

Empirical Analysis of the Role of Energy in Economic Growth

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Abstract

***** Add abstract *****

Keywords: economic growth, energy, cobb-douglas, CES, LINEX

Caleb, put your LaTeX code here.

1. Cobb-Douglas Without Energy

```
Warning: Convergence failure: false convergence (8)
Nonlinear regression model
  model: iGDP ~ exp(lambda * iYear) * iCapStk^min(a, b) * iLabor^abs(b - a)
  data: dataTable
    lambda      a      b
0.00877 0.54436 0.88424
residual sum-of-squares: 0.262

Algorithm "port", convergence message: false convergence (8)
$isConv
[1] FALSE

$finIter
[1] 3
```

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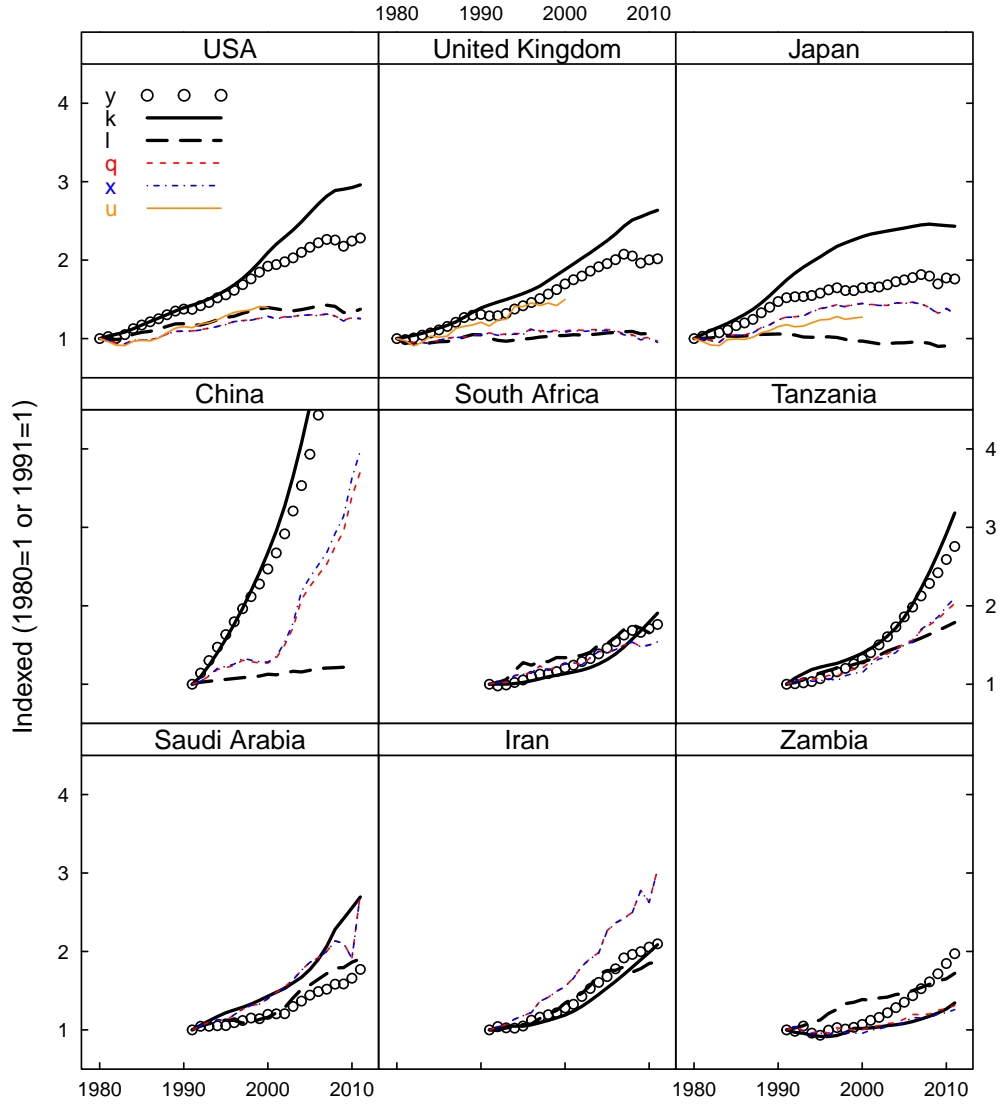


Figure 1: Indexed GDP (y), capital stock (k), labor (l), thermal energy (q), exergy (x), and useful work (u) for all economies. (China's indexed GDP and indexed capital stock rise to $y = 7.3$ and $k = 9.2$ in 2011.)

```

$finTol
[1] -1.9

$nEval
function gradient
      44      3

$stopCode
[1] 8

$stopMessage
[1] "false convergence (8)"

```

Table 1: Cobb-Douglas parameters for 1980-2011 (US, UK, JP) or 1991-2011 (others). (Parameter estimates beneath symbol. 95% confidence interval bounds to left and right.)

	λ			α			β		
US	0.0087	0.0102	0.0116	0.21	0.27	0.34	0.66	0.73	0.79
UK	-0.0066	0.0097	0.0215		0.44		-0.13	0.56	1.24
JP	0.0021	0.0052	0.0082	0.44	0.52	0.59	0.41	0.48	0.56
CN	-0.0021	0.0188	0.0688	0.11	0.71		-0.32	0.29	0.89
ZA	-0.0007	0.0008	0.0022	0.46	0.60	0.73	0.26	0.40	0.54
SA	-0.0159	-0.0123	-0.0087	0.21	0.45	0.68	0.32	0.55	0.78
IR	0.0032	0.0039	0.0045	0.49	0.60	0.70	0.30	0.40	0.51
TZ	-0.0039	0.0015	0.0068	0.50	0.73	0.95	0.05	0.27	0.50
ZM	0.0154	0.0174	0.0191	0.93	1.00		-0.25	0.00	0.25

2. Cobb-Douglas With Energy

We can force α , β , and γ to be in $[0, 1]$ by a reparameterization:

$$a \in [0, 1], b \in [0, 1], \alpha = \min(a, b), \beta = |b - a|, \gamma = 1 - \max(a, b)$$

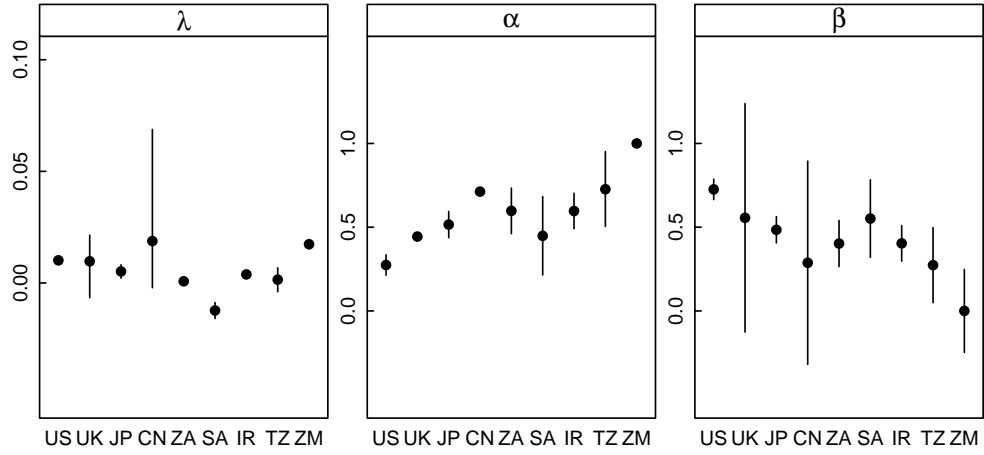


Figure 2: Cobb-Douglas (without energy) model parameters. Vertical bars indicate 95% confidence intervals.

2.1. *Cobb-Douglas with Q*

2.2. *Cobb-Douglas With X*

2.3. *Cobb-Douglas With U*

3. CES

3.1. *CES with Q*

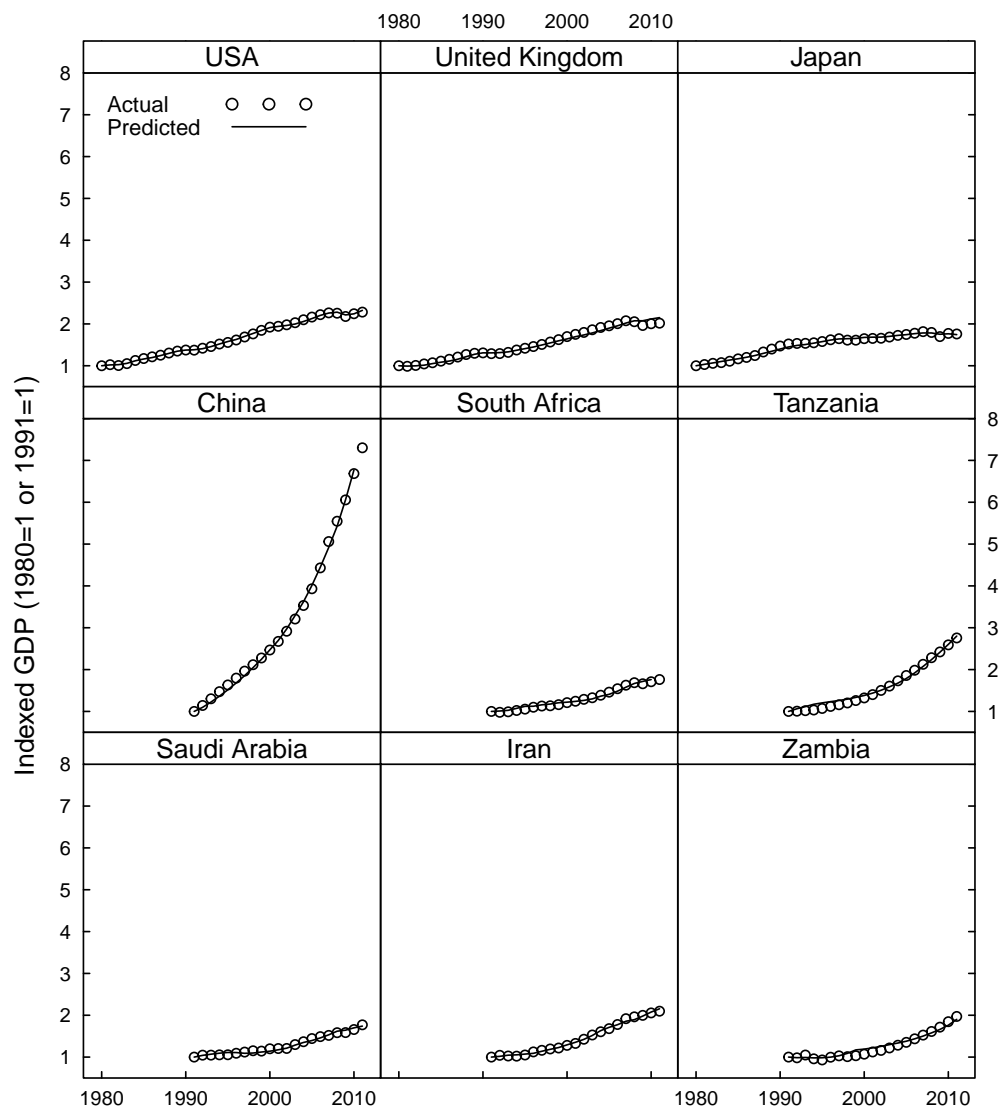


Figure 3: Cobb-Douglas (without energy) results.