ANALYSIS OF ENERGY MARKETS

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Abstract

Due to the pressing global concern around climate change, the non-renewable energy industry is experiencing an unprecedented pace of growth. Taking into account the results of previous studies, it's important to consider energy costs, technological equities, and the level of unpredictability in regulations as they may influence the development of non-renewable energy, which can also be affected by external changes. The non-renewable energy market is highly vulnerable to significant fluctuations caused by certain variables, which can significantly elevate the chances of substantial alterations in profits. Given that non-renewable energy stocks are a recently developed investment asset, it is critical to accurately forecast the likelihood of substantial variations in the returns of non-renewable energy stocks. This is particularly important for managing the risk of a non-renewable energy investment portfolio.

Key words: Energy ,the non-renewable energy sector technology stocks, the energy sector, global warming, green energy, diesel, oil, heatoil, gsln.

Introduction

Alternative global energy futures showing wide spread both in methodology and content are commonly proposed in literature, and are also used for decision-support (Grunwald, 2011). Although the meaning can vary between situations or perspectives, an energy transition can be defined as a transition of an economic system from being dependent on one or several energy technologies to others (Fouquet and Pearson, 2012). On an aggregated global level such a transformation could be considered a global energy transition.

Smil (2014) describes two major global energy transitions from one dominant fuel to another that appear to have happened in modern history. First the change from wood to coal and later from coal to oil, both of which took 50 to 60 years. Despite these energy transitions, the use of coal continues to increase on a global scale and according to most statistics biomass still makes up around 10% of global primary energy supply (IEA, 2014). Since these apparent historical energy transitions has been correlated with increases in energy consumption, the absolute consumption of the individual energy sources have continued to increase, despite the fact that the share of individual energy sources might have decreased (Fouquet and Pearson, 2012).

Whether dependence on non-renewable resources should be seen as a problem or not is still somewhat disputed within the scientific community. Tilton (1996) even describes two different schools or paradigms concerning resource depletion consisting of those who are "concerned" and "unconcerned". The concerned claim that Earth cannot support current or expected future demand for non-renewable natural resources while the unconcerned think that market incentives, public policy and new technology will be able to provide for society's needs in an indefinite future. This could also be connected to the notion of weak and strong sustainability, where the proponents of weak sustainability thinks that all kinds of natural capital can be substituted by man-made capital, while others believe that there are limits to this kind of substitutability (Ayres, 2007).

A common argument against potential limitations for access to natural resources is to simply point at the fact that the reserves or resources are very large, or much larger than the current production. This argument is true for 14 many resources, but how it will affect future production is not clearly predictable. Taking the large global reserves and resources of coal as an example it has been claimed that they are sufficient to meet demand for "many decades" (BGR, 2009). Others point to the fact that more than 20 countries already appears to have reached a maximum coal production (Lin and Liu, 2010), or argue that the available coal might be less abundant than commonly assumed, which combined with a rapidly growing global demand could cause problems in the future (Heinberg and Fridley, 2010).

While similar discussions have occurred for a wide range of different natural resources, the most vivid debate on exhaustibility of resources has been about oil. Studies concerning if or when the global oil production will reach a maximum level (peak) as well as whether this is a problem or not lead to the formation of the concept commonly referred to as peak oil. Hubbert (1949) stated that the production of fossil fuels, not limited to oil, will inevitably rise until it passes through one or several maxima (peaks) and then decline to zero, where the area under the curve must be equal or lower than the initially present quantity. This can be seen as the foundation of resourceconstrained modelling based on the finite nature of oil and other nonnon-renewable resources (Jakobsson et al., 2009). Since then, a wide range of different attempts to describe potential future oil production has been made, leading to a range of different conclusions. However, in a study reviewing over 500 studies on these matters, the UK Energy Research Centre (UKERC) concludes that a peak in production of what is commonly referred to as conventional oil is likely before 2030, with a significant risk of it happening before 2020 (Sorrell et al., 2010). While some argue that a peak in conventional oil production is imminent, others argue that this peak could happen due to a peak oil demand (Brandt et al., 2013). The reasons for a peak in oil production are the result of an interplay between below ground constraints, such as physical depletion of resources and above ground limitations, for instance prices and demand, and could also be affected by increased production of what is commonly referred to as unconventional resources (IEA, 2013).

Although the focus is commonly on fossil fuels, and especially oil production and the notion of peak oil, there is a growing debate on the depletion of other non-renewable resources, sometimes referred to as peak minerals (May et al., 2012). With regard to non-energy minerals, one important difference is that while energy resources, such as oil and other fossil fuels, are usually combusted and destroyed, the metals that are produced from other materials are recyclable (May et al., 2012).

METHODOLOGY

For this study, we will utilize the Hill estimator and an OLS log-log rank-size regression method, incorporating a perfect shift of Y=1/2, to evaluate the tail indices for non-renewable energy.

Hill's estimator

- Let $r_1, r_2, \ldots, r_N$ be a sample drawn from a population satisfying power law be decreasingly ordered largest absolute value of observations in the sample
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$$|\mathrm{r}|_{(1)} \geq |\mathrm{r}|_{(2)} \geq \ldots \geq |\mathrm{r}|_{(\mathrm{n})} \geq |\mathrm{r}|_{(\mathrm{n}+1)}$$

- A subsample of *n* observations is chosen from the upper tail in ordered sample N:

$$|x_{max}| \geq |x_2| \geq |x_3| \geq |x_4| \ldots \geq |x_n|$$

n = kN, while k stands for the truncation

- The Hill's estimator $\hat{\zeta}_{Hill}$ of the tail index ζ is as follow:

$$\hat{\zeta}_{Hill} = \frac{n}{\sum_{t=1}^{n}(log|r|_{(t)} - |r|_{(n+1)})}$$

- The standard error of the estimator is:

$$s.e._{hill} = \frac{1}{\sqrt{n}}\hat{\zeta}_{Hill},$$

- The corresponding 95% confidence interval for the true tail index ζ is denoted by:

$$95\%\ CI_{Hill} = \left(\hat{\zeta}_{Hill} - \frac{1.96}{\sqrt{n}}\hat{\zeta}_{Hill},\ \ \hat{\zeta}_{Hill} + \frac{1.96}{\sqrt{n}}\hat{\zeta}_{Hill}\right)$$

- Limitations
- Small sample bias
- Dependency issues

Gabaix and Ioannides (2004) assert that the Hill's estimator retains the efficiency attributes of a maximum likelihood estimator. Additionally, Hsing (1991) established the convergence to a normal distribution of Hill's estimator for stationary sequences that satisfy certain mixing conditions, and also offered accurate estimators for the asymptotic variance. Quite a few inquiries have revealed that Hill's estimations have certain limitations on the inferences that can be derived from tail indices.

Embrechts et al. have demonstrated that in circumstances where observations are dependent and heterogeneous, the standard errors produced may be exaggerated, particularly in smaller sample sizes. The year of 1997 was significant in the literature on this subject, as evidenced by the works of Rosen and Gabaix in 1997, as well as Gabaix and Ioannides in 2004. Assuming data independence can lead to significant underestimation of the standard errors, as it is commonly accepted that a large number of extreme stock market returns occur in clusters, indicating a lack of independence among observations (Gabaix, 2009).

The OLS log-log rank=size regression with $\gamma = 0$ to estimate the tail index ζ :

$$log(t-\gamma) = a - b\, log|\mathrm{r}|_{(t)},\ \text{ where t} = 1,\ \ldots,\ \mathrm{n}$$

In other words, *t* is referred to the rank of an observation, and $|r|_{(t)}$ is its size:

$$log(\mathrm{Rank} - \gamma) = a - b\, log(size)$$

The OLS estimate $\hat{b}$ is the log-log rank-size regression estimate of the tail index ζ

The standard approach of log-log rank-size regression in the form of equation (6) has been widely embraced in existing works including Rosen and Resnick (1980), Eaton and Eckstein (1997), Levy (2003) and Levy and Levy (2003).

OLS log-log rank-size regression with $\gamma = 1/2$

The OLS log-log rank=size regression with $\gamma = 1/2$ to estimate the tail index ζ :

$$log(\mathrm{t} - 1/2) = a - b\, log|\mathrm{r}|_{(t)},\ \text{ where t} = 1,\ \ldots,\ \mathrm{n}$$

The OLS estimate $\hat{b}$ is the log-log rank-size regression estimate of the tail index ζ

The shift of ½ is optimal as it significantly reduces the finite-sample bias of the estimates.

The correct standard errors of the estimators can be calculated as:

$$s.e._{RS} = \sqrt{\frac{2}{n}}\hat{\zeta}_{RS}$$

The corresponding 95% confidence intervals for ζ is as follow:

$$95\%\ CI_{RS} = \left(\hat{\zeta}_{RS} - 1.96\ \times \sqrt{\frac{2}{n}}\hat{\zeta}_{RS},\ \ \hat{\zeta}_{RS} + 1.96\ \times \sqrt{\frac{2}{n}}\hat{\zeta}_{RS}\right)$$

The advanced version of the OLS log-log rank-size regression technique, which incorporates an optimal shift and accurate standard errors suggested by Gabaix & Ibragimov in 2011, has been widely utilized in various research studies like Hinloopen and Gabaix and Landier (2008) and Ioannides et al. This text pertains to the year 2008.

The log-log rank-size regression using a 1/2 exponent is highly precise and effective even when power laws and GARCH processes with heavy tails are applied, common methods for representing economic and financial variables such as exchange rates. This differs from the typical approach of estimating log-log rank-size regressions when equal to zero. Ibragimov and colleagues (2013). (2008) also incorporated an adoption of the same methodology to investigate the impact of cultural diversity on the productivity of firms." Bosker et al. (2008) followed the lead of Hinloopen and Marrewijk (2006) by utilizing the same approach to explore how cultural diversity affects the efficiency of businesses. In the years 2007 and 2008, the authors Gabaix and Landier (2008), as well as Ioannides et al., published relevant works in their field. In the year 2008, Chasco and Le Gallo along with Chen et al. conducted research. The OLS log-log rank-size regression, which includes optimal shift and accurate standard errors as suggested by Gabaix & Ibragimov (2011), has become a popular method utilized in various studies, including those published in 2009.

Data description

We analyzed 5 types of non-renewable energy daily data. All information is provided by Global financial.com. We analyzed the data for diesel, gasoline, heatoil and oil from 31 December 2004 to 31 December 2021. Also we analyzed Gsln data from December 30, 2004 to November 29, 2021.

Table

Tail index estimates for non-renewable energy indexes (total sample).

	Truncation	Tail RS	$s.e._{RS} = \sqrt{2/n}\,\hat{\xi}_{RS}$	$95\%\ CI_{RS}$	Tail Hill	$s.e._{Hill} = \sqrt{1/n}\,\hat{\xi}_{Hill}$	$95\%\ CI_{Hill}$

Diesel	10%	3.25	0.22	(2.82, 3.68)	2.80	0.13	(2.54, 3.06)
	5%	3.58	0.34	(2.91, 4.25)	3.34	0.22	(2.90, 3.78)
Gasoline	10%	2.45	0.17	(2.11, 2.78)	2.55	0.12	(2.31, 2.79)
	5%	2.37	0.23	(1.92, 2.82)	2.49	0.18	(2.15, 2.83)
Heatoil	10%	2.79	0.19	(2.42, 3.17)	2.86	0.14	(2.59, 3.14)
	5%	2.77	0.27	(2.25, 3.30)	2.74	0.19	(2.37, 3.10)
Oil	10%	2.50	0.17	(2.17, 2.82)	2.65	0.13	(2.40, 2.90)
	5%	2.37	0.23	(1.93, 2.81)	2.60	0.18	(2.26, 2.95)

Note. 31 December 2004–31 December 2021:
N = 4436, N = 4216   N = 4289   N =4436
10%N =443.6 10%N =421.6   10%N=428.9   10%N=443.6
5%N = 221.8 5%N =210.8   5%N =214.45   5%N =221.8

- Point estimates $\hat{\zeta}_{RS}$ for non-renewable energy indices lie between 2.5 to 3.6
- Point estimates $\hat{\zeta}_{Hill}$ for non-renewable energy indices lie between 2.55 to 3.34.

Among non-renewable energies, Gasoline has the smallest tail index at both truncation levels.

Results and discussion

- $\zeta = 1$ is rejected. Because $\zeta > 1$ for all indices by both the log-log rank-size regression and Hill's estimation procedures.
- The null hypothesis $\zeta = 2$ is rejected in favour of $\zeta > 2$ for Gasoline 10% , Gasoline 5% Heatoil 10%, Heatoil 5%, Oil 10% Oil 5% by . both the log-log rank-size regression and Hill's estimation procedures.
- When we use the Hill estimator and the log-log rank-size regression $\zeta = 3$ and $\zeta > 3$ is not rejected for Diesel 10% Diesel 5% using the Hill's estimation
- The null hypothesis $\zeta = 4$ is rejected in favour of $\zeta < 4$ for all indices by both approaches

The conclusions that can be drawn are all non-renewable energy indices have finite first and second moments according to both approaches. Gasoline, heatoil, oil have finite second moments. But third moments may be infinite. In contrats, according to both estimation procedures, Diesel has finite third moments. The results illustrate that Heatoil. Oil , Gasoline are the most heavy tailed among the non-renewable energy indices by both approaches

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