ADBI Working Paper Series

MODELING THE RUSSIAN FEDERATION–ASIA AND THE PACIFIC ENERGY TRADE

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No. 1008
September 2019

Asian Development Bank Institute

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The Asian Development Bank refers to "China" as the People's Republic of China; and to "South Korea" as the Republic of Korea.

In this report, "$" refers to United States dollars.

Suggested citation:

Rasoulinezhad, E., F. Taghizadeh-Hesary, N. Yoshino, and T. Sarker. 2019. Modeling the Russian Federation–Asia and the Pacific Energy Trade. ADBI Working Paper 1008. Tokyo: Asian Development Bank Institute. Available: https://www.adb.org/publications/modeling-russian-federation-asia-pacific-energy-trade

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Abstract

Asia remained the largest market for energy sources in 2018. The Russian Federation has a clear vision to develop its Asian energy projects in order to provide a greater share of Asian energy imports. This paper models Russian Federation–Asia and the Pacific energy trade patterns via the gravity trade theory and GMM panel estimation for quarterly data in the period 2010–2017 for 16 selected Asia and Pacific nations. The results demonstrate that Russian Federation energy exports to Asia and the Pacific follow the Linder hypothesis. Furthermore, the findings reveal that economic growth is a positive influencing factor on the Russian Federation's energy exports to this region. In addition, a depreciation of the national currencies of Asia and Pacific nations against the Russian ruble will accelerate the latter's energy export volume. To improve energy security in this region, we recommend policies such as the development of an energy trading hub in Asia, increased regional pricing power, and energy import diversification and reduced distance between the Russian Federation (exporter) and Asia and the Pacific (importers).

Keywords: Asia and the Pacific, energy trade, energy security, gravity trade modeling, Russian Federation

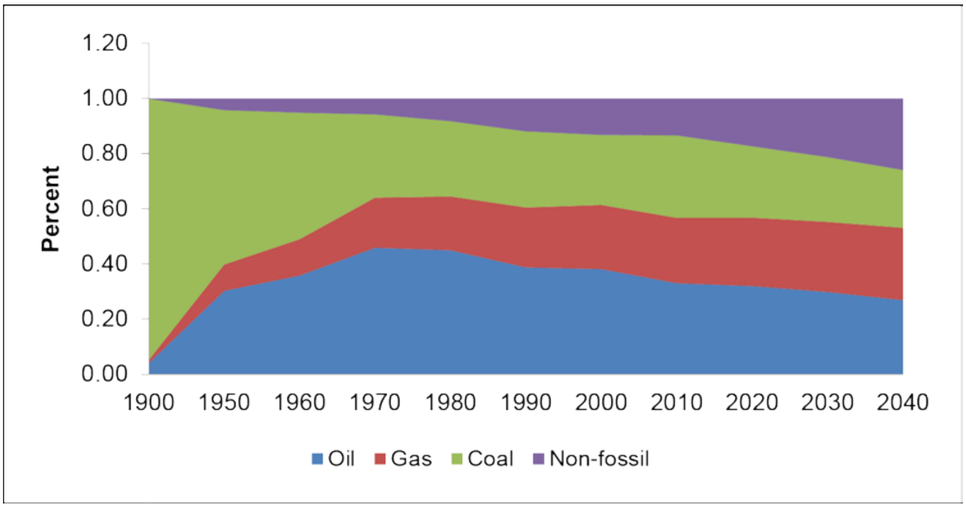
JEL Classification: Q37, R11, F14

Contents

1. INTRODUCTION

The role of different energy sources as important production inputs has increased in recent decades. According to British Petroleum's (2019) *BP Energy Outlook 2019*, consumption of crude oil increased from 2,253 million toe in 1970 to over 4,021 million toe in 2010, and is estimated to reach 4,564 million toe in 2020 and nearly 4,830 by 2040. Moreover, gas and coal consumption respectively totaled over 890 and 1,480 million toe in 1970, and these figures are estimated to increase to almost 4,707 and 3,762 million toe in 2040. In addition, the consumption of renewable energy sources is growing. While nuclear energy consumption was approximately 18 million toe in 1970 and is estimated to reach over 912 million toe in 2040, hydro energy contributed 5% to total primary energy consumption in 1970 and is projected to reach 7% of total global primary energy consumption in 2040. Figure 1 illustrates the shares of primary energy sources over 1900–2040, with oil, gas and coal globally predominant.

Figure 1: Shares of Primary Energy Sources (1900–2040, %)



Source: Authors' compilation from *BP Energy Outlook 2019.*

The main reason behind the growing role of energy sources is their remarkable contribution to economic growth and development. Several studies have discussed the positive role of energy sources on different nations' economic development. For instance, Aung, Saboori and Rasoulinezhad (2017) and Balitskiy et al. (2016) have demonstrated a positive relationship between gas consumption and economic development in the European Union (EU). Fadiran, Adebusuyi and Fadiran (2019) note that in nations with a high level of gas consumption, all energy-based industries can perform positively and stimulate the nation's economic growth. According to the International Renewable Energy Agency's (IRENA) *Global Energy Transformation Report*, the future of energy sources will be focused on renewables (in line with Gielen et al. 2019), the share of renewables in total primary energy supply will rise from 14% in 2015 to 63% in 2050, and only natural gas will be heavily used among non-renewables. Zou et al. (2016) have predicted that natural gas' annual production peak will occur around 2060 and will play a pivotal role in sustainable energy development. The positive role of crude oil on economic growth in different nations and regions has been proved by numerous scholars, including Carfora et al. (2019), Difiglio (2014), Hanabusa (2009), Noguera-Santaella (2016), and Zhou et al. (2019), while non-renewable energy consumption-economic growth causality has been investigated in studies such as Kahia (2017), Pao (2013), and Tugcu and Topcu (2018).

Asia is becoming a major energy-demanding region due to many of its countries' determination and success in developing economically. Table 1 reports the energy consumption volumes of different regions around the world.

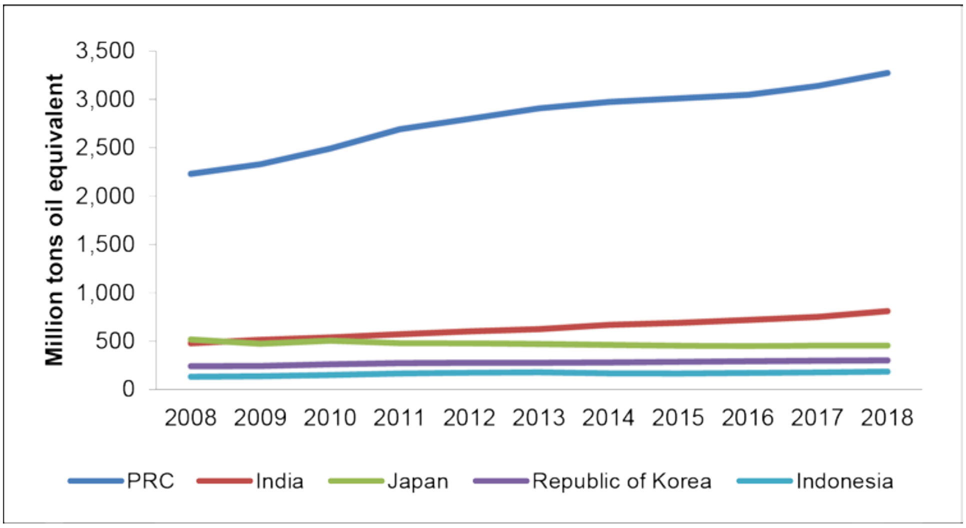
Table 1: Energy Consumption by Different Regions, 2008–2018, Million Tons Oil Equivalent

Region	2008	2010	2012	2015	2016	2017	2018
North America	2,751	2,709.8	2,657.4	2,736.2	2,737.2	2,755.5	2,832
South and Central America	600.8	627.1	670.9	695.3	691.1	699.8	702
Europe	2,173.3	2,124.6	2,072.3	1,996.8	2,027.5	2,050	2,050.7
CIS	844.7	843.2	886.7	867.9	881.5	891.2	930.5
Middle East	653.7	709.8	767.3	843.7	864.9	881.4	902.3
Africa	365.4	383.8	399.2	430.1	439.4	448.6	461.5
Asia and the Pacific	4,316.2	4,701.5	5,121.6	5,475.7	5,587	5,748	5,985.8
Total world	11,705.1	12,099.9	12,575.5	13,045.6	13,228.6	13,474.6	13,864.9

Source: Authors' compilation from *BP Statistical Energy Review 2019.*

In 2018, Asia and the Pacific remained the world's largest market for energy resources, taking in 43.17% of the global supply. Demand in this region continues to be led by the People's Republic of China (PRC) (3,273.5 million tons oil equivalent), with India (809.2 million tons oil equivalent) and Japan (454.1 million tons oil equivalent) being a distant second and third, respectively. Figure 2 shows the consumption trends of top energy demanders in Asia and the Pacific (2008–2018). It can be seen that the PRC (as a giant energy consumer), India, Japan, the Republic of Korea and Indonesia are the biggest energy demanders in the region.

Figure 2: Top Asia and Pacific Energy Demanders, 2008–2018



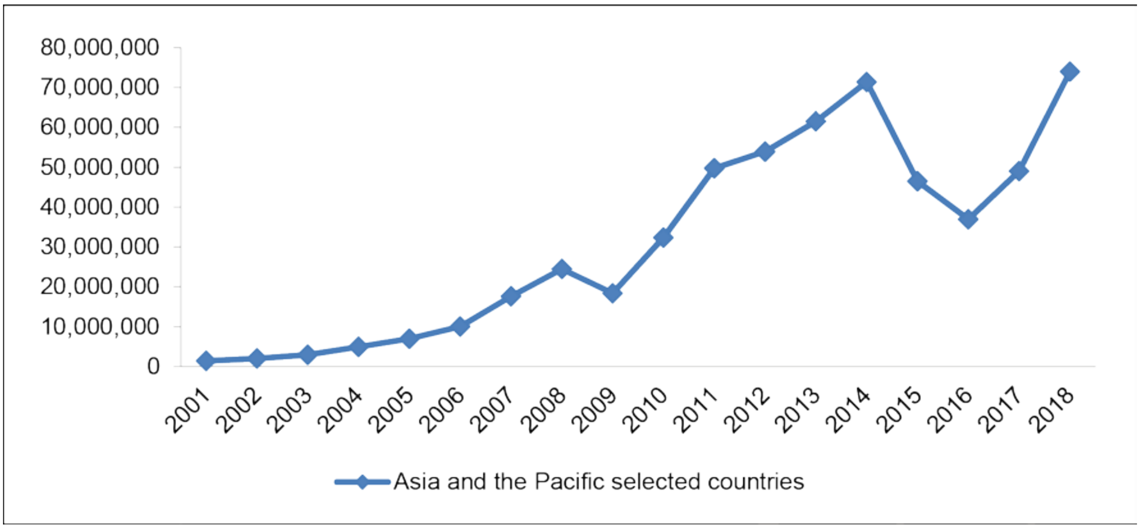
Source: Authors' compilation from *BP Statistical Energy Review 2019.*

However, reliance on energy imports may be considered a source of energy insecurity. According to Charp and Jewell (2014), energy insecurity can be defined based on four ‘A’s: availability, accessibility, affordability, and acceptability. Alternatively, it can be deemed an adequate and reliable supply of energy resources at a reasonable price (Bielecki 2002). In the literature, energy security in a broader sense implies the availability of energy resources. This can be measured further under the concept of “diversification,” or hedging. There are three aspects to interpretations of diversification: variety, balance, and disparity (Stirling 2010). Variety asks how many options there are; balance checks the dominance of any one option; and disparity examines the similarities and differences between options. In recent years, the issue of energy insecurity has represented an overriding challenge in Asia, particularly for developing countries (Taghizadeh-Hesary et al. 2019).

When an economy depends on particular imports, its security is potentially threatened. Predictions of increased Asia and Pacific energy consumption raises concerns about energy insecurity in this region’s economies. By considering 20 countries in the Asia and Pacific region (the PRC; the Republic of Korea; Japan; Singapore; Taipei,China; India; Malaysia; the Philippines; Viet Nam; Hong Kong, China; Indonesia; Pakistan; Bangladesh; the Democratic People’s Republic of Korea; Myanmar; Sri Lanka; Cambodia; Nepal; the Maldives; and Timor-Leste) and Harmonized System (HS) Code 27 (mineral fuels, mineral oils and products of their distillation; bituminous substances; mineral waxes) for energy exports from the Russian Federation to these countries, we can see that Russian energy export volumes to this region have increased from $1,431 million in 2001 to nearly $73 billion in 2018. Despite shares of Russian energy in the Asia and Pacific import basket being smaller than those in the Europe basket (Russian energy export volumes to the EU were approximately $352 billion in 2018), the Russian Federation has a clear vision to develop its Eastern energy projects to provide a greater share of Asia’s energy imports. For example, according to the Russian Federation’s long-run 2030 strategy, its gas industry will be focused to the East, with export volumes of nearly 75 billion cubic meters by 2030 (Henderson 2011). To this end, the Russian Federation is trying to expand its Eastern liquefied natural gas (LNG) fields to cover its potential exports to Asia and the Pacific, as well as the world as a whole. Henderson and Stern (2014) have accordingly predicted that the East Siberia Pipe and Vladivostok LNG will come to play the most important roles in the Russian Federation’s energy exports to Asia.

Although a number of studies (e.g., Fortescue 2016; Hartley et al. 2009; Raj et al. 2016; Shibasaki et al. 2018; Yennie-Lindgren 2018) have considered Russian Federation energy exports to Asia and Pacific nations, we cannot see any serious and in-depth work modeling energy trade patterns between the two. Hence, the novelty of this paper is in addressing and modeling the trade pattern characteristics of energy between a major energy exporter (Russian Federation) and a panel of 16 energy importers in Asia and the Pacific (the PRC; the Republic of Korea; Japan; Singapore; Taipei,China; India; Malaysia; the Philippines; Viet Nam; Hong Kong, China; Indonesia; Pakistan; Bangladesh; Myanmar; Sri Lanka; Cambodia; and Nepal). To this end, we employ an advanced econometric estimation methodology under the gravity theory trade construction.

Figure 3: Energy Exports from the Russian Federation to Asia and the Pacific, 2001–2018, US$ (thousands)



Source: Authors' compilation from *BP Statistical Energy Review 2019.*

The remainder of this paper is organized as follows. Section 2 provides a brief review of previous literature. Section 3 describes the theoretical background of the paper. Section 4 discusses the data and empirical model specification. Section 5 presents the empirical analysis. Section 6 concludes the paper and offers some policy recommendations.

2. LITERATURE REVIEW

The relevant literature can be divided into three main strands: trade modeling via econometrics; Asian energy security; and all earlier studies about energy trade.

The first strand of literature focuses on trade pattern modeling through econometric instruments. Pomery (1984) considered uncertainty in trade models, arguing that it is contingent on the extent of markets and market institutions. Furthermore, Nishimura and Shimomura (2002) investigated relationship between trade and indeterminacy in a dynamic general equilibrium model, noting that the long-run Heckscher-Ohlin prediction is vulnerable to the introduction of externality. Yeaple (2005) used a general equilibrium trade model to identify linkages between firm heterogeneity, international trade, and wages. They discovered that in equilibrium, the interaction between the characteristics of competing technologies, international trade costs, and the availability of workers of heterogeneous skill gives rise to firm heterogeneity. Martin-Moreno et al. (2014) used a dynamic stochastic general equilibrium (DSGE) model for Spain to analyze real business cycles with tradable and non-tradable goods, finding that cyclical properties of inflation for non-tradable and tradable goods are replicated. Viorica (2015) sought to model the foreign trade efficiency of EU members by using stochastic frontier analysis in a gravity equation, and discovered that the economic crisis has not significantly altered trade patterns and hierarchies among EU countries: it has merely reduced trade performance. Jong et al. (2017) proposed a new model for trade flows in Europe through logsum variables. Their trade modeling was based on gravity theory and country-specific random effects, and their major results proved that the new model can fit more effectively with the trade patterns of the EU. Van ha et al. (2017) attempted to build a better trade model through the Global Trade Analysis Project (GTAP), their findings proving that there have been significant shifts in export markets, agricultural output and prices in Viet Nam's economy.

In the second strand of literature, diversity is the most frequently employed aggregate energy security indicator. Yao and Chang (2014) mentioned availability of energy resources, applicability of technology, acceptability by society, and affordability of energy resources (4 'A's) as four pillars that can be used to quantify the level of energy security. In addition, several studies have proposed that the versatility of fossil fuel import origins will increase levels of energy security (Tongsopit et al. 2016; Yao and Chang 2014). Calder (2006) investigated the role of the PRC vis-à-vis global energy insecurity, concluding that its prodigious needs necessitate the promotion of efficiency, the diversification of its energy basket, improvements in its domestic energy infrastructure, and reducing its reliance on sea lanes. In another study, Sovacool (2013) analyzed the level of energy security in different Asian nations, demonstrating that Myanmar was the country that saw its energy security deteriorate the most. In addition, Malaysia achieved diversification and almost universal energy access using only large subsidies alongside one of the fastest growth rates in greenhouse gas emissions. Rasul (2014) focused on the linkages between food, water, and energy security in India, recognizing that alongside cross-sectoral integration to improve the resource-use efficiency and productivity of the three sectors, regional integration between upstream and downstream areas is critical. Stegen (2015) found that as part of its global energy strategy (which presents domestic, regional, and global energy security together), the PRC has secured the resources of several Central Asian states for its "Silk Road" plan. Matsumoto and Andriosopoulos (2016) analyzed energy security in East Asia in a context of climate mitigation and proved empirically that in order to reduce CO_2 emissions, the PRC, Japan, and the Republic of Korea must alter their energy composition from fossil fuels to renewables. Taniguchi et al. (2017) investigated energy security in the Asia and Pacific region with a particular focus on water and food securities, presenting relationships between self-sufficiency (i.e., self-production) and diversity for water, energy, and food in the region. Moshin et al. (2018) proposed a composite index to evaluate the oil supply risk of South Asian countries. Their major findings concluded that India is the least vulnerable to oil prices, whereas Afghanistan and Bangladesh are the most vulnerable. Ralph and Hancock (2019) analyzed the connections between energy security, transnational politics and electricity exports using five dimensions of availability, affordability, technological development and efficiency, environmental and social sustainability, and regulation and governance in Australia and Southeast Asia. They concluded that Australia's stalled energy politics and Indonesia's sudden policy shifts are the two main components affecting their mutual energy security. Taghizadeh-Hesary et al. (2019) identified a relationship between energy security and food security in a panel of eight Asian economies during 2000–2016. Their results suggest that an optimal combination of renewable and nonrenewable energy resources will help facilitate not only energy security but also food security.

The third strand of literature pertains to energy trade flows among nations, which has drawn considerable attention from researchers. Cabalu and Manuhutu (2009) examined the relative vulnerability of eight gas-importing countries in Asia for the year 2006 using principal component analysis (PCA) for four market risk indicators. This showed that there are significant differences in the values of individual and overall indicators of gas vulnerability among countries. Wood (2012) reviewed the global LNG trade, particularly in two major regions of Asia and Europe, and depicted the complexity of its commercial, political, and technical drivers. Tong, Zheng, and Fang (2014) analyzed the establishment of a natural gas trading hub in the PRC, and concluded that its supporting policies in the natural gas sector, along with the initiation of spot and futures markets, the rapid growth of gas production, and highly improved infrastructure, as well as

Shanghai's advantageous location, afford it greater advantages than countries such as Malaysia, Japan, and Singapore. Chen et al. (2016) focused on trade competition patterns of the global LNG trade by showing networks developing from 2005 to 2014. Their study revealed that some European countries, such as Spain and Belgium, chose to re-export their LNG because of the reduced demand caused by their weak economies. Moreover, shale gas from the United States (US) has not significantly affected the LNG export trade pattern. Kim (2017) analyzed changes in the Northeast Asian energy landscape based on the decline in global oil prices, and concluded that the Russian Federation will seek to keep US LNG in check through price negotiations; moreover, the evolution of an Asian gas hub will be influenced by the ways in which the Russian Federation and the PRC reconsider their energy strategies. Holzer et al. (2017) investigated the potential effects of the LNG trade shift on the transfer of ballast water and biota by ships, and estimated changes in the associated flux of ships' ballast water to the US during 2015–2040 using existing scenarios for projected exports of domestic LNG. Their results predicted an approximate 90-fold annual increase in LNG-related ballast water discharge to the US by 2040 (42 million m^3). Zhang et al. (2018) investigated the driving factors of global LNG trade flows by applying the gravity model over the period 2004–2015. They discovered that pipeline natural gas has a significant substitute effect on LNG trade within the global model. Furthermore, LNG trade in Asia is more sensitive to import prices and research and development (R&D) investment than in the global model. Varahrami and Haghighat (2018) analyzed the effects of the LNG product in Organization for Economic Co-operation and Development (OECD) countries using the dynamic panel method for seasonal data from 2011–2015. The estimation results proved that LNG demand in the selected importing countries is relatively reversible in the short and long term.

Overall, it can be concluded from the existing literature that no serious studies have sought to model energy trade flows between the Russian Federation and the Asia and Pacific region. Hence, our paper is the first to consider this topic and to model the Russian Federation–Asia and the Pacific energy trade pattern by employing a panel-GMM-gravity trade model.

3. THEORETICAL BACKGROUND

This section's theoretical background supports the empirical variables and model that will be created in Section 4.

Energy is mainly used for electricity generation. In this section, we assume that it is consumed only in two main sectors, and that it is generated only by energy resources. This means that demand for energy resources comes from two groups. Group one is the industry sector, and group two is the residential sector (households).

3.1 Industry's Energy Demand

Equation 1 shows the production function of industry, assumed to be in the form of Cobb-Douglas:

$$Y_t^I = F\left(K_t, L_t, E_t^I\right) = K_t^{\alpha} L_t^{\beta} (E_t^I)^{(1-\alpha-\beta)} \tag{1}$$

Where Y^I is the total output of industry, K is the capital input, L is the labor input, and E^I is the energy inputs of industry. We assume that there is constant return to scale. α is the elasticity of production of capital, β is the elasticity of production of labor, and the elasticity of production of energy resources is equal to $1-\alpha-\beta$.

Firms in this sector seek to maximize their profits, as shown in Equation 2:

$$Max\,\pi_t = P_t^Y Y_t^I - r_t K_t - w_t L_t - e_t(P_t^E + T_t)E_t^I \quad (2)$$

Where π is the sector's profit, P^Y is the price of the final products of industry, r denotes the interest rate, w denotes the wage rate, e denotes the exchange rate, P^E denotes the electricity tariff depending on energy prices in dollars, and T denotes the transportation costs in dollars, this being the function of the distance between the energy exporter and importer.

Equation 3 shows the first-order condition of profit with respect to E^I:

$$\frac{\partial \pi_t}{\partial E_t^I} = (1-\alpha-\beta)\frac{P_t^Y Y_t^I}{E_t^I} - e_t(P_t^E + T_t) = 0 \quad (3)$$

Energy demand is represented in Equation 4:

$$E_t^I = (1-\alpha-\beta)\frac{P_t^Y Y_t^I}{e_t(P_t^E + T_t)} \quad (4)$$

As shown, industry's energy demand is a function of the elasticities of production of labor and capital, the real output of the industry sector, the price of energy, the exchange rate, and the transportation cost, this being a function of the distance between the supplier and the consumer. This model is in line with the gravity trade theory, in which the trade flows between two nations directly depend on economic size and indirectly depend on the geographical distance between them.

3.2 Residential Energy Demand

Equation 5 is the utility function of households, which is a function of the consumption of non-electricity goods (C) and electricity (E^H):

$$U_t = (C_t, E_t^H) = \frac{1}{1-\gamma}(C_t)^{1-\gamma} + \frac{1}{1-\delta}\left(E_t^H\right)^{1-\delta} \quad (5)$$

Households look to maximize their utility with respect to their budget, which is the constraint, as shown in Equation 6:

$$S.t.\, P_t^C C_t + e_t(P_t^E + T_t)E_t^H = Y_t^H \quad (6)$$

Where P^C denotes the price of non-electricity goods, P^E denotes the electricity tariff, which depends on energy prices denominated in dollars, and T denotes the transportation costs in dollars, which is a function of distance. Y^H is the total income of the households.

In order to maximize the utility function of households to define the factors that determine electricity demand, we develop the Lagrange function, as in Equation 7:

$$\Gamma = U(C_t, E_t^H) - \lambda\{P_t^C C_t + e_t(P_t^E + T_t)E_t^H - Y_t^H\} \quad (7)$$

Obtaining the first-order conditions with respect to the E^H , C , and λ results in Equations 8–10:

$$\frac{\partial \Gamma}{\partial E_t^H} = (E_t^H)^{-\delta} - \lambda\{e_t(P_t^E + T_t)\} = 0 \rightarrow E_t^H = f(e_t(P_t^E + T_t),\, Y_t^H) \tag{8}$$

$$\frac{\partial \Gamma}{\partial C_t} = C_t{}^{-\gamma} - \lambda\{P_t^C\} = 0 \tag{9}$$

$$\frac{\partial \Gamma}{\partial \lambda} = P_t^C C_t + e_t(P_t^E + T_t) - Y_t^H = 0 \tag{10}$$

As shown in Equation 8, a household's energy demand is a function of its exchange rate, electricity tariff, transportation costs (distance between exporter and importer), and the income level of the importer. Total energy demand is equal to the combined energy demand of households and industry (Equation 11).

$$E_t = E_t^I + E_t^H \tag{11}$$

Therefore, total energy demand is a function of different factors, as shown in Equation 12:

$$E_t = f(P_t^E, T_t, e_t, Y_t) \tag{12}$$

Where P^E is the electricity tariff, contingent on energy price; T denotes the transportation costs, a function of distance; e is the exchange rate between the energy exporter and importer; and Y_t is the total gross domestic product (GDP) of the economy, contingent on the income level of households (Y_t^H) and the total output of the industry (Y_t^I).

4. DATA AND EMPIRICAL MODEL SPECIFICATION

In this section, we use the variables obtained from the theoretical model in the previous section to conduct our empirical analysis and explore the determinants of the export pattern of Russian Federation energy to Asia and the Pacific. Here, we utilize the following real and dummy variables:

- Energy export volume (LEV);
- Economic growth (GRO);
- Difference in per capita income (DI);
- Population growth (URB);
- Bilateral exchange rate (EX);
- Sanctions (SANC);
- Geographical distance (DIS).

In addition to the theoretical model variables, we added population growth and sanctions as two controls. As documented in the literature, energy is consumed by both households and industry, hence its consumption is a function of population growth. Sanctions are another factor shaping Russian Federation export patterns.

We gathered quarterly data from the World Bank Development Indicators (WDI), the Centre d'Études Prospectives et d'Informations Internationales (CEPII), International Monetary Fund (IMF) data (https://data.imf.org), National Bureau of Statistics of China (www.stats.gov.cn), Trade Map, Statistics Korea (www.Kostat.go.kr), Open Government Data Platform India (https://data.gov.in), Central Bank of Sri Lanka (www.cbsl.gov.lk), Department of Statistics Malaysia (www.dosm.gov.my), State Bank of Pakistan (www.sbp.org.pk/ecodata/index2.asp), Japan's Ministry of Economy, Trade and Industry (www.meti.go.jp) and the Federal State Statistics Service (www.gks.ru). Our quarterly series covers the period 2010–2017 for the Asia and Pacific region.

Table 2 presents the primary descriptive characteristics of our data. Energy export volume (in this paper we consider the HS Code 27 trade map as the basis of energy export data) is measured in millions of US dollars ($). The Russian Federation's energy exports to Asia and the Pacific have a mean of $1.16 billion over the period 2010–2017. The mean of the selected Asia and Pacific countries' economic growth is 5.3%, with a maximum and minimum of 22.5% and –19.8% in 2010–2017, respectively. The differences in per capita income between the Russian Federation and Asia and the Pacific during the period 2010–2017 take the mean of $26,970.30 per person. The average population growth in the selected Asia and Pacific countries is 3.2%, with a maximum of 10.9% and minimum of –1.4% from 2010 to 2017. The bilateral exchange rate between the Russian Federation ruble and the national currencies of Asia and the Pacific during 2010–2017 takes an average of 493.8, with a maximum and minimum of 1,646.6 and 10,461.2, respectively. Regarding geography, based on GeoDist data of CEPII, the maximum distance between the Russian Federation and the 16 selected Asia and Pacific nations is 6,963 km, and the minimum is 2,853 km.

Table 2: Variables' Descriptive Statistics

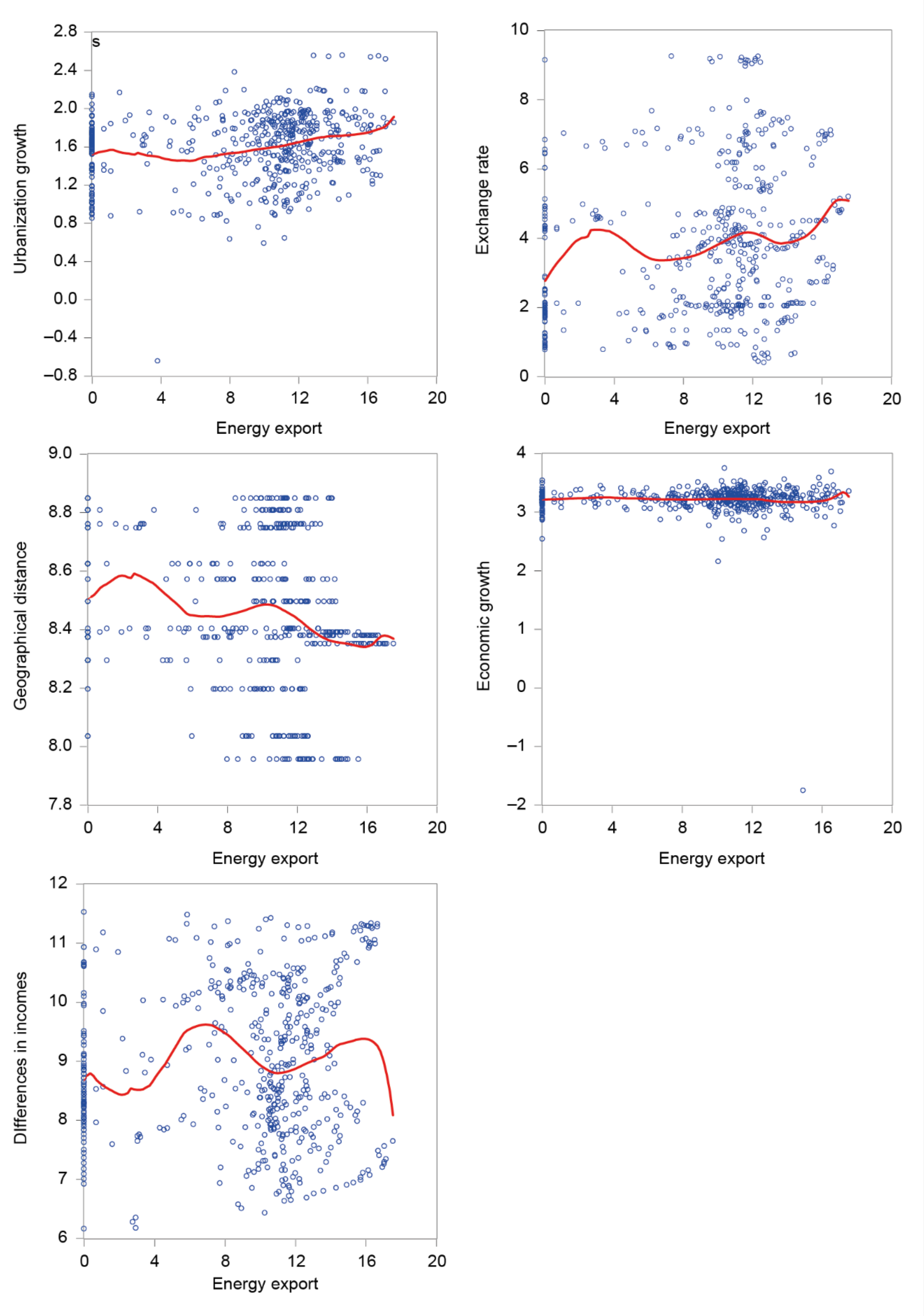
Variables	Unit	Obs.	Mean	Std. Dev.	Max.	Min.
EXV	$ Thousand	512	1,166,305	39,692	41,226,438	0.0
GRO	%	512	5.3	3.8	22.5	–19.8
DI	$ per person	512	26,970.3	21,352.7	101,352.6	473.8
PGR	%	512	3.2	1.8	10.9	–1.4
EX	Ruble/currency	512	493.8	1,646.6	10,461.2	1.49
DIS	Kilometer	512	4,838.5	1,213	6,963	2,853

Notes: DI = difference of incomes, DIS = geographical distance, EX = bilateral exchange rate, GRO = economic growth, EXV = Energy exports of Russian Federation to Asia and the Pacific, PGR = population growth.

Source: Authors' compilation.

Figure 4 shows how the correlation between economic growth and the Russian Federation's energy exports to Asia and the Pacific is positive. This is in line with Varahrami and Haghighat's 2018 findings, which demonstrate the same relationship in selected OECD countries. Energy exports of the Russian Federation to selected Asia and Pacific countries are positively related to urbanization growth, while their correlation with differences in per capita income has fluctuated and is totally negative. The relationship between economic growth and bilateral exchange rate has also fluctuated, but it is totally positive. Furthermore, the correlation between geographical distance and the Russian Federation's energy export volumes to Asia and the Pacific is negative.

Figure 4: Correlation with Kernel Fit Line



Source: Authors' compilation from Eviews 9.0.

We empirically investigate the following model based on gravity trade theory and variables in natural logarithms as well:

$$lnLEXV_{ijt} = \delta_1\, ln\big(GRO_{jt}\big) + \delta_2 \ln\,(\,DI_{ijt)} + \delta_3\, ln\big(PGR_{jt}\big) + + \delta_4\, ln\big(EX_{ijt}\big) + \delta_5\, SANC + \delta_6\, ln(DIS_{ij}) + + \varepsilon_{ijt} \tag{13}$$

The coefficients δ_1, δ_2, δ_3, δ_4, δ_5, and δ_6 represent the long-run elasticity estimates of Russian Federation's energy exports to Asia and the Pacific with respect to economic growth, differences in per capita income, population growth, bilateral exchange rate, sanctions, and geographical distance. Based on the theory and correlation results, we expect that increased economic and population growth will lead to an increase in the Russian Federation's energy export volumes to Asia and the Pacific, while differences in per capita income, bilateral exchange rate, and sanctions will prove unclear. Moreover, any increase in geographical distance as a proxy for transportation cost is expected to reduce energy trade between these countries.

To estimate our coefficients, the generalized method of moments (GMM) will be performed in a panel-gravity framework for energy trade flows from the Russian Federation to 16 selected countries in the Asia and Pacific region. The reliability of the GMM method has been proved by numerous scholars, such as Arellano and Bond (1991), Kahouli and Maktouf (2015), Lin (2015), and Martinez-Zarzoso et al. (2009). Arellano and Bond (1991) argued that the GMM estimator, including the lagged endogenous variable as an explanatory variable, is more convenient for panel data because it yields more consistent and robust results in the presence of arbitrary heteroskedasticity. A general regression model in the form of GMM is written as follows:

$$Y_{it} = \alpha + \beta Y_{it-1} + \gamma X_{it} + \eta_{it} + \varepsilon_{it} \tag{14}$$

Where Y indicates the dependent variable (Russian energy export flows to the selected Asia and Pacific nations), and X represents all explanatory variables (economic growth, exchange rate, urbanization growth, differences in income, geographical distance, sanctions). η_{it} denotes the country-specific effects, and ε_{it} is the error term.

To derive reliable empirical estimations, we must conduct some preliminary tests. As the first pre-estimation test, the variance inflation factor (VIF) will be performed to ascertain whether there is any multicollinearity among the series. The second preliminary test is the Hausman test to check for the existence of heterogeneity, clarifying the presence of random or fixed effects in our panel. Given that the economies of the Russian Federation and the selected sample have experienced various exogenous and endogenous shocks, the next pre-estimation test will be to check for cross-section dependency among the series. The second-generation unit root test will be the last preliminary test to ascertain whether the series are I(1) stationary or I(0) non-stationary.

Furthermore, we will conduct two different diagnostic tests after running the GMM estimations. The first is the Arellano-Bond test for zero autocorrelation in the first-differenced errors, and the second is the Sargan test to verify the overidentifying restrictions.

5. EMPIRICAL ANALYSIS

Before our econometric gravity model can be estimated, multicollinearity among the series, heterogeneity and cross-section dependency needs to be checked. Table 3 reports the results of the VIF (multicollinearity among variables) and Hausman (to clarify the nature of the panel data series, i.e., RE or RF) tests:

Table 3: VIF Statistics and Hausman Test Results

Independent Variables	Explanatory Variables					
	LEXV	LDI	LGRO	LURB	LEX	LDIS
LEXV	–	1.13	1.03	1.44	1.29	1.30
LDI	1.58	–	1.10	1.42	1.29	1.05
LGRO	1.14	1.31	–	1.25	1.33	1.48
LURB	1.60	1.43	1.09	–	1.19	1.53
LEX	1.22	1.04	1.46	1.51	–	1.35
LDIS	1.12	1.53	1.39	1.04	1.51	–
Mean VIF	1.33	1.28	1.21	1.33	1.32	1.34
Chi2(7)	11.52					

Notes: 1. DI = difference of incomes, DIS = geographical distance, EX = bilateral exchange rate, GRO = economic growth, EXV = Energy exports of Russian Federation to Asia and the Pacific, PGR = population growth.

2. (L) indicates variables in the natural logarithms.

Source: Authors' compilation.

The findings of the VIF test, presented in Table 3, depict low multicollinearity between the cross-sections. Moreover, the results of the Hausman test propose the panel data with random effects.

The next step is to verify the presence of cross-section dependence in the series. Table 4 shows the results of the cross-section dependence (CSD) test:

Table 4: CSD Test Results

Variables	CSD Test	Corr.	Abs. (Corr.)	Significant at 1% Level
LEXV	5.15	0.235	0.235	Yes
LGRO	10.83	0.718	0.718	Yes
LDI	7.73	0.510	0.510	Yes
LURB	8.95	0.588	0.588	Yes
LEX	6.25	0.317	0.317	Yes
LDIS	8.44	0.604	0.604	Yes

Notes: 1. DI = difference of incomes, DIS = geographical distance, EX = bilateral exchange rate, GRO = economic growth, EXV = Energy exports of Russian Federation to Asia and the Pacific, PGR = population growth.

2. (L) indicates variables in the natural logarithms.

Source: Authors' compilation.

The results of the CSD test, reported in Table 4, reveal that cross-sections are present in all series. This means that our samples in the Asia and Pacific region share the same characteristics. Generally, in situations where there is low multicollinearity and cross-section dependence in the variables, it is necessary to check the stationary of variables. Here, we conducted the second-generation panel unit root test (Pesaran's 2007 Cross-Sectionally Augmented Im, Pesaran, and Shin [CIPS] test) with the null hypothesis of all series being I(1). The results of this test are shown in Table 5:

Table 5: Pesaran (2007) Panel Unit Root Test Results

Variables	Without Trend	With Trend

LEXV	0.243	1.683
LGRO	0.311	–0.849
LDI	0.269	–0.790
LURB	–0.782	–0.811
LEX	0.218	1.823
LDIS	0.392	–0.833

Notes: 1. DI = difference of incomes, DIS = geographical distance, EX = bilateral exchange rate, GRO = economic growth, EXV = Energy exports of Russian Federation to Asia and the Pacific, PGR = population growth.

2. (L) indicates variables in the natural logarithms.

3. * Denotes statistically significant at 5% levels.

Source: Authors' compilation.

The findings of Pesaran's (2007) panel unit root test in the above table prove that all series are I(0).

After conducting all of the necessary preliminary tests, we ran the Arellano-Bond dynamic GMM estimation in order to ascertain the coefficients. The results of the GMM estimation are reported in Table 6 as follows:

Table 6: Arellano-Bond Dynamic GMM Model Estimations

Explanatory Variables	Coefficients	Significant at 1% Levels
Constant	–1.738	Yes
LGRO	0.024	Yes
LDI	–0.149	Yes
LURB	2.174	Yes
LEX	0.882	Yes
LDIS	–0.092	Yes
SANC	0.004	Yes
No. of observations		512
Periods included		32
Cross-sections included		16
Wald Chi2 (5)	462.28	Yes

Notes: 1. DI = difference of incomes, DIS = geographical distance, EX = bilateral exchange rate, GRO = economic growth, EXV = Energy exports of Russian Federation to Asia and the Pacific, PGR = population growth.

2. (L) indicates variables in the natural logarithms.

Source: Authors' compilation.

According to the results, shown in Table 6:

- First, economic growth is found to be highly significant and positive, indicating that a 1% increase in the economic growth of the selected Asia and Pacific economies leads to an increase in Russian energy export flows to this region by nearly 0.02%. This is in line with Rasoulinezhad (2019a), who noted a positive relationship between economic size and trade flows.
- Second, the impact of difference between per capita incomes on the Russian Federation's energy exports to the Asia and Pacific region is statistically significant and negative, supporting the Linder hypothesis (i.e., the more two countries are similar in terms of income, the more they might trade).
- Third, the effect of urbanization growth is found to be positive and statistically significant. The Russian Federation's energy exports to the Asia and Pacific region increase by approximately 2.17% for every 1% increase in the region's urban population. This result is in line with Kurniawan and Managi (2018), who showed a positive relationship between urban population and trade flows.
- Fourth, we can observe that bilateral exchange rate has a positive sign, which means that a 1% depreciation of the Asia and Pacific nations' currencies against the Russian ruble will accelerate energy export volume by about 0.8%. When the selected Asia and Pacific nations' national currencies depreciate, their import costs will increase and energy resources will become more expensive in their domestic currencies, although their export of final products will be more competitive. Therefore, they will exhibit greater demand for energy and thus import more of it from other countries, including the Russian Federation.
- Fifth, the impact of the time-invariant factor (sanctions imposed by the West against the Russian Federation) is positive and statistically significant. This means that the sanctions imposed by the West since 2014 have not constituted a barrier to this country's energy exports to the Asia and Pacific nations, and have enabled it to become a trade pivot from the West to the East.
- Sixth, a negative nexus can be seen between geographical distance and energy trade flows between the Russian Federation and the selected Asia and Pacific economies. Any increase in geographical distance as a proxy for transportation cost lowers Russian Federation energy exports to this region. This result is in accordance with Rasoulinezhad (2019b), who has demonstrated the geographical shift of the Russian Federation to the East under sanctions.

As the final stage in the empirical estimations, we need to carry out diagnostic tests to verify the characteristics of the model. To this end, the Arellano and Bond diagnostic test and Sargan test are conducted, yielding the following results:

Table 7: Diagnostic Test Results for GMM Estimation

Statistics	AR(2)z	Chi2
Arellano Bond test	–2.62**	–
Sargan test	–	3412.92***

Notes: ** and *** indicate statistically significant at 1% and 5% levels.

Source: Authors' compilation.

The results, shown in Table 7, strongly reject non-autocorrelation, and so the Arellano-Bond model assumptions are satisfied. In addition, the Sargan test findings show that there are not any overidentifying restrictions. In other words, we can conclude that our model is suitable.

6. CONCLUDING REMARKS AND POLICY IMPLICATIONS

This study has represented an empirical attempt to econometrically model the Russian Federation’s energy export pattern among 16 Asia and Pacific nations, specifically the PRC; the Republic of Korea; Japan; Singapore; Taipei,China; India; Malaysia; the Philippines; Viet Nam; Hong Kong, China; Indonesia; Pakistan; Bangladesh; Myanmar; Sri Lanka; Cambodia; and Nepal. Importing energy resources can improve energy security in these selected Asia and Pacific nations through diversifying their energy baskets (all three dimensions of diversification, that is, variety, balance, and disparity), reducing dependency on crude oil imports, providing a better energy source for generating electricity, and facilitating climate change mitigation.

To conduct our research, we employed the gravity theory framework and the econometric approach, namely the GMM panel model for quarterly data in the period 2010–2017 for 16 countries. In order to attain reliable estimation results, we carried out various pre-estimation and diagnostic tests, including the variance inflation factor (VIF) to ascertain whether there is any multicollinearity among the series, the Hausman test to check for the existence of heterogeneity, the panel unit root test to discover whether the series are I(1) stationary or I(0) non-stationary, the Arellano-Bond diagnostic test for zero autocorrelation in the first-differenced errors, and the Sargan diagnostic test to verify the overidentifying restrictions.

Through modeling the energy trade from the Russian Federation to Asia and the Pacific, and estimating it via the GMM model, it can be observed that this process follows the Linder hypothesis, denoting that the latter imports energy resources more if it shares similarities with the former in terms of factor endowment. This finding stands in contrast with Rasoulinezhad and Jabalameli (2018), who discovered that Russian export patterns in manufactured goods and raw material commodities are based on the Heckscher–Ohlin (H-O) hypothesis.

Our study has revealed that economic growth is a positive influencing factor on Russian energy exports to this region. Greater economic growth or production levels result in increased energy demand and consumption in Asia and the Pacific. The result of the positive relationship between economic growth and energy demand is in line with Rasoulilnezhad (2019) and Saidi and Hammami (2015), although scholars such as Karanfil (2009) did not find any positive relationship between these two variables.

In addition, we have found that a depreciation of the national currencies of the Asia and Pacific nations against the Russian ruble will accelerate the Russian Federation’s energy export volume. This result is similar to Arize’s (1998) discovery of a negative relationship between exchange rate and import flows, but contradicts Chaudhary, Hashmi, and Khan’s (2016) finding of no relationship between the two variables in the short run.

Our findings have also indicated that the imposition of sanctions by the West against the Russian Federation since 2014 has stimulated an increase in Russian energy exports to the Asia and Pacific region. This finding reflects the Russian Federation's "Pivot to Asia" given the West's sanctions, as demonstrated by scholars such as Yennie-Lindgren (2018). In other words, and as Nasre Esfahani, and Rasoulinezhad (2017) argue, sanctions have instigated the Russian Federation to conduct an economic policy of Asianization and de-Europeanization.

The positive link between urban population growth and energy imports to Asia and the Pacific from the Russian Federation is depicted by the results. Russian energy exports to Asia and the Pacific have increased by approximately 2.17%, given a 1% increase in regional urban population growth. This result is in line with Brakman and Marrewijk (2013), who found a causal relationship between population and trade flows in different nations. On the one hand, a higher level of urban population growth means a higher need for commodities, leading to increased trade flows. On the other hand, as Yuan and Guanghua (2015) have expressed, many countries are adopting policies geared toward imports to increase their levels of urbanization.

In addition, we have proved a negative relationship between geographical distance and the Russian Federation's energy exports to Asia and the Pacific, meaning that any increase in geographical distance leads to greater transportation costs, always an obstacle to trade between nations.

The Russian trade pivot to the East as well as increased energy consumption in the Asia and Pacific region have augmented issues of energy insecurity in the region. Here we can recommend some policies. First, an energy trading hub should be established, consistent with Shi (2016), who notes that gas trading hubs have been developed in the US in the 1980s, the United Kingdom (UK) in the 1990s, and across Europe in the 2000s. Similar policy measures have been suggested by Tong et al. (2014), who argue that any gas trading hub can make regional benchmark prices, a favorable strategy for the Asia and Pacific region. The establishment of a gas hub would positively contribute to the accessibility and affordability of LNG and improve energy security in the region. A key issue regarding the creation of a gas hub pertains to liquidity. Indeed, this is one of the most important requirements for successful trading, which in the case of the Asia and Pacific market can be improved through the standardization of traded contract terms and conditions. Furthermore, developing financial markets (physical and futures) might be key to providing a liquidity hub in this region. In addition, import diversification may reduce energy insecurity in the region. This policy is in line with Shaikh et al. (2016), who have shown a positive relationship between diversification of suppliers and LNG supply security. The importance of energy supplier diversification has been proved by Taghizadeh-Hesary et al. (2017) for Japan, a country that flourishes under self-dependency and energy security. Moreover, this policy can help countries to reduce CO_2 emissions from fossil fuels (Nasre Esfahani and Rasoulinezhad 2016; Saboori et al. 2017).

Modeling energy trade patterns running from the Russian Federation to the Asia and Pacific economies using various variables has demonstrated how these variables do not operate alone. Numerous other variables, including energy prices, geographical borders, and financial stability can be deemed variables affecting the Russian Federation's energy exports to this region. We therefore recommend that future studies utilize some new variables and patterns to model the energy trade between nations.

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