The Impact of Climate on Coal Demand in China

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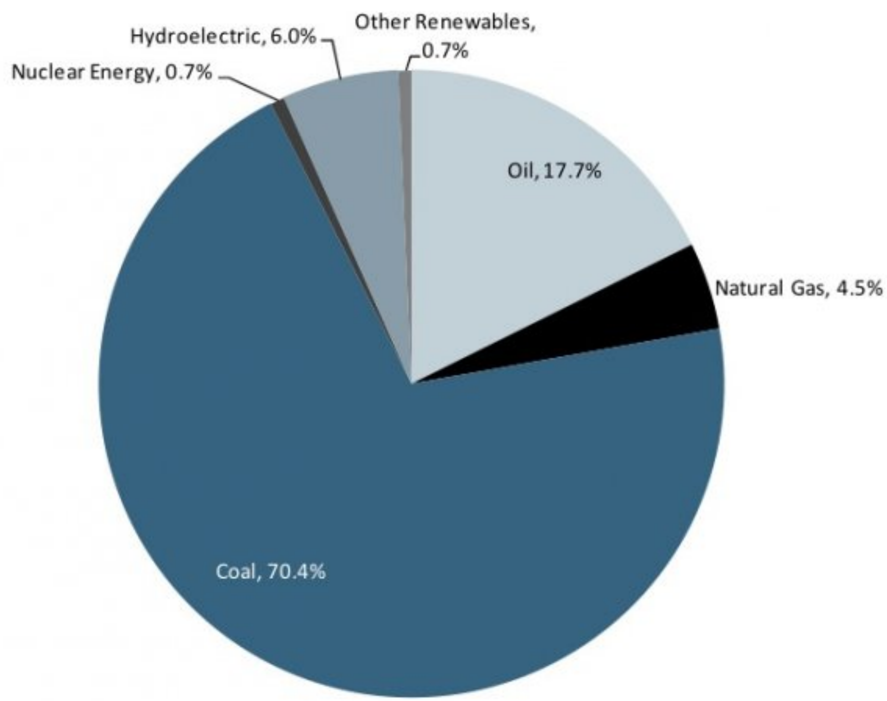
Background

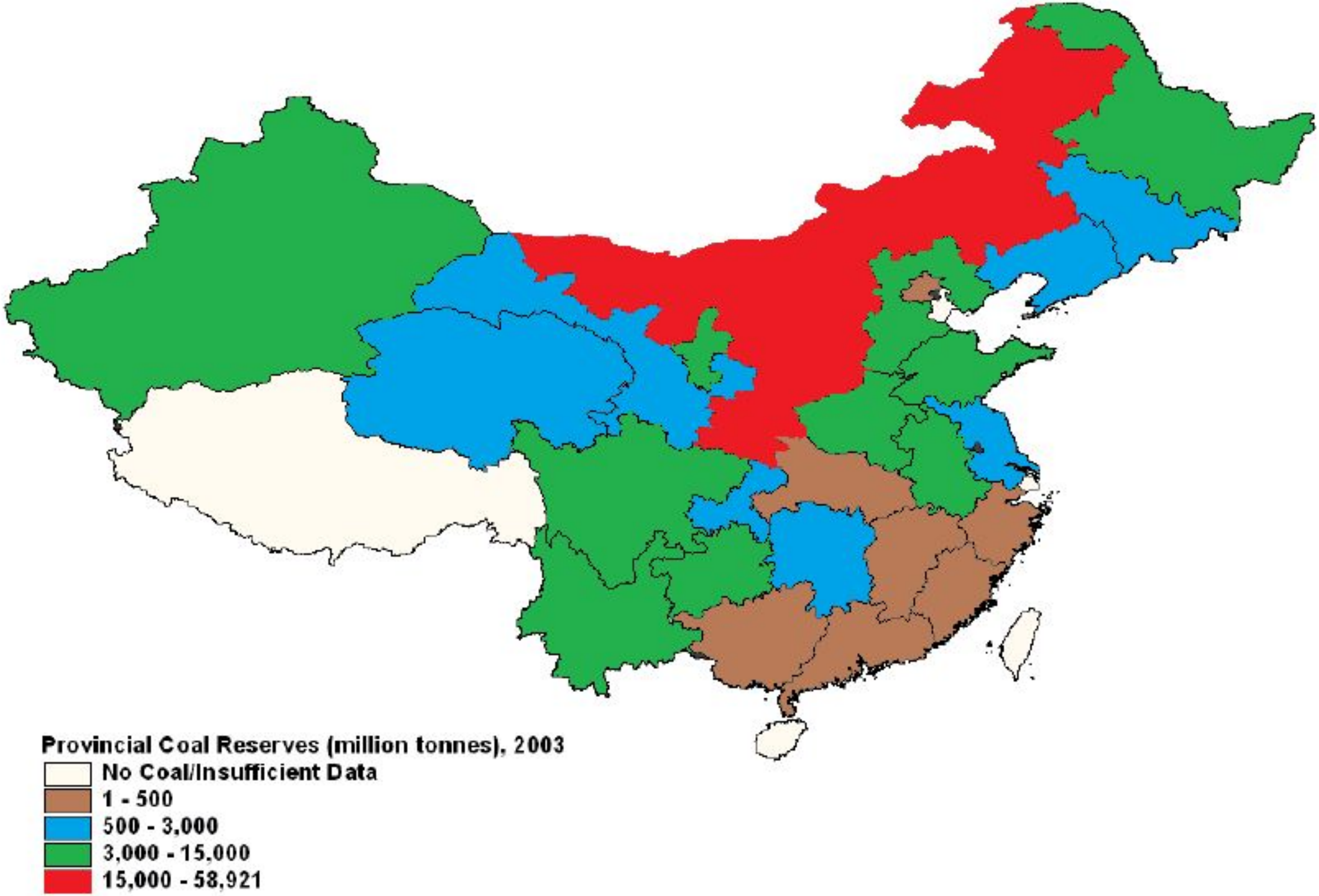
Exhibit 12: China's primary energy consumption by fuel type
Coal is the dominant source



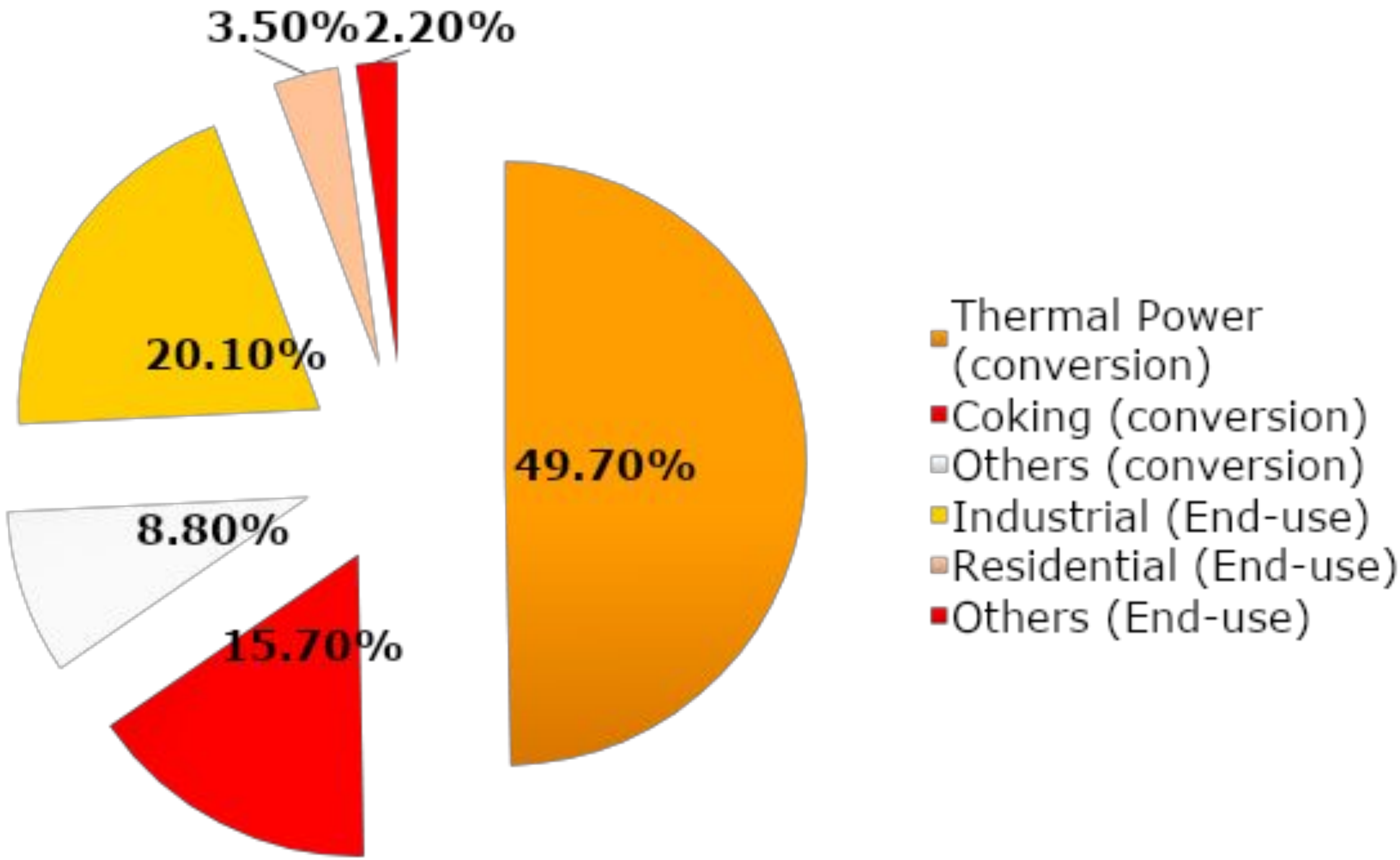
Source: BP Statistical Review of World Energy 2012.

Background Continues

- common calendar in China
  - Lunar New-Year effect Winter effect Summer Effect Spring effect


Provincial Coal Reserves (million tonnes), 2003
No Coal/Insufficient Data
1 - 500
500 - 3,000
3,000 - 15,000
15,000 - 58,921

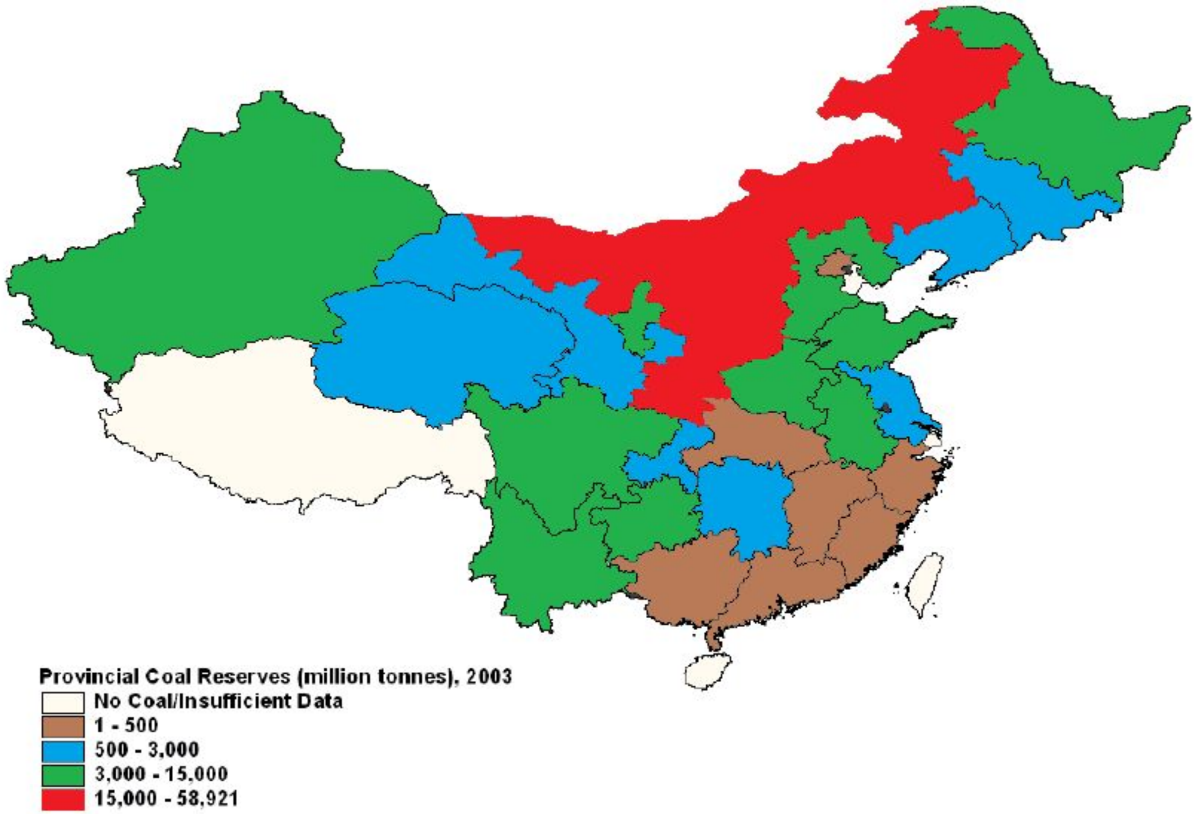
Coal End-use and Inputs to conversion in 2006 (Shares)



Literature Review

- According to BP statistical review of world energy, China has become the biggest coal producer in the world since 1983. (BP statistical review of world energy, 2012. In per capita level, the average annual growth rate of energy consumption was 7.9% between 2001 and 2006, while the average population growth rate was 0.6% in the same period (Chunchun Ni China Energy Primer, 2010), which means the population growth was not the main reason to Chinese rapidly increasing primary energy consumption

Theoretical Background



- Girardin and Herrerias (2011) investigated Chinese coal production at the provincial level.

Objective

- Estimate the impact that temperature and seasonality patterns have on China's coal demand at the provincial-level

Theoretical Background

- Consumer's optimal choice was computed s.t. a consumer's utility subject to the budget constraint

- If we work with a generic utility function (we do not know its mathematical formula), then we express the demand function as:

- $y^* = y(p_x, p_y, I)$

Theoretical Background

- We will keep assuming that prices and income is exogenous, that is:

Theoretical Background

- Demand is Homogeneous of Degree Zero (e.g. If we were to double all prices and income, the optimal quantities demanded will not change).

Theoretical Background

- Variables:

- Dependent:
  Coal consumption

- Independent:
  GDP, population, supply of natural gas, consumption of steel, net export, price of coal, time trend, temperature seasonality

Theoretical Background

- Coal consumption, GDP, population, quantity of natural gas, consumption of steel, net export, price of coal, time trend, temperature seasonality

Model & Data

- Panel Data—150 Observations
  - 25 provinces
  - 6 years from 2001 – 2006

Model & Data

- Dependent Variable
  - Coal Consumption, Million ton

- Climatic Independent Variables
  - Mean temperature
  - Capital of Province
  - Jan, April, July, Oct

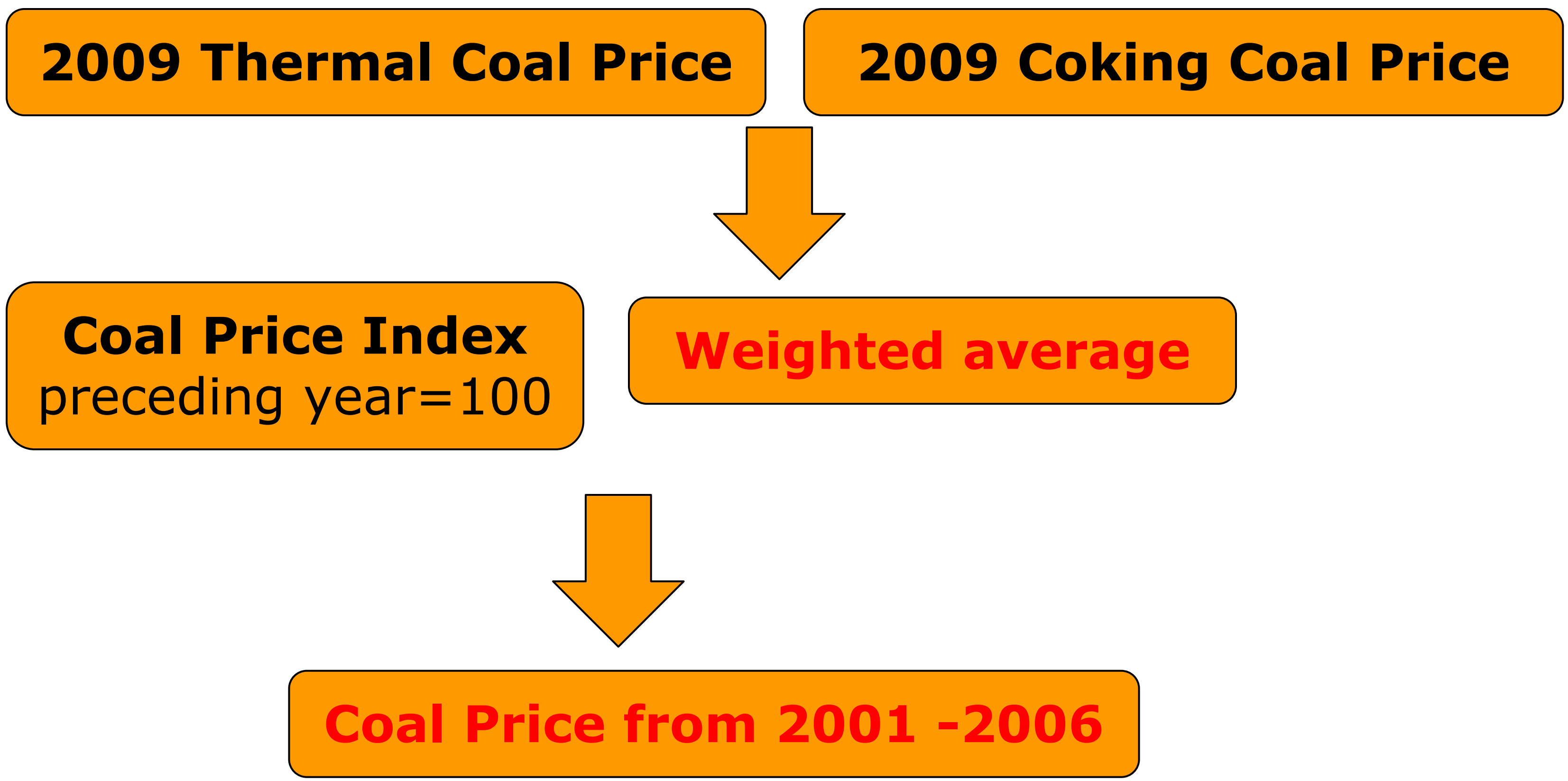
Model & Data

- Independent Variables
  - GDP, Billion yuan, 2000
  - Population, Million
  - Price, yuan per ton, 2000
  - Net export, Million ton
  - Natural gas pipe length, kilometer
  - Crude steel production, Ten thousand ton
  - 5 Yearly dummy
- China Energy Databook
- Chinese National Bureau of Statistics

Model & Data

- Coal Price in 2009
  - 2009 Thermal Coal Price
  - 2009 Coking Coal Price
- Weighted average
- Coal Price Index from 2001 to 2009
  - Base year is preceding year (preceding year=100)

Model & Data


2009 Thermal Coal Price
2009 Coking Coal Price
Coal Price Index
preceding year=100
Weighted average
Coal Price from 2001 -2006

Data Analysis

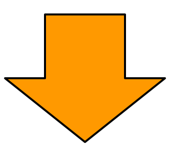
- Pooled OLS
  - BP test heteroskedasticity
  - VIF test multicollinearity
- Robust model & FGLS

Independent variables	Coefficient	t
Jan temperature	-0.607***	-4.91
April temperature	0.448*	1.67
July temperature	0.191	0.66
Oct temperature	-0.643***	-2.67
GDP	0.039***	4.07
population	0.629***	5.73
Crude Steel	0.015***	7.39
Natural gas pipe length	-0.001	-1.48
y02	1.182	0.56
y03	3.201	1.30
y04	7.098**	2.17
y05	10.896**	2.50
y06	16.490***	3.61
NetExport	0.044	0.87
Realprice	0.032	1.17
constant	7.732	0.35

***, **, ***,Statistically significant at the 10%, 5%, 1% level, respectively**

Data Analysis

- Fixed Effect
- Random Effect
- Hausman Test
  - Insignificant at 5% level
- Breusch-Pagan Lagrange Multiplier(LM)
  - Random Effect vs. Pooled OLS



Random Effect Model

Model

- Theoretical Model:
- $CoalConsumption = b_0 + b_1 P_{coal} + b_2 P_{sub} + b_3 GDP + b_4 Pop + b_5 Temp$
- Model: total coal consumption at each province is dependent on four temperature variables, six non-temperature variables and five yearly dummy variables as explanatory variables:
- $CoalConsumption_{it} = \beta_0 + \sum_{m=1}^{4} \beta_m temp_{itm} + \sum_{n=1}^{6} \beta_n nontemp_{itn} + \sum_{k=1}^{5} \beta_k Y_{tk} + u_{it}$

Independent variable	Coefficient	t
Jan temperature	-0.841**	-2.41
April temperature	1.208**	2.01
July temperature	-0.395	-0.60
Oct temperature	-0.845	-1.29
GDP	0.065***	4.85
population	0.456**	2.26
Crude Steel	0.015***	7.26
Natural gas pipe length	-0.001	-0.86
Net Export	0.170***	4.14
Real price	0.041	0.88
y02	1.409	0.27
y03	3.420	0.67
y04	2.700	0.43
y05	9.059**	1.23
y06	15.154***	2.04
constant	26.004	0.56

***, **, ***,Statistically significant at the 10%, 5%, 1% level, respectively**

Result Analysis

- Overall R-square: 0.84
- F-test Temperature Variables
  - Joint Significant
- Positive Price
  - Inelastic Coal Demand
  - Output price ↑ → Coal (Input factor) Price ↑
  - Coal Price is not exogenous
    - Consumption ↑ → Price ↑

Implications for Greenhouse Warming

- CO_2 doubling scenario (Intergovernmental Panel on Climate Change, 2007)
  - 5° F increase in global mean temperature

	Coal Consumption(MT)
Spring	151.02
Summer	-49.39
Autumn	- 105.60
Winter	-105.14
Overal	**-109.11**

Conclusion

- Higher temperature in **Autumn** and **Winter** will decrease Coal Consumption
- Higher temperature in **Spring** will increase coal consumption
- The total coal consumption will decrease as temperature increases
  - 5° F increase → 109.11 MT Coal Consumption decrease
- The coal exporting provinces have higher coal consumption

Future Research

- Better estimation of climatic variables
- Separate total coal consumption
  - Industry coal
  - Non-industry coal
- Spatial Economics
  - Coal Reserve
  - Coal Production
  - Other substitute resource
    - Hydro Electricity
    - Wind Power

QUESTIONS