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EVALUATION OF THE ECONOMIC IMPACT OF ELECTRICITY PRICES CHANGE (AZERBAIJAN CASE)

Abstract. *This paper has examined the impact of electricity tariff changes to other economic sectors, as well as to potential changes of price levels in the overall economy. In this regard, the authors have applied the Inter-Industry Balance Model and its modification, i.e. Equilibrium Price Multiplier Model. The authors have also empirically built the inter-industry balance and equilibrium price models for the case of Azerbaijan's economy, and conducted analysis and assessments for this case. The inter-industry balance tables of production and distribution of products and services, officially published by the State Statistical Committee of the Republic of Azerbaijan, were taken as the primary database for this study. It should be noted that the inter-industry balance model for Azerbaijan was built based on 96 sectors of the economy. The model was used to assess the economic impact of electricity price changes in the national economy. Finally, simulations relevant to 10, 20 and 30 % increase of electricity prices were conducted and potential impacts to Azerbaijan's economy were assessed. The obtained results were analyzed and summarized.*

Keywords: *electricity prices (tariff), price change, equilibrium price model, input-output model, impact analysis, economic policy.*

INTRODUCTION

Electricity is of great importance both in human life and in ensuring economic development. Rapid development of industry and information technologies is increasingly strengthening the role of electricity in the economy. At the same time, almost all production processes use electricity. This is reflected in the formation of the cost of products.

According to scientific literature, in recent years, electricity consumption has increased more rapidly than total energy consumption. It is expected that, this process will continue in the coming years [21]. The main reason for this is the rapid industrialization process all over the world, especially in developing countries.

Under these conditions, regular analysis of energy prices, evaluation of the financial and economic performance of the country's electric power enterprises, determination of the impact of any possible price changes on population, and generally the economy is of particular importance in terms of energy security.

As part of this fast-tracking process, Azerbaijan meets some of the world's energy needs by using both hydrocarbon resources and electricity. Thus, electricity exports are among the products that bring the most amount of foreign currency to Azerbaijan.

The largest share of exports in Azerbaijan is accounts for hydrocarbon resources. Recent changes in the price of these resources in international markets revealed the need of comprehensive study of the economically efficient production and consumption of electricity in the domestic market. At the same time, along with the export of electricity, the ever-increasing electricity consumption local market puts the energy sector at the forefront. Regulating tariff rates at the country level and improving efficient use of energy are the key ways of comprehensive policy.

Thus, in the presented article the scientific and methodological assessment of the impact of electricity prices changes on the level of prices of the other sectors in the Azerbaijani economy was carried out. The assessments was fulfilled by using an equilibrium pricing model based on the inter-sectoral balance sheets for the production and distribution of products and services officially provided by the SSC.

The paper has the following structure: (i) introduction, (ii) literature review, (iii) task statement, (iv) design and methodology, (v) data, (vi) results, (vii) conclusion and references.

LITERATURE REVIEW

Y. Hasanli, F. Hasanov və M. Mansimli, researchers from the Institute for Scientific Research on Economic Reforms of the Ministry of Economy of the Republic of Azerbaijan, in their work presented at the EcoMod conference in 2010, created a balanced pricing model for the Azerbaijani economy. It should be noted, that this model is based on intersectoral balances of production and distribution of goods and services for the year of 2001 and 2006. During the study, along with the simulations for 2001 and 2006, the comparative analysis was carried out. At the same time, the existing model was developed in the format of 101 spheres of economic activity [5]. Please note, that the authors considered a balanced pricing model in terms of economic activity provided by SSC. They also modeled the interconnection between value added rates and price levels through a balanced pricing model. As a rule, the articles and books of Hasanli Y. concerning “input-output” models play an exceptional role in conducting research and expanding knowledge in Azerbaijan.

G. Bijnens, J. Konings and S. Vanormelingen using data of 10 European, highly industrialised countries, and estimate the impact of electricity prices on jobs and investment in Belgian production. The models estimate impact of electricity prices on employment and investment [1].

D. Gonese, D. Hompashe and K. Sibanda examined the impact of electricity prices on sectoral output in South Africa from 1994 to 2015. Also they econometrically examined the impact of electricity prices on output at sectoral levels over the same period. Local sources of data were utilised in applying panel data analysis. The research was done on the economy of South Africa. The results showed that electricity prices increase have a negative impact on sectoral output [3].

Associate Professor of Economics University of Pensylvania J. M. Griffin estimated the demand for electricity based on an econometric model. Thus, the model was evaluated on the basis of electricity prices, the efficiency of fuel conversion and the influx of coal, natural gas, fossil fuels and nuclear fuel [4].

Senior Economic Policy Adviser at the Federal Reserve Bank of Dallas Lutz Kilian in article “The Economic effects of energy prices shocks” published in 2008, examined the impact of shocks on energy prices in the US economy on energy demand, consumer spending, real gross output, inflation, stock prices, and so on. He has tried to answer the questions as to why there has been an increase in oil prices in recent years and why this new energy price shock has not caused a recession so far [7].

Researchers from the University of Tennessee S. Kwon, S. H. Cho, R. K. Roberts, T. Kim and T.E. Yu analyzed the effect of volatility in electricity prices based on the fact that many countries are interested in reducing energy consumption in recent years due to increased demand for electricity. It is known that price control is often used as a method of managing short-term electricity demand. However, a decrease in electricity demand may lead to a decrease in economic activity. Researchers in the article evaluated the impact of changes in electricity prices on its demand and at the same time on the manufacturing industry using econometric methods. Thus, they evaluated various scenarios using the two-stage least squares model (GS2SLS) [9].

E. Lange, in his master’s work, assessed the impact of rising electricity prices on consumer demand. The study was conducted in the field of economics of South Africa [10].

In 2011, a study by N. Q. Khanh showed that electricity prices in Vietnam were lower than the long run marginal costs in 2011, and that this did not increase energy efficiency and did not affect the security of energy supply. He notes that to this end, the Vietnamese government plans to raise electricity prices. The study evaluated the impact of raising electricity tariffs on the prices of goods and services using a static “input-output” model [12].

The Economic Development Department (EDD) and the Department of Trade and Industry (DTI) have evaluated the impact of rising electricity prices in South Africa on the competitiveness of individual mining and value chains. This paper aims to investigate the relationship between South Africa’s mining value chains and a greener development path, focusing on energy issues. Effectively, it explores whether recent electricity price increases have triggered a shift towards greener behaviors and practices by local mining and linked manufacturing companies [17].

It is known, that Iran is the largest water user in the agricultural sector, and the price of electricity for irrigation has an impact on this area. Therefore, M. T. P. Zarandi and T. Rahmani in their articles evaluated the impact of rising electricity prices on Iran’s economy on groundwater prices and agricultural production. Using the economic valuation method, it was found that electricity prices have a significant share in the price of water and, thus, have a negative impact on agricultural production [22].

Thus, a lot of research was conducted on the example of different countries in these areas. Methodological approaches are mainly based on econometric regression analysis and “input-output” models. In our study, we used the “input-output” approach to integrate all economic areas in a comprehensive way and balance the conditions.

TASK STATEMENT

The changing energy consumption pattern of economies throughout the world makes necessary the frequent revision of electricity prices. This ultimately poses impacts to price levels in overall economies of countries. Given these specifics, the assessment of potential impact of electricity price level changes on individual economic sector, as well as on the overall economy, is contemplated as one of the key areas in terms of implementing state policy and ensuring economic growth.

In Azerbaijan, electricity prices are set and regulated by the government due to lack of functional electricity market. The regulation applies to both electricity generation costs and end user prices. The Strategic Road Map on Development of Public Utilities (including electricity, gas, heat and water) adopted with the Presidential Decree No. 1138 from December 6, 2016, has the priorities called “Increase the efficiency of power plants and use the existing potential efficiently”, “Use optimal mechanisms to raise efficiency in consumption” and “Create effective regulation and auction mechanisms”, which requires a cohesive approach in setting electricity prices and measuring their impact. Thus, any change to end user prices of electricity would lead to impacts on products and services outputs in economic sectors and on the electricity demand of those sectors, which would ultimately affect the overall optimization of products and services in those sectors. These impacts will therefore bolster the optimization of both supply and demand sides of electricity sector in total.

To this regard, the potential impacts of electricity price changes to various sectors of the Azerbaijan’s economy were empirically assessed as a case study based on the methodological approach described in this paper.

DESIGN AND METHODOLOGY

The input-output model is considered the most appropriate tool in terms of impact analysis in the economy, simulation of economic arear, and study of the multiplicative effects between economic sectors. It is possible to take into direct, indirect and induced effects when conducting impact analysis based on the input-output model.

In this section of the article, we will briefly present the main points about the theoretical-methodological basis of the equilibrium price model, which is a modification of input-output model. Note that this approach is a valuation technique that allows you to accomplish any task in this regard, as well as in different countries.

In the input-output model, inter-sectoral relationships are expressed by a system of equations. Inter-sectoral analysis is performed by solving the system of equations. The general scheme of the input-output model table with mathematical symbols is as follows **(Table 1)**.

Table 1

Scheme of Input-Output Table

№	Product and services gross output (x)	Intermediate consumption					Final goods	Expenditures			
		1	…	j	…	n		Consumption expenditures	Investment expenditures	Government expenditures	Net export
1	x_1	x_{11}	…	x_{1j}	…	x_{1n}	y_1	C_1	I_1	G_1	XIX_1
…	…	…	…	…	…	…	…	…	…	…	…
İ	x_i	x_{i1}	…	x_{ij}	…	x_{in}	y_i	C_i	I_i	G_i	XIX_i
…	…	…	…	…	…	…	…	…	…	…	…
N	x_n	x_{n1}	…	x_{nj}	…	x_{nn}	y_n	C_n	I_n	G_n	XIX_n
Σ	Intermediate consumption (Z)	Z_1	…	Z_j	…	Z_n	y Z	C	I	G	XIX
Value added	Compensation of employees (W)	W_1		W_j		W_n	W				
	Taxes on production (T)	T_1		T_j		T_n	T				
	Subsidies (SB)	SB_1	…	SB_j	…	SB_n	SB				
	Operating surplus (M)	M_1	…	M_j	…	M_n	M				
	Consumption of fixed capital (AMO)	AMO_1	…	AMO_j	…	AMO_n	AMO				
	Net profit (XM)	XM_1	…	XM_j	…	XM_n	XM				
	Value added (AD)	AD_1	…	AD_j	…	AD_n	AD				
	Total Output (X)	x_1	…	x_j	…	x_n	x				

The balanced pricing model is a combination of Leontief's input-output balance model. As in the input-output model, let's take the following symbols:

A — Matrix of direct cost;

$\bar{x} = (x_1, x_2, ..., x_n)$ — Gross output vector;

$\bar{p} = (p_1, p_2, ..., p_n)$ — Prices vector;

P_i — Price or price index of the unit product of field;

$p_i x_i$ — output as value of field i.

Each industry spends part of its revenues to purchase products from other industries to ensure its production. For example, in order to produce a single product from the field of i, you a_{1i} from the first area, a_{2i} from the second area, and from the nth. To purchase these products you need to spend $a_{1i}p_1 + a_{2i}p_2 +, ..., a_{ni}p_n$ amount. Thus, in order to produce a product in field of i amount of $x_i(a_{1i}p_1 + + a_{2i}p_2 +, ..., a_{ni}p_n)$, we need to spend x_i amount to purchase products from other sectors. Let us denote the remainder of the product release (value added) with V_i. Salaries, social contribution, net income (profit) and taxes on production are part of this release.

Thus,

$$x_i p_i = x_i(a_{1i}p_1 + a_{2i}p_2 +, ..., a_{ni}p_n) + V_i \quad i = \overline{1,n}$$

If we divide both sides of the equation to x_i, let us use the following equation system:

$$p_1 = (a_{1i}p_1 + a_{2i}p_2 +, ..., a_{ni}p_n) + V_i$$

Where, $v_i = V_i/x_i$ norm of value added, that is, the amount of value added per unit product.

$$\begin{pmatrix} p_1 = a_{11}p_1 + a_{21}p_2 +, \dots, +a_{n1}p_n + v_1 \\ p_2 = a_{12}p_1 + a_{22}p_2 +, \dots, +a_{11}p_n + v_2 \\ \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \\ p_n = a_{1n}p_1 + a_{n2}p_2 +, \dots, +a_{nn}p_n + v_n \end{pmatrix}$$

We can write this system in the form of a matrix-vector as follow:

$$\bar{p} = A^T \bar{p} + \bar{v}$$

$\bar{v} = (v_1, v_2, ..., v_n)$ — Vector of norm of value added.

It is possible to predict the change in the prices of the products of each sectors by knowing the value added norm in the equilibrium pricing model. The equilibrium price model allows for the determination of price fluctuations in other sectors as a result of price fluctuations in one sector. Also it allows forecasting inflation.

$$\bar{p} = (E - A^T)^{-1} \bar{v}$$

Where, $(I - A^T)^{-1}$ — is a transponder full cost matrix.

There are three ways to solve the equilibrium price model equations when solving practical problems:

a) Coefficient of direct costs, so $(I - A^T)^{-1}$ inverse matrix are given, value-added norms of the sectors $V = (V_1, V_2, ..., V_n)$ are known. Equilibrium prices of the sectors $P = (P_1, P_2, ..., P_n)$ are found;

b) $(I - A^T)^{-1}$ Matrix and $P = (P_1, P_2, ..., P_n)$ are given. $V = (V_1, V_2, ..., V_n)$ norm of value added of the sectors are found.

c) $(I - A^T)^{-1}$ Matrix and value-added norms for some sectors $V = (V_1, V_2, ..., V_k \quad k<n)$, the prices levels for remaining sectors $P = (P_{k+1}, P_{k+2}, ..., P_n \quad k<n)$ are known. An unknown part of the value-added norms and prices levels are found. Thus, $V_{k+1}, V_{k+2}, ..., V_n$ and $P_1, P_2, ..., P_n$ are found.

The tariff changes were simulated by establishing the appropriate model in the third item. When modeling, a special methodology was applied to sectors where price levels were adjusted, and the inter-sectoral balance sheet was decomposed as follows.

Let us accept the following mark:

Let us point out, V_t^m which the value-added norm of the fields whose price levels are regulated by tariffs, and V_{qt}^t which the value-added norm of the areas where price levels are not regulated.

$$V_t^t = (v_1, v_2, ..., v_k), \quad V_{qt}^m = (v_{k+1}, v_{k+2}, ..., v_n)$$

Let us denote the price index of the known k fields with , and the price index of the unknown n-k fields of sectors with P_{qt}^{qt}.

$$P_t^m = (p_1, p_2, \dots, p_k), \quad P_{qt}^{qt} = (p_{k+1}, p_{k+2}, \dots, p_n)$$

$\bar{p} = (I - A^T)^{-1} \bar{v}$ if you write the phrase in some detail, the problem is as follows.

In the **Figure 1**: B_{tt} – $k*k$ matrix, which characterizes areas where price levels are regulated by tariffs, B_{qtt} – $(n\text{-}k)*(k)$ matrix, which characterizes the full cost of areas where price levels are not regulated by the tariff, B_{qtqt} – $(n\text{-}k)*(n\text{-}k)$ matrix, which characterizes the full cost of non-tariff sectors spent on tariff areas, B_{qtqt} – $(n\text{-}k)*(n\text{-}k)$ matrix, which characterizes the full cost of tariff areas for non-tariff areas.

The above is a special case of the equilibrium pricing model that has been set up to assess the tariffs.

Where: $(I - A^T)^{-1} = B^T$ — is a transponder full cost matrix. The solution of the problem in the figure is brought to the solution of the following equation system:

$$B_{tt} \cdot V_t + B_{qtt} \cdot V_{qt} = P_t$$
$$B_{tqt} \cdot V_t + B_{qtqt} \cdot V_t = P_{qt}$$

In the first equation, V_t is found as follows:

$$B_{tt} \cdot V_t = P_t - B_{qtt} \cdot V_{qt}$$
$$V_t = B_{tt}^{-1}(P_t - B_{qtt} \cdot V_{qt})$$

The value of V_t is replacing by second equation and P_{qt} is found. That is, if V_t is executed in the second equation:

$$P_{qt} = B_{tqt} \cdot B_{tt}^{-1}(P_t - B_{qtt} \cdot V_{qt}) + B_{qtqt} \cdot V_{qt}$$

The task of revising tariffs on electricity, natural gas, and public transport has emerged as a policy decision. The impact of the new tariffs on

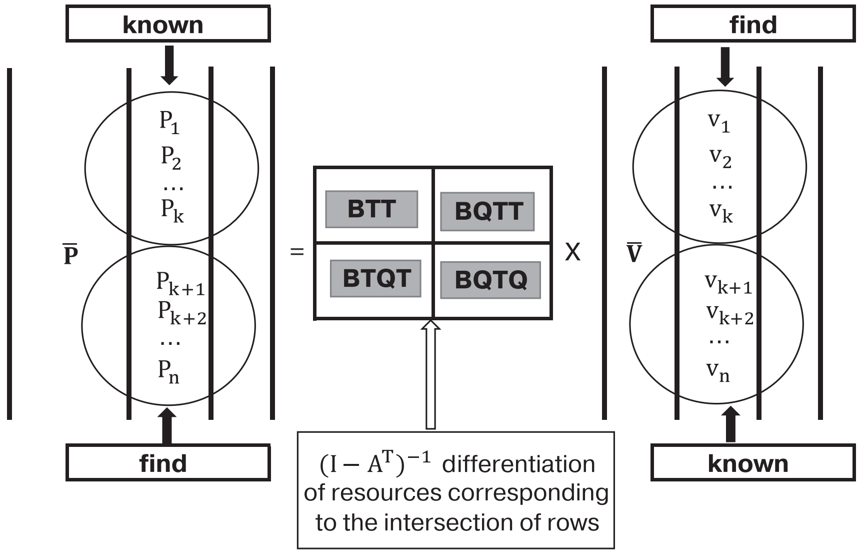

Figure 1. A special case of Equilibrium Price Model for tariff evaluation

the level of prices by economic sectors can be interpreted in several ways. Of course, certain assumptions are made when measuring the outcome of each policy decision. The scenarios are based on these assumptions. Because it is not clear how all economic agents will build their behavior when modeling.

The following assumptions were made when revising tariffs in the direction indicated in the study **(Figure 2)**:

1. When reviewing tariffs, economic agents agree to work only on new tariffs for electricity, gas and transport services, which are intermediate products they use;

2. Changes in the prices of other intermediate products are caused only by changes in the specified rates;

3. Changes in value-added norms are only due to changes in tariffs;

4. All other behaviors of economic agents are stable, and they adjust only to changes in their prices to retain their previous economic status, that is, their profitability.

Evaluation of macroeconomic implications of tariff revision sequence using a balanced pricing model is shown in the following **Figure 3**. Note that the revised tariffs are set at the first stage. In the second phase, changes in the price levels in other areas and at the same time the norm of value added are identified. Finally, the economic consequences of changes in tariffs are obtained. At the end of these stages, it is decided that tariffs will be revised and not changed.

DATA

The case study database is based entirely on the SSC of the Azerbaijan Republic official data. Thus, the establishment of the input-output model

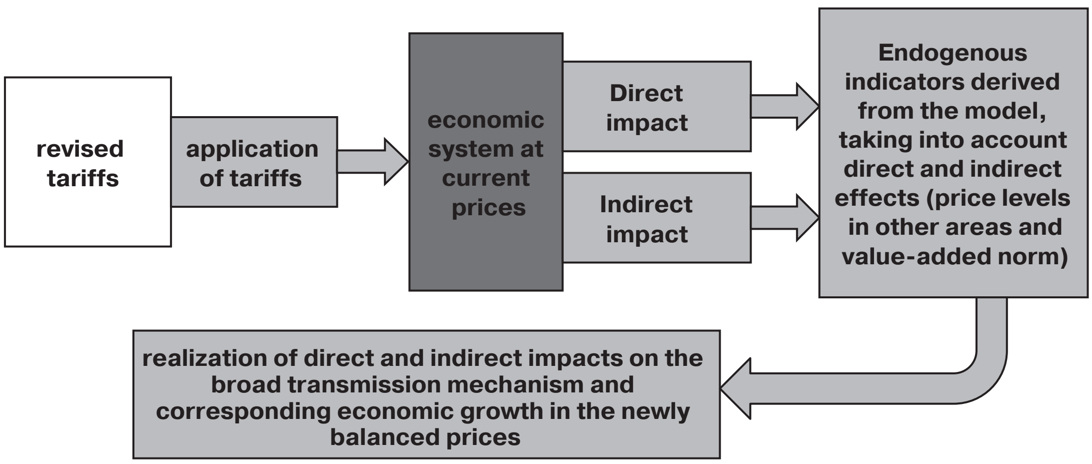

Figure 2. Scheme of transmission mechanism of price change

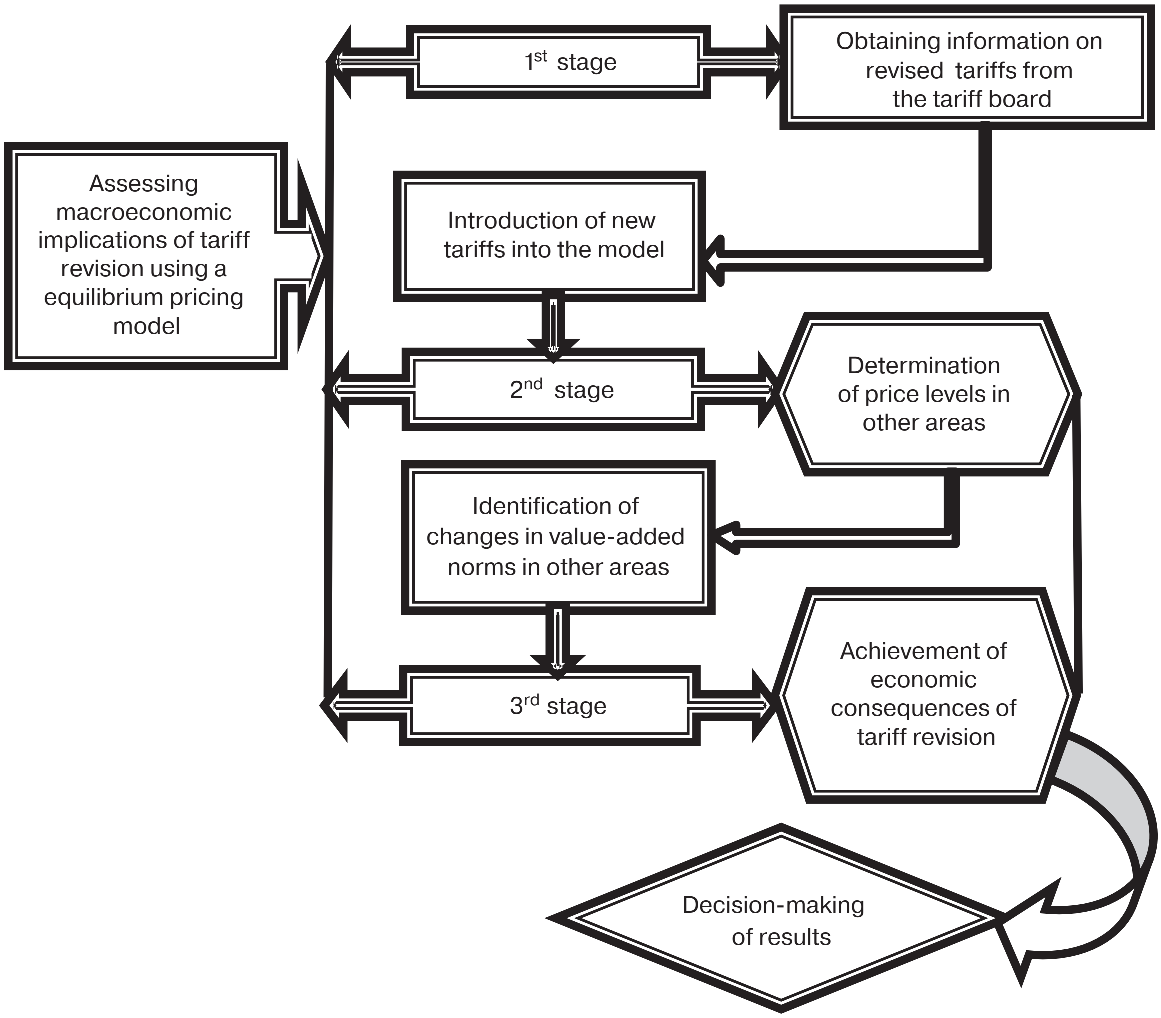

Figure 3. Block scheme of measuring the change of prices

and the equilibrium price multiplier model is based on the inter-sectoral balance sheets for the production and distribution of products and services provided by SSC in 2011.

The SSC publishes the inter-sectoral balance sheets for the production and distribution of products and services every five years. At the moment, the most recent is the data for the year of 2011. For this reason, in the paper used the inter-sectoral balance sheets for the production and distribution of products and services in 2011. However, even though the technological matrix remained stable during scenario assessments, the exogenous data were provided with the latest official statistics.

In addition let's say the built-in input-output model can be updated using the RAST method. Given the shortcoming of the RAST method, the scenario assessments were performed on the basis of 2011 but in line with the current economic situation.

RESULTS

As the next step, the authors assessed the impacts of 10, 20 and 30 % increase (i.e. increase scenarios) of the electricity tariffs to potential price increases in 96 economic sectors of the Azerbaijani economy based on the Equilibrium Prices Model. The results of the impact assessment as per all sectors are provided in the Annex. The sectors with highest price changes per all scenarios were ranked accordingly. The ranking results are given below.

As seen from the table, the simulation on 10 % increase of electricity tariffs triggers almost few changes in the prices of other sectors, and causes 0.2 % increase in inflation in the country's economy.

The second simulation scenarios of 20 % and 30 % electricity price growth lead to price rise in certain economic sectors. This could be related with high share of electricity costs in production and services in those sectors, thus, these sectors

Table 2

Ranking results for the ranking of sectors with highest price changes per all scenarios

Top 10 sectors highly affected by tariff increase	Electricity tariff increase scenarios		
	10 %	**20 %**	**30 %**
Mining of metal ores	2.77 %	5.54 %	8.31 %
Manufacture of paper and paper products	2.07 %	4.17 %	6.27 %
Manufacture of rubber and plastic products	1.07 %	2.16 %	3.24 %
Manufacture of glass and glass products	0.94 %	1.88 %	2.82 %
Manufacture of refractory products	0.90 %	1.80 %	2.70 %
Manufacture of other porcelain and pottery	0.73 %	1.46 %	2.18 %
Manufacture of other pre-processed steel products	0.68 %	1.36 %	2.04 %
Manufacture of casting services	0.61 %	1.22 %	1.83 %
Manufacture of electric equipment and their spare part	0.59 %	1.18 %	1.77 %
Water collection, treatment and supply	0.57 %	1.15 %	1.73 %
Overall countrywide inflation rate	**0.20 %**	**0.42 %**	**0.64 %**

are very sensitive to significant electricity tariff increases.

20 % and 30 % growth of electricity tariffs are certainly deemed as ponderable for economic sectors, and ultimately lead to increase of the costs of their manufactured products and rendered services. This is due to the application of a single electricity tariff rate for economic sectors. On the other hand, this condition unleashes the issue of rational electricity consumption in sectors. Fostering the rational electricity consumption can be ensured by implementing mainly through price-specific actions, i.e. price regulation. In Azerbaijan, different day and night electricity tariffs for industrial enterprises[1] are set only for large enterprises with monthly electricity consumption of above 5 million kilowatt-hours [25]. The number of such category of enterprises are however few, while the rest of economic sectors (so-called “non-residential” category) have single electricity tariff for day and night time consumption. The application of a flexible tariff system based on differentiated day and night tariffs and/or “increasing block tariffs”[2] for all “non-residential” consumers in all economic sectors might therefore allow for flexible cost of product or services, and lead to efficient electricity consumption. With optimal demand side management for electricity in economic sectors, it would also enable the optimal electricity generation at supply side.

[1] Day time tariff — 5.8 US cents per kWh; Night time tariff — 2.8 US cents per kWh

[2] Electricity consumption billing based on quantity charges — i.e. higher tariff rates for higher quantities of consumption

CONCLUSION

This paper was prepared at the Economic Modelling and Analysis Department of the Institute for Scientific Research on Economic based on the routine research works implemented for the Tariff Council of the Republic of Azerbaijan.

The objective of the paper was to develop an empirical assessment model for assessing the potential impacts of electricity prices changes to price changes in individual economic sectors, as well to price changes in the overall economy, and to analyze the findings obtained for the case of Azerbaijan.

Conducting assessments based on the methodological approach described in the paper allows for consideration of comprehensive relation within the economy. In other words, it is feasible to empirically assess the both sectoral and economy-wide impacts caused by simulated price changes.

Input-Output Tables and an Equilibrium Prices Model for Azerbaijani economy were built with relevant methodological tool and statistical database. This model enables the assessment of potential impacts of price changes not just in electricity sector, but rather in all sectors of economy. Moreover, it is feasible to weight the inflation rate, caused by price changes impacts changes, for entire economy.

Price changes simulation for economic sectors using this methodological approach can be useful in adoption of policy decisions.

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ОЦІНКА ЕКОНОМІЧНОГО ЕФЕКТУ ВІД ЗМІНИ ЦІН НА ЕЛЕКТРОЕНЕРГІЮ (НА ПРИКЛАДІ АЗЕРБАЙДЖАНУ)

Резюме. *У цій статті вивчено вплив змін тарифів на електроенергію на інші сектори економіки, а також на потенційні зміни рівнів цін в економіці загалом. У зв'язку з цим автор застосував модель міжгалузевого балансу та її модифікацію, тобто модель множинника рівноважної ціни. Також автор емпірично побудував моделі міжгалузевого балансу і рівноважних цін для економіки Азербайджану та здійснив аналіз і оцінку для цього випадку. В якості первинної бази даних для цього дослідження були взяті міжгалузеві баланси виробництва і розподілу продуктів та послуг, щ обули офіційно опубліковані Державним статистичним комітетом Азербайджанської Республіки. Слід зазначити, що модель міжгалузевого балансу для Азербайджану була побудована на основі 96 секторів економіки. Модель використовувалася для оцінки економічного впливу*

зміни цін на електроенергію в національній економіці. Тако було проведено моделювання підвищення цін на електроенергію на 10, 20 і 30 % і оцінено потенційний вплив на економіку Азербайджану. Отримані результати проаналізовані та узагальнені.

Ключові слова: *ціни (тариф) на електроенергію, зміна ціни, модель рівноважної ціни, модель введення-виведення, аналіз впливу, економічна політика.*

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ПРОГНОЗНЕ ДОСЛІДЖЕННЯ ЩОДО ПРІОРИТЕТНИХ НАПРЯМІВ ДЛЯ ДОСЯГНЕННЯ ЦСР № 14 «ЗБЕРЕЖЕННЯ ТА РАЦІОНАЛЬНЕ ВИКОРИСТАННЯ ОКЕАНІВ, МОРІВ І МОРСЬКИХ РЕСУРСІВ В ІНТЕРЕСАХ СТАЛОГО РОЗВИТКУ»

Резюме. *Стаття присвячена результатам прогнозного дослідження для виявлення пріоритетних напрямів наукових досліджень і технологій у сфері збереження морських ресурсів для досягнення Цілі сталого розвитку (ЦСР) № 14 «Збереження та раціональне використання океанів, морів і морських ресурсів в інтересах сталого розвитку». Дослідження виконано в розрізі національних завдань зазначеної цілі за такими етапами: 1) опитування експертів-представників наукових організацій і закладів вищої освіти щодо досліджень і технологій, які може запропонувати вітчизняна наука та які є необхідними для реалізації завдань ЦСР № 14; 2) опитування експертів-практиків щодо запропонованих на першому етапі досліджень/технологій, які потрібні реальному сектору; 3) визначення конкурентоспроможності запропонованих досліджень/технологій на основі бібліометричного/патентного аналізу. Здійснено узагальнену оцінку всіх запропонованих напрямів наукових досліджень і технологій за цими етапами, а також їх кластеризацію за отриманою оцінкою. Згідно з результатами проведеної роботи, з-поміж 13 пропозицій за національними завданнями ЦСР № 14 пріоритетними було визначено такі: технології інтегральної оцінки екологічного стану природних екосистем ділянок моря на основі натурних досліджень і методів дистанційного зондування землі; експрес-індикатор токсичності води; екологічний менеджмент прибережних-морських акваторій лиманів і гирлових ділянок річок в умовах розвитку природоохоронної діяльності; адаптовані для України міжнародні методи визначення чисельності риб та оцінки загальних допустимих уловів в акваторіях Чорного та Азовського морів; нові підходи управління використання водних біологічних ресурсів Чорного та Азовського морів, що спрямовані на стале використання ресурсів.*

Ключові слова: *форсайт, прогнозування, морські ресурси, цілі сталого розвитку, національні завдання, пріоритетні напрями, технології.*