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Natural Gas Production and Energy Prices in China

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Abstract: **Natural gas imports in China has been increasing quickly, reflecting a shortage of natural gas supply. I argue that China's natural gas production is demand driven but not energy price-orientated. Hence, this paper primarily aims to examine if energy prices have influenced natural gas production. Monthly data spanned 2011-2017. Fuel and power price index was used to represent energy prices. CPI was taken into account. The Phillips-Perron test, the augmented Dickey-Fuller test, the Dickey-Fuller generalised-squared test suggested a unit root for three variables. Cointegration did not exist. A conventional vector-autoregression model in first differences was estimated. No Granger causal relationships were suggested. The study suggests that natural gas production in China is rarely impacted by energy prices and CPI and vice versa in the short run as well as in the long run. Increasing demand for natural gas leads to the gas supply shortage, which has encouraged the governmental control on the production. Empirical evidence shows that gas production may not be market-orientated.**

Keywords: **Natural gas, production, price, demand, long term, short term.**

I. INTRODUCTION

In 2010 and 2015, China produced 94.85 and 134.61 billion cubic meters of natural gas, respectively. Its natural gas consumption was 107.58 and 158.91 billion cubic meters, respectively [1]. Therefore, the gap between production and consumption increased from 12.7 to 24.3 billion cubic meters over the past decade, which had resulted in a great growth in gas imports (TABLE I). Increasing air pollution and quickly expanding economy may lead to more demand for gas than usual [2, 3].

TABLE I: NATURAL PRODUCTION AND INTERNATIONAL TRADE, CHINA

	2015	2014	2013	2012	2011	2010	2009	2008	2007
Imports (100 million cubic meters)	611	591	525	421	312	165	76	46	40
Exports (100 million cubic meters)	33	26	27	29	32	40	32	32	26

Note: Sources: National Bureau of Statistics of China [1].

In China, demand for natural gas is much than supply. In equilibrium, natural gas production and supply are greatly impacted by prices. However, if the authority can impose a significant effect on natural gas prices [4], production and supply, changes in gas production may not depend on changes in energy prices. This paper mainly aims to examine whether energy prices influence natural gas production either in the short run or the long run.

II. METHODOLOGY

Unit root tests used three alternative techniques: the augmented Dickey-Fuller (ADF) test [5, 6], the Dickey-Fuller GLS method [7-11], and the Phillips-Perron test (PP) [12, 13].

A vector-autoregression model (VAR) in first differences or an error-correction model (ECM) could be constructed. A traditional VAR means that variables are $I(1)$ but not cointegrated. An ECM means that variables are $I(1)$ and cointegrated. Engle-Granger [14] and Johansen trace tests will be conducted for cointegration test [15-18].

Granger causality tests can be made within either a VAR or an ECM.

III. DATA

Gas production was statistics onwards from January (*Gas production*). Energy prices were represented by fuel and power purchase price index (same period of the last year=100) (*Fuel & power purchase price*). This type of prices reflects the equilibrium price in the market and is a demand price. Moreover, changes in CPI may impact the production. National CPI (same period of the last year=100) (*CPI*) was applied. Data were monthly changes, covering the period from 2011 to 2017. Data are available in the National Bureau of Statistics of China [19]. TABLE II describes the data. Fig. 1. Plotted three variables, which shows that *Gas production* and *Fuel & power purchase price* were mean nonzero and may contain a trend. *CPI* appeared to be mean nonzero but contain no trend.

TABLE II: DESCRIPTIVE STATISTICS

Description	**Gas production (onwards from January, 100 million cubic meters)**	**Fuel and power purchase price index (same period of the last year=100)**	**National CPI (same period of the last year=100)**
Variable	*Gas production*	*Fuel & power purchase price*	*CPI*
Mean	6.30	4.61	4.63
Median	6.31	4.58	4.63
Maximum	6.52	4.76	4.66
Minimum	6.11	4.48	4.61
Std. Dev.	0.12	0.09	0.01
Skewness	0.17	0.27	1.13
Kurtosis	1.89	1.82	3.10
Jarque-Bera	4.71	5.84	17.62
Probability	0.09	0.05	0.00

Notes: Series were seasonally adjusted using the X13 (additive). Data were transformed into logarithms.

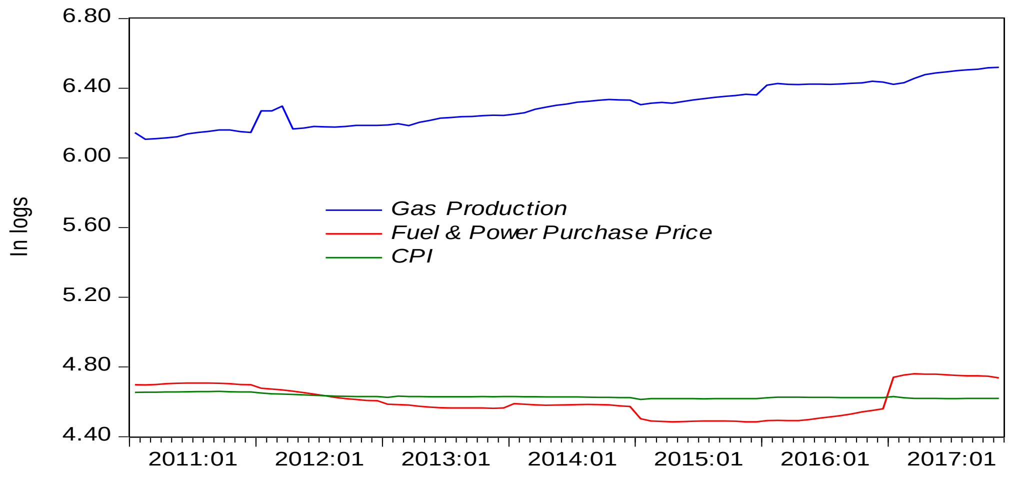

Fig.1: NATURAL GAS PRODUCTION AND ENERGY PRICES IN CHINA

IV. EMPIRICAL RESULTS

Fuel & power price and *CPI* were integrated of order one, and *Gas production* nearly contained a unit root (TABLE III). Hence, this study suggests that these three variables are *I*(1).

Both the Engle-Granger and Johansen trace tests showed no cointegration (TABLE IV, TABLE V).

Hence, a VAR in first differences was estimated (TABLE VI). Estimates on lagged *Fuel & power price* terms and lagged *CPI* terms influencing *Gas production* were statistically insignificant. Within this VAR, the Granger causality test was performed; no causal relationships existed between variables (TABLE VII).

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TABLE III: ALTERNATIVE TESTS FOR VARIABLE INTEGRATION

Variable	**Method**	***k***	**Level**	***k***	**First difference**	***k***	**Second difference**
Gas production	ADF	3	-2.62	11	-5.20***		
	PP	6	-3.90	36	-18.22***		
	DF-GLS	3	-1.43	7	-0.65	10	-0.40
Fuel & power price	ADF	0	-0.47	0	-7.76***		
	PP	3	-0.71	1	-7.75***		
	DF-GLS	0	-0.85	0	-7.52***		
CPI	ADF	0	-1.64	0	-9.73***		
	PP	3	-1.64	3	-9.70***		
	DF-GLS	0	0.00	2	-3.45***		

Notes: For ADF and DF-GLS tests, lags *k* were decided by *t*-statistics. For PP tests, *k* was decided using the Newey-West technique [20]. As Fig. 1. indicated, test equations for *Gas production* and F*uel & power price* contained the trend and intercept. Test equations for *CPI* contained only the intercept [21]. **, ***Rejection of a unit root at the 5% and 1% levels, respectively.

TABLE IV: THE ENGLE-GRANGER COINTEGRATION TEST

Log dependent variable	***z****	***P*-value****
Gas production	-5.97	0.89
Fuel & power price	-6.46	0.86
CPI	-6.68	0.85

Notes: *indicated the test statistic. Lags were chosen using the modified AIC. **MacKinnon's (1996) *P*-values [22]. Test equations included the constant and linear trend.

TABLE V: THE JOHANSEN COINTEGRATION TEST

r	***k***	**Eigenvalue**	**Trace**	**O-L***	**C&L****	**Reinsel-Ahn*****
0	3	0.28	38.34	42.92	47.59	32.80
≤1		0.09	12.87	25.87	28.69	11.01
≤2		0.06	5.11	12.52	13.88	4.37

Notes: *denotes Osterwald-Lenum 5% critical values [23]. ** denotes Cheung-Lai 5% finite-sample critical values 5% [24]. *** denotes Reinsel-Ahn finite-sample trace corrections [25]. Lag length *k* was selected by AIC. Portmanteau autocorrelation = 3.84 (lags=4, *P*-value=0.89).

TABLE VI: ESTIMATES OF VAR IN FIRST DIFFERENCES

Indept. lagged variable	***Gas production***	***Fuel & power price***	***CPI***
Gas production$_{t-1}$	-0.11	-0.02	0.00
t-Statisic	-1.02	-0.12	-0.31
Gas production $_{t-2}$	-0.02	0.05	0.01
t-Statistic	-0.20	0.39	0.89
Gas production $_{t-3}$	-0.37	0.00	0.01
t-Statistic	-3.53	-0.01	0.60
Fuel & power price $_{t-1}$	0.02	0.12	-0.03
t-Statistic	0.15	0.80	-2.45
Fuel & power price $_{t-2}$	-0.01	0.06	-0.02
t-Statistic	-0.07	0.37	-1.49
Fuel & power price $_{t-3}$	0.10	0.07	0.01
t-Statistic	0.75	0.47	0.90
CPI $_{t-1}$	-0.23	0.46	0.03

t-Statistic	-0.17	0.30	0.19
CPI_{t-2}	1.37	0.69	0.29
t-Statistic	1.05	0.47	2.10
CPI_{t-3}	1.65	0.30	0.10
t-Statistic	1.38	0.22	0.74
error	0.01	0.00	0.00
t-Statistic	3.17	0.25	-1.05
R-squared	0.23	0.05	0.18
Adj. *R*-squared	0.13	-0.08	0.08
Sum sq. resids	0.03	0.04	0.00
S.E. equation	0.02	0.02	0.00
F-statistic	2.25	0.37	1.72
Log likelihood	198.00	188.51	374.03
Akaike AIC	-4.76	-4.52	-9.22
Schwarz SC	-4.46	-4.22	-8.92
Mean dependent	0.01	0.00	0.00
S.D. dependent	0.02	0.02	0.00

Notes**:** lag k was chosen by AIC. Portmanteau autocorrelation = 6.95 (lags=9, *P*-value=0.64).

TABLE VII: GRANGER CAUSALITY TESTS IN VAR

H_0	**Chi-square**	***P*-value**
Fuel & power price did not Granger cause *Gas production*	0.69	0.87
CPI did not Granger cause *Gas production*	3.34	0.34
Gas production did not Granger cause *Fuel & power price*	0.18	0.98
Gas production did not Granger cause *CPI*	1.22	0.75

V. CONCLUDING REMARKS

Over the past decade, air pollution has been a big problem. Clean natural gas has been used as an instrument to reduce carbon emissions. However, gas production cannot keep pace with quickly increasing gas consumption. Gas imports have reached a new record in recent years. China has many strict controls on natural gas prices. Production of natural gas is often made not depending on profits but administrative measures. Hence, this study empirically examined the effect of energy prices on natural gas production.

Leading methods were cointegration tests. The Johansen trace test and the Engle-Granger test were performed. Pre-tests included the Phillips-Perron test, the augmented Dickey-Fuller test, the Dickey-Fuller generalised-squared test. The study applied monthly data that covered the period from 2011-2017. Energy prices used the fuel and power price index. The study also took CPI into account.

The paper found that natural gas production in China was not cointegrated with energy prices and CPI, which implies that no long-run equilibrium exists. VAR estimates and Granger causality tests show that both energy prices and CPI did not impact gas production in the short run. Hence, this study suggests that natural gas production in China is rarely market-orientated.

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