Energy Security of Poland and Coal Supply: Price Analysis

Honorata Nyga-Łukaszewska [1], Kentaka Aruga [2,*] and Katarzyna Stala-Szlugaj [3]

[1] SGH Warsaw School of Economics, Al. Niepodleglosci 162, 02-554 Warsaw, Poland, hlukas@sgh.waw.pl

[2] Graduate School of Humanities and Social Sciences, Saitama University, 255 Shimo-Okubo, Sakura-ku, Saitama, 338-8570 Japan, aruga@mail.saitama-u.ac.jp

[3] Mineral and Energy Economy Research Institute, Polish Academy of Sciences; ul. Wybickiego 7A, 31-261 Krakow, Poland, kszlugaj@min-pan.krakow.pl

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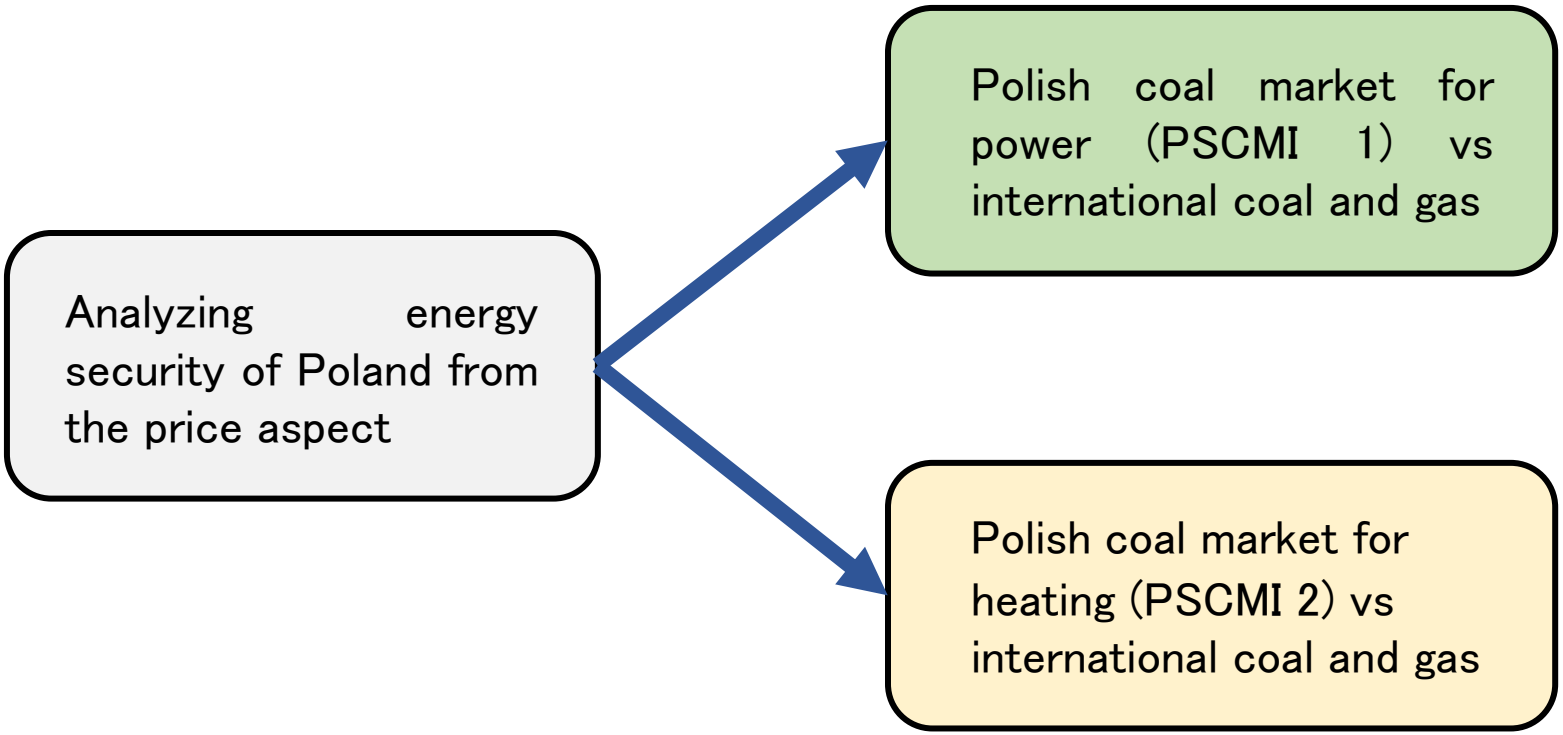
Goals


Analyzing energy security of Poland from the price aspect
Polish coal market for power (PSCMI 1) vs international coal and gas
Polish coal market for heating (PSCMI 2) vs international coal and gas

Hypotheses

H1

PSCMI1 (steam coal fines sold to power industry): depends highly on domestic coal production

→

PSCMI1 linked with the international coal market?

H2

PSCMI2 (steam coal fines sold for heating purpose): use of natural gas is increasing

→

PSCMI2 linked with the international gas market?

Relevant studies

- Studies related to energy security
  - Studies defining energy security and finding its indicator (Holley and Lecavalier, 2017; Cecchi et al., 2009; Kruyt et al., 2009).
  - Energy importing and energy security issue (Vivoda, 2009; Cohen et al. 2011).
  - Both imports and domestic production may pose similar threats for supply security (Luciani, 2004; Mitechell, 2002).
- Studies using similar methods
  - Effects of the 2008 financial crisis on the linkages among the oil, gold, and platinum markets (Aruga and Kannan, 2020).

Methods: assumptions

There is not a consistent definition for energy security.

Due to the unclear nature of the energy security phenomenon, we consider energy security based on the definition of the International Energy Agency (IEA):

- "uninterrupted availability of energy sources at an affordable price" (IEA. Energy Security. 2019).
- "physical availability of energy and prices."

This study focuses on the price-dimension of energy security.

Methods: quantitative methods

Examine the price linkages between the Polish coal indices vs the European gas and Australian coal prices during linkages during 2011:1–2019:1

Cointegration test without effects of a structural break in the series

Johansen (1991) test

Test whether the cointegration relationships are time varying

Bierens–Martins (2010) test

Perform a time varying and cointegration with effects of a break

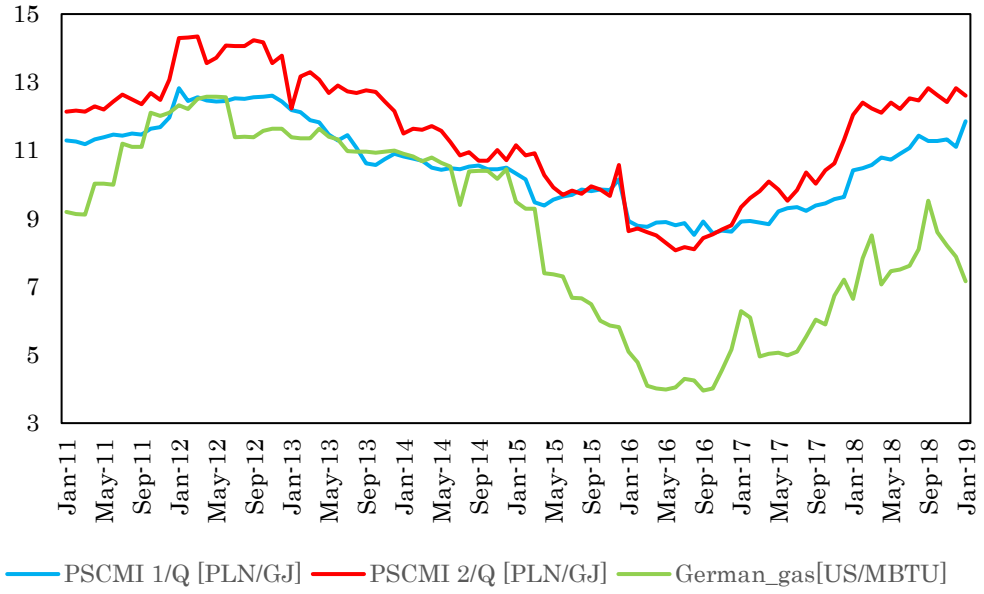
Recursive Johansen and Gregory–Hansen (1996) tests

Data: domestic coal market indices

- Polish steam coal market indices
  - PSCMI1(PLN/GJ): steam coal fines sold to the power sector and industrial power plants.
  - PSCMI2(PLN/GJ): steam coal fines sold to industrial and municipal heating plants, other industrial consumers and others.

Data: international gas and coal prices

- Natural gas: monthly Russian natural gas border price in Germany (USD/BTU).
- International coal: monthly Australian thermal coal price (USD/MT).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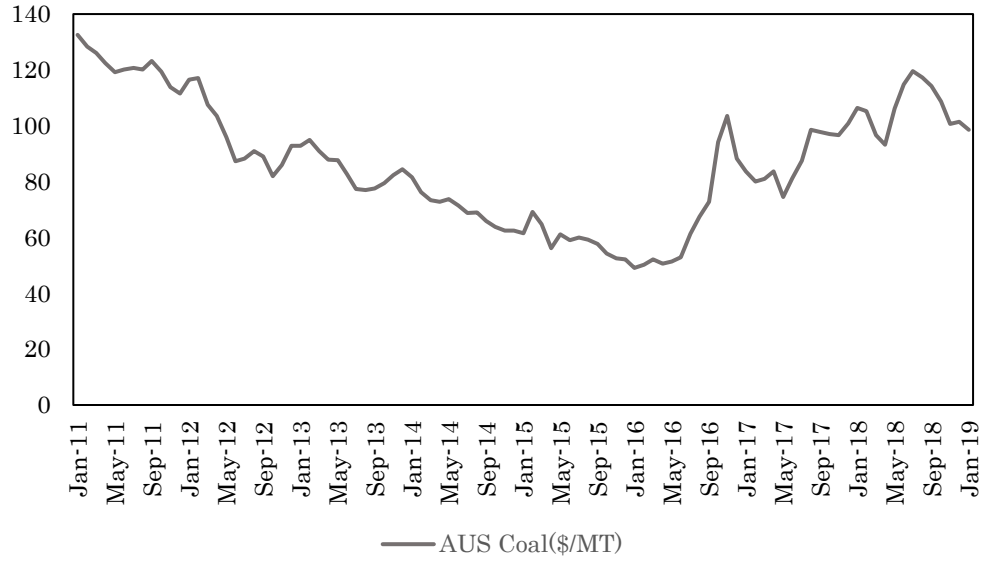
PSCMI 1/Q [PLN/GJ]
PSCMI 2/Q [PLN/GJ]
German_gas[US/MBTU]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Unit root tests

	Level				First differences			
	ADF	PP	KPSS	LS (two break)	ADF	PP	KPSS	LS (two break)
PSCMI1	-0.88	-0.87	0.70 **	-4.85	-9.69 ***	-9.69 ***	0.43 *	-11.39 ***
PSCMI2	-1.12	-1.10	0.56 **	-5.19	-11.30 ***	-11.20 ***	0.28	-13.11 ***
Coal	-1.82	-1.93	0.36 *	-4.67	-7.32 ***	-7.27 ***	0.34	-8.25 ***
Natural gas	-1.53	-1.09	0.79 ***	-3.98	-2.89 *	-8.83 ***	0.16	-10.31 ***

ADF, PP, and KPSS unit root tests include only a constant. ***, **, and * denotes significance at 1%, 5%, and 10% respectively.

Johansen test

Variables	H_0: rank=r	Trace stat.	Max-Eigen stat.
Gas vs PSCMI1	r=0	5.12	4.30
	r<=1	0.82	0.82
Gas vs PSCMI2	r=0	6.50	5.43
	r<=1	1.07	1.07
PSCMI1 vs PSCMI2	r=0	12.84	11.97
	r<=1	0.87	0.87
Coal vs Gas	r=0	22.83 **	16.73 **
	r<=1	6.09	6.09
Coal vs PSCMI1	r=0	23.92 **	19.08 **
	r<=1	4.84	4.84
Coal vs PSCMI2	r=0	26.85 ***	21.89 **
	r<=1	4.97	4.97

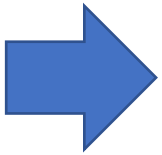
*** and ** denotes significance at 1% and 5% levels.

Cointegrated

Bierens-Martins time-varying cointegration test

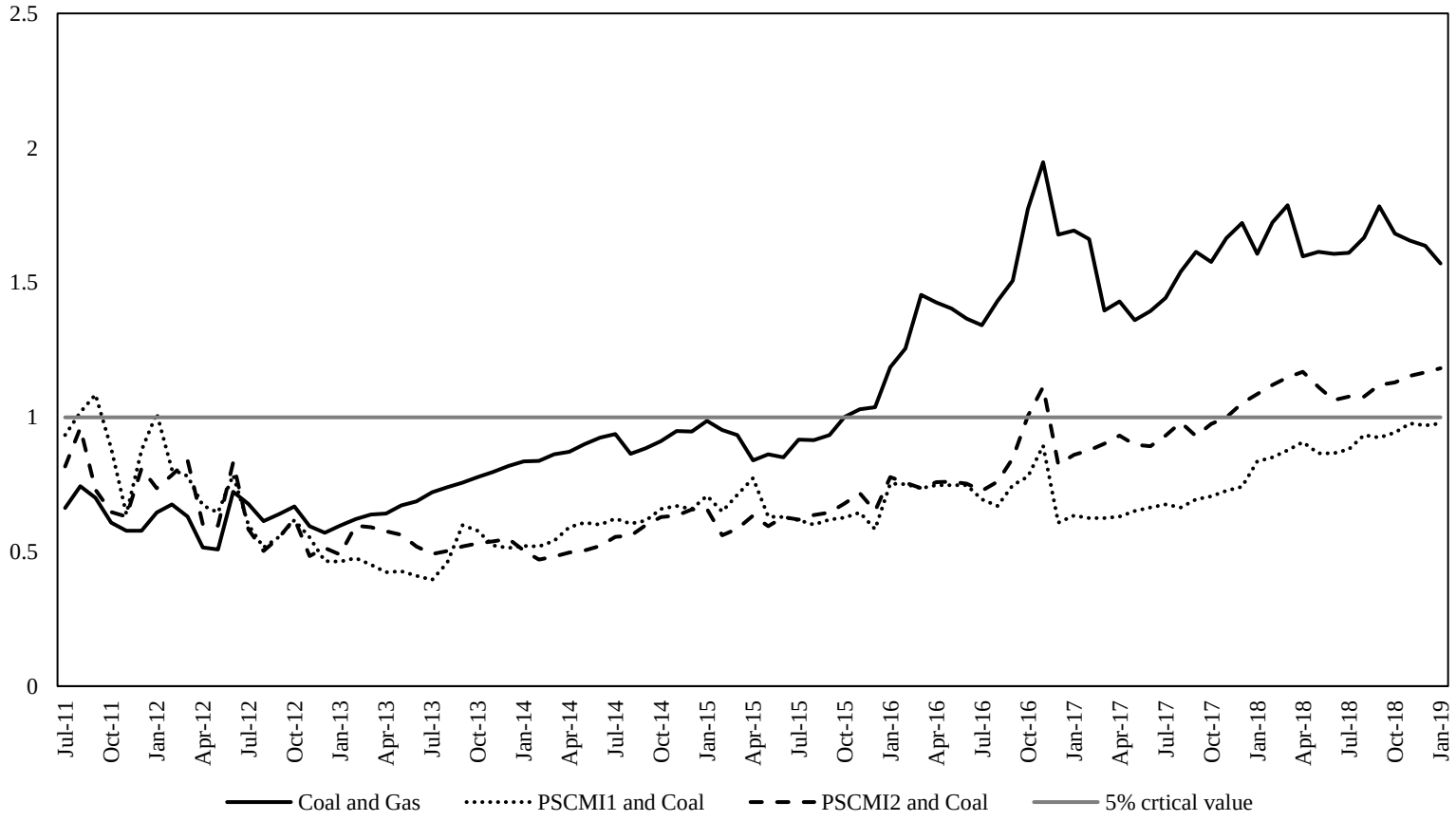
Variables	Chebyshev Time Polynomials	Test statistic	P-value
Coal vs Gas	m=1	9.18 **	0.010
	m=2	27.86 ***	0.000
	m=4	40.11 ***	0.000
Coal vs PSCMI1	m=1	1.45	0.484
	m=2	9.45 *	0.051
	m=4	31.22 ***	0.000
Coal vs PSCMI2	m=1	2.94	0.230
	m=2	5.41	0.247
	m=4	27.12 ***	0.001

Note: *** and ** denote significance at the 1% and 5% levels, respectively.



All relationships contain time varying component

Recursive cointegration test



Gregory-Hansen test

	ADF		Z_t		Z_α	
Variables	test statistic	Break point	test statistic	Break point	test statistic	Break point
Gas vs PSCMI1	-4.82 *	May, 2015	-4.87 *	May, 2015	-41.36	Jul., 2015
Gas vs PSCMI2	-5.50 **	Jul., 2015	-5.59 ***	Jul., 2015	-48.76 **	Jul., 2015
PSCMI1 vs PSCMI2	-4.49	Oct., 2016	-4.43	Nov., 2016	-35.99	Nov., 2016
Coal vs Gas	-4.93 *	Apr. 2016	-4.38	May, 2016	-32.01	May, 2016
Coal vs PSCMI1	-4.99 *	Aug. 2016	-4.96 *	Aug. 2016	-37.68	Aug. 2016
Coal vs PSCMI2	-4.60	Apr. 2016	-4.55	Jul., 2016	-33.56	Jul., 2016

Gas and PCMI2 cointegrated

Coal and PCMI1 cointegrated

***, **, and * denotes significance at 1%, 5%, and 10% respectively.

Conclusions: summary of findings

PSCMI1 (power market–oriented coal) linked with the international coal market? → Yes

PSCMI2 (heating market–oriented coal) linked with the international gas market? → Yes

Implications

- The electricity sector exhibits energy security as long as the domestic coal market remains self-sufficient.
- Energy security might be questioned for the heating sector as Poland rely natural gas on imports.
- Energy security analysis is highly context dependent.

Thank you for listening!

Please contact the following presenter for further questions:
kentaka.aruga@gmail.com