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Energy and Economic Growth: A State-Level Analysis

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Energy & Economic Growth in California, Oregon, & Washington

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Literature

- Kraft & Kraft (1978) “On the relationship between energy and GNP”
- Stern (2000) “A multivariate cointegration analysis of the role of energy in the US macroeconomy”
- Zachariadis (2007) “Exploring the relationship between energy use and economic growth with bivariate models: New evidence from G-7 countries”
- Metcalf (2008) “An empirical analysis of energy intensity and its determinants at the state level”
- Payne (2009) “On the dynamics of energy consumption and employment in Illinois”

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Hypothesis	Direction of Granger Causality
Growth	Energy Consumption → Economic Growth
Conservation	Economic Growth → Energy Consumption
Feedback	Energy Consumption ↔ Economic Growth
Neutrality	None

Econometric Literature

- Granger (1969) “Investigating causal relations by econometric models and cross-spectral methods”
- Johansen (1991) “Estimation and hypothesis testing of cointegration vectors in Gaussian vector autoregressive models”
- Johansen (1995) “Likelihood-based inference in cointegrated vector autoregressive models”

Data: 1970 - 2009

- Gross State Product (GSP)
  - Source: BEA; Million 2000 Dollars
- Manufacturing Employment (Mfg)
  - BEA; Total employment in sector
- Energy Consumption (E_Con)
  - Source: EIA; Billion BTU
- Price of Energy (E_Price)
  - EIA; Real price per billion BTU
- Input Energy Price (Prim)
  - EIA; Real price per billion BTU of primary energy

Methodology

- Cointegration Analysis
- Supply & Demand Framework
- $Q_D = \beta_o + \beta_1 P_E + \beta' X$
- $Q_S = \alpha_o + \alpha_1 P_E + \alpha' Y$
- Vector Error Correction Model (VECM)

$$\Delta y_t = \alpha_i + \delta_j CE_{j,t-1} + \sum_{l=1}^{p} \Gamma_l \Delta y_{t-l} + \varepsilon_{i,t}$$

VECM: GSP Equation

$$\Delta GSP_t =$$

$$\alpha_1 + \delta_1(GSP_{t-1} - \beta_1 E\_Con_{t-1} - \beta_2 E\_Price_{t-1} - \beta_3 Mfg_{t-1} + c)$$

$$+ \delta_2(Prim_{t-1} - \beta_4 E\_Price_{t-1} - \beta_5 E\_Con_{t-1} + \beta_6 Mfg_{t-1} + d)$$

$$+ \gamma_1 \Delta GSP_{t-1} + \gamma_2 \Delta E\_Con_{t-1} + \ldots\ldots \gamma_5 \Delta Mfg_{t-1} + \varepsilon_{1,t}$$

Estimated speed of adjustment parameters

State	LHS Variable	CE_D		CE_S	
CA	GSP	-0.120244	**	-	
	Mfg	-0.300279	***	-0.221944	**
	E_Price	0.803567	*	-	
OR	E_Con	0.162217	***	-	
WA	GSP	-		-0.102101	**
	E_Con	0.123007	**	-	
	Mfg	-		-0.175330	***

Wald *F*-Tests
GSP LHS Variable

	CE_D & Δ(E_Price)		CE_D & Δ(E_Con)		CE_D & Δ(Mfg)	
State						
CA	4.7209	*	0.0296		8.2750	**
	[0.0944]		[0.8634]		[0.016]	
OR	1.7473		1.0194		0.9616	
	[0.4174]		[0.6007]		[0.6183]	
WA	4.2557		2.3215		2.1440	
	[0.1191]		[0.3133]		[0.3423]	

Wald *F*-Tests
GSP LHS Variable

	CE_S & Δ(Prim)		CE_S & Δ(E_Price)		CE_S & Δ(E_Con)	
State						
CA	0.7467		1.7513		1.0935	
	[0.3875]		[0.4166]		[0.5788]	
OR	1.5653		3.2165		1.2535	
	[0.4572]		[0.2002]		[0.5343]	
WA	4.9096	*	5.9193	*	4.7049	*
	[0.0859]		[0.0518]		[0.0951]	

Conclusion

- Supply & demand framework
- Important state-level differences found
- Future work