Energy Industry Projections

Ryan Reiser

Data Collection & Expected Signs of Variables

Dependent Variables:

- Yearly Global Fossil Fuel Energy Consumption (*TWh*)
- Yearly Global Renewable Energy Consumption (*TWh*)

Independent Variables:

- Yearly World GDP (*USD*) (+) (+)
- Yearly Crude Oil Prices (*USD*) (-) (+)
- Yearly Global Tertiary Education Enrollments (+) (+)
- Yearly Global Nuclear Powerplants Built (-) (+)
- Environmentalism Movement (*Dummy Variable for Year > 2007*) (-) (+)

Generate Log Differences of Variables

- Approximates growth rates
- Reduces heteroskedasticity
- Reduces multicollinearity
- Prevents trending relationships from inflating results (spurious correlations)

"**How much did a variable change in percentage from one year to the next?**"

Empirical Models

$$dln\_FossilFuelTotal_t = \beta_0 + \beta_1 * dln\_WorldGDP_t + \beta_2 * dln\_CrudeOilPrice + \beta_3 * dln\_TeriaryEnrollment_t + \beta_4 * dln\_NuclearPlants + \beta_5 * EnviroDummy + \varepsilon_t$$

$$dln\_RenewableTotal_t = \beta_0 + \beta_1 * dln\_WorldGDP_t + \beta_2 * dln\_CrudeOilPrice + \beta_3 * dln\_TeriaryEnrollment_t + \beta_4 * dln\_NuclearPlants + \beta_5 * EnviroDummy + \varepsilon_t$$

Predicting Fossil Fuel Energy Consumption

```
. reg dln_FossilFuelTotal dln_WorldGDP dln_CrudeOilPrice dln_TertiaryEnrollment dln_NuclearPlants EnviroDummy
```

Source	SS	df	MS		
Model	.008072011	5	.001614402	Number of obs	= 51
Residual	.011643522	45	.000258745	F(5, 45)	= 6.24
				Prob > F	= 0.0002
Total	.019715533	50	.000394311	R-squared	= 0.4094
				Adj R-squared	= 0.3438
				Root MSE	= .01609

dln_FossilFuelTotal	Coefficient	Std. err.	t	P>|t|	[95% conf.	interval]
dln_WorldGDP	.176529	.0486956	3.63	0.001	.078451	.2746071
dln_CrudeOilPrice	.004592	.0104722	0.44	0.663	-.0165001	.0256842
dln_TertiaryEnrollment	.0902082	.1268508	0.71	0.481	-.1652823	.3456988
dln_NuclearPlants	.0072385	.0034326	2.11	0.041	.0003248	.0141521
EnviroDummy	-.0022642	.0054171	-0.42	0.678	-.0131747	.0086463
_cons	.0047125	.0058947	0.80	0.428	-.00716	.016585

- Model explains 34.38% of variation within fossil fuel based energy consumption
- Statistically Significant Variables: WorldGDP & Nuclear Plants Built (+?)
- Surprising to see Crude Oil have a low impact and positive coefficient

Further Testing

Variance Inflation Factor Test

```
. vif

    Variable |       VIF       1/VIF
-------------+----------------------
dln_CrudeO~e |      1.52    0.655787
dln_WorldGDP |      1.47    0.678328
 EnviroDummy |      1.15    0.868132
dln_Nuclea~s |      1.14    0.877222
dln_Tertia~t |      1.08    0.927430
-------------+----------------------
    Mean VIF |      1.27
```

Heteroskedasticity Test

```
. estat hettest

Breusch-Pagan/Cook-Weisberg test for heteroskedasticity
Assumption: Normal error terms
Variable: Fitted values of dln_FossilFuelTotal

H0: Constant variance

    chi2(1) =   0.82
Prob > chi2 = 0.3644
```

Omitted Variable Test

```
. estat ovtest

Ramsey RESET test for omitted variables
Omitted: Powers of fitted values of dln_FossilFuelTotal

H0: Model has no omitted variables

F(3, 42) =   1.92
Prob > F = 0.1414
```

No signs of significant multicollinearity, heteroskedasticity, or omitted variables

Predicting Renewable Energy Consumption

```
. reg dln_RenewableTotal dln_WorldGDP dln_CrudeOilPrice dln_TertiaryEnrollment dln_NuclearPlants EnviroDummy

      Source |       SS           df       MS      Number of obs   =        51
-------------+----------------------------------   F(5, 45)        =      7.10
       Model |  .003334542         5  .000666908   Prob > F        =    0.0001
    Residual |  .004228574        45  .000093968   R-squared       =    0.4409
-------------+----------------------------------   Adj R-squared   =    0.3788
       Total |  .007563115        50  .000151262   Root MSE        =    .00969

------------------------------------------------------------------------------
dln_RenewableTotal | Coefficient  Std. err.      t    P>|t|     [95% conf. interval]
-------------------+----------------------------------------------------------------
      dln_WorldGDP |   .0248489   .0293457     0.85   0.402    -.0342564    .0839542
  dln_CrudeOilPrice |   .0019446   .0063109     0.31   0.759    -.0107662    .0146555
dln_TertiaryEnrollment |  -.384521   .0764448    -5.03   0.000    -.5384887   -.2305533
  dln_NuclearPlants |    .004658   .0020686     2.25   0.029     .0004916    .0088244
        EnviroDummy |   .0041742   .0032645     1.28   0.208    -.0024009    .0107492
              _cons |   .0298719   .0035523     8.41   0.000     .0227171    .0370267
------------------------------------------------------------------------------
```

- Marginally better results than the fossil fuel regression
- Model explains 37.88% of variation within renewable energy consumption
- Statistically Significant Variables: Tertiary Education Enrollments (-?) & Nuclear Plants Built

Further Testing (again)

Variance Inflation Factor Test

```
. vif

    Variable |       VIF       1/VIF
-------------+----------------------
dln_CrudeO~e |      1.52    0.655787
dln_WorldGDP |      1.47    0.678328
 EnviroDummy |      1.15    0.868132
dln_Nuclea~s |      1.14    0.877222
dln_Tertia~t |      1.08    0.927430
-------------+----------------------
    Mean VIF |      1.27
```

Heteroskedasticity Test

```
. estat hettest

Breusch-Pagan/Cook-Weisberg test for heteroskedasticity
Assumption: Normal error terms
Variable: Fitted values of dln_RenewableTotal

H0: Constant variance

    chi2(1) =   0.10
Prob > chi2 = 0.7498
```

Omitted Variable Test

```
. estat ovtest

Ramsey RESET test for omitted variables
Omitted: Powers of fitted values of dln_RenewableTotal

H0: Model has no omitted variables

F(3, 42) =   3.49
Prob > F = 0.0239
```

No signs of significant multicollinearity, heteroskedasticity, or omitted variables

Why does this matter to business majors?

```
. reg dln_ChevronStock dln_WorldGDP dln_CrudeOilPrice dln_TertiaryEnrollment dln_NuclearPlants EnviroDummy
```

Source	SS	df	MS
Model	.197109971	5	.039421994
Residual	1.11466381	45	.024770307
Total	1.31177378	50	.026235476

Number of obs	=	51	
F(5, 45)	=	1.59	
Prob > F	=	0.1819	
R-squared	=	0.1503	
Adj R-squared	=	0.0558	
Root MSE	=	.15739	

dln_ChevronStock	Coefficient	Std. err.	t	P>|t|	[95% conf.	interval]
dln_WorldGDP	.6347096	.4764527	1.33	0.190	-.3249155	1.594335
dln_CrudeOilPrice	.1269868	.1024633	1.24	0.222	-.0793848	.3333585
dln_TertiaryEnrollment	.4721215	1.241146	0.38	0.705	-2.027675	2.971918
dln_NuclearPlants	.0058849	.0335859	0.18	0.862	-.0617606	.0735303
EnviroDummy	-.0025144	.0530021	-0.05	0.962	-.1092661	.1042374
_cons	.0610587	.0576753	1.06	0.295	-.0551054	.1772228

- Model explains 0.056% of variation within Chevron stock
- Statistically Significant Variables: None ☹

Further Testing (again, again)

Variance Inflation Factor Test

```
. vif

    Variable |       VIF       1/VIF
-------------+----------------------
dln_CrudeO~e |      1.52    0.655787
dln_WorldGDP |      1.47    0.678328
 EnviroDummy |      1.15    0.868132
dln_Nuclea~s |      1.14    0.877222
dln_Tertia~t |      1.08    0.927430
-------------+----------------------
    Mean VIF |      1.27

. estat hettest
```

Heteroskedasticity Test

```
. estat hettest

Breusch-Pagan/Cook-Weisberg test for heteroskedasticity
Assumption: Normal error terms
Variable: Fitted values of dln_ChevronStock

H0: Constant variance

    chi2(1) =   2.15
Prob > chi2 = 0.1427
```

Omitted Variable Test

```
. estat ovtest

Ramsey RESET test for omitted variables
Omitted: Powers of fitted values of dln_ChevronStock

H0: Model has no omitted variables

F(3, 42) =   3.11
Prob > F = 0.0362
```

No signs of significant multicollinearity, heteroskedasticity, or omitted variables

One final regression!

```
. reg dln_NEEStock dln_WorldGDP dln_CrudeOilPrice dln_TertiaryEnrollment dln_NuclearPlants EnviroDummy

      Source |       SS           df       MS      Number of obs   =        36
-------------+----------------------------------   F(5, 30)        =      0.51
       Model |   .0393785         5    .0078757   Prob > F        =    0.7628
    Residual |   .45886869       30   .015295623   R-squared       =    0.0790
-------------+----------------------------------   Adj R-squared   =   -0.0745
       Total |   .49824719       35   .014235634   Root MSE        =    .12368

------------------------------------------------------------------------------
 dln_NEEStock | Coefficient  Std. err.      t    P>|t|     [95% conf. interval]
--------------+---------------------------------------------------------------
 dln_WorldGDP |   .2803077   .4825143     0.58   0.566    -.7051179    1.265733
dln_CrudeOil~e |  -.1064215   .0879279    -1.21   0.236    -.2859942    .0731513
dln_Tertiary~t |   .7911505   1.315831     0.60   0.552    -1.896135    3.478436
dln_NuclearP~s |  -.0067154   .0295641    -0.23   0.822    -.0670934    .0536626
   EnviroDummy |   .0449871   .0456695     0.99   0.332    -.0482824    .1382567
         _cons |   .0685848    .064979     1.06   0.300      -.06412    .2012897
------------------------------------------------------------------------------
```

- Model explains… less than nothing?
- Statistically Significant Variables: None ☹

Further Testing (again, again, again)

Variance Inflation Factor Test

```
. vif

    Variable |       VIF       1/VIF
-------------+----------------------
dln_CrudeO~e |      1.46    0.684868
dln_WorldGDP |      1.39    0.717334
dln_Nuclea~s |      1.22    0.817815
 EnviroDummy |      1.17    0.857169
dln_Tertia~t |      1.13    0.885070
-------------+----------------------
    Mean VIF |      1.27

. estat hettest
```

Heteroskedasticity Test

```
. estat hettest

Breusch-Pagan/Cook-Weisberg test for heteroskedasticity
Assumption: Normal error terms
Variable: Fitted values of dln_NEEStock

H0: Constant variance

    chi2(1) =   0.07
Prob > chi2 = 0.7909
```

Omitted Variable Test

```
. estat ovtest

Ramsey RESET test for omitted variables
Omitted: Powers of fitted values of dln_NEEStock

H0: Model has no omitted variables

F(3, 27) =   0.06
Prob > F = 0.9810
```

No signs of significant multicollinearity, heteroskedasticity, or omitted variables

Thank you!

Data Source Citations

- https://www.macrotrends.net/stocks/charts/NEE/nextera-energy/stock-price-history
- https://www.macrotrends.net/stocks/charts/CVX/chevron/stock-price-history
- https://inflationdata.com/articles/inflation-adjusted-prices/historical-crude-oil-prices-table/
- https://globalenergymonitor.org/projects/global-nuclear-power-tracker
- https://ourworldindata.org/fossil-fuels
- https://ourworldindata.org/renewable-energy
- https://ourworldindata.org/global-education
- https://data.worldbank.org/indicator/NY.GDP.MKTP.CD?end=2023&start=1960