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Russia-East Asia LNG trade pattern and the regional energy security

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Outline

1. Introduction and background
   - 1-1. Increasing preferences of natural gas
   - 1-2. Overview of the gas market
   - 1-3- Import dependency and energy insecurity
2. Role of Russia in developing the Asian LNG market
3. Theoretical Model
4. Data and methodology
5. Empirical analysis and discussion of results
6. Concluding remarks and policy implications

Clean energy is directly and indirectly related to various SDGs

Relationship	SDG number	Definition	Information
Direct	SDG7	affordable and clean energy	Ensure access to affordable, reliable, sustainable and modern energy for all users
	SDG11	sustainable cities and communities	Make cities and human settlements inclusive, safe, resilient and sustainable
	SDG13	climate action	Take urgent action to combat climate change and its impacts
Indirect	SDG3	good health and well-being	Ensure healthy lives and promote well-being for all at all ages
	SDG14	life bellow water	Conserve and sustainably use the oceans, seas and marine resources for sustainable development
	SDG15	life on land	Protect, restore and promote sustainable use of terrestrial ecosystems; sustainably manage forests; combat desertification; halt and reverse land degradation and halt biodiversity loss

Source:

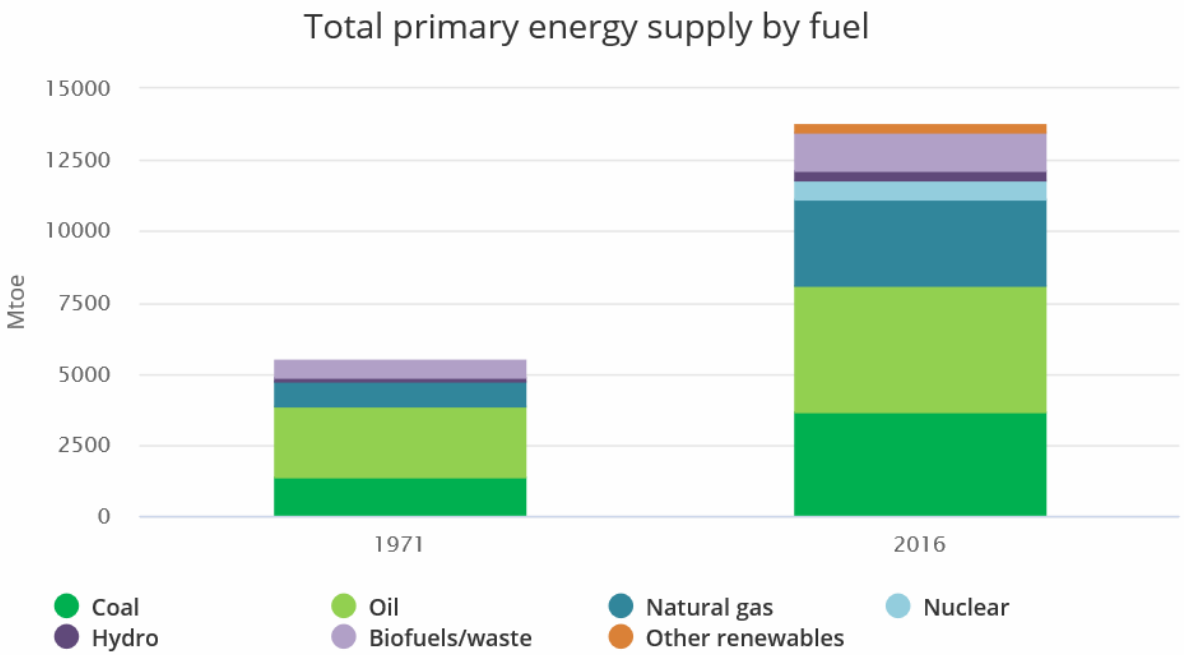
Taghizadeh-Hesary F., Yoshino N. (2019). The way to induce private participation in green finance and investment, *Finance Research Letters*,31: 98-103, doi.org/10.1016/j.frl.2019.04.016

1. Introduction

Energy Balances

Between 1971 and 2016, world total primary energy supply (TPES) increased by almost 2.5 times.

While oil was still the dominant fuel in 2016, its share has fallen over the past decades. In contrast, the share of natural gas and nuclear power have both grown significantly. In 2011, coal reached its highest level since 1971 at 29% (peaking at 71% of TPES in China). However in the past five years its share has declined.



Source: IEA, 2019

1-1-The role of natural gas as a preferred source of energy is increasing

- According to Global Energy Transformation Report by IRENA (International Renewable Energy Agency), the future of energy sources will be focused on new renewable energy resources (in line with Gielen et al. (2019) the share of renewable energy in total primary energy supply would rise from 14% in 2015 to 63% in 2050)

- …and only natural gas will be highly used among non-renewable energy sources.

- Zou et al. (2016) predicted that natural gas will enter the heyday period and its annual production peak will be around 2060 and will play a pivotal role in the future energy sustainable development.

Substitution of crude oil and coal by natural gas

- Busch and Gimon (2014), Thomson et al. (2015) and Barreto (2018) express that Natural Gas (LNG) can be an important source of energy in reducing air pollutants, such as sulfur oxides.

- In comparison with other popular non-renewable energy resources such as coal, using natural gas is better for the climate

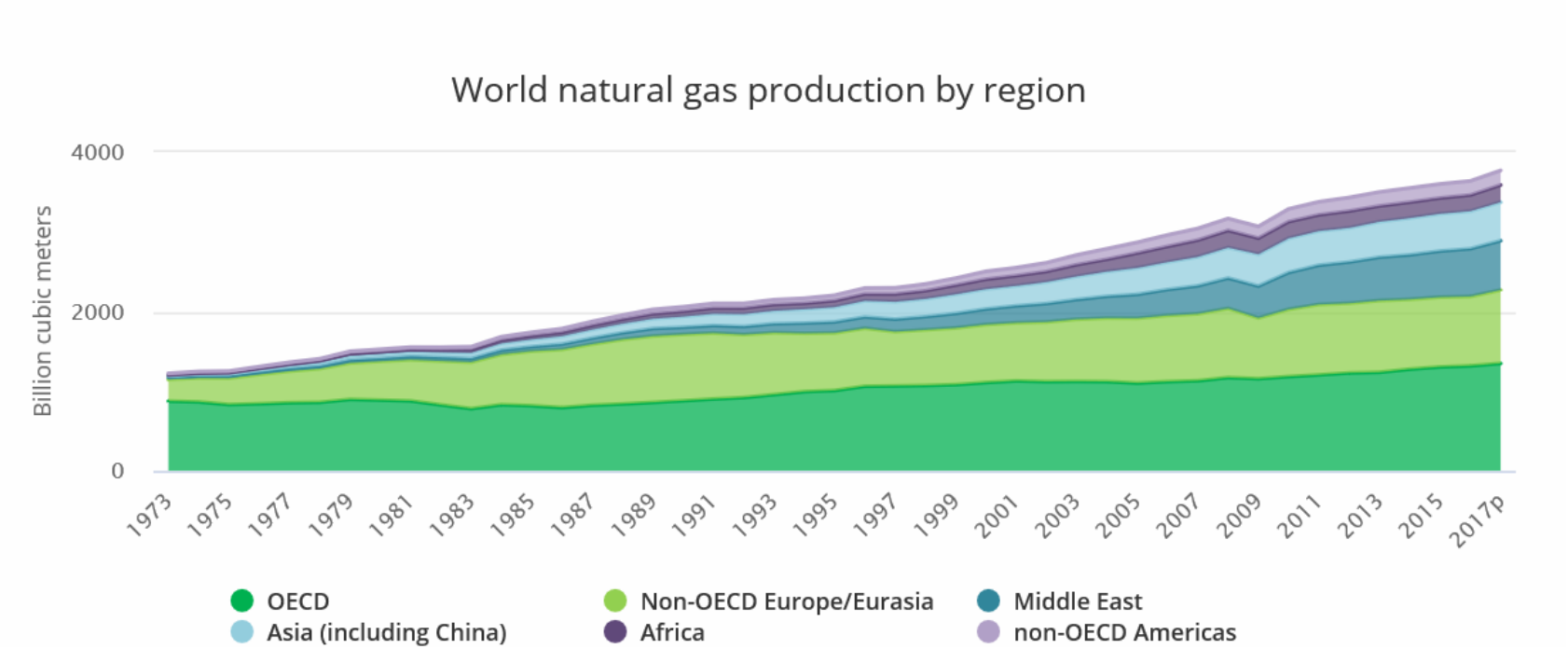
- Dhameliya and Agrawal (2016) nominated various advantages of using natural gas such as the ease of production, great availability and lower transportation cost and argued that LNG as green fuel has become a new hot spot for global energy markets.

- Similarly Withers et al. (2014) mentioned that LNG as an alternative transportation fuels can help nations in the way of diversifying energy supplies and mitigating transportations' impact on climate and air quality.

- Saboori et al. (2017) proved that oil consumption of Asia-Pacific nations has a positive link with their amount of CO_2 emissions, hence they have to shift to the cleaner energy sources

1-2- Overview of the gas market
Natural gas production

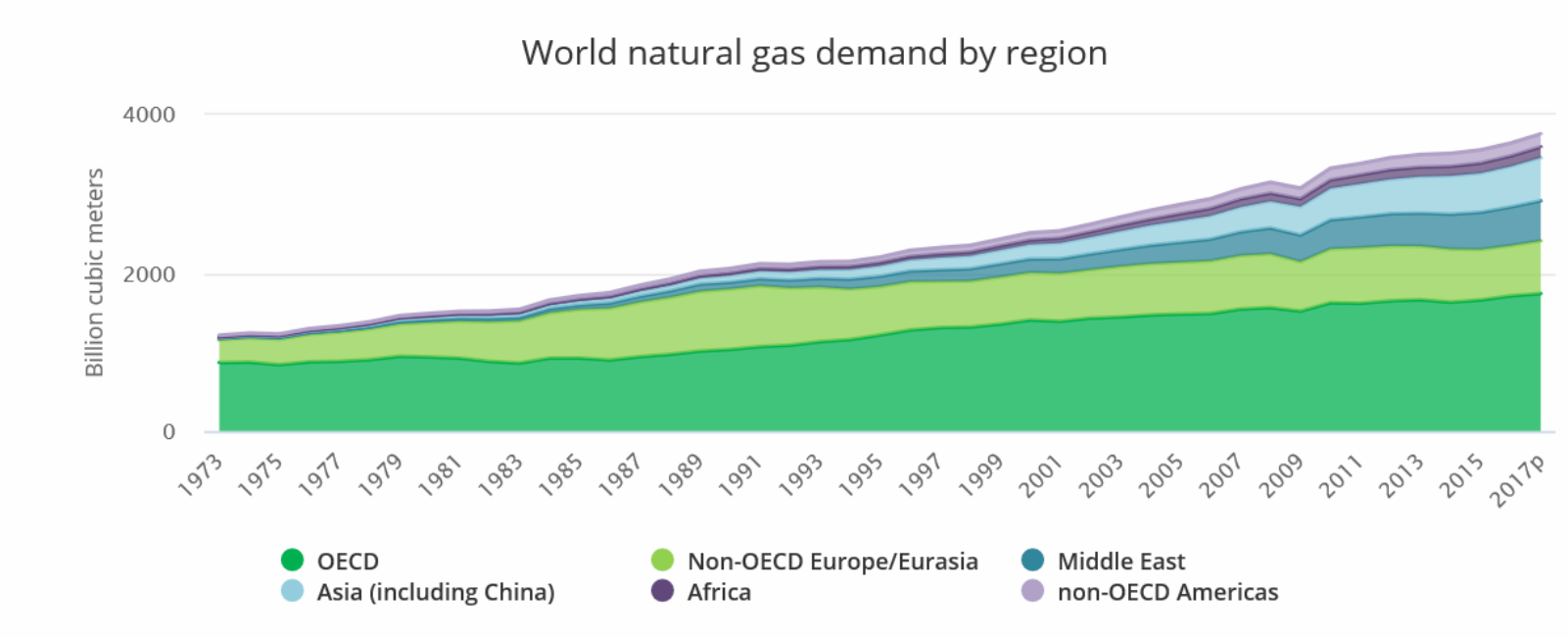
- In 2017, global natural gas production hit a new record of 3768 billion cubic meters.
- This is a 3.6% increase compared to 2016 and constitutes the largest increase since 2010. In fact, natural gas production has been rising since the economic crisis of 2009 with a compound annual growth rate of 2.6%.



Source: IEA, 2019

Natural gas demand

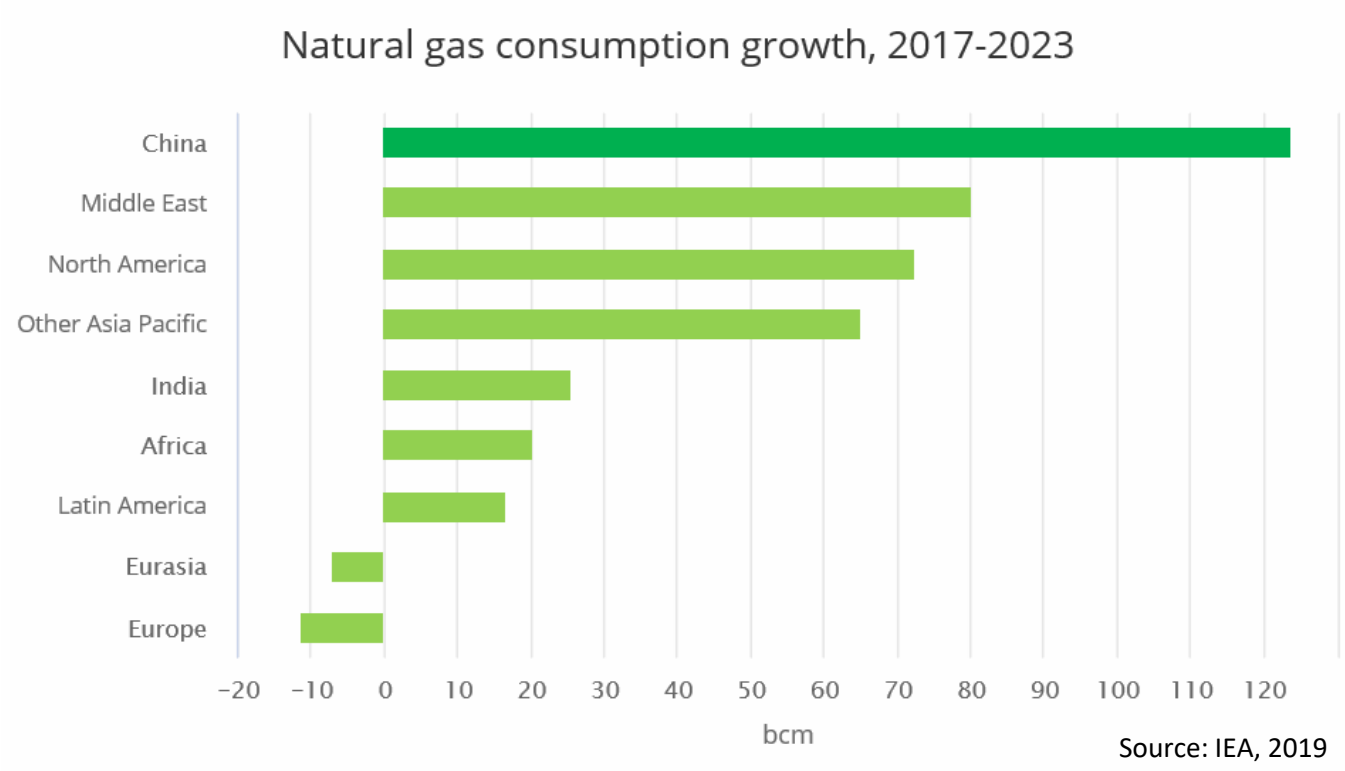
- In 2017, global demand for natural gas increased by 3.2% compared to 2016, rising to 3757 Billion cubic metres. This was the eighth consecutive year of increase.
- Since 1990, global natural gas consumption has grown at an average of 6.3% per year. Consumption growth has been even stronger in China, averaging 13.1% per year over the past 20 years



Source: IEA, 2019

China is set to dominate rising gas demand...

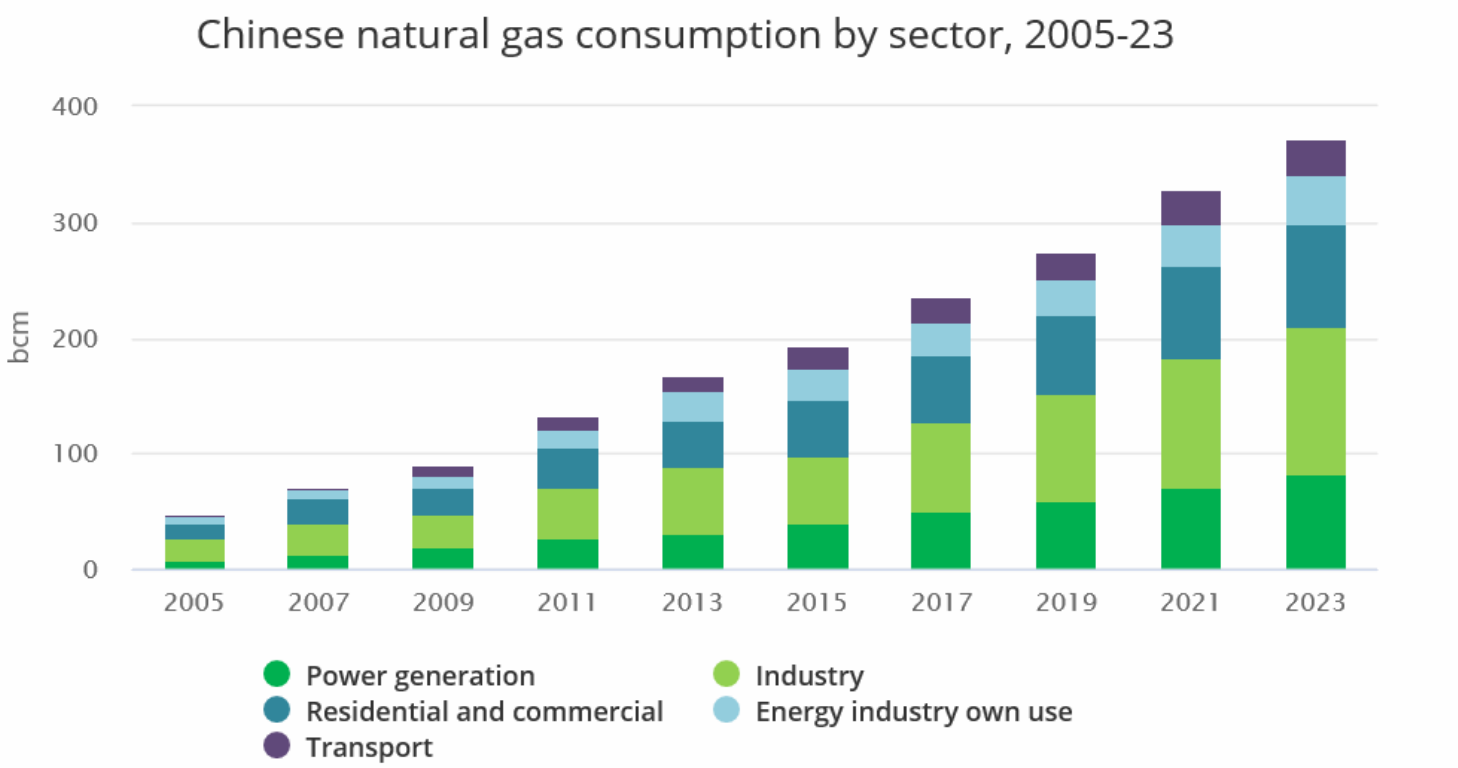
Global demand for natural gas is forecast to increase at an average 1.6% over the next 5 years with emerging Asian markets as the main engine for demand. China alone accounts for a third of global demand growth to 2022 thanks in part to the country's "Blue Skies" policy and the strong drive to improve air quality. (IEA, 2018)



Source: IEA, 2019

... driven by demand from industry

Industry will be the main driver for gas consumption growth in China, led by the chemical and manufacturing sectors. Meanwhile, gas demand in the residential and commercial sectors are clearly benefiting from the ongoing coal-to-gas switch.

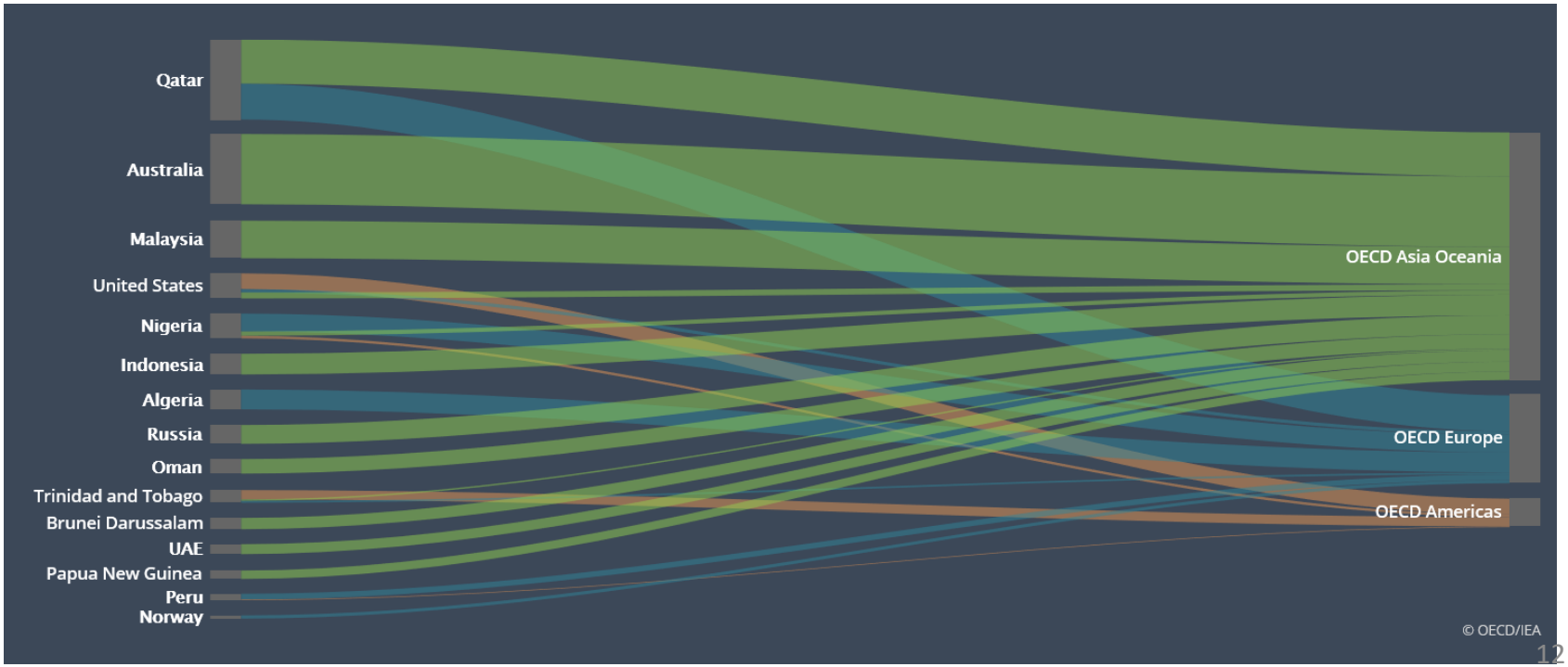


Source: IEA, 2019

Import

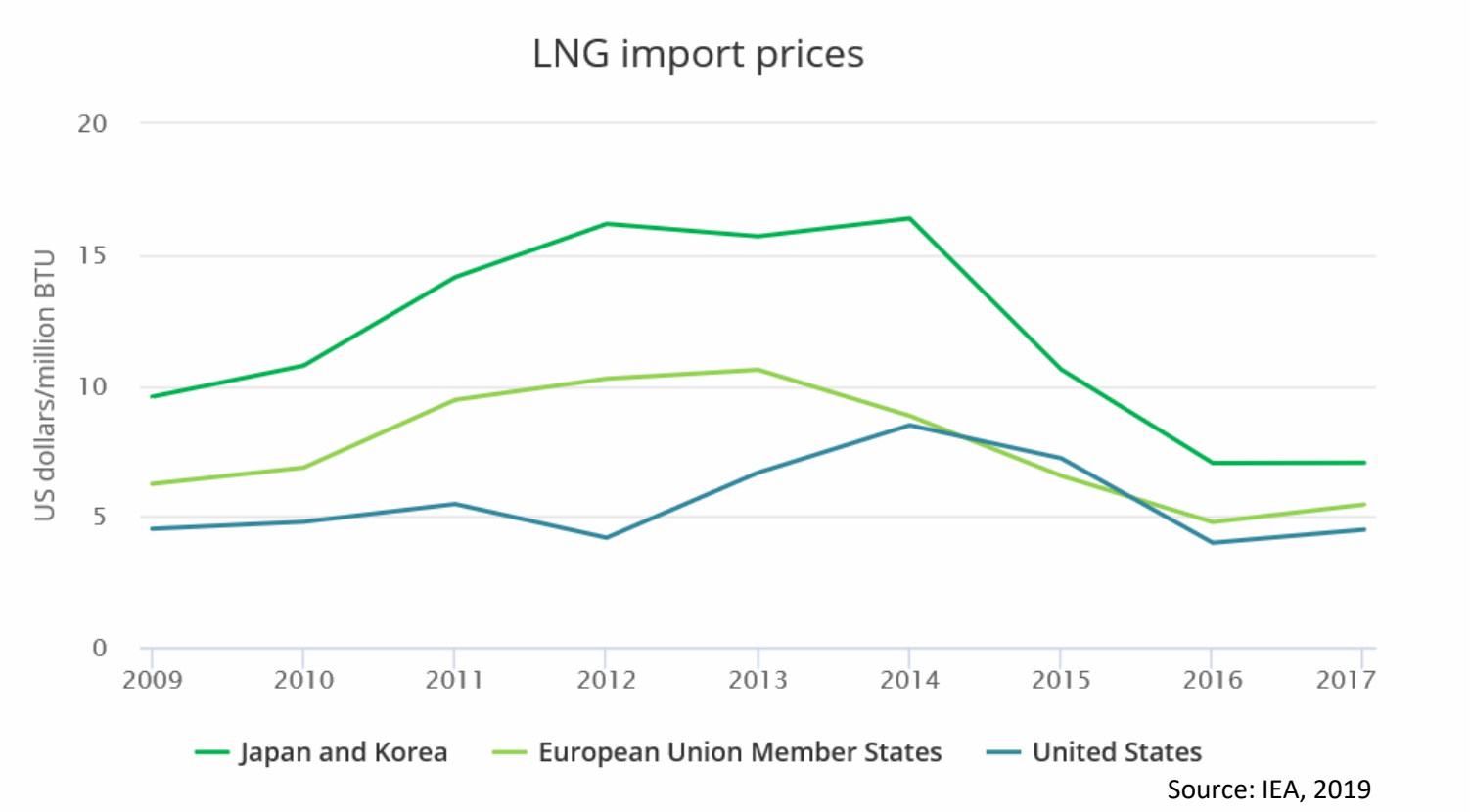
Global gas trade approached 1.2 Tcm in 2017, with LNG gaining ground and accounting for 32.9% of global trade. This LNG growth is primarily attributed to the surge in LNG exports from the United States and Australia. Within the OECD, there was a substantial increase of LNG imports in 2017, with the OECD Americas seeing an increase almost exclusively due to Mexican imports from the United States.
Qatar remains the major LNG exporter for OECD countries, just ahead of Australia.

LNG imports (bcm) to OECD regions in 2017



Prices

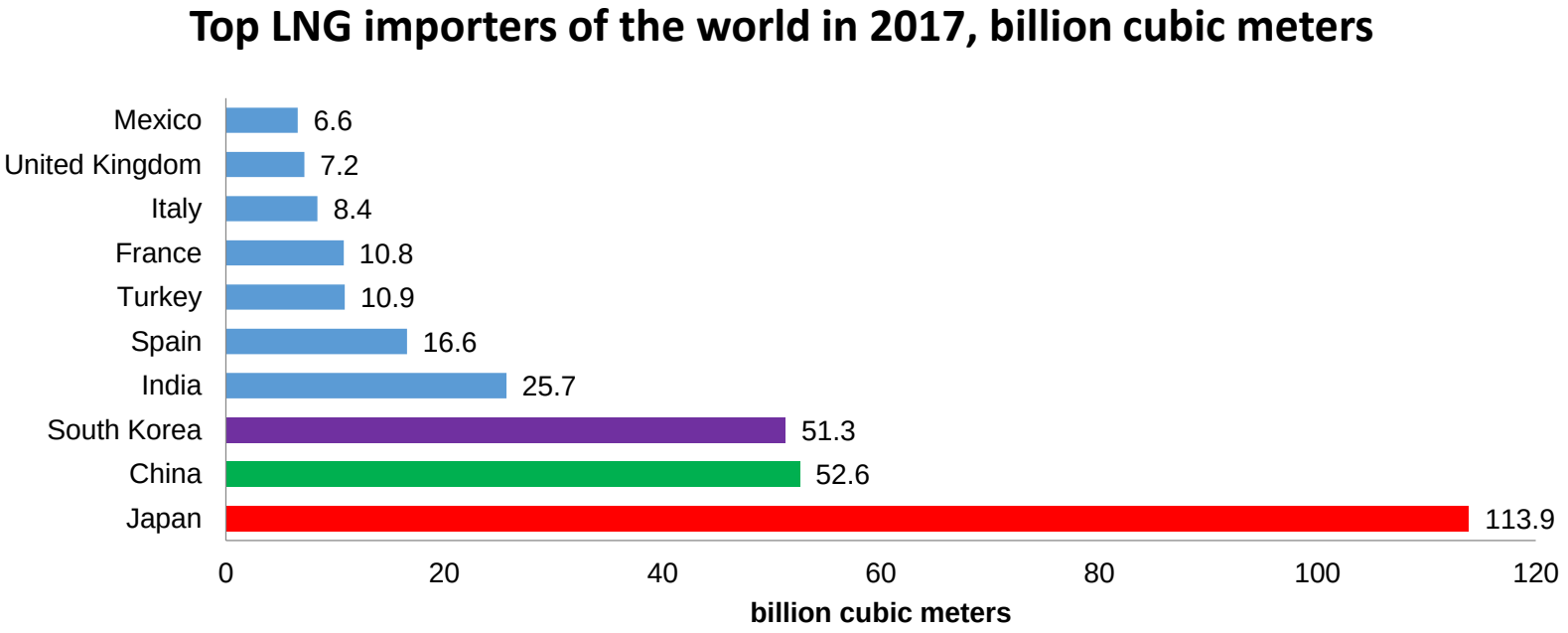
LNG prices in Europe and the US remained similar in 2017 after converging in 2014, while the price gap between the US and Japan and Korea continued to narrow.
This convergence has been partially driven by the increase in global liquefaction capacity, especially in Australia.



Source: IEA, 2019

LNG market in Asia

- Asia remained the biggest market for LNG in 2016, taking in **53.6% of global supply**. Demand in Asian continues to be led by **Japan (113.9 billion cubic meters), followed by China (52.6 billion cubic meters) and South Korea (51.3 billion cubic meters).**
- However, it should be mentioned that these three east Asian nations are 3 major importing countries of LNG in the whole world as at 2017. The following figure illustrates top 10 LNG imports in the world in 2017:



Source: Authors' compilation from statistica.com

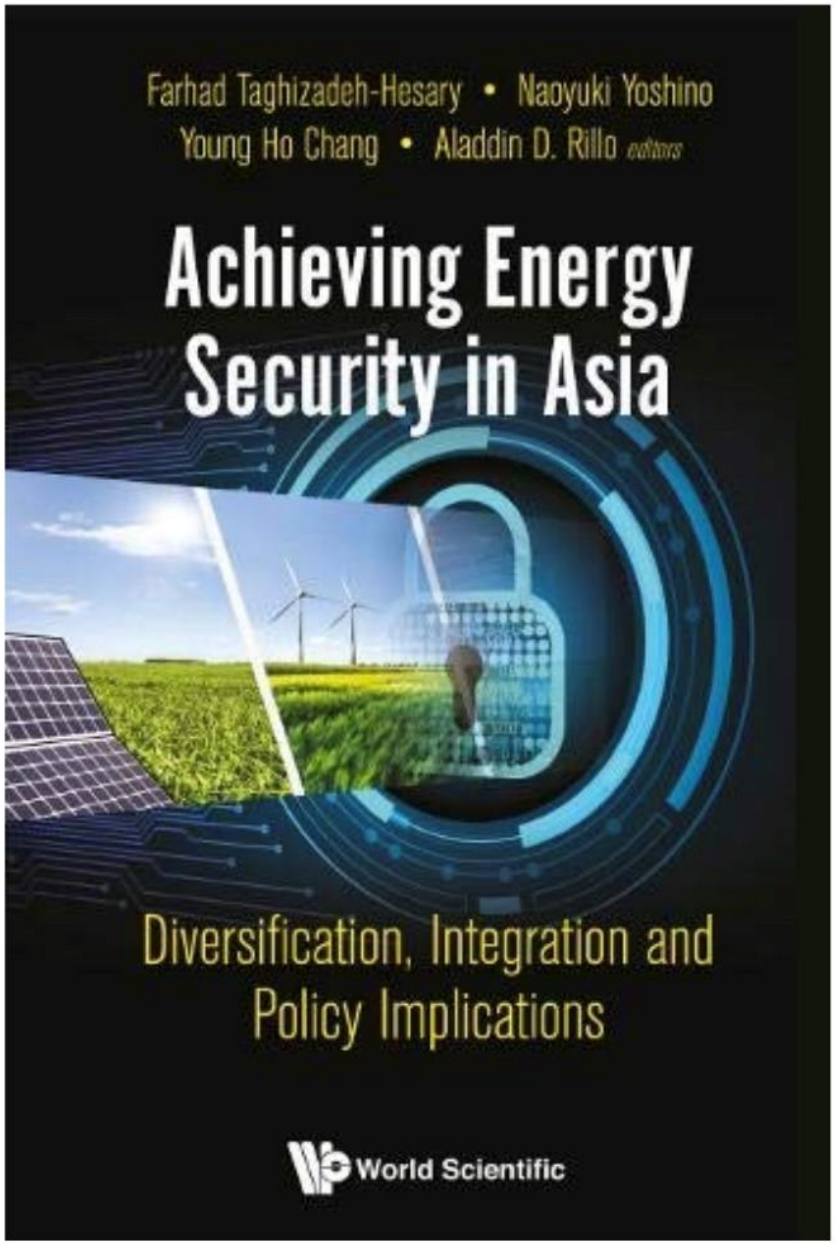
1-3- Energy security

- Energy security can be defined as an adequate and reliable supply of energy resources at a reasonable price (Toman, 1993; Bohi and Toman, 1996; Bielecki, 2002).
- Energy security in the literature, in general or 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 of the interpretation of diversification – variety, balance and disparity (Stirling, 2010). Variety asks how many options are. Balance checks how dominant one option is. Disparity examine how different or similar all options are.
- In recent years, the issue of energy insecurity has been identified as an overriding challenge in Asia, particularly for developing countries. (Taghizadeh-Hesary et al. 2019)

1-3-1 Import dependency and energy security

- In the field of energy security, there are several studies that proposed diversification of energy resources, versatility of the fossil fuel import origins will increase the energy security level (Cohen et al., 2011; Yao and Chang, 2014; Tongsopit et al., 2016).

- In addition, As for the import dependency, one issue that has been neglected in the literature is measurement of the distance between the energy-exporting and energy-importing countries. As reliance on import of energy carriers (fossil fuels) on countries in other regions and with far distances is inherently riskier, therefore endangering the energy security.



Achieving Energy Security in Asia

Diversification, Integration and Policy Implications

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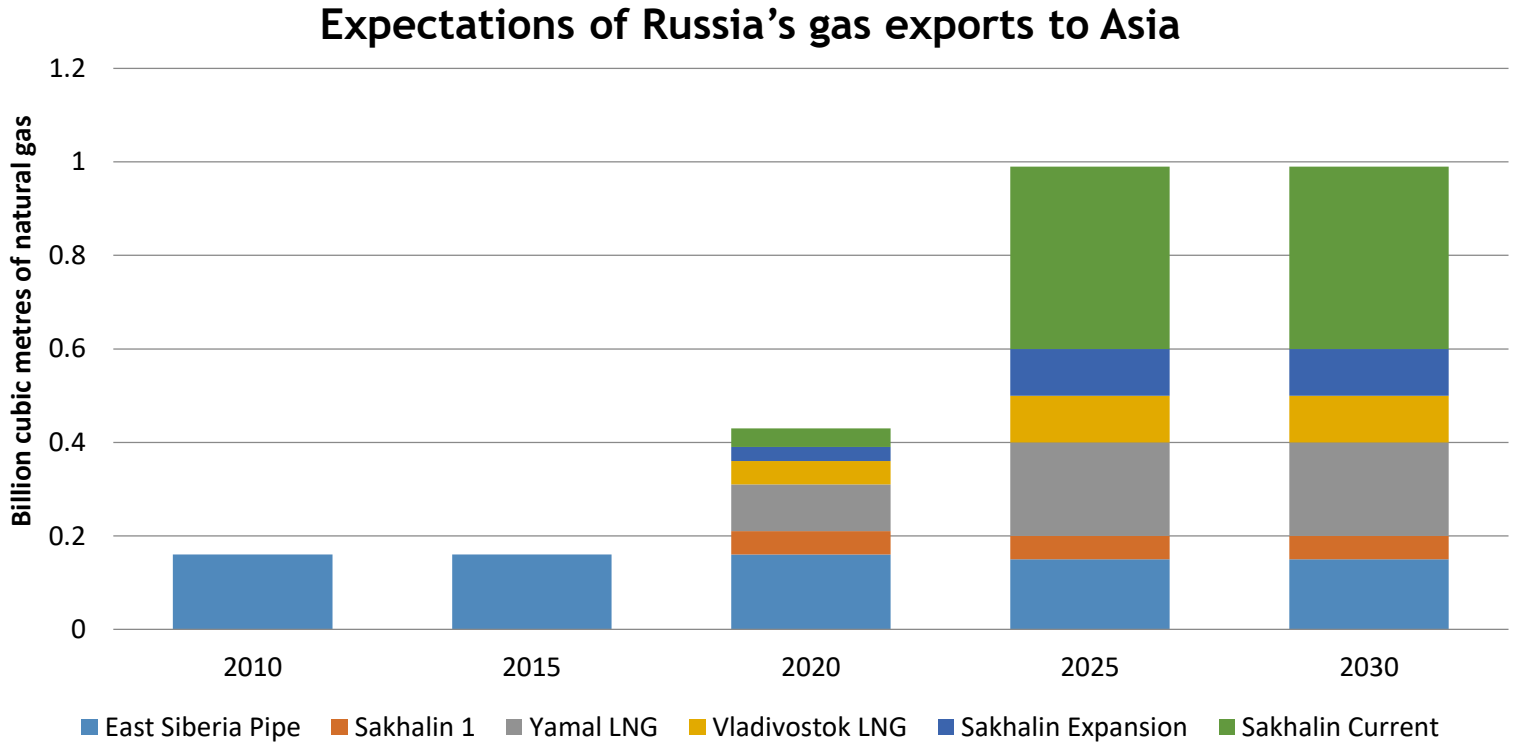
2. Role of Russia in developing the Asian LNG market

Role of Russia in the Asia-Pacific is increasing

- LNG trade of Asia-Pacific region has been shaped by a number of LNG exporters such as Qatar, Australia mainly and share of Russia in smaller.
- Among these LNG exporters, Russian Federation has a clear vision to develop its East LNG projects to provide a bigger share of Asia-Pacific LNG imports.
- According to the Russian long-run 2030 strategy, its gas industry would be focused to the East with export volume of nearly 75 billion cubic meters by 2030 (Henderson, 2011).

Russia is expanding its Eastern LNG fields to cover up its potential LNG exports to East-Asia nations

- Henderson (2014) predicted East Siberia Pipe and Vladivostok LNG will play the most important role in Russia's gas exports to the Asia in the near future.



Source: Henderson and Stern (2014)

Russia's economic ties with East-Asia for the Russian far east economic development

Lukin and Yakunin (2018) expressed that the only way to develop the Asiatic Russia is to increase foreign trade with East-Asian nations.

Ostevik and Kuhrt (2018) highlighted the relationship between development of the Russian Far East and economic ties with the East-Asian region.

Izotov (2017) found that Russia's trade flows with some major nations in Asia have a tendency to an increase due to their large markets and potential in manufacturing of products.

Idrisov et al. (2016) proved that for social stability and reducing the impact of variability, Russia is trying to diversify its trade partners, especially from East-Asian economies.

Sanctions are forcing Russia to shift from West to East

Rasoulinezhad (2017) proved that sanctions create Trade Divergence (TD) between a target nation and sanction imposers, while it makes Trade Convergence (TC) between a target nation and nations who do not support the existence sanction.

Fortescue (2016) showed that under sanctions, Russia tries to replace revenues earned by resource exports to the West through an economic "turn to the East".

Yennie-Lindgren (2018) highlighted that energy is important factor in Russia-Japan trade relation. These two countries are trying to increase their energy relations in the post-Fukushima period and reduce effects of Japanese sanctions due to the Ukraine crisis.

Paramonov and Puzanova (2018) also expressed the stronger Tokyo's diplomacy with Russia to provide its national energy security.

Fernandez and Palazuelos (2011) argued that the future of Russian gas and LNG exports to East Asia will be high and East-Asia will be the great player in developing gas market of Russia in future.

3- Model

Industry and service sectors' energy demand
(Electricity consumption in Industrial and service sectors)

$$Y = F(K, L, E) = K^{\alpha} L^{\beta} E^{(1-\alpha-\beta)} \quad (1)$$

Y : *total production*, K: Capital, L: *Labour and* E : *electricity inputs*

$$Max\ \pi = P_Y Y - rK - wL - e(P_E + t)E \quad (2)$$

π: *profit*, P_Y=*price of products*, r: *interest rate*, w: *wage rate*, e: *exchange rate*, P_E: *electricity tariff*, t: *transportation costs (distance)*

$$\frac{\partial \pi}{\partial E} = (1 - \alpha - \beta)\frac{P_Y Y}{E} - e(P_E + t) = 0 \quad (3)$$

$$E = (1 - \alpha - \beta)\frac{P_Y Y}{e(P_E + t)} \quad (4)$$

Household sector's energy demand
(electricity consumption at housing sector)

Utility function of household:

$$Max \quad U = (C, E) = \frac{1}{1-\gamma} C^{1-\gamma} + \frac{1}{1-\delta} E^{1-\delta} \qquad (5)$$

$U : utility\ of\ household, C$: consumption of non-electricity goods of household,

E: consumption of electricity of household

$$S.t. \quad P_C C + e(P_E + t)E = Y$$

P_C: price of non-electricity goods

Lagrange function:

$$\Gamma = U(C, E) - \lambda\{P_C C + e(P_E + t)E - Y\} \qquad (6)$$

Utility maximization behaviour of the household

$$\frac{\partial \Gamma}{\partial E} = E^{-\delta} - \lambda\{e(P_E + t)\} = 0 \rightarrow E = f(e(P_E + t), Y) \quad (7)$$

$$\frac{\partial \Gamma}{\partial C} = C^{-\gamma} - \lambda\{P_C\} = 0 \quad (8)$$

$$\frac{\partial \Gamma}{\partial \lambda} = P_C C + e(P_E + t) - Y = 0 \quad (9)$$

$$Total\ E\ Demand = E_{industry} + E_{Consumer} \quad (10)$$

4- Data and methodology

Variables

In order to conduct our empirical analysis and explore the characteristics of LNG export pattern from Russia into the East-Asia region, we need the following real and dummy variables for all studied selected Asia-Pacific region:

- LNG export volume (LNGE)
- Economic size (GDP)
- Difference in per capita income (DI)
- Urbanization growth (URB)
- Bilateral exchange rate (EX)
- Sanctions (SANC)

Variables' descriptive statistics
(Period 2010-2017)

Variables	Unit	Mean	Std. Dev.	Max	Min
LNG export volume (LNGE)	Mln ton	3.53	3.36	9.40	0.0
Economic size (GDP)	Current US$	5.40e+12	3.66e+12	1.22e+13	1.09e+12
Difference in per capita income (DI)	US$ per person	12444.40	14901.08	33382.70	-9096.60
Urbanization growth	%	1.34	1.12	3.25	0.24
Bilateral exchange rate	Ruble/currency j	9.85	13.76	38.06	0.09

Source: Authors' compilation

Correlation matrix

	LGDP	LLNGE	LEX	LURB	LDI
LGDP	1.00	0.17	-0.95	0.55	-0.46
LLNGE	0.17	1.00	0.40	0.79	0.79
LEX	-0.95	0.40	1.00	-0.70	0.63
LURB	0.55	0.79	-0.70	1.00	-0.87
LDI	-0.46	0.79	0.63	-0.87	1.00

Note 1: LLNGE, LGDP, LDI, LURB and LEX indicate logarithm of LNG export of Russia into the selected Asia-Pacific nations, logarithm of Gross Domestic Product, logarithm of Difference of Incomes , logarithm of urbanization growth and logarithm of bilateral exchange rate, respectively

Source: Authors' compilation from Eviews 9.0

Above table shows the correlation matrix. The correlation between GDP and LNG export of Russia to the Asia-Pacific region is positive. This primary positive relationship is in line with Varahrami and Haghighat (2018)'s findings who proved this linkage in selected OECD countries. LNG export is positively related to bilateral exchange rate, urbanization growth and differences in per capita income. The relation between GDP and bilateral exchange rate and difference in per capita income is negative.

Empirical model

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

$$lnLNGE_{ijt} = \delta_1 \ln\left(GDP_{it} * GDP_{jt}\right) + \delta_2 \ln\left(DI_{ijt}\right) + \delta_3 \ln\left(URB_{jt}\right) + + \delta_4 \ln EX_{ijt} + \delta_5 \,\mathrm{SANC} + \varepsilon_{ijt}$$

The coefficients δ_1 , δ_2 ,δ_3,δ_4 and δ_5 represent the long-run elasticity estimates of LNG export of Russia to CJK with respect to joint GDP, difference in per capita income, urbanization growth, bilateral exchange rate and sanctions. We expect that increase of joint GDP and urbanization growth leads to an increase in Russian LNG export volume to the Asia-Pacific region, while the signs of difference in per capita income, bilateral exchange rate and sanctions are vague.

5- Empirical analysis and discussion of results

Panel unit root tests

Before our econometric gravity model can be estimated, the stationary and co-integration of series need to be determined. We used a certain standard panel unit root tests, namely Levin, Lin & Chu (LLC), ADF-Fisher Chi-Square, and Philips-Perron- Fisher Chi-Square to determine whether our series have unit root test. The results of these three panel unit root tests are displayed in bellow table:

Panel unit root test results

Variable	Levin, Lin & Chu t	ADF-Fisher Chi-square	Philips-Perron – Fisher Chi-square	H0 (majority)	Stationary
LLNGE	-0.72 [0.23]	5.75 [0.45]	5.66[0.46]	Accept	No
D(LLNGE)	-3.94[0.00]	22.30[0.00]	23.76[0.00]	Reject	Yes
LGDP	-0.78[0.49]	5.33[0.50]	4.93[0.49]	Accept	No
D(LGDP)	-3.40[0.00]	12.16[0.05]	20.39[0.00]	Reject	Yes
LDI	-0.52[0.41]	5.45[0.21]	7.52[0.36]	Accept	No
D(LDI)	-3.77[0.00]	37.40[0.00]	36.83[0.00]	Reject	Yes
LURB	0.17[0.56]	4.45[0.61]	4.06[0.66]	Accept	No
D(LURB)	-4.85[0.00]	16.31[0.01]	22.60[0.00]	Reject	Yes
LEX	-0.97[0.16]	1.80[0.93]	1.50[0.95]	Accept	No
D(LEX)	-4.40[0.00]	11.94[0.06]	17.93[0.00]	Reject	Yes

Note 1: Numbers in brackets indicate p-values
Note 2: LLNGE, LGDP, LDI, LURB and LEX indicate logarithm of LNG export of Russia into the selected Asia-Pacific nations, logarithm of Gross Domestic Product, logarithm of Difference of Incomes , logarithm of urbanization growth and logarithm of bilateral exchange rate, respectively
Source: Authors' compilation

Panel cointegration test

Based on the results of panel unit root tests, we conducted the second preliminary test which is the Pedroni panel cointegration test to discover whether there is any long-run equilibrium nexus between the series of our model. The results of this test are reported in bellow table:

Pedroni Panel Cointegration Test results

	Statistic	Prob.	Weighted statistic	Prob.
Panel v-statistic	0.41	0.33	-0.20	0.57
Panel rho-statistic	0.74	0.77	0.83	0.79
Panel PP-statistic	-3.68*	0.00	-4.68 *	0.00
Panel ADF-statistic	-3.35 *	0.00	-4.02 *	0.01
Group rho-statistic	1.59	0.94	-	-
Group PP-statistic	-5.22*	0.00	-	-
Group ADF-statistic	-4.26 *	0.02	-	-

The probability of all the panel, group and weighted statistics express that six statistics of all eleven ones are less than 0.05 and hence, the majority of the all statistics tests can significantly reject the H0 of no cointegration at the 5% significance level. In other words, the results reveal an evidence of a long-run relationship between our variables.

Fully Modified OLS (FMOLS)

- The existence of a long-run linkage between our variables lets us to employ the Cointegrating Panel model. We selected one of the most popular estimator of this kind of panel data model, namely FMOLS (Fully Modified OLS) to analyze the Russia-Asia Pacific gas export pattern in the gravity theory framework. The estimation findings are represented in bellow table

FMOLS estimation results

Dependent variable	Regressors	Coefficient	t-statistic	p-value
LNG export (LLNGE)	Difference in Income (LDI)	-16.02	-47.86	0.00
	Urbanization growth (LURB)	1.59	5.06	0.00
	GDP (LGDP)	5.10	38.10	0.00
	Exchange rate (LEX)	4.91	28.58	0.00
	Sanctions (SANC)	7.69	22.59	0.00

Source: Authors' compilation

Discussion of results

- First, the economic size (GDP) is found to be highly significant and positive
  - ✓ A 1% increase in joint economic size of Russia and CJK leads to increase of Russian gas export flows into these nations by nearly 5.1%.
  - ✓ Our finding is consistent with Ahmed and Suardi (2009), Guan and Hong (2012) and Jerven (2014) while it is in contrast with Musila and Yiheyis (2015).

- Second, the impact of difference between per capita incomes on Russian gas export into the Asia-Pacific nations is statistically significant and negative.
  - ✓ supporting the Linder Hypothesis (the more two countries are similar in income, the more they might trade).

…

- Third, the effect of urbanization growth is found to be positive and statistically significant. The Russian gas export to CJK increases by approximately 1.5% by a 1% increase in urbanization growth of CJK. This result is in line with Petrakos (1989) and Kurniawan and Managi (2018)
- Fourth, bilateral exchange rate has a positive sign which means that a 1% depreciation of CJK' currencies against Russian Ruble will accelerate LNG export volume by about 4.9%.
- Fifth, the impact of time-invariant factor (the imposed sanctions by the West against Russia) is found to be positive and statistically significant. Means that start of sanctions imposition by the West against Russia since 2014 was not a barrier to LNG export of this country to CJK. It helps Russia to conduct trade pivot from the West to the East.

VI. Concluding remarks and policy implications

Conclusion

- Our study revealed that GDP is a positive influencing factor on the Russian LNG export to east-Asia.
- A bigger economic size or production level leads to demand and consume LNG by east Asian nations, as LNG is mainly consuming in power generating sector.
- The positive link between urbanization growth and LNG import of CJK from Russia was depicted by the results.
- Imposition of sanctions by the West against Russia which has been started since 2014 leads to increase of the Russian LNG export to East-Asia.

Policy implications

- Russian trade pivot to the East and the growing LNG consumption can contribute to the energy security in the region by increasing the availability and accessibility of LNG.
- Establishment of a regional gas hub, will facilitate the regional gas transactions and will have impact on lowering the future LNG prices. This will positively contribute to energy security by improving the availability, accessibility and affordability. **(US gas hub in 1980s, UK in 1990s and in European in the 2000s)**
- Any gas trading hub can make the regional benchmark prices which can be a favorable strategy for the Asia-Pacific region (Tong et al.)
- Additionally, import diversification can reduce energy insecurity in the region.

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Russian Federation–East Asia Liquefied Natural Gas Trade Patterns and Regional Energy Security

Publication | June 2019

Importing liquefied natural gas can improve energy security in the People's Republic of China, Japan, and the Republic of Korea.

East Asia has remained the biggest market for liquefied natural gas (LNG) in 2018. The Russian Federation has a clear vision to develop its East Asia LNG projects to provide a bigger share of Asian LNG imports. We model Russian Federation–East Asia LNG trade patterns via the gravity trade theory, which is shown to fit well with energy trade patterns. Our findings reveal that a 1% increase in population growth in the People's Republic of China, Japan, and the Republic of Korea increases Russian Federation LNG exports by nearly 3.43%, and economic growth by 6.16%, while any increase in geographic distance decelerates LNG exports to the selected East Asian economies by nearly 7.3%. This means that the close proximity of the Russian Federation to East Asia is an advantage for its LNG exports. Furthermore, the West's sanctions against the Russian Federation are a positive

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