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King Abdullah Petroleum Studies and Research Center

Economic Cycles and the Responsiveness of Natural Gas Demand in China's Residential Sector

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Outline

- The Objective
- Why it is important
- Contribution to Existing Research
- Methodology
- Data
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The Objective

This research examines household demand for natural gas and estimates price and income elasticities, accounting for cycles

Why it is important

Five-Year Cycles and Economic Cycles

- Kwan (2013), Chang et al. (2015)
- Five-Year Cycles can trigger longer cyclical swings. In 1996, the 8th National People's Congress passed a long-term plan to bolster heavy industry, resulting in an increase in urbanization and infrastructure development, and contributing to increased natural gas consumption.

Residential Sector

- Residential energy consumption in China ranks second behind the industrial sector
- Its share of natural gas consumption increased from around 1% in 1980 to around 18% in 2016

Natural Gas - China's 13th Five-Year Plan

China's 13th Five-Year Plan promotes the use of natural gas and China's government provides consistent regulatory support to increase its consumption.

The goal is to fulfil the dual objectives of its Energy Development Action Plan:

- (a) to increase the share of natural gas in energy demand to at least 10% by 2020, and
- (b) to reduce coal consumption, thereby decreasing pollution levels and achieving a cleaner energy mix.

Why it is important

China's Role in the Global Economy

- China was the third-largest consumer of natural gas in the world in 2014 and is a vital player in global energy markets as both an importer and an investor (Ratner et al. 2016).
- Accordingly, implications of China's Energy Development Strategy Action Plan for 2014–2020 are unlikely to be limited to the domestic economy and will potentially have global spillover effects (Ratner et al. 2016; Paltsev and Zhang 2015).
- If consumption actually grows at the rates required to achieve the announced targets in the 13th Five-Year Plan, natural gas imports and production, and investments in infrastructure (i.e., shipping terminals, pipelines, and power plants) must increase along with it.
- These changes will certainly affect both domestic investment and prospects for exporting hydrocarbons to China (Ratner et al. 2016).
- Foreign investment in the country's energy sector and China's investments abroad also will be affected (Tan 2013).

Why it is important

Hence...

Understanding the trends, variations, and determinants of the demand for natural gas in China is vital to

- predict the success of the 2020 plan and
- comprehend its likely impact on China's economy and
- the international economy
- as well as the potential to export resources to the Chinese market.

Contribution to Existing Research

- There is scarce research on both natural gas demand (Wang and Lin 2014; Yu et al. 2014) and cycle-trend decomposition in China (Chang et al. 2015) ; and there is not any research, to my knowledge, that jointly tackles the two aspects.
- Research that applies UCM to energy demand has not accounted for cyclical effects.
- This paper empirically studies the residential sector's natural gas demand in urban China, accounting for cyclical effects.

Methodology - Why the UCM

Wang and Lin's (2014) residential model

Initial analyses

Therefore, I apply an unobserved components model (UCM) to deal with non-stationarity and data limitations.

- The UCM technique decomposes a series into latent components (e.g. stochastic trend and cycle); and overcomes non-stationarity, small sample, and data irregularities issues; and handles structural changes (Brintha et al. 2015).
- Broadstock and Hunt (2010), Bernard et al. (2006), and Hunt et al. (2000, 2003a, 2003b) explained that estimating the underlying energy demand trend by allowing a stochastic trend captures the effect of exogenous factors such as socioeconomic factors, technological advancements and technical progress.
- According to Guangrong and Yanjun (2011, 1178), state space modeling is useful for modeling changes in “government policy and economic institutions.”
- Dong et al. (2010) applied shifting trend model to study regulated energy prices in China.

Given the nature of the available data for the residential sector's demand for natural gas and the pricing regime in China, the UCM methodology is useful.

Methodology - The Model

- I apply a UCM to estimate price and income elasticities of residential demand for natural gas in urban China.
- The model accounts for cyclical effects, separating the two effects of the Five-Year Plans which reflect movements around a steady state irrespective of economic growth and economic cycles which capture fluctuations around a growth trend.
- A cyclical component could be incorporated to account for serial autocorrelation in the idiosyncratic shock. And, a simple random walk model could be expanded to include “a stationary cyclical component that produces serially correlated shocks around the random-walk trend” (Baum 2013 43; Harvey 2002; Harvey et al. 2004; Koopman et al. 2009; Pelagatti 2015). Similar to Baum (2013), I dropped the idiosyncratic shock and included stochastic cycles.
- Hence, I estimate a model that includes a random walk trend, two stochastic cycles, and price and income variables

$$D_{NG,t} = \mu_t + \Psi_{1t} + \Psi_{2t} + \pi_p Price_t + \pi_I Income_t$$

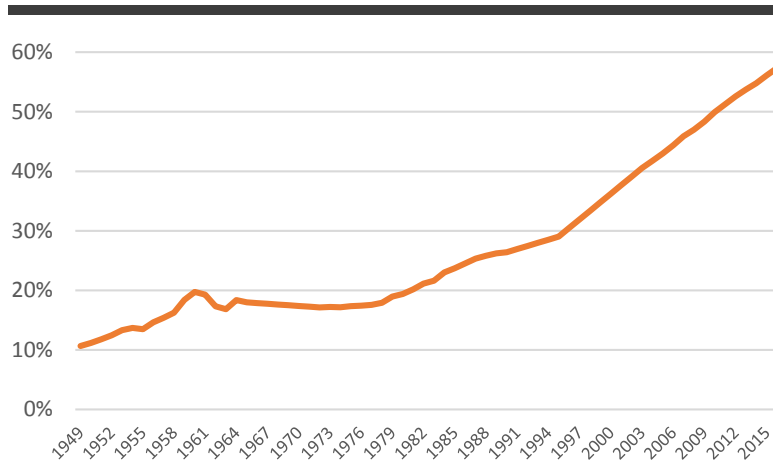
$$\mu_t = \mu_{t-1} + \eta_t$$

where $D_{NG,R,t}$ is natural gas demand, μ_t is the stochastic level, Ψ_{1t} is the short-term cycle to capture the Five-year plans effect, Ψ_{2t} is the medium-term cycle to capture the economic-cycle effect, $\mu_t + \Psi_{1t} + \Psi_{2t}$ is the stochastic cyclical trend, and $\pi_p Price_t + \pi_I Income_t$ is the regression effect.

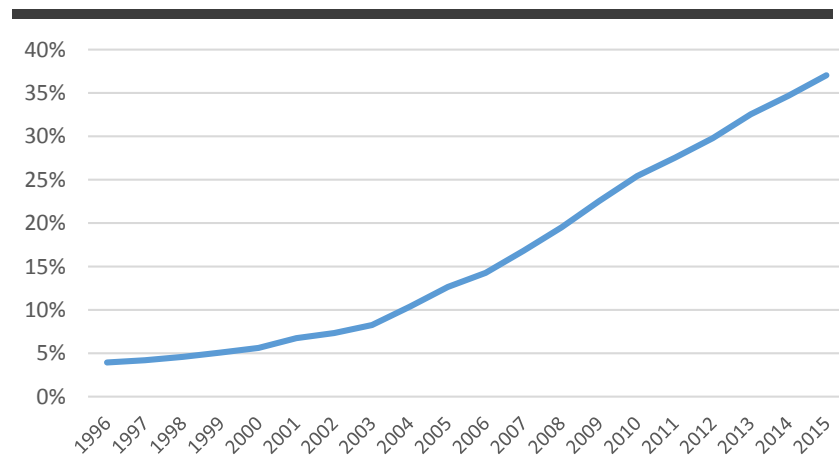
Methodology - Urban China

Residential energy consumption in China ranks second behind the industrial sector, with most consumption occurring in urban residential areas due to the construction of urban pipeline networks

Ratio of Urban Population to Total Population (National)



Ratio of Urban Population with Access to Natural Gas to Total Urban Population (National)



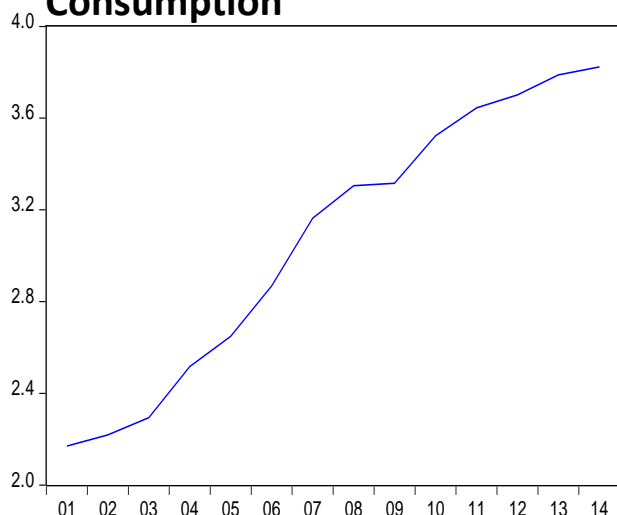
Data - Variables

Using data from CEIC, I:

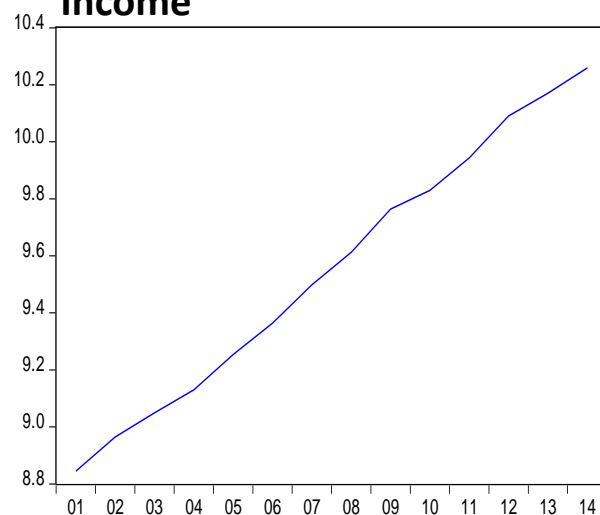
- (a) calculate the ratio of “Natural Gas Consumption: Residential” to the urban population as a measure of per-capita residential consumption of natural gas in urban China;
- (b) use “Disposable Income per Capita: Urban” as a measure for income and deflate it by the urban retail price index; and
- (c) employ “Service Price: 36 City Average: Pipe Natural Gas: for Resident” as the price variable and deflate it by urban consumer price index.

The Figures illustrate the logarithmic level of the three variables. Data that would enable urban and rural demand for natural gas to be separated are unavailable. However, residential demand for natural gas is primarily in urban China.

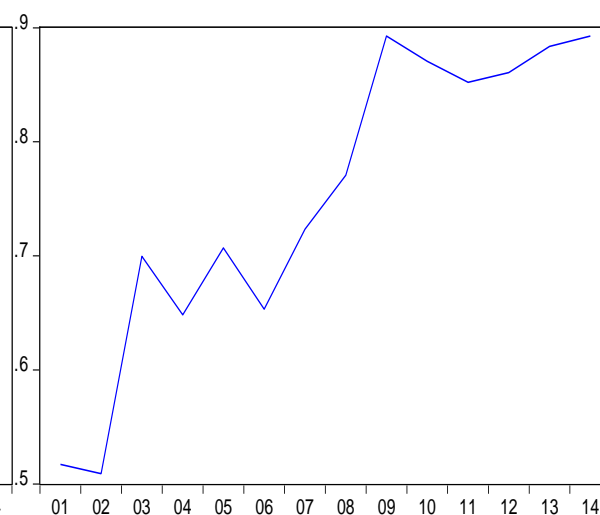
Per-Capita Natural Gas Consumption



Per-Capita Real Disposable Income



Real Price of Natural Gas



Data - Time Sample

- The time sample is 2001 to 2014 due to data availability limitations.
- The time sample ends in 2014 due to data availability issues. Data on the price variable start in 2001, which restricts the time sample.
- However, 2001 is an adequate starting point because:
 - China was not a major natural gas consumer until the early 2000s (Wainberg et al. 2017).
 - Second, according to Chang et al. (2015), trends and cycles in China reflect changes in fundamentals of China's economy and institutional arrangements since the late 1990s. Particularly, changes were triggered in March 1996 when the 8th National People's Congress passed a long-term (15-year) plan to adjust the industrial structure to strengthen heavy industry. The effects of this plan would propagate through the economy with a lag.
 - Furthermore, China joined the World Trade Organization (WTO) in 2001.

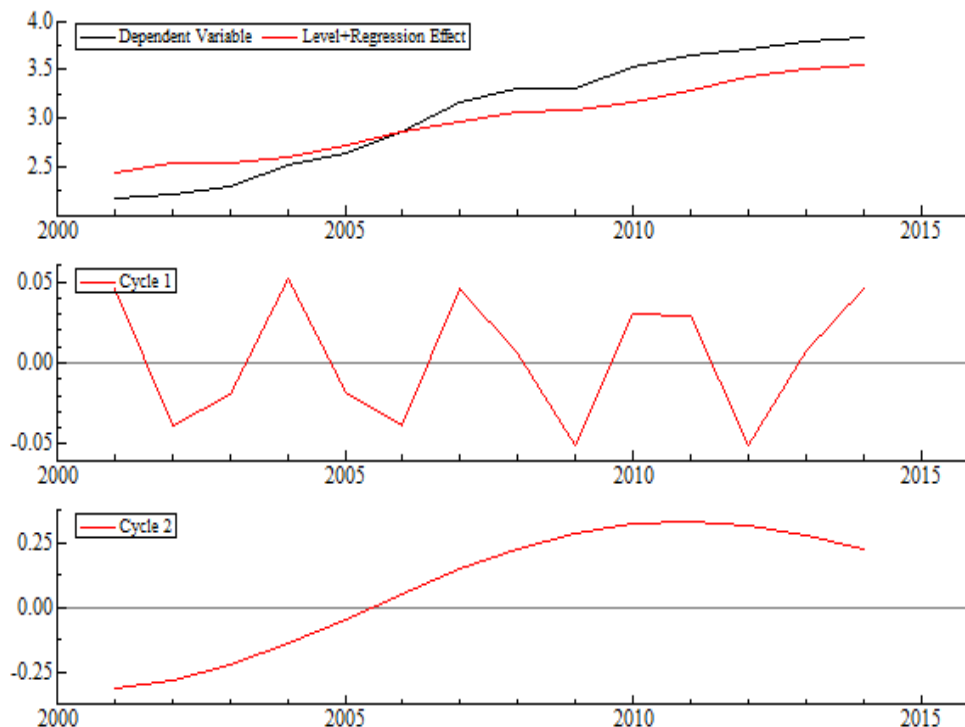
UCM Results

Regression effects in final state at time 2014	Log of real disposable income	Log of real price
Coefficient	0.91959	-0.51631
t-value	3.99592***	-3.01338***

Cycle 1 other parameters	
Variance	0.00163
Period	3.24659
Frequency	1.93532
Damping factor	0.99983
Order	1

Cycle 2 other parameters	
Variance	0.00044
Period	24.02665
Frequency	0.26151
Damping factor	0.93758
Order	2

State vector analysis at period 2014	
Level	-5.41834
Cycle 1 amplitude	0.31276



Results/ Findings

Price and Income Responsiveness

Natural gas is a normal good that is price-sensitive and approximately unit income-elastic, which reveals its substitutability

Natural gas for urban consumers tends to be a comfort good that provides a good quality standard of living, and is neither a necessity nor a luxury good, reflecting the substitutability of natural gas.

- Coal is cheaper, so residents may choose coal over natural gas.
- In urban areas, if infrastructure is available, households opt to use natural gas
- As more infrastructure is built, households shift to using natural gas. For those who already have access to natural gas, as their income increases, natural gas consumption for cooking and water heating increases and/or they move to larger dwellings and consumption for space heating increases accordingly

Dongmei (2017) and Ren (2017)

Results/ Findings

Five-Year-Plan Cycles: Cycle 1

A Five-Year Plan could trigger a longer cyclical swing as with the 8th National People's Congress in 1996, which passed a long-term plan to bolster heavy industry. This Plan was associated with an increase in urbanization and infrastructure development, contributing to natural gas consumption increase.

Three Overlapping Five-Year Cycles

"Temporally misaligned " (Xu 2011).

Example: "A new administration took full charge in March 2003 when the 10th five year plan had been going for two years" (Xu 2011).

National Party's Congress

16th (Oct. 2002 – Oct. 2007), 17th (Oct. 2007 – Nov. 2012) and 18th (Nov. 2012 -)

The National Party's Congress selects party's leaders who assume governmental jobs in the following National People's Congress

National People's Congress

10th (Mar. 2003 – Mar. 2008), 11th (Mar. 2008 – Mar. 2013) and 12th (Mar. 2013 -)

National People's congress lags few months behind the National Party's Congress

Five-Year Plans

10th (2001-2005), 11th (2006-2010) and 12th (2011-2015)

Preparation, Mobilization, Implementation

Implementation stage is less than 5 years + lagged effect on households before a new 5 year plan is announced + Cycles for National Party's Congress, National People's congress and Five year plans overlap

Results/ Findings - Economic Cycle Indicator: Cycle 2

March **1996**: the 8th National People's Congress passed

a long-term plan to bolster heavy industry (Chang et al., 2015)

April **1999**: marks a trough in China's Economic cycle when the

government switched to an expansionary fiscal policy (Yamasawa, 2008)

November **1999**: China- US bilateral trade negotiations, compromise

reached enabling China to WTO (Yamasawa, 2008)

2001: China joins WTO

2012: The 18th National Party's congress concerns about low economic

growth and consumption, and overcapacity of heavy industries with rising debt risk

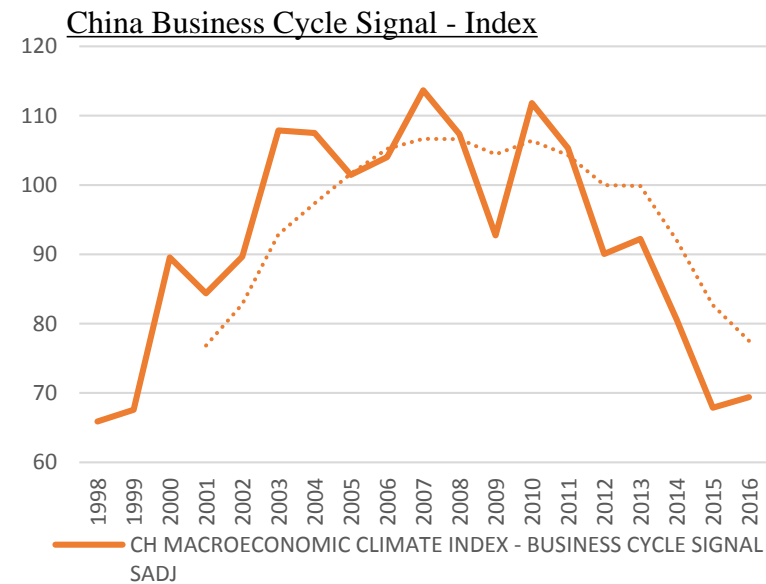
2013: Economic Slowdown in china since 2013 is attributed to

slowdown in investment which has been the engine of growth since 1997 (Chang et al., 2015)

2014 and **2015**: Vanderklippe (2015) and Wainberg et al. (2017) reported a decrease in China's natural gas consumption accompanied by economic slowdown in 2014 and 2015

I find that infrastructure development manifested in the cyclical effect contributed to the rise in demand.

This shows that the model reasonably mimics China's economy and residential demand for natural gas in urban areas. Hence, this derived cycle can be considered a business cycle indicator.



Policy Recommendations

- Natural gas is substitutable, yet preferred when it is accessible to households.
- A message to natural gas exporters is that the market for natural gas in China is still under development. Household demand is increasing and still maturing.
- Knowledge about Five-Year Plans and economic cycles is integral to comprehend China's economy and potential for the natural gas export market.
- Hence,
 - Expansion of infrastructure development will augment income growth effects and support natural gas price reform efforts to increase natural gas demand; that is, both affordability and accessibility of natural gas are important.
 - The government needs to enforce policies to incentivize households to switch to natural gas by increasing the prices of substitutes, particularly coal, and promoting public environmental awareness.
 - A business cycle indicator is a useful measure of the direction of change in demand and infrastructure development, given data limitations in China.

Robustness

Results are robust when:

- The cyclical component is modeled as an AR(2) process
- Relative price of natural gas to coal
- Backward simulation to derive the price variable in an attempt to extend the sample back to 1996
- Broyden-Fletcher-Goldfarb-Shanno (BFGS) method to deal with small sample
- Replacing the cycles with the idiosyncratic shock
- Cycles are removed and the stochastic trend is modelled as a smooth trend (an integrated random walk trend)

The results are robust to all of these variations