UDC 339.944
Kovalko O.M., Novoseltsev O.V., Boublik V.V.

THE RICARDIAN MODEL OF ENERGY SERVICE COMPANIES TRANSBOUNDARY COOPERATION

У статті викладено аргументи на користь доцільності системного поєднання рікардіанської моделі порівняної переваги та моделі перфоманс-контрактингу в задачі підвищення ефективності транскордонної взаємодії енергосервісних компаній. Формалізовано основні аспекти побудови запропонованої системної моделі та представлено результати розрахунків, що підтверджують її ефективність.

In this article the arguments confirming practicability of the Ricardian model of comparative advantage and the performance-contracting model system integration for the efficiency improvement of energy service companies' transboundary cooperation are given. The basic aspects of the proposed system model are formalized and the results of computer calculations which confirm its efficiency are presented.

Statement of a problem in a general view. Consistent tendency to the growth of energy consumption in the world, due to the objective needs of countries' economic development on the one hand, and the limited and inhomogeneous placement of natural energy resources on the planet on the other hand, put the issue of energy efficiency on the same level with the problems of energy security of the countries, which today have to be solved in conditions of the active and even aggressive energy markets redistribution in the direction of their globalization, diversification of supply sources, use of alternative energy resources, etc.

The sphere of the energy services is an essential part of any country's energy sector which provides complex problems solutions of efficiency, quality and reliability improvements of energy supply and energy consumption, as it should reconcile the interests of manufacturers, suppliers and consumers of products and services in both energy and a variety of related industries of the country's economy.

International (transboundary, cross-border, etc.) cooperation creates a fundamentally new challenges in the field of energy services provision, aimed at carrying out upgrade and innovative technical and technological development of each company and national economies of the countries which cooperate, and are realized through the interaction of manufacturers and financial institutions, energy service companies and state and local authorities in the market environment.

At the same time, the efficiency and effectiveness of transboundary cooperation in the sphere of energy services provision today cannot be considered satisfactory, especially due to the unaccounted in this process specific features of energy service companies' activities in the interrelated markets of the fuel and energy resources, energy-efficient equipment and energy services, systemically coordinated with the conceptual fundamentals of the theory of absolute and comparative advantages which to a certain extent determine the characteristics of effectiveness and efficiency of this interaction.

The analysis of researches and publications of last years. Modern theory of international transboundary cooperation is based upon the scientific researches of A. Smith, D. Ricardo, E. Heckscher, J. Hicks, B. Ohlin, V. Leontief, P. Samuelson, P. Krugman, as well as works of A. P. Kireev, O. V. Sidorovich, K. S. Solonenko, A. S. Philipenko and many others [1, p.36–37; 2, p.410–411; 3, p.253; 4, p.810, 821].

Historically first Smith's and Ricardo's models were built on the principles of the theory of labor cost, where the major factor, determining the benefits from production of services due to the transboundary interaction, is considered work. Smith's model is based on the principle of absolute advantage in the production of services, where export of services is considered beneficial for the country (company, etc.), which produces them at a lower cost of resources (in our consideration at a lower cost of production time) than the partner country (company), and imports those services, in which the absolute advantage belongs to cooperation partners.

Ricardo's model is based on a more universal principle of comparative advantage of the country in the production of specific services at lower economic costs than in other countries. Within his approach Ricardo reveals opportunities of applying the principles of natural advantages in the production of services specified by the unique natural resources and climatic conditions of the country, and the principle of the advantage achieved by the country due to more efficient technologies and use of highly-qualified specialists. At the same time, his model of comparative advantage has a quite significant drawback – it can be only applied to countries and companies, with almost equal production potential, and where changes in domestic demand in one country will noticeably influence the level of prices in another country (company).

Heckscher-Ohlin model is based on the principles of the theory of factors of production, where the export of services is considered beneficial, when there is a surplus of factors of production in the country for their production, and, on the contrary, it has to import the services for production of which it has scarce resources. Samuelson has strengthened the theoretical basis of Heckscher–Ohlin model introducing the principle of price equilibrium of factors of production, which takes place due to transboundary interaction.

Krugman's model with more details than the previous ones, describes the complex relationship between the quantity of companies on the market and the price of their services, according to which the more companies are on the market, the less is the amount of production of each of them, the higher are average costs per unit of service, however the higher is the competition, the lower are the prices. In this case, if the price of production is above the market one, the new companies appear, and if on the contrary the production price is below the market, companies disappear.

The results of more detailed analysis of models of comparative advantage can be found in the following publications [1, p.10–11; 2, p. 83–98; 3, p.239–240; 4, p.341–350].

Energy service companies (ESCO) which operate on performance-contracting basis, are one of the most effective and most commonly-used in the world organizational form of the energy efficiency of national economies improvement, which effectiveness has been proved practically both in developed and developing countries. The ideologist and author of most of conceptual statements of modern ESCO-model is considered to be Sh. Hansen, and the ideologist of its dissemination in Europe is P. Bertoldi, to whom more than ten published monographs on this topic, including [5, p.29–38; 6, s.1–12] belong.

ESCOs are commercial organizations (companies, enterprises), acting on the basis of the energy-service contract and providing a wide range of complex energy services that cover technical, economic, financial and legal aspects of design, engineering, installation, commissioning, monitoring and verification of the results achieved from the implementation of innovative projects in the area of energy savings and energy infrastructure development at the industrial, communal and social facilities, based on the principles of the performance-contracting, energy outsourcing, project financing, taking into account transaction costs and risk management, etc., through the use of their own and attracting external sources and resources including financial, legal, material, technical, energy and labor ones.

Energy performance-contracting is the main form of providing complex «turnkey» services by ESCO, which offers their clients a full set of business-projects to improve energy efficiency and energy conservation, the results of which are monitored (measured and verified) during the conditions of the contract, and provides guarantees that the savings achieved as a result of the projects implementation will be sufficient enough to cover the projects total costs [5, p.1–7, 29–38, 197–220].

Manufacturers of energy-efficient equipment, energy supply companies, energy engineering and energy maintenance companies often operate as effective energy service companies. However, the energy services of ESCOs are fundamentally different from other types of energy service companies – suppliers. [5, p.1–38, p.197–220; 6, p.1–12; 7, p.5–19; 8, p.51–53].

Most of the problematic issues related to the specific features of the ESCOs on the domestic energy resources, energy-efficient equipment and energy services markets are already solved in theory and in practice of ESCO-approach implementation. First of all, you should apply to the publications of such researchers as P. Bertoldi, J. Bleyl-Androschin, C. Bullock, G. Caraghiaur, J. Ellis, M. Evans, C. Goldman, S. Hansen, N. Hopper, B. Knox, M. Kolarik, P. Langlois, M. Lee, V. Lew, M. Magee, A. Marino, C. Murakoshi, H. Nakagami, N. Okay, J. Osborn, J. Painuly, H. Park, S. Rezessy, D. Schinnerl, S. Sorrell, A. Thumann, W. Turner, E. Vine, H. Zhao, and others. Among the researchers in Ukraine and on post-Soviet space the publications of I. A. Bashmakov, S. V. Golìkova, V. A. Zhovtyanskiy, M. P. Kovalko, E. E. Nikitin, A. V. Prahovnik, S.V. Sìvayev, V.A. Stepanenko, O.M. Sukhodolia, Y.I. Shulga, and others, should be mentioned in which the conceptual basis of foundation and the basic principles of ESCOs performance are considered.

Regarding the specific features of the ESCOs concerning their costs, first of all, the major role of transaction costs should be noted. The latter incur both inside the companies and outside it, as a result of their interactions in the energy services market and include any necessary costs that are not connected directly to the production of goods and services (production costs), but provide the successful implementation of transboundary cooperation. The concept of transaction costs was introduced into economics by R. Coase in the 30-s of the last century for substantiating the existence of firms and companies on the market, which in its essence are hierarchically-structured systems with the administratively-command management. Among many fundamental publications on the theory of transaction costs, which have been analyzed in this article, we should first mention the works of such researchers as K. Arrow, U. Asan, P. J. Buckley, M. Chapman, S. Cheung, R. H. Coase, N. Foss, C. Kadaifci, A. Kutlu, D. C. North, J. Ju, S. Sorrell, E. Wang, O. E. Williamson, and S. Yu. Barsukova and R. I. Kapelyushnikov. Despite the large number of fundamental publications, including monographs, most of which are made on verbal level, scientific works dedicated to the formalization of identified laws and especially their use for quantitative parameters identification of transboundary cooperation, there is a very small number [9, p.518–519; 10, p.154–157; 11, p.129–137], which underline the difficulty of this problem solving.

Unsolved parts of the general problem. Despite the fundamental achievements in the theory and practice in the three abovementioned areas of research, the problem of quantitative evaluation of the effectiveness and efficiency of transboundary cooperation among ESCOs on domestic and international markets, first of all, evaluation and realization of comparative advantage potential still remains unsolved.

The idea of the article. The purpose of this article is to justify the selection of comparative advantage and performance-contracting economic models, in the task of effectiveness improvement of ESCOs transboundary cooperation, formalization of system model equations on this basis, calculations provision and presentation of results, confirming the efficiency of the proposed model used in this task.

Statement of the basic material. Taking into account the Sorrell's methodical approach in constructing a performance-contracting model [9, p.512–513], we can define the first condition of viability (more accurately, self-supporting) of ESCO approach in the following form: the client's total cost savings, before and after signing the contract, should exceed the client's payments under the contract with ESCO (contract payments) in the amount of potential gain of the client under the contract, namely:

$$(\overset{\frown}{C}{}^{0}_{pr} - \breve{C}^{0}_{pr}) + (\overset{\frown}{C}{}^{0}_{tr} - \breve{C}^{0}_{tr}) = \breve{P}^{0} + \breve{B}^{0}, \qquad (1)$$

where: $\overset{\frown}{C}{}^{0}_{pr}$ – are the client's production costs before the contract signing (this is indicated by the superscript); $\widehat{C}^0_{tr}$ – the client's transaction costs on the same conditions; $\breve{C}^0_{pr}$ – the client's production costs on the object of energy services under the contract, after the contract signing (indicated by the superscript); $\breve{C}^0_{tr}$ – the client's transaction costs on the same conditions; $\breve{P}^0$ – the client's contract payments (ESCO income); $\breve{B}^0$ – the client's potential gain according to the contract.

The second condition for self-supporting of ESCO-approach states that the income of ESCO under the contract should be more than the total amount of expenses, incurred by ESCO, by the amount of its gain:

$$\breve{P}^1 = \breve{P}^0 = (\breve{C}^1_{pr} + \breve{C}^1_{tr}) + \breve{B}^1 , \tag{2}$$

where: $\breve{B}^1$ – is ESCO's bonus according to the contract; the upper index 1 will determine the expenses of ESCO on the object of energy services under the contract after the contract signing (the superscript)).

The third condition for self-supporting of ESCO-approach is that the client and ESCO overall production cost savings should exceed the overall increase in the transaction costs by the opportunity costs of the client:

$$(\widehat{C}^0_{pr} - \breve{C}^0_{pr}) - C^1_{pr} = C^1_{tr} - (\widehat{C}^0_{tr} + \breve{C}^0_{tr}) + \breve{C}^0_{alt} . \tag{3}$$

where $\breve{C}^0_{alt}$ – opportunity costs of the client after the contract signing.

As it's necessary to take into account other kinds of costs, besides those mentioned in equations (1) – (3), such as distribution costs associated with the promotion by ESCO of energy services and goods on the transboundary markets (for example, freight forwarding, customs, port, etc. costs), it is advisable to generalize the system (1) – (3) in the form of:

$$\begin{aligned} &\sum_{i=1}^{n} \widehat{C}^0_i - \sum_{i=1}^{n} \breve{C}^0_i \ge \breve{P}^0; \\ &\sum_{i=1}^{n} \widehat{C}^0_i - \sum_{i=1}^{n} \breve{C}^1_i \ge \breve{C}^0_1 - \sum_{i=2}^{n} \breve{C}^0_i; \\ &\sum_{i=1}^{n} \breve{C}^1_i \le \breve{P}^0 - \breve{B}^1 , \end{aligned} \tag{4}$$

where lower index $i = \overline{1, n}$ will list the relevant costs, introduced by indexes $i = (pr, tr, ds, ...)$; ds – distribution costs index.

In case of client's cooperation with several ESCOs or ESCO with several clients, for each case there are similar equation systems (4). Also note that the presented (1) – (4) equations are some kind of economic balance equations. It is clear that to complete mathematical description of the interactions between the client and ESCO, these equations have to be supplemented by the relevant equations of energy balances which restrict the acceptable modes of energy equipment operation and adjust the rules of mutual payments between the client and ESCO, caused mainly by changes in production amounts, and the corresponding decrease in the consumption of fuel and energy resources, and loading of the energy equipment which are the objects of ESCO services contract.

While choosing the model of comparative advantage we should notice once again that ESCO by its main function is a service-oriented, and not a production company, so the bulk of its expenses (up to 70%) are expenditures on intellectual work, and other types of costs are usually taken by manufacturers of energy-efficient equipment and suppliers of fuel and energy resources. Therefore, the use of Ricardian model [1, p.10–11; 2, p.83–98, 4, p.341–350], where the only factor of production is labor and which assumes that each technology can be only characterized by one coefficient of labor productivity – by laboriousness, in our case, is justified and allows to conduct a quantitative evaluation of the effectiveness and efficiency of transboundary cooperation between such ESCOs.

Let's consider the peculiarities of the Ricardian model application on the example of two ESCOs, located in different countries, which intend to cooperate with each other, in buying and selling goods and services. We will define each ESCO by top index j (in this case j=1,2). Suppose that each of the ESCOs, using existing technology, is able to provide two types of services, which can be defined by the lower index i=1,2. Then, the production of each of these services according to the Ricardian model will be characterized by its own factor of labor productivity τ_i^j, and the existing limits of production opportunities and options for the use of labor resources can be put in the form of :

$$\sum_i (\tau_i^1 \cdot Q_i^1) \le L^1 \; ; \; \sum_i (\tau_i^2 \cdot Q_i^2) \le L^2 \, , \tag{5}$$

where: Q_i – the amount of i -the service production during the working hours which are considered; L^j , $j = \overline{1,2}$ – limited amount of labor resources, which j -the ESCO possesses.

In conditions of constant labor costs, as well as the amount of available labor resources, production opportunity curves are straight lines, which equations assume the following form in coordinate axes $Q_1 Q_2$:

$$Q_2^1 = \frac{L^1}{\tau_2^1} - \frac{\tau_1^1}{\tau_2^1} \cdot Q_1^1; \; Q_2^2 = \frac{L^2}{\tau_2^2} - \frac{\tau_1^2}{\tau_2^2} \cdot Q_1^2 \, . \tag{6}$$

Equations (6) showing that opportunity costs of the first service production, expressed in units of the second one, or costs of substitution (substitution costs) of the first service by another one, is defined by the ratio between labor costs on the first and second services production (τ_1^j / τ_2^j) by each of the companies. Remember that the amount of losses incurred by the company in connection with refuse from production of one service due to increased production of another service on 1 unit defines the opportunity costs of existing resources used. Adding these costs to the amount of the actual (explicit) production costs that are fixed in accounting book allows the company to specify the amount of lost profit, related to irrational distribution of available resources, refuse from other possibilities of their use in production of alternative services, etc.

To select from a number of possible combinations of a particular kind and amount of each of the two services, those which are profitable for ESCO to produce, the comparison criterion of relative price of one of the service measured per unit of the other service (the price of the substitution of one service by the other) is used in the Ricardian model. Let p_1^j and p_2^j be the prices of the first and the second services of j -the ESCO, then the labor costs per hour λ_i^j will be equal to the costs of the first and the second services produced per hour: $\lambda_i^j = (p_i^j / \tau_i^j)$. If $(p_1^j / p_2^j) > (\tau_1^j / \tau_2^j)$, i.e. the substitution price of the first service by the second one is more than alternative production costs of these services, then labor costs per hour will be higher in the production of the first service, and under the condition of $(p_1^j / p_2^j) < (\tau_1^j / \tau_2^j)$ – the same but for the second service. Taking into account the natural need of employees to receive higher payment for their labor, ESCOs according to the Ricardian model will specialize in production of one of the services and only under condition of equal payment for both of them – both services.

Let's assume that:

$$(\tau_1^2 / \tau_2^2) > (\tau_1^1 / \tau_2^1) \text{, or the same as } (\tau_2^1 / \tau_2^2) > (\tau_1^1 / \tau_1^2) \, . \tag{7}$$

The first inequality of two in (7) is called the formula of relative advantage, which shows that the labor costs for the substitution of one unit of the first service by the second service for ESCO1 are lower than in ESCO2. In this case, ESCO1 turns out to be more effective in production of the first service than the second one (the second inequality), i.e. has comparative advantage over ESCO2 in production of this service.

Thus, to select a more beneficial company for production of the first service in conditions of transboundary cooperation is not enough just to compare labor costs of both ESCOs necessary for production of one unit of this service and to make a decision on starting its production on the basis of such absolute advantage. According to Ricardo's theory, company should rely on the principle of comparative advantage, taking into account production costs of each of the services that both companies are potentially able to produce (provide to the market).

Prices for these services, which under the principle of absolute advantage depended solely on the internal factors of production, under conditions of transboundary cooperation should also take into account market supply and demand factors for the services that now are exported or imported, because the ESCO, which has lower prices, in market conditions begins to compete with other companies for the transboundary market share, that in turn stimulates the relative price equalization (equilibrium) for these services. The final result of equilibrium is that market prices are somewhere between the existing relative prices, and their definite level will be conditioned by the amount of mutual demand and supply. That is, the price of imported services will depend on the price of the service that company want to export, to pay for the import, and the ratio of these prices will depend on domestic demand for these services in the sphere of influence of each of the ESCOs [1, s.17–20; 2, p.87–94].

Let ESCO1 labor effectiveness in the production of the first and the second services (i.e. the amount of each of these services, produced per unit of time) be $\alpha_1^1 = 1/\tau_1^1$, $\alpha_2^1 = 1/\tau_2^1$, and the substitution price of the first service by the second one be (p_1^1 / p_2^1), where p_1^1 i p_2^1 are equilibrium prices under transboundary cooperation. Under these conditions, ESCO1 has a choice, to produce (to supply) per hour either α_1^1 units of the first service, or α_2^1 units of the second service, because it has the possibilities to produce and sell the surplus of the first service and buy (and not to produce) the necessary amount of second service in the ratio of 1 unit of the first service per (p_1^1 / p_2^1) units of the second one. This will allow ESCO1 to receive per 1 unit of used labor time $Q_2^{*1} = (p_1^1 / p_2^1) \cdot \alpha_1^1$ units of the second service, and this procedure of substitution of their own (internal) production of this service by import will be profitable for ESKO1 while $Q_2^{*1} > \alpha_2^1$, or:

$$(p_1^1 / p_2^1) > (\alpha_2^1 / \alpha_1^1) = (\tau_1^1 / \tau_2^1), \qquad (8)$$

that is until it is able to receive a greater amount of the second service from abroad for its export of the first service than to buy it on the domestic market or to produce and provide it by itself.

It is easy to notice that the inequality (8) is the same as the formula of comparative advantage (7), so for ESCO1 the best strategy would be transboundary cooperation with ESCO2, oriented on increase of export of the first service and import of scarce amount of the second service, and for ESCO2 on the contrary, focused on increase of export of the second service and import of the first one. Such strategy «of indirect production» (indirect method of production) in conditions of market economy also allows to increase the consumption of both services in each country. For the calculations of transboundary cooperation values are proposed to apply the following formulas:

$$\breve{Q}_1^1 = (1 + \delta_1^1) \cdot Q_1^1; \quad p_{2/1}^1 = ((p_1^2 / p_2^2) \cdot p_2^1 - p_1^1) \cdot d_{2/1}^1; \quad \Delta_1^1 = \delta_1^1 \cdot Q_1^1; \quad R_{2/1}^1 = p_{2/1}^1 \cdot \Delta_1^1, \qquad (9)$$

where: $\breve{Q}_1^1$ – amount of service 1 enlarged production by ESCO1; $\delta_1^1 = (\tau_2^1 / \tau_1^1 - \tau_2^2 / \tau_1^2)$ – coefficient of service 1 enlarged production; Δ_1^1 – amount of alternative service 1 production; $d_{2/1}^1 = \exp(-\tau_1^1 \cdot (\breve{Q}_1^1 - Q_1^1) / (\tau_1^1 \cdot Q_1^1 + \tau_2^1 \cdot Q_2^1))$ – transboundary demand curve equation.

On the basis of equations and formulas (1) – (9) the computer model of comparative advantage of ESCO transboundary cooperation has been realized in tabulated Excel-processor with the use of Solver optimizing program, which allows to make series of parametric calculations and presents the results of calculations in table and graphic forms.

For example, the results of the model calculations of the amount of alternative service 1 production (a/service 1) as well as production possibilities lines before and after ESCOs cooperation are presented on Figure 1. On Figure 2 you can see the calculated amount of alternative revenue $R_{2/1}^1$, received by ESCO1 due to transboundary cooperation with ESCO2, from the substitution of service 2 by service 1 (a/revenue 2/1), which are measured by the right vertical axis in foreign currency 1 (the currency of ESCO1), from the price $p_{2/1}^1$ of transboundary substitution of service 2 by service 1 (t/substitution price 2/1 in currency 1), calculated by the exponential curve $d^1_{2/1}$ of transboundary demand for the substitution of service 2 by service 1 (t/demand 2/1) and from the amount Δ^1_1 of alternative service 1 production (a/service 1), necessary for transboundary substitution, and all that – is the result of change in the amount $\breve{Q}^1_1$ of service 1 production by ESCO1.

It is seen that in the considered range of enlarged production (provision) of service 1 the amount of alternative revenue of ESCO1 from its transboundary cooperation with ESCO2 has been steadily growing, and by amount of 39.1 natural units of service 1 production and the price of transboundary substitution of 1.74 monetary units in currency 1 is 28.0 monetary units in currency 1 At the same time, the amount of alternative revenue of ESCO2 from its transboundary cooperation with ESCO1 is 15.45 monetary units in currency 2, which is received as a result of production (provision) of 73,7 natural units of service 2 by the price of transboundary substitution of service 1 by service 2 in the amount of 0.39 monetary units in currency 2.

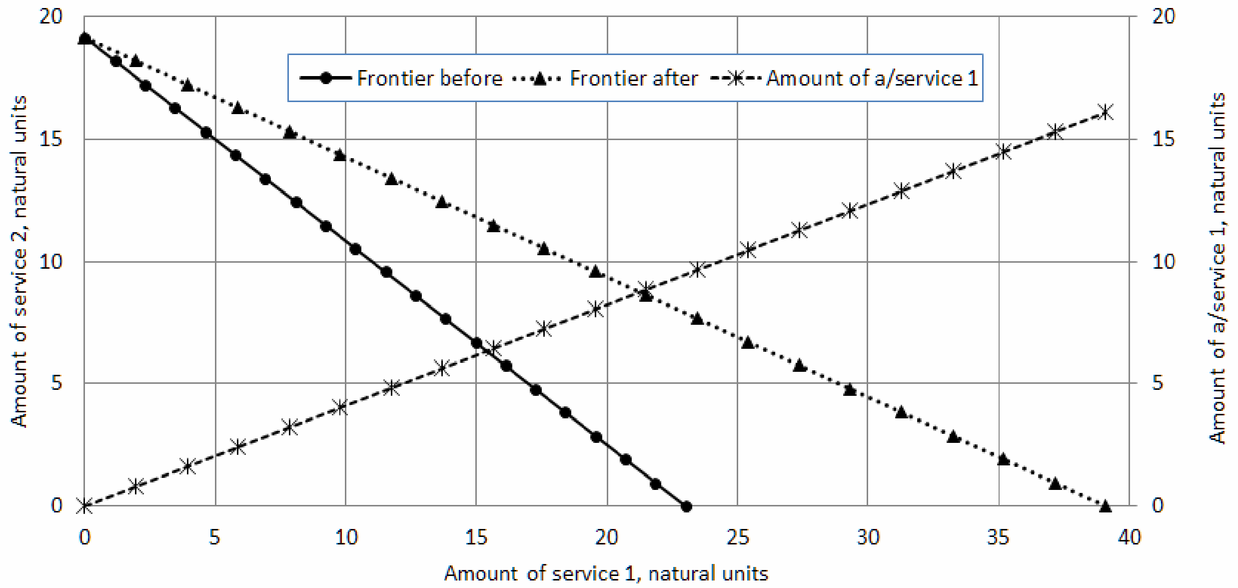

Figure 1. ESCO1 growth of service 1 production (provision)

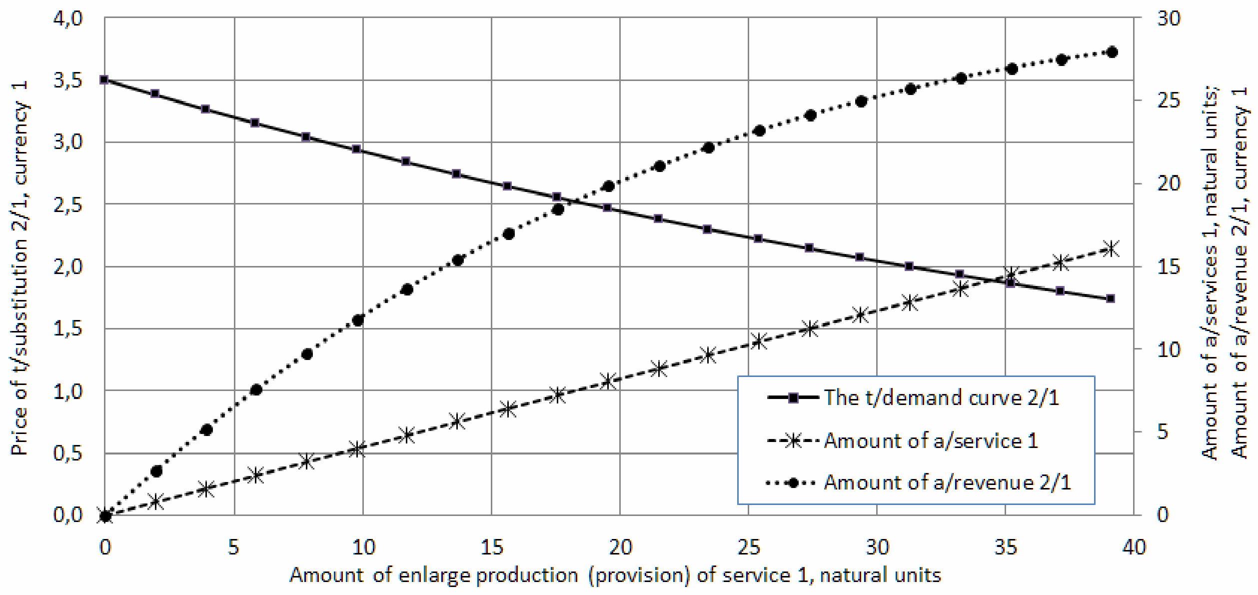

Figure 2. Dependence for ESCO1 of alternative revenue amount from the price of transboundary substitution and the amount of alternative service 1 production

Conclusions and prospects of the further studies. Despite the accepted assumptions, the Ricardian model supplemented with client objects' sub-models, in this case, ESCOs, and with formalized procedures of transboundary cooperation parameters definition allows to calculate, transparently enough, the numerical values of benefits from such interaction for all of its participants, taking into account their absolute and comparative advantages in technology and labor productivity, the difference in payments for labor and the amount of labor resources available. It is important that the defined values of comparative advantage theory can be applied to both cross-border and transboundary cooperation between definite areas, regions, and other administrative-territorial divisions and units, in one or in different countries.

The prospects for further comparative advantage research in the field of energy services are primarily conditioned by the need to supplement the model of comparative advantage with the equations of energy balances that will give a chance to use this extended model in technical and economic calculations of benefits from investments attraction in energy systems' equipment upgrading, such as the gas transportation system of Ukraine, taking into account comparative advantages that arise as a result of use of the saved volumes of natural gas under transportation as a substitution product.

References

1. Krugman P. R. International Economics: Theory and Policy / P. R. Krugman. – M.: Obstfeld. Boston: Pearson Education, 2003. – 782 p.
2. Киреев А. П. Международная экономика. В 2-х ч. – Ч. I. Международная микроэкономика: движение товаров и факторов производства / А. П. Киреев. – М.: Международные отношения, 1997. – 416 с.
3. Ju J. Hicks theorem: Effects of Technological Improvement in the Ricardian Model / J. Ju, X. Yang // International Review of Economics and Finance. – 2009. – № 18. – P. 239–247.
4. Сидорович А. В. Курс экономической теории / [А. В. Сидорович, Т. А. Агапова, Н. И. Васильев; под. ред. А. В. Сидоровича]. – М.: Дело и Сервис, 2001. – 832 с.
5. Hansen S. J. Performance Contracting for Energy and Environmental Systems / S. J. Hansen. – Lilburn: The Fairmont Press, 1992. – 317 p.
6. Hansen S. J. ESCOs Around the World: Lessons Learned in 49 Countries / S. J. Hansen, P. Bertoldi, P. Langlois. – Lilburn: The Fairmont Press, 2009. – 377 p.
7. Сиваев С. Б. Создание и деятельность энергосервисных компаний и перфоманс-контрактов в России. Том 1: Энергосервис и перфоманс контракты: возможности и проблемы их реализации в России / С. Б. Сиваев. – М.: WWF, 2011. – 111 с.
8. Bachmann J. Partnership and Incentives: Making Performance Contracting Work in Ukraine / J. Bachmann, A. Novoseltsev // Energy Engineering. – 2004. – Vol.101. – № 6. – P. 49–70.
9. Sorrell S. The Economics of Energy Service Contracts / S. Sorrell // Energy Policy. – 2007. – Vol. 35. – № 10. – P. 507–521.
10. Wang E. Transaction Attributes and Software Outsourcing Success: An Empirical Investigation of Transaction Costs Theory / E. Wang // Information Systems Journal. – 2002. – № 12. – P. 153–181.
11. Buckley P. J. The Perception and Measurement of Transaction Costs / P. J. Buckley, M. Chapman // Cambridge Journal of Economics. – 1997. – № 21. – P. 127–145.

Accepted for publication 20.03.2013