

Does Energy Consumption Drive Economic Growth? A Meta-Analysis

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Overview

We report on a meta-analysis of the very large literature on testing for Granger causality between energy use and economic output (Bruns *et al.*, 2014). We find that most seemingly statistically significant results in the literature are probably the result of statistical biases that occur in models that use short time series of data - “overfitting bias” - or the result of the selection for publication of statistically significant results from sampling variability – often referred to as “publication bias”. We find robust evidence of causality from GDP to energy use when energy prices are controlled for. Finally we reflect on why evidence for causality from energy to output is so elusive.

Methods

We carry out a meta-analysis of 75 single country Granger causality and cointegration studies comprising more than 500 tests of causality in each direction. Our model extends the standard meta-regression model for detecting genuine effects in the presence of publication selection based on sampling variability. We depend on the statistical power trace to distinguish genuine effects and biases as the source of statistical significance. If there is a genuine effect between two variables then studies conducted with larger sample sizes should have more significant test statistics for rejection of the null hypothesis of no relation between energy and growth than do studies with smaller samples, *ceteris paribus*. We standardise the various test statistics in the literature to standard normal variates and regress these on the square root of degrees of freedom and other variables - the most important of which is the number of degrees of freedom lost in fitting the model. This variable controls for the tendency to over-fit vector autoregression models in small samples. These overfitted models suffer from an increased rate of false-positive findings of Granger causality which results in excess of statistical significance in the primary literature.

Results

We find that most seemingly statistically significant results in the literature are probably the result of statistical biases that occur in models that use short time series of data - “overfitting bias” - or the result of the selection for publication of statistically significant results from sampling variability – often referred to as “publication bias”. We cannot find a genuine causal effect in the literature as a whole. However, there is a robust genuine effect from output to energy use when energy prices are controlled for. We find that studies that control for capital do not find a genuine effect of energy on growth or vice versa. We had too small a number of studies that used quality-adjusted energy to test whether there was a genuine relationship between energy and growth when this measure of energy use was employed.

Conclusions

We reflect on why evidence for causality from energy to output is so elusive despite the engineering relationship between the use of energy and the production of goods and services. One reason is probably because the elasticity of output with respect to energy is much smaller than that of energy with respect to output and hence is harder to detect. Another possible reason is that some shocks that decrease energy use decrease output while others increase output. These effects cancel out in most of the reduced form models used to test for Granger causality.

References

Bruns S. B., C. Gross, and D. I. Stern (2014) Is there really Granger causality between energy use and output? *Energy Journal* 35(4), 101-134.