



# Report Summary: The Effects of Energy Prices on State GDP and Employment

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# Two Main Contributions

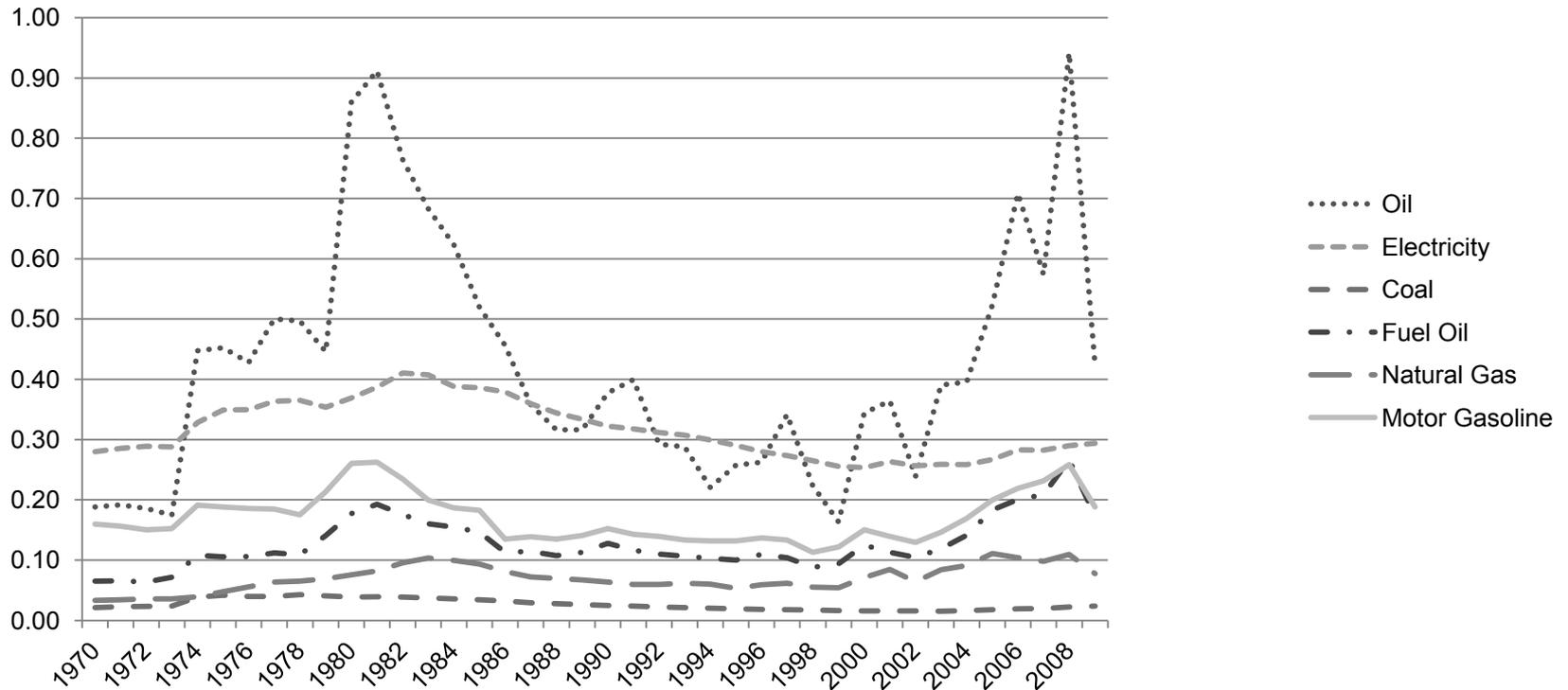
- Estimates of the relationship between energy consumption and the prices for energy sources, i.e., a demand study, with particular focus on electricity.
  - We confirm many of the findings in the literature and provide more details in some respects.
- Estimates of the relationship between economic outcomes – state GDP and state employment – and energy prices.
  - These are especially informative and unique findings.
- This presentation focuses on the latter.

# Basic Data Utilized

- Larger variations in energy prices over time; considerable variation across states.
- Data set of annual energy prices over time and across states; annual economic outcomes for states: real GDP growth, real GDP level, employment growth, employment level.

# Energy Price Variation Over Time

Average Annual U.S. Energy Prices, dollars per million BTU, 2010\$



# Basic Empirical Approach

- Estimate effects of electricity prices (and other energy prices) on: state GDP growth, state GDP level, state employment growth, state employment level.
- We use the partial adjustment model. This assumes that the change for each state reflects moving part of the way to the long run value.

# Basic Approach – cont'd

- $Y_{it}$  = value for state  $i$ , time  $t$
- $Y^*$  = long run value that state moves toward
- $Y_{it} - Y_{it-1} = \lambda(Y^* - Y_{it-1})$ ,  $i$ = state,  $t$ =time
- If  $\lambda=1$ , instant movement to  $Y^*$ . If  $\lambda=0$ , no movement.

# Basic Approach – cont'd.

- $Y_{it} - Y_{it-1} = \lambda(Y^* - Y_{it-1})$
- Solving for  $Y_{it}$ :
- $Y_{it} = (1-\lambda)Y_{it-1} + \lambda Y^*$

Let  $Y^* = \beta X_{it}$ , where  $X_{it}$  are energy prices.

- $Y_{it} = (1-\lambda)Y_{it-1} + \lambda\beta X_{it} = \delta_1 Y_{it-1} + \delta_2 X_{it}$
- Modify by including lagged value of prices:

$$Y_{it} = \delta_1 Y_{it-1} + \delta_2 X_{it} + \delta_3 X_{it-1}$$

- And include state and time dummies:

$$Y_{it} = \delta_1 Y_{it-1} + \delta_2 X_{it} + \delta_3 X_{it-1} + \sum \theta_i s_i + \sum \mu_t T_t$$

# Comments on This Approach

$$Y_{it} = \delta_1 Y_{it-1} + \delta_2 X_{it} + \delta_3 X_{it-1} + \sum \theta_i s_i + \sum \mu_t T_t$$

- “Agnostic” approach. We do not specify a regulatory/political environment, but allow state and time dummies to capture them, as well as other time/state specific influences.
- Using annual, cross-state data, 1970-2010 that captures wide swings in prices over time as well as variations across states.
- Prices are viewed as affecting state GDP and employment, but no reverse causation for each state.
- Differs from Vector Auto-Regression approach.

# Some Estimates

Table 5: Growth in State GDP

Variables	(1)	(2)	(3)
	Baseline	KY Interaction	Group Interaction
GDP Growth (t-1)	0.285*** (0.0549)	0.285*** (0.0549)	0.280*** (0.0540)
Oil price	-0.0192*** (0.00361)	-0.0192*** (0.00365)	-0.0196*** (0.00349)
Oil Price (Interaction)		-0.000305 (0.00387)	0.000667 (0.00727)
Natural Gas Price	-0.0132*** (0.00483)	-0.0131*** (0.00485)	-0.00996** (0.00456)
Natural Gas price (Interaction)		-0.00276 (0.00431)	-0.00800 (0.00730)
Electricity Price	-0.0130** (0.00565)	-0.0129** (0.00573)	-0.00652 (0.00635)
Electricity Price (Interaction)		-0.000426 (0.00612)	-0.0134 (0.0114)

# “Similar States” Group

Table 3: Energy Intensive States

States	(1) % of Electricity generate from Coal	(2) Electricity Consumption (bil BTU) per Dollar of Real Gross State product
Alabama	62.31%	1.94
Arkansas	55.08%	1.65
Arizona	46.09%	1.02
Georgia	64.65%	1.09
Iowa	84.41%	1.13
Indiana	95.07%	1.33
Kansas	72.53%	1.13
<b>Kentucky</b>	<b>96.84%</b>	<b>1.87</b>
Missouri	82.13%	1.08
Montana	61.25%	1.82
North Carolina	62.10%	1.15
North Dakota	92.84%	1.39
Nebraska	63.41%	1.15
New Mexico	85.43%	1.01
Nevada	53.35%	0.99
Ohio	86.92%	1.17
Oklahoma	64.17%	1.46
Tennessee	64.92%	1.45
Virginia	51.51%	1.00
Wisconsin	70.93%	0.99
West Virginia	98.21%	1.80
Wyoming	95.78%	1.95

# Estimates – cont'd.

Table 6: Total State GDP

Variables	(1) Baseline	(2) KY Interaction	(3) Group Interaction
GDP Level (t-1)	0.965*** (0.00644)	0.965*** (0.00649)	0.965*** (0.00705)
Oil price	-0.0141*** (0.00507)	-0.0140*** (0.00514)	-0.0172*** (0.00431)
Oil Price (Interaction)		-0.00204 (0.00596)	0.00599 (0.0104)
Natural Gas Price	-0.0200*** (0.00689)	-0.0197*** (0.00691)	-0.0112* (0.00606)
Natural Gas price (Interaction)		-0.0128** (0.00577)	-0.0174* (0.0103)
Electricity Price	-0.0166* (0.00948)	-0.0164* (0.00962)	-0.0102 (0.00980)
Electricity Price (Interaction)		0.00815 (0.00852)	-0.0128 (0.0149)

# Estimates – cont'd.

Table 7: Employment Growth

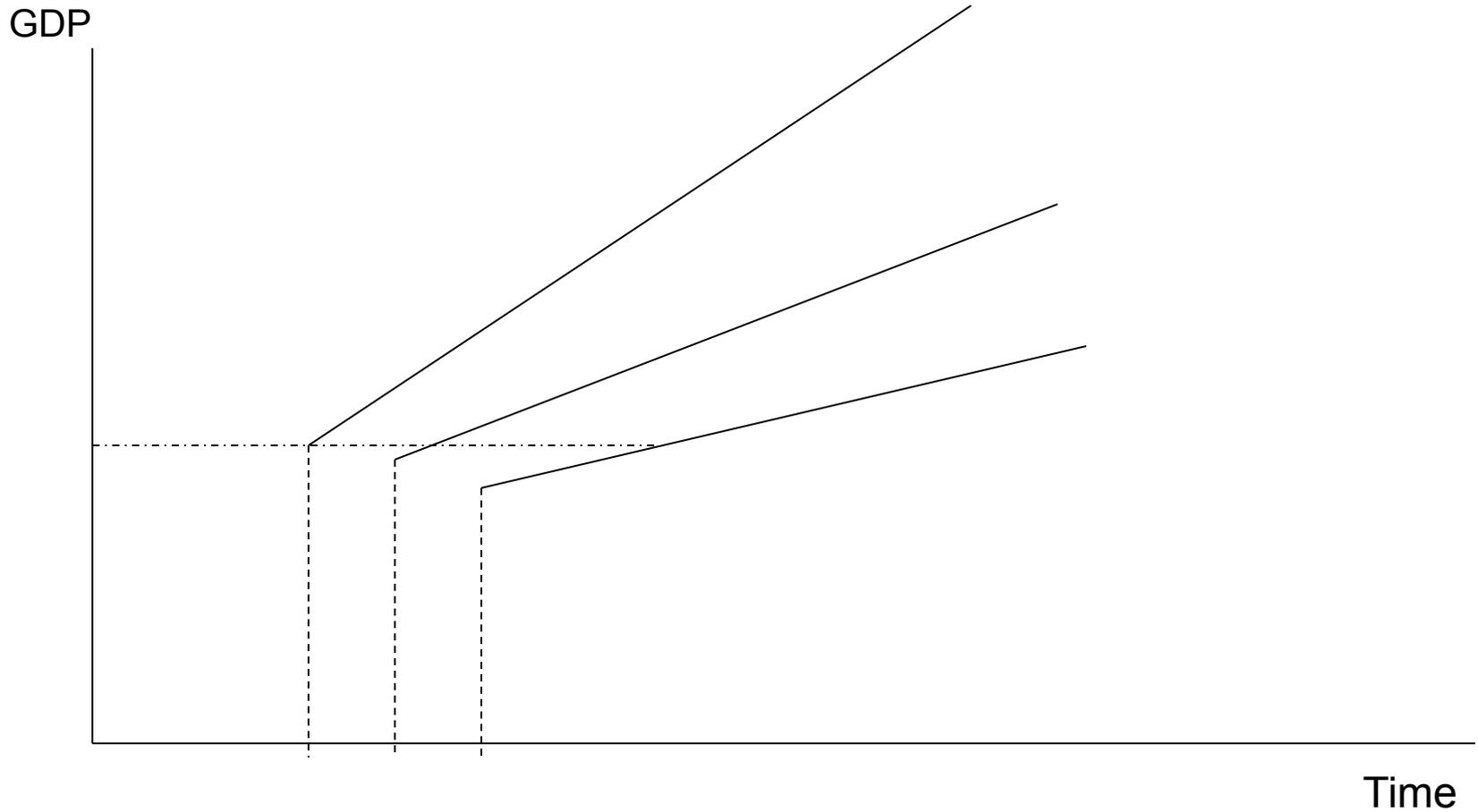
Variables	(1)	(2)	(3)
	Baseline	KY Interaction	Group Interaction
Employment Growth (t-1)	0.609*** (0.0178)	0.608*** (0.0179)	0.607*** (0.0178)
Oil price	-0.00668*** (0.00145)	-0.00655*** (0.00147)	-0.00579*** (0.00156)
Oil Price (Interaction)		-0.00832*** (0.00165)	-0.00180 (0.00300)
Natural Gas Price	-0.00621*** (0.00201)	-0.00625*** (0.00204)	-0.00665*** (0.00233)
Natural Gas price (Interaction)		0.00506*** (0.00184)	0.000154 (0.00378)
Electricity Price	-0.00678*** (0.00232)	-0.00698*** (0.00237)	-0.00527** (0.00243)
Electricity Price (Interaction)		0.0102*** (0.00234)	-0.00319 (0.00454)

# Estimates – cont'd.

Table 8: Total Employment

Variables	(1)	(2)	(3)
	Baseline	KY Interaction	Group Interaction
Employment Growth (t-1)	0.968*** (0.00498)	0.968*** (0.00497)	0.968*** (0.00522)
Oil price	-0.00715*** (0.00233)	-0.00688*** (0.00237)	-0.00696*** (0.00252)
Oil Price (Interaction)		-0.0157*** (0.00309)	-0.000503 (0.00546)
Natural Gas Price	-0.0109*** (0.00382)	-0.0109*** (0.00385)	-0.00873* (0.00441)
Natural Gas price (Interaction)		0.00433 (0.00370)	-0.00500 (0.00672)
Electricity Price	-0.0141*** (0.00523)	-0.0141** (0.00533)	-0.0103* (0.00559)
Electricity Price (Interaction)		0.0139*** (0.00441)	-0.00772 (0.00802)

# Illustrating the Idea of the Simulations



# Some Assumptions Regarding the Simulations

- The simulations consider a one-time shock and permanent shock in energy prices.
- The scenarios assume that the electricity price shock is not accompanied by any other changes such as technological advances. Therefore, our scenarios should be treated as simulations of future conditions under the status quo (except for the shock) rather than forecasts or estimates of future growth.
- Naturally, the simulations rely on the validity of the underlying econometric model.
- The simulations are based on estimates that have a “margin of error” associated with them.

# GDP Growth (relative to 3%)

10% Price Incr.	Overall	Kentucky	Similar States	
Short Run	2.878	2.619	2.796	
Long Run	2.830	2.470	2.718	
	Overall	Kentucky	Similar States	3% Growth
5 years	1.149136	1.129084675	1.139761263	1.159274
10 years	1.320513	1.274832204	1.299055736	1.343916
20 years	1.743754	1.625197149	1.687545806	1.806111

Simulations are based on model with contemporaneous and lagged prices.



# GDP Growth (relative to 3%)

25% Price Incr.	Overall	Kentucky	Similar States	
Short Run	2.695	2.047	2.4905	
Long Run	2.575	1.675	2.296	
	Overall	Kentucky	Similar States	3% Growth
5 years	1.134061	1.084982916	1.110985531	1.159274
10 years	1.286095	1.177187928	1.234288851	1.343916
20 years	1.654039	1.385771418	1.523468968	1.806111

Simulations are based on model with contemporaneous and lagged prices.

# GDP Level

<b>10% Price Incr.</b>	<b>Overall</b>	<b>Kentucky</b>	<b>Similar States</b>
Short Run	-0.173%	-0.31%	-0.27%
Long Run	-4.94%	-8.85%	-7.93%

Simulations are based on model with contemporaneous and lagged prices.



# Employment Growth (relative to 1% growth)

10% Price Incr.	Overall	Kentucky	Similar States	
Short Run	0.957	0.9815	0.9376	
Long Run	0.8905	0.9530	0.8424	
	Overall	Kentucky	Similar States	1.0% Growth
5 years	1.0453	1.0484	1.0427	1.0510
10 years	1.0927	1.0992	1.0872	1.1046
20 years	1.2480	1.2667	1.2326	1.2824

Simulations are based on model with contemporaneous and lagged prices.



# Employment Growth (relative to 1% growth)

25% Price Incr.	Overall	Kentucky	Similar States	
Short Run	0.8925	0.9537	0.844	
Long Run	0.7264	0.8826	0.6060	
	Overall	Kentucky	Similar States	1.0% Growth
5 years	1.0370	1.0448	1.0309	1.0510
10 years	1.0754	1.0916	1.0627	1.1046
20 years	1.1994	1.2449	1.1642	1.2824

Simulations are based on model with contemporaneous and lagged prices.

# Employment Level

<b>10% Price Incr.</b>	<b>Overall</b>	<b>Kentucky</b>	<b>Similar States</b>
Short Run	-0.14%	-0.022%	-0.192%
Long Run	-4.43%	-0.687%	-6.02%

Simulations are based on model with contemporaneous and lagged prices.

Other Questions?