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Investigating the natural gas supply security: A new perspective

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ABSTRACT

This paper assesses the natural gas supply security of 23 importing countries from divergent regions of the world for the period between 2001 and 2013. The indicators used for the study are the volume of imported natural gas, the number of natural gas suppliers, the level of dependency on one country, import dependency, the fragility of supplier countries, and the share of natural gas in primary energy consumption. The method used to establish the supply security index is the PCA (principal component analysis) over the indicators in the model for each country on a yearly basis for the period 2001 to 2013. The dispersed country sample enables the established index to measure the sensitivity of specific natural gas importer countries using a uniform framework. According to the results, the most effective indicators for the measurement of supply security are the number of supplier countries, supplier fragility, and the overall volume of imported gas.

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1. Introduction

Following oil and coal, natural gas is the third most consumed fuel, accounting for 23.7% global energy consumption [5]. The share of natural gas in global energy mix is increasing, since it is highly concentrated, flexible and versatile - as it can be used for not only for power generation, but also industrial, commercial and residential applications. This is because, compared to other fossil fuels, it is reliable, easy to store and transport, extremely efficient, and less harmful to the environment [14].

Hence, the consumption level has increased from 1960.14 bcm in 1990–2412.53 bcm in 2000, and to 3347.63 bcm by the end of 2013 [5]. Currently, OECD members account for 47.8% of the global consumption. The main contributors to this increase in consumption are OECD member countries, particularly The United States (US), Mexico, Canada, Japan, South Korea, Germany, Italy, Turkey, France, The United Kingdom (UK) and Spain. However, there are differences between the consumption trends for European and Asian OECD countries, which are generally importing countries, and OECD countries in North America, which account for 35.8% global production [5].

There has been a corresponding rapid increase in Non-OECD members' natural gas consumption. The level of consumption has increased from 1057.14 bcm in 2000, accounting for 43.8% of the global consumption, to 1751.12 bcm in 2013, accounting for 52.2% of the global consumption. China's natural gas consumption increased six-fold from 2000 to 2013 [5]. Economic growth and increasing needs in both power and industrial sectors are the key drivers for this rapid escalation [14].

Production has increased in line with consumption, growing from 2006.64 bcm in 1990–3369.88 bcm in 2013. The US has become the leading producer, with a 20.6% share of the global production in 2013, followed by Russia with 17.9%, Iran with 4.9%, Qatar with 4.7%, Canada with 4.6%, China with 3.5%, Norway with 3.2% and Saudi Arabia with 3.0%. These countries' combined production accounts for 62.4% of the global production [5]. These production trends are not, however, in proportion to the reserves of the countries concerned, the biggest of which are held by Iran, with 18.2% of the world's reserves, followed by Russia with 16.8%, Qatar with 13.3%, Turkmenistan with 9.4%, US with 5.0% and Saudi Arabia with 4.4%. These six countries combined account for 67.1% of the global reserves [5].

Since natural gas reserves are limited geographically, the largest natural gas consumers are dependent on imports, resulting in an increase in the global natural gas trade from 554.27 to 1035.95 bcm between 2001 and 2013 [5]. Currently, the major importers are Japan, the US, Germany, Italy, South Korea, UK, France, Turkey,

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China, and Spain. Of these, all except the US, the UK and China are dependent on imports for at least 80% of their consumption, due to the low level of indigenous production [5]. Nevertheless, China's escalating energy consumption, in addition to its policy of increasing the proportion of natural gas in its energy mix, sealed with a recent $400 billion deal with Russia [4], will reposition China in the group of natural gas importers, with an increase of 80% or more in the medium term.

Another important issue regarding trade is the method of natural gas transportation. Unlike the transportation of oil, at present, there are only two methods, pipeline and LNG (liquefied natural gas). The share of LNG in overall trade in 2001 was 25.7 percent at 142.95 bcm. By 2013, it increased to 31.4 percent at 325.32 bcm, representing a more than two fold increase in terms of volume [5].

Thus, natural gas prices have increased due to growing demand, similar to global oil prices. The UK Heren NBP (national balancing point) prices increased from 1.87 to 10.63 US dollars per Btu between 1996 and 2013, while the average German import LNG prices (Union CIF) increased from 2.46 US dollars to 10.72 US dollars per Btu [5] over the same period. The higher prices of LNG compared to piped gas reflects the additional costs incurred, due to transportation, liquefaction, and re-gasification.

Despite the increasing exploitation of natural gas, there are continuing problems related to supply. Natural gas importers around the globe are increasingly affected by factors such as the increasing level of traded volume, mounting fragility due to economic, political, and legal conflicts in the producing areas and transit countries, fluctuating prices, the growing dependency on foreign imports, the escalating share of natural gas in final energy consumption, and a lack of diversification [3]. In particular, level of supply security needs to be reconsidered by those countries highly dependent on a single supplier, such as Turkey, the UK, Poland, Hungary, Singapore, and Brazil. The dangers of dependency can be seen in the crises between Russia and Ukraine, in 2007, 2008 and 2009, which led to a supply disruption in the European Union (EU), due to its dependency on Russia for almost one third of its natural gas imports [20]. Similarly, dependency on a small number of suppliers could result as a threat to supply security. For instance, the negative impact of the Arab Spring on Libyan and Egyptian gas infrastructure and production threatened supplies to Italy and Israel respectively [2].

In addition, a larger portion of LNG in overall natural gas imports allows the importer countries to increase the level of supply security by adding more suppliers. However, it is important to note that there are currently only 17 LNG exporter countries available in the global natural gas market; Qatar leads with a 32.6% share in 2012, followed by Malaysia with 10%, Australia and Nigeria with almost 9% respectively, and Indonesia with almost 8%. These five countries account for almost 70% of the global LNG supply [15]. Countries such as Japan, South Korea, Chile, Spain and Portugal use LNG to meet more than 60% of their natural gas demand, leaving them vulnerable to various challenges to their supply security, for example the effects of Fukushima disaster, and price increases caused by increasing Asian demand [15].

There is a strong possibility that lack of supply security and diversification could jeopardize the economies of all natural gas importer countries. Taking steps to counteract all the above mentioned problems, while increasing diversification efforts is key to sustaining natural gas supply security worldwide. However, the number of importing countries is large, and each will require a specific strategy to secure their supply. Therefore, it is important to develop a supply security index which can adequately measure and evaluate the supply security of the major main natural gas importers.

Prior to the current study, a number of studies focused on developing a SSI (supply security index), mainly for the supply security of oil for the importing countries [9,11]; and [27], although a small number consider the supply security of natural gas importers [6,7,28]. The emphasized studies above present security indexes for the classification of related countries for their oil and/or gas vulnerability through a group of distinct variables, classified as market risk, supply risk and environmental risk factors [10]. While, in previous studies, a number of variables have been proposed for the relevant risk factors, no consensus currently exists as to the relative significance of indicators for the robustness of the indexes [7]. This is due to the country-specific variations for both importers and exporters of oil and natural gas.

The first common econometric model used is the PCA (Principal Component Analysis) [6,27,28]. The oil vulnerability index is calculated through the PCA method, which assigns weights for the principal components of the model-making indicators in the model. These components are each assigned specific weights, unlike the more subjective approach of the composite index method, which is the second most commonly used econometric model in studies related to SSI [7,9]. The interrelated indicators inserted into the index serve to rank the countries depending on their score, with a higher the score showing a greater risk.

Furthermore, the supply security literature indicates different approaches to measurement, therefore it is difficult to "*quantify and assess*" the level of energy vulnerability. The factors affecting vulnerability are dispersed across the market, supply and environmental levels, thus causing problems for the calculation of vulnerability indexes due to the extensive indicator portfolio that needs to be considered [30]. Additionally, the weights and scoring rules of the indicators by subjective expert opinions also vitiates the significance of the model, which negatively affects the actual outcome of the security indexing.

Considering the above analysis, the main aim of the current study is to measure and evaluate the natural gas supply security of the major main natural gas importers in regard to the supply risk and market risk factors. This evaluation is based on indicators such as the volume of the imported natural gas, diversification level, the level of dependency on the dominant supplier, import dependency, the economic, political and security risks related to supplier countries, supplier fragility, and the share of natural gas in primary energy consumption. The principal component analysis method is used to create the supply security index for the selected countries, taking into consideration country variables on an annual basis between 2001 and 2013, as indicated in the established model.

2. Research design and indicators

In the first stage, the selection of appropriate indicators is crucial to obtaining accurate results. Therefore, the primary phase of the indicator selection process was the review of the common indicators cited in the existing literature, specifically for supply side of the matrix. After this review, the two selected indicators were *import dependency* and *share of natural gas in primary energy consumption*. However, in order to show the importance of the *volume of the natural gas imported*, it was decided to include the actual volume, rather than simply demonstrating the impact of import dependency as a percentage. A comparison between the US and Turkey illustrates the reason for this. Although the US and Turkey had similar import volumes in 2013, 49.64 and 45.64 bcm respectively, their dependency level was vastly different, 7% and 99% respectively. Thus, from current study's perspective, import dependency as a percentage alone is not as significant as the actual

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