



# International crude oil prices and the stock prices of clean energy and technology companies: Evidence from non-linear cointegration tests with unknown structural breaks



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## ABSTRACT

Increasing greenhouse gas emissions, exhaustibility and geo-politics induced price volatility of crude oil has magnified the importance of looking for alternative sources of energy. In this paper, we investigate the long term relationship of stock prices of alternative energy companies with oil prices in a multivariate framework. To this end, we use threshold cointegration tests, which endogenously incorporate possible regime shifts in long run relationship of underlying variables. In contrast to the findings of the previous study by Managi and Okimoto (2013), our results indicate presence of cointegration among the variables with two endogenous structural breaks. This study confirms that ignoring the presence of structural breaks in a long time series data, as has been done in previous study, can produce misleading results. In terms of causality, while the stock prices of alternative energy companies are impacted by technology stock prices, oil prices and interest rates in the short run, there is no causality running towards prices of alternative energy stock prices in the long run. The study discusses the possible reasons behind the empirical findings and concludes with a discussion on short run and long run investment opportunities for the investors.

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## 1. Introduction

Energy has become an integral part of our lives in some form or the other. An uninterrupted supply of energy is now a necessity for smooth functioning of our daily work and personal chores. At a national level, the importance of energy is further amplified as energy is one of the essential inputs for socio-economic development of a nation. In its International Energy Outlook, 2013 [1] published by EIA (Energy Information Administration), it has been projected that the world energy consumption would rise by 56%, from 524 quadrillion BTU (British Thermal Unit) to 820 quadrillion BTU, between 2010 and 2040. Moreover, more than 85 percent of this increased consumption is expected to come from

non-OECD<sup>3</sup> countries, which have been witnessing high population and economic growth in recent years.

The sources of energy can be primarily clubbed into fossil, renewable and fissile<sup>4</sup> [2]. Fossils have historically been the largest source of energy globally and according to EIA, it is expected to remain so in future. While the consumption of energy is expected to be led by non-OECD countries through fossil fuels in coming years, one of the major problems in global economy is the geographical distribution of fossil fuels. The availability of fossil fuels, especially crude oil, is restricted only to certain parts of the world. Apart from scarcity of supply, combustion of fossil fuels results in emission of GHGs (Green House Gases), which is considered as one of the major causes of climatic change and global warming [3,4].

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<sup>3</sup> Organization of Economic Cooperation and Development (OECD) is an international organization composed of the industrialized market economy countries, as well as some developing countries, by providing a forum in which to establish and coordinate policies. Non-OECD countries represent developing countries.

<sup>4</sup> Fossil fuel comprises of oil, natural gas, coal etc. Renewable energy comprises of hydro, wind, biomass, solar etc. and fissile fuel comprises of uranium, thorium etc.

Crude oil gains immense importance in the world of energy as it has historically been a major source of energy supply worldwide. World oil production increased from 63,987.1 thousand barrels per day in 1980 to 90,904 thousand barrels per day in 2013, representing a CAGR (compound annual growth rate) of 1.07%. North America became the biggest supplier of oil during the period 1982–87 followed by Middle East. However, post 1987, Middle East has remained the top oil supplier with an average market share of 29% followed by North America with an average market share of 20%. In terms of consumption, Asia, North America and Europe remain the top consumers of oil. However, one can clearly see the gradual increase in oil consumption by Asian region over the period 1980–2013 (Fig. 1a and b).

During the past decade, AES (alternative energy sources) consisting primarily of RES (renewable energy sources), have been increasingly seen as one of the ways to combat climate change. As against the use of fossils, which result in anthropogenic GHG emissions, AES are considered sustainable source of energy which are environmentally benign in nature [5]. AES can also aid in energy security by diversification of the energy supply mix. In 2012, 13.2% of world’s total primary energy supply came from RES. In its International Energy Outlook in 2013 [1], EIA expects government policies and incentives worldwide to support the rapid construction of facilities generating RES. While the total energy demand is expected to increase by 1.5 percent per year, RES are expected to be among the fastest-growing sources of world energy, increasing at an average annual rate of 2.5 percent during 2010–2040.

The conventional media wisdom suggests that increasing oil prices are favorable for financial performance of alternative energy companies since rising oil prices provide high incentive to shift to alternative energy. In this paper, we investigate the long term

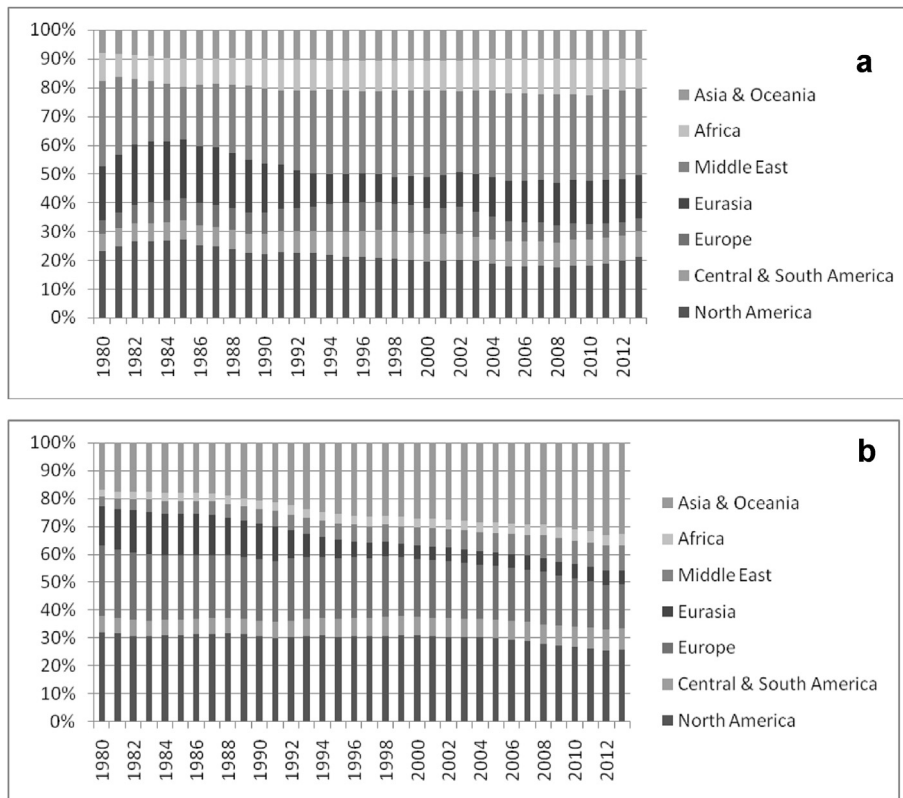
relationship of stock prices of alternative energy companies with oil prices in a multivariate framework.

The remainder of the article is organized as follows. Section 2 gives an overview of past studies. Section 3 provides data descriptions. Section 4 describes estimation methodology. Section 5 discusses empirical findings. Finally, section 6 concludes the study.

**2. Literature review**

Being one of the major sources of primary energy, oil price fluctuations have been considered to have a significant impact on economic growth and several macroeconomic variables for a long time. Several studies have been undertaken to examine the impact of oil price movements on economic growth [6–11], inflation [12–15], investment [16,17] and output [18,19]. There are several channels through which oil prices may impact economic activity. A rise in oil price leads to increase in energy bill for consumers and increased costs for producers. Further, from the classic supply-side effect, increasing oil prices are indicative of reduction in availability of a primary input in production, thereby leading to decrease in potential output. There is rise in production cost and a fall in growth of output and productivity. A drop in productivity in turn has an impact on employment, inflation, profits and investment [7,20,21].

There is also a large and growing body of literature that focuses on impact of oil price movements on financial markets [22–26]. The theoretical foundation of this relationship stems from the oil price effect diffusing to macroeconomic variables discussed above which in turn have an impact on investments and profits. On the supply side, increased oil prices increase cost of production thereby adversely impacting the profits of companies. On the



**Fig. 1.** (a): Oil production share in the world. (b) Oil Consumption share in the world. Source: [www.eia.gov](http://www.eia.gov)

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