Oliskevych, Marianna; Beregova, Galyna; Tokarchuk, Viktor

Article

Fuel consumption in Ukraine : evidence from vector error correction model

International Journal of Energy Economics and Policy

ISSN: 2146-4553

available at http: www.econjournals.com

International Journal of Energy Economics and Policy, 2018, 8(5), 58-63.

Fuel Consumption in Ukraine: Evidence from Vector Error Correction Model

Marianna Oliskevych[1]*, Galyna Beregova[2], Viktor Tokarchuk[3]

[1]Ivan Franko National University of Lviv, Ukraine, [2]Lviv Institute of Banking University, Ukraine, [3]National University of "Kyiv-Mohyla Academy," Ukraine. *Email: olisk@ukr.net

ABSTRACT

This paper aims to investigate the problems of energy market in Ukrainian economy. The empirical research of various energy sources in Ukraine showed the existence of significant relationships between coal, gas, diesel fuel, gasoline and oil consumption. We estimated the vector error correction model that combined evaluation of long-term interrelations between different fuels indexes and the dynamic description of their short-term behaviour. The modelling showed that in the long-run there were two equilibrium relationships that determined the dynamics of fuel consumption in Ukraine. We estimated the adjustment speeds and described the correlation between short-run changes in fuel usage and deviations from long-run equilibrium. The gas consumption was the most valuable kind of energy that had a great impact on functioning of Ukrainian energy market and the whole economy. The diversification of energy consumption types can give an opportunity to improve the economic situation.

Keywords: Energy Market; Fuel Consumption, Vector Autoregressive Model
JEL Classifications: O13, C32

1. INTRODUCTION

In contemporary economic world, it is too important to pay attention to the concept of energy safety of country taking into consideration its integration into the global economy. The energy economics covers various spheres of interest. The investigation of economic development efficiency and energy safety is based on the analysis of macroeconomic indicators that characterize the dynamics of production and utilization for different kind of energy, the amount of fuel usage, prices on energy resources, employment and inflation.

The scientists around the world study the problems of energy market, combine them with investigation of fuel consumption and emphasize the impact of efficiency in energy industry on economic success. The scientists reveal the strong relation between energy market development and economic growth. Fouquet (2016) suggested the analysis of government investment in engineering projects and subsidy policy in order to provide the access to cheap energy and economic development. He investigated industrializing economies and discussed the risks of energy-intensive pathways. Wamankar and Murugan (2015) studied the role of energy consumption for sustainable world development. The scientists presented views about characterization and utilization of different kind of solid fuels, in particular, coal, charcoal, carbon nanotube blended with biofuel, Nano additive blended fuels, carbon black based fuels and biomass based solid fuels used in compression ignition engine applications. Economou (2010) investigated the impact of the increase of carbon dioxide emissions on the increase of the surface temperature and causes of the climatic changes. He suggested that correct management of renewable energy sources especially by means of private sector regulation could protect the environment damages and contribute the economic development. Csereklyei et al. (2014) used the combined analysis of panel data for hundred countries over forty years and found stable cross-sectional relationship between energy usage per capita and income per capita. That proved that the elasticity of energy consumption with respect to income is less than 1 and showed that energy intensity decreased in richer countries. Strielkowski et al. (2013) investigated the process of implementation of rules for carbon footprint reducing in European Union in early 1990s. They defined various types of renewable energy sources and analyzed the EU legislation. Guryanova et al. (2017) emphasized that conditions of enterprising are characterized by a large number of negative factors that included business activities fluctuation on stock markets, their low level of predictability, uncertainty in future price behavior. The ineffective distribution in energy consumption can generate additional risks and lead to disturbances that could enhance the financial crises. Lukianenko and Oliskevych (2017) gave the evidences of significant asymmetries and nonlinearities in behavior of macroeconomics labor market indicators which are characterized by smooth transitions between different regime over business cycles that caused the fluctuation and shifts in the consumption on energy market. Alp (2016) examined the effect of environmental factors and energy-based economic on the economic growth. Using, vector autoregressive models and Johansen co-integration procedure, the research investigated the causality and relation between energy consumption and economic growth in OECD countries and provided evidence of validation for neutrality, growth and conservation hypothesizes for some economies.

The number of articles emphasize the importance of natural kind of energy. Landry et al. (2013) developed a methodology for the evaluation of the wind energy economic impact in Canada that took into account the construction and operations phases. Zaman (2015) used an autoregressive distributed lag approach to investigate the relation between nuclear energy consumption, labor force, gross fixed capital formation, gross domestic product per capita and energy security issues. The scientist found the evidences that technology infrastructure, energy sources, conditions of land, concern of energy security and political stability were the important factors for nuclear energy. Astariz and Iglesias (2015) evaluated the direct and indirect costs of a wave energy projects and its prospective income. Bauer (2016) evaluated the solar cooking technology and wood consumption in Nicaragua and emphasized its importance for solving of global poverty and environmental degradation problems. Chacartegui et al. (2013) investigated the utilization of low-calorific syngas fuels in gas turbines. They evaluated the effect of different fuels usage for the gas and steam combined cycle performance.

The authors investigated the usage of fuel in some particular sectors. Brueckner and Abreu (2017) constructed the model for airline's total fuel usage and investigated the impact of different factor such as the average annual fuel price, the available ton miles of capacity, the seat capacity, average distance, average load factor, the average construction year, the percentage of the airline's flights that are delayed. Peters and Manley (2012) presented the research of fuel usage in construction. They investigated the quantifying of the magnitude of fuel consumption and associated possibilities for efficiency improvements. The authors suggested that developing of standardizing fuel consumption reporting and evaluating methodologies for construction projects could help to quantify the opportunities for efficiency improvements for the equipment and project levels. Fisne and Esen (2014) investigated the coal and gas outbursts in Turkey and provided analysis of possible causes of accidents influenced by mining and geological conditions, the depth of occurrence, thickness and inclination of coal seams, the amount of ejected material, tectonic disturbances on coal and gas outburst occurrences. Klebanova et al. (2014) constructed the econometric model of warning and crises prevention. They indicated the resonance in cyclic dynamics of economics variables. Oliskevych (2015) indicated the impact of different kinds of shocks on productivity and revealed that technological shock had a strong positive long run effect on labor market development and less dependency on energy usage. Blazejczak et al. (2014) considered reaching the energy efficiency targets by government of German. They investigated the savings of household energy reduces energy consumption and greenhouse gas emissions, building renovation to upgrade energy performance and indicated that energy efficiency improvements had a positive impact on economic growth and employment.

In order to investigate energy market, the scientists built the multivariate econometric time series models. Wei (2012) constructed GARCH-type model, stochastic volatility model and realized volatility model to examine the fuel oil futures on the Shanghai Futures Exchange and captured long-memory volatility and the asymmetric force effect in volatility. Balcilar et al. (2015) developed the Bayesian Markov-switching vector error correction (VEC) model and the regime-dependent impulse response functions to evaluate the transmission dynamics of oil spot prices, spot prices of valued metals such as gold, silver, platinum, and palladium and the exchange rate. Burakov and Freidin (2017) investigated the relation between renewable energy consumption, economic growth and financial development in Russia. They constructed the VEC model and examined the short term and long term causal links among variables. Nwosa (2012) provided empirical investigation of fuel price and various macroeconomic variables in Nigeria. He developed the vector autoregressive and the VEC models and found the existence of unidirectional causality from domestic fuel price to short-term interest rate as well as from domestic fuel price to inflation rate in the long run and in the short run.

2. DATA ANALYSIS

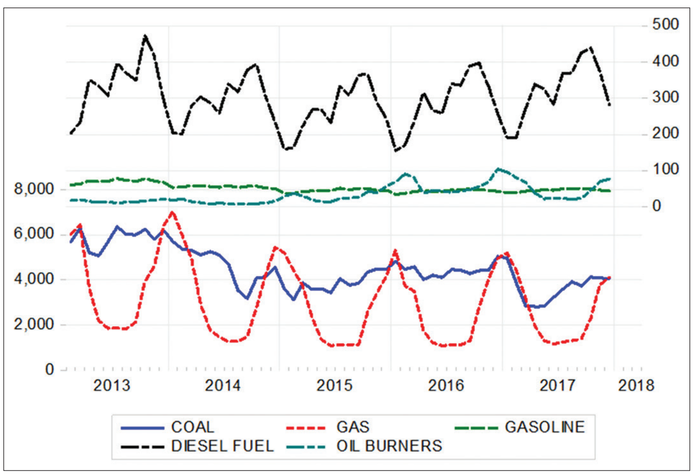
In order to investigate the problems of Ukrainian energy market it is necessary to evaluate the level and characteristic features distribution for different type of fuel usage as well as their dynamic properties. The fuel utilization structure in Ukraine encompasses six main components that include: (1) coal; (2) oil; (3) gas; (4) gasoline; (5) diesel fuel; (6) oil burners. Figure 1 depicts the monthly data dynamics of fuel utilization for its various kind during 2013–2017. We use logarithmic transformation in order to make the possibility of comparing and consider the first differences of logarithms that approximate the monthly growth rate of fuel usage. Statistic observations demonstrate that the most important sources in functioning of Ukrainian energy market y are the amount of coal and gas. However, their total amount shows slightly decline dynamics over the span of investigated period. The dynamics of gas usage reveals the strong relation with seasonal factors that emphasizes the dependence on gas usage in cold weather periods. The Ukrainian household and business consume a great amount of gas for heating purpose in winter as well in late autumn and beginning of spring. Commonly, they do not worried about saving or reservation of gas energy because of substantive price curtails and subsidies that provide government. Moreover, the usage of diesel fuel exhibit considerable fluctuation along business cycle and seasons.

It should be noted that, coal and gas utilization exceed the amount of other fuel usage more than twice. The less fraction of energy market belong to gasoline and oil burners. Generally, the behaviour of gasoline is relatively stable. In contrary, the behaviour of oil burners is increasing and shows several peaks and downturns. An amplitude of fluctuations of different kind of fuel vary. An average deviation during short-run fluctuations of gas takes 34%, whereas an amplitude of fluctuations of coal, diesel fuel, gasoline and oil burners accounts for 11%, 22%, 9%, and 30% respectively.

3. ECONOMETRIC MODELING

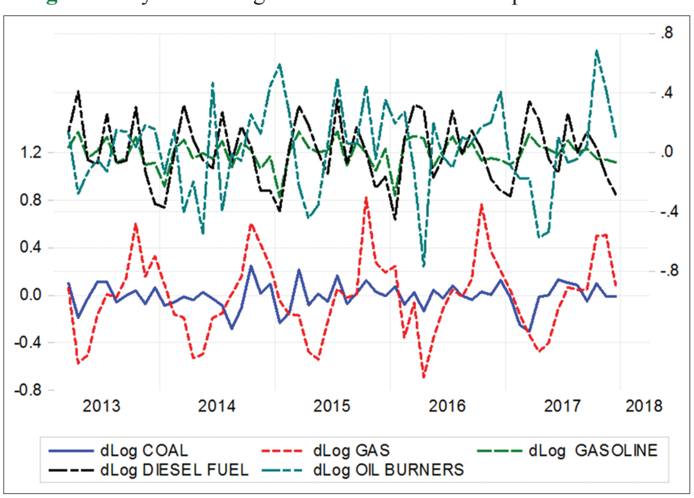
We provide an empirical modelling of dynamic relationships between different kinds of fuel usage in Ukraine on the basis of multivariate autoregressive analysis. Since statistical properties of time series that compose the system are important for multivariate modelling, we conduct the investigation of stochastic features for each variable. Figures 1 and 2 shows that all series are non-stationary, display complicate trending behaviour and seasonal movements. To remove from series the seasonal fluctuations and extract the trend component, we use moving average methods. We investigate also the presence of stochastic trend in the series by augmented Dickey–Fuller (ADF) unit root test. Table 1 represents the results of ADF test concerning unit root for logarithms of adjusted series.

Figure 1: Dynamics of fuel utilization in Ukraine during 2013–2017



Source: Data of the State Statistics Service of Ukraine, elaborations of authors

Figure 2: Dynamics of growth rate in fuel consumption in Ukraine



Source: Elaborations of authors

The results show that ADF unit root test is not able to reject the null hypothesis that logarithmic transformation of each series level include an unit root when their first differences that measures fuel growth rates are stationary.

We provide the evaluation of the existence of cointegrating relationships among non-stationary fuel time series for coal, gas, diesel fuel, gasoline and oil burners. We use Johansen system cointegration tests that include step procedure. Table 2 presents the result of sequential testing technic.

The results indicate two cointegrating equations between five investigated energy indexes. Logarithms of variables are cointegrated of order (1, 1) and the deviation from long-run equilibrium is temporary in nature. Taking into account the results of cointegration tests we estimate VEC model.

Table 1: Results of unit root ADF test

Null Hypothesis: Unit root (individual unit root process)			
Level for log series of fuel usage			
Exogenous variables: Individual effects, individual linear trends			
Series	**t-Stat**	**Prob.**	**Lag**
LOG (COAL)	−2.6237	0.2718	0
LOG (GAS)	−1.3865	0.8530	8
LOG (DIESEL FUEL)	−2.6088	0.2781	0
LOG (GASOLINE)	−0.6078	0.9740	10
LOG (OIL)	−3.1013	0.1159	1
Differences of log series of fuel usage			
Exogenous variables: Individual effects			
Series	**t-Stat**	**Prob.**	**Lag**
DLOG (COAL)	−7.1122	0.0000	0
DLOG (GAS)	−8.0231	0.0000	7
DLOG (DIESEL FUEL)	−7.9401	0.0000	0
DLOG (GASOLINE)	−7.3716	0.0000	10
DLOG (OIL BURNERS)	−5.7582	0.0000	0

Source: Evaluation of authors. ADF: Augmented Dickey–Fuller

Table 2: Johansen system cointegration test

Trend assumption: Linear deterministic trend (restricted)				
Series: LOG (COAL), LOG (GAS), LOG (DIESEL FUEL), LOG (GASOLINES), LOG (OIL)				
Lags interval (in first differences): 1–2				
Cointegration rank tests (trace and maximum eigenvalue)				
Hypothesized number of CE (s)	**Eigenvalue**	**Trace statistic**	**Max-eigen statistic**	**Prob.**
None*	0.829848	178.3796	99.17952	0.0000
At most 1*	0.537814	79.20004	43.22016	0.0015
At most 2	0.344956	35.97988	23.69099	0.2070
At most 3	0.110765	12.28889	6.574031	0.7916
At most 4	0.097017	5.714857	5.714857	0.4973

*Denotes rejection of the hypothesis at the 0.05 level. Source: Evaluation of authors

$$\Delta \log X_t = B_0 + C(1)\Delta \log X_{t-1} + C(2)\Delta \log X_{t-2} + \mu_1 E1_{t-1} + \mu_2 E2_{t-1} + \varepsilon_t, \quad (1)$$

Where $X_t=(COAL_t, GAS_t, DIESEL_t, GASOLINE_t, OIL_t)$' is vector of endogenous variables. Time series $COAL_t$ denotes seasonally adjusted coal utilization; GAS_t denotes seasonally adjusted gas utilization; $DIESEL_t$ denotes seasonally adjusted diesel fuel utilization; $GASOLINE_t$ denotes seasonally adjusted gasolines utilization; OIL_t denotes seasonally adjusted oil burners utilization. The $C(1)$, $C(2)$ are the matrices of unknown parameters of the model; B_0 is a vector of intercept terms; ε_t - a vector of error terms. Variables $E1_{t-1}$, $E2_{t-1}$ are the vectors of deviations from estimated long-run equilibrium cointegrating equations; μ_1, μ_2 are the vectors of adjustment speed parameters.

4. RESULTS

As a result of VEC model estimation (1), we have obtained 2 cointegrating equations (t-statistics in parentheses).

log $COAL_t$=8.855762+4.877045 log $GASOLINE_t$– 6.468011 log $DIESEL_t$

(7.59*) (– 12.61*)

– 0.403737 log OIL_t+0.056612 *Trend*+$E1_t$; (2)

(– 4.88*) (8.32*)

log GAS_t=– 3.513402– 0.512936 log $GASOLINE_t$– 0.348003 log $DIESEL_t$

(– 0.61) (– 0.51)

– 0.135839 log OIL_t + 0.004847 *Trend* + $E1_t$; (3)

(– 1.25) (0.54)

where $E1_t$, $E2_t$ are the residuals of two equilibrium regressions, respectively. * denotes rejection of the hypothesis of parameter insignificance at the 0.01 level.

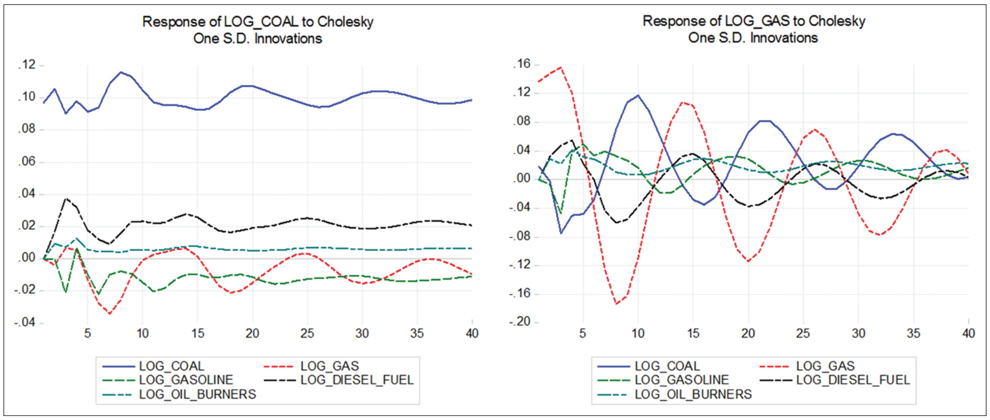
According to the Engle-Granger terminology, equilibrium equations (2)–(3) explain causal behaviour of fuel utilization for different kinds of energy by the long-run relationships between them. Dynamics of fuel series in the short run depends on deviations of variable levels from these long-run equilibrium equations, occurred in the previous period. The first equation defines the long-run equilibrium relationships among coal fuel, gasolines, diesel fuel and oil burners. All time series are not statistically significant in this equation. The second equation combines gas, gasolines, diesel fuel and oil burners. Furthermore, in equations (2) trend variable is significant. In process of VEC model estimation, we have obtained the estimation of adjustment speeds and coefficients of short-run effects that are presented in Table 3.

Table 3: Estimation results for VEC model (1)

Variables	VAR Equation for				
	Δ log *COAL*	Δ log *GAS*	Δ log *DIESEL*	Δ log *GASOLINE*	Δ log *OIL*
Cointegrating Eq:	Adjustment speed parameters				
E1	−0.080098	−0.188231	0.109825	0.348831	−0.239808
	[−1.81]	[−2.99**]	[3.16**]	[6.04**]	[−2.25*]
E2	0.008739	−0.321032	−0.125975	−0.352731	−0.122050
	[0.165]	[−4.26**]	[−3.03**]	[−−5.12**]	[−0.961]
Variable	Coefficient				
Δlog $COAL_{t-1}$	0.163524	−0.040635	−0.064202	−0.424657	0.291871
	[1.02947]	[−0.17971]	[−0.51409]	[−2.04594]	[0.76467]
Δlog GAS_{t-1}	−0.123597	0.208338	0.104663	0.411656	−0.190112
	[−1.31651]	[1.55894]	[1.41795]	[3.35562]	[−0.84271]
Δlog $DIESEL_{t-1}$	−0.146030	−0.596761	0.476529	1.117607	−0.683334
	[−0.74157]	[−2.12890]	[3.07787]	[4.34330]	[−1.44408]
Δlog $GASOLINE_{t-1}$	−0.114503	−0.304381	−0.913762	−1.156947	−0.769923
	[−0.27938]	[−0.52172]	[−2.83570]	[−2.16028]	[−0.78176]
Δlog OIL_{t-1}	0.013046	0.017382	−0.014760	0.028004	−0.155038
	[0.20548]	[0.19231]	[−0.29568]	[0.33753]	[−1.01615]
Δlog $COAL_{t-2}$	0.041414	−0.257761	−0.075018	−0.220224	0.443001
	[0.25092]	[−1.09710]	[−0.57809]	[−1.02110]	[1.11696]
Δlog GAS_{t-2}	−0.037138	0.262466	0.022343	0.053162	0.194862
	[−0.39034]	[1.93796]	[0.29868]	[0.42761]	[0.85232]
Δlog $DIESEL_{t-2}$	0.202175	−0.441946	0.412022	0.885168	−0.889158
	[0.93374]	[−1.43389]	[2.42033]	[3.12859]	[−1.70895]
Δlog $GASOLINE_{t-2}$	−0.987690	−1.163691	−0.715824	−1.254856	−0.201153
	[−2.42682]	[−2.00864]	[−2.23706]	[−2.35958]	[−0.20568]
Δlog OIL_{t-2}	−0.024786	−0.117327	0.016912	0.031966	−0.089171
	[−0.38215]	[−1.27080]	[0.33165]	[0.37718]	[−0.57215]
Log likelihood	58.51367	38.73964	71.98255	43.53331	9.418125
Adj. R-squared	0.384180	0.866677	0.476792	0.719744	0.537252
F-statistic	2.235464	23.29373	3.265439	9.202597	4.160265

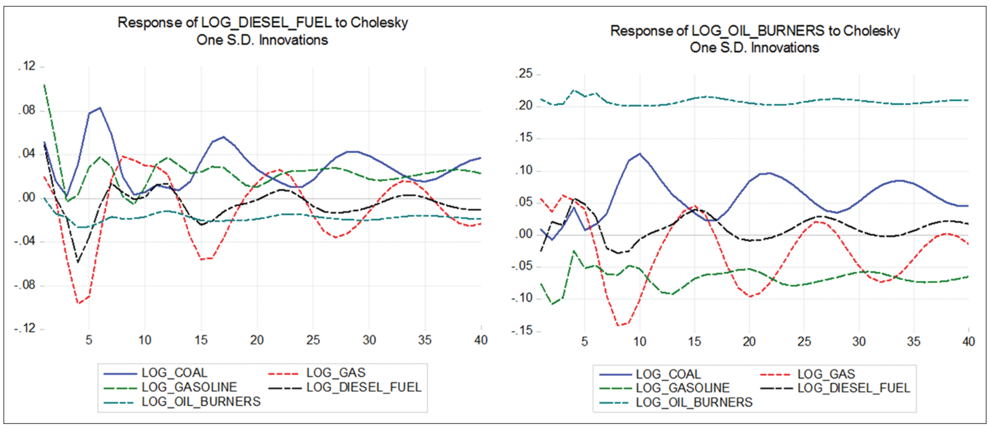
Source: Estimation of authors

Figure 3: The impulse response function of coal and gas fuel



Source: Estimation of authors

Figure 4: The impulse response function of diesel and oil fuel



Source: Estimation of authors

The estimated coefficients of adjustment speeds revealed the convergence to long-run equilibrium relationships. The coefficients significance for adjustment speed coefficients indicate that gas, diesel, gasoline and oil fuel respond to the deviation from long-run equilibriums (2) – (3) that occurred in previous periods. Besides, gas, diesel and gasoline adjust deviations from both equilibriums whereas the oil fuel only from equilibrium (3). Negative signs of the coefficients showed that variables tend to shrink the gap among them and had the tendency to decrease in case of positive deviation from equilibrium relationships.

We used the constructed VEC model to test causality by Granger between different types of fuel. Using Lagrange multiplier test we obtained that short-run changes in gas cause the changes in gasoline and oil burners, changes in coal cause the changes in diesel fuel.

To obtain the information about the shocks impact we used the innovation diagnosis and conducted impulse responses and variance decomposition analysis. Figure 3 shows impulse response functions of coal and gas fuel to one standard deviation in the each types fuel variables which included VEC model. Figure 4 presents impulse responses of diesel and oil fuel.

5. CONCLUSIONS

The empirical research of various energy sources in Ukraine showed the existence of significant relationships between coal, gas, diesel fuel, gasoline and oil burners consumption. We estimated the VEC model that combined evaluation of long-run interrelations between different fuels indexes and dynamics of their short-term behaviour description. The modelling showed that in the long run there were two equilibrium relationships that determined the dynamics of fuel consumption in the economy of Ukraine and the correlation between short-run changes in fuel usage and deviations from long-run equilibrium. The gas consumption was the most valuable kind of energy that had a great impact on functioning of Ukrainian energy market and the whole economics. The change of amount of gas fuel would lead to the significant impact on utilization of other types energy and create the seasonal fluctuation on energy market. The coal was also important source of fuel that created the big impact on dynamics of other types of energy and economic development of country.

The dependence of Ukrainian economy from one type of fuel create challenges for effective development of energy market and is one of sources for corruption and government inefficiency. The diversification of energy consumption types can give an opportunity to improve the economic situation. The developed model can be extend by including exogenous macroeconomic factors and help to carry out a complex analysis of economic processes in the national energy market as well as perform the analysis of perspectives for its development in the short and long run.

REFERENCES

Alp, E.A. (2016), Energy consumption and economic growth in OECD countries. International Journal of Energy Economics and Policy, 6(4), 753-759.

Astariz, S., Iglesias, G. (2015), The economics of wave energy: A review. Renewable and Sustainable Energy Reviews, 45(C), 397-408.

Balcilar, M., Hammoudeh, S., Asaba, N. (2015), A regime-dependent assessment of the information transmission dynamics between oil prices, precious metal prices and exchange rates. International Review of Economics and Finance, 40(C), 72-89.

Bauer, G. (2016), Evaluation of usage and fuel savings of solar ovens in Nicaragua. Energy Policy, 97(C), 250-257.

Blazejczak, J., Edler, D., Schill, W. (2014), Improved energy efficiency: Vital for energy transition and stimulus for economic growth. DIW Economic Bulletin, 4(4), 3-15.

Brueckner, J.K., Abreu, C. (2017), Airline fuel usage and carbon emissions: Determining factors. Journal of Air Transport Management, 62(C), 10-17.

Burakov, D., Freidin, M. (2017), Financial development, economic growth and renewable energy consumption in Russia: A vector error correction approach. International Journal of Energy Economics and Policy, 7(6), 39-47.

Chacartegui, R., Sanchez, D., Munoz de Escalona, J.M., Munoz, A., Sanchez, T. (2013), Gas and steam combined cycles for low calorific syngas fuels utilization. Applied Energy, 101(C), 81-92.

Csereklyei, Z., Varas, M., Stern, D. (2014), Energy and Economic Growth: The Stylized Facts. CCEP Working Papers 1417, Centre for Climate Economics and Policy, Crawford School of Public Policy, The Australian National University.

Economou, A. (2010), Renewable energy resources and sustainable development in Mykonos (Greece). Renewable and Sustainable Energy Reviews, 14(5), 1496-1500.

Fisne, A., Esen, O. (2014), Coal and gas outburst hazard in Zonguldak Coal Basin of Turkey, and association with geological parameters. Natural hazards. Journal of the International Society for the Prevention and Mitigation of Natural Hazards, 74(3), 1363-1390.

Fouquet, R. (2016), Path Dependence in Energy Systems and Economic Development. LSE Research Online Documents on Economics 67119, London School of Economics and Political Science, LSE Library.

Guryanova, L., Klebanova, T., Trunova T. (2017), Modeling the financial strategy of the enterprise in an unstable environment. Economic Studies, 3, 91-109.

Klebanova, T.S., Guryanova, L.S., Shevchenko, I.K. (2014), Model basis of early warning and localization of crises in economic systems of territories. Actual Problems of Economics, 153, 269-278.

Landry, M.A., Leclerc, A., Gagnon, Y. (20130, A Methodology for the evaluation of the economic impacts of wind energy projects. Energy and Environment, 24(5), 735-748.

Lukianenko, I., Oliskevych, M. (2017), Evidence of asymmetries and nonlinearity of unemployment and labour force participation rate in Ukraine. Prague Economic Papers, 2017(5), 578-601.

Nwosa, P. (2012), Domestic fuel price and the Nigerian macroeconomy. African Journal of Economic and Sustainable Development, 1(4), 353-365.

Oliskevych, M. (2015), Hysteresis, structural shocks and common trends in labor market: Consequence for Ukraine. Economic Studies, 4, 120-137.

Peters, V.A., Manley, D.K. (2012), An examination of fuel consumption trends in construction projects. Energy Policy, 50(C), 496-506.

Strielkowski, W., Krska S., Lisin, E. (2013), Energy economics and policy of renewable energy sources in the European Union. International Journal of Energy Economics and Policy, 3(4), 333-340.

Wamankar, A.K., Murugan, S. (2015), Review on production, characterization and utilization of solid fuels in diesel engines. Renewable and Sustainable Energy Reviews, 51(C), 249-262.

Wei, Y. (2012), Forecasting volatility of fuel oil futures in China: GARCH-type, SV or realized volatility models? Physica A. Statistical Mechanics and its Applications, 391(22), 5546-5556.

Zaman, K. (2015), Determinants of nuclear energy consumption in South Asia: Economic and energy security issues. International Journal of Energy Economics and Policy, 5(3), 822-827.