ANALYSIS OF THE MARKET OLIGOPOLISTIC MODEL (ON AN EXAMPLE OF AN ELECTRICITY MARKET IN MEXICO)

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V. Kalashnikov
S. Kavun

In this article, research of electricity market oligopolistic model, applied in Mexico, has been carried out and their results have been analyzed. Mexican electricity market is currently a monopoly regulated by the government (a competitive market has not been established yet). Thus, the given article can be evaluated as an empirical study of possible liberalization effects on Mexico. Analysis of the current electricity market has been conducted, the market structure (oligopolistic market), characterized not only by mutual influence on the market share price and government influence level, but a limited number of power suppliers on the market, has been explained. With the help of Cournot-Nash model electric companies maximize their profit and expand their market shares. For the comparison, we also introduce the notion of perfect competition, where each agent acts as a price taker equalizing prices and marginal costs in order to determine and maximize its profit has been introduced. The computational game theory, composed of mixed complementary problems (MCP), solved by the GAMS (www.gams.com) with the application of PATH algorithm has been offered as a modeling tool. It has been applied to the primary data of the Mexican electricity market data to obtain Nash equilibrium and Cournot cases as well as development scenario of the USA international open trade market.

Key words: Mexican electricity market, liberalization effects, Cournot-Nash model, game theoretic, algorithm PATH, market scenario.

АНАЛІЗ ОЛІГОПОЛІСТИЧНОЇ МОДЕЛІ РИНКУ (НА ПРИКЛАДІ РИНКУ ЕЛЕКТРОЕНЕРГІЇ В МЕКСИЦІ)

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Калашников В. В.
Кавун С. В.

Проведено дослідження олігополістичної моделі ринку електроенергії, яка застосовується в Мексиці, і проаналізовано отримані результати. У даний час мексиканський ринок електроенергії є монополією, регульованою державою (конкурентний ринок ще не сформований). Таким чином, подана стаття є емпіричним дослідженням можливих наслідків лібералізації ринку електроенергії для Мексики. Проведено аналіз сформованого ринку електроенергії в Мексиці, пояснено структуру ринку (олігополістичний ринок), що характеризується не тільки загальним впливом на ціну частки ринку і рівнем державного впливу, а й обмеженою кількістю представлених на ринку фірм – виробників електроенергії. За допомогою моделі Курно-Неш багато фірм максимізують свій прибуток і збільшують свою частку на ринку. Для порівняння запропоновано поняття ринку ідеальної конкуренції, де кожен учасник діє як контролер цін, вирівнюючи їх і свої маржинальні витрати з метою правильного визначення прибутку та його максимізації. Як інструмент моделювання було запропоновано теорію ігор, що складається зі змішаних взаємодоповнюючих завдань, які розв'язуються за допомогою The General Algebraic

Modeling System (GAMS, www.gams.com) за алгоритмом PATH (http://www.gams.com/solvers/sol vers.htm#PATH). Запропонований інструмент був застосований до вихідних даних мексиканського ринку електроенергії для отримання "рівноваг Неша" і "випадків Курно", а також до сценарію розвитку міжнародного відкритого ринку торгівлі з США.

Ключові слова: ринок електроенергії Мексики, ефект лібералізації, модель Курно-Неша, теорії ігор, алгоритм PATH, сценарії розвитку ринку.

АНАЛИЗ ОЛИГОПОЛИСТИЧЕСКОЙ МОДЕЛИ РЫНКА (НА ПРИМЕРЕ РЫНКА ЭЛЕКТРОЭНЕРГИИ В МЕКСИКЕ)

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Калашников В. В.
Кавун С. В.

Проведены исследования олигополистической модели рынка электроэнергии, применяемой в Мексике, и проанализированы их результаты. В настоящее время мексиканский рынок электроэнергии является монополией, регулируемой государством (конкурентный рынок еще не сформирован). Таким образом, представленная статья является эмпирическим исследованием возможных последствий либерализации рынка электроэнергии для Мексики. Проведен анализ сложившегося рынка электроэнергии в Мексике, объяснена структура рынка (олигополистический рынок), который характеризуется не только общим влиянием на цену доли рынка и уровнем государственного влияния, но и ограниченным количеством представленных на рынке фирм – производителей электроэнергии. С помощью модели Курно-Нэш многие фирмы максимизируют свою прибыль и увеличивают свою долю на рынке. Для сравнения предложено понятие рынка идеальной конкуренции, где каждый участник действует как контролер цен, выравнивая их и свои маржинальные издержки с целью правильного определения прибыли и ее максимизации. В качестве инструмента моделирования была предложена теория игр, состоящая из смешанных взаимодополняющих задач, разрешаемых с помощью The General Algebraic Modeling System (GAMS, www.gams.com) по алгоритму PATH (http://www.gams.com/solvers/solvers.htm#PATH). Предложенный инструмент был применен к исходным данным мексиканского рынка электроэнергии для получения "равновесий Нэша" и "случаев Курно", а также к сценарию развития международного открытого рынка торговли с США.

Ключевые слова: рынок электроэнергии Мексики, эффект либерализации, модель Курно-Неша, теория игр, алгоритм PATH, сценарии развития рынка.

Electricity systems are currently being restructured, or are about to be restructured, in many parts of the world. The process does not follow a single paradigm, but some features are common to most situations. Competition is introduced in the generation of electricity while transmission and distribution remain regulated monopolies. A new function, namely supply, that matches loads and generation of variables of different types is introduced. It is undertaken by generators and/or by intermediaries commonly referred to as "power marketers". Generators and/or power marketers need to have access to transmission and distribution services in order to reach their customers.

Thus, there also exists an organization in charge of supplying these services. A wide variety of institutions can be constructed on the basis of these few principles. Different paradigms of restructured electricity systems are already found in Europe and the United States today.

Within the liberalization process of the European energy market guaranteed territorial monopolies were canceled in the electricity production, resulting in a new structure of energy supply and technologies. An industrial and household consumer was granted free access to different electricity providers. In many cases we even get internal and external competition in the market due to foreign providers entering the market. The competition process on electricity markets provides for great changes and new challenges to all energy producers. Still. in order to provide a sufficient and long term cost-efficient energy policy by the former "natural monopolies", as well as for an undistorted competition, strong guidelines from state authorities must be implemented.

Different kinds of non-cooperative games within various and spatially distinct markets have been examined by diverse authors.

Murphy et al. demonstrate mathematical programming approach in order to determine oligopolistic market equilibria.

Salant and Shaffer illustrate the theoretical impacts on production and social welfare by two stage Cournot-Nash solutions including investments due to learning by doing and R&D determining marginal costs of identical agents differently.

On the way to perfect competition in the electricity market, strategic behavior (i.e. cooperation, refusal of collaboration, of refusal of net access) will determine the development of energy suppliers market structure and the composition of technologies employed. Energy suppliers will optimize their production gains and their strategic behavior by maximizing market shares, increasing electricity prices, and lowering demand or consumption surplus. New energy products – such as energy services, and new market actors – such as electricity brokers, will be established.

In particular, maximizing market shares could lead to higher electricity prices, increasing production and decreasing consumption surplus, while perfect competition warrants lower prices and market gains, and an apparent increase in demand for electricity.

The principal aim of the given analysis was to investigate different strategic behaviour opportunities of Mexican market agent.

The paper is organized in the following way: the next section contains a brief description of main ideas and links of the game theoretic modeling tool, and describes the conjectural Nash equilibrium framework. The last section summarizes numerical test results and completes the paper with conclusions.

This section is based mainly on the paper by Kemfert and Kalashnikov (2002) [1], which specifies that the current Germany electricity market supply structure is characterized by natural oligopolies. Principal market agents are spatially separated in their current regional territories in Germany. Similarly, regional producers of the electricity, which now belong to Commission Federal de Electricidad (CFE), are allowed to act independently and offer their service not only to the regional, but also to neighboring regions' customers. Electricity supply and demand by aggregated households and industries determine regional equilibrium price. In order to investigate the effects of a liberalized electricity market in Europe/Germany, and the authors are going to apply it now for Mexico, a computational analysis tool EMELIE has been developed. It includes strategic behavior of firms and market agents.

EMELIE can be characterized as a computational game theoretic modeling tool in order to investigate strategic behavior of firms in Europe. The EMELIE model is a static year-based model and not an hour-based model, because we are interested in economic and environmental consequences of market producer behavior at the aggregate level. It was not our primary interest to address the economic conse¬quences of the daily electricity trade at the electricity exchanges. The process of liberalization may have serious consequences for the market structure of the European electricity market. From the economic theory of industrial organization, known that there is a range of possible market structures, it is known which could become applicable to the liberalized electricity market. There are two extreme possible market structures, namely monopoly and perfect competition. In the monopoly case, there is one large and dominant company (monopolist), as is the case of EdF in France. Due to its position, EdF could affect the market price of electricity in France in a liberalized market. In perfect competition, there are a substantial number of electricity producers with small market shares. None of the firms can execute any dominancy in the electricity market, and therefore, they cannot affect market prices. Between these two extreme market structures, there is a wide range of other possibilities, which are the so-called oligopolies. In the case of oligopolies, there are a limited number of medium-sized or large firms, and these firms dominate the supply of electricity.

Due to the size of these firms, they can affect market prices. In Germany, for instance, the initial number of 30 small companies has reduced to four large firms over a time span of a few years due to the process of liberalisation. In order to reduce market power on the national markets, governments introduce maximum allowable market shares. Although these limitations apply to domestic markets, there is no restriction on acquiring market shares in adjoin¬ing markets.

In this paper we have examined the case when, at the starting and the finishing stages of the game, electricity suppliers realize a Cournot-Nash equilibrium with their profits maximized.

Profits are calculated upon marginal production costs and price dependent demand, the latter relationship being represented by an inverse demand function, which is twice continuously differentiable.

At the intermediate stage of the game, firms maximize their profits given the strategic behavior of the other agents. Profits are computed on the basis of variable production costs, maximum net power, net access costs and transportation costs.

Market shares, which may change with merges or cooperation, also play an important role. In the oligopolistic market structure, prices can be dependent upon the market shares and market powers. Prices are also influenced by the price elasticity of demand, and it is exactly here that the influence coefficients arise. In a situation of perfect competition, that we calculate for the purpose of comparison reason, that is not the case.

The main scientific goal of this paper is to evaluate possible liberalization processes of the Mexican electricity market with the application of a game theoretic modeling tool at the Mexican level, which uses data and information from key Mexican energy suppliers and their market behaviour. The output of the model is used to analyze the implications on trade, economic change, technology choices and the environment. The main emphasis of this project is on the liberalization process from a monopolistic or imperfect market towards a fully competitive electricity market in Mexico.

When solving optimization problems, it is often useful to remember that each problem of this kind can be reduced to a complementarity problem. Generally speaking, in the complementarity framework, either a nonnegative variable is zero or the corresponding inequality constraint is active, i.e. is in fact equality. Primarily, by solving a mixed complementarity problem (MCP), the Karush-Kuhn-Tucker (KKT) optimality conditions are determined and solved for a decision variable. The MCP format and the KKT conditions are equivalent. Therefore, each MCP can be transformed to the classical optimality conditions and vice versa. The idea behind the MCP formulation is to develop a program that permits the classical decomposition method to be obsolete, instead ascertaining the MCP conditions directly. The main advantages of MCP are: (1) simultaneous and parallel determination of decision variables and side constraints, and (2) solution of complex mathematical programs without an explicit formulation of the objective function. Specially developed solvers detect the MCP format directly and point out, if necessary, if side constraints are defined incorrectly. Present day computer technologies allow an uncomplicated and fast solution of MCPs by mathematical algorithms. At this moment, for instance, GAMS provides MILES and PATH as major solvers.cf. Rutherford (1993) and Ferris and Sinaoiromsaran (1998) [2; 3], respectively. In addition, applying the MCP method, one avoids the intricacy of finding a solution by a standard nonlinear programming (NLP) solver when the starting values are distant from the optimum point.

Transforming an optimization problem into a MCP formulation requires specification of the first-order optimality conditions taking into account all upper and lower bounds of the decision variables.

The MCP format allows a quite simple characterization of simultaneously processed decision variables (as in Games Theory) and a fast solution procedure. GAMS provides this highly efficient formulation mainly to realize reciprocal modeling approaches arising, for example, in game theoretic or applied general equilibrium concepts, cf. Ferris and Pang (1995) [2].

The Cournot-Nash game is characterized by mutual strategic reactions of individual market agents. This results in Nash equilibrium where all strategies of market agents are the best replies (optimal responses) to the same of the other market participants.

In MEMM (Mexican Electricity Market Model), we have divided the country into 3 parts: Mexico North, DF+Central Part and Mexico South. 32 energy suppliers or market agents have been distinguished, corresponding to their natural areas: Baja California, Baja California Sur, Coahulla, Chilhuahua, Durango, Nuevo Leon, Sonora, Tamaulipas, Aguascalientes, Colima, Distrito Federal, Guanajuato, Guerrero, Hidalgo, Jalisco, Mexico, Mechiocan, Morelos, Nayarit, Puebla Queretaro, San Luis Potosi, Sinaloa, Tiaxcala, Veracruz, Zacatecas, Campeche, Chiapas, Oaxaca, Quintana, RooTabasco, Yucatán.

Each individual energy supplier reacts as a market player that observes the quantity strategy within a non-cooperative oligopolistic game and maximizes his/her individual profit assuming that all other players also apply the gain maximization strategy. They are allowed to supply electricity to their part, as well as to a neighboring part (e.g. Mexico North supplier can trade within his own region and with DF+Central Part, DF+Central Part agents can trade with both North and South, as well as within their own region, South can trade within its own region and with the Center). Electricity produced by one competitive player affects the sales and trade volumes of other producers. Within the classical Cournot model, each producer assumes that it is only himself/herself who varies his/her output, not other producers. At last, on the perfect competition market, agents behave as price takers, equalizing market prices to marginal production costs.

As well, we include the open trade scenario, in which free electricity trade is established between Mexico and USA.

MEMM can be characterized as a game theoretic model for the electricity market assuming perfect information, constant price elasticity within all regions, linear cost functions and a regional electricity production linked by trade flows. Each producer renders his/her supply only in one region.

Apart from input parameters of electricity production, price elasticity of demand, transportation costs and transmission grid capacities are exogenous. MEMM determines regional electricity prices, marginal electricity production costs, produced and traded electricity per technology per firm. Principal outcomes are the optimal market shares of each electricity producer in terms of the Hirschmann-Herfindal index (HHI) to measure market concentration, regional prices and interregional trade flows.

With

F – set of firms

R – set of regions

I – set of technologies

and

$l : F \to R$ – location mapping such as that $l(f) = r$ only incase firm

f is located mainly in region r

t(l(f), r) – net access for electricity l(f) to regions including taxes

c(i) – variable production costs for technology i

de0(r) – reference demand for electricity in region r

pe0(r) – reference price for electricity in region r

σ (f, r) – regional price elasticity of electricity demand in region r conjectured by firm f

capaco(r, r*) – interregional net capacity

xlim(i, f) – maximum capacity of technology i in firm f

pe(r) – demand price for electricity in region r

mc(f) – marginal costs of electricity production by firm f

τ(l(f), r) – shadow price of electricity transportation from region l(f) to region r

u(f, r) – market share of firm f in region r

s(f, r) – supply of firm f to region r

x(i, f) – production by firm f with technology i

netx(r, r*) – net export of electricity from region r to region r*

The Nash equilibrium is determined by the optimality conditions for profit maximization, equalizing marginal production plus transportation costs and prices corrected for monopoly markup and price elasticity of demand. The MCP expression applies the optimality conditions of non-linear programs as KKT conditions and obtains the optimal value of the decision variable due to their upper and lower bounds (see Ferris and Sinaoiromsaran, 1998). Following the Kemfert and Kalashnikov (2002) [1] framework, we can write the equilibrium conditions as follows.

$$mc(f) + \tau(l(f),r) + t(l(f),r) = pe(r)\left(1 - \frac{\upsilon(f,r)}{\sigma(f,r)} \times nash\right), \forall r \in R, \forall f \in F \quad (1)$$

with τ (l(f), r) = t (l(f), r) = 0 if l(f) = r, which means that the willingness for an electricity supplier to pay extra charge for net access is zero if the network is not exhausted, and we also assume, that within the regions our network connection is well developed, so we do not run into intra regional energy transfer problems.

Coefficient nash = 0 for perfect competition, nash = 1 for Nash-Cournot equilibrium.

Electricity is transported and traded from region l(f) to region r if l(f) ≠ r. Marginal production costs may increase together with the shadow prices of the capacity constraints. Net access may include taxes (which aren't in our current version of the model).

n the Nash equilibrium, prices are presented by the inverse demand function which includes price elasticity of demand and the market share of firms.

The individual demand share is determined by

$$\upsilon(f,r) = \frac{s(f,r)}{\sum_{g \in F} s(g,r)} \quad \forall r \in R, \forall f,g \in F \quad (2)$$

An upper bound of marginal costs is given by

$$mc(f) \le c(i) \quad \forall i \in I, \forall f \in F \quad (3)$$

Note that this inequality constraint is formulated this way because the lower bound of mc is zero.

The total supply is equal to the total production (that is, the market is cleared completely):

$$\sum_{i \in I} x(i,f) = \sum_{r \in R} s(f,r) \quad \forall f \in F \quad (4)$$

Aggregate supply of firms in region r equals the corrected total demand in that region, i.e.

$$\sum_{f \in F} s(f,r) = de_0(r) \cdot \left(\frac{pe(r)}{pe_0(r)}\right)^{-\sigma(r)} \quad \forall r \in R \quad (5)$$

where σ (r) > 0 is a parameter based upon the elasticity conjectured by firms-producers in region r. We assume that the elasticity parameters are 0.4 for North and Central Mexico, which is standard for the electricity markets and 0.29 for South, where we have underdeveloped inter-regional network capacities.

Net exports of region r to region r* with r ≠ r* is established by

$$netx(r,r^*) = \sum_{f \in M} s(f,r^*) - \sum_{f^* \in M^*} s(f^*,r) \quad \forall r,r^* \in R \text{ and } r \ne r^*, \quad (6)$$

where $M = \{f \in F \mid l(f) = r\}$ and $M^* = \{f^* \in F \mid l(f^*) = r^*\}$.

Exports and imports are limited by net capacity:

$$netx(r,r^*) \le capaco(r,r^*) \quad \forall r,r^* \in R \text{ and } r \ne r^*. \quad (7)$$

The maximum net production of each individual technology i bounds production or supply of electricity by firm f:

$$x(i,f) \le x\lim(i,f) \quad \forall i \in I \text{ and } \forall f \in F. \quad (8)$$

Nonnegative constraints are valid for the variables below:

$$s(f,r), x(i,f), pe(r), mc(f), \tau(l(f),r), \upsilon(f,r) \ge 0. \quad (9)\text{-}(14)$$

These models relationships are programmed in the language GAMS as a MCP solved by the algorithm PATH. An optimal solution is found by maximizing regional profits under all the constraints.

Table 1 and Table 2 display, respectively, perfect competition and Cournot-Nash equilibrium optimal prices, demands, exports and imports.

Table 1

Regional Model Results: Perfect Competition

Region	Prices in Pesos/KWh	Demand in TWh/year	Export in TWh/year	Import in TWh/year
Region 1	0.450	74.051	62.906	60.286
Region 2	0.450	126.728	133.799	57.113
Region 3	0.500	31.430	16.947	29.783

Table 2

Regional Model Results: Cournot-Nash Equilibrium

Region	Prices in EURO/KWh	Demand in TWh/year	Export in TWh/year	Import in TWh/year
Region 1	0.466	72.993	60.286	51.287
Region 2	0.534	118.396	119.041	53.880
Region 3	0.096	26.087	20.596	20.792

Tables 3 and table 4 display, respectively, perfect competition and Cournot-Nash equilibrium optimal prices, demands, exports and imports in case of the open market, e.g. the United States exporters are able to sell electricity on the domestic Mexican market.

Table 3

Regional Model Results with Open Trade: Perfect Competition

Region	Prices in Pesos/KWh	Demand in TWh/year	Export in TWh/year	Import in TWh/year
Region 1	0.378	76.220	64.555	64.357
Region 2	0.423	126.98	134.044	57.640
Region 3	0.499	31.432	16.946	29.788

Table 4

Regional Model Results with Open Trade: Cournot-Nash Equilibrium

Region	Prices in EURO/KWh	Demand in TWh/year	Export in TWh/year	Import in TWh/year
Region 1	0.453	78.270	64.361	54.033
Region 2	0.512	119.504	121.88	53.344
Region 3	0.096	26.23	21.0	20.792

Presently, the Mexican electricity market can be represented as a monopolistic market structure characterized by highly increased prices. But, if we give regional representatives of CFE some degree of freedom (we still can have all the production and network centralized and owned by the state corporation – CFE), like the possibility to offer their electricity to neighboring regions, and some net access, we obtain the oligopolistic market with competition of the participants. Computationally, this oligopolistic market structure can be realized as a Cournot-Nash equilibrium game in which the firms maximize their profits. This model is composed in GAMS as a mixed complementarity problem (MCP) solved by nonlinear complementarity and equation system solvers.

The test calculations show that the switch from the monopoly to the classical Cournot-Nash equilibrium may lead to lower consumer prices combined with higher demand, which means higher level of public wealth. It seems to be more efficient to allow the domestic supply authorities to trade with neighboring regions by offering their services to customers. The degree of achieved competition can be noticeably high – the comparison with the perfect competition model shows that the price difference is very small for northern Mexico, making more difference to the Center and especially South, though. That can be explained by the underdeveloped network connection between central and southern regions of Mexico.

As well, the possibility of international trade shows positive effect on prices and demand growth, but this effect is not crucial due to underdevelopment of the transportation capacities.

References: 1. Kemfert, C., Kalashnikov, Vitaly V., "Economic effects of the liberalization of the German electricity market – Simulation results by a game theoretic modelling tool". – In. Ronald C. Clute (ed.), Proceedings of the European Applied Business Research Conference (EABRC'2002), Rothenburg, Germany, 2002. 2. Ferris, M., J.-S. Pang. 1995. Engineering and Economics Applications of Complementarity Problems, Kluwer Academic Publishers. 3. Salant, S. W., G. Shaffer. 1999. Unequal treatment of identical agents in Cournot equilibrium. The American Economic Review 89 (3), 585-604. 4. Borenstein, S., J. Bushnell. 1996. An Empirical Analysis of Market Power in a Deregulated California Electricity Market. University of California Energy Institute, Berkeley, CA (January). 5. Bower, J., D. Bunn. 1999. A model-based comparison of pool and bilateral market mechanisms for electricity trading. London. 6. Bulavsky V. A., V. V. Kalashnikov 1998. An alternative model of spatial competition. Operations Research and Decision Aid Methodologies in Traffic and Transportation Management. Martine Labbé, Gilbert Laporte, Katalin Tanczos, Philippe Toint eds. . NATO ASI Series, Series F: Computer and Systems Science. Vol. 166, Springer-Verlag Berlin-Heidelberg, 302-318. 7. Bulavsky, V. A., V. V. Kalashnikov 1999. Fuzzy equilibrium in generalized Cournot and Stackelberg models. Proceedings of the 4th

European Workshop on Fuzzy Decision Making, Optimization, and Analysis .Rudolf Felix ed., Dortmund, Germany, 1999, June 14 – 15, 25–50. 8. Bulavsky, V. A., V. V. Kalashnikov. 1999. Equilibrium in Generalized Cournot and Stackelberg Models. Discussion Paper No. 99116, published at the CentER (Center for Economic Research), Tilburg University, The Netherlands, November 1999, ISSN 0924-7815, Pp. 1–28. 9. Claudia Kemfert, Vitaly Kalashnikov, P. E. Grohnheit, P. Fristrup, R. Denmark, W. Lise, V. Linderhof, L. Bergmann, Chloé le Coq, R. Oestling, R. Tol, Th. Heinzow, J. Bjørndalen, "Electricity Market Liberalisation in Europe (EMELIE). Market Imperfections and its Applications on the European Economic and Environmental Situation". Final Report of the EU Project "EMELIE". Berlin, January 2005, 168 p. 10. Day, C., D. Bunn. 1999. Generation asset divestment in the England and Wales electricity market: a computational approach to analyzing market power. London. 11. Kalashnikov V. V. 1995. Complementarity Problems and Generalized Oligopoly Models, (in Russian, Habilitation Thesis), Central Economics and Mathematics Institute, Moscow, 243 p. 12. Kalashnikov, V. V., N. I. Kalashnikova. 1996. Solving two-level variational inequality, J. Global Optim. 8 (3), 289–294. 13. Kemfert, C. 1999. Das Mixed Complementarity Problem (MCP) – Problemstellung und Anwendungen. IER AP-99-3, Stutgart. 14. Klemperer, P. D., M. Meyer. 1989. Supply function equilibria in oligopoly under uncertainty. Econometrica 57 (6), 1243–1277. 15. Lise, W., C. Kemfert and R. S. J. Tol (2003a): The German electricity market – Does Liberalisation bring competition? Nota di Lavoro. Milan, Italy. 3.2003. 16. Murphy, F., H. Sherali, A. Soyster. 1986. A mathematical programming approach for determining oligopolistic market equilibria. Math. Programming 24, 92–106. 17. Wei, J.-Y., Y. Smeers. 1999. Spatial oligopolistic electricity models with Cournot generators and regulated transmission prices. Oper. Res. 47 (1), 102–112.

Information about the authors

Vitaly Kalashnikov – Doctor of Economics (ED), Assistant Professor, Universidad Autonoma de Nuevo Leon (Mexico) (e-mail: kalashnikov_de@yahoo.de).

Sergii Kavun – Ph.D. (Tech.), Associate Professor, Kharkiv National University of Economics (e-mail: kavserg@gmail.com).

Інформація про авторів

Калашников Віталій В'ячеславович – доктор економіки (ED), доцент Автономного університету штату Нуево-Леон (Мексика) (e-mail: kalashnikov_de@yahoo.de).

Кавун Сергій Віталійович – канд. техн. наук, доцент Харківського національного економічного університету (e-mail: kavserg@gmail.com).

Информация об авторах

Калашников Виталий Вячеславович – доктор экономики (ED), доцент Автономного университета штата Нуэво-Леон (Мексика) (e-mail: kalashnikov_de@yahoo.de).

Кавун Сергей Витальевич – канд. техн. наук, доцент Харьковского национального экономического университета (e-mail: kavserg@gmail.com).

Рецензент
докт. екон. наук,
професор Лепейко Т. І.

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РОЗВИТОК НАУКОВО-МЕТОДИЧНИХ ПІДХОДІВ ДО РОЗУМІННЯ ПОТЕНЦІАЛУ ЯК ЕКОНОМІЧНОЇ КАТЕГОРІЇ

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Касьяненко В. О.

Узагальнено існуючі, а також виокремлено цілий ряд нових науково-методичних підходів до визначення поняття "потенціал": ресурсний – у вузькому та широкому розумінні, ймовірнісний, результатний, структурний, цільовий, результатно-ймовірнісний, що здійснювалося за критерієм урахування у визначеннях основних характеристик досліджуваної категорії, зокрема: ресурси – наявні або потенційні, можливості досягнення ефекту, фактори формування потенціалу, здатність до розвитку, ступінь потужності ресурсів та можливостей.

Ключові слова: потенціал, ресурси, можливості, запаси, джерела.