Empirical Analysis of the Role of Energy in Economic Growth

Caleb Reese[a], Lucas Timmer[a], Matthew Kuperus Heun[a,*]

[a]*Engineering Department, Calvin College, Grand Rapids, MI 49546, USA*

Abstract

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

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

Caleb, put your LaTeX code here.

1. Cobb-Douglas Without Energy

```
[1] "US"
    pred
1  1.000
2  1.020
3  1.026
4  1.057
5  1.119
6  1.161
7  1.196
8  1.244
9  1.296
10 1.348
11 1.375
12 1.383
```

*Corresponding author

Email address: mkh2@calvin.edu, tel: +1 (616) 526-6663, fax: +1 (616) 526-6501 (Matthew Kuperus Heun)

```
13 1.408
14 1.458
15 1.520
16 1.579
17 1.628
18 1.702
19 1.772
20 1.844
21 1.912
22 1.940
23 1.963
24 1.997
25 2.058
26 2.128
27 2.204
28 2.260
29 2.280
30 2.214
31 2.241
32 2.323
[1] "UK"
     pred
1  1.0000
2  0.9791
3  0.9841
4  1.0027
5  1.0325
6  1.0868
7  1.1253
8  1.1719
9  1.2250
10 1.2865
11 1.3170
12 1.3292
13 1.3248
14 1.3535
15 1.3991
```

```
16 1.4403
17 1.5209
18 1.5508
19 1.5964
20 1.6428
21 1.6781
22 1.7411
23 1.7699
24 1.8196
25 1.8725
26 1.9292
27 1.9699
28 1.9903
29 2.0312
30 2.0002
31 2.0666
32 2.0676
[1] "JP"
    pred
1  1.000
2  1.037
3  1.077
4  1.118
5  1.144
6  1.177
7  1.216
8  1.256
9  1.306
10 1.356
11 1.406
12 1.455
13 1.495
14 1.515
15 1.543
16 1.577
17 1.614
18 1.639
```

```
19 1.648
20 1.648
21 1.672
22 1.679
23 1.680
24 1.699
25 1.719
26 1.737
27 1.762
28 1.781
29 1.786
30 1.761
31 1.762
32 1.749
[1] "CN"
    pred
1  1.000
2  1.096
3  1.223
4  1.365
5  1.519
6  1.685
7  1.859
8  2.054
9  2.255
10 2.483
11 2.708
12 2.979
13 3.296
14 3.619
15 4.008
16 4.443
17 4.917
18 5.424
19 6.061
20 6.769
21    NA
```

```
[1] "ZA"
    pred
1  1.000
2  1.018
3  1.024
4  1.081
5  1.103
6  1.126
7  1.193
8  1.181
9  1.223
10 1.257
11 1.282
12 1.284
13 1.358
14 1.434
15 1.458
16 1.523
17 1.605
18 1.686
19 1.701
20 1.772
21    NA
[1] "SA"
    pred
1  1.000
2  1.040
3  1.067
4  1.089
5  1.094
6  1.107
7  1.104
8  1.114
9  1.132
10 1.156
11 1.193
12 1.230
```

```
13 1.297
14 1.363
15 1.410
16 1.464
17 1.529
18 1.614
19 1.622
20 1.620
21 1.790
[1] "IR"
    pred
1  1.000
2  1.018
3  1.045
4  1.055
5  1.072
6  1.091
7  1.141
8  1.187
9  1.229
10 1.293
11 1.354
12 1.424
13 1.516
14 1.629
15 1.711
16 1.774
17 1.856
18 1.894
19 1.982
20 2.072
21 2.156
[1] "TZ"
    pred
1  1.000
2  1.057
3  1.110
```

```
4  1.135
5  1.163
6  1.200
7  1.212
8  1.266
9  1.312
10 1.349
11 1.436
12 1.517
13 1.585
14 1.673
15 1.792
16 1.899
17 2.078
18 2.223
19 2.380
20 2.569
21 2.757
[1] "ZM"
    pred
1  1.000
2  1.016
3  1.013
4  1.007
5  1.026
6  1.038
7  1.099
8  1.140
9  1.204
10 1.230
11 1.279
12 1.325
13 1.380
14 1.425
15 1.494
16 1.578
17 1.639
```

```
18 1.713
19 1.815
20 1.914
21 2.055
```

Table 1: Cobb-Douglas (without energy) 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	-0.0104	0.0097	0.0303	-0.25	0.44	1.12	-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	-0.0405	0.0188	0.0779	0.11	0.71	1.32	-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	0.0218	0.0249	0.0280	1.25	1.41	1.57	-0.57	-0.41	-0.25

```
Warning:  step factor 0.00012207 reduced below 'minFactor' of 0.000244141
Warning:  step factor 0.00012207 reduced below 'minFactor' of 0.000244141
Warning:  step factor 0.00012207 reduced below 'minFactor' of 0.000244141
Warning:  step factor 0.00012207 reduced below 'minFactor' of 0.000244141

[1] "predGDPQ"

Warning:  step factor 0.00012207 reduced below 'minFactor' of 0.000244141
Warning:  step factor 0.00012207 reduced below 'minFactor' of 0.000244141

[1] "predGDPX"
```

2. Cobb-Douglas With Energy

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

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

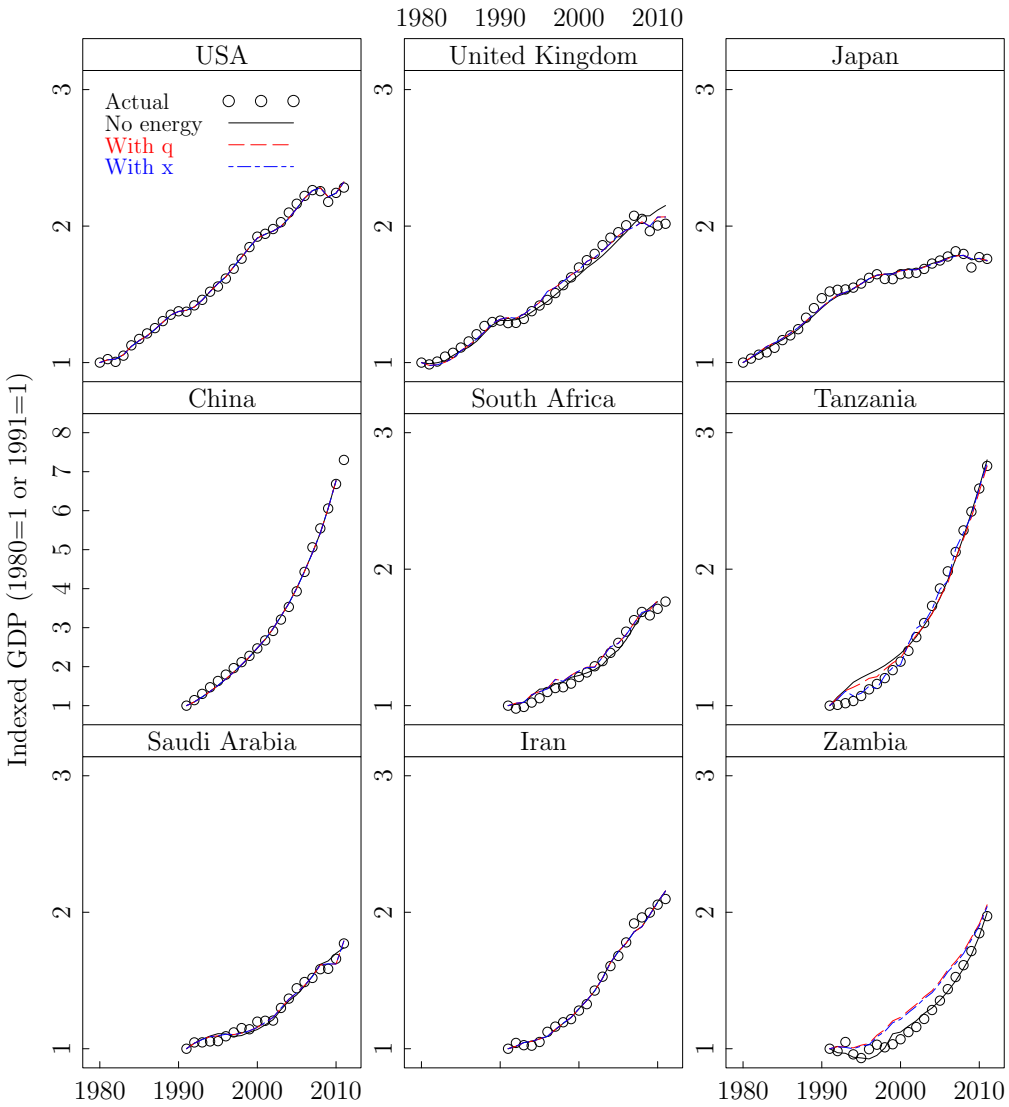

Figure 1: Cobb-Douglas results.