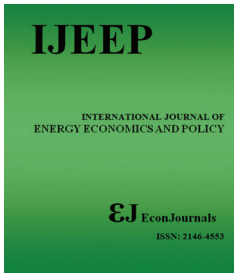

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Measuring the Security of External Energy Supply and Energy Exports Demand in Central Asia

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ABSTRACT

Ensuring the security of the demand for energy exports and the supply of external energy is among the top priorities for Central Asian republics. This paper utilizes disaggregated risky external energy supply (REES) and risky energy exports demand (REED) indexes to measure the securities of energy supply and energy demand in the region. The results are compared to the indexes in the European Union (EU) and the Organization of Petroleum Exporting Countries (OPEC). Furthermore, this paper measures individual contribution of each Central Asian country to the regional risk exposure to disruptions of energy export demand and external energy supply. The REES indexes for coal and gas of Central Asian energy-importing countries are lower than in the EU, while the regional oil RESS index for oil is significantly higher than in the EU. The average REED indexes for both crude oil and gas are significantly lower than in OPEC economies.

Keywords: Energy Security, Central Asia, Energy Export and Supply
JEL Classifications: O13, P28, P48

1. INTRODUCTION

The former Soviet Central Asia consists of five landlocked republics, Kazakhstan, Kyrgyz Republic, Tajikistan, Turkmenistan and Uzbekistan, located in the center of Eurasian continent. The economy of the region represents around 0.5% of the world economy (World Bank, 2015). After the collapse of the Soviet Union and its planned economy, each republic has pursued its own development path. While energy resource-rich Kazakhstan, Turkmenistan and Uzbekistan have focused on hydrocarbons export, Kyrgyz Republic and Tajikistan have faced energy shortages that affected their development path.

The total reserves of crude oil, natural gas and coal in the region are 2%, 11% and 8% respectively of total world proved reserves. However, the reserves are distributed unequally among the nations as seen in Table 1. Kazakhstan, Turkmenistan and Uzbekistan possess majority of hydrocarbon reserves in the region, while Kyrgyz Republic and Tajikistan rely on energy import to satisfy their domestic demand. Despite the significant coal resources in Kyrgyz Republic, it has only four small mines due to high cost of production (Eurasian Coal Portal, 2015).

The proved hydrocarbon reserves made Kazakhstan, Turkmenistan and Uzbekistan the center of geopolitical interests for different countries who want to address their own energy security issues (Blank, 1995; Boonstra, 2011; Cohen, 2006; Dhaka, 2006; Hu and Cheng, 2008; Bahgat, 2006). Meanwhile, Kyrgyz Republic and Tajikistan heavily rely on their hydropower that accounts for about 90% of the regional potential, and this creates heated political water-food-energy disputes with downstream countries of Kazakhstan, Turkmenistan and Uzbekistan (Jalilov et al., 2013; Libert et al., 2008). Attempts to create a regional water management structure in the form of barter for oil and gas for increased water discharge to downstream countries have not been very successful (Olcott, 2000). The water-energy disputes have been at the core of the rivalry and competition for regional dominance (Olcott, 2011). The regional cooperation in energy and water could produce huge gains for energy importers by improving their energy security, while energy exporters could increase their irrigated agriculture.

Oil and gas export income has been a backbone of the economy in energy exporting Central Asian countries. The governments of Central Asia address their concern for the security of external

Table 1: Fossil fuel reserves in Central Asia

Country	Crude oil, billion barrels	Natural gas, trillion m^3	Coal, billion tons
KZ	30.0	1.5	33.6
KG	<0.1	<0.1	31.0
TJ	<0.1	<0.1	4.0
TM	0.6	17.5	<0.1
UM	0.6	1.1	2.4
Total	31.2	20.1	71.0

Source: BP (2014), EIA (2015), Eurasian Coal Portal (2015), Kabutov (2008) and USGS (1997), KG: Kyrgyz Republic, TJ: Tajikistan, UZ: Uzbekistan, KZ: Kazakhstan, TM: Turkmenistan

demand by exploring different pipeline routes and markets. Pipeline routes have become an extremely important bargaining chip used in negotiations with interested parties (Cobanli, 2014; Fishelson, 2007). Ensuring income generated through the export of hydrocarbons is the main factor for economic and political stability of oil exporting countries, where the government revenues significantly depend on the oil and gas price and export volumes (Ross, 2011). Meantime, disruptions of the external energy supply to Kyrgyz Republic and Tajikistan not only affect the functioning of the regional energy sector, but also impact the socio-economic development, stability and progress of the countries (Kasymova and Arkhangelskaya, 2011). Furthermore, the households in relatively poorer Kyrgyz Republic and Tajikistan are vulnerable to energy insecurities due to shortage of energy, under-investment in infrastructure and growing electricity tariffs (Slay, 2009). The security of external energy supply has been one of the most important agenda for the governments of Kyrgyz Republic and Tajikistan since the collapse of the Soviet Union. Increasing electricity tariffs was one of the main causes that triggered the Kyrgyz Revolt of 2010.

Therefore, it is important to assess the security levels of both external energy supply for energy-importing countries and energy export demand for energy exporters of the region. Understanding the energy export and supply risks facing Central Asian countries could help develop policies that address possible shocks to Central Asian economies from energy export and import disruptions.

2. METHODOLOGY

This study uses methodologies developed to measure the security of external supply in the European Union (EU) and the security of energy exports demand in the Organization of Petroleum Exporting Countries (OPEC) in order to compare the results with Central Asian countries.

Le Coq and Paltseva (2009) developed a set of indexes to measure the risks related to the external supply of coal, oil and gas for all EU member states and the resulting contribution to EU risk exposure. The methodology combines the measures of import diversification, political risks in supplying countries, transportation and economic risks.

The methodology to measure the risks of energy exports demand developed by Dike (2013) puts together the estimates of energy export diversification, economic dependence on export, transportation disruption risk and share of energy in export profile of the OPEC countries.

The security of external energy supply is measured using the six-factor risky external energy supply (REES) index for each Central Asian country for the period 2010-2012 (Le Coq and Paltseva, 2009):

$$REES_a = M_a \times F_a \times R_a \times D_a \times NID_a \times SF_a \quad (1)$$

Where, M_a is the supply monopsony factor of fuel *a* (coal, crude oil and oil products, gas), F_a is the import fungibility of fuel *a*, R_a is the political risk index of the supplier of fuel *a*, D is the indicator of transaction costs, NID_a is the net import dependency of fuel *a* and SF_a is the share of fuel *a* in the total energy consumption.

M_a reflects the share of exporting countries in the import of fuel *a*:

$$M_a = \sum_i \left(\frac{NPI_{ai}}{NPI_a} \right)^2 \quad (2)$$

Where, NPI_{ai} is the net positive import of fuel *a* from country *i* in USD, NPI_a is the total net positive import of fuel *a* in USD.

R_a measures the political risk in the supplier country as follows,

$$R_a = \sum_i \frac{100 - PRI_i}{100} \quad (3)$$

Where, PRI_i is the political risk index in exporting country *i* produced by the PRS Group (PRS Group, 2015).

The net import dependency index NID_a is calculated as follows,

$$NID_a = \frac{NPI_a}{C_a} \quad (4)$$

Where, NPI_a is the net positive import of fuel *a* in ktoe and C_a is the total fuel *a* consumption in the country in ktoe.

The security of energy exports demand is calculated using the risky energy exports demand (REED) index for each Central Asian country for the period 1995-2012 (Dike, 2013):

$$REED_b = X_b \times M_b \times D_b \times E_b \quad (5)$$

Where, X_b is the fuel *b* (crude oil and gas) export dependence, M_b is the import monopsony and E_b is the economic impact of fuel *b* export.

The energy export dependence represents the share of crude oil and gas export in total export from the country:

$$X_b = \frac{EE_b}{TE} \quad (6)$$

Where, EE_b is the export value of fuel *b* and TE is the total export value from the country, both in USD.

The monopsony index of energy export is calculated as follows:

$$M_b = \left(\frac{EX_{bj}}{EX_b}\right)^2 \quad (7)$$

Where, EX_{bj} is the net export of fuel *b* to country *j* and EX_b is the total export of fuel *b*, both in USD.

The economic impact of fuel *b* export is estimated as the rate of fuel export to the gross domestic product (GDP):

$$E_b = \frac{EX_b}{GDP} \quad (8)$$

D_a and D_b represent transaction costs factor for energy import and export respectively:

$$D_a = \sum_i d_i \quad (9)$$

$$D_b = \overline{d_j} \quad (10)$$

Where, *d* is a measure of distance between country of energy import origin (*i*) and energy export destination (*j*). According to Le Coq and Paltseva (2009) and Dike (2013) all country pairs are classified according to the distance between their capitals and indexes assigned as follows:

$$D = \begin{cases} 1, & \text{if } d < 1500 \text{ km} \\ 2, & \text{if } 1500 \le d < 4000 \text{ km} \\ 3, & \text{if } d \ge 4000 \text{ km} \end{cases} \quad (11)$$

Given the size of Kazakhstan and the fact that the major oil and gas field are located in the western part of the country, Atyrau is used instead of Astana to measure the distance between the countries. Furthermore, the export destination of hydrocarbons from Central Asia to China is Xinjiang. Hence, Urumqi, the capital city of Xinjiang, is used to estimate the factor of distance.

After calculation of REES and REED indexes for all countries of the region, the relative impact of each state on the aggregate regional risk of energy supply and demand is estimated by the Central Asia Risk Exposure of Supply (CARES) and the Central Asia Risk Exposure of Export (CAREX) respectively. The CARES is estimated as follows:

$$CARES_a = \frac{REES_a \times SI_a}{\sum(REES_a \times SI_a)} \quad (12)$$

Where, SI_a is the share of each country in net regional imports of fuel *a*.

The CAREX is expressed as follows:

$$CAREX_b = \frac{REED_b \times SE_b}{\sum(REED_b \times SE_b)} \quad (13)$$

Where, SE_b is the share of the individual country in total regional crude oil and gas exports.

The higher values of REES and REED indexes indicate the bigger risks. On the final stage of assessment, the REES and REED indexes of Central Asian countries are compared with the indexes of the EU (Le Coq and Paltseva, 2009) and OPEC (Dike, 2013) countries respectively.

3. DATA

The time intervals under investigation range from 1990 to 2012 for energy export and from 2010 to 2012 for energy import due to data availability. Bilateral energy import and export data in monetary terms is acquired from Hausman et al. (2011) and Simoes and Hidalgo (2011). Data on energy consumption, share of fuel and import in ktoe originates from the International Energy Agency (IEA, 2015). GDP data of Uzbekistan and Turkmenistan are derived from the World Bank (The World Bank, 2015), while GDP of Kazakhstan is taken from the Committee of Statistics of the Republic of Kazakhstan (The Committee of Statistics of the Republic of Kazakhstan, 2015).

Political risk index produced by PRS Group represents political risk in 100 countries with values between 1 and 100, where higher numbers indicate lower risk. If there is no political risk data for exporting country, the average regional data is used.

The fungibility index represents the ease of switching suppliers in case of disruptions. Pipeline oil and gas imports have a fungibility index of 2, while other means of transportation are associated with a fungibility index of 1.

4. RESULTS

The results of external energy supply risk calculations are presented in Tables 2 and 3.

4.1. The Coal REES Index

Kazakhstan has emerged as the main supplier of coal to other Central Asian countries, while the shares of Russia and other countries are declining. The coal REES indexes are lower than both the gas and oil indexes in Kyrgyz Republic and Tajikistan. The index indicates that the coal import dependency is significantly

Table 2: REES indexes of coal, oil and gas external supply for the period 2010-2012

Fuel	KG			TJ			UZ		
	2010	2011	2012	2010	2011	2012	2010	2011	2012
Coal	0.989	0.705	0.289	0.004	0.000	0.004	0.002	0.002	0.004
Oil	70.807	191.065	263.837	39.266	53.707	17.782	0.000	0.001	0.000
Gas	0.943	0.373	1.444	0.195	0.290	0.065	0.000	0.000	0.000

KG: Kyrgyz Republic, TJ: Tajikistan, UZ: Uzbekistan. Only crude oil accounted for Uzbekistan. No coal import to Tajikistan in 2011, REES: Risky external energy supply

larger in Kyrgyz Republic. Although the index has been declining in the country due to lower transaction costs and political risk, Kyrgyz Republic has the biggest contribution to the regional exposure to external coal supply risk. This is due to its coal-based power sector and relatively cheaper cost of Kazakhstani coal. Although Uzbekistan is increasing its coal import, its contribution to CARES is insignificant.

4.2. The Oil REES Index

The supply of oil to Central Asian countries imposes the bigger risk than gas and coal supplies to Kyrgyz Republic and Tajikistan. The oil products are dominant fuel in total fuel consumption in Kyrgyz Republic and Tajikistan and up to 90% of consumption is imported, while Uzbekistan imports 0.3% of total crude oil consumption to be processed at its refineries. The main origin of oil import to Kyrgyz Republic and Tajikistan is Russia, while Uzbekistan imports crude oil from Kazakhstan.

The oil REES index of Kyrgyz Republic has been rapidly increasing since 2010 due to poorer monopsony, bigger dependence on energy import and substantial transaction costs factor. Meanwhile, Tajikistan has improved the security of external oil supply mainly by diversification of the import. This had effect on the countries' contribution to the regional oil supply security. The oil CARES index of Kyrgyz Republic has increased by 21% since 2010 due to the decreased oil REES in Tajikistan.

4.3. The Gas REES Index

The natural gas supplies from Uzbekistan, the main supplier since Soviet times, to Kyrgyz Republic and Tajikistan have had frequent disruptions due to political disputes over water resources. The gas REES index of Kyrgyz Republic is higher mainly due to its dependence on pipeline, while Tajikistan primarily imports liquefied petroleum gas from Kazakhstan. Furthermore, Tajikistan has addressed the security of gas supply by decreasing its gas consumption by 36% since 2010. Hence, contribution of Kyrgyz Republic to the regional security has increased by more than 10%, while the gas CARES index of Tajikistan has become lower than the oil CARES index.

4.4. Comparison with EU Indexes

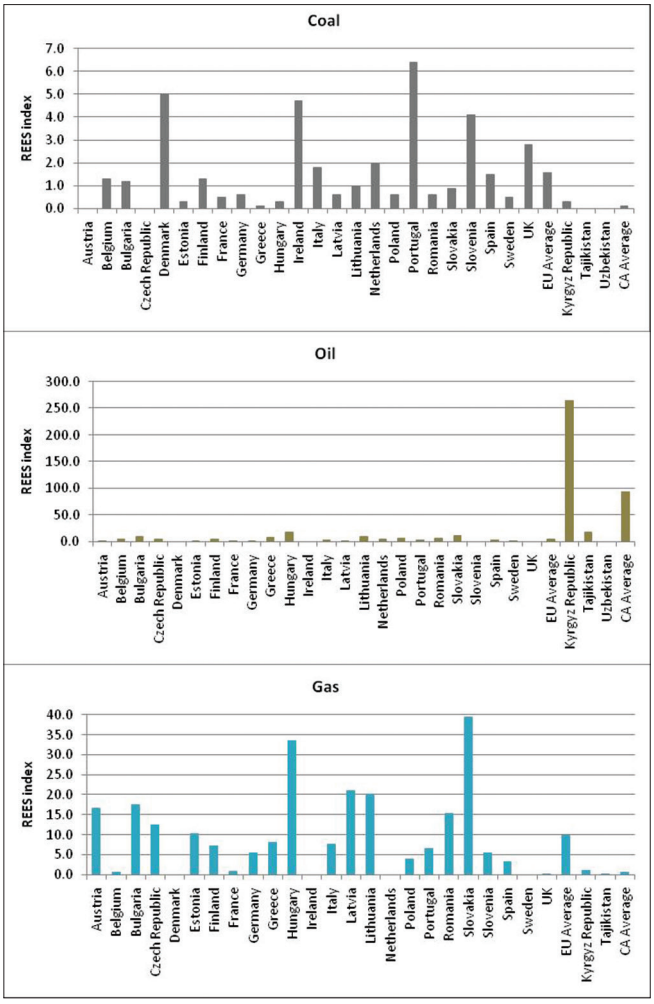
In general, the REES indexes of Central Asian countries are lower for coal and gas, while the average REES index for oil is significantly higher than in the EU as seen in Figure 1. The average coal REES index in Central Asia is lower than in the EU, and the coal REES index of Kyrgyz Republic is comparable to Estonia and Hungary. The average oil REES index of Central Asia is higher than the EU average. Kyrgyz Republic's risk of external oil supply is 60 times higher than the EU average, while Tajikistan's oil REES index is similar to one in Hungary. The Central Asian

Table 3: CARES indexes, in percentage

Country	Coal	Oil	Gas
2010			
KG	99.99	76.32	88.59
TJ	0.00	23.68	11.41
UZ	0.01	0.00	0.00
2011			
KG	99.98	89.29	69.14
TJ	0.00	10.71	30.86
UZ	0.01	0.00	0.00
2012			
KG	99.91	97.74	98.54
TJ	0.02	2.26	1.46
UZ	0.07	0.00	0.00

CARES: Central Asia Risk Exposure of Supply, KG: Kyrgyz Republic, TJ: Tajikistan, UZ: Uzbekistan

Figure 1: Comparison of risky external energy supply indexes for European Union and Central Asia



Source: The European Union data from Le Coq and Paltseva (2009)

dependence on external gas supply is lower than the EU. The average gas REES index of Central Asia is 20 times lower than the EU. The gas REES index of Kyrgyz Republic is comparable to France, while Tajikistan's index is similar to Belgian.

The results of external energy demand risk calculations are presented in Tables 4 and 5.

4.5. The Crude Oil REED Index

Kazakhstan is the main crude oil exporter in the region with a net export of 44 billion USD or 99.7% of total crude oil export from Central Asia. Hence, the contribution to the CAREX index comes from Kazakhstan. Crude oil has become the dominant exported commodity from Kazakhstan, and its share in total export has increased from 3.6% in 1995 till 55.3% in 2012. Hence, the economic impact of crude oil export has increased from 0.2% till 22.7% for the same period. The crude oil REED index has decreased since 2000 due to improved monopsony factor by diversification of export destinations. China has emerged as the main crude oil importing country from Kazakhstan, while the share of the EU import has been declining since 2005. China's crude oil import from Kazakhstan has increased from 4 million USD in 1997 to 8 billion USD in 2012.

Unlike natural gas, crude oil export from Turkmenistan is insignificant, and its share in total export has never exceeded 5%. Hence, the crude oil REED index of Turkmenistan has been low. The EU countries are the main importers of crude oil from Turkmenistan. Due to insufficient domestic production and growing domestic consumption, Uzbekistan has become a net crude oil importer since 2001.

Table 4: REED indexes of crude oil and gas export for the period 1995-2012

Year	Crude oil				Gas			
	KZ	TM	UZ	Average	KZ	TM	UZ	Average
1995	0.0000	0.0008	0.0000	0.0003	0.0000	0.0000	0.0000	0.0000
1996	0.0043	0.0001	0.0000	0.0014	0.0000	0.0226	0.0000	0.0075
1997	0.0055	0.0000	0.0000	0.0019	0.0000	0.4024	0.0000	0.1341
1998	0.0046	0.0005	0.0000	0.0017	0.0000	0.0000	0.0000	0.0000
1999	0.0072	0.0040	0.0000	0.0038	0.0000	0.1167	0.0001	0.0389
2000	0.0386	0.0002	0.0000	0.0129	0.0000	0.2044	0.0009	0.0684
2001	0.0258	0.0005	0.0000	0.0088	0.0000	0.4103	0.0019	0.1374
2002	0.0392	0.0009	0.0000	0.0134	0.0001	0.3728	0.0004	0.1244
2003	0.0150	0.0005	0.0000	0.0052	0.0001	0.3121	0.0011	0.1044
2004	0.0141	0.0001	0.0000	0.0047	0.0002	0.2530	0.0008	0.0847
2005	0.0218	0.0005	0.0000	0.0074	0.0001	0.2895	0.0016	0.0971
2006	0.0191	0.0002	0.0000	0.0064	0.0001	0.3271	0.0023	0.1099
2007	0.0153	0.0002	0.0000	0.0051	0.0002	0.4203	0.0017	0.1407
2008	0.0180	0.0002	0.0000	0.0061	0.0003	0.2990	0.0229	0.1074
2009	0.0133	0.0004	0.0000	0.0046	0.0004	0.0159	0.0156	0.0106
2010	0.0216	0.0002	0.0000	0.0073	0.0002	0.0184	0.0002	0.0062
2011	0.0238	0.0000	0.0000	0.0080	0.0003	0.1328	0.0011	0.0447
2012	0.0255	0.0000	0.0000	0.0085	0.0003	0.2793	0.0001	0.0932

KZ: Kazakhstan, TM: Turkmenistan, UZ: Uzbekistan, REED: Risky energy exports demand

Table 5: CAREX indexes, in percentage

Year	Crude oil			Gas		
	KZ	TM	UZ	KZ	TM	UZ
1995	8.0	92.0	0.0	100	0.0	0.0
1996	100	0.0	0.0	0.0	100	0.0
1997	100	0.0	0.0	0.0	100	0.0
1998	99.8	0.2	0.0	0.0	100	0.0
1999	96.4	3.6	0.0	0.0	100	0.0
2000	100	0.0	0.0	0.0	99.9	0.1
2001	100	0.0	0.0	0.0	99.9	0.1
2002	100	0.0	0.0	0.0	100	0.0
2003	100	0.0	0.0	0.0	100	0.0
2004	100	0.0	0.0	0.0	99.9	0.1
2005	100	0.0	0.0	0.0	99.9	0.1
2006	100	0.0	0.0	0.0	99.9	0.1
2007	100	0.0	0.0	0.0	99.9	0.1
2008	100	0.0	0.0	0.0	97.1	2.8
2009	100	0.0	0.0	1.7	31.8	66.5
2010	100	0.0	0.0	1.7	98.1	0.3
2011	100	0.0	0.0	0.2	99.7	0.1
2012	100	0.0	0.0	0.1	99.9	0.0

CAREX: Central Asia Risk Exposure of Export, UZ: Uzbekistan, KZ: Kazakhstan, TM: Turkmenistan, UZ: Uzbekistan

4.6. The Gas REED Index

Kazakhstan has become a net gas exporter since 2001 and its export reached 3.6 billion USD in 2012. However, gas export from Kazakhstan is 12 times lower than the export of crude oil. Due to combination of diverse export destinations, low export dependence and economic impact of gas export, the gas REED index is the lowest in the region. Kazakhstan's gas CAREX index has not exceeded 2% since 2000.

Turkmenistan is the main gas exporter in the region with a net export of 7.6 billion USD or 66% of total Central Asian gas export. Turkmenistan's gas export sharply declined by 86% in 2009 following the "Lehman" shock and recovered in 2011. The gas REED index is lower than in the pre-crisis period due to lower economic impact of gas export. During the crisis the gas export dependence has almost halved and the economic impact of gas export has reduced by seven times. The contribution of Turkmenistan to the regional risk exposure has been almost 100% except for 2009 when the gas export declined. China has emerged as the main consumer of Turkmen gas since 2010, and its share of total gas export reached 98% in 2012.

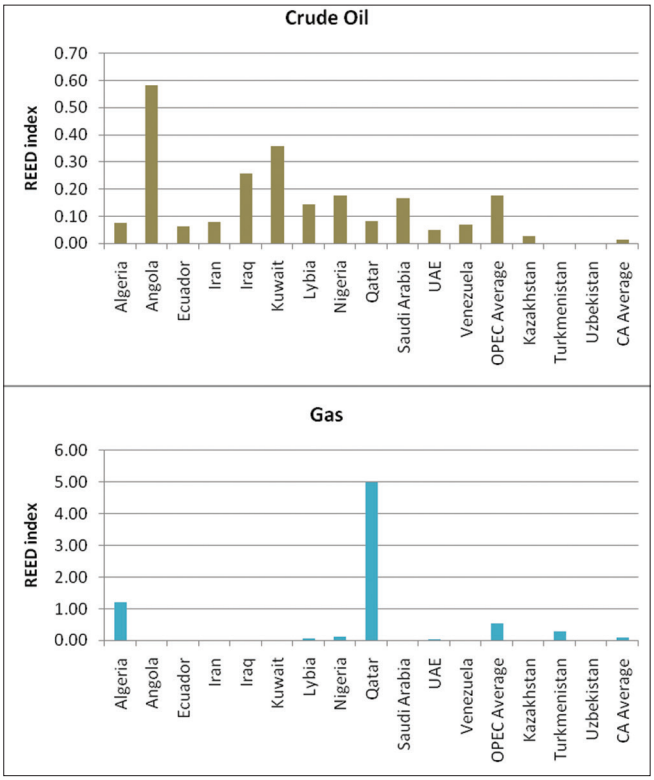
The gas export from Uzbekistan has been growing from 1999 till 2008 when it reached its peak. However, after 2009 the gas export has been decreasing due to decline in production and increase in domestic consumption. Hence, Uzbekistan's gas CAREX has consequently reduced.

4.7. Comparison with OPEC Indexes

The crude oil and gas exports from Central Asia are equal to 7% and 3% of OPEC's total crude oil and gas exports respectively. The net crude oil export from Kazakhstan is almost equal to Nigerian export, while gas export from Turkmenistan is almost twice lower than Iranian export as displayed in Figure 2. In general, the average REED indexes of Central Asian countries are significantly lower for both crude oil and gas.

The main factor of lower crude oil REED index of Kazakhstan than the OPEC indexes is lower monopsony factor. Furthermore, Kazakhstan's crude oil export and economic dependence is lower than the average values for OPEC countries.

Figure 2: Comparison of risky energy exports demand indexes for Organization of Petroleum Exporting Countries and Central Asia



The gas REED index of Turkmenistan is almost twice lower than the OPEC average. However, only Qatar and Algeria have bigger REED indexes. The monopsony factor of the Turkmen index is significantly higher than the OPEC average. Generally, it could be said that the security of energy demand in Central Asia is better than in OPEC economies. Tables A1-A9 provide full details of calculations.

5. CONCLUSIONS AND POLICY IMPLICATIONS

The analysis of the time series data allows understanding the development of energy security aspects of Central Asia. The security of energy supply is one of the main political agendas in Kyrgyz Republic and Tajikistan. Meanwhile, Kazakhstan and Turkmenistan, the main oil and gas exporters in the region, have been exploring new markets and export routes to secure the demand for crude oil and gas exports. In the meantime, growing domestic consumption and depleting reserves of hydrocarbons have reduced Uzbekistan's role as regional energy player.

The results of assessment of external energy supply indicate a large variation of risk profiles of energy importing countries. Kyrgyz Republic is the most exposed country to the risk of external energy supply disruption. This may indicate that improvements to energy saving and energy efficiency could significantly boost Kyrgyz Republic's security of external energy supply. Although the energy supply risk profile of Tajikistan is better, development of renewable energy and introduction of energy efficiency measures could also reduce its dependence on external energy supply. Increase in coal import to Uzbekistan could be expected as the government is trying to reduce domestic consumption of gas in order to fulfill its export obligations to China.

The results of analysis of energy export demand security reveal China's rise in Central Asian energy market. China has increased its presence in the region by launching construction of a gas pipeline passing through Kyrgyz Republic and Tajikistan. The project would have twofold effect in the form of improved gas supply to China and higher political and economic influence in Kyrgyz Republic and Tajikistan as energy supplier. The pipeline would improve the security of energy supply in the republics.

Although overall security of energy export demand in Central Asia is better than in OPEC economies, export diversification is vital. The worsening geopolitical and geo-economic situation in Russia endangers the existing energy export routes to Europe. Hence, alternative supply routes to Europe should be considered. Furthermore, India and Pakistan could be attractive destinations for Central Asian energy exports.

On the regional level, a regional cooperation for effective water-energy management could be beneficial for both energy exporting and importing countries. Development of CASA-1000 project and agreement between Kazakhstan and Kyrgyz Republic to purchase electricity from each other during shortage periods could help to solve the water-energy disputes and improve the regional energy security. However, the existing political situation is competitive rather than oriented towards cooperation.

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APPENDIX A

Table A1: Coal import origins to energy importing countries of Central Asia for a period 2010-2012, in percentage of total fuel import

Countries	KG			TJ			UZ		
	2010	2011	2012	2010	2011	2012	2010	2011	2012
CA	96.4	100	100	47.4	74.2	100	53.2	51.9	99.8
RUS	3.6	0.0	0.0	35.4	13.7	0.0	3.7	2.2	0.1
CHN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FSU	0.0	0.0	0.0	17.2	12.1	0.0	43.1	45.0	0.0
Asia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EU	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9	0.1
Other	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

CA: Central Asia, RUS: Russia, CHN: China, FSU: Former Soviet Union republics excluding Estonia, Latvia and Lithuania, EU: European Union including candidate states, KG: Kyrgyz Republic, TJ: Tajikistan, UZ: Uzbekistan

Table A2: Oil and gas import origins to energy importing countries of Central Asia for a period 2010-2012, in percentage of total fuel import

Countries	Oil						Gas					
	KG			TJ			KG			TJ		
	2010	2011	2012	2010	2011	2012	2010	2011	2012	2010	2011	2012
CA	12.2	3.7	2.0	1.7	5.1	9.4	98.8	97.9	97.5	81.7	99.9	100
RUS	75.6	73.3	93.4	97	88.2	58.5	1.2	2.1	2.5	18.3	0.1	0.0
CHN	0.1	0.8	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0
FSU	9.5	13.5	0.0	0.1	2.7	1.7	0.0	0.0	0.0	0.0	0.0	0.0
Asia	0.1	0.2	0.3	0.4	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EU	2.5	8.4	4.3	0.8	3.5	5.1	0.0	0.0	0.0	0.0	0.0	0.0
Other	0.0	0.1	0.0	0.0	0.0	25	0.0	0.0	0.0	0.0	0.0	0.0

CA: Central Asia, RUS: Russia, CHN: China, FSU: Former Soviet Union republics excluding Estonia, Latvia and Lithuania, EU: European Union including candidate states, KG: Kyrgyz Republic, TJ: Tajikistan

Table A3: Coal REES index for a period 2010-2012

Index	KG			TJ		UZ		
	2010	2011	2012	2010	2012	2010	2011	2012
M	0.930	0.999	1.000	0.347	0.684	0.335	0.388	0.664
D	6	5	3	6	2	6	8	6
NID	0.703	0.597	0.596	0.034	0.053	0.022	0.015	0.023
SF	0.255	0.225	0.253	0.041	0.084	0.030	0.029	0.029
F	1	1	1	1	1	1	1	1
R	0.990	1.050	0.640	1.470	0.680	1.430	1.810	1.390
REES	0.989	0.705	0.289	0.004	0.004	0.002	0.002	0.004

REES: Risky external energy supply, KG: Kyrgyz Republic, TJ: Tajikistan, UZ: Uzbekistan, NID: Net import dependency

Table A4: Oil REES index for a period 2010-2012

Index	KG			TJ			UZ		
	2010	2011	2012	2010	2011	2012	2010	2011	2012
M	0.590	0.559	0.874	0.940	0.780	0.411	1.000	0.996	1.000
D	61	99	89	39	48	40	1	2	1
NID	0.820	0.872	0.904	0.907	0.909	0.908	0.002	0.002	0.003
SF	0.361	0.392	0.399	0.231	0.243	0.248	0.092	0.079	0.069
F	1	1	1	1	1	1	2	2	2
R	6.65	10.11	9.40	5.11	6.49	4.80	0.35	0.72	0.33
REES	70.807	191.065	263.837	39.266	53.707	17.782	0.000	0.001	0.000

REES: Risky external energy supply, KG: Kyrgyz Republic, TJ: Tajikistan, UZ: Uzbekistan, NID: Net import dependency

Table A5: Gas REES index for a period 2010-2012

Index	KG			TJ		
	2010	2011	2012	2010	2011	2012
M	0.656	0.543	0.698	0.698	0.996	0.999
D	7	4	8	4	4	2
NID	0.923	0.921	0.933	0.882	0.907	0.924
SF	0.090	0.084	0.086	0.074	0.074	0.052
F	2	2	2	1	1	1
R	1.240	1.110	1.610	1.070	1.080	0.680
REES	0.943	0.373	1.444	0.195	0.290	0.065

REES: Risky external energy supply, KG: Kyrgyz Republic, TJ: Tajikistan, NID: Net import dependency

Table A6: Crude oil export destinations from energy exporting countries of Central Asia for a period 1995-2012, in percentage of total crude oil export

Countries	KZ				TM				UZ	
	1995	2000	2005	2012	1995	2000	2005	2012	1995	2000
CA	0.0	0.0	0.6	0.7	0.0	0.0	0.0	0.0	87.3	100
RUS	0.0	11.5	2.9	0.1	0.0	0.0	0.0	0.0	0.0	0.0
CHN	0.0	2.0	3.2	18.8	0.0	0.0	0.0	0.0	0.0	0.0
FSU	0.0	4.4	0.3	1.3	0.0	0.0	0.0	0.0	0.0	0.0
Asia	0.0	0.5	9.6	3.3	0.0	0.0	0.0	0.0	0.0	0.0
EU	100	40.3	71.5	69.5	100	100	100	100	12.7	0.0
Other	0.0	41.3	11.9	6.3	0.0	0.0	0.0	0.0	0.0	0.0

Uzbekistan has been a net crude oil importer since 2001, CA: Central Asia, RUS: Russia, CHN: China, FSU: Former Soviet Union republics excluding Estonia, Latvia and Lithuania, EU: European Union including candidate states, UZ: Uzbekistan

Table A7: Gas export destinations from energy exporting countries of Central Asia for a period 1995-2012, in percentage of total gas export

Countries	KZ			TM			UZ		
	1995	2005	2012	2000	2005	2012	2000	2005	2012
CA	0.0	2.9	5.3	3.8	1.3	2.1	25.6	31.5	79.3
RUS	0.0	9.5	5.6	0.0	0.0	0.0	0.0	0.0	0.0
CHN	0.0	0.4	0.1	0.0	0.0	97.9	0.0	0.0	20.7
FSU	0.0	20.1	31.8	96.2	79.7	0.0	74.2	39.2	0.0
Asia	0.0	1.6	1.3	0.0	0.0	0.0	0.0	0.0	0.0
EU	100	65.5	55.8	0.0	19.0	0.0	0.2	29.3	0.0
Other	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0

Kazakhstan was a net gas importer from 1996 till 2000, no gas export from Turkmenistan in 1995 and Uzbekistan was a net gas importer from 1995 till 1998, CA: Central Asia, RUS: Russia, CHN: China, FSU: Former Soviet Union republics excluding Estonia, Latvia and Lithuania, EU: European Union including candidate states, UZ: Uzbekistan, KZ: Kazakhstan, TM: Turkmenistan

Table A8: Crude oil REED index for a period 1995-2012

Index	KZ				TM				UZ	
	1995	2000	2005	2012	1995	2000	2005	2012	1995	2000
Export, $B	0.043	5.388	12.325	44.068	0.026	0.031	0.190	0.119	0.000	0.002
D	2	2	2	2	2	2	2	2	2	1
M	0.234	0.117	0.087	0.102	0.616	0.344	0.236	0.445	0.778	1.000
E	0.003	0.295	0.295	0.217	0.011	0.011	0.023	0.003	0.000	0.000
X	0.037	0.510	0.534	0.553	0.064	0.020	0.043	0.013	0.000	0.001
REED	0.000	0.039	0.022	0.025	0.001	0.000	0.001	0.000	0.000	0.000

UZ: Uzbekistan, KZ: Kazakhstan, TM: Turkmenistan, REED: Risky energy exports demand

Table A9: Gas REED index for a period 1995-2012

Index	KZ			TM			UZ		
	1995	2005	2012	2000	2005	2012	2000	2005	2012
Export, $B	0.001	0.637	3.640	0.414	3.121	7.584	0.172	0.486	0.224
D	2	2	2	1	2	2	1	2	1
M	1.000	0.152	0.170	0.921	0.603	0.959	0.615	0.216	0.587
E	0.000	0.011	0.019	0.292	0.385	0.216	0.012	0.034	0.004
X	0.000	0.040	0.046	0.542	0.712	0.810	0.087	0.134	0.047
REED	0.000	0.000	0.000	0.204	0.290	0.279	0.001	0.002	0.000

No gas export from Kazakhstan in 2000, Turkmenistan and Uzbekistan in 1995, REED: Risky energy exports demand, UZ: Uzbekistan, KZ: Kazakhstan, TM: Turkmenistan