. and Novak, M. 2004. Model spremljanja dereguliranih cen v nemenjalnem sektorju slovenskega gospodarstva. Delovni zvezek 7. Koper: Fakulteta za management Koper.