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Geo-economic approach to energy security measurement – principal component analysis

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ABSTRACT

Currently, there is no single accepted methodology for measuring energy security, while the prevailing scientific attitude is that energy security should be defined and quantified in a way to be able to follow rapid developments on the global economic and geopolitical scene. Considering the fact that the national economies represent an integral part of a dynamic international economy where external shocks (global financial and economic crisis, political conflicts, war, etc.) have the impact on energy prices and energy security in general, the paper proposes a new geo-economic concept of energy security. The new approach differs from the existing ones as regards the fact that, in addition to basic indicators, it takes into account sovereign *credit rating* as a measure of economic, financial and political stability - as one of the decisive factors which determines global energy trade and the ability of national economies to be stable and secure when it comes to energy. Determination and testing of *Geo-economic Index of Energy Security* was conducted by using the *Principal Component Analysis* in the European Union and in the selected countries of the world, over a period of ten years (2004–2013). The measured values of a newly proposed *Geo-economic Index of Energy Security* demonstrate significant deviations from the data obtained by using usual indicators of energy security. Observed individually, GDP per capita has the greatest impact on the change in final value of *Geo-economic Index of Energy Security*, while the impact of *sovereign credit rating* is slightly less. The study has shown that the least impact on energy security is exerted by energy dependence (which is traditionally used as a proxy indicator of energy security) and production of energy from renewable sources (which is defined by the EU policy as one of the methods for the improvement of energy security). Due to the results obtained, it is necessary to conduct further analysis of *sovereign credit rating* and to review the type and significance of the impact of *Energy Dependence* indicator as a measure of energy security in general.

1. Introduction

Energy security is today one of the most important geopolitical issues worldwide, largely affected by the economic crisis, and vice versa [1]. The “continuing financial crisis similar to the 2008–2009 recession including significant debt defaults” is expected in the future [2]. It is believed that the new wave of the financial crisis will be largely determined by the developments in energy market and will be even sharper than the initial crisis recorded in the period 2008–2010 [3]. The energy security issue has been greatly enhanced with the appearance of the emerging countries that have become major energy consumers. Therefore, significant changes occurred and will continue to occur on geopolitical scene [4]. Accordingly, significant changes occur in macroeconomic policy and financial stability, particularly in

the countries and regions that are large energy consumers [5].

Energy profile of European Union (EU) is characterized by several specifics and characteristics resulting from changes in global economic and political environment [6]. The EU as a region is, on the one hand, large energy consumer and, on the other hand, faced with numerous problems concerning internal organization and priorities of its 28 member states (EU-28). Specifically, while the EU has a common energy policy on paper, its implementation has remained weak. EU energy security has been undermined by an internal challenge: a patchwork of national mini-markets, and a lack of political cohesion and solidarity. In addition, *Energy Union* strategy largely relies on changes in the field of electricity, since the EU is able to produce enough electricity for its own needs, and it strives for progressive electrification of its economy and for decarbonization. The EU imports

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more than half of all the energy it consumes [7]. Its import dependency is particularly high for crude oil (more than 90%) and natural gas (66%). The total import bill is more than €1 billion per day [8]. There is a complete consensus about the fact that high energy dependence directly threatens energy security, as well as the security of each member country as well as a whole EU [9]. Economic development of any country may decelerate in the case of any disruption on global energy market [10]. For now, energy dependence can be considered the most important indicator of energy security [11].

As priorities of its energy policy EU states reducing energy intensity and greenhouse gas emissions, which will be considered in this paper as one of the factors of energy security. The data show gradual but continuous reduction in energy intensity in all countries, which consequently leads to reduced energy imports and has a positive effect on energy security in the long term [12]. Greenhouse gas emissions are also reduced in all the EU countries, although the reduction is uneven in different member states. Although there is a consensus on the need to reduce pollution, the relationship between economic growth, energy and environmental policies in EU is still a major issue of the future development of EU-28 [13]. This paper will also deal with residential electricity prices as a special factor of energy security, since the EU electricity market is largely liberalized and different electricity prices reflect, inter alia, different share of taxes and fees that further reflect the attitude towards environmental and energy policy. Thus, the final price also includes a number of incentives to increase the share of electricity generated from renewable sources, thereby gradually reducing import dependence and greenhouse gas emissions.

Due to said problems in the very approach and understanding of energy security, defining of energy security management method still remains a subject of study. Studying of energy security is very complex, because the “twenty-first century access to energy sources depends on a complex system of global markets, vast cross-border infrastructure networks, a small group of primary energy suppliers, and interdependencies with financial markets and technology” [14]. In fact, energy security is affected by many factors that are often impossible to accurately measure. Moreover, there are certain relations between the factors affecting energy security, and such relations are sometimes ambiguous, variable in their direction and intensity and differently manifested in different countries, regions and periods. Due to all the above, measuring the level of energy security still remains a particular challenge. It is necessary to focus on “three distinct perspectives on energy security: the ‘sovereignty’ perspective with its roots in political science; the ‘robustness’ perspective with its roots in natural science and engineering; and the ‘resilience’ perspective with its roots in economics and complex systems analysis.” [15]

Currently, 11 most commonly used approaches to measuring energy security have been defined, all of which can be divided into two major groups: measurement based on security of supply and measurement based on aggregation of different indicators [16]. Each of these approaches has its advantages and disadvantages, which make it more or less suitable for measurement in this field. However, given the current trends, it is necessary to adopt the position that the measurement methods must be constantly reviewed and modified in accordance with the specifics on the world stage. The change in geopolitical relations is a dynamic process that takes place in the modern world, far more quickly than in the past [17]. Therefore, a detailed monitoring of all factors that affect changes in this field is of prime importance, as well as is the involvement of “governments, companies, military, environmental, law and intelligence agencies” to a much greater extent than before [18].

From the EU perspective, the best method to improve energy security is the pressure on the banking and financial sectors of the Russian Federation, which is evident from a sharp drop in crude oil prices during 2015 and further on in 2016. In addition, the EU can use all the first-class banking instruments, but there is evidence that these are not always based on real indicators. One of the ways to put a

country in favorable or unfavorable position in terms of access to global banking market and energy trade (as well as in other fields), is certainly to define its credit rating in a speculative manner [19]. There is evidence that the three major credit rating agencies (Standard & Poor's, Moody's and Fitch Ratings) failed to properly assess the situation in certain countries of the EU during and after the financial crisis of 2008, whereby these countries were assigned more favorable credit ratings and thus more privileged positions [20]. Higher sovereign credit rating of a particular country largely affects the increase in corporate credit rating of the companies operating in the given country and in the global energy market, thus becoming artificially stronger [21]. Given the geopolitical turmoil and dynamic changes in the global economic environment where a new wave of financial crisis emerges, whereby all of which certainly jointly reflects on energy security, quantitative assessment of energy security should take into account economic and political aspects. In regard to political aspects there is one major constraint given that these are difficult to measure quantitatively, and there is a general problem of high-quality data on political dimensions. In an effort to identify a sufficiently comprehensive indicator to include both of these aspects [22], *Sovereign Credit Rating* is used in this paper as an indicator for the calculation of energy security.

The main contribution of this study is the introduction of *Sovereign Credit Rating* in the procedure for measuring of energy security, noting that similar studies are unknown, whereby the comparison of the degree of *Sovereign Credit Rating* significance against other components of energy security, which are the subject of previous studies, is certainly most important. It should be borne in mind that measuring of energy security by the method proposed in this study can neither be considered universal nor acceptable in all cases, but that it represents a contribution in finding ways to measure energy security. Instead of defining a unique solution, “experts are guided toward identifying key energy security components, including indicators and policies, and in making these components consistent, focused, and customized for a particular country” [23]. International Energy Agency points to the fact that the methodology developed by them for determining energy security “can serve as a starting point for studies of national energy security by providing a systematic, generic assessment framework that can be complemented by nationally relevant indicators and considerations” [24].

2. Theory/calculation

Sovereign Credit Rating as a measure of the creditworthiness of a sovereign government takes into account a range of indicators the processing of which results in the “assessment of the political and economic strength of a government, as well as the ability of its economy to withstand financial and political shocks”. It should be noted that the indicators used to assess *Sovereign Credit Rating* have different impact. Studies have shown that Gross Domestic Product (GDP) related indicators have only a short-term impact on *Sovereign Credit Rating* of a particular country. External debt, foreign reserves and government effectiveness have much larger and longer-term impact. The importance of certain indicators changes over time depending on a change in macroeconomic environment. During the European debt crisis, the financial balance, the economic development and the external debt indicators became more important after 2009 [25]. Several studies were conducted during the European debt crisis and showed empirical evidence of the impact of ratings and rating changes on fiscal discipline [26] and on banking sector and its regulation [27,28]. Changes in rating have impact on the bond and stock market, as well as on the firms' borrowing costs [29]. Generally, during the European financial crisis a strong interconnection between sovereign spreads, sovereign ratings and bank ratings was empirically recorded [30].

Estimates of *Sovereign Credit Rating* are made by the three largest

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