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Štefan Bojnec*, Drago Papler**

The analysis of liberalisation of the electricity market in Slovenia

1. Introduction

The electricity markets in Europe are undergoing considerable economic and technological restructuring (Stoft, 2002; Nillesen et al., 2004; Bojnec and Papler, 2016; Cialani and Mortazavi, 2018; European Commission, 2019). The increasing dependency on electrical energy, along with continued economic growth, has caused electricity consumption to be raised as an important economic and ecological question for our common future at a global level (e.g. Pearce and Warford, 1993; Nordhaus, 1994; Blok, 2005; Stern, 2007; Wagner et al., 2007; Bojnec and Papler, 2011a, 2011b; Damm et al., 2017). On the one hand, the electricity markets are in a process of economic deregulation and market liberalisation. On the other hand, the aim is to strengthen the importance of sustainable development in electricity supply management with an increase in alternative, renewable sources of electrical energy that is driven both by ecological standards and by the introduction of new technological changes and restructuring in more efficient electricity supply and its uses. The rapid increases in electricity supply in developed countries have been caused by increasing industry, public lighting and household electricity demands during the last decades. A systematic approach to supplier improvement in marketing management between wholesalers and retailers in the electricity supply chain management is growing, and more competitive electricity markets have gained an increasing importance.

Slovenia, similar to most other European countries, has undergone electricity market deregulation and price liberalization. Prior to 2001, the Slovenian electricity market was monopolized by a single large regional market supplier (Papler and Bojnec, 2006, 2007, 2012). Trade in electrical energy is limited by

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cross-border transfer capacities. When prices of electrical energy were high, some export was also supplied to Austria and Germany. For example, in 2006 Slovenia was a net importer of electrical energy, as export from Slovenia was 5,027 GWh, while import was 7,706 GWh. The net import represents around 20% of total Slovenian electrical energy consumption.

This paper focuses on wholesale-to-retail-sale electricity supply chain management in Slovenia in association with the economic, management and social issues, which lie behind the electricity supply chain management. The main wholesale supplier in the Slovenian electricity distribution supply chain management is organized as a systemic provider of electricity networks, which is balancing the wholesale electricity supply with different segmented demands on the domestic Slovenian markets (industry, public lighting and households). As a part of the systemic provider of electricity networks, there is also the nuclear electricity power station in Krško as a producer of electrical energy. The systemic provider of electricity networks is a main provider of electrical energy to retailer electricity distribution enterprises, which then sell electricity further to final consumers in industry, public lighting, and households. The wholesale-to-retail-sale electricity marketing and electricity supply chain management have also been to a lesser extent developed through the stock exchange of electrical energy called "Borzen", which has been introduced since the electricity market deregulation in 2001. The retail electricity distribution enterprises are also purchasing electrical energy from small electricity producers/suppliers, which have a relatively small market share in the wholesale electricity supply in Slovenia.

At the retail electricity marketing level, the Slovenian public retail electricity distribution enterprises, which are organized on a regional basis, have maintained the greatest market share. They are organized as a share holding company: four enterprises within the Holding of the Slovenian electricity suppliers (HES), which is balancing electricity supply within the HES, while the fifth one is organized as a spin-off enterprise, with the majority state ownership. Their role has been in mitigating transmission of electrical energy from wholesale distribution network enterprises to final consumers as well as development of electricity distribution systems. The market share of these five retail electricity distribution enterprises in the Slovenian electricity consumer markets is around 80 percent.

We specifically focus on the electricity supply chain management in the relation between the electricity producers/wholesalers and the retail electricity distribution enterprises. More specifically, we are using Electro Gorenjska, which is one of the retail electricity distribution enterprises in Slovenia, as a case study. This retail electricity distribution enterprise is compared with other retail electricity distribution enterprises in Slovenia to illustrate that Electro Gorenjska is not an exception in the Slovenian retail electricity distribution market. The retail electricity distribution enterprises are purchasing electrical energy from different

electricity producers and wholesale electricity suppliers, but it is identified clearly that the HES has increased its share to around 90 percent, whereas the remaining electricity purchases by the retail electricity distribution enterprises have shifted towards small private electricity suppliers that particularly are producing electrical energy from local renewable sources of electrical energy.

The rest of the paper is structured in the following way. We first present some empirical facts on the structure of electricity purchases by the retail electricity distribution enterprises from producers/wholesalers of electrical energy to provide a basis for understanding the wholesale-to-retail-sale electricity supply chain management. Then we present briefly the Slovenian stock exchange "Borzen" of electrical energy as an issue of electricity market liberalisation and as a market outlet for regional electricity market cooperation. The next section presents the methodology and empirical results. The case study of the retail distribution enterprise of the Electro Gorenjska is used to provide in-depth analysis and comparisons of structures of electricity purchases and electricity supply management from producers/wholesalers-to-retailers. The final section derives the main conclusions and policy implications.

2. Empirical evidence on the Slovenian wholesale-to-retail-sale electricity markets

Since 2001, the Slovenian electrical energy markets have been gradually deregulated (Papler and Bojnec, 2006, 2007). The purchases of electrical energy at the organized stock exchange "Borzen" have also started since 2001, and the peak in its size was in 2003. The most important wholesale supplier of electrical energy for the retail electricity distribution enterprises is the HES, through long-run closed contracts on the purchases of electrical energy. As a starting point into the analysis of the Slovenian electricity wholesale-to-retail-sale markets, we present four items of empirical evidence that have occurred as a result of the electricity market deregulation and electricity price liberalisation.

First, to examine electricity wholesale-to-retail-sale supply chain management in Slovenia, we start our analysis with the size of the electricity distribution markets to the final consumers in Slovenia, which are covered by the five largest Slovenian retail electricity distribution enterprises (Fig. 1). Due to increasing electricity demands, the electricity supply has increased. The increases in the market size as measured by the size of electricity sales are recorded for each of the retail electricity distribution enterprises. However, the sizes of electricity sales and their dynamics between the individual retail electricity distribution enterprises vary.

Electro Ljubljana is the largest single retail electricity distribution enterprise with its further sale increases. On the other hand, Electro Gorenjska is – by the size of sales – the smallest one.

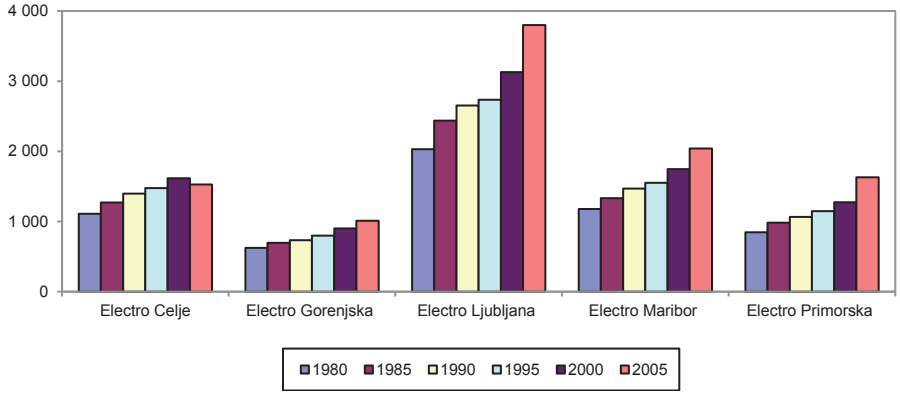

Figure 1. Supply of electricity by the retail distribution enterprises in Slovenia by selected years, 1980–2005 (in GWh)

Source: own calculations

Second, we present the changing patterns and structures in the density of the purchases of electrical energy per square kilometer by the main retail electricity distribution enterprises. This indicator is the highest, and with an increasing tendency for Electro Ljubljana, and the lowest with yearly variations for Electro Celje (Tab. 1).

Table 1

Purchases of electrical energy per square kilometer in Slovenia by the electro-distribution enterprises, 1990–2005 [MWh/ km^2]

Year	Electro Celje	Electro Gorenjska	Electro Ljubljana	Electro Maribor	Electro Primorska	Slovenia
1990	321.5	351.1	507.2	377.5	245.4	367.8
1991	315.0	356.6	503.0	379.9	237.5	364.6
1992	305.7	341.6	486.6	367.5	228.7	352.4
1993	311.8	350.8	496.1	382.2	235.7	361.5
1994	324.2	364.7	506.5	386.2	249.2	372.2
1995	339.4	381.5	522.8	398.7	264.9	387.4
1996	339.6	391.4	541.6	405.2	265.9	394.9
1997	354.1	400.0	557.0	414.5	265.7	404.8

Table 1 cont.

1998	363.4	413.6	582.5	428.4	286.3	422.2
1999	360.0	415.0	587.9	439.3	288.1	425.5
2000	371.7	430.6	598.0	437.7	294.1	433.4
2001	387.3	438.6	619.9	451.4	303.0	448.0
2002	369.7	448.5	667.0	465.7	315.5	463.1
2003	425.5	463.5	670.2	486.2	327.6	484.4
2004	399.3	475.3	695.9	495.3	354.2	494.2
2005	351.9	483.4	726.2	510.9	376.4	500.6

Source: own calculations

Third, we present the density in the purchases of electrical energy per capita by main retail electricity distribution enterprises. We expect that electricity consumption per capita is associated with the level of technological development of industry and the level of overall economic development, which cause demands for electrical energy by the different economy sectors, public lighting, and households. The consumption of electrical energy per purchase place and per capita has increased over time (Fig. 2 and Tab. 2). The electrical energy consumption per capita is the highest for Electro Primorska and the lowest for Electro Maribor, while Electro Celje, Electro Gorenjska, and Electro Ljubljana have a consumption of electrical energy per capita which is close to the Slovenian average.

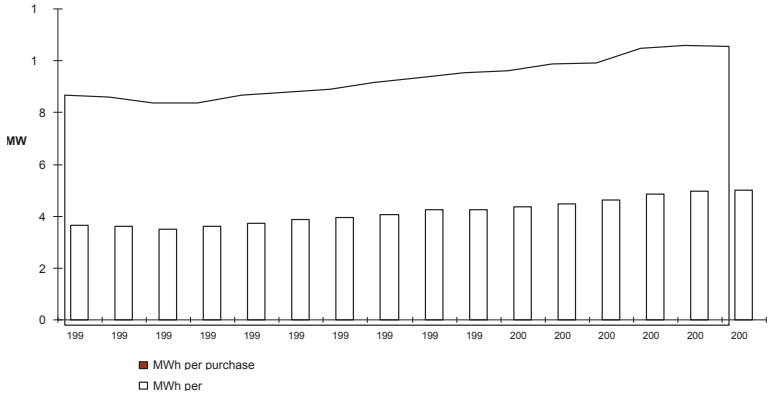

Figure 2. Purchases of electrical energy in MWh per purchase place and MWh per capita, 1990–2005

Source: own calculations

Table 2

Purchases of electrical energy per capita in Slovenia by the retail electro distribution enterprises, 1990–2005 (MWh per capita)

Year	Electro Celje	Electro Gorenjska	Electro Ljubljana	Electro Maribor	Electro Primorska	Slovenia
1990	4.1	3.7	3.6	3.0	4.4	3.7
1991	5.0	3.8	3.4	3.1	3.9	3.6
1992	5.1	3.6	3.3	3.0	3.7	3.5
1993	4.2	3.7	3.6	3.1	3.8	3.6
1994	4.5	3.8	3.6	3.1	4.1	3.7
1995	4.6	4.1	3.7	3.2	4.4	3.9
1996	4.7	4.2	3.9	3.3	4.4	4.0
1997	5.0	4.2	4.0	3.4	4.3	4.1
1998	5.2	4.4	4.2	3.5	4.7	4.3
1999	5.1	4.4	4.2	3.6	4.7	4.3
2000	5.2	4.5	4.3	3.6	4.8	4.4
2001	5.4	4.7	4.4	3.7	5.0	4.5
2002	5.1	4.8	4.7	3.9	5.2	4.6
2003	5.8	4.9	4.8	4.0	5.4	4.9
2004	5.5	5.0	4.9	4.1	5.9	5.0
2005	5.0	5.1	5.1	4.2	5.9	5.0

Source: own calculations

Fourth, the increases in purchases of electrical energy by the retail electricity distribution enterprises and their sales for different consumption of electrical energy tend to move in the same direction with the increases in gross domestic product (GDP) per capita (Fig. 3). This implies that the increases in GDP per capita, which is one of the main aggregates for measuring the level of economic development, are positively associated with the greater use of electrical energy for intermediary consumption and greater demands for electrical energy for final consumption by households.

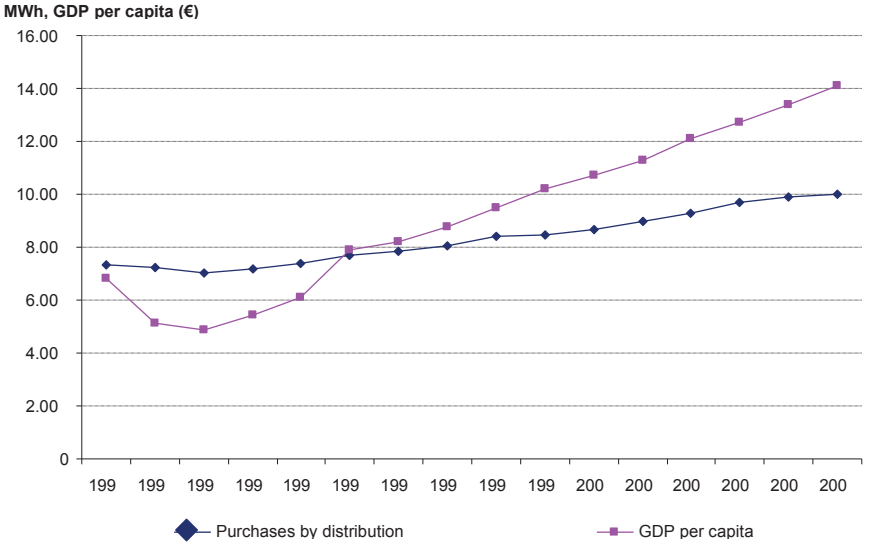

Figure 3. Purchases of electrical energy by the retail electro distribution enterprises and gross domestic product per capita, 1990–2005

Source: own calculations

3. Stock exchange "Borzen" of electrical energy

The purchases of electrical energy at the stock exchange "Borzen" of electrical energy are introduced as a measure to increase market competition and to improve efficiency in the marketing and functioning of the wholesale electricity supply as well as to serve as a market outlet for entering foreign competitors on the Slovenian electricity markets, and for broader regional integration of electricity markets in South-Eastern Europe.

Up to 2001, before the electricity market deregulation in Slovenia was introduced, the retail electricity distribution enterprises in Slovenia were purchasing electrical energy on the basis of the evaluated electro energy balances and programs of the electro energy system by the Electro Slovenia enterprise (Eles). Since 2001 there has been an aim towards strengthened liberalisation in an emerging market of electrical energy, but with a prevailing role of the HES. That has been the main reason for the less promising role of the stock exchange "Borzen" of electrical energy on the Slovenian electricity markets. Since 2004, four retail electricity distribution enterprises (Electro Celje, Electro Gorenjska, Electro Ljubljana

and Electro Primorska) have purchased electrical energy from the HES in order to then further supply electrical energy to electricity consumers (industry, public lighting and final consumption by households).

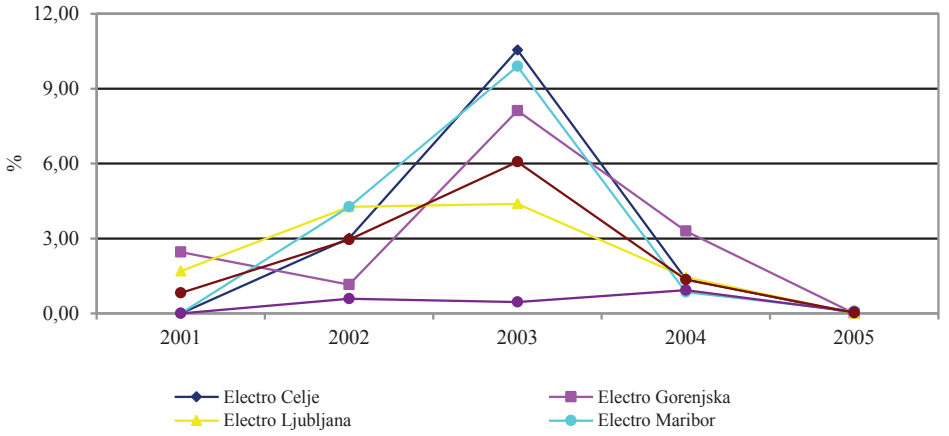

Figure 4. The role of the stock exchange "Borzen" of electrical energy in the purchases of electrical energy by the retail electricity distribution enterprises in Slovenia (in percent of total purchases of electrical energy), 2001–2005

Source: own calculations

In 2001, at the weekly meetings of the stock exchange "Borzen" of electrical energy they started with the sale of electrical energy to the retail electricity distribution enterprises in Slovenia (Fig. 4). An increase in electricity transactions is seen by 2003. In 2005, there was a considerable decline in purchases on the stock exchange of electrical energy "Borzen" by the retail electricity distribution enterprises. Since then, the importance of the stock exchange of electrical "Borzen" in the purchases of electrical energy by the retail electricity distribution enterprises, as well as in general, has been given rather low importance.

4. Methodology

As the methods of analysis we apply the Lorenz curve, Gini coefficient of concentration, regression analysis, and multivariate factor analysis (e.g. Kachigan, 1991; Hair et al., 1998; Gujarati, 2003). The analysis of market structures and market concentrations is one of the bases of the economic business analysis

and economics of industrial organization (e.g. Chrystal and Lipsey, 1997; Cabral, 2000; McAleese, 2004). We analyse market structures, and specifically the structures of electricity purchases by the retail electricity distribution enterprises, in order to illustrate the structures in the wholesale-to-retail-sale electricity supply chain management. The most commonly used measures of distributional inequalities in the literature are Lorenz curves and Gini coefficients of concentration. By using statistical methods, we analyse frequency in the distribution of electricity supply or purchases by the retail electricity distribution enterprises in quantity and value terms. The frequency distribution is calculated in the following way:

$$K = 1 + 3.3 \log N \tag{1}$$

$$F_k = f_{k1} + f_{k2} + \ldots \tag{2}$$

$$F_k\% = \frac{F_k}{N} = 100 \tag{3}$$

$$x_k = \min + \frac{(\max - \min)}{2} \cdot F_k \tag{4}$$

$$X_k\% = \frac{x_{k1}}{\sum x} \cdot 100 \tag{5}$$

$$\phi_k\% = x_{k1}\% + x_{k2}\% \tag{6}$$

Symbols:

N – number of observations of variables,
K – number of distribution or quintile groups,
f_k – frequency,
F_k – cumulative frequency,
$F_k\%$ – share of cumulative frequency [%],
x_k – mean value for distribution or quintile group,
$x_k\%$ – share of the mean value of distribution or quintile group [%],
$\phi_k\%$ – cumulative of relative totals.

For graphical presentation of relative frequency distribution by quintile groups and its cumulative relative frequency concentration we use the Lorenz curve. The graphical presentation of the Lorenz curve has a quadratic form. On the horizontal axis is a scale for cumulative relative frequency expressed in percent ($F_k\%$). On the vertical axis is a scale for cumulative of relative quintile group totals expressed in percent ($\phi_k\%$). In such a quadratic chart there are included pairs of

both variables. The obtained pair points in the chart are then connected from the bottom left corner. The obtained curve is the Lorenz curve, which expresses the concentration of the wholesale suppliers in the purchases of electrical energy by the retail electricity distribution enterprises. The more the shape of the Lorenz curve moves to the right bottom corner, the greater is the concentration, and vice versa when the Lorenz curve is situated closer to the diagonal of the chart. Therefore, the Lorenz curve is derived from the calculated frequency distribution. In our analysed cases, the Lorenz curve shows the concentration of electricity purchases, which is expressed by the share of different wholesale electricity suppliers in total electricity purchases by the electricity distribution enterprises. It indicates the importance of strategic suppliers with the greatest share in total electricity purchases by the retail electricity distribution enterprise. This equality can be shown by the straight line of perfect equality, which captures the cumulative share of electricity supply (vertical axis) by each quintile group and particularly the ones below it (horizontal axis). The first quintile group receives a 0.2 share or 20 percent of total electricity supplies, the first and second quintiles receive 40 percent of total electricity supply, and so forth. If the distribution of electricity supply is not equal for each quintile group, then the Lorenz curve connecting the cumulative percentages of electricity supply by the cumulated quintiles lies below the line of perfect equality, as it is in our case of the wholesale electricity supply to the retail electricity distribution enterprises.

The second measure of concentration is the Gini coefficient of concentration, which expresses the degree of market concentration. Therefore, in our case, concentrations of electricity suppliers in the electricity purchasing structures by the electricity distribution enterprises is also analysed using the Gini coefficient of concentration. The Gini coefficient is defined as the ratio of the area between the Lorenz curve and the line of perfect equality to the total area under the line of perfect equality. When there is perfect equality, then the Gini coefficient would equal zero. More specifically, the Gini coefficient of the degree of market concentration is calculated in the following way:

$$G = 1 - \frac{\sum_{k=1}^{K} f_k\%(\phi_k\% + \phi_{k-1}\%)}{10\,000} \tag{7}$$

Symbols:

G – Gini coefficient of concentration,
$f_k\%$ – share of cumulative frequency [%],
$\phi_k\%$ – cumulative of relative flows.

When the Gini coefficient is equal to 0, then there is no market concentration, and when it is equal to 1, then there is full market concentration.

We estimate the demand function for purchases of electrical energy by the retail electricity distribution enterprise, which is explained by the real purchase electricity price and GDP:

$$D_w = f(P_w, GDP)$$

where D_w is the demand for electrical energy defined as the purchased quantity of electrical energy by the retail electro distribution enterprise, P_w is the real purchase price of electrical energy, and GDP is gross domestic product. Moreover, the dummy variable equal to 1 for the liberalisation years with the start in 2001 is included, and zero otherwise.

We also estimate the total real revenue function for electricity sales by the retail electricity distribution enterprise, which is explained by the real purchase wholesale electricity price, expenses for paid taxes and expenses for paid wages:

$$\text{Revenue}_w = f(P_w, C_{tax}, C_{wages})$$

where Revenue_w is total real revenue from the sale of electrical energy by the electro-distribution enterprise, P_w is the real wholesale purchase price of electrical energy by the electricity distribution enterprise, C_{tax} are the real expenses paid by the electricity distribution enterprise for taxes, and C_{wages} are the real expenses paid by the electricity distribution enterprise for wages.

The regressions are estimated using the ordinary least square (OLS) method.

The multivariate factor analysis (Norušis, 2002) is applied in the analysis of the unique survey evidence to identify common factors important in wholesale-to-retail-sale electricity supply chain management, which is important for wholesale suppliers and for the retail electricity distribution enterprise.

5. Empirical results

5.1. Lorenz curve

The Lorenz curve presents the concentration of the wholesale electricity suppliers in total purchases of electrical energy by the retail electrical distribution enterprise. The wholesale suppliers of electrical energy are segmented by the quantity of the supplied electrical energy. Figure 5 indicates that 3% of the largest

wholesale electricity suppliers out of 91 wholesale electricity suppliers have a 95% share in total purchases of electrical energy by the retail electricity distribution enterprise. The Lorenz curve in the right hand bottom corner clearly confirms the very high concentration of the wholesale electricity suppliers (108) in Slovenia: 6% of the largest wholesale electricity suppliers supply 98% of total electrical energy to the retail electricity distribution enterprises, and 1% of the largest ones supply 72% of electrical energy. The HSE is the largest single wholesale electricity supplier. The Gorenjska electricity plant is also one wholesale electricity supplier with its 17 electricity plants. A slightly lower concentration of electricity supply is seen for private and industrial small hydro-electricity plants.

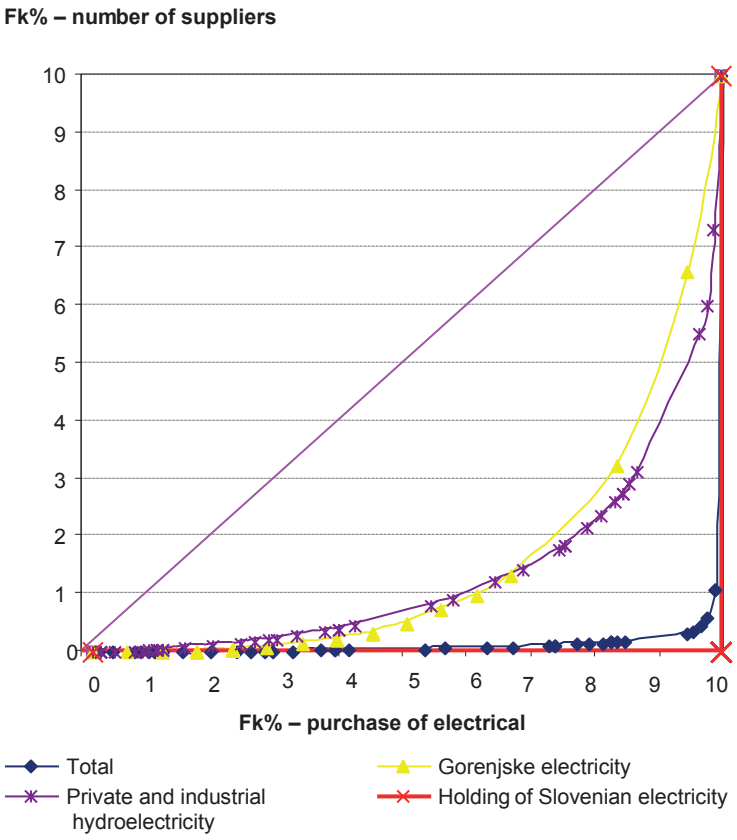

Figure 5. Lorenz curve of concentration of suppliers of electrical energy, 2006

Source: own calculations

5.2. Gini coefficient of concentration

The Gini coefficient for the concentration of the purchases of electrical energy by the retail electro distribution enterprise is 0.97028, which implies a very high concentration of wholesale electricity suppliers to the retail electro distribution enterprise. The HSE is the largest wholesale supplier of electrical energy to the retail electro distribution enterprise on the basis of long-run agreements and contracts.

Among the number of the wholesale electricity suppliers, those prevailing are the smallest wholesale electricity suppliers (Fig. 6). The greatest number of the wholesale electricity suppliers comprises the smallest suppliers, with an annual electricity supply from 160 GWh to 600 GWh (36.3%). In second place is ranked the group of the wholesale electricity suppliers from 50 to 160 GWh (26.4%), and in third place are ranked from 1,200 GWh to 2,000 GWh (9.9%). The smallest number of the wholesale electricity suppliers represents the largest wholesale electricity suppliers of sizes greater than 2,000 GWh annually.

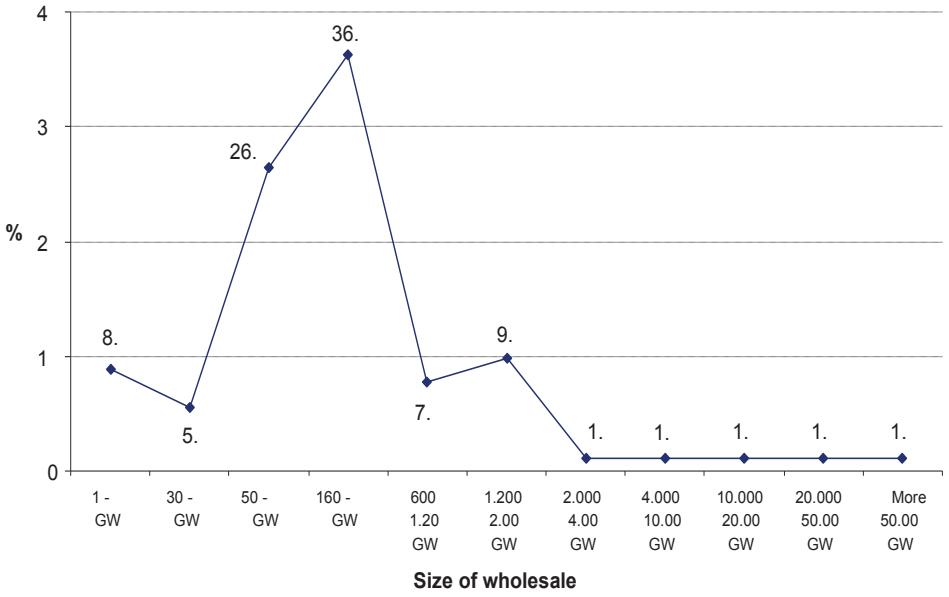

Figure 6. The share of the frequency distribution of the number of wholesale electricity suppliers of electrical energy by the annual size of supply, 2006

Source: own calculations

5.3. Demand functions

Demand functions for the purchases of electrical energy by the retail electro distribution enterprise from the wholesale electricity suppliers are estimated in the logarithm forms by the OLS method (Tab. 3). The increase in the real wholesale purchase price of electrical energy causes a reduction in demands for purchases of electrical energy. The coefficient of elasticity pertaining to the real wholesale purchase price is estimated at −0.59. On the other hand, the increase in real GDP increases purchases of electrical energy by the retail electricity distribution enterprise. The coefficient of elasticity is estimated at 0.18. The impact of market deregulation and liberalisation on demands for electrical energy by the retail electricity distribution enterprise is not found to be statistically significant.

Table 3

Estimated demand functions, 1998–2008

Model	Dependent variable: electricity demand	ln(Constant)	Real purchase price: ln(*Pw*)	Gross domestic product: ln(*GDP*)	Dummy: ln(*dummy*)	$AdjR^2$	*F*
1	$\ln(D_w)$	9.745	−0.590	0.181	–	0.974	63.697
		(8.840)	(−10.786)	(2.410)			
2	$\ln(D_w)$	9.804	−0.598	0.181	−0.020	0.948	36.448
		(7.188)	(−5.376)	(2.234)	(−0.088)		

Note: ln – natural logarithm. In the brackets are *t*-statistics.

Source: own calculations

During the analysed period the real GDP increased, and also purchases of electrical energy by the retail electricity distribution enterprise tended to increase, while the real wholesale purchase price of electrical energy cyclically oscillated: first, it declined with the electricity market deregulation, and since 2006 it has increased (Fig. 7). This clearly illustrates only the temporary decline in the real wholesale price of electrical energy, following the market deregulation and price liberalisation.

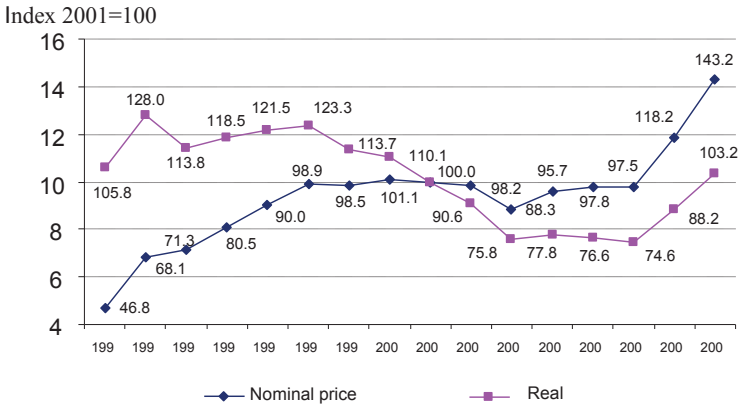

Figure 7. Index of nominal and real purchase *It* prices of electrical energy, 1993–2008 (2001=100)

Source: own calculations

5.4. Revenue function

The increase in the real wholesale purchase price of electrical energy by 1% increases the electro distribution enterprise's total revenues for its further sale of electrical energy by 0.685% (Tab. 4). This suggests that the retail electricity distribution enterprise is not able to fully transmit the increased costs for the purchased electrical energy to the final consumers of electrical energy, i.e., industry, public lighting and households. At the same time, the retail sale of electrical energy is associated with some other costs that are a part of the retail electricity price or total revenues from the sale of electrical energy to consumers such as costs of wages and expenses for taxes.

Table 4

Estimated total real revenue function, 1993–2005

Dependent variable: real revenue	ln(Constant)	Purchase real price: ln(*Pw*)	Tax costs: ln(*Ctax*)	Costs for wages: ln(*Cwages*)	*AdjR*²	*F*
ln(Revenue)	4.702	0.685	0.062	0.264	0.564	6.596
	(1.457)	(2.758)	(1.140)	(1.301)		

Note: ln – natural logarithm. In the brackets are *t*-statistics.

Source: own calculations

6. Opinions on quality management of wholesale electricity supply

The increasing competitive pressures in the electricity markets are forcing the electricity distribution enterprises to compete in both price and quality of supply. We investigate the important elements on wholesale-to-retail-sale chain supply management as seen by the participants and customers in these relations. We have conducted surveys with the respondents by using the own developed written questionnaire to gain insights into opinions on factors of quality management in wholesale-to-retail-sale electricity supply chain management. The answers to nine questions were obtained in a form of the Likert scale, where 1 means not important at all, and 5 means very important. In addition, we include control questions to gain additional insights into important determinants for competitive electricity supply chain management. Among the respondents in the surveys, several are experts in energy supply chain management. We obtained 72 completed surveys out of 150. By education, there are 5.6% with a Master's degree or higher, 41.7% with a graduate degree, 22.2% with a higher education degree, 23.6% with secondary education, and 6.9% with vocational education. By gender, 83.3% are male and 16.7% female.

The correlation analysis of variables for the set questions confirms a positive association between development recognition and business trust in the wholesale-to-retail-sale electricity supply chain management (Pearson correlation coefficient 0.622), development products and those still to be known (0.599), references and long-term cooperation (0,554), references and relations with suppliers (0.537), references and local patriotism (0.514), but less for other pairs of variables.

Table 5

Matrix of different estimation methods (2 common factors)

Variables of the set of nine questions	Maximum likelihood method – Factor Matrix[a]		Maximum likelihood method with Kaiser normalization – Pattern Matrix Factor[b]		Maximum likelihood method with Kaiser normalization – Structure Matrix Factor		Maximum likelihood method with Varimax Kaiser normalization – Rotated Factor Matrix[c]	
	Factor 1	Factor 2	Factor 1	Factor 2	Factor 1	Factor 2	Factor 1	Factor 2
Developmental products	0.370	0.617	0.139	0.645	0.439	0.709	0.660	0.286
Price supply	0.202	–0.004	0.214	–0.031	0.200	0.069	0.023	0.200

Table 5 cont.

Commercial conditions	0.316	0.668	0.061	0.709	0.391	0.737	0.704	0.226
Reference	0.999	–0.002	1.054	–0.133	0.993	0.358	0.129	0.991
Long-term cooperation	0.555	0.232	0.491	0.188	0.578	0.416	0.302	0.520
Local-patriotism	0.515	0.150	0.481	0.102	0.529	0.326	0.216	0.491
Relations with suppliers	0.537	0.226	0.474	0.184	0.560	0.405	0.294	0.503
To be known	0.334	0.596	0.109	0.625	0.400	0.676	0.634	0.253
E-communication	0.146	0.732	–0.145	0.803	0.229	0.735	0.745	0.049

Note: [a] 6 iterations, [b] 2 iterations, [c] 3 iterations.

Source: own calculations

The multivariate factor analysis was conducted in order to identify common factors on opinions about wholesale-to-retail-sale electricity supply chain management. The Scree plot suggests two common factors. The first common factor explains 40.0% of variance, while the second common factor additionally explains 14.5% of variance. The method of principal axis factoring does not provide estimates of factor weights nor of communalities. The maximum likelihood method without factor rotation estimates two common factors (Tab. 5). The first common factor is related to trust, with higher weights for variables in the electricity enterprise references, long-term cooperation, relations with suppliers, and local patriotism. The second common factor is identified as recognition, with higher weights for the variables of e-communications, commercial conditions, and development of new products and services, and those still to be known. The maximum likelihood method with Oblimin with Kaiser normalisation strengthened two common factors. For the first one, the important weights for variables has not changed. The second one has the highest weights for the variables of commercial conditions, e-communications, development of new products and services, and recognition. The maximum likelihood method with Varimax with Kaiser normalisation has given similar results. Development recognition and business trust are found as the two common factor components, which are important for improving wholesale-to-retail-sale supply chain management within the existing Slovenian wholesale-to-retail-sale electricity distribution market.

7. Conclusion and policy implications

The demand for electrical energy has increased and has largely been driven by economic growth in the economy and real income increases of households. Due to this, during the most recent recession period, there has been a slight decline in demand and consumption of electrical energy.

As electrical energy is a crucial input into intermediary and final consumption, its real price and quality of supply are also crucial for production costs, competitiveness of the economy, and living standard of the population. As the electricity energy markets in the past were traditionally monopolized by the local suppliers, the objective of the deregulation and liberalisation of the electricity energy markets in Europe and in Slovenia is to induce and to encourage market forces and restructuring towards more dynamic market transactions with the abolishment of critical inefficiencies, and to establish competitive supply of electrical energy to industrial users and to other final electricity consumers such as for public lighting and for final household consumption.

The deregulation and liberalization of the electro energy system in Slovenia has aimed towards market restructuring with more dynamic market transactions in the wholesale-to-retail-sale electricity markets, abolishment of critical inefficiencies and competitive supply to final electricity consumers. We have focused on the analysis of the market structures and competition in the wholesale-to-retail-sale electricity markets in Slovenia. The empirical evidence confirms the entry of new suppliers into the wholesale markets, but their role is less significant vis-à-vis the prevailing wholesale electricity supplier. The objective of the electro energy sector is restructuring in order to improve efficiency and to adjust to a greater role of market forces in the wholesale electricity market. The crucial factor is the abolishment of critical inefficiencies in order to achieve a more competitive wholesale supply of electrical energy to the retail electricity distribution enterprises as an intermediary in more efficient and competitive electricity supply chain management for the final electricity consumers. However, the empirical evidence suggests that the institutional and organisational changes in the Slovenian wholesale electricity market so far have not resulted in substantial changes in the number of suppliers, and particularly not in their market structures. While the competition in the wholesale electricity market is encouraged by the entry of new suppliers, the state role in the wholesale electricity enterprises and in the wholesale-to-retail-sale electricity management is still important. The Lorenz curve and Gini coefficient of concentration clearly reveal a relatively high concentration of the wholesale suppliers in the electricity market. As expected, the retail electricity distribution enterprises and final consumers of electrical energy are rational in their responses and economic decisions to the increasing role of market forces,

as suggested by the statistically significant negative association between electricity demands and real electricity price. The regression analysis for the price or revenue function for the retail electricity distribution enterprise also confirms the crucial role of direct price elasticity, which is measured by the real wholesale purchase price for the purchased electrical energy at the wholesale market. The multivariate factor analysis, which is based on the unique survey data, shows the increasing importance for long-term business development recognition and business trust between participants on the wholesale and retail sale electricity distribution market. All these, in a spite of the slow path, indicate the emerging and increasing role of market forces into the previously monopolised and government regulated wholesale-to-retail-sale electricity supply chain management and electricity markets.

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Youth unemployment and crime: an empirical investigation for Turkey

1. Introduction

The crime economy has lately become a popular field of research because of the regular increases in crime rates. Questions such as what the main socio-economic factors affecting crime rates are and why crime rates are higher in some regions and at certain times, are the main issues for which not only economists but also researchers from other disciplines seek answers.

Economists' interest in crime analysis goes back to Becker's (Becker, 1968) model. According to this model, criminal behaviour is governed by an evaluation of benefits and costs of crimes. If the benefit from the crime is higher than the cost to be faced, the individual will be willing to commit the crime. Concerning this model, the probability of being caught and punished of individuals are the main factors that directly affect the tendency to crime. As an increment in these possibilities increases the cost of illegal activity, the crime tendency of the individuals will decrease. Later, Becker's model was extended by Ehrlich (Ehrlich, 1973) with the addition of the time allocation problem. According to Ehrlich's crime model, individuals have to decide how to distribute their time between legal and criminal activities. Based on this model, it can be said that legal and criminal activities are the substitute activities, and individuals' decisions are determined by opportunity costs. If the individual's income from the legal activity is low, the time allocated to illegal activity will be increased because the opportunity costs that an individual gives up is low. It is possible that Ehrlich model can be tested by empirical studies. Therefore a vast empirical literature has been emerged up to date. In these studies, the most commonly

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used variables are income, income distribution, unemployment, educational levels, and migration, etc.

One of the factors studied within the crime phenomenon is migration. The main reason for migration is unemployment and poverty. The problem of adaptation to the city with migration increases the likelihood of people turning towards crime (TESEV, 2005). Migration is a case that affects almost every structure of society as well as the psychology of the individual (Güvenç, 1996).

The main purpose of this study is to determine the relationship between youth unemployment and crime rates by migration-receiving of regions. For this purpose, aggregated crime rates, as well as non-aggregated crime rates (property crime, theft, and violent crime), were used. Also, the youth unemployment rate has been subdivided by gender differences and educational levels. Thus, the effects of gender differences on crime rates can be tested separately. Additonally, the effectiveness of the education system in Turkey can also be investigated, in terms of what it does to keep individuals away from illegal activities. We prefer to use spatial econometrics models in this study because of the unemployment rate and crime rate show regional cluster pattern. A spatial weight matrix is created by migration-receiving of regions.

The rest of the paper is organized as follows. The next section briefly summarizes how crime rates in Turkey develop over the years. In section 3, the empirical literature is discussed. The data are introduced in section 4, and spatial econometrics model used in this paper is summarized. After this section, the empirical results obtained by our spatial model are explained. Finally, the last section concludes the paper.

2. Change in crime rates over time in Turkey

Crime rate shows a steady increase in Turkey as well as in the whole world. As seen in Figure 1, the total crime rate was 277.3 in 2008 reached 690.9 in 2017.

This situation indicates that the total number of criminals increased by an average of 12.2% per year in the 2008–2017 period. The total crime rate per 10 000 individuals, which depict a relatively stable structure in the 2008–2011 period, showed a significantly increasing trend until 2015 after decreasing to a minimum level in 2011. The total crime rate increased by 9% and 10% respectively in the last two years, after a fall of approximately 4.5% in 2015.

Table 1 shows the descriptive statistics of total crime rates concerning NUTS2 (26 sub-regions of Turkey) classification[1], while Figure 2 illustrates the spatial distribution of total crime.

[1] This classification is given on appendix.

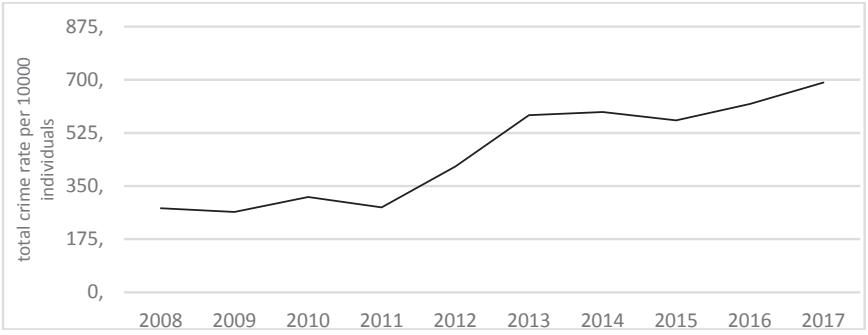

Figure 1. Change in total crime over time: Turkey

Source: Turkish Statistical Institute

Table 1

Descriptive statistics of total crime rate: 2008–2017

Region	Max	Average	Std Deviation
TR32	38.70883	27.87632	8.105167
TR61	41.26014	27.50691	8.736113
TR31	40.03573	26.78062	9.813951
TR22	33.6495	25.85908	6.89334
TR62	40.39491	23.9313	10.83657
TR33	31.367	22.84178	6.622252
TR21	30.7911	21.89715	6.346248
TR41	29.33979	18.78544	6.65831
TR52	29.04211	18.31287	7.856127
TR71	26.58296	18.07949	7.18804
TR83	25.51033	17.95031	6.612537
TR81	25.29	17.74285	6.157427
TR72	28.09648	17.31333	7.407439
TR42	25.14531	16.77452	5.651034
TR82	22.08004	16.1766	6.116586
TRC1	24.52746	16.05426	5.618019
TRA1	21.87608	15.40074	5.793147

Table 1 cont.

Region	Max	Average	Std Deviation
TR63	21.86609	14.76649	6.394683
TRB1	21.42279	14.50654	5.816536
TRA2	21.78686	13.88148	6.107592
TR51	21.53892	13.68774	4.535747
TR10	22.27792	13.35211	4.658629
TR90	21.04441	12.98516	6.537087
TRC2	18.31154	10.85225	4.784498
TRB2	17.44751	9.697744	4.836632
TRC3	14.80248	7.550883	4.131512

Source: Turkish Statistical Institute

According to Table 1, the highest crime rates are observed in TR32 (Aydın sub-region), TR61 (Adana sub-region) and TR31 (Izmir sub-region). On the other hand, the lowest crime rates are observed in TRC2 (Şanlıurfa sub-region), TRB2 (Van sub-region) and TRC3 (Mardin sub-region). Observed high standard deviation values in all regions indicate that high variability in crime rates in Turkey. According to the above information, in Turkey, regions where relatively developed have high crime rates, while it is seen that relatively less developed regions have a low crime rate. Figure 2 illustrates this information.

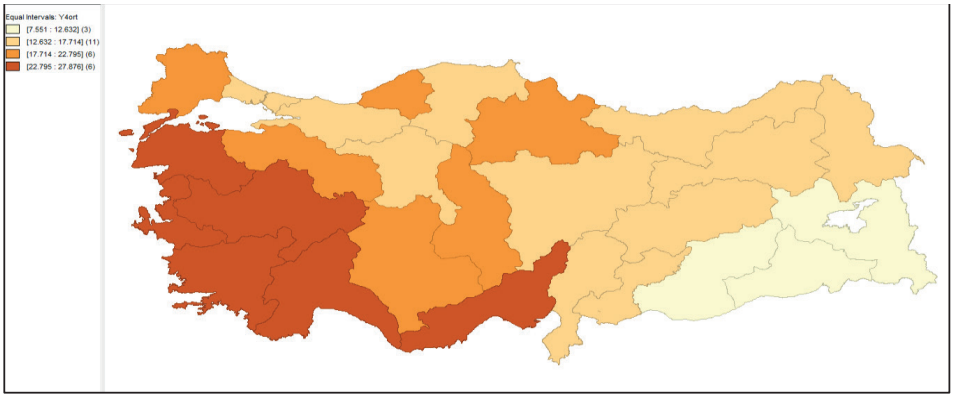

Figure 2. Spatial map of total crime rate distribution

Source: own calculation

The dark colour areas on the map show high crime rates, while in the regions whose colour is getting lighter crime rates decrease. The west part of Turkey has relatively better developed regions than the rest of the country. So this map clearly indicates that there is a positive relationship between crime rate and developing levels. Besides this, we can certainly say by this map that crime rates have a distinct spatial pattern.

3. Survey of empirical literature

As mentioned before, after Becker and Ehrlich's paper, a vast empirical literature occurred about crime economy. Economists' have preferred to research crimes against property rather than other types of crimes, so the relationship between crimes against property and socio-economic variables were more examined. Empirical studies in the literature may be differentiated by the employed model, investigated period, sample size, and used variables. Variables such as income, unemployment, poverty, inflation, wage, economic crisis, and poor income distribution are more employed than the other in the empirical literature. But there is no common consensus about how these variables affect the crime rates.

Altındağ (Altındağ, 2012) analyzed the relationship between crime and unemployment for the period 1995–2003 in 33 European countries. Eight different crime definitions such as homicide rate, assault rate, rape rate, robbery rate, property crime rate, etc. were used as dependent variables in the study. Estimated results showed that there was a positive and significant relationship between unemployment and property crime, larceny, and vehicle theft. Moreover, the unemployment rate was subdivided according to education levels, and it was seen that the effects of low education levels on crime are more significant.

In Lombardo and Falcone (2011) 103 Italian provinces were sub-divided into seven different groups by using cluster analysis. Their results indicated that the highest crime rates are seen in regions where divorce rate, youth unemployment and women's employment are high. Contrary to expectations, it was found that crime rates do not have a spatial pattern.

Saridakis and Spengler (Saridakis and Spengler, 2012) estimated panel models for Greece using regional data for the 1991–1998 period. In the model, three different crimes against property and three different violent crime were used as the dependent variable, and rate of caught, unemployment and the lagged crime rate were used as explanatory variables. The results indicated that there was a significant and expected relationship between a crime against property and the explanatory variable, while there was not any relationship with respect to violent crime.

Cerro and Meloni (Cerro and Meloni, 2000) investigated socio-economic determinants of the crime rate in Argentina for the period 1990–1999. They found a significant deterrence effect. Furthermore, the unemployment rate and income inequality were found to have a positive and significant effect on the crime rate.

Entorf and Spengler (Entorf and Spengler, 2000) employed panel data for the German states to explore criminal behavior. They used eight different crime variables like robbery, theft, fraud, murder, rape, etc. Their result indicated a strong deterrence effect. Additionally, they found that "being young," and GDP have a positive effect on crime. But these effects were more pronounced with regard to all types of property crime. The effect of unemployment was found as small, often insignificant of ambiguous sign in models. But, being young and unemployed, increases committing a crime and this variable had a positive effect on all types of crime.

Jennings et al. (Jennings et al., 2012) employed time series analysis to determine how to effect socio-economic variables to the property crime rate in England and Wales for the 1961–2006 period. For these purposes, they used unemployment, income inequality, welfare spending, and incarceration variables and found that expected sign and a significant effect on property crime rate except for income inequality.

Ajaegbu (Ajaegbu, 2012), in another study using descriptive analysis, stated that youth unemployment in Nigeria is the main cause of violent crime. Consequently, policies implemented to eliminate youth unemployment will also lead to a reduction in violent crimes. Adebayo (Adebayo, 2013), another study used descriptive analysis, showed the existence of a positive relationship between youth unemployment and crime rates in Nigeria, and stated that the biggest obstacle to economic development is the young unemployed who are involved in crime.

Narayan and Smyth (Narayan and Smyth, 2004) applied the co-integration analysis to explore the relationship between 7 different types of property crime and violent crime, male youth unemployment and male income in Australia from 1964 to 2001. It was found that fraud, homicide and motor vehicle theft are co-integrated with male unemployment and income. However, there was no relationship between other crime types, unemployment and income.

Özer and Topal (Özer and Topal, 2017) estimated a panel data model by using Turkey's NUTS2 regions' data for the 2004–2016 period. According to the estimation results, there was a statistically significant and positive relationship between youth unemployment and crime, migration, suicide and divorce.

Fougere et al. (Fougere et al., 2009) investigated the impact of unemployment on property crimes and violent crimes in France for the period 1990–2000. Estimation results showed a positive relationship between unemployment and crime. Also, the increase in youth unemployment stimulated the increase in crime. It is emphasized that to struggle against crime effectively; firstly, it must be fought with youth unemployment.

Carmichael and Ward (Carmichael and Ward, 2000) tried to explore the relationship between unemployment and crime in England and Wales from 1985 to 1995. Different types of crime rates were used in the study. Empirical results of the study indicated that there is a positive relationship between burglary and male unemployment regardless of age. However, they found that while youth unemployment is positively related to violent crime and robbery, there was no evidence of a relationship between adult unemployment and these crimes. However, results confirmed a positive connection between adult unemployment and theft.

Grönqvist (Grönqvist, 2011) investigated the link between youth unemployment and different types of crime in Sweden. The results revealed that youth unemployment had a positive effect on crime, and the strongest effect was observed in theft. Besides that, the longer the period of unemployment, the greater the positive impact on crime. Also, the lagged crime variable was found to be significant; in other words, crime rates tended to reinforce themselves.

Filiztekin (Filiztekin, 2013) examined the NUTS 2 regions in Turkey by six different types of crime as the dependent variable, while the unemployment and wages were used as independent variables. Empirical results showed that a positive relationship between youth unemployment and all crime type except sex crimes. But results indicated that there was a negative relationship between wage and all crime except sex crimes and financial crimes.

Lauridsen et al. (Lauridsen et al., 2014) employed a spatial panel model by using data obtained sub-regional level (NUTS2) in Turkey for the 2008–2010 period. The empirical results obtained from the model can be summarized as follows; to commit criminal activity in Turkey was negatively related to deterrence. Urbanization, young people population and unemployment rates were positively related to a crime. Although educational attainment was also positively related to crime, this effect seemed to be very small. Finally, they found strong positive spatial spillover effects. However, this spillover was not clear, taking into account the endogenous relationship between crime and risk of deterrence.

Pazarlıoğlu and Turgutlu (Pazarlıoğlu and Turgutlu, 2007), explored the relationship between 10 different crime types, unemployment and gross domestic product by using the co-integration analysis for 1968–2004 period. Their results showed that some crime types were positively related to income in the long term in Turkey, but no relationship was detected between unemployment and crime.

4. Dataset and Method

4.1. Dataset

The dataset used in this study is gathered from Turkey Statistical Institute (TURKSTAT) database. The dependent and independent variables included in

the model estimates are listed in Table 2. Data on these variables was obtained by 26 sub-regions of Turkey between the years 2008–2017.

Table 2

The dependent and independent variables in the models

Variable		Definition	Source	Expected Sign
Dependent Variable	Total	Total number of convicted prisoners	TURKSTAT	
	Theft	Total number of convicted prisoners for theft	TURKSTAT	
	Cap	Total number of convicted prisoners for a crime against property	TURKSTAT	
	Violent	Total number of convicted prisoners for violent crimes	TURKSTAT	
Independent Variable	Youth	Youth unemployment rate	TURKSTAT	(+)
	Adult	Adult unemployment rate	TURKSTAT	(+)
	Male	The youth unemployment rate, male	TURKSTAT	(+)
	Female	The youth unemployment rate, female	TURKSTAT	(+)
	Under High	The youth unemployment rate, underhigh school education level	TURKSTAT	(+)
	Above High	The youth unemployment rate, abovehigh school education level	TURKSTAT	(+)
	Higher	The youth unemployment rate, higher educational level	TURKSTAT	(+)
	GDP	Gross domestic product per capita (TL)	TURKSTAT	(+),(–)

In Table 2, the definitions of each variable are given. To be more specific, some definitions will be expanded.

The third dependent variable, cap consists of the crimes such as fraud, forgery, debit, bribery, smuggling, damage to property, opposition to bankruptcy and enforcement law. The fourth dependent variable, violent, includes crimes such as homicide, injury, sex crimes, deprivation of liberty, insult, robbery, threat, other crimes with knives and firearms.

Youth unemployment is defined as comprising young people of age is between 15–24. However, adult unemployment is descriptive of the people who are 25 years and older.

The youth unemployment rate by education level cannot be obtained from TURKSTAT for the whole period. Thus, the model that includes under high, above high, and higher variable is estimated in the 2008–2013 period.

Finally, the total number of convicted prisoners are used as independent variables. When the variables included were per person instead of total numbers, we obtained the same results.

4.2. Empirical model

Spatial dependence can be expressed in general in Tobler's (Tobler, 1979) first law: "everything is related to everything else, but near things are more related than distant things." Spatial dependence can occur between dependent variables or error terms. In the spatial lag model, the dependent variable in a region is associated with the dependent variable in neighbouring regions, whereas in the spatial error model, this relationship is seen in the error term. In the first one, the spatial effect is added to the model as an independent variable. In the last one, this effect is included in the error term.

Spatial-effect model estimates can also be made in the panel dataset consisting of time series observations of spatial units. Panel data models are described as the fixed and random effect models according to unobservable effects. If the unobservable effects are included in the constant term in the model, the model is defined as "fixed effect model." However, if the unobservable effects are taken in the error term, the model is called as "random effect model." In this case, it should be decided whether the model has a fixed or random effect as well as a spatial lag or error effect.

The spatial lag model is formulated for the fixed effect panel data model as seen in the following example.

$$Y_{it} = \rho W Y_{it} + X_{it}\beta + \mu_i + \varepsilon_{it} \tag{1}$$

$$E\left(\varepsilon_{it}\right) = 0, \qquad E\left(\varepsilon_{it}\varepsilon_{it}^{'}\right) = \sigma^2 I_N$$

Also, the spatial error model is written for the fixed effect model as follows:

$$Y_{it} = X_{it}\beta + \mu_i + \phi_{it}$$

$$\phi_{it} = \lambda W \phi_{it} + \varepsilon_{it} \tag{2}$$

$$E\left(\varepsilon_{it}\right) = 0, \qquad E\left(\varepsilon_{it}\varepsilon_{it}^{'}\right) = \sigma^2 I_N$$

Similarly, we can write spatial lag and spatial error models for random effect panel model as formulated in 3 and 4 below.

$$Y_{it} = \rho W Y_{it} + X_{it}\beta + \varepsilon_{it} \tag{3}$$

$$\varepsilon_{it} = \alpha + \mu_{it}$$

$$Y_{it} = X_{it}\beta + \varepsilon_{it} \tag{4}$$

$$\varepsilon_{it} = \alpha + B^{-1}u_{it}, \qquad B = I_N - \lambda W$$

Where Y_{it}; dependent (crime) variable vector, X_{it}; independent (youth and adult unemployment and GDP) variables matrix and ε_t; random disturbance term, W; spatial weight matrix, ρ; spatial lag term, λ; spatial error term. WY_{it} refers to spatial lagged crime levels obtained by multiplying the regional crime levels with a spatial weight matrix.

In the spatial lag models (1 and 3) ρ can be interpreted the existence of spatial interaction, and in our models, positive and significant ρ can be commented as a positive migration effect. The spatial effect in the spatial lag models implies that change in crime level of given sub-region depends on the crime level of the contiguity sub-regions. On the other hand, spatial error models can also be detected existence spatial interactions by λ spatial term, but it fails to identify the possible source of spatial effect. This implies that spatial interaction can occur through by variables which are not represented in the model.

Estimation of spatial models with OLS will lead to inconsistent and biased results because the basic assumptions of the OLS estimation process do not apply to spatial models. Therefore, many different models have been proposed by Anselin (Anselin, 1988), Elhorst (Elhorst, 2003) and Baltagi (Baltagi, 2005) to reach consistent predictors as a result of model estimation. In this study, spatial lag models will be estimated using Maximum Likelihood, and spatial error models will be estimated using Generalized Least Squares models.

The existence of spatial effect is determined by the Lagrange Multiplier (LM) test (Anselin, 1988; Bera and Yoon, 1993; Anselin et al., 1996; Anselin et al., 2006). In the determination of spatial lag and error models, respectively, $H_0 : \rho = 0$ (under the assumption of $\lambda = 0$), $H_0 : \lambda = 0$ (under the assumption of $\rho = 0$) are tested. On the other hand, whether the model has a fixed or random effect is determined by the Hausman test (Hausman, 1978). In this case, $H_0 : E\left(u_{it} / X_{it}\right) = 0$ is tested.

The structure of the weight matrix in the spatial models has great importance for meaningful estimation. The weight matrix was constructed using the migration dataset obtained from the Turkish Statistical Institute to define the spatial effect, which reflects the migration effect in our models. Since the weight matrix always

Table 3

Estimation results with spatial weight matrix according to the migration of regions

	Theft			Cap			Violent			Total		
	Model1	**Model2**	**Model3**	**Model4**	**Model5**	**Model6**	**Model7**	**Model8**	**Model9**	**Model10**	**Model11**	**Model12**
intercept	−778.931 (0.000)		−555.624 (0.000)	50.772 (0.930)	35.288 (0.949)	163.568 (0.746)	−1236.2 (0.003)	−1286.2 (0.002)	−717.198 (0.138)	−371.525 (0.591)	−465.500 (0.518)	
youth	−22.424** (0.017)			−6.215 (0.632)			7.962 (0.616)			−39.140 (0.332)		
male		15.564* (0.061)			−6.269 (0.581)			17.358 (0.207)			−17.389 (0.634)	
female		−13.656** (0.016)			3.594 (0.637)			-9.182 (0.309)			−9.676 (0.681)	
gdp	0.094* (0.000)	0.079*** (0.000)	0.057*** (0.000)	0.023*** (0.005)	0.024*** (0.004)	0.048*** (0.005)	0.145*** (0.000)	0.148*** (0.000)	0.118*** (0.000)	0.421*** (0.000)	0.418*** (0.000)	0.294*** (0.000)
adult	49.432*** (0.004)	4.718 (0.798)	24.645* (0.052)	32.670 (0.175)	26.996 (0.258)	21.112 (0.574)	−0.473 (0.987)	0.360 (0.989)	4.718 (0.858)	81.148 (0.281)	61.279 (0.407)	−101.269* (0.053)
underhigh			−5.064 (0.432)			4.794 (0.791)			-3.784 (0.775)			42.891* (0.067)
abovehigh			−2.616 (0.512)			−6.127 (0.584)			0.059 (0.994)			9.679 (0.507)
higher			1.019 (0.628)			-0.828 (0.889)			6.191 (0.149)			8.175 (0.289)
ρ(error)/λ(lag)	−0.340		0.648	0.716	0.711	0.596	0.621	0.623	0.804	−0.424	−0.409	0.715
spatial effect	Lag	None	Error	Error	Error	Error	Error	Error	Error	Lag	Lag	Error
LM test	5.469		21.989	91.752	98.4469	36.632	43.2453	42.704	72.961	16.703	15.733	6.039
p-value	0.019		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.014
model effect	Random	Fixed	Random	Random	Random	Random	Random	Random	Random	Random	Random	Fixed
Hausmann test	42.111	8.6528	104.89	9.968	13.102	583.54	97.982	618.99	112.57	42.111	11.862	3.923
p-value	0.000	0.07039	0.000	0.019	0.011	0.000	0.000	0.000	0.000	0.000	0.037	0.561

***significant at 0.01, ** significant at 0.05, *significant at 0.10 in p – values

has zeros on the main diagonal, only the effects of the neighbouring region are taken into consideration. Neighbourhood levels were determined according to the amount of migration received by the regions. In other words, if one region receives a lot of immigration from the other region, the neighbouring degree of these two regions is high. So, *W*; spatial weight matrix, was created according to the migration-receiving of regions and row-standardized.

5. Findings

The estimation results are given in Table 3. It was decided by Hausman test to use a random-effect model except models 2 and 12. Based on the LM test, the spatial effect was detected in all models except 2. In models 1, 10 and 11, the spatial effect emerged as a spatial lag. In all other models the spatial effect appeared as a spatial error. As mentioned before, due to the variables not included in the model, the spatial effect was observed in the error term in all these models.

In the models using both aggregated and disaggregated crime variables, the existence of the same relationship between crime and unemployment could not be confirmed. The adult unemployment rate is only significant in Model 1, Model 3 and Model 12, but in Model 12, it has a sign that does not match expectations. The dependent variables are theft in model 1 and 3. The results imply that adult unemployment is correlated to theft. These results are similar to Altındağ (Altındağ, 2012), Saridakis and Spengler (Saridakis and Spengler, 2012) and Pazarlıoğlu and Turgutlu (Pazarlıoğlu and Turgutlu, 2007), but are not in accordance with Entrof and Spengler (Entrof and Spengler, 2000).

On the other hand, Model 1 is the only model where the youth unemployment rate is found to be statistically significant. Unlike expected, the sign is negative. This is explained by the traditional family structure in Turkey.

As unemployed young people are protected by their families, their tendency to crime is low. Similar results were reached when the youth unemployment rate was subdivided into gender and included in the analysis. Young unemployment rates defined by gender were found to be significant only in Model 2, where theft was a dependent variable, and in other models, coefficients that were insignificant and did not match expectations were obtained. While this result is in contradiction with the findings of many studies in the literature (e.g., Lombardo and Falcone, 2011; Özer and Topal, 2017; Fougere et al., 2009), Narayan and Smyth (Narayan and Smyth, 2004) found supportive results for our study. The results in Model 2 indicate a positive relationship between male youth unemployment and theft, whereas female youth unemployment and theft are inversely related. These results can be interpreted that women leave the labor market as the unemployment period

increases. Crimes such as embezzlement and fraud in the definition of the crimes committed against the property require that the individual would first need to work in the relevant branch to commit that crime. As the participation of young people in the labor market is difficult, there is no relationship between these crimes.

In the estimation process, the youth unemployment rate was also subdivided according to education level and included in the model. While we expect that individuals are less prone to crime as their education level increases, the results supporting this hypothesis could not be obtained. While the results obtained from the model estimation are opposite to Altındağ (Altındağ, 2012), it is similar to Lauridsen et al. (Lauridsen et al., 2014). Entorf and Spengler (Entorf and Spengler, 2000) mentioned that these unexpected results are hard to explain in a conventional framework. Therefore, they stated that "employment increases illegal behaviour by exposing individuals to a wider network of delinquent peers" by referring to criminologists. So, we can say that the education system has no meaningful effect on individuals in Turkey committing a crime. It is fair to say that the education system in Turkey is not successful in keeping individuals away from crime.

The income variable (GDP) is statistically significant in all models estimated and has a positive coefficient. In this case, as the income level increases, crime rates increase and this result supports the results of Pazarlıoğlu and Turgutlu (Pazarlıoğlu and Turgutlu, 2007). This result, which seems to be opposed to the opinion expressed in the economic model of crime developed by Becker (Becker, 1968) and Ehrlich (Ehrlich, 1973), is also seen in many studies in the literature. Income can be used for illegal as well as legal reasons. If income is used to commit crimes (except rape and murder) in a society, it is not surprising that the rate of crime increases in that society (Entorf and Spengler, 2000).

The causes of violence crimes may be economic or non-economic reasons. It is stated in the literature that non-economic reasons are of greater importance in explaining violent crimes and the questions that sciences of psychology and sociology are trying to answer are discussed. Therefore, it is not surprising that statistically insignificant results are obtained in models 7, 8 and 9, where violent crimes are treated as dependent variables. However, the fact that many unemployment variables have positive coefficients, even though it is statistically insignificant, shows that the results are consistent with expectations.

The most important finding is that the estimated results revealed a spatial structure of crime in Turkey. The spatial relationship was shown mostly in the spatial error model and the positive coefficient obtained showed the presence of positive migration effect. This coefficient shows that the migration-receiving increases the crime rates of the region. The main reasons for the positive correlation between immigration and regional crime rates are the variables not included in the model, so the spatial effect is determined in the error term. This result is similar to the results of Lauridsen et al. (Lauridsen et al., 2014).

6. Conclusions

There has been an increase in crime rates and youth unemployment in Turkey in recent years. In this study, the relationship between youth unemployment and crime rates in Turkey was analysed by using spatial econometrics methods. The weight matrix created to define the structure of the spatial relationship consists of the migration amounts received by the regions. In order to examine the relationship between youth unemployment and crime rates, youth unemployment is divided into subgroups according to gender and their educational level. In the model, GDP and adult unemployment rates were used as control variables.

The results of the study do not show the expected relationship between youth unemployment and crime rates. This also applies to the sub-groups defined for youth unemployment. This can be explained by the social structure in Turkey. Young people are under the supervision of their families or close relatives for almost their entire lives. Newly graduated young unemployed people in Turkey get the full financial and spiritual support their families in all matters. Therefore, they are not exposed to the devastating effects of unemployment. This social structure, which is more conservative, increases solidarity under adverse economic circumstances and prevents individuals from tending to illegal behaviours.

The unemployment rate is insignificant defined by educational status shows that the inefficiency of the education system in Turkey. Both university and high school and vocational education levels are significantly lacking in terms of providing individuals with the skills required by today's labour market. This situation prevents individuals from finding a comfortable job. Therefore, the education system urgently needs to be reformed.

The results of the study have shown that crime has a spatial structure. The amount of migration received by the regions increases the crime rates in those regions. Migration causes many socio-economic variables in the region to be negatively affected, especially the social and demographic structure and labor market. In our study, since such variables were not represented in our models, spatial interaction could be explained by the spatial error model. This indicates that internal migration has significant impacts and emphasizes the revision and reconstruction of migration policies and all regional policies. The determination of socio-economic variables that have not been included in the study but may have led to the emergence of spatial interaction which should be the subject of future studies.

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Appendix

TR10 İstanbul
TR21 Tekirdağ, Edirne, Kırklareli
TR22 Balıkesir, Çanakkale
TR31 İzmir
TR32 Aydın, Denizli, Muğla
TR33 Manisa, Afyon, Kütahya, Uşak
TR41 Bursa, Eskişehir, Bilecik
TR42 Kocaeli, Sakarya, Düzce, Bolu, Yalova
TR51 Ankara
TR52 Konya, Karaman
TR61 Antalya, Isparta, Burdur
TR62 Adana, Mersin
TR63 Hatay, Kahramanmaraş, Osmaniye
TR71 Kırıkkale, Aksaray, Niğde, Nevşehir
TR72 Kayseri, Sivas, Yozgat
TR81 Zonguldak, Karabük, Bartın
TR82 Kastamonu, Çankırı, Sinop
TR83 Samsun, Tokat, Çorum, Amasya
TR90 Trabzon, Ordu, Giresun, Rize, Artvin, Gümüşhane
TRA1 Erzurum, Erzincan, Bayburt
TRA2 Ağrı, Kars, Iğdır, Ardahan
TRB1 Malatya, Elazığ, Bingöl, Tunceli
TRB2 Van, Muş, Bitlis, Hakkari
TRC1 Gaziantep, Adıyaman, Kilis
TRC2 Şanlıurfa, Diyarbakır
TRC3 Mardin, Batman, Şırnak, Siirt

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Methods of limiting selected risk types in the municipal waste incineration plant

1. Introduction

Risk is a very common phenomenon in the conditions of market economy and every decision made is closely connected with it. Operating in the conditions of risk is an inherent property of each economy. When observing the development of human and their surroundings, one may not ignore the risk which has always existed and been associated with it. Therefore, it may be assumed that broadly understood risk is associated not only with activities but also conditions. Predicting the determined future condition is an indispensable element of each decision but it does not always comply with our expectations. Business operations bear various kinds of risks. Most business entities try to protect themselves from its adverse effects. The development of risk management allows for partial or total risk elimination. In today's quickly developing world, enterprise operations require efficiency and determination. This is the reason why the application of the proper risk management methods for the calculation of potential profits and losses is so important.

The main objective of each enterprise is to increase its value for its owners. High risk may be an effective obstacle to the achievement of this objective. Thus, risk management is a process which forms a very important element of entire enterprise management. The development of risk management methods is associated with the emergence of an increasing number of risk types in business (Bernstein, 1995; Grace et al., 2015; Fotr, et al., 2014). Thanks to skilful activity in the sphere, an enterprise may avoid situations when it fails to reach its goals and it may also restrict losses associated with the appearance of particular hazard types. The operations of an incineration plant entail taking risks in multiple areas but the conditions

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and specific character of work are conducive mainly to the emergence of hazards associated with ecological risk. The purpose of this article is to demonstrate how the most serious dangers affecting such an enterprise as a waste incineration plant can be identified and how losses related to their appearance may be diminished.

2. Risk management methods

Risk identification involves the analysis of opportunities and hazards from the enterprise surroundings with consideration of its strong and weak points. The main instruments used to identify risk are as follows: descriptive risk assessment, inventive (heuristic) methods, e.g. brainstorming, 66 discussion, Delphi method, method of good examples, discovery matrix, Altszuller method, defectuologic method, method of voluntary limitations, etc., analysis of opportunities and risks, early recognition systems, and risk equalisation method (Butler, 2001; Haubenstock and Mude, 2002). The next stage of risk management is risk measurement. Theory of probability is one of the most effective tools for risk assessment. The assessment of risk is a starting point for making decisions on the selection of the appropriate risk manipulation methods. Two types of risk measures may be distinguished: measure at the selection stage and measure at the implementation stage (Bowels, 2004; Tepnan, 2002). Risk may also be measured with the use of probabilistic and statistical methods, sensitivity analysis methods, profile analyses used to compare alternative possibilities, scenario methods, operational methods – used in case of complex risk when other methods are ineffective (Dunett, 2004; Lam, 2003; Schroeck, 2002). The "game strategy" is used most frequently. The third stage is risk control at the strategic level, which involves an analysis of possible solutions and subsequent selection of the most optimum method for risk management. Examples of methods: assuming risk, methods aimed at limiting or eliminating risk causes or insurance against risk consequences (Charsley and Brown, 2002; Nocco and Stulz, 2006). The last stage is risk monitoring and control. Physical and financial risk control methods can be distinguished. Physical control of risk means all activities taken in order to reduce losses. Physical control may involve complete elimination of loss probability or reduction of risk through the use of measures to enable identifying the frequency and extent of damage. Financial risk control involves independent risk management by the company, i.e. retention, or using cash flows to pay potential instalments, sale of assets, special funds, loans, etc. or risk transfer to another entity (Hoyt, and Liebenberg, 2011; Davis and Agliilano, 2002; Chartered Global Management Accountant, 2015). There are no uniform methods of risk management in waste incineration plants as risk has multiple aspects in such enterprises. Aspects may refer to types of hazards – to executives, to employees, to the natural environment, to the

probability of occurrence of an adverse event, to the gravity of its consequences, etc. (Bromiley et al., 2014; McShane et al. 2011).

Figure 1 shows a scheme of the main types of risk in a municipal waste incineration plants due to the criterion of their causes. It takes into account the typical types of risks found in specialist literature, as well as new, specific types of waste incineration plants -related threats. The risk management methods presented in this paper will concern ecological risk but they can be used to test each risk type.

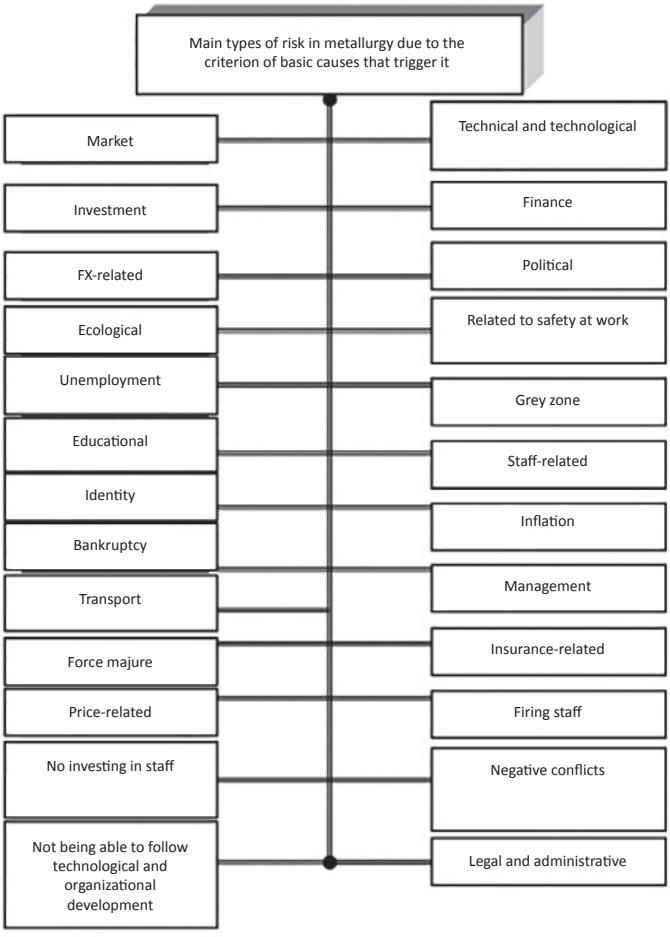

Figure 1. Types of risk in a municipal waste incineration plants due to the criterion of causes – author's study

Source: own study

Ecological risk can be connected with excessive emission of harmful substances and the emergence of large quantities of secondary waste, which accompanies the incineration process. The legislator may increase emission standards concerning the amounts of permissible emission of harmful substances into the air, water and soil, and the management of the incineration plant has not had time to prepare for that. This may mean the imposition of severe penalties for exceeding the standards. Similarly, fees for the storage of production waste may be increased and may result in penalties for breaching requirements in that scope. This may put incineration plants at risk of serious financial consequences.

2. Using the matrix method

The identification of risk areas is the first stage of the described method. The required data includes the most important types of risk and information on how a given company is prepared for the occurrence of this risk, as well as a list of reaction options to the anticipated or emerging risks based on which it will be possible to assess the effectiveness of anti-risk activities in a given company. For this purpose, a chart of analysis of threats and opportunities concerning the analysed risk type should be prepared (Tabs 1, 2). For example, Table 1 shows only eight threats to show the methodology. A three-degree scale was adopted: *l* – low likelihood, *m* – medium likelihood, *h* – high likelihood, *L* – low opportunity/low risk, *M* – medium opportunity/medium risk, *H* – high opportunity/high risk.

Table 1

Analysis of threats connected with ecological risks

Threats	Likelihood	Severity of effects
1. Contamination of air, surface water and ground water, soil	*h*	*H*
2. Emission of secondary contamination to the environment	*h*	*H*
3. Increase of the mass of waste after the incineration process	*m*	*M*
4. Social resistance to locating the incineration plant close to residential areas	*m*	*M*
5. Noise exposure	*m*	*L*

Table 1 cont.

6. Contamination with liquids, threat of slag and furnace ashes	*h*	*H*
7. Low calorific value of waste	*m*	*M*
8. Odour risk	*m*	*L*

Source: own study

Table 2

Analysis of opportunities connected with ecological risks

Possibilities to counteract	Likelihood	Favourability of effects
1. The use of specific devices and technologies in order to limit the emission of contamination	*h*	*H*
2. The use of a multi-stage system of fume purification, i.e.: dust removal system, acidic gas removal system, dosing of active coke (active carbon) for elimination (adsorption) of polychlorinated dioxins and furans	*h*	*H*
3. Appropriate, rational disposal of waste	*h*	*M*
4. Designing architecturally acceptable and functional incineration plants, which fit well to the surrounding landscape, which in themselves will be sites of architectural	*m*	*H*
5. The location of a municipal waste incineration plant on plots of significant area located in a certain distance from residential areas	*m*	*H*
6. The use of dust emission reduction techniques – electrostatic, condensation and ionising dust collectors, wet scrubbers, fabric filters, cyclones and multi-cyclones	*h*	*H*
7. Mixing municipal waste with a more calorific fuel, e.g. coal or high-calorific industrial waste	*h*	*M*
8. The use of vacuum deodorising installations	*h*	*H*

Source: own study

The conducted analysis of threats and opportunities has allowed the author to distinguish the most significant factors affecting the ecological risk in a negative or positive way.

The most significant risks which should be dealt with first are risks number: 1, 2, 6. In turn, the major possibilities to counteract the negative effects of threats connected with ecological risks are: 1, 2, 6, 8.

The next step involves risk assessment, i.e. numerical expression of the extent of threats or opportunities associated with a given risk to make an assessment. To this end, a matrix is used to strengthen the reaction between the probability of occurrence and severity or favourableness of effects in relation to the number of indications for particular relationships, using the data from tables 1 and 2. Counted, identical relations have been entered into the relevant fields of the matrix (Tabs 3, 4). Then, groups of factors were distinguished: A, B, C. GR. A are events that occur between: *bH*, *bM*, *mH*. GR. B are events that occur between: *lH*, *mM*, *bLl*. In turn, GR. C are events that occur between: *lM*, *lL*, *mL*. Then, a quantitative and qualitative comparison was made in each group to compare chances and risks.

Table 3

Matrix of relations: opportunities – probability – severity/favourableness concerning ecological risk

		Severity			**Favourableness**		
		H	***M***	***L***	***H***	***M***	***L***
Probability	***b***	3	0	0	4	2	0
	m	0	3	2	2	0	0
	l	0	0	0	0	0	0

Source: own

The quantitative analysis (Tab. 4) involves summing up individual events taking place in groups. For severity: $S_{DA} = bH + bM + mH = 3 + 0 + 0 = 3$, $S_{DB} = lH + mM + bL = 0 + 3 + 0 = 3$, $S_{DC} = lM + lL + mL = 0 + 0 + 2 = 2$, $S_Z = S_{DA} + S_{DB} + S_{DC} = 3 + 0 + 2 = 5$. For favourableness: $S_{KA} = bH + bM + mH = 4 + 2 + 2 = 8$, $S_{KB} = lH + mM + bL = 0 + 0 + 0 = 0$, $S_{KC} = lM + lL + mL = 0 + 0 + 0 = 0$, $S_S = S_{KA} + S_{KB} + S_{KC} = 8 + 0 + 0 = 8$.

Table 4

Quantitative analysis of severity/favourableness indicators concerning ecological risk

	For severity	**For favourableness**
Gr. A	$K = \frac{S_{DA}}{S_Z} = \frac{8}{17} = 0.47$	$K = \frac{S_{KA}}{S_S} = \frac{14}{17} = 0.82$
Gr. B	$K = \frac{S_{DB}}{S_Z} = \frac{5}{18} = 0.29$	$K = \frac{S_{KB}}{S_S} = \frac{3}{17} = 0.17$
Gr. C	$K = \frac{S_{DC}}{S_Z} = \frac{4}{17} = 0.23$	$K = \frac{S_{KB}}{S_S} = 0$

Source: own

Cumulative tally of quantitative and value-wise assessment of opportunities and risks is presented in Table 5.

Table 5

Cumulative tally of quantitative and value-wise assessment of opportunities and risks

	Severity		**Favourability**	
	quantity	**value**	**quantity**	**value**
Gr. A	3	0.6	8	1
Gr. B	3	0.6	0	0
Gr. C	0	0.4	0	0

Source: own

As shown in Table 5, for favourability, factor group A having the most significance for the proper functioning of an incineration plant connected with threats concerning ecological risks assumes the value of 0,6; while for severity, where group A causes most adverse effects connected with such risks, it assumes the value of 1. This means that actions aimed at reducing the listed threats need to be undertaken, as they are economical (Kubińska-Jabcoń, 2018).

4. Using the modified FMEA method

FMEA method – the analysis of causes and effects, a method that companies use to prevent and mitigate the effects of defects. Its purpose is to identify and assess the risk associated with weak points that occur during production planning and the manufacturing process, which significantly reduces this risk (Shahin, 2004; Vacik, Fotr, Špaček and Souček, 2014). The risk priority number – RPN – is a product of integral numbers rom the range (1–10) that describe the frequency of a defect (risk of defect: 1 – low probability, 10 – high probability). Number (R), meaning of defect for the client: 1 – negligible importance, 10 – significant. Number (Z), detection level; describes the probability that a defect will not be detected by the manufacturer and will go to the client: 1 – easy to detect, 10 – hard to detect. Number (W), the values that RPN can take are in the range from 1 up to 1000. The higher the RPN value, the greater the risk associated with a defect. The assessment indicator in the FMEA method – the number of priority risk is:

$$RPN = P \cdot Z \cdot T \tag{1}$$

where:

P – probability of error/defect,
Z – meaning for the client,
T – ease of detection.

Modified FMEA method has been used to assess risk in the municipal waste incineration plant. Indicators are adopted based on Table 6 (Kubińska-Kaleta, 2008).

Table 6

Adopted scale for P, H_s, T indicators

$P_R P_M$		H_s		T_R/T_M	
Low chance of occurrence	1	No significance	1	Very easy to counteract / very difficult to apply	1
Very unlikely	2–3	Low significance	2–3	Easy to counteract / difficult to apply	2–3

Table 6 cont.

Unlikely	4–6	Average significance	4–6	Medium difficult to counteract / can be applied	4–6
Rather likely	7–8	High significance	7–8	Very difficult to counteract / easy to Apple	7–8
Very likely	9–10	Very high significance	9–10	Cannot be counteracted / very easy to apply	9–10

Source: own

For the purposes of the study of risks occurring in industrial plants, a modification has been proposed consisting in adjusting the RPN indicator, and following designations have been assumed:

$$C_R = P_R \cdot H_S \cdot T_R \tag{2}$$

$$C_M = P_M \cdot H_S \cdot T_M \tag{3}$$

where:

C_R – risk assessment indicator,
C_M – opportunity assessment indicator,
P_R – likelihood of occurrence of a given risk,
P_M – likelihood of occurrence of a given opportunity,
H_S – significance for the proper functioning of an incineration plant,
T_R – difficulties in counteracting a risk,
T_M – ease of adjusting given opportunities.

Numbers C_R and C_M are integral numbers from the range (1.1000). If the number is significantly greater than one, preventive measures should be taken (in case of risk); or a given threat can be easily counteracted (if possible). To be able to effectively counteract the risks and to make these activities profitable, $\Sigma C_M < \Sigma C_R$. In accordance with the scale adopted above, particular types of threats related to a given risk were considered. After calculations: sum of C_R indicator: 6221, sum of C_M indicator: 9873. $\sum C_M < \sum C_R$, so the risk can be effectively counteracted and those actions are economical.

5. The application of FTA method with reference to the analysed risk

Fault tree analysis (FTA) is an ordered graphic representation of specific conditions and other factors which cause or contribute to the occurrence of a specific adverse event, also known as the "top event." The representation is made in such a form as to be comprehensible and enable the analysis and change of a tree to facilitate the determination of:

- factors affecting reliability and characteristics which describe system functioning, e.g. type of element unfitness, operator's error, conditions of surroundings, programming errors;
- contradictory requirements which may affect faultless functioning;
- combined events affecting more than one functional element of the system which may destroy the benefits resulting from the use of the redundancy of reliability structures.

The analysis of systems using redundancy trees is a deductive (top-down) method aimed at identifying causes or combinations of causes which may lead to a specific top event. The analysis may be a quality analysis or, in specific cases, also a quantitative analysis. The process of tree creation begins with the identification of a top event. The event is an output of a top logic gate while the relevant input events identify possible causes and conditions of the occurrence of a top event. Each input event may also be an output event of a lower-level logic gate. If an output event of the gate determines the incapacity to perform the assumed function, the corresponding input event may describe the incapacity of the device or its functional limitations. If an output event means damage to the device, the relevant input event may be the defect of a device, lack of control and basic power supply provided that these events may actually happen and they have not been incorporated earlier as parts of limitations in device functioning.

The extension of a tree branch ends when one or more of the following events take place:

- basic events, i.e. independent events for which important characteristics may be defined differently than with the use of a fault tree;
- events which need not be extended;
- events which were or will be further extended in another fault tree (PN-EN 61025:2007 Fault Tree Analysis).

Figure 2 shows a fragment of a fault tree for the analysed types of risk.

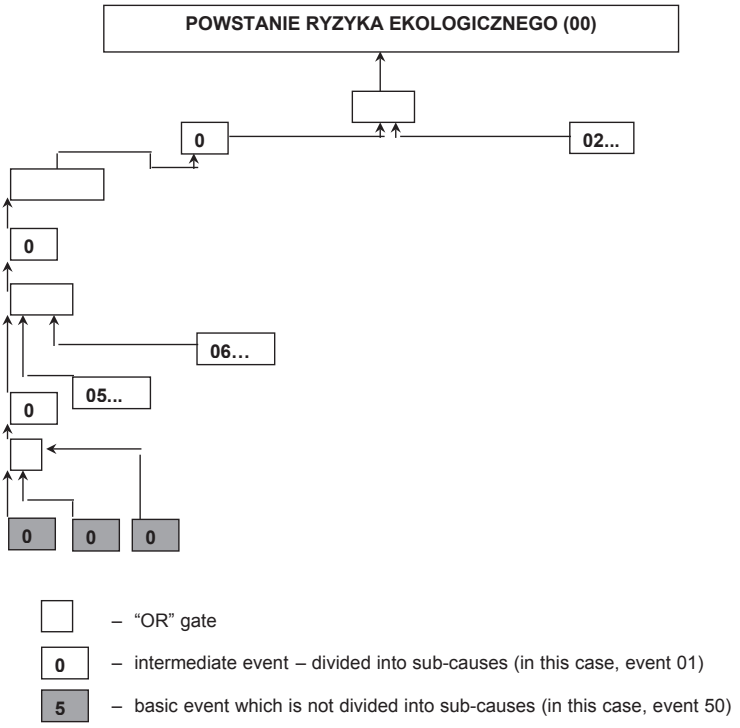

Figure 2. Fault tree

Source: own

Explanation:

01 – air pollution, contamination of surface and underground waters, soil and fossil deposits, people, fauna and flora, landscape, material goods,
02 – increasing the mass of waste after the combustion process... (this tree branch should be extended similar to the presented example starting with hazard 01),
03 – emission of secondary contamination to the environment as matter is not destroyed in combustion but only changes its form and chemical composition,
04 – contamination which goes to water,
05 – pollution with dusts,
06 – danger of slags and combustion ashes,
07 – wastewater from devices controlling air pollution, e.g. salts, heavy metals,
08 – final process of discharging wastewater from the treatment plant, e.g. salts, heavy metals,
09 – water from the boiler room – leaks during boiler blow-out, e.g. salts.

When using the FTA fault tree and the proposed solutions, an algorithm must be created in the next step to separate basic events corresponding to ecological risk. The first step after algorithm starting is to check if ecological risk has not increased. If not, the algorithm stops; if yes, the algorithm looks for causes in the subsequent steps. The second step is to start a loop which is the main part of the algorithm. It involves the verification of all factors which increase ecological risk and have earlier been included in the designed fault tree. Beginning with the first conditional instruction inside the loop, note that the algorithm uses the effects produced by the fault tree, which makes them closely connected. The conditional instruction retrieves data from the fault tree on whether i-th event is basic, and then, based on the instruction, it goes further, depending on the value obtained from FTA, i.e. if the condition is fulfilled, it goes to the next conditional instruction; if not, the next event is verified. If it is assumed that the condition is met, or the currently tested event is a basic event, the next conditional instruction checks if the tested basic event occurs. If not, then the next event is checked and if so, when possible, the algorithm suggests the solution to be used to eliminate or limit an adverse event or prompts preventive activities to be taken so that the event would not be a problem again in the future. Here, the algorithm is a tool to efficiently locate adverse events increasing ecological risk and to quickly obtain information on how to counteract them (if possible).

In that case, the treatment algorithm would not work without a fault tree thanks to which basic events on which its procedures are based may be separated (Kubińska-Kaleta, 2008).

Preventive activities:

07' – appropriate management of process waste from exhaust fumes treatment,
08' – appropriate management of process waste from exhaust fumes treatment,
09' – appropriate management of process waste from exhaust fumes treatment.

The examples of the application of this solution may be seen in Vienna where cake wash strainers from the wet purification of exhaust fumes are taken to waste disposal sites in salt workings, outside the territory of Austria.

6. Conclusions

In order to manage risk effectively, an enterprise should determine areas of risk, its extent, ways of influencing activity, process, organisation, and steps to take in order to eliminate or restrict risk to an acceptable level. Risk management may bring expected effects, e.g. reduce losses when activities are undertaken in

the enterprise in a continuous and effective manner. As the results of the research carried out using two methods show, threats associated with risk play a huge role in a company's proper functioning.

In method I, a group of factors with the most significance for the proper functioning of an enterprise for favourable phenomena exceeded the group of factors causing the most adverse effects connected with a given risk, which indicates that actions limiting or eliminating such risk are economical.

In method II, the sum of C_R indicator is smaller than the sum of C_M indicator, which means that it is economical to take actions aimed at limiting or eliminating such risks.

At the final stage, based on the obtained results, it is possible to create an algorithm that would monitor the analysed risk, which would aim to isolate the basic event responsible for the creation of ecological risk, using the FTA fault tree and the proposed solutions.

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Summaries

Štefan Bojnec, Drago Papler: **The analysis of liberalisation of the electricity market in Slovenia** ▪ Managerial Economics 2019, vol. 20, No. 1

JEL Classification: L94, L81, L11, D49, C22, C83

Keywords: *electricity market, electricity enterprises, market concentration, determinants of price, wholesale-to-retail-sale supply chain management, Slovenia*

The purpose of this paper has been to investigate wholesale-to-retail-sale electricity supply management in Slovenia. The rapid increase in electricity supply in Slovenia has been determined by increasing industry, public and household electricity demands. The paper analyses structures and dynamics in wholesale-to-retail supply chain structures and management that are important for purchases of electrical energy by electricity distribution retailers. By using Lorenz's curve and Gini's coefficient of concentration, there is found to be a relatively high degree of concentration of wholesale electricity suppliers in the delivery of electrical energy to the retail electricity distribution enterprises. Whereas the number of the wholesale electricity suppliers has increased, the great majority of them hold with relatively small market shares vis-à-vis the large traditional wholesale electricity supplier. The electricity supply by smaller electricity producers is largely based on renewable sources of energy, which also depends on the weather conditions. The empirical evidence suggests that wholesale-to-retail electricity supply structures are shifting slowly from a monopoly market structure towards greater competition with the characteristics of product differentiation and market segmentation. The regression analysis for the electricity price formation for the retail electricity distribution enterprise confirms the significance of the costs for the purchased electricity, expenses for wages and for taxes. The multivariate factor analysis confirms the importance of recognition and business trust in the wholesale-to-retail-sale electricity supply chain management.

Halil Tunca, Ferda Esin Gulel, **Youth unemployment and crime: an empirical investigation for Turkey** ▪ Managerial Economics 2019, vol. 20, No. 1

JEL classification: C33; J64; A12

Keywords: youth *unemployment, crimes, spatial econometrics*

The crime economy has lately become a popular field of research because of regular increases in crime rates. Economists' interest in crime analysis goes back to Becker's (1968) model. "Cost--benefit" analysis determined the crime preferences of rational individuals in this model. According to this analysis, if the benefit from the crime is higher than the cost to be faced, the individual will be willing to commit the crime. One of the factors studied in the crime phenomenon is migration. The main reason for migration is unemployment and poverty. The main purpose of

this study is to determine the relationship between youth unemployment and crime rates by migration-receiving regions. By this purpose, aggregated crime rates, as well as non-aggregated crime rates (property crime, theft, and violent crime), were used. Also, the youth unemployment rate has been subdivided by gender differences and educational levels. We prefer to use spatial econometrics models in this study because of the unemployment rate, and crime rate showing the regional cluster pattern. Migration-receiving is considered as regions neighboring.

Ewa Kubińska-Jabcoń, Mariusz Niekurzak: **Methods of limiting selected risk types in the municipal waste incineration plant** ▪ Managerial Economics 2019, vol. 20, No. 1

JEL Classification: B41, L60.

Keywords: *risk, risk management, risk control methods, ecological risk, sustainable enterprise.*

Risk has become one of the most important categories in the global economy. This term belongs to the most popular phenomena in the economy. Decision making is always connected with risk. It is an inseparable part of human history and there are no man's actions which cannot be associated with it. The notion of risk is universal: it concerns political, economic and social activities. It takes on specific meaning in the space of economic activity: taking risk entails certain financial consequences. Due to this fact, the essence of risk, methods of its evaluation, as well as its management are the topics of a growing number of publications in various scientific fields. The key problem for an entrepreneur is to first determine sources of risk, to assess its size and the influence it may have on the business, and then–to take action in order to minimize this influence. The article analyses dangers in a municipal waste incineration plant. In incineration plants there are various risks but environmental threats, broadly analysed in this article, belong to the most serious ones. Two independent risk analysis methods have been used for this purpose to determine the most serious threats related to environmental risk and options of counteracting them.

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