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EnergyLab

ENERGY EXPORT STRATEGIES OF THE CENTRAL ASIAN CASPIAN REGION

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Introduction

This study aims:

to test the effects of long-term energy export strategies on the energy system of the Central Asian Caspian Countries (Azerbaijan, Kazakhstan, Turkmenistan and Uzbekistan).

by exploring:

- the trade-off curves between a comprehensive “risk” indicator

  and

- the outcomes of key variables of the energy system, such as the cost of the strategies, and the corresponding quantities of the export and revenues.

The concept of energy security

The IEA definition:

"*the uninterrupted physical availability at a price which is affordable, while respecting environment concerns*"

Security of supply ⟺ **Security of energy demand**

A comprehensive concept of "energy security" for the Central Asian and Caspian Countries has been adopted, based on the following goals:

to ensure secure transportation of oil and gas to the market through multiple pipeline network in geopolitical cooperation among producers and transit countries of the area, to keep a sufficient willingness to invest in the energy sector, and to reduce the risk of export concentration.

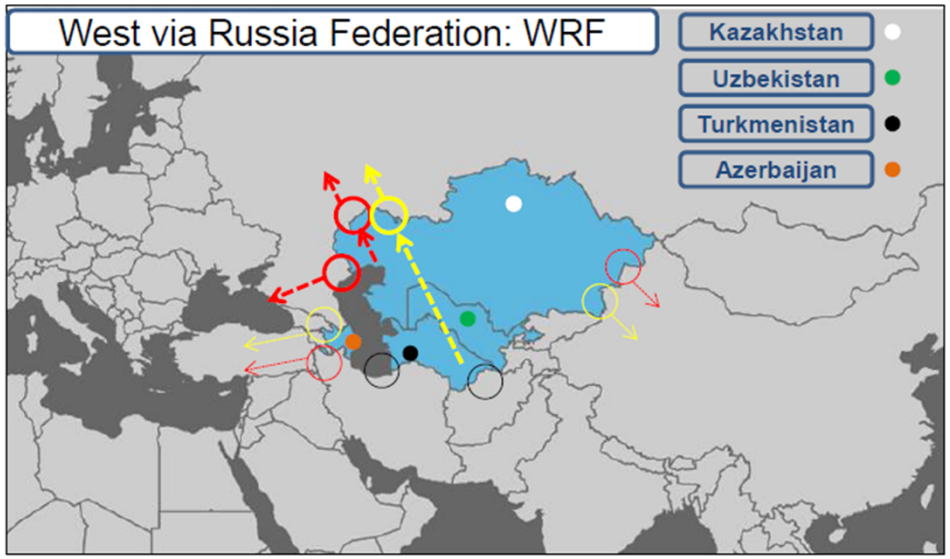
Overview

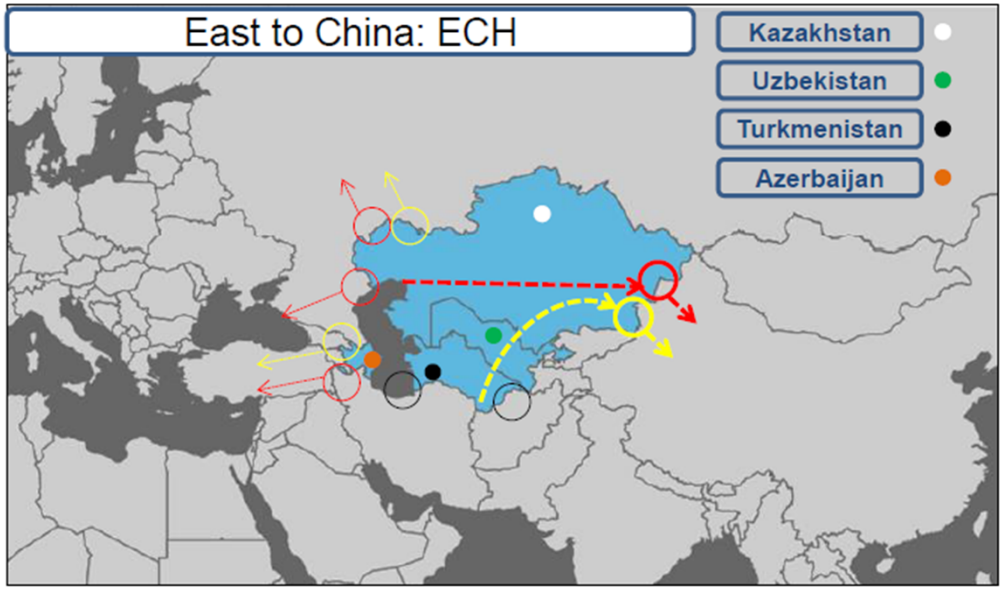
- CENTRAL ASIA CASPIAN (CAC) TIMES MODEL:
  - the bottom up technical-economic partial equilibrium growth model;
  - built using the TIMES model generator developed by the ETSAP of the IEA;
- **Geographical boundaries:** a 4-region model of Azerbaijan, Kazakhstan, Turkmenistan and Uzbekistan
- **Time horizon:** 2009-2050
- **System boundaries:** the entire energy system (from the upstream to the demand) with the trade infrastructures and the flows level among the 4 CAC countries and to the ROW

Indicators	KZK 	AZJ 	TKM 	UZB 	Sum	OECD	World
Population density (cap/sqkm)	6	111	11	69	--	36	13.5
Hydrocarbon rents, average (% GDP)	37	56	82	60	55	--	--
Energy consumption, 2011 (toe/cap)	4.7	1.4	4.8	1.6	2.7	2.9	1.9
CO2 emissions, 2011 (tco2/cap)	14	2.9	12	3.8	7.2	9.8	4.5

- The overall efficiency (TFC/TPES) of CAC was much below the world average: CAC: 56% - World: 68%;
- The domestic energy systems of CAC appear obsolescent technically and economically;
- The governments of the countries focus on increasing the revenues from energy export.

EXPORT ROUTES: Exit points

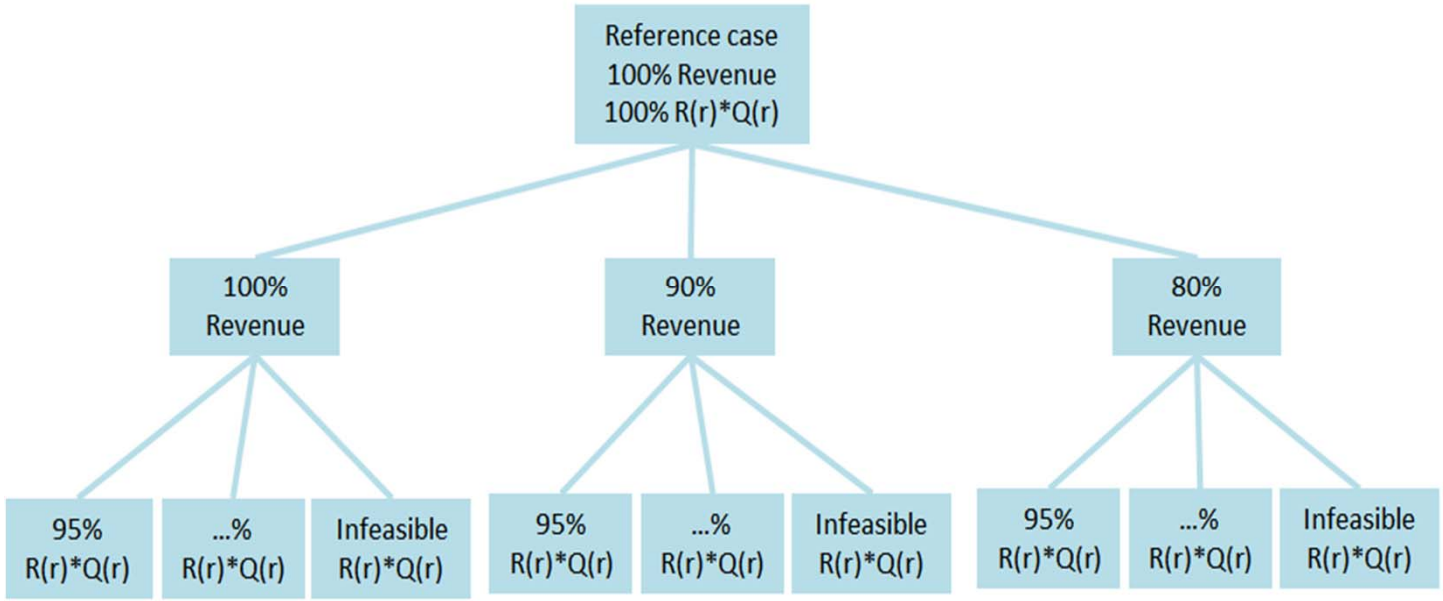




Scenario analysis

$$\boldsymbol{Min}\ [\boldsymbol{cX}]$$
$$\boldsymbol{subject\ to}:$$
$$\boldsymbol{R(r) * Q_t(r)\ <=\ (1-b)\ *\ Max\{R(r) * Q_{1,t}(r)\}}$$
$$\boldsymbol{and}$$
$$\boldsymbol{Sum_r\{p_t * Q_{t(r)}\}_t\ >=\ (1-a) * Sumr\{p_t * Q_{1,t}(r)\}_t}$$

- $\boldsymbol{R(r)}$ is route-specific composite risk parameter;
- $\boldsymbol{Q_t(r)}$ is the endogenous quantity exported via route "r" in period t;
- $\boldsymbol{R(r) * Q_1(r)}$ is the route-specific risk as calculated at stage 1;
- $\boldsymbol{p_t}$ is the exogenous selling price of the commodity in period t;
- $\boldsymbol{b}$ is a set of risk decrease parameters ("n" elements) which has been set to be zero at stage 1;
- **a** is a set of revenue decrease parameters.



Composite risk indicator

Composite Risk Indicator calculated based on four components for each export route:

(1) geopolitical/socioeconomic component (non-energy related)
(2) the energy market liquidity (energy-related)
(3) the energy self-sufficiency (energy-related)
(4) the expectation about energy/environmental policies of the potential customers (energy-related)

Energy related factors have been estimated for oil and gas only.

$$\boldsymbol{RISK = R_C * e^{\left(1-\frac{1}{R_f}\right)} * \left(1-\frac{P}{R}\right) * \frac{PES2010}{PES2040}}$$

Risk components

#	Component	Description
1	R_C	It represents a risk of the destination Country (or market), and of the transit Countries (due to political instability, terrorism, uncertain regulatory framework and the rules of law, etc.). Based on World Governance Indicators.
2	$e^{\left(1-\frac{1}{R_f}\right)}$	It represents a market liquidity indicator. (R_f is the ratio between the global PES/ the PES of the consumer" (R_f >1)).
3	$\left(1-\frac{P}{R}\right)$	It represents the domestic potential of the importing Country, and captures the info in terms of the expected degree of "domestic exploitation" of the potential customers based on the existing (short-term) trends of domestic production.
4	$\frac{PES2010}{PES2040}$	It represents the efficiency and environmental commitments/policies of the potential customers, and their corresponding expected future energy hunger (and willingness to pay for energy).

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Composite risk indicator

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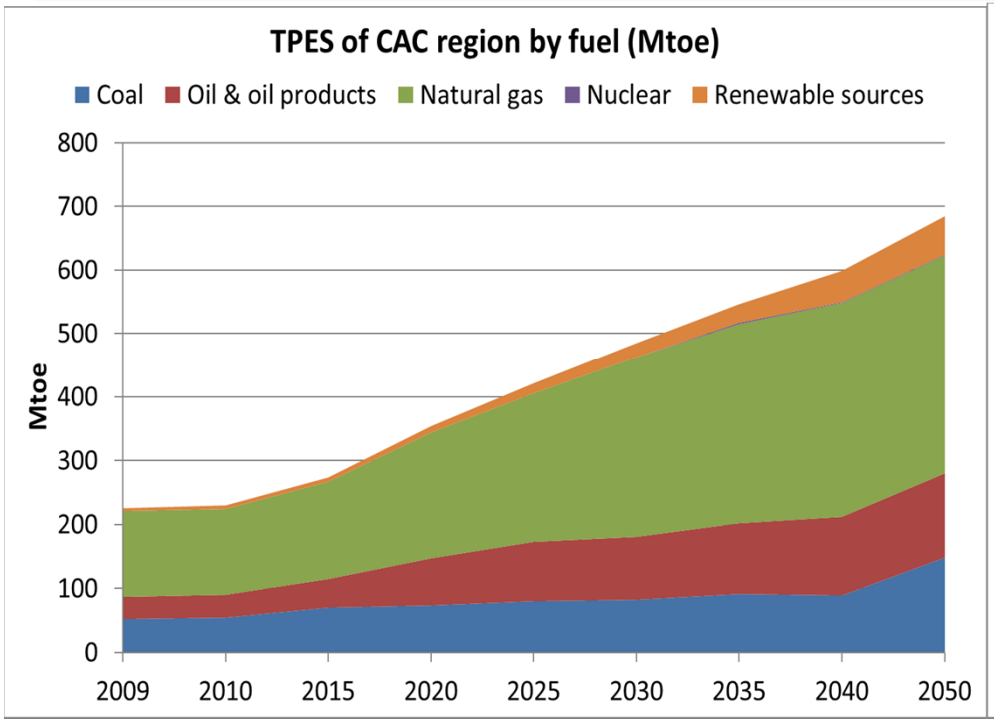
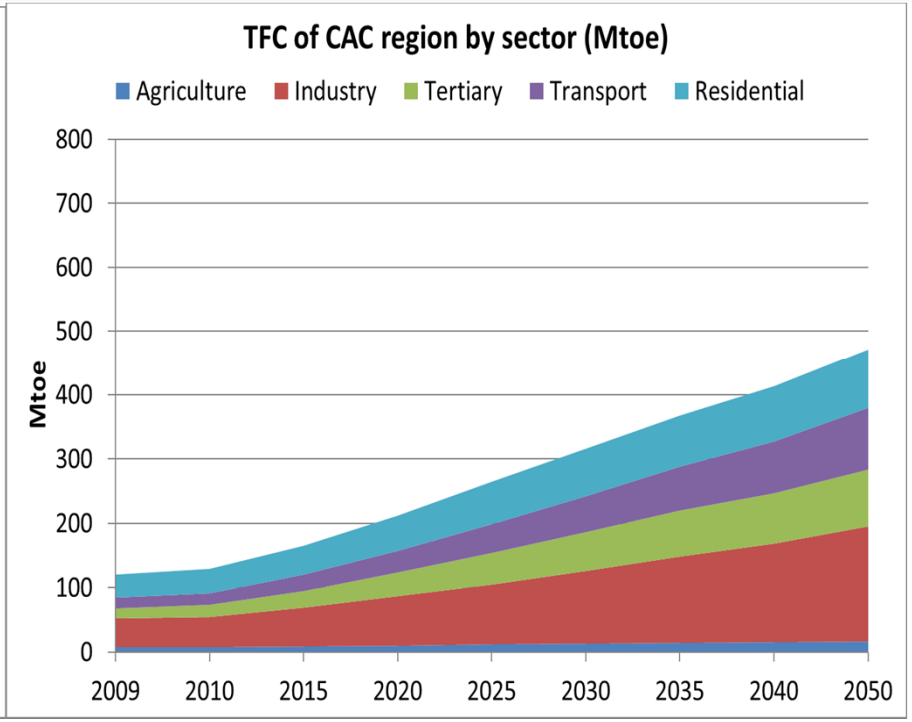
	Price ($USD/GJ)	R_C	$e^{\left(1-\frac{1}{R_f}\right)}$	$\left(1-\frac{P}{R}\right)$	$\frac{PES2010}{PES2040}$	Composite risk parameter
Type:	Importing-market specific [by period]	Route specific	Importing-market specific	Importing-market specific	Importing-market specific	Route specific
Route:	[2015, 2050]					
Gas AZJ-MED	[7.46, 12.46]	92.4	2.386	0.92	1.181	239.6
Gas KZK–RF-EU	[2.00, 12.46]	67.5	2.386	0.92	1.181	174.9
Gas TKM–AZJ-MED	[7.46, 12.46]	97.4	2.386	0.92	1.181	252.5
Gas TKM-India	[0.00, 12.46]	100	2.612	0.961	0.468	117.6
Gas TKM-IRA	[0.00, 12.46]	86.2	2.472	0.983	0.735	154.0
Gas TKM–KZK–RF-EU	[2.00, 12.46]	87.1	2.386	0.92	1.181	225.9
Gas TKM–UZB–KZK-CHI	[5.00, 12.46]	98.6	2.501	0.954	0.485	114.0
Gas TKM–UZB–TAJ–KYR-CHI	[5.00, 12.46]	99.6	2.501	0.954	0.485	115.2
Gas UZB–KZK–RF-EU	[2.00, 12.46]	87.1	2.386	0.92	1.181	225.9
Oil AZJ-MED	[10.96, 15.96]	92.4	2.386	0.92	1.181	239.6
Oil KZK–AZJ-MED	[10.96, 15.96]	97.4	2.386	0.92	1.181	252.5
Oil KZK-CHI	[7.68, 11.18]	60.4	2.501	0.954	0.485	69.8
Oil KZK–IRA-World	[0.00, 11.18]	86.2	2.472	0.983	0.735	154.0
Oil KZK–RF-MED	[6.00, 14.37]	67.5	2.386	0.92	1.181	174.9

A Reference Scenario

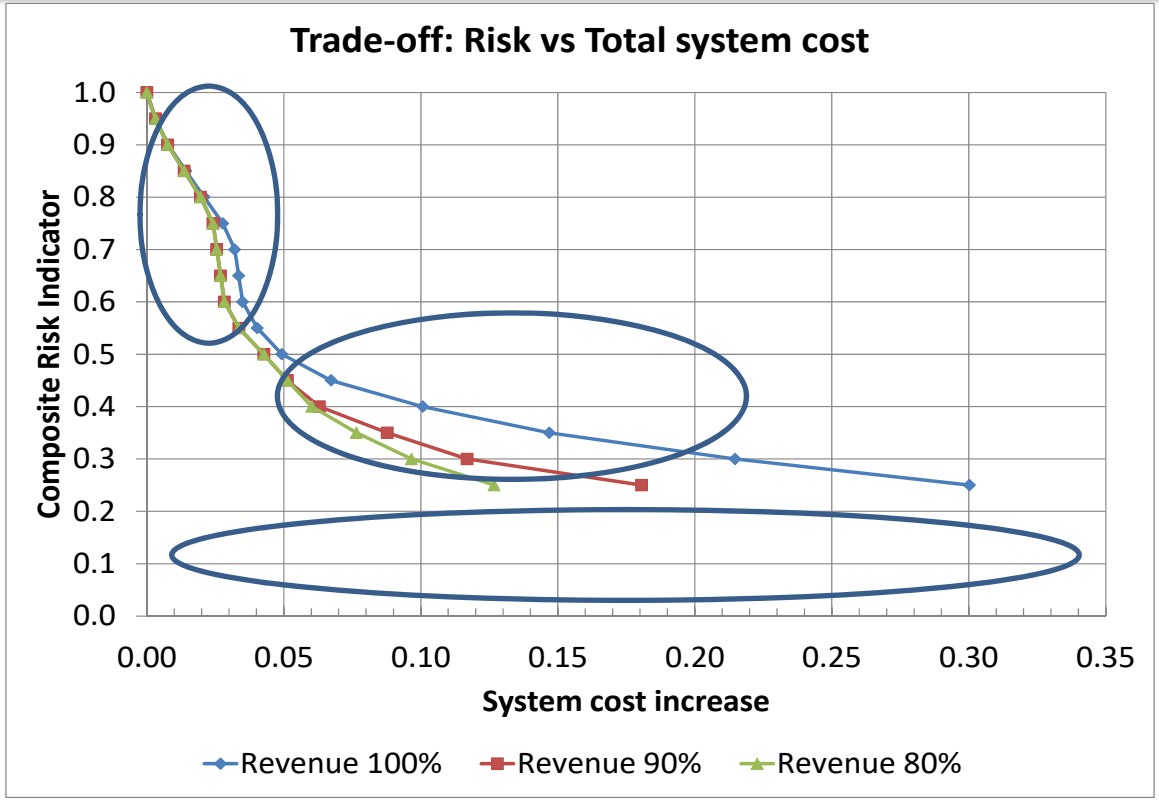




Without specific strategies and goals in Reference case:

- the total supply is projected to be more than three times higher than in 2009, while the final consumption (the industry in particular) is projected to grow even faster.
- the decoupling between the TPES and TFC points out the significant efficiency improvement of the secondary transformation processes in the medium-long term

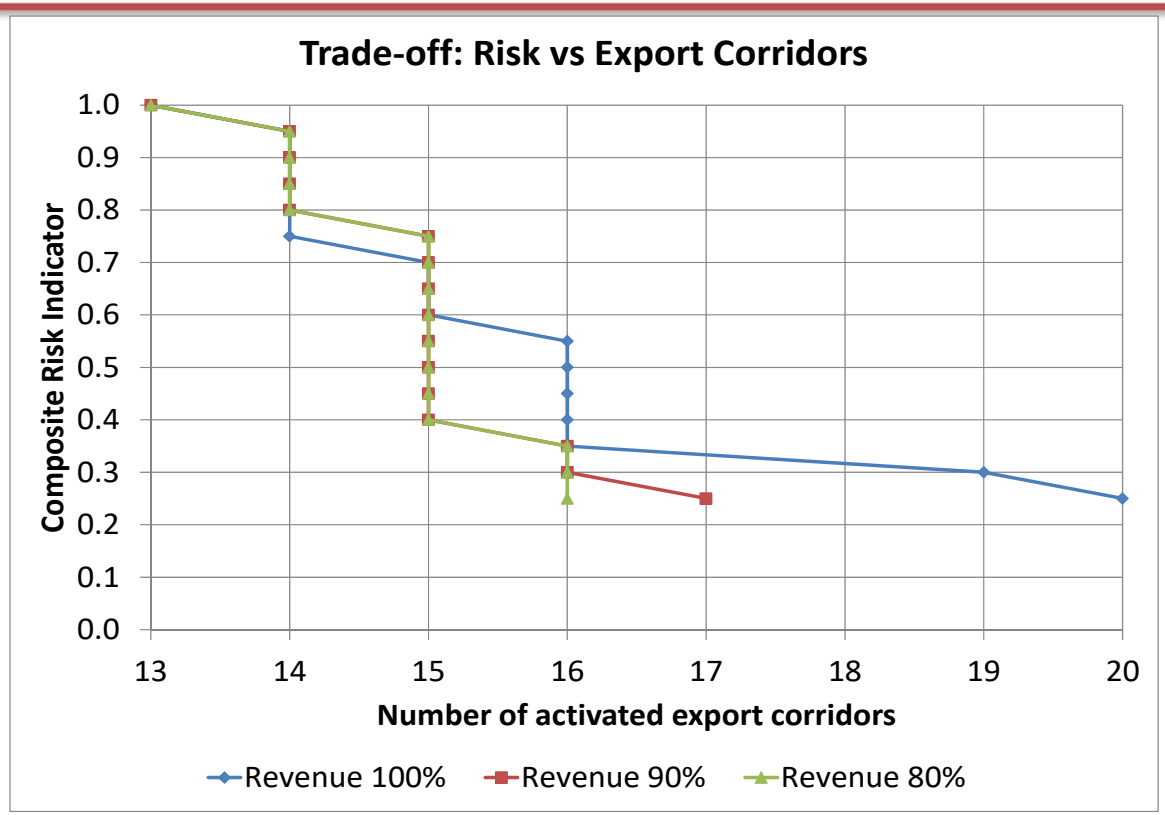
Trade-off: Risk vs Cost



The graph can be divided into three major areas:

- The first one (top-left) shows that within a total cost increase of 5%, the system can sharply decrease the risk indicator of 50% on the basis of the reference case.
- The second area covers the risk decrease from 50% till around 20%, and shows the high sensitivity of the total system costs to such much more challenging goals.
- The third area, which is below 20% of risk reduction, results “infeasible” for the Central Asian Caspian system when subject to the minimum revenues control.

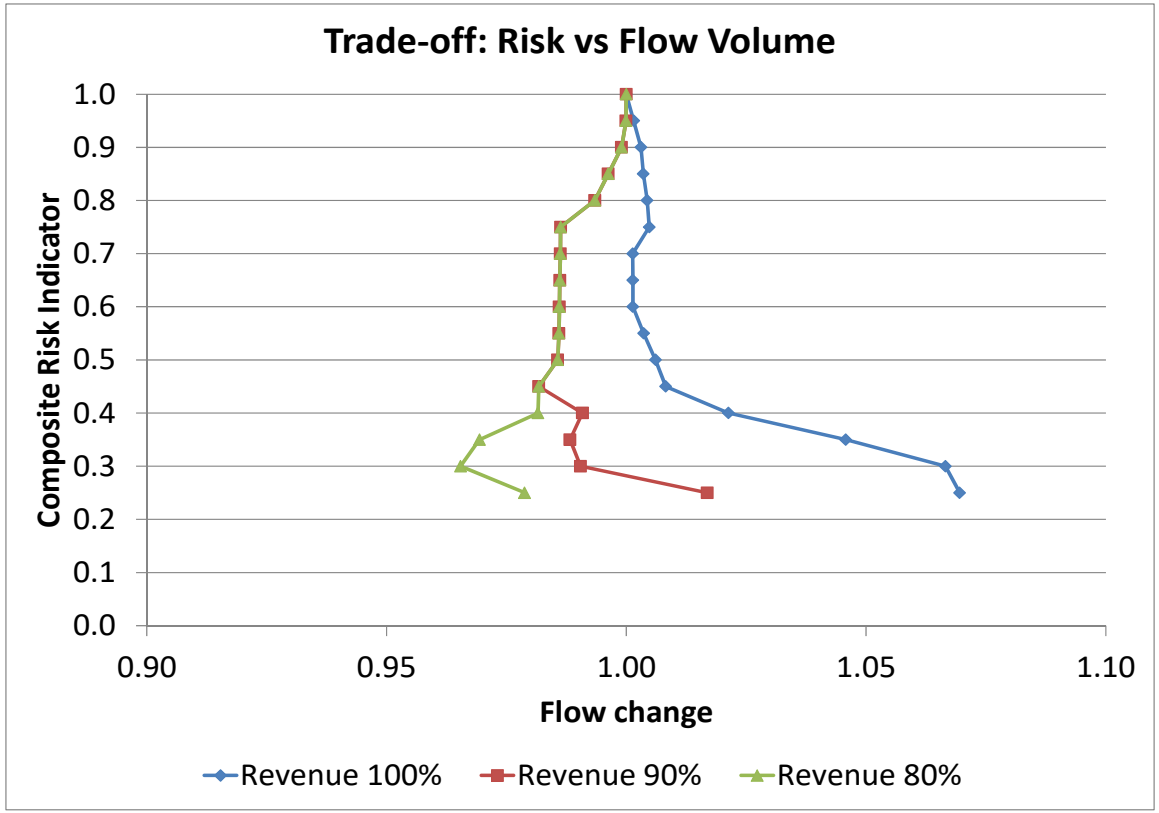
Trade-off: Risk vs Export Corridors



An overview of the response of the system in terms of number of "activated" corridors:

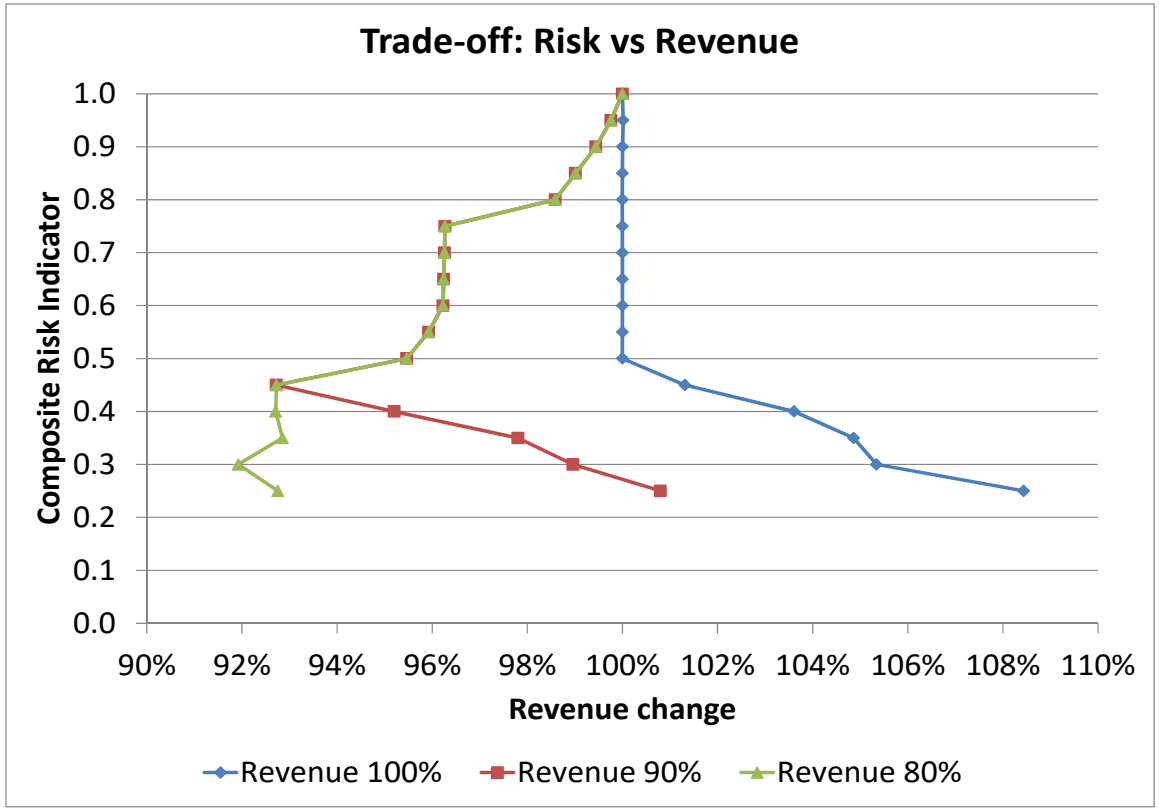
- A decrease of 5% of the risk indicator, requires one more infrastructure to the Western direction
- The stream of flows in the various available corridors (utilization of the captive infrastructures) can be organised in such a way that the overall risk reduction is further decreased down to around 80%.
- Lower levels of risk need new/more corridors, up to twenty

Trade-off: Risk vs Export Flows



In order to reduce the vulnerability and ensuring at the same time the level of revenues of the reference case, the CAC system is called to export more (from 1% to 7% more in terms of cumulative export quantities) and change the mix of destinations (routes).

Trade-off: Risk vs Revenue



- Exported quantities and revenues get higher when the risk reduction is below the threshold of 50%.
- This is due to the higher amount of natural gas and oil exports to the Eastern direction (China) which allow both to exploit alternative routes with much lower composite risk values, as well as to increase the consequent overall revenues (quantities) from the export.
- Such a configuration of the export flows generates a higher cost function since it involves more investments infrastructures and higher export costs.

Summary

The study aims:

- to test the effects of long-term energy export strategies on the energy system of the CAC

Making use of:

- CENTRAL ASIA CASPIAN (CAC) TIMES MODEL
- Composite Risk Indicator: 4 components
- A multi-stage (1+n) approach
- Trade-offs curves between a comprehensive “risk” indicator and the outcomes of key variables

Conclusion:

- There is a big room for reducing the vulnerability (with respect to the energy export) that the Central Asian Caspian area is currently facing.
- The cost of such reduction is relatively small (5% greater than the reference case) for a significant improvement of the indicator down to 50%.

Thank You!

Acknowledgements

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