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# **Electricity consumption and economic growth in China: assessing Granger causality at provincial, electricity- market, and national levels**

Aleksis Xenophon

The University of Adelaide

Contributed presentation at the 60th AARES Annual Conference,  
Canberra, ACT, 2-5 February 2016

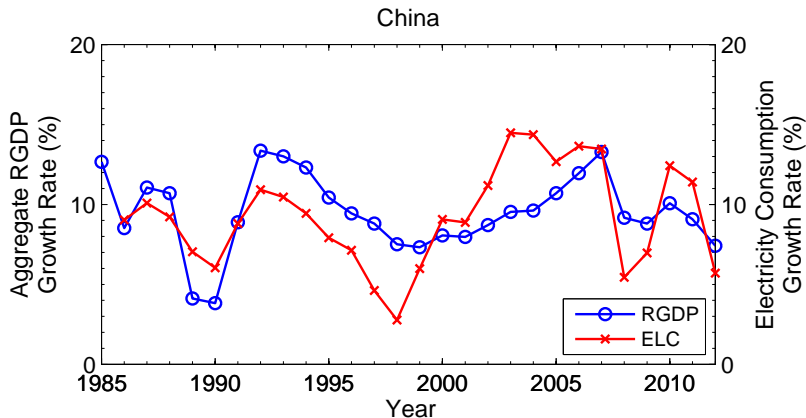
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# Electricity consumption and economic growth in China: assessing Granger causality at provincial, electricity-market, and national levels

Aleksis Xenophon

The University of Adelaide

# Which comes first?



# Why?

- ▶ Role of electricity consumption in economic development
- ▶ Planning infrastructure
- ▶ Nationwide carbon trading scheme - 2017

# Most studies look at China as a whole



# Electricity markets in China



# No consensus in the literature

Study	Direction of Granger causality
Shiu & Lam (2004)	$ELC \Rightarrow RGDP$
Boqiang (2003)	$RGDP \Rightarrow ELC$
Chen et al. (2007)	$RGDP \nRightarrow ELC$

Table 1 : Previous studies

# Data

- ▶ Chinese Statistical Yearbooks
- ▶ Electricity consumption and real gross regional product for 28 provinces
  - ▶ Excluded: Hainan and Tibet
  - ▶ Aggregated: Chongqing and Sichuan

# Vector error correction model (VECM)

ELC = Log Electricity Consumption

RGRP = Log Real Gross Regional Product

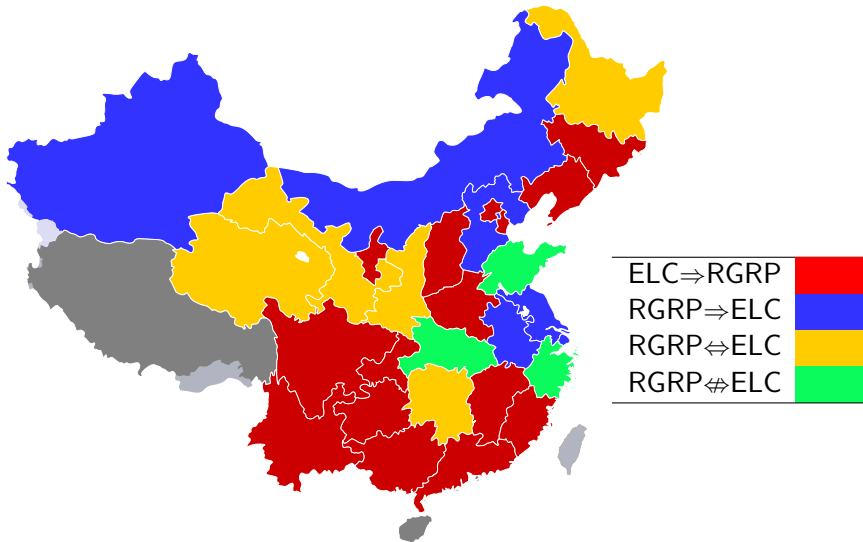
$$RGRP_t = \beta_0 + \beta_1 ELC_t + \mu_t$$

$$\Delta ELC_t = \alpha_1 + \alpha_x \mu_{t-1} + \sum_{i=1} \alpha_{11}(i) \Delta RGRP_{t-i} + \sum_{i=1} \alpha_{12}(i) \Delta ELC_{t-i} + \epsilon_{xt}$$

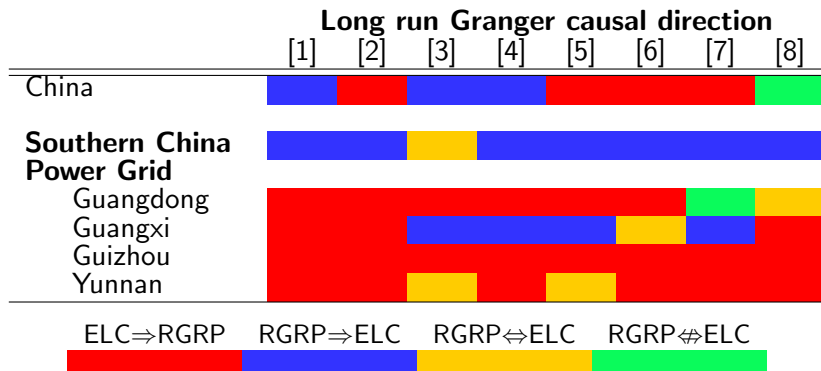
$$\Delta RGRP_t = \alpha_2 + \alpha_y \mu_{t-1} + \sum_{i=1} \alpha_{21}(i) \Delta RGRP_{t-i} + \sum_{i=1} \alpha_{22}(i) \Delta ELC_{t-i} + \epsilon_{yt}$$

Shiu and Lam (2004)

# Long run Granger causality map



# Aggregation and robustness



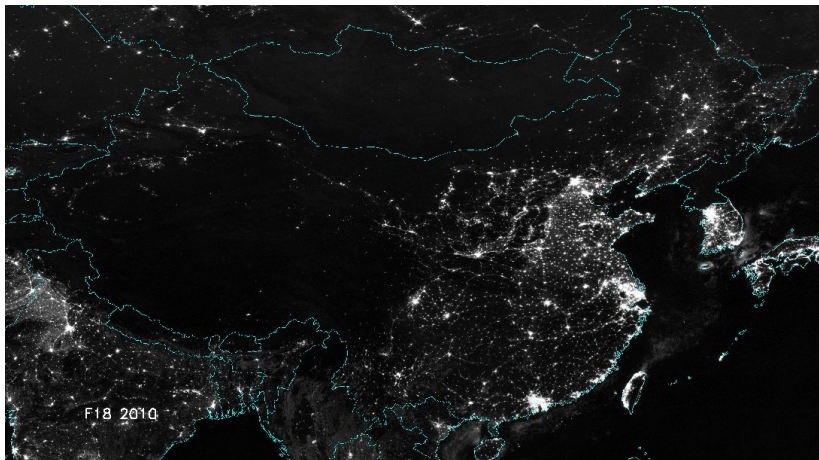
## Model number and sample period key

[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
1985-2012	1985-06	1986-07	1987-08	1988-09	1989-10	1990-11	1991-12

# Conclusions

- ▶ Regional clustering
- ▶ Limitations of highly aggregated data
- ▶ Case study for further analysis

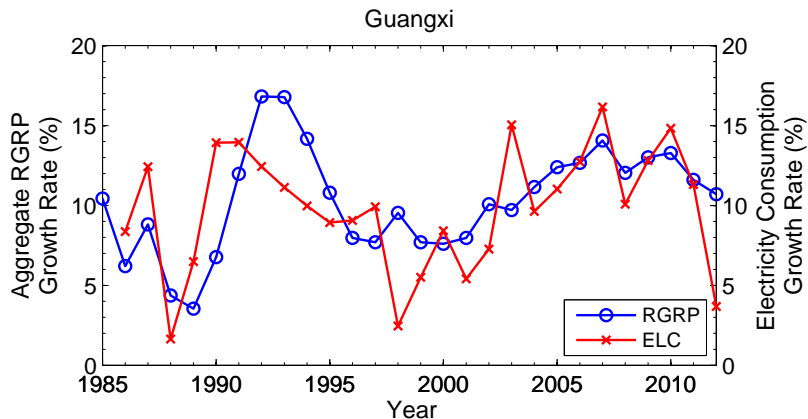
# Questions



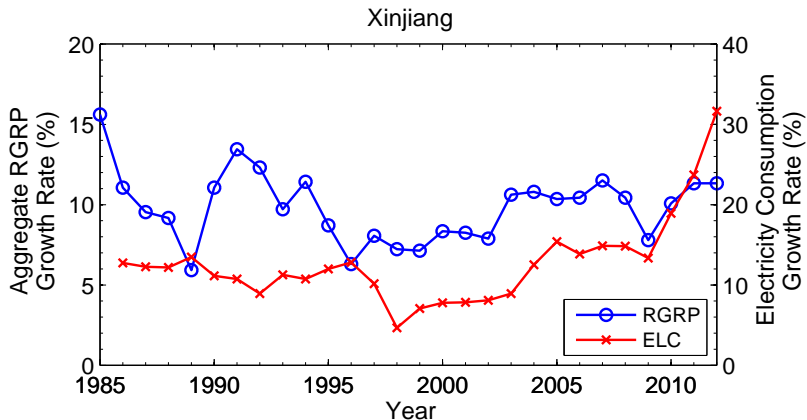
# References

- Boqiang, L. (2003), 'Structural changes, efficiency improvement and electricity demand forecasting', *Economic Research Journal* **5**, 57–65.
- Chen, S.-T., Kuo, H.-I. and Chen, C.-C. (2007), 'The relationship between GDP and electricity consumption in 10 Asian countries', *Energy Policy* **35**(4), 2611–2621.
- Shiu, A. and Lam, P.-L. (2004), 'Electricity consumption and economic growth in China', *Energy Policy* **32**(1), 47–54.

# Co-movement



# No co-movement



# National level data

	Dependent variable	
	$\Delta\text{RGDP}$	$\Delta\text{ELC}$
Constant	0.044 (0.209)	-0.006 (0.894)
$\text{ECT}_{t-1}$	0.033 (0.597)	0.228*** (0.008)
$\Delta\text{RGDP}$		
L1	0.895*** (0.001)	-0.516 (0.181)
L2	-0.891*** (0.006)	0.007 (0.987)
L3	0.034 (0.910)	-0.812** (0.048)
$\Delta\text{ELC}$		
L1	-0.076 (0.652)	1.03*** (0.000)
L2	0.162 (0.478)	-0.682** (0.030)
L3	0.214 (0.288)	0.973*** (0.000)

P-values in parentheses

# Signs

$$RGRP_t = \beta_0 + \beta_1 ELC_t + \mu_t$$

$$\mu_t = RGRP_t - \beta_0 - \beta_1 ELC_t$$

$$\mu_t > 0 \text{ if } RGRP_t > \beta_0 + \beta_1 ELC_t$$

Restore  $\mu_t$  to 0 by  $\downarrow RGRP_t$  OR  $\uparrow ELC_t$

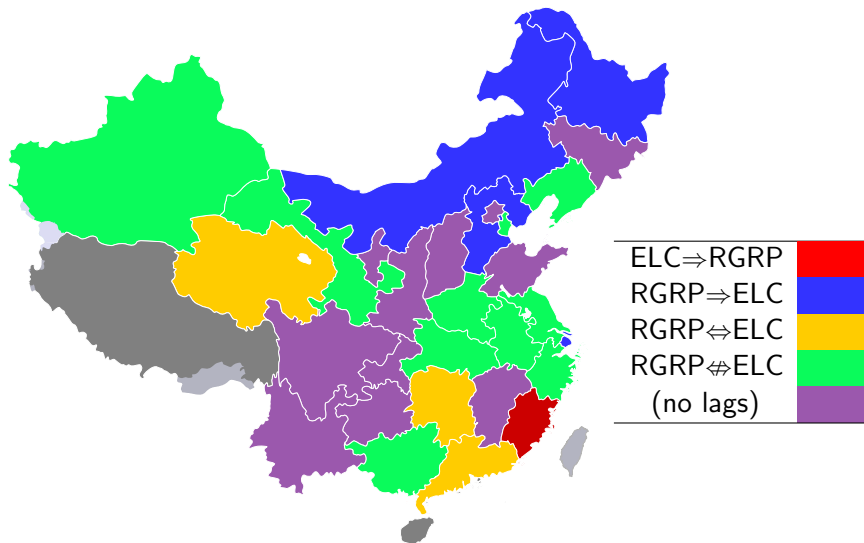
$$\Delta RGRP_t = \beta_0 + \beta_1 \mu_{t-1} + \dots$$

►  $(-)\beta_1 \Rightarrow \downarrow \Delta RGRP_t$  helps restore equilibrium

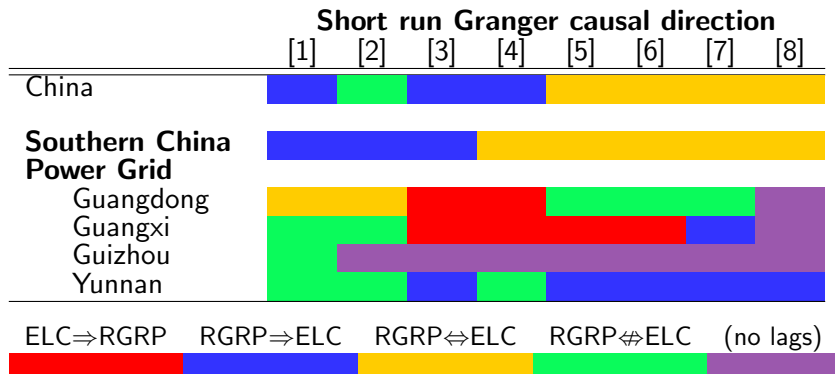
$$\Delta ELC_t = \beta_0 + \beta_1 \mu_{t-1} + \dots$$

►  $(+)\beta_1 \Rightarrow \uparrow \Delta ELC_t$  helps restore equilibrium

# Short run Granger causality map



# Aggregation and robustness



## Model number and sample period key

[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
1985-2012	1985-06	1986-07	1987-08	1988-09	1989-10	1990-11	1991-12

# Procedure

- 1 Calculate optimal lag-length in underlying VAR (SBIC)
- 2 Check for stationarity (ADF Test)
- 3 Check for co-integration (Johansen Test)
- 4 Apply VECM
- 5 Check for serial correlation (LM Test)