Energy Prices and Economic Growth

Granger Causality*

Samuel Quick†

May, 2019

*Dr. Ransom, thanks for being so consistently helpful, excited to teach, and well-prepared for class. It has been a pleasure

†Department of Economics, University of Oklahoma. E-mail address: squick@ou.edu

1 Introduction

My interest in this subject came about from two events. The first was my capstone course where we read one academic paper on the effect that oil price changes have on employment. As an energy management dual major, the intersection of these topics was nearly too much to resist. The other event was simply my interest in the energy sector broadly. The U.S. became a net energy exporter in 2018 for the first time since the 1950s, which can have very real, and very beneficial effects on our economy. For example, in the 1970s, the United States economy was dramatically effected by the OPEC oil crises in 1973 and 1979. At that time we were to reliant on foreign energy sources that when OPEN severely cut production and simultaneously jacked up prices the price of WTI crude oil increased by over 100 percent overnight. With energy independence comes less volatility in these commodity prices, which could have positive effects on employment sectors across the economy.

My research topic for this paper has to do with analyzing the empirical relationship between energy commodity prices, both oil and natural gas, and economic growth in the form of real GDP. Phrased as a question, it would be: Does there exist a relationship between real gross domestic product, spot prices for WTI crude oil, and spot prices of HH natural gas? And, is this relationship causal. I have tested the relationships between all three variables on each other. Better understanding the relationship between them can allow for policy makers to be more informed when setting the agenda for energy policy for the future. One example would be granting the treasury or commerce department the ability to suspend futures trading during geopolitical turmoil, much like they are able to do with the stock market.

2 Literature Review

Here (Asafu-Adjaye, 2000) Here (Zhang and Cheng, 2009) Here (Paul and Bhattacharya, 2004) Here (Mehrara, 2007) Here (Ritchie, McDougall, and Claxton, 1981)

3 Data

The data used for this project comes from two main sources. The first data set comes from the Energy Information Association, which is an independent governmental agency that focuses on all statistics and analysis related to energy. In order to retrieve this data, I utilized the site API that will allow for specific time range of values to be pulled. This API function was included in the R package "EIAdata". It includes the spot prices for West Texas Intermediate (WTI) crude oil, which is set each day in Cushing, Oklahoma, where the largest intersection of pipes occur in the United States. These prices are for an entire barrel of crude oil, which is roughly 42 gallons worth. The date range for this data originally was from 1986-12-31 to 2018-12-31, and measured on an annual averaged basis, though I was forced to trim the years used in analysis to 1997-12-31 forward, as the specific code function I used for the Granger test required data columns of the same length. The second data set from this source included the spot price of Henry Hub (HH) Natural Gas, which is set daily in Erath, Louisiana. This price is measured as dollar per million British Thermal Units (BTU), which is the most common form of energy measure used in the US. Much like the WTI data, the HH spot prices are measured on an annual average frequency; this frequency was chosen only after attempting to utilize both weekly and monthly averaged data. In addition, the data were again trimmed to fit analysis length. I chose these variables because petroleum and natural gas represent the two highest percentage sources of energy in the United States at 36 percent and

28 percent respectively. The prices of these commodities are directly related to the demand and supply of energy (read production and consumption), and will allow us to get a broader image of the relationship.

The final data set comes from the final source from the St. Louis branch of the Federal Reserve. To retrieve this data, I again utilized a site API to pull data. This API function included in the R package "fredr". As for content, the data set was of real gross domestic product (rGDP throughout). It is measured in billions of chained 2012 Dollars that have been seasonally adjusted at an annual rate. The date ranges were again chosen to match the above range of 1997 to 2018 following many attempts at utilizing weekly, monthly, and quarterly data .I chose this variable to represent the Economic Growth portion of my analysis because adjusted GDP is the most basic measure of economic growth in the US Economy, just from a quantity measure that has been adjusted. To measure growth, it would be ideal to measure the log of rGDP or even the log of log(rGDP) as these measures would show a form of growth great or at least the percentage change; however, that is beyond what this paper examines as I was unable to get the said data measures to work with the lmtest granger operation. Figure one shows summary statistics for the three variables of measure.

4 Empirical Methods

My approach, as apparent by the title of the paper, relies on a Granger causal analysis, which is a statistical hypothesis testing method used for determining whether one a given time series is useful in forecasting another. In this case, we will be using spot price time series data for WTI crude oil and HH natural gas to determine if they are useful in forcasting real GDP, and vise versa.

My tests can best be depicted as a variation of the following equation:

$$Y_{it} = \alpha_0 + \alpha_1 Z_{it} + \alpha_2 X_{it} + \varepsilon, \tag{1}$$

where Y_{it} is a continuous outcome variable for unit i in year t, and Z_{it} are characteristics about the firm at which i is working, while X_{it} are characteristics about i. The parameter of interest is α_1.

5 Research Findings

The main results are reported in Table **??**.

6 Conclusion

References

Asafu-Adjaye, John. 2000. "The relationship between energy consumption, energy prices and economic growth: time series evidence from Asian developing countries." *Energy economics* 22 (6):615–625.

Mehrara, Mohsen. 2007. "Energy consumption and economic growth: the case of oil exporting countries." *Energy policy* 35 (5):2939–2945.

Paul, Shyamal and Rabindra N Bhattacharya. 2004. "Causality between energy consumption and economic growth in India: a note on conflicting results." *Energy economics* 26 (6):977–983.

Ritchie, JR Brent, Gordon HG McDougall, and John D Claxton. 1981. "Complexities of household energy consumption and conservation." *Journal of Consumer Research* 8 (3):233–242.

Zhang, Xing-Ping and Xiao-Mei Cheng. 2009. "Energy consumption, carbon emissions, and economic growth in China." *Ecological Economics* 68 (10):2706–2712.

Figures and Tables

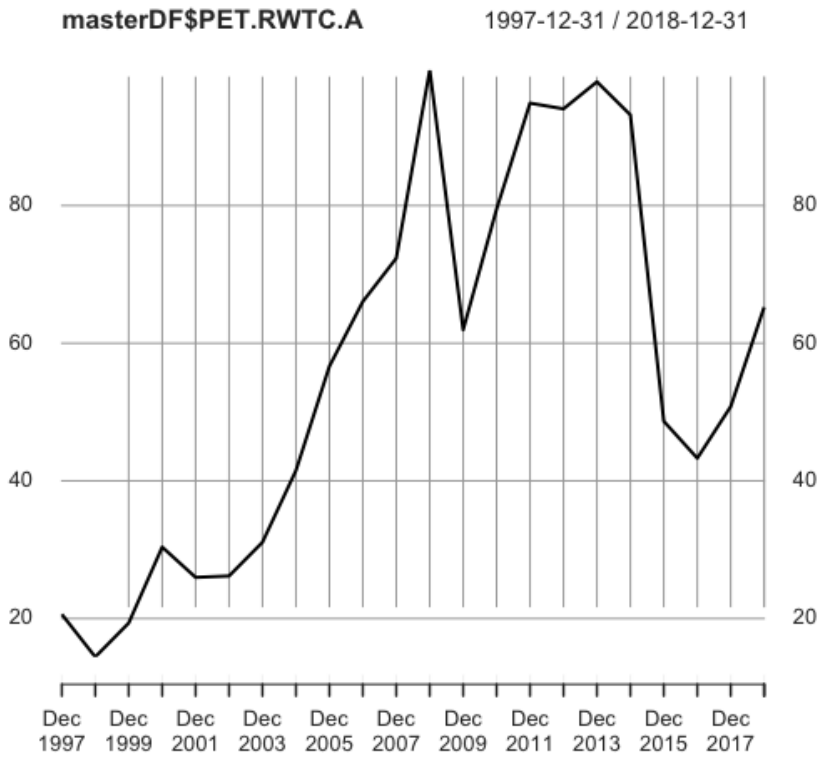

Figure 1: WTI Crude Plotted

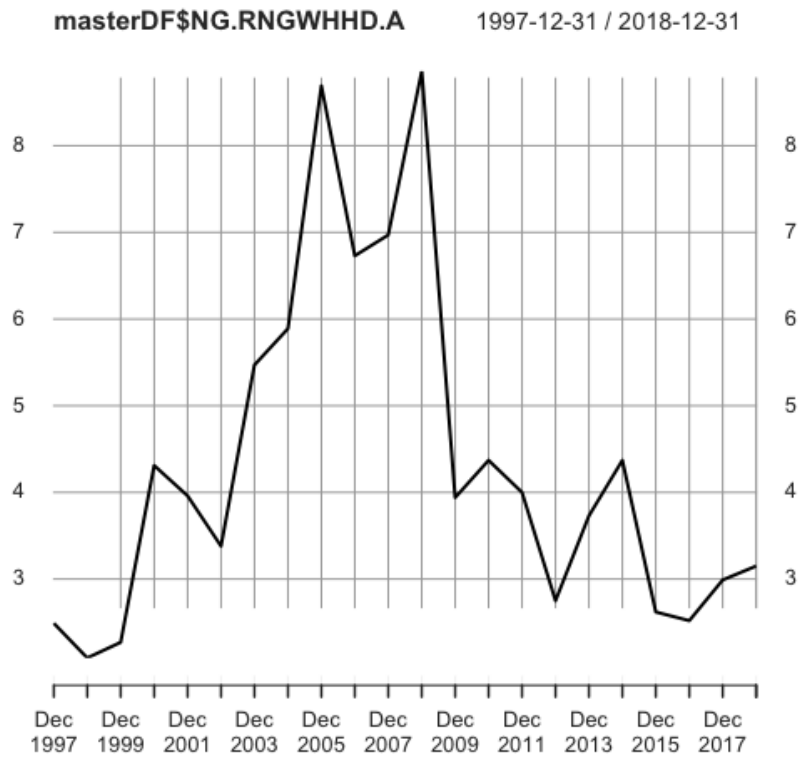

Figure 2: HH Natural Gas Plotted

Table 1: Summary of x Variable

Min.	1st Qu.	Median	Mean	3rd Qu.	Max
14.42	30.55	53.72	56.08	77.69	99.67

Table 2: Summary of y

Min.	1st Qu.	Median	Mean	3rd Qu.	Max
2.090	2.810	3.950	4.343	5.195	8.860

Table 3: Summary of z

Min.	1st Qu.	Median	Mean	3rd Qu.	Max
11522	13590	15469	15169	16421	18566

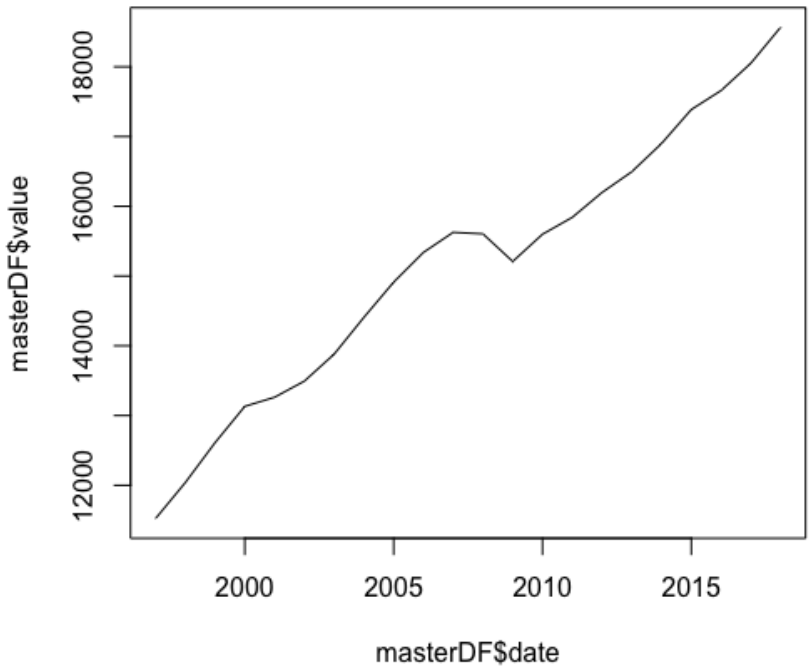

Figure 3: rGDP Plotted