Graduate School of Development Studies

The Environmental Consequences of Rising Oil Prices: An Investigation

A Research Paper presented by:

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(Japan)

in partial fulfillment of the requirements for obtaining the degree of
MASTERS OF ARTS IN DEVELOPMENT STUDIES

Specialization:
Environment and Sustainable Development
(ESD)

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The Hague, The Netherlands
November, 2009

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List of Acronyms

CERA	Cambridge Energy Research Associates
CO_2	Carbon Dioxide
CPI	Consumer Price Index
EIA	Energy Information Administration, Official Energy Statistics from the U.S. Government
EU	European Union
GDP	Gross Domestic Product
GHG	Greenhouse gas
IAEA	International Atomic Energy Agency
IEA	International Energy Agency
IMF	International Monetary Fund
IPCC	Intergovernmental Panel on Climate Change
IRENA	International Renewable Energy Agency
ITPOES	UK Industry Taskforce on Peak Oil and Energy Security
NOC	National Oil Company
OECD	Organisation for Economic Co-operation and Development
OPEC	Organization of the Petroleum Exporting Countries
REN21	Renewable Energy Policy Network for the 21st Century
UN	United Nations
UNDESA	United Nations Department of Economic and Social Affairs
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
US	United States
USDA	United States Department of Agriculture
WB	World Bank

Abstract

The primary focus of this research is the environmental consequences of higher oil prices. Environmental consequences are taken to be the impact on the level of greenhouse gas emissions. The premises of the study are that an understanding of these consequences requires a prior understanding of the causes of the rise in oil prices, and both (the causes and consequences) in turn require an understanding of the nature of the rise in prices i.e., whether the rise has been nominal or real – whether they rose relative to other prices.

The major finding of the study is that high oil price *per se* have thus far not had much of a positive impact on the environment (although it is as yet perhaps too early to have any decisive conclusions regarding these). On the one hand, it was found that higher oil prices have not had much of a dampening impact on the demand for oil, and correspondingly not much of an impact in terms of shifts in demand towards alternative energies. On the other hand, it was found that higher oil prices may have had some consequences in terms of a shift in supply, but the shift has thus far been towards non-friendly alternatives, mostly coal. If there are signs of a shift towards more friendly alternatives, it is in terms of investments. However, as the literature also suggests, it would seem that what has been most important in terms of these developments is government support. With regards to trends, the study found that there has been a long upward movement in oil prices in absolute and relative terms, which could be broken down into five distinct sub-periods of rising, falling and stable price trends, and culminating in a period of rapidly rising prices beginning from 1999. It was noted that there is no single explanation for the long-upward movement in oil prices, but that the recent (post-1998) increase is mostly explained by institutional factors, particularly changes which allowed the oil majors, producers and speculators to exert a continuous upward pressure on prices. It was argued that possible strategic (promotion of alternative energy sources which were located in more stable and controllable parts of the world for energy security) and environmental considerations (particularly for global climate change by increasing supply and demand from environmentally friendly sources) led to governments of advanced countries acquiescing to these increases. The widespread belief that higher oil prices were due to demand pressure by emerging economies was shown to have had little or no empirical support, and doubt was also cast on the cost-push thesis, whether emanating from peak-oil or other sources.

Keywords

High oil price, Relative price, Environmental impact, CO_2 emissions, Oil demand, Alternative energy development

Chapter 1 : Introduction

"Energy has become the currency of political and economic power, the determinant of the hierarchy of nations, a new maker, even, for success and material advancement" – Paul Roberts, 2005

"Presumably, the growing problem of environmental damage and degradation worldwide can be explained in terms of market failure wherein the negative externalities imposed by producers and consumers of goods and services are not reflected in the pricing system" – Rajendra K. Pachauri, former chair of IPCC, 2009

"The fallacy of the oil price argument is that substitutions and income effects that would result from higher oil prices are not considered" – Marc Vielle and Laurent Viguier, 2007

"Fossil fuel price hikes provide a solution to human-induced anthropogenic emissions and the heavy dependency on fossil fuels" –Ullash K. Rout et al., 2008

1.1 Introduction

The fundamental concern of this paper is the environmental consequences of oil price movements. In 2008, oil prices rose to above US$ 145/barrel in US dollar (absolute) term, which was also an inflation-adjusted high after seven consecutive years of increases (BP 2009). Although oil prices retreated from these highs in the latter part of 2008 and early 2009 as recession gripped the world economy, they are currently still around the US$ 75-80/barrel mark in US dollar term, suggesting that high oil prices might be here to stay.

The significance of the high oil prices for the environment stems from the fact that oil is argued to be among one of the most environmentally damaging as an energy source. This is because of the high levels of CO_2 emission which its burning and use gives rise to, and CO_2 is argued to be one of the major causes of climate change[1]. Figure 1 below depicting the changes in oil consumption and CO_2 emissions clearly illustrates this link.

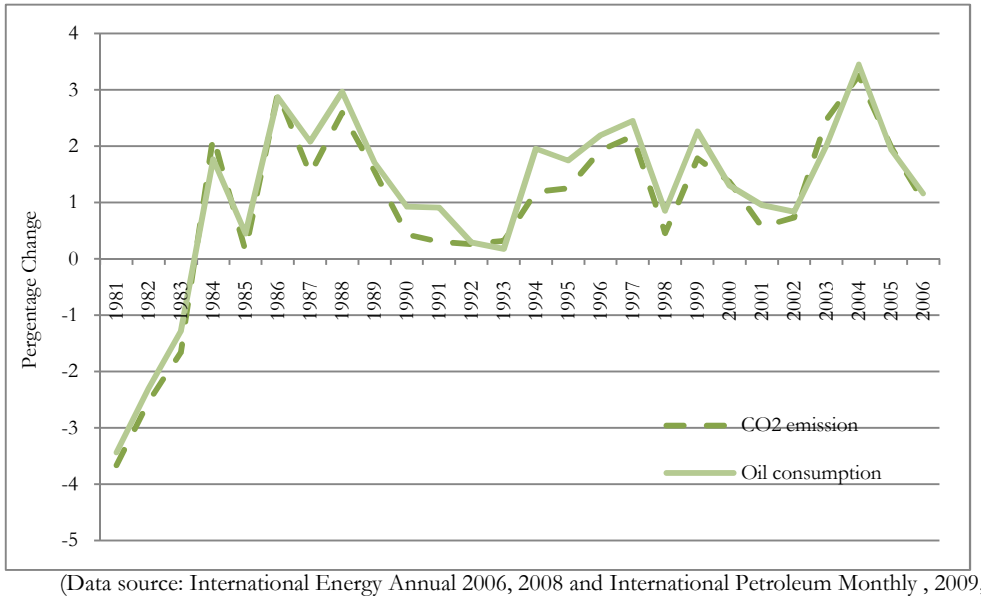
What this suggests, and what most environmentalists and international community[2] argue, is that a reduction in CO_2 emissions requires considerable

[1] IPCC Fourth Assessment Report (AR4) reported that the main driver of climate change is GHG (greenhouse gas) emissions especially carbon dioxide (CO_2) which is the most important anthropogenic GHG (see Pachauri et al. 2007).

[2] The main measure is based on an international treaty called United Nations Framework Convention on Climate Change (UNFCCC). A legal binding agreement, the Kyoto Protocol is currently under enforcement, which offering three different market-based mechanisms (Emission trading, Clean Development Mechanism (CDM) and Joint Implementation (JI)) as a means of greenhouse gas reduction (United Nations Framework Convention on Climate Change n.d.).

reductions in the burning of fossil fuels including oil, and their (its) replacement by what is referred to as renewable or "environmentally friendly" energy sources[3], although many industry analysts expect that oil (will) sustain its dominant position as the fundamental source of energy and production.

Figure 1: World CO_2 emission and Oil demand growth, 1981-2006



(Data source: International Energy Annual 2006, 2008 and International Petroleum Monthly , 2009, Energy Information Administration; Figure and calculation by the author)

1.2 Relevance and justification

Although high oil prices are known to be damaging to the general health of the global economy[4], they are seen as having beneficial effects for the environment because of their alleged implications for reductions in consumption of oil and shifts in production towards more environmentally friendly alternatives. The Economic Report of the [US] President (2006) contended, for example, that high oil prices have moderated and will continue to moderate the demand for oil. Along somewhat similar lines the World Energy Council Report of 2008 saw oil prices as improving the efficiency of global energy use. Lastly, the Report of the [US] President (2008) saw the rise of oil prices as making the adoption of alternative energy sources more likely, a view shared by the chief economist of the IEA, Fatih Birol (see Baldwin 2009).

[3] What actually constitutes these sources will be discussed below in the course of the analysis since it is subject to considerable debate.

[4] For example, the joint study by United Nations Development Programme and World Bank's Energy Sector Management Assistance Programme (2005) estimated world growth to have fallen by 0.5% in 2004 as a result of higher oil price in that year.

1.3 Research objectives

The major objective of the present study is to assess the environmental consequences of higher oil prices. For this purpose, it is considered important to undertake a prior analysis of the causes of higher oil prices and a study of their trends. Studying the causes is considered important because it puts into context how the consequences are to be understood. An awareness of trends is considered to be important for both an understanding of the causes and consequences of higher oil prices. When considering the trends, particular attention is paid to whether the increases in oil prices are nominal or real – in the sense of rising relative to other prices. It is well known that a rise in oil prices in the context of a general rise in prices will have very different consequences for, say, the demand for and supply of oil, as compared with a rise in oil prices relative to other prices.

Therefore, the study objectives are setting up as follows:

1. To look at movements and trends in absolute (dollar value) and relative (to other commodity and real) oil prices.
2. To find out the major causes of these movements and trends.
3. To work out the significance of trends and cause in particular for the environment.

1.4 Research questions

In respect of objectives (section 1.3 above), the basic research question asked by this paper is: What are the consequences of oil price rise to the environment especially in relation to the greenhouse emission?

The sub-questions emanating from this are:

1. Are there any identifiable long-term trends in oil price, particularly relative oil price?
2. What are the major causes for the apparent rise in trend oil prices, and;
3. How, and to what extent, are rising oil prices impacting on the environment, especially the demand for oil and supply of alternative energies?

1.5 Main arguments

The main arguments of the study are as follows. Firstly, the recent rise in oil prices is part of a long-term upward trend in prices in both absolute (US dollar) and real terms (relative to other prices). Secondly, economic, political and institutional factors have all contributed to rising prices at various junctures, but institutional factors have been the major drivers of higher oil prices in the recent past. Third, and coming to the core of the paper, higher oil prices *per se* have thus far not had significant positive environmental consequences in terms of cut-backs in oil consumption or a shift to environmentally friendly alternatives, but it cannot be denied that they might have created the

conditions for such shifts to take place. Fourth, what shifts in energy production towards environmentally friendly alternatives that have taken place are largely due to government support.

1.6 Scope and limitations

The scope of this study is limited to crude oil prices. Little attention is paid to retail gasoline prices and none to focus carbon price[5]. The present study takes environmental consequences as to be greenhouse gas emissions. Most of the information on environmental consequences of higher oil prices in respect of supply pertains to the advanced countries, due to the difficulty of obtaining the relevant data for developing countries. It is accepted that this is an important lacuna of the study since developing countries such as China, India and Brazil are known to be making considerable headway in the development of alternative energy capacities. Even in respect of advanced countries, the analysis of the supply consequences of shifts to renewable energy is limited to those involved in electricity generation. Finally, since this study uses data from different secondary sources, there are bound to be inconsistencies in terms of time periods covered. In the present study, this inconsistency is manifest in the different time periods shown for various graphs and tables.

1.7 Approach and method

The present study will undertake a literature review as well as a basic statistical analysis of secondary data. The analytical approach adopted in the present study is to begin with a literature review, then provide some relevant background information, and then undertake a simple statistical analysis of the relevant secondary data. The literature review attempts to establish the measures and techniques used to track oil price trends and movements, as well as identifying gaps in this literature. It also looks at debates regarding the primary causes of these trends and movements, particularly with regard to relative price movements, and their consequences for the environment. The literature review is intended as providing theoretical and empirical guidance for the present study, as well as bench-marking its findings. The statistical analysis of secondary data involves simple data transformations and graphing/tabulation of data. Simultaneous equation econometric modelling is not used because of the above mentioned data limitations[6]. The primary source of data is the International Financial Statistics (IFS) of the International Monetary Fund (IMF) and the Energy Information Administration (EIA).

[5] The price for carbon dioxide under the carbon trading scheme.

[6] There are also increasing concerns about the theoretical assumptions underlying these models (see for example Taleb 2008).

1.8 Chapter outline

The structure is as follows; Chapter 2 reviews existing literatures in order to identify the gap and attempt to provide both conceptual and analytical framework for the following study. Chapter 3 provides the background and overview of the structure and dynamics surrounding oil and alternative energy by basic information. Chapter 4 analyzes and identify the relative oil price movement for long-term as a basis for later chapters analysis. Chapter 5 reveals the cause of the trend movements, only limited to related reason to environmental consequences by looking at political, economic and institutional factors. Chapter 6 evaluates the environmental consequences by oil price movement, especially focusing on demand on oil and supply on alternative energy sources. Finally, Chapter 7 summarizes the main findings and concludes the study.

Chapter 2 : Literature review

2.1 Introduction

This chapter reviews the existing literatures that attempts to explain the nature, causes and environmental consequences of the movement of oil prices. The review is intended as providing analytical and empirical guidance for the present study, as well as bench-marking its findings. Specifically, it will begin by looking at studies which identify trends in oil prices, paying particular heed to the indicators used to identify the trends. It will then proceed to look at studies which explain the causes of oil price movements. Of concerns are the alleged political, economic and institutional factors which might be considered to be important. Finally, the review will consider the literature on the alleged environmental consequences of movements – which is the major focus of the present study. Particular attention is paid to the perceived environmental consequences of the recent sharp rise in oil prices. It is of note that without a proper understanding of the causes, there can be no real appreciation of the consequences.

2.2 Trend movement

What is evident is that there is a relative scarcity of literature on oil price movements. In most cases, it is only annual changes in oil prices that are considered relevant, and charts and data in literatures are merely presented to "show" the movement. Very few analyse trends in the sense of period averages. Within this limited study, most studies are concerned with either very short term (3-4 years) cyclical movements in oil prices (e.g., Tomes 2005, Hamilton 1983, Ott, Tatom 1986) or their relative volatilities (e.g., Regnier 2007, Plourde, Watkins 1998). It is generally agreed that there has been a rise in oil price over the recent past, but there is little or no discussion of longer term trends, and certainly no attempt to periodize trends (i.e., break up the longer term trends into identifiable shorter term ones, which can then be used for the purposes of analysis). Looking at longer term trends in oil prices is considered important in the present study for an understanding of both the causes of the recent rise in oil prices and their consequences for the environment. In terms of causes, it is important to see if causes of trend movements in previous sub-periods (e.g., the sharp rise from 1973-80) can be ascribed to the causes of the movements in the present period, and in terms of the consequences whether we see any real difference in the consequences for alternative energy production of the present period of sharply increasing oil prices as compared to the preceding periods of falling and stable prices.

Most studies of oil prices use absolute oil prices, i.e., prices denominated in US dollars. A few look at these prices in real terms, that is allowing for inflation (e.g., Terraco, Mendis & Fitzgerald 1989, Chevillon, Rifflart 2009, Sadorsky 2009), and fewer still look at them relative to other commodity prices

(e.g., Blanchard, Gali 2007). No significance appears to be attached to different measures of oil prices, contrary to conventional economic thinking. Thus, according to most orthodox economic thinking, the causes and consequences of absolute price changes (in this case absolute oil prices) will be very different from real or relative (to other commodities) prices (see Maunder et al. 2000). For example, according to economic orthodoxy, a rise in oil prices in US dollar terms can be the result of either an excess of US dollars in the global economic system causing all commodity prices including oil, to rise in US dollar terms, or simply the result of specific conditions of supply and demand in the oil industry (substitution). To distinguish between the two sources of increases in oil prices, one would have to look at whether oil prices were simply rising in US dollar terms or were also rising relatively to other (US dollar) commodity prices. Similarly, a rise in the price of oil would have very different consequences depending on whether the rise is deemed to be in absolute or (also) relative terms. If there was a rise in oil prices which was accompanied by a rise in all other commodity prices, then at least according to conventional economic thinking, there should be no real demand or supply effect.

2.3 Explanations movements in oil prices

Most of the emphasis in the literature explaining oil price movements, particularly the recent rises, has focused on economic factors, neglecting somewhat political and institutional factors. Matutinovic (2009) regrets this tendency, while Fattouh reflects it when he states "although oil is a political commodity, it is still a commodity and like any other, in the long run its price responds largely to economic factors" (Fattouh 2007:18).

Looking at the literature which emphasizes economic factors particularly that seeking to explain the recent rise in oil prices, the focus is on demand/supply factors and speculation with no particular consensus, which of these is the most important. On demand, most attention is the alleged impact of rapidly growing developing countries such as China and India. Berkmen et al. (2005), Tsoskounoglou et al. (2008) and Lipsky (2009) all argue that there has been a strong China-effect on oil. Stevens (2008) too argues that China had an important impact, but notes that China could not account for the entirety of the recent rise in oil prices. Studies by Chevillion and Rifflart (2009), Blanchard and Gali (2007) and Chen et al. (2009) however deny that China could be the major reason for the rise in prices. One reason for the differences in findings is no doubt the methodologies used. For example, the study by Berkmen et al. (2005) and Lipsky (2009) focuses on very few years within 2000s, while Chen et al. (2009) looks at over longer period since 1990s. Moreover, Tsoskounoglou et al. (2008) uses as the indicator of demand on per capita GDP and population growth, while Chevillion and Rifflart (2009) uses as entirely physical quantity as indicator.

With regard to the supply factors, most attention is paid to the so-called "peak oil" story and its implied significance for costs, while some attention is also paid to investments and implied significance for capacity expansion. The

peak oil theory begins with Hubbert (1956) who observed that the rate of extraction in individual oil fields followed a bell-shaped pattern, rising exponentially up to a certain point and then falling precipitously thereafter due to the fact that extraction becomes increasingly difficult. He expanded this analysis to oil production in the US and predicted correctly that it would peak by 1970s (Hubbert 1956). Others have extended this analysis to global oil production arguing that oil production has already peaked or likely to peak soon. Johnson et al. (2004), de Almeida and Silva (2009), Industry Taskforce on Peak Oil & Energy Security (2008) all put the peak as having occurred in early 2000 or will occur before 2011 at latest. Their arguments are based on (proved) oil reserves and historical rate of production. Opponents of the peak-oil theory base their rejection of the peak oil story on technological changes in oil production and the availability of vast reserves of oil from unconventional sources (see Mills 2008, Cambridge Energy Research Associates 2006, and International Energy Agency 2005). With regard to investments and supply capacities, studies by both Berkmen et al. (2005) and Stevens (2008) point to significant shortfalls in these. Stevens provides the more comprehensive study of the two, finding that there has been inadequate investment on the part of all oil producing countries (OPEC and non-OPEC) and oil majors for some considerable period of time. The indicator is based on quantitative measurement such as the rate of production and capacity increase.

While not much attention has historically been paid to the role speculation in explaining oil prices, an increasing number of studies are pointing to this as an important factor in the recent run-up of oil prices (e.g., Cho 2008, Sornette, Woodard & Zhou 2009, and United Nations 2009). It is also known that the US Commodity Futures Trading Commission will shortly come out with a report in which recent oil price rises are directly attributed to speculative activities. The studies of note in this regard, some (e.g., Kaufmann, Ullman 2009) realized the causal relationship between supply-demand fundamentals with spot price and future market as a favourable environment for the speculator, while de Almeida and Silva (2009) and Stevens(2008) found the separation of two markets and the widening gap.

Although there is less emphasis on political and institutional factors in the literature explaining the movement of oil prices, there is not a total absence of such literature. Matutinovic (2009), for example, argues that the recent rise in oil prices reflects a) a growing resource pragmatism on the part of oil producing countries, i.e., a recognition of the need to keep more of their oil for themselves for economic and security reasons, and b) geo-political shifts and rising nationalism. Wirl admits "some of the past oil price jumps that are typically linked to political events" (Wirl 2008:1041). But perhaps the most emphasis in this regard has been placed on the power of OPEC, and its use of this power. The study by Aune et al. (2005) suggested that the oil price US$40-50 per barrel (in nominal term) is profitable range, which actually required to sustainable national development for OPEC countries. Some studies, such as that by Cremer and Weizman (1976) looks monopolistic behaviour by cartel in 1970s, and Chevillon and Rifflart (2009) and Smil (2008) see OPEC as having oligopolistic pricing power and using it periodically by creation of artificial

scarcity, while others, perhaps the majority see this power as declining due to the decline in excess capacity of the OPEC producers (see Fattouh 2007, Berkmen, Ouliaris & Samiei 2005, Adelman 2002) and complete shift to market-based pricing mechanism (Fattouh 2007).

Possibly, the more important discussion with regard to political/institutional factors has been on the question of collusion. Here, recent studies are pointing to collusion between oil majors and OPEC to deliberately restrict oil supply (see Aune et al. 2009), and between oil majors and big banks to push up spot and futures prices (see Cook 2009). Cook points to a strategic tie up between a prominent US investment bank, Goldman Sachs, and BP. Maull (1977) and Rutledge (2003) have argued that the strategic links between the US and Saudi Arabia have been crucial in determining the movements of oil prices over long periods of time.

2.4 The environmental consequences of global oil prices

When considering the environmental consequences of higher oil prices, the literature focuses broadly on the demand and supply aspects, with most attention focused on supply. Although demand and supply move together, and most studies see both aspects as important in the explanation of the environmental consequences, it is considered analytically useful in the present study to separate out the findings in respect of each aspect.

Before getting into this literature, it should be noted that there are major divisions between researchers over what constitutes "environmentally friendly alternatives". Some researchers limit the definition to sources with relatively low carbon emissions (e.g., Sadorsky 2009). On this basis, nuclear power and even clean burning fossil fuels could be taken to be environmentally friendly (see Sadorsky 2009, Salameh 2003:39). An alternative conceptualization – one subscribed to by Sathaye and Meyers (1995), EIA (2009f), and World Watch (2008) – takes environmentally friendly energy sources to not only be those with low carbon emissions but also naturally replenishable and inexhaustible in supply. These sources are so-called "renewable energy", which would include the sun, biomass, wind and water, but exclude such sources as natural gas and nuclear power. Needless to say, there is no emerging consensus in the debate, making comparisons of studies using the concept of alternative energy very difficult.

Beginning with the demand consequences, the studies have focused on; the direct consumption effect, efficiency in the use of oil, and the switch to alternative energy sources. On the consumption effect, studies by Matutinovic (2009) and Lipsky (2009) suggest that the price elasticity of global oil demand is actually quite low. In contrast, Mills (2008) and Martinsen et al. (2007) argue that the rise in oil prices have had, and will continue to have a dampening effect on consumer demand. No doubt one reason for the different findings is that the study by Mills looks only at US demand, while the other two look at global demand.

Findings are similarly divided on the question of whether higher oil prices have led to a greater efficiency in the use of oil. A study by World Energy Council (2008), Rout et al. (2008) and Wirl (2008) suggest that there have been/will be major efficiency gains in oil use as a result of the recent rise in oil prices. In contrast, van Ruijven and van Vuuren (2009) argue that higher oil prices alone are not enough to force greater efficiency in oil use, what also matters are the relationship with other sector (mainly transportation) and relative price to other energy source especially coal. This argument is no doubt correct, also in the case of China as an example, where government support for increased efficiency in the use of oil has also been quite possibly more important than the increase in oil prices (see for example, Price et al. 2001) .

And, finally, on the matter of the shifts in demand to non-oil alternatives, there appears to be broad agreement that higher prices could lead to a shift in demand to non-oil sources. However, the literature suggests that the major shifts are towards environmentally unfriendly sources, especially coal (e.g., van Vuuren, Riahi 2008). Although it would appear that there is a consensus that higher prices have not thus far provided much of an impetus for shifts in consumption to environmentally sources, there is little consensus about the drivers of the latter excepting the importance of policy initiatives by the government particularly towards environmentally friendly alternatives (e.g., Sadorsky 2009, van Ruijven, van Vuuren 2009). These initiatives are argued to be motivated by strategic concerns in respect of supply uncertainty and environmental concern seems to be the impetus for the shift (see section 2.3 below and Salameh 2003, de Castro, Miguel & Mediavilla 2009).

Turning now to the supply side, the relevant issues in terms of the needs of the present paper are whether higher oil prices have led to substitution effects in supply and, if so, whether they these have been towards environmentally friendly alternatives. The first thing to note is that, surprisingly, most studies make little mention of substitution as an effect of higher oil prices in terms of supply. UNEP and New Energy Finance (2009) and Renewable Energy Policy Network for the 21st Century(REN21) (2009, 2008) argue that there is evidence of some shift towards environmentally friendly sources both in terms of production and investment, however what precisely they see as the impact of oil price on alternative energy supplies is unclear. Mead and Mohammad (1990) contend that higher oil prices have direct impact on technological advancement in respect of environmentally friendly sources because they make expensive marginal technology more economically viable. Yet, other studies argue that higher oil prices have not had much of an impact on the supply of environmentally friendly alternatives because of various obstacles in terms of economies of scale, development and running costs and energy density (e.g., Terraco, Mendis & Fitzgerald 1989, Smil 2006). It is noted that environmentally friendly alternative energy supply responses have mostly resulted where there has been considerable state support (see van Ruijven, van Vuuren 2009, Lund 2009). Some argue that in fact the price effect has been primarily towards non-environmentally sources. Mills (2008) notes that higher oil prices have provided a considerable impetus for the development of

unconventional oil[7] resources, which are even worse in terms of CO_2 emissions than conventional oil.

It should be noted in respect of the preceding that the different findings of the studies are partly due to the aforementioned different definitions of alternative energy adopted. Another possible reason for the different conclusions and one which permeates the entire literature, is the oil price variable used. Most studies use the absolute price of oil, while a few use the real price of oil. Surprisingly, none consider the use of the relative price of oil.

[7] According to the IEA, unconventional oil includes oil shales, oil sands-based synthetic crudes and derivative products, coal-based liquid supplies, biomass-based liquid supplies, and liquids arising from chemical processing of gas (International Energy Agency 2001).

Chapter 3 : The structure of the oil industry and significance of alternative energy sources

3.1 Introduction

This chapter seeks to provide an overview of the structure and functioning of the oil and alternative energy markets. Specifically the chapter will begin by looking at the nature of the oil markets, including the nature and main sources of supply and demand as well as the institutional setting in which prices are formed. It will then provide an insight into the emerging alternative energy market, focusing in particular on the extent (how much energy it accounts for in relation to the oil market) and structure of this market. This will provide a backdrop to understanding the subsequent analyses of the causes of the rise in oil prices and resulting environmental consequences of the rise.

3.2 The structure and functioning global oil market

3.2.1 General

The oil market comprises producers, consumers, exporters and importers. The table below provides information on the countries making up the two groupings. It may be seen that there are notable differences, although there is some overlap between the two clusters of countries. Some countries (e.g., United States and China) are both large producers and importers, while others are either producers (e.g., Saudi Arabia and Iran) or importers (e.g., Japan and Germany). The significant dependency structure is created between exporting and importing countries in order to sustain economy mainly due to the geographical reasons.

Table 1: Ranking in oil market - Producers, consumers, importers and exporters, 2008

Rank	Production	Consumption	Imports	Exports
1	Saudi Arabia	United States	United States	Saudi Arabia
2	Russia	China	Japan	Russia
3	United States	Japan	China	United Arab Emirates
4	Iran	Russia	Germany	Norway
5	China	India	South Korea	Iran
6	Mexico	Germany	India	Kuwait
7	Canada	Brazil	France	Nigeria
8	United Arab Emirates	Canada	Spain	Venezuela
9	Venezuela	South Korea	Italy	Algeria
10	Kuwait	Saudi Arabia	Taiwan	Angola

(Data Source: Country Energy Profile, Energy Information Administration)

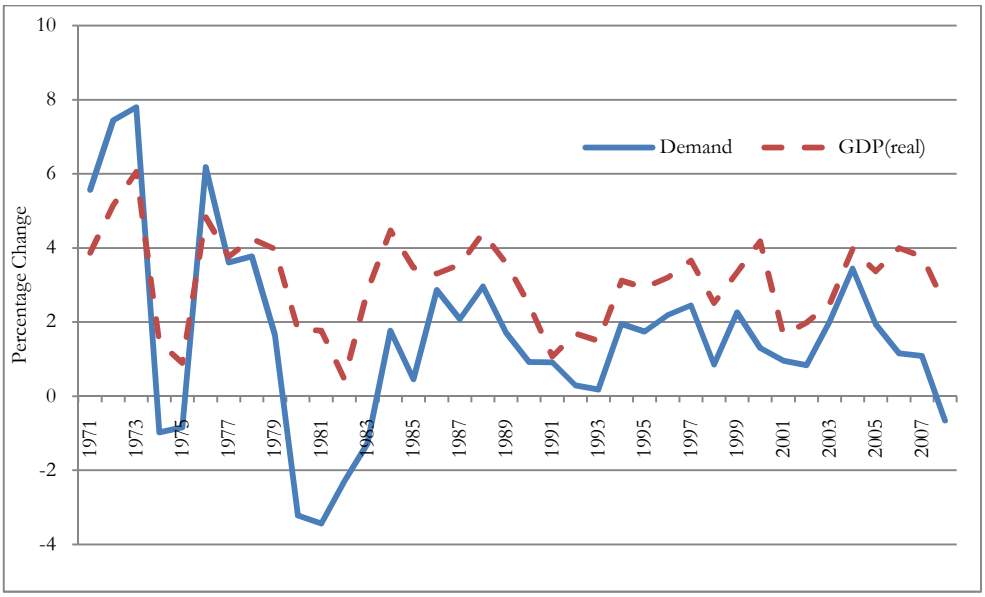
3.2.2 Demand

World absolute oil demand has steadily since the early 1970s with only one notable interruption - in the period from 1978-83. As one might expect the

main driver of the demand increase is world GDP growth (Pirog 2005). The figure below (Figure 2) shows world oil demand moves fairly closely with world GDP. This figure suggests that the growth in demand has slowed significantly since late 1980s. In fact, relative to world GDP global oil demand has actually fallen (see Figure 3). Many commentators (see for example Organization of the Petroleum Exporting Countries 2009c) attribute this to the growing efficiency of energy use, but, as we will see later, it may also be due to the impact of rising real oil prices and substitution effects.

Most demand for oil comes from the advanced countries, regardless of decline over time (see Figure 4). The most important among these is the United States. It has been and still is the largest individual country consumer of oil, even though its consumption has begun to decline of late after hitting peak demand in 2007. In contrast, the growth in demand of emerging countries (viz., China, India and Brazil) has risen significantly. The average consumption growth rate between 1998 and 2008 account for around 91% in China, 60% in India and 20% in Brazil, while 3% growth in US[8]. Most commonly said that global future demand is expected to keep rising and its source is mainly from Asian countries, which implies potential alternation of trade flow in market, government and industry (Gately, Streifel 1997).

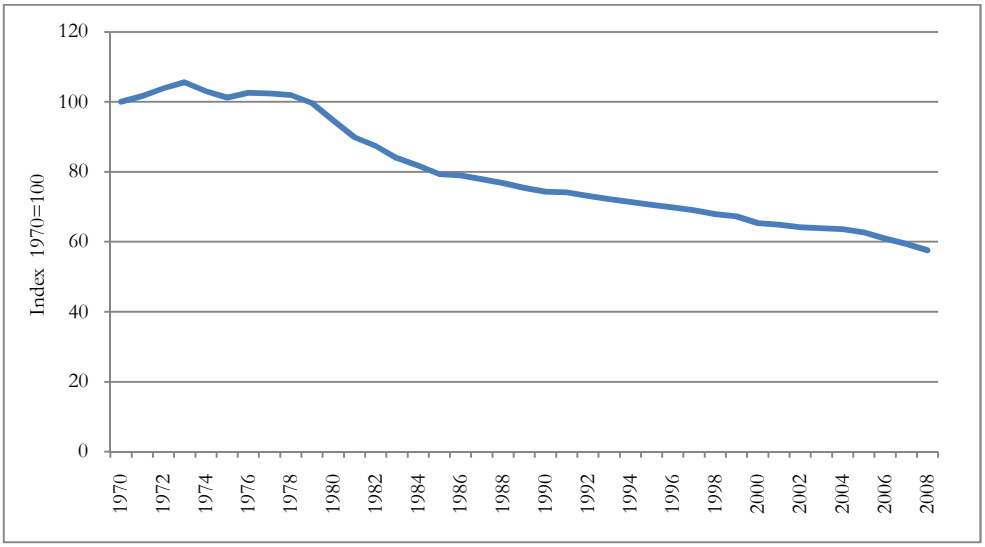
Figure 2: Real GDP and Oil demand growth, 1971-2008



(Data Source: International Petroleum Monthly, Energy Information Administration and International Macroeconomic Data Set, Shane (USDA) , 2008, Figure and calculation by the author)

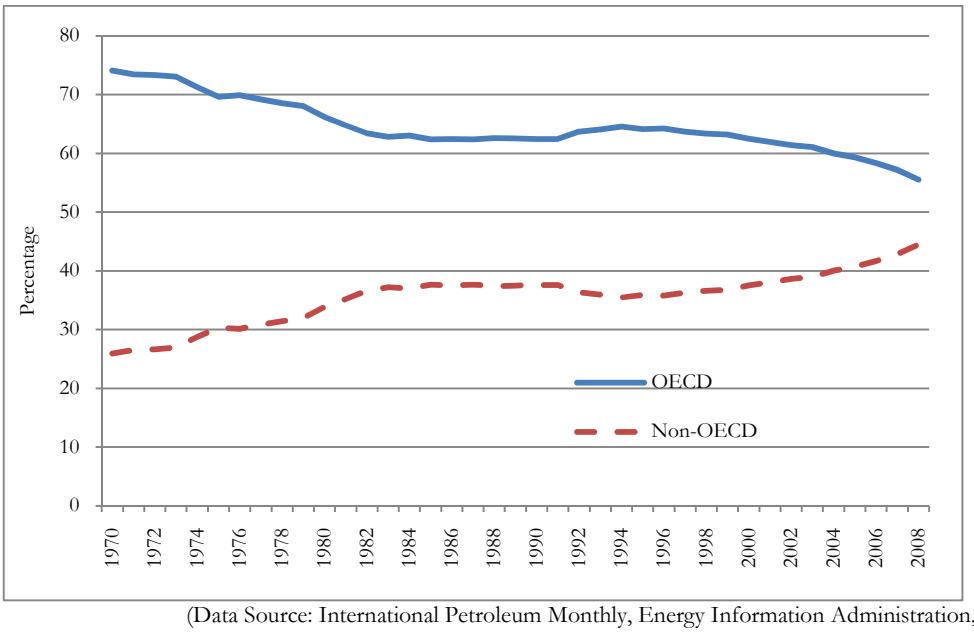
[8] Data from International Energy Annual 2006, Energy Information Administration, calculation by the author.

Figure 3: Oil demand over GDP (normalized), 1970-2008



(Data Source: International Petroleum Monthly, Energy Information Administration and International Macroeconomic Data Set, Shane (USDA) , 2008, Figure and calculation by the author)

Figure 4: Demand shares - OECD and Non-OECD, 1970-2008



(Data Source: International Petroleum Monthly, Energy Information Administration, Figure and calculation by the author)

3.2.3 Supply

Oil supply typically follows demand. Accordingly, the rate of growth in oil supply has fallen along with demand. The main suppliers of oil are those from the so-called Organization of the Petroleum Exporting Countries (OPEC). OPEC was formed in 1960 by five major oil exporting countries and now

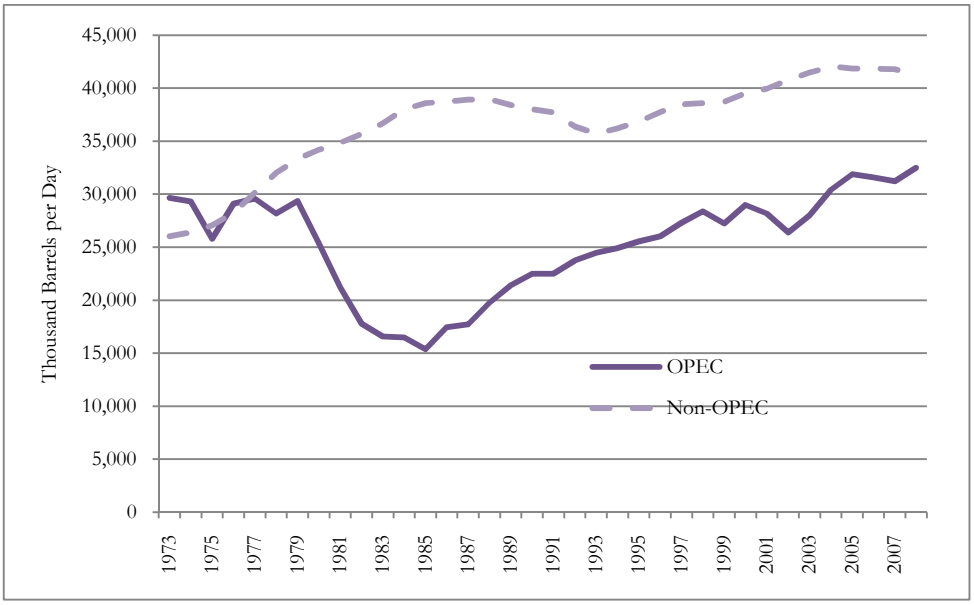
comprises 13 countries [9]. OPEC accounts from about 46% of world production and 60% of total oil exports in international trade in 2008 (see Table 2). Although the non-OPEC share of global oil production in absolute term has risen largely due to increases in Eurasian production, this has now levelled off, mostly as a result of the fall in European production (see Energy Information Administration n.d.b). Production in most oil producing countries is undertaken by national oil companies. The largest of these are the national oil companies (NOCs) of Saudi Arabia, Russia, China, Iran, Venezuela, Brazil and Malaysia. They are often positioned as "the instrument for achieving a broad range of national, social and political objectives that go well beyond their original purpose of maximizing revenues for their governments" (World Bank 2008:3).

Table 2: OPEC/Non-OPEC production and export share, 1990, 2000 and 2008

	Production		Export	
	OPEC	Non-OPEC	OPEC	Non-OPEC
1990	38.5%	61.5%	60.9%	39.1%
2000	43.8%	56.2%	55.5%	44.5%
2008	45.9%	54.1%	60.3%	39.7%

(Data Source: Annual Statistical Bulletin 2008, Organization of the Petroleum Exporting Countries, 2009, Table by the author)

Figure 5: Crude oil production: OPEC and non-OPEC, 1973-2008



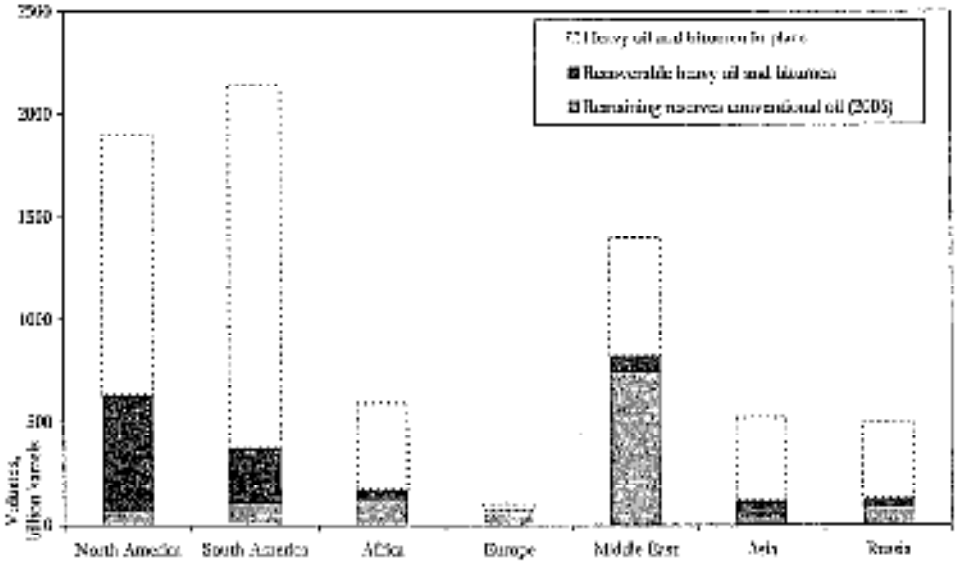
[9] Original five member states are consisted of Iran, Iraq, Kuwait, Saudi Arabia and Venezuela. Other eight countries joined OPEC later; Algeria, Libya, Nigeria, Qatar, United Arab Emirates (all joined 1971), Angola, and Ecuador. Through history, Indonesia withdrew from OPEC in January 2009, Angola joined in 2007, Ecuador rejoined in 2007 (suspended membership during 1992-2007), and Gabon withdrew from OPEC in 1996(Organization of the Petroleum Exporting Countries 2009a).

(Data Source: International Petroleum (Oil) Production, Energy Information Administration, Figure by the author)

The actual refining, distribution and sale of oil (so-called "downstream") is mostly controlled by the "super majors" group of six advanced country private oil companies - ExxonMobil, Chevron, Royal Dutch Shell, ConocoPhillips, Total S.A and BP. The combined revenue of these companies in 2008 exceeds the Gross Domestic Product of counties such as Canada and Netherlands in nominal term[10]. It is well known that they exercise considerable influence over the international price of oil by using various tactics such as intentional supply constraints, manipulation of the trading market, and political influence through lobbying, the realignment within the sector from so-called "seven sisters" in late 1990s reinforced their power in the market.

Although there has been continued concern about the depletion of oil reserves, available data suggests that these concerns are largely misplaced. Reserves are categorized for 1) proven - certain estimation of future output, and 2) non-proven (probable, possible, speculative and undiscovered) reserves – development potential largely depending on future technological and geological advancement (Adelman 2002). Indeed, the increase in proven reserves has outstripped the growth of supply by some considerable margin (see Organization of the Petroleum Exporting Countries 2009b). In terms of unconventional oil, the figure below shows that large reserves exist, and in many regions it even exceeds conventional (light) crude oil reserves.

Figure 6: Global resources of conventional and non-conventional (heavy oil and bitumen) oil



(Figure Source: Mills, 2008, p.155)

[10] Data source by World Bank (World Bank 2009) and OPEC (Organization of the Petroleum Exporting Countries n.d.).

3.2.4 Price

"Oil price" is usually refers to West Texas Intermediate-Cushing (WTI), Brent and/or Dubai oil prices, valued in US dollar. All three prices tend to move together, although each represents oil of different quality. Often an equally weighted average of these prices is used and referred to as "three spot (petroleum crude) price" (see International Monetary Fund 2009). Due to volume and transparency of trade the WTI is regarded as the major international reference and is frequently quoted by the media as "the oil price". A fourth important indicator of oil prices is the OPEC Reference Basket (ORB). This is a weighted average of the oil prices of all OPEC members.

The price of crude oil is set in two markets; the wet barrel market and the paper barrel markets. The wet barrel or spot market is where physical oil is traded at specific locations for specific prices – spot or current prices. The paper barrel or futures market is where promises to buy or sell oil in the future are traded. These so-called oil futures are typically traded in futures markets such as the New York Metal and Energy Exchange (NYMEX) or the Intercontinental Exchange (ICE) in London, and currently "crude oil is the world's most actively traded commodity" globally (CME Group Inc 2009). In terms of volumes, the spot market is still larger than the futures market, although as we will see later the futures market has come to dominate the spot market price movements in recent times.

3.3 The environmental consequences of different energy source

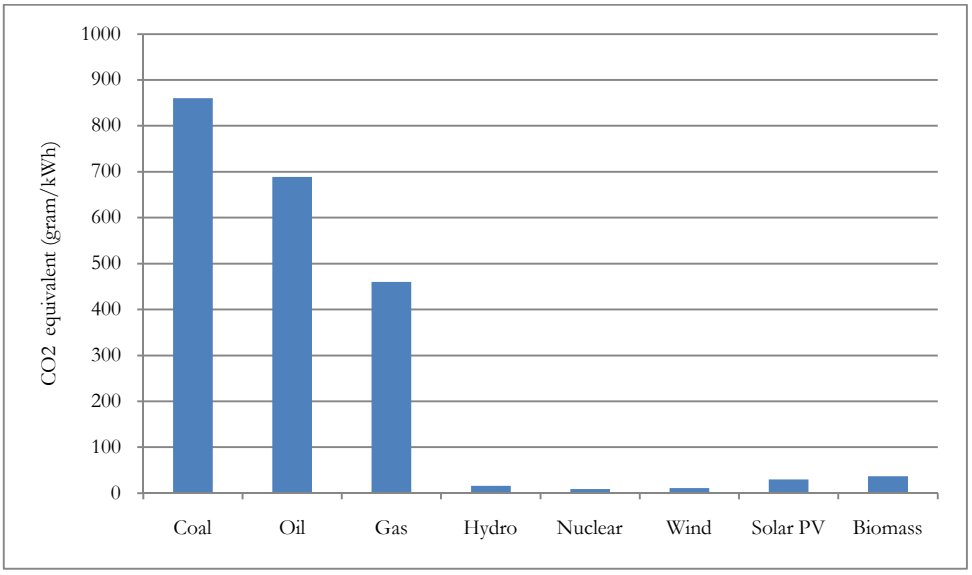
3.3.1 Greenhouse gas emissions

In terms of CO_2 emission levels, and for the limited purposes of the present paper, energy sources can be classified as either environmentally friendly or non-environmentally friendly. Obviously, all fossil fuels (notably oil and coal) belong to the former category (see Figure 7). In fact, emission level of oil and coal are rather similar. Moreover, although natural gas emission levels are somewhat less than those of oil and coal, the extent of emission levels from this energy source in comparison with others is such that it too can be classified as environmentally unfriendly. In contrast, nuclear and all so-called renewable energy sources such as hydro, solar, and wind are associated with such low levels of emission that they can be said to be environmentally friendly[11] (see Figure 7).

[11] It is of note that many academics and environmental activists would classify nuclear as in the camp of non-environmentally friendly energy sources in terms of nuclear waste, but data and other limitations preclude this classification in the present study.

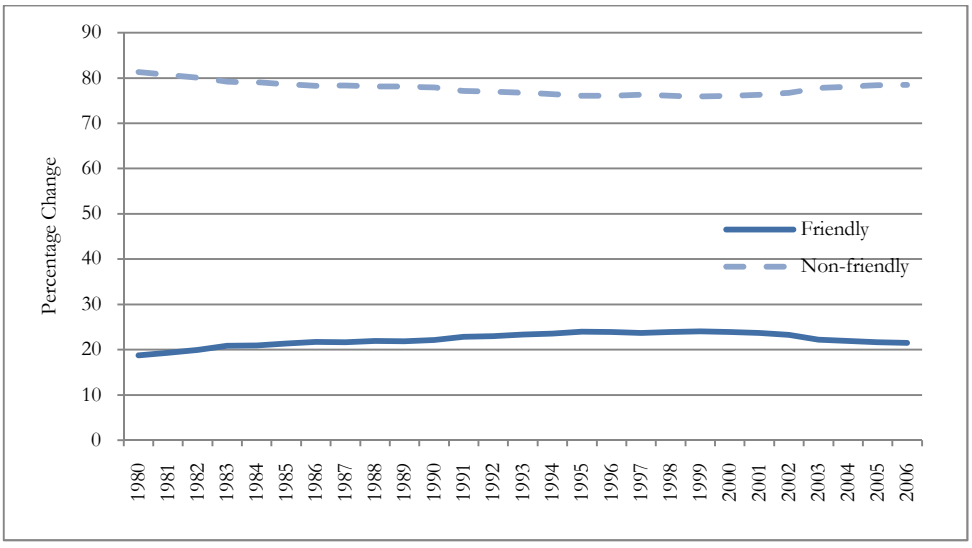
Defining environmentally friendly as lower carbon emission energy source including renewables and nuclear, Figure 8 below shows that most energy consumption is accounted for by non-environmentally friendly sources. Among unfriendly sources, the most important contributor to the rise out of oil has been coal, which has of late even surpassed oil in terms of its contributions to carbon emissions (see Figure 9).

Figure 7: CO_2 emissions by different energy sources (gram/kWh)



(Data Source: Rogner and Khan, International Atomic Energy Agency, 1998, Figure by the author)

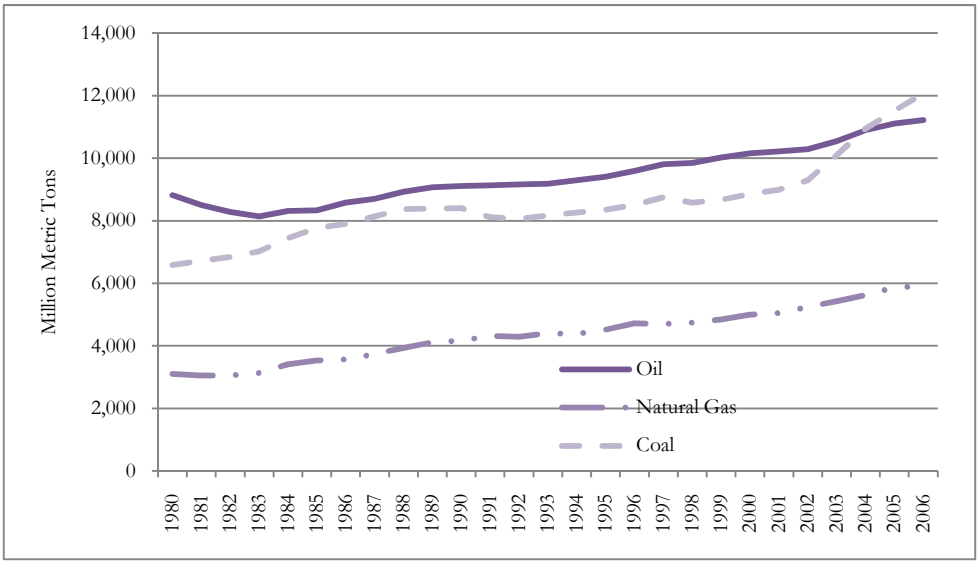
Figure 8: Consumption shares: Environmentally friendly and non-friendly sources (excluding oil) [12], 1980-2006



[12] Environmentally friendly sources include nuclear and renewables, while unfriendly sources consist of coal and natural gas.

(Data Source: International Energy Outlook 2009, Energy Information Administration,
Figure and calculation[13] by the author)

Figure 9: Total CO_2 emission by different energy sources, 1980-2006



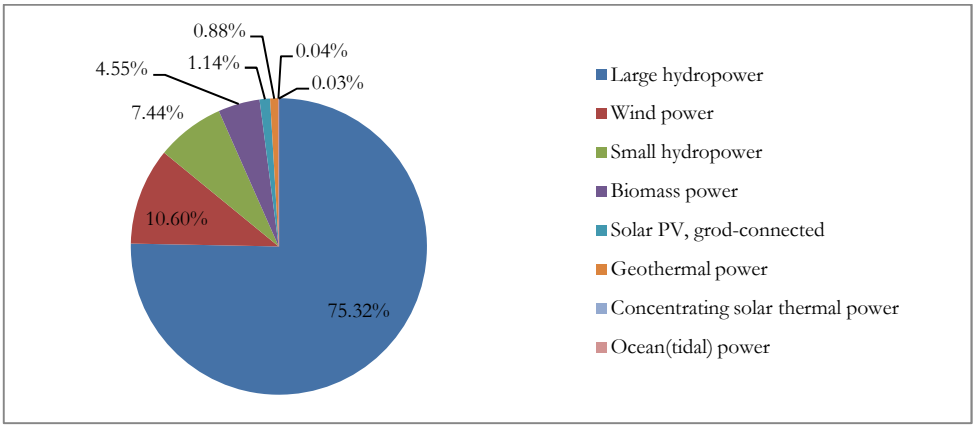
(Data Source: International Emissions Data, Energy Information Administration,
Figure by the author)

3.3.2 Renewables

Within the renewables sector, by far the largest source is hydropower (Figure 10), which accounts for as much as 82% of total renewable energy. Although the share of renewable energy production and consumption has not been rising, it is probably the most rapidly developing energy source in terms of investment and technological advancement. And technological development in respect of alternative energy are such that the World Watch Institute reckons, we already have already the capability in the sector to meet world energy demand (World Watch Institute 2008). Moreover, in recent years, the renewables catch a large attention in political forum too. At least 73 individual countries have renewable energy related policy by early 2009(Renewable Energy Policy Network for the 21st Century 2009) and first multinational agency, the International Renewable Energy Agency (IRENA), was established with 78 countries affiliation in 2009, which support and provides a knowledge for further development and wide-spread renewable energy.

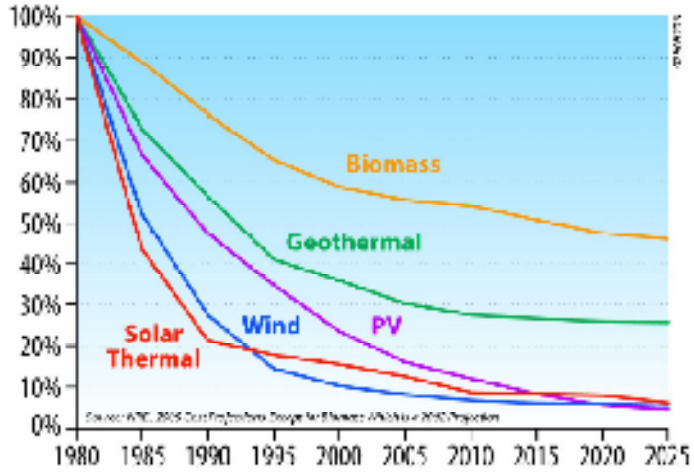
[13] Consumption of each category divided by total energy consumption.

Figure 10: Renewable energy power generation



(Data Source: Renewables Global Status Report: 2009 Update, Renewable Energy Policy Network for the 21st Century, 2009, Figure by the author)

Figure 11: Renewable energy electric generation costs as percentage of 1980 levels, 1980-2025



(Source Figure: Increasing Global Renewable Energy Market Share Recent Trends and Perspectives, p.12, 2005, United Nations Department of Economic and Social Affairs)

Chapter 4 : Trend movements in global oil prices

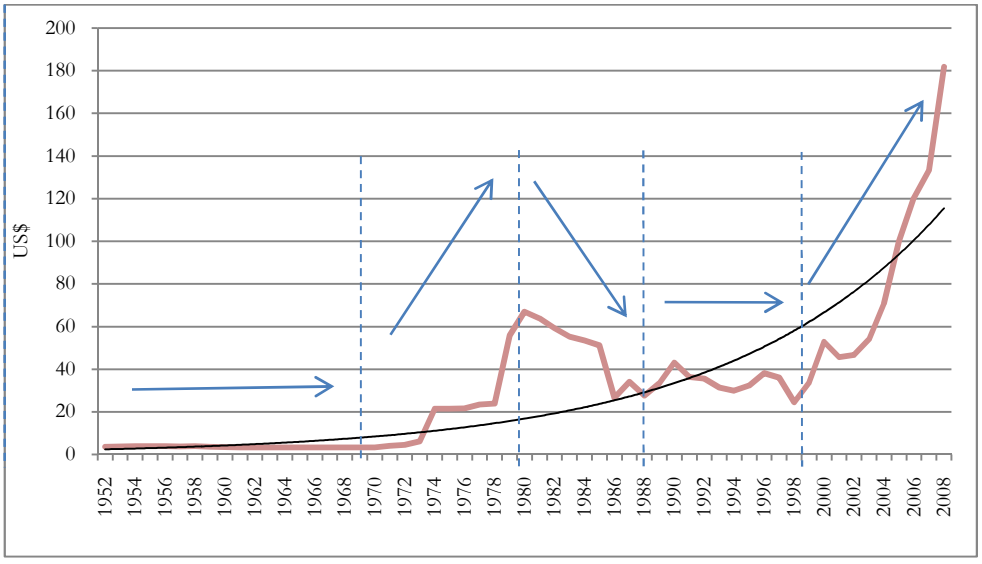
4.1 Introduction

This chapter aims to both identify trends and periodize the movement of oil price. The critical review of the literature presented in chapter 2 suggests that the trend movement in oil prices which are of relevance for the present study are relative movements, particular in relation to other primary commodity prices (excluding other energy prices) and retail prices of consumer goods. It is the contention of the present paper (for reasons already given in chapter 2, p.13) that identifying trends in real oil price is crucial to an understanding of the determinants of price movements and impact on the environment in terms of oil demand and the development of alternative energy sources. The starting year for data sets used in this chapter is dictated by the availability of data.

4.2 Trends

The chart of the US dollar price of oil from 1952 to the present (see Figure 12) shows clearly an upward trend in oil prices for the period as a whole. This in itself is not particularly remarkable given that most prices trend upwards over time. What is also apparent from the data is that there are five identifiable sub-periods, characterized by; 1) a steady low price trend (-1970), 2) a rising trend (1971-80), 3) followed by a falling trend (1981-1988), then 4) a period of stable but low oil prices (1988-1998), and then 5) a further period of rising prices (1999-2008).

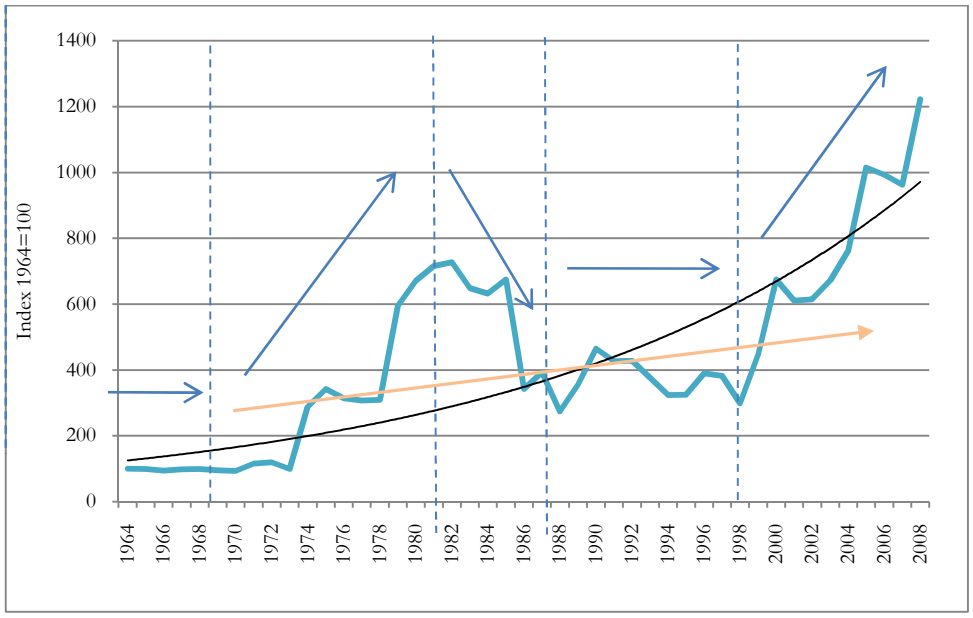
Figure 12: Oil price in US dollar price (nominal), 1952-2008



(Data Source: International Financial Statistics, International Monetary Fund, 2009, Figure including periodization by the author)

Perhaps what is more remarkable is that the same long term upward trend (and sub-trends) in oil prices is observable, when these prices are compared with all other primary commodity prices, and even sub-groupings of the latter. Figure 13 depicts the trend in oil prices relative to all other non-fuel primary commodity prices[14] for the period 1964 to 2008. An exponential trend line is fitted to the data to show the upward (steepening) trend, and an arrow shows that the price never hit back the bottom price level in early 1970s again. The data shows that oil prices have risen by twelve times the price of all other commodities over the period 1964-2008. Figure 14 depicts trends in oil prices relative to individual sub-groupings of primary commodity prices. Its shows that oil prices rose relative to all other sub-groupings of primary commodities, and that the same sub-period trends were also evident with respect to these relative price movements, even though there are very few differences in the length of the sub-period.

Figure 13: Relative movement of oil prices to prices of other commodities (normalized), 1964-2008

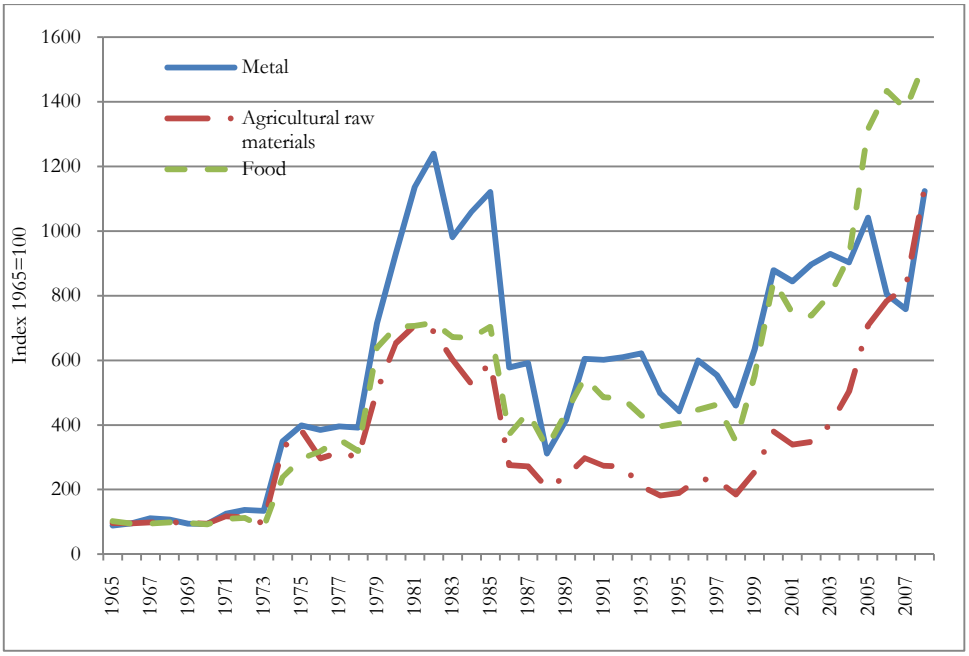


(Data Source: International Financial Statistics, International Monetary Fund, 2009, Figure including periodization and calculation[15] by the author)

[14] Fuel commodity prices are excluded from the category of other primary commodity prices since they have been moving fairly closely to oil prices.

[15] Relative oil prices are normalized by setting the first value in the series equal to 100. The relative oil price is then computed by dividing oil price by all other primary commodity prices.

Figure 14: Relative movement oil prices to prices of food, metals and agricultural raw materials (normalized), 1965-2008

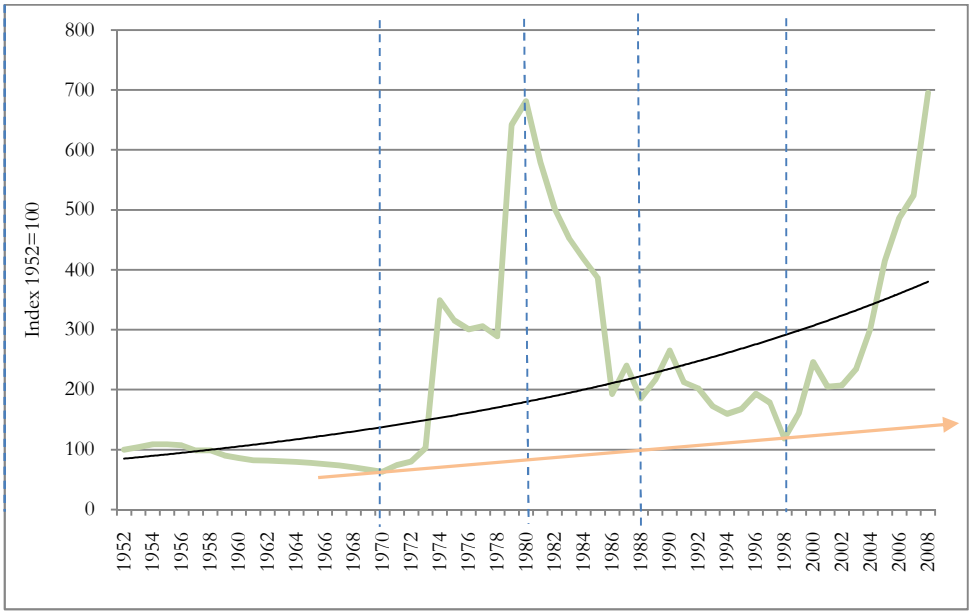


(Data Source: International Financial Statistics, International Monetary Fund, 2009, Figure including calculation by the author)

Finally, Figure 15 provides data on oil prices in relation to US consumer prices. US consumer prices are chosen as the deflator because it effectively translates US dollar oil prices into real oil prices[16]. Of particular note is the fact that the upward trend in oil prices in relation to US consumer inflation is less steep than in the caes of the trend in oil prices in relation to primary commodity prives, and oil prices in relation to US inflation in 2008 were barely higher than they were in 1981 (the previous peak). The distinction between the two will be relevant for explanations of oil price movements below.

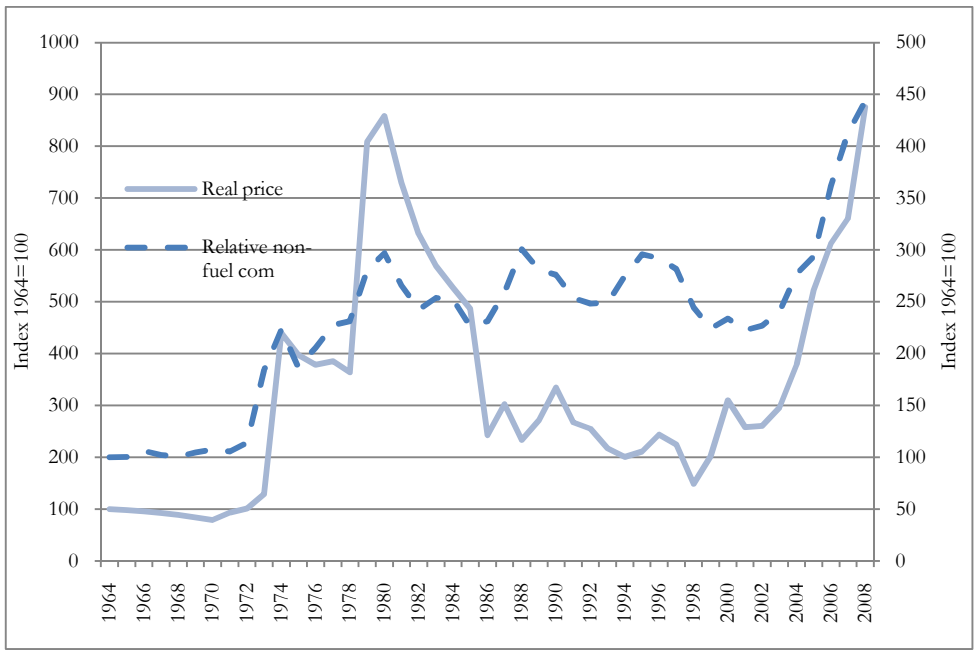
[16] It was noted in the literature review that the use of US consumer prices to deflate the oil price is common in the literature.

Figure 15: Real oil price (normalized), 1952-2008



(Data Source: International Financial Statistics, International Monetary Fund,2009,
Figure including periodization and calculation[17] by the author)

Figure 16: Real and relative price of oil (normalized), 1964-2008[18]



(Data Source: International Financial Statistics, International Monetary Fund,2009,

[17] The real oil price is taken to be the three spot oil prices deflated by US consumer prices.

[18] The chart does not include sub-grouping commodities (i.e., food, metal, and agricultural raw materials), since they move similar to other non-fuel commodities as shown in Figure 13.

Figure by the author)

4.3 Summary

This chapter studied three different types of price movement; 1) absolute oil price (US dollar), 2) relative oil price especially for non-fuel commodities, food, metals and agricultural raw materials, and 3) real oil price (relative to US consumer price). The latter two are considered as a basis for the study of cause and consequences of rising oil prices for reasons given in Chapter 2. What the data showed is that there is a long-term upward trend in real oil prices in relation to other primary commodities, and five identifiable sub-periods where trends were alternatively flat, rising, falling, flat and rising. The sub-period trends were apparent in both US dollar and real terms (both relative to primary commodity prices and US consumer price inflation.

Chapter 5 : Explaining trend movements in oil prices

5.1 Introduction

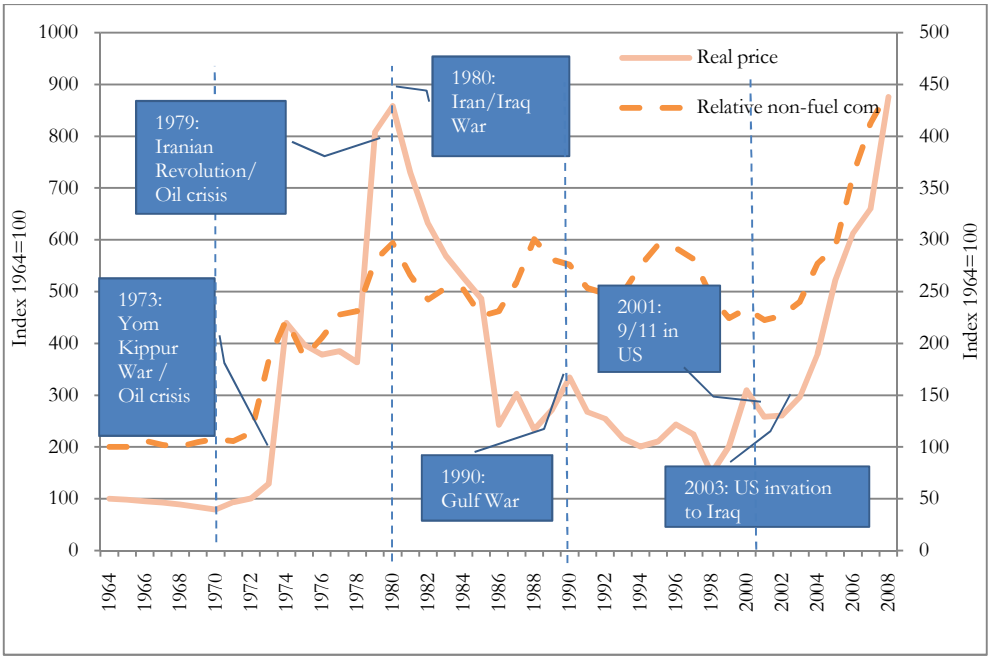
This chapter attempts to highlight the major factors underlying the trend movements in oil prices, and in particular the rise in relative oil prices that has already investigated in chapter 4 above. Main consideration will be given to both political and economic factors. Particular attention will be paid to the institutional setting underlying the economic factors. Moreover, strategic and environmental concern will be also taken into consideration particularly in most recent period (fifth sub-period). It will be argued in fact that these explain most of the trend rise in relative oil prices. I will begin with a consideration of the political factors. It has to be noted that the analysis in terms of length of the period is largely constrained by the data availability therefore some does not fully correspond to the period study in chapter 4.

5.2 Political factors

The political factors which are most often cited in the literature are political turbulences including wars and instability in the major oil producing and exporting countries, particularly those located in the Middle East. Of particular note in this regard corresponds to the periods in chapter 4 are the following; in the second period from 1971-1980, the Yom Kippur war (1973), Oil embargo (1973), Iranian Revolution (1979), and Iran/Iraq war (1980-). In the third and fourth period from 1981-98 the most notable incident is the first Gulf war in 1990/91. In the fifth period since 1999, there is the World Trade Centre bombing (2001) and the second Gulf war (Iraq war) in 2003. These political developments are shown in a chart along with relative oil prices (Figure 17).

What should be apparent from the figure is that while political factors most certainly have some bearing on certain sub-periods (most notably the second and last) movement, they cannot be argued to explain the long term trend rise in relative prices. Most importantly, there is no evidence of continuous and worsening political disturbances in the key oil producing and exporting countries of the world. Moreover, while the political turbulence in the Middle East region in the mid- and late-1970s undoubtedly contributed to the upward movement in oil prices during this time, and in the same way that the second Gulf war no doubt contributed to the rise in oil prices in the 2000s, the first Gulf war was followed by some period of fairly stable relative oil prices. In other words, political factors appear to reinforce other factors, but are not in themselves the major cause of long-term trends.

Figure 17: World political incidents with real and relative price (to other commodities) (normalized), 1964-2008



(Source: author)

5.3 Economic factors

The economic factors which are deemed to affect oil prices are mainly; the global business cycle, demand, supply related factors (costs and profits) and speculation. Underlying the economic factors, particularly the supply related factors and speculation are certain institutional structures.

5.3.1 Global business cycle

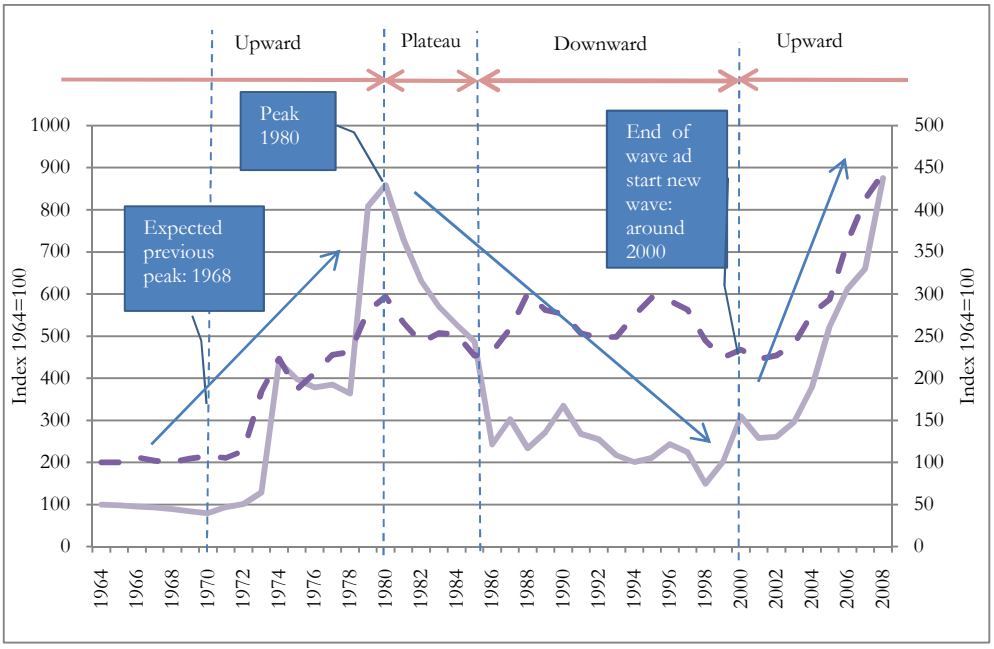
Business cycles are perceptible fluctuations in economic activity. Economists have traditionally identified three types of business cycle, differentiated from one another primarily by their duration. The three cycles are; long wave (or Kondratieff wave, 60-70 years), the Juglar (7-11 years) and the Kitchin (some 3-4 years). Of concern in the present study is the first of the cycles; the long wave, which is argued to be caused by major changes in technology[19]. It is seen as consisting of three different stages; the up-wave, the plateau (initial phase of decline with relative stability), and the down-wave. Most dating of long waves is done in terms of prices. According to most long wave theorists (e.g., Goldstein (1988)), the most recent long wave begins in 1940, reaches a peak in 1980, goes a trough in around 2000, thereafter giving way to a new up-wave.

[19] Prices corresponding to the long-wave are considered most relevant for the purposes of the present study since they pertain to long-term trends in prices, and it is these that are seen as being most important for assessing supply (and, therefore, environmental) consequences.

The empirical evidence on all other primary commodity prices certainly appears to corroborate this dating[20].

Consideration of trends in relative (and real) oil prices would suggest that these seem to follow the long cycle fairly closely; the up-wave causes relative (and real) oil prices to rise while the down-wave causes them to fall (see Figure 18). This would also mean that the rise in relative oil prices since the late 1990s might also be at least in part explained by a shift to the upward phase of the long business cycle in new wave. However, what this still does not explain is why oil prices have been rising relative to all other primary goods prices when looked at in terms of trends over the last 40-50 years[21].

Figure 18: Business cycle with real and relative prices (normalized), 1964-2008



(Source: Goldstein, 1988, Figure and price data by the author)

5.3.2 Demand of oil

As we saw in the literature review, one of the most popular explanations for the trends rise in oil prices, particularly since the late 1990s, is the growth of demand, particularly demand from fast growing emerging market economies. However, as Table 3 shows (data available from third period), it is unclear that there is any significant relationship between the rise in relative oil prices and the growth of quantity demand for oil. For example, although oil prices rose sharply in the period from 1999-2008 (last period) as compared with the

[20] For details on the theory of long-waves and the movement in different variables during different phases, see Tylecote (1991) and Freeman (1984).

[21] Thus, in relation to all primary goods prices (excluding energy) oil price have risen by more than 300% since 1964, and are currently 50% higher than at the peak of the last rise sharp rise in relative oil prices (i.e., 1980).

preceding 1989-99 (fourth period), world demand only rose marginally between the two period and demand in emerging economies actually fell.

Table 3: Changes in the price of oil and real oil demand, 1981-2008

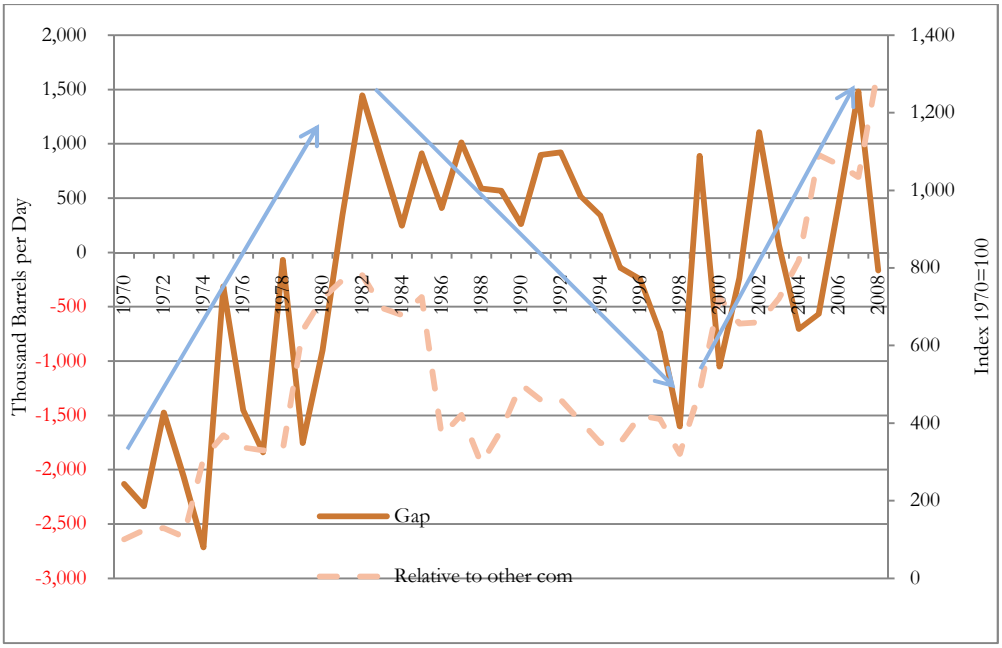
Period[22]		Third(1981-88)	Fourth(1989-99)	Fifth(1999-2008)
Oil Price Growth	Relative to other commodities	-49.64	2.43	92.38
	Real price	-12.71	-2.86	21.04
Real oil demand growth	World	0.39	1.32	1.45
	Emerging economies[23]	3.50	5.63	5.18

(Data source: All Countries, Total OECD, and World Total, Most Recent Annual Estimates, Energy Info rmation Administration, 2009, Table, price data and calculation [24] by the author)

Of course, it could be argued that what matters is so-called 'fundamentals', i.e., the demand for oil in relation to supply of oil or the demand-supply gap. Figure 19 presents the relevant data on this. At first glance, the data in this figure suggest some link between the demand-supply gap and relative price movements over different sub-periods. Thus, one sees excess supply in third period, excess demand in fourth period, and non systematic and rather volatile movement in fifth period, corresponding to rising, falling and then rising oil price trends. But what the data also shows is that the rise in the gap in the post 1998 period cannot possibly account for the sharp rise in relative prices over this period (especially when it is noted that the gap actually narrows towards the end of this period when prices are rising at their fastest).

[22] See Chapter 4 for a justification of the time periods used.
[23] It consists of China, India and Brazil.
[24] These are annual averages for the different periods.

Figure 19: Relative oil prices (normalized) and world oil demand and supply gap, 1970-2008



(Data source: International Petroleum Monthly, International Energy Administration, Figure, calculation and price data[25] by the author)

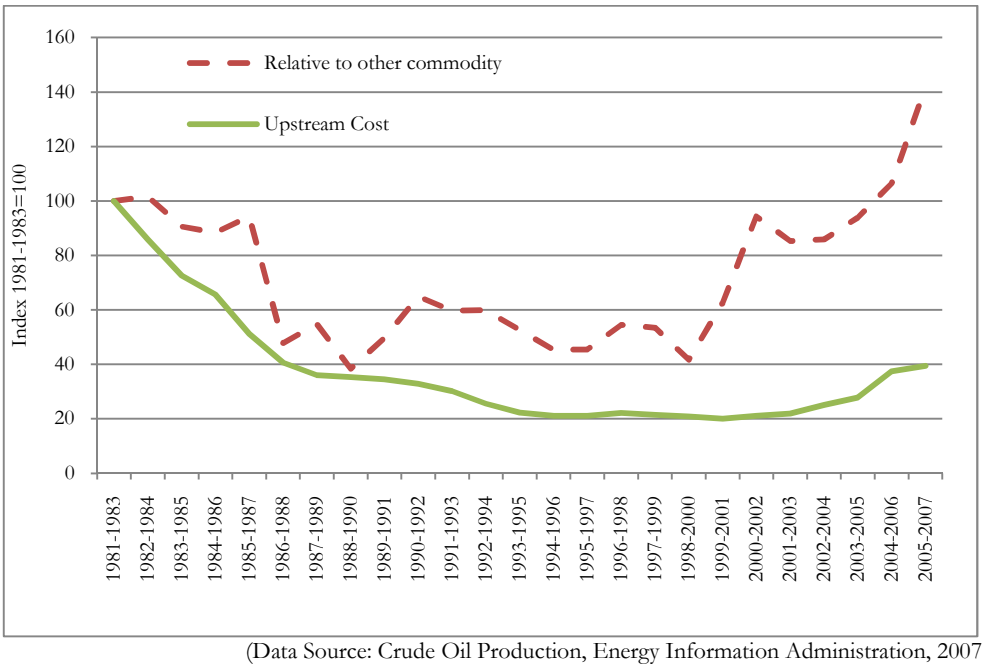
5.3.3 Supply side factors

Another factor that we have seen in the literature review has been invoked to explain oil price trends has been production costs, especially fixed production costs. One of the most popular of these theories is the so-called peak oil theory. Figure 20 provides data on unit fixed costs[26], and relates these to oil prices. One drawback with the cost data is that they are only available from 1981 onwards. These data are computed on a three year average basis, hence the accompanying price data are computed on a similar basis for the purposes of comparison. What the figure suggests is that costs may most certainly have been a factor in explaining the downward trend in real oil prices from 1981 to 1998 (the third period) and the subsequent upward trend in the post 1998 period (the fifth period). However, it is of note that costs did not appear to rise until about 2003, and even then by nowhere near as much as the rise in real oil prices with showing the lower degree of increase.

[25] The demand and supply gap is computed to be the quantity demanded minus the quantity supplied.

[26] Fixed cost is one of the two elements of total cost for production (the other is variable cost). According to EIA, fixed cost for oil producers is so-called "upstream cost". It substantially varies in locations due to the characteristics of reservoir (such as pressure) and nature of crude oil. Generally, total upstream cost consists of both a) "lifting cost" (bring up crude oil from ground to surface), and b) "finding cost" (exploring and developing the oil fields) (Energy Information Administration n.d.b).

Figure 20: Fixed cost with relative oil price (to other commodities) (normalized), 1981-2007[27]



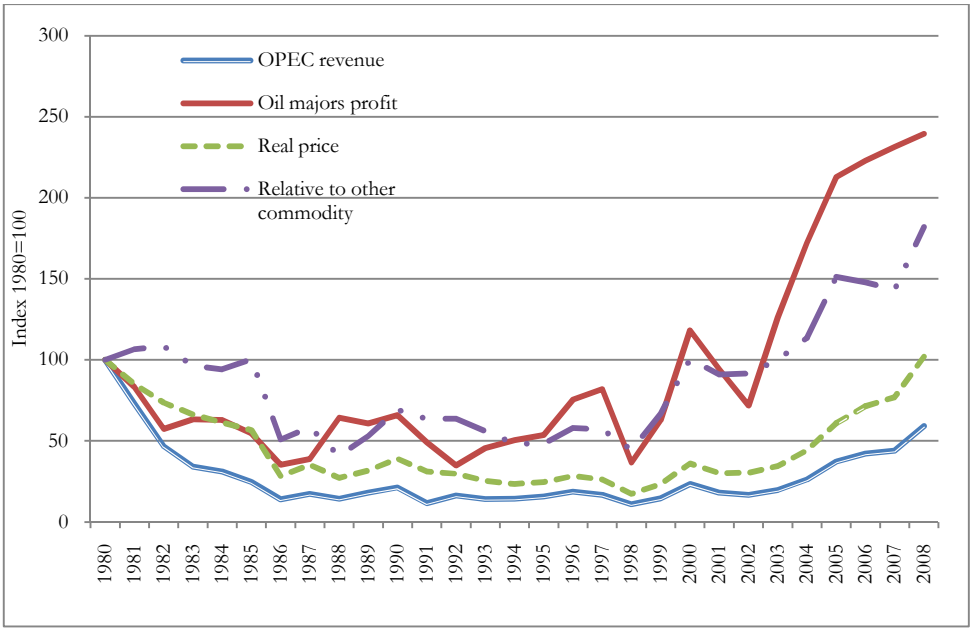
(Data Source: Crude Oil Production, Energy Information Administration, 2007
Figure and price data by the author)

In fact, data on revenues and profits of oil majors seem to belie the cost push explanation of rise in oil prices, and would seem to suggest that the primary reason for the rise in the latter, certainly the rise in relative oil prices since 1998, is the ability of the oil majors and oil producers to drive up prices and thereby enhance their own profits (see Figure 21). If rising costs had been the driver of higher oil prices, we would not have seen profits growth of this order. Thus, since 1998, real profits of oil majors have risen by some 553%, while real income of OPEC producers has risen by 436%. It is of note that the oil majors also make profits through their control of the distribution of oil in the form of diesel and gasoline – and the additional charges for these too.

The important condition for the increased ability of oil majors and producers to drive up prices has undoubtedly been restrictions in supply. The relevant data were presented above (see Figure 19). But two other factors which appear to have had a bearing on the recent rise in prices, i.e., since the late 1990s, are 1) speculative activity and 2) the acquiescence of the advanced countries for strategic and environmental reasons. I will look at each of these in turn at the following section.

[27] Other primary commodities (raw materials) can generally be regarded as a good approximation of input (variable) costs.

Figure 21: Oil price, OPEC revenue and Oil major profit in real term (normalized), 1980-2008



(Data source: OPEC Revenues Fact Sheet, Energy Information Administration, 2009 and Revenue, Operating Costs, Deductions, Taxation and Net income of the Major Oil Companies, Organization of the Petroleum Exporting Countries, Figure, calculation and price data[28] by the author)

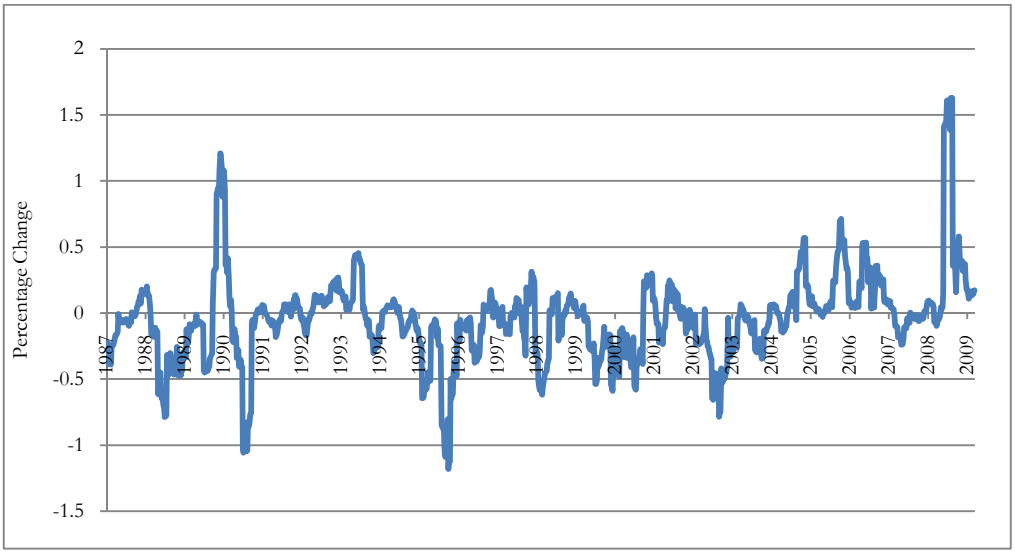
5.3.4 Speculation

One of the ways in which the oil majors (and OPEC producers) have been able to drive up absolute (money, nominal) and relative oil prices in the period after 1998 is through their intervention in the futures market. We noted in the literature review studies which suggested a growing collusion of oil majors and western banks to drive up prices. Indeed, there is now a widespread consensus that this type of futures market speculative behavior involving oil majors and even oil producers has been a major factor in the upward movement of oil prices in the recent past.

Some indication of the extent to which futures prices have been driving up spot prices can be gotten from the following chart (Figure 22) plotting the future/spot price differential for the period May 1987 to October 2009. For the most part futures prices fluctuate around spot prices such that the moving average differential fluctuates around zero. What this chart shows is that in the post-2004 period, the differential is not only positive but has been increasing over time – confirming the suspicion that the futures market is the tail that is wagging the spot market dog.

[28] Oil major profits and OPEC revenue data were deflated by US CPI.

Figure 22: Relative future to spot prices, 1987-2009



(Data Source: Weekly Cushing, OK Crude Oil Future Contract 1 and Weekly Cushing, OK WTI S pot Price FOB, Energy Information Administration, 2009, Figure and calculation[29] by the author)

5.3.5 Strategic and environmental considerations

It was noted in the literature review in chapter 2 that high oil prices may also be in part the result of more concerted attempts by advanced country attempts to diversify energy production both in respect of strategic considerations (i.e., energy security) and environmental concerns (i.e., particularly for global climate change). Given that the security (read military) cost of maintaining oil supplies to the advanced countries has been growing, while the reliability of the flow of oil to these countries has been declining (viz., the war in Iraq, the growing conflict in Afghanistan and growing strong nationalism by oil rich countries such as Venezuela), it is only natural that there should be an attempt to develop alternative sources of oil including unconventional oil (with the largest reserves known to exist in North America), and more generally alternative source of energy in order to secure (future) supply. As we have seen the rise in prices in the recent period (after 1998) appears to have been driven by the oil majors and producers. Unlike the 1970s rises in oil prices, the increase of the recent price have not elicited the same hostile responses from the governments in the advanced countries, suggesting that they have at the very least acquiesced to the increases.

It warrants remarking in this context that, the production of unconventional oil is very costly and would require exceptionally high subsidies from governments, unless the price of oil was enough to make such production viable. A study by Bartis et al. in 2005 suggested that oil prices would need to rise to between US$70 and US$95 per barrel at 2005 prices (i.e., between US

[29] Three month moving averages of future minus spot oil prices divided by spot oil prices.

$ 80 and US $ 105 at today's prices but without allowing for the fall in the value of the US dollar) for unconventional oil production to be privately sustainable (Bartis et al. 2005). In OPEC calculation, the range of $50-70 per barrel in future price (specifically WTI, in absolute term) is required for the new oil sand projects to be sustainable (Organization of the Petroleum Exporting Countries 2009c). Certainly, as we will see in Chapter 6, the large investments undertaken by the oil majors in unconventional oil production would suggest that they see oil prices remaining at this level, notwithstanding possible contractions in demand.

High oil prices are similarly important for the promotion of non-oil energy production, both environmentally-friendly and unfriendly. It has long been argued that the production of energy from agricultural products such as biofuels could address both security and environmental concerns. But, once again, for this production to get going and be financially sustainable the price of energy (specifically oil) needs to be high.

5.4 Summary

This chapter attempted to understand the reasons behind the long-term relative price movement in terms of economic, political and institutional factors. It was shown that while price movements over the longer term are the result of a combination of factors, over the recent past (post 1998), they were primarily the result of institutional (political) factors. Of particular note in this regard is the institutional setting in which oil majors and producers have been able to drive up prices with the apparent concurrence of advanced country governments.

Chapter 6 : The environmental consequences of trends in global oil prices

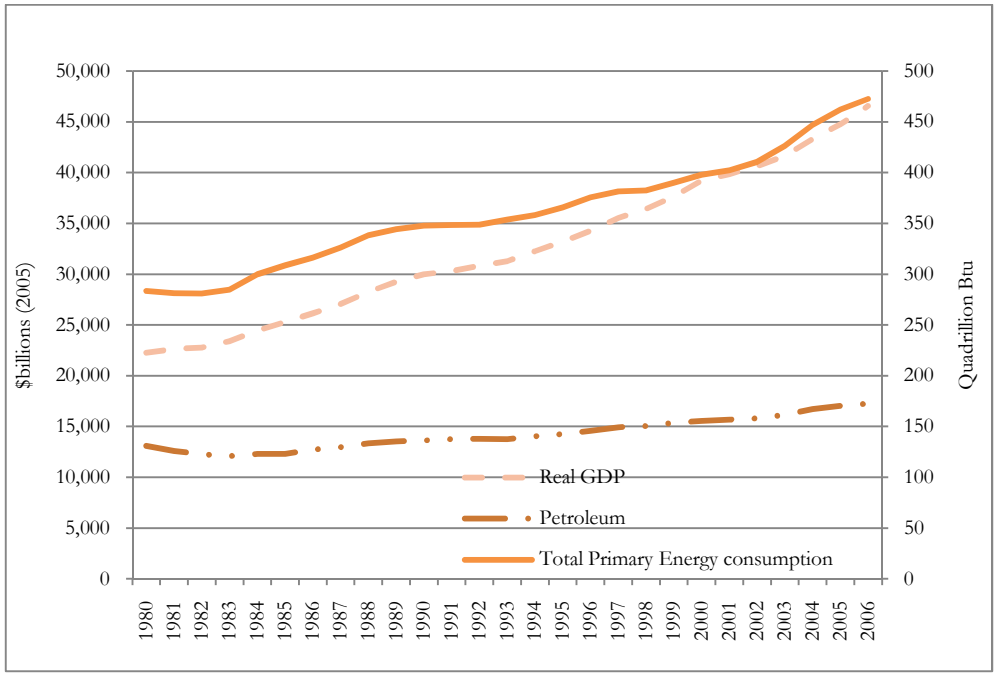
6.1 Introduction

This chapter aims to analyze the environmental consequences of the rising trend in relative oil prices by focusing on two major factors: 1) the demand for oil 2) the supply of oil and, more importantly, the shift to alternative energy sources. When looking at the supply impact on alternative energy sources emphasis will be placed on the distinction between environmentally friendly and environmentally unfriendly energy sources in accordance with the discussion of chapter 3. The analysis faces limitations in regard to the difficulties for the collection of the (raw) data, especially related to price for renewables and government support such as subsidies.

6.2 Demand consequence

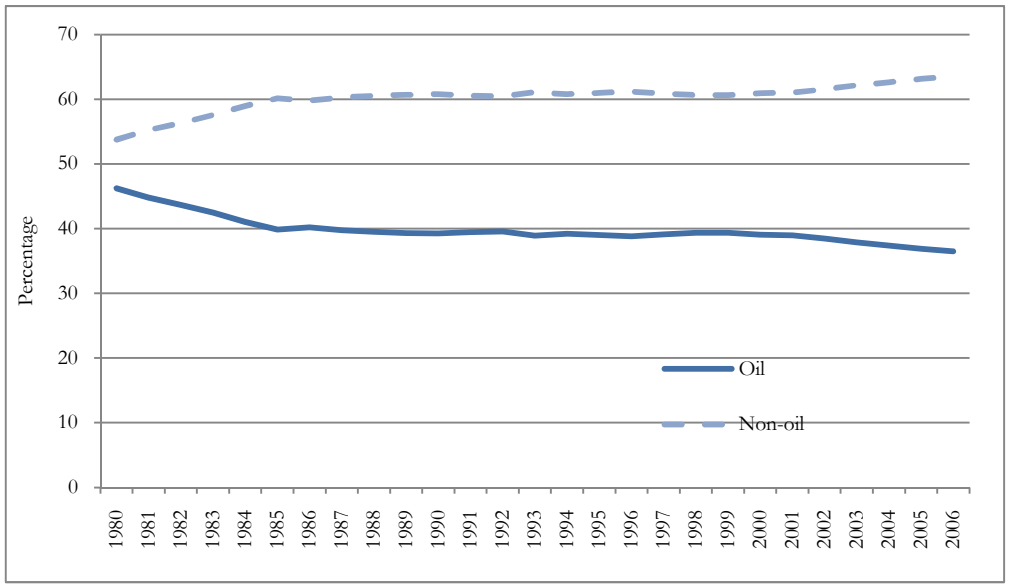
From the literature review in chapter 2, one would expect to see the responsiveness of oil demand to oil price rises being fairly limited, and with most of the responsiveness coming from longer-term substitution effects – shifts in consumption to non-oil energy sources. Figure 23 suggests that there has indeed been such a shift in the composition of energy consumption. The chart relates primary energy and oil consumption to world GDP (at constant prices) for the period 1980 to 2006. It shows, as one might expect primary energy consumption rising together with real world GDP. That the rate of growth of the former is somewhat slower than the latter would seem to suggest energy efficiency gains over time. The considerably slower rate of growth of oil consumption in relation to total energy consumption would suggest that there has been a shift from the former to consumption of alternate energies. This is confirmed by Figure 24 which plots the share of oil and non-oil energy consumption. It may be seen from this figure that the share of oil falls from 46.2% of total primary energy consumption in 1980 to 36.5% of the total in 2006, while the share of non-oil primary energy consumption rises correspondingly from 53.8% to 63.5% between the same two dates.

Figure 23: Primary energy consumption and real GDP, 1980-2006



(Data Source: International Energy Outlook 2009, Energy Information Administration, 2009 and International Macroeconomic Data Set, Shane (USDA) , 2008, Figure by the author)

Figure 24: Consumption shares: Oil and non-oil energy sources[30], 1980-2006



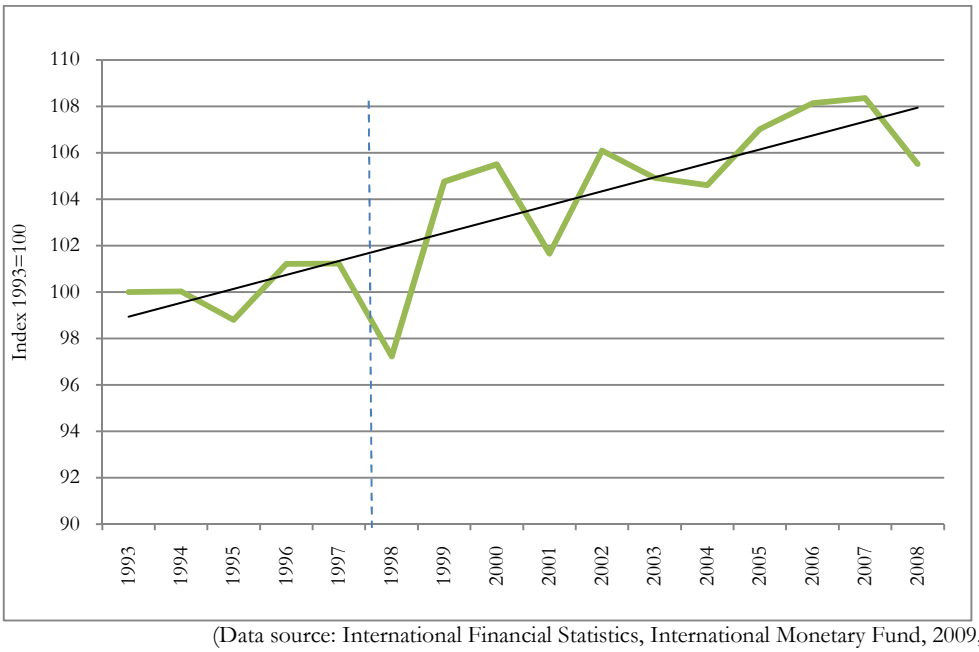
(Data Source: International Energy Outlook 2009, Energy Information Administration, 2009, Figure and calculation by the author)

When one looks at the relative price movements however, it is doubtful if the substitution effect has resulted from a shift in the relative price of oil – that is,

[30] Non-oil energy sources include coal, natural gas, nuclear and renewables.

relative to other energy sources. Figure 25 is a plot of the price of oil in relation to alternative (coal and gas) energy sources from 1993 to 2008 (the period for which data are available). Although there is most certainly a rise in the relative price of oil over the period under consideration, it amounts to between 5% and 6% (or about one thirds of a percentage point per year). This would suggest that the substitution effects have more to do with non-price related shifts in supply than demand.

Figure 25: Oil relative to other energy prices (normalized), 1993-2008



(Data source: International Financial Statistics, International Monetary Fund, 2009, Figure and calculation by the author)

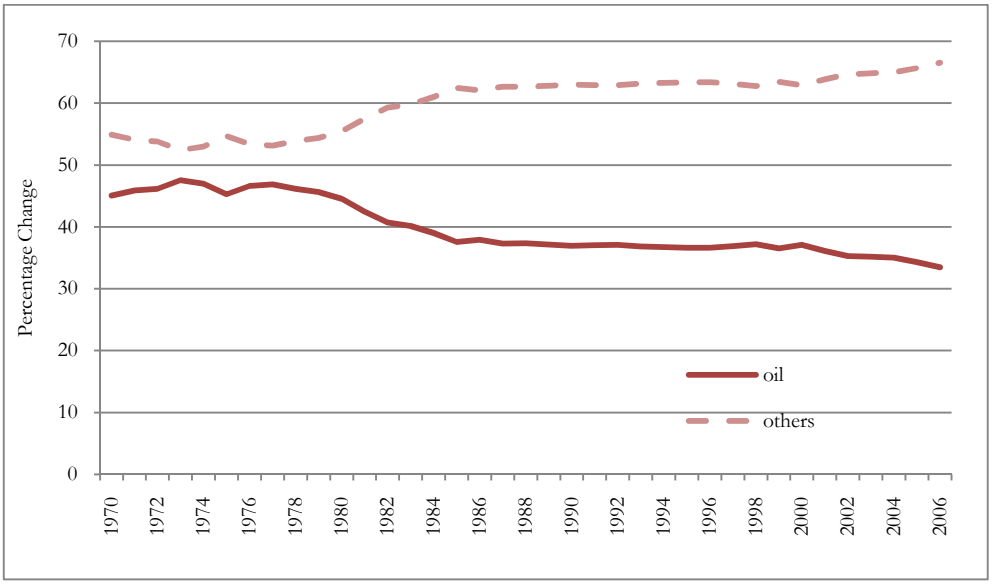
6.3 The impact on alternative energy supply

6.3.1 Oil production

Theoretically, the relative rise in oil prices and revenues/profitability of the sector should have elicited an increase in oil supply. However, what is evident is that while there was most certainly an increase in oil supply, it did not keep pace with world primary energy consumption. Indeed, relative oil production – relative to other energy[31] production - even fell (see Figure 26). This would suggest in fact that the rising real oil revenues of oil producers and earnings of the oil majors were at least in part the result of (possibly deliberate) restrictions in supply – confirming findings of several studies noted in the literature review.

[31] Other energy is taken here to be coal, natural gas, nuclear, hydro and geothermal and others.

Figure 26: Production shares: Oil and other energy sources, 1970-2006

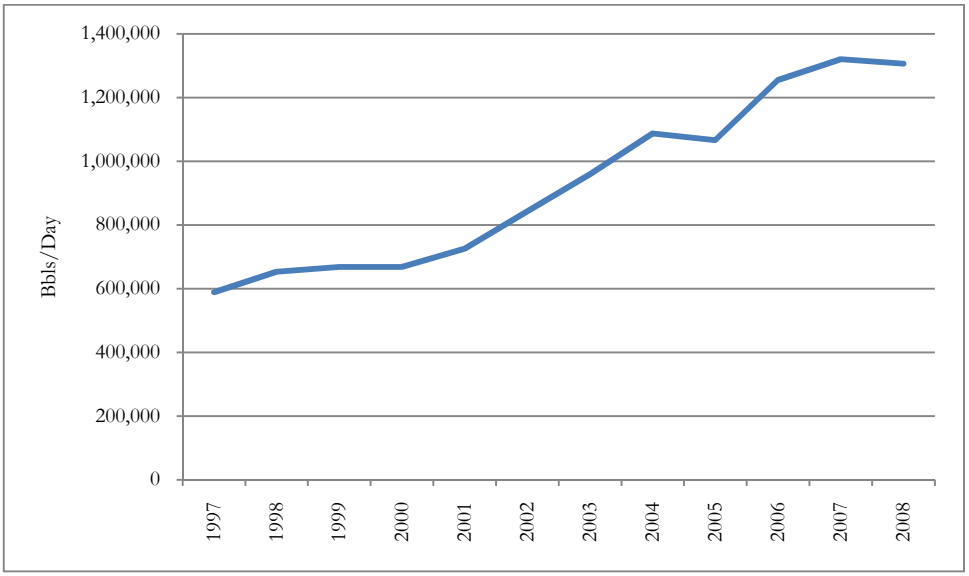


(Data Source: Annual Energy Review (AER), Energy Information Administration, 2009, Figure and calculation by the author)

While there has been no significant oil production response, it warrants noting that there has been some response in terms of investment and production in what is referred to as "unconventional oil". Although production of unconventional oil is still embryonic and information on it is sketchy, some indication of the production response can be gathered from the following chart of unconventional oil production in Canada. The Canadian data is pertinent because Canada is presently the largest commercial producer of unconventional oil. It may be seen from these data that since the late 1990s, when oil prices began to rises, production of unconventional oil has been rising similarly sharply (see Figure 27).

As for the environmental consequences of the growth of this alternative energy source, it is generally agreed that unconventional oil production is more damaging to the environment than conventional oil production since its production requires larger amounts of fresh water than conventional oil production, and the heavy crude tend to release larger CO_2 than in the case of conventional oil (Mills 2008).

Figure 27 Oil sands[32] production in Canada (Alberta), 1997-2008



(Data source: Government of Alberta, 2009, Figure by the author)

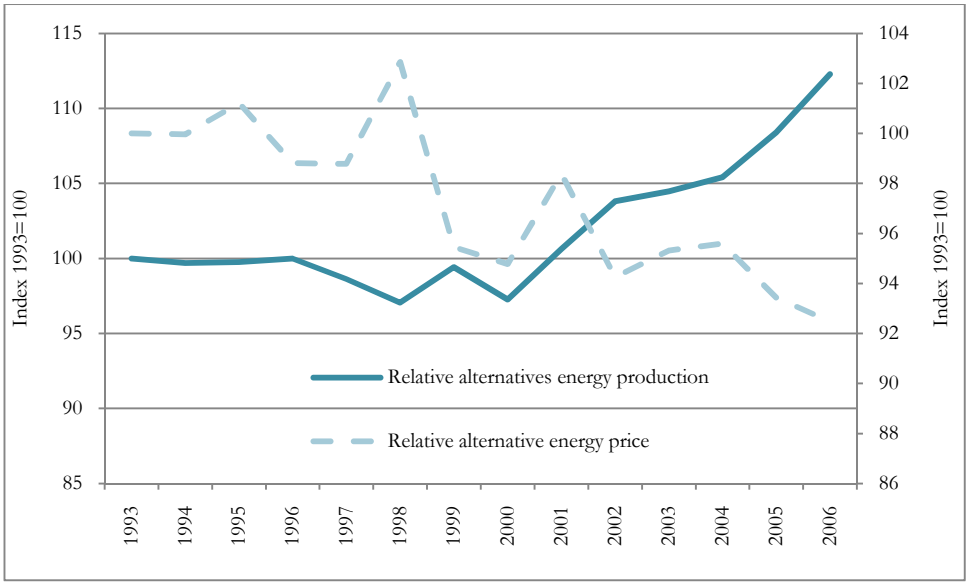
6.3.2 Alternative energy production

As we saw above, although oil production did not keep pace with the growth of the world economy, the supply of alternative (non-oil) energy certainly has (allowing for gains in efficiency of energy use). It may be seen from Figure 27 that relative to oil the production of alternatives has risen, especially after 2000, but that the rise has not been due to a rise in the relative price of alternatives vis-à-vis oil.

Of course, what matters in terms of the environmental consequences of this rise in alternative energy production is whether it represents an increase in environmentally friendly or environmentally unfriendly energy supply. Figure below (Figure 29) suggests that from 1970 up to the late 1990s, the rise in share of alternative energy has been due to a rise in share of environmentally friendly alternative energy, but since the late 1990s, that is since the beginning of the rise in oil prices, the rise in alternative energy production has been largely accounted for by non-friendly alternatives, mostly coal production. Certainly, one reason could be the sharp rise in oil prices have had a commensurate increase on coal prices, making previously unprofitable coal deposits much more profitable (Figure 30). Another could be the greater flexibility in use of coal as an energy source (e.g., in electricity generation) given the technologies available in the recent past.

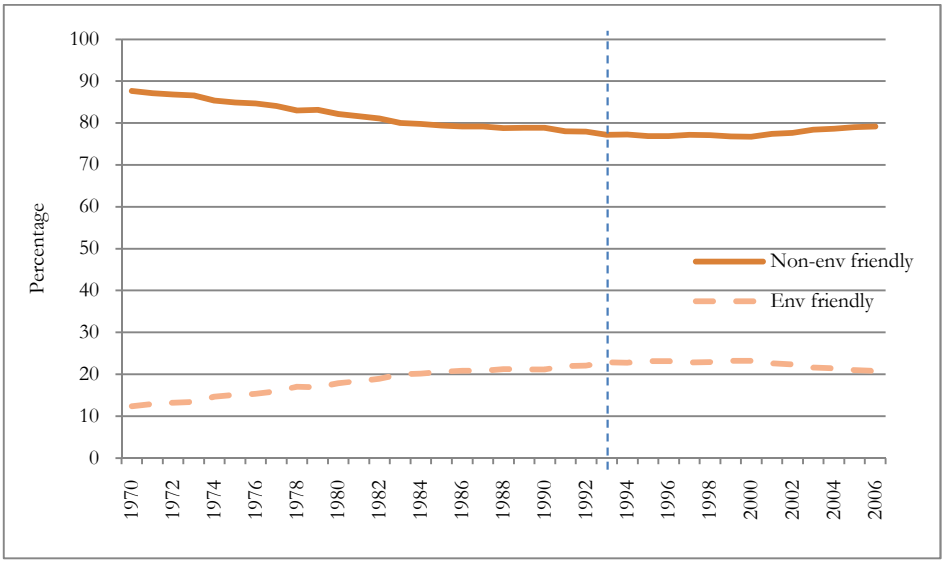
[32] Specifically crude bitumen (one of the unconventional oil types).

Figure 28: Oil price/production relative to alternatives[33], 1993-2006



(Data Source: International Petroleum Monthly: Petroleum (Oil) Supply, Energy Information Administration, 2009, and International Financial Statistics, International Monetary Fund, 2009
Figure, price data and calculation[34] by the author)

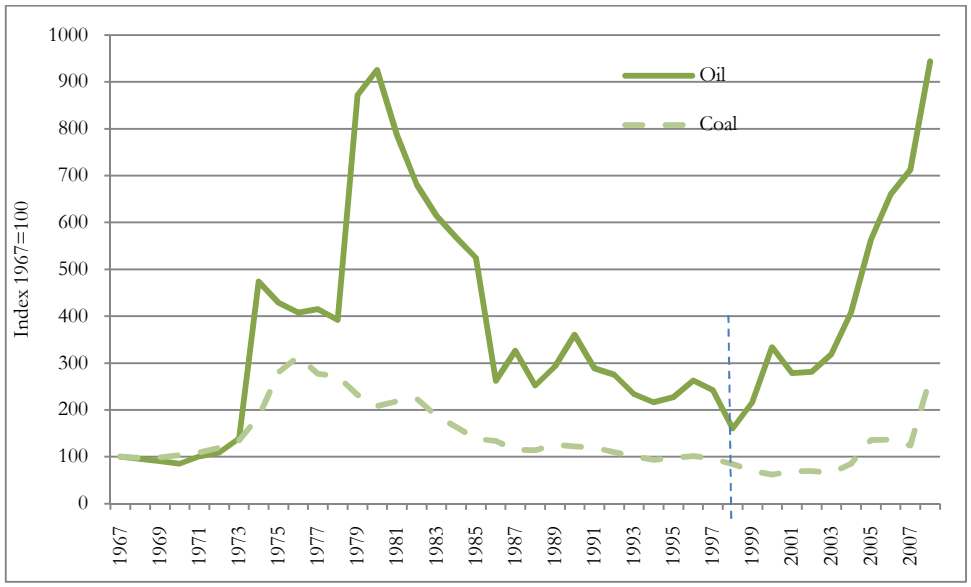
Figure 29: Production share: Environmentally friendly and unfriendly energy sources (excluding oil) [35], 1970-2006



(Data Source: Annual Energy Review (AER), Energy Information Administration, 2009,
Figure and calculation by the author)

[33] Alternatives include coal, natural gas, nuclear, hydro, and geothermal and others.
[34] Relative alternative energy production is the normalized quantity of alternatives in relation to oil. The relative price of alternatives is the normalized price of alternative energy relative to oil.
[35] Environmentally friendly sources include nuclear, hydro, and geothermal, while coal and natural gas are categorized as environmentally unfriendly sources.

Figure 30: Real oil and coal prices (normalized), 1967-2008

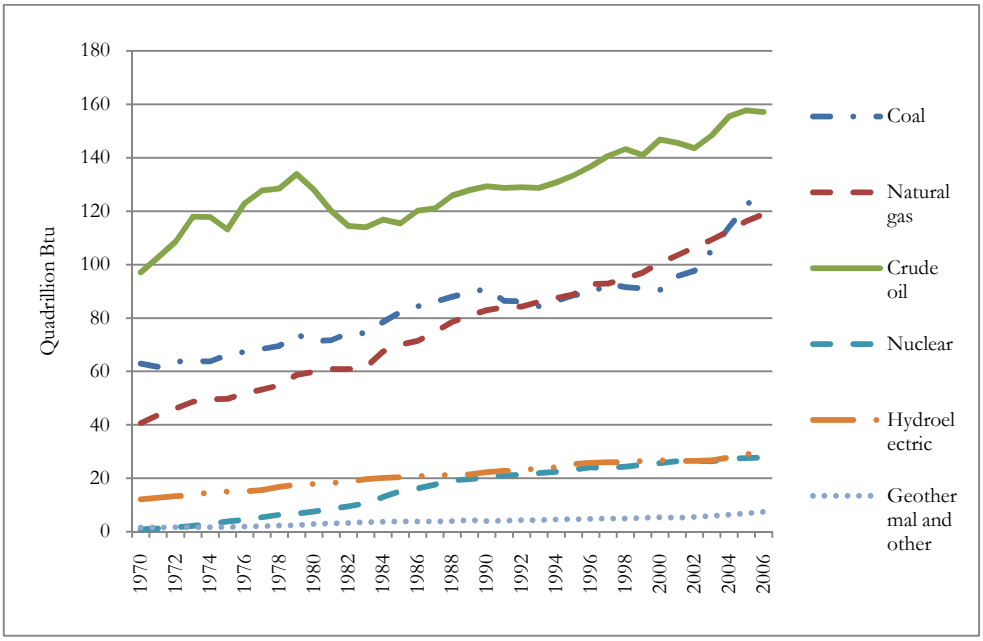


(Data Source: International Financial Statistics, International Monetary Fund, 2009, Figure and calculation by the author)

The rise in the environmentally friendly alternative production sources up to the late 1990s was largely due to the growth of nuclear and hydroelectric power (see Figure 31). Significantly, thus far there appears to have been little or no production impact on other renewable energy sources, such as wind, solar, and the like. One reason has no doubt been the considerable costs involved[36]. Many environmentalists do not see nuclear power and hydropower as environmentally friendly, and possibly more damaging to the environment than the burning of fossil fuels in terms of nuclear waste, air and water contamination, and the damage done to the natural environment.

[36] See REN21 (2008), UNEP(2009) and IEA (2004)

Figure 31: World primary energy production by source, 1970-2006



(Data Source: Annual Energy Review (AER), Energy Information Administration, 2009, Figure by the author)

6.3.3 Alternative energy investments

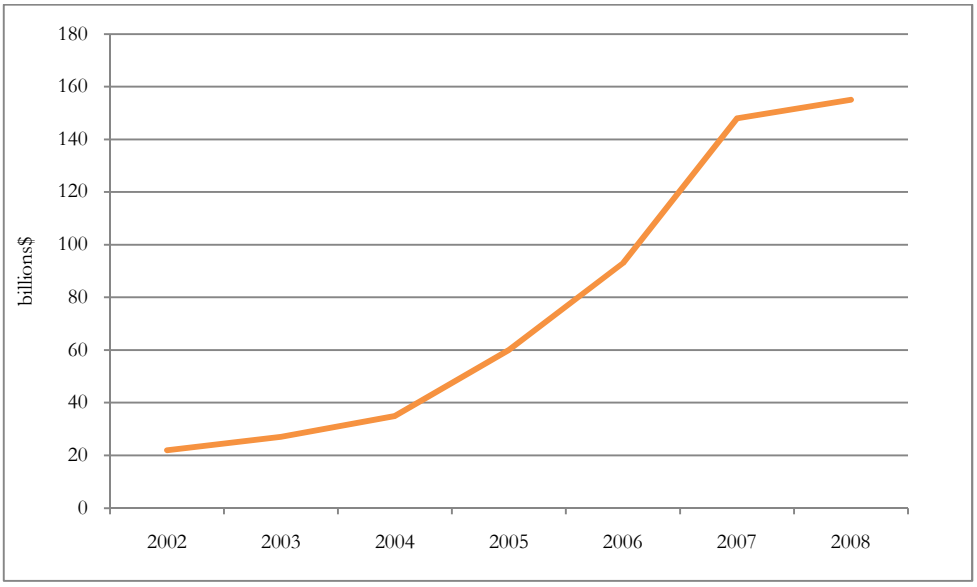
This is not to say that the higher oil prices have had no simulative impact on the alternative energy industry, particularly the environmentally friendly sector. UNEP recent data shows investment in renewable energy sources has been growing rapidly of late, paralleling the rise in oil prices (see Figure 32). As Figure 32 shows, investment in sustainable energy has risen sharply since 2002, recording a sevenfold increase from 2002 to 2008. With large gains in terms of efficiency, the commercial potential of the sector seems to be considerable. To put this data in some sort of context, one might note that in 2008, "new power generation investment in renewables was greater than investment in fossil-fueled technologies" (United Nations Environment Programme, New Energy Finance Limited 2009:11).

It needs pointing out, however, that the rise in oil prices is only part of the story with regard to the rise in investment in renewable energy. The rise in oil prices certainly creates the necessary condition for the increase in investments in renewable energy, i.e., the necessary profits environment, but without state direct and indirect support, it is unlikely that such increases in investment in the sector would have taken place given the massive (start-up) costs and risks involved with alternative energy production.

Consistent and comprehensive data on the extent of support given is difficult to come by, but the following data is perhaps indicative of the support given in advanced countries. Consider, for example, the following chart (see Figure 33) comparing US energy subsidies for 1999 and 2007. Although all energy subsidies rose between the two dates, the increase in subsidies for the renewable dwarfs the other increases. Of note is the fact that subsidies for

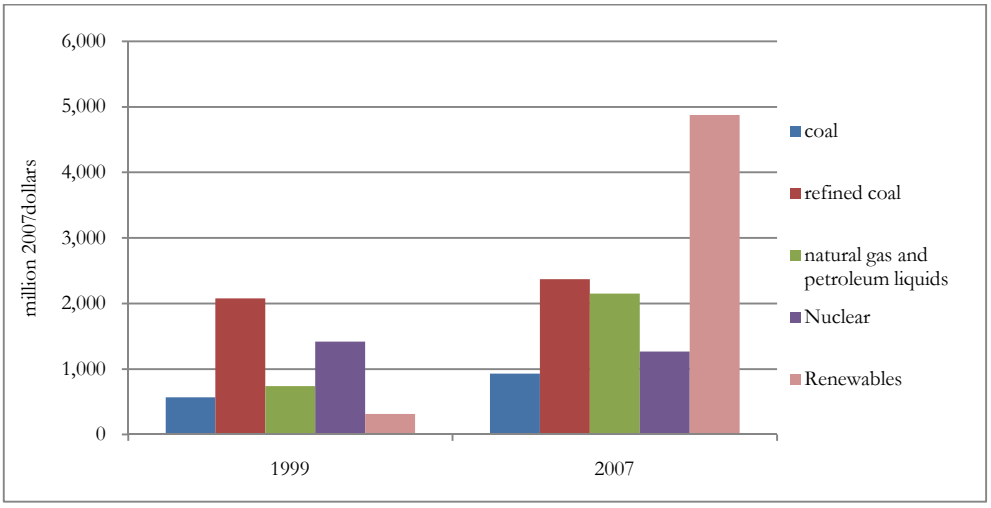
natural gas and petroleum liquids has also risen, but not by nearly so much as for renewable. Consider also Figure 34 which shows that the binding energy target of the EU by renewables for 2025. It should be noted that they are more than double the current target levels.

Figure 32: Investment in sustainable energy, 2002-2008



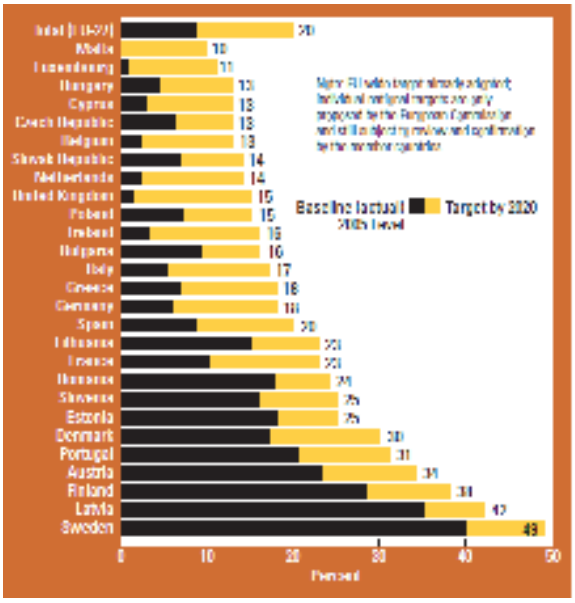
(Data Source: Global Trends in Sustainable Energy Investment 2009, United Nations Environment Programme and New Energy Finance, 2009, Figure by the author)

Figure 33: US energy subsidies to electricity production, 1999 and 2007



(Data Source: Federal Financial Interventions and Subsidies in Energy Markets 2007, Energy Information Administration, 2008, Figure by the author)

Figure 34: EU renewable energy targets share of final energy by 2020



(Source Figure: Renewables 2007 Global Status Report, Renewable Energy Policy Network for the 21st Century, p.22, 2008)

6.4 Summary

This chapter attempted to analyze the environmental consequences of rising relative oil price. Particular focus was on the demand and supply of oil, and supply of alternatives to oil distinguishing environmentally friendly and unfriendly energy sources. It was shown that higher oil prices did not have much of a demand effect. Certainly, the substitution from (conventional) oil to other non-oil energy sources occurs in both oil consumption and supply on oil, however the causality between relative price and this shift is less accountable. Non-conventional oil production shows steady rise in recent period in correspondence with high price however it did not reflected to the supply on total oil production. With regard to alternatives supply, the environmentally friendly source production is largely limited at current climate. High oil price is merely the condition rather the strong government support is crucial factor to sustain the renewable sector viable.

Chapter 7 : Conclusions

The primary focus of this research has been the environmental consequences of higher oil prices. The premises of the study were that an understanding of these consequences would require a prior understanding of the causes of the rise in prices and both (the causes and consequences) in turn would require an understanding of the nature of the rise in prices i.e., whether the rise was nominal or real – whether they rose relative to other prices.

The major findings of the study as regards trends are that there has been a long upward trend in oil prices in absolute and relative terms, especially in relation to all other primary commodity prices. It is noted that one can distinguish into possibly five distinct sub-phases involving changes in trends, with the most recent trend beginning in 1999 and being sharply upward.

In terms of the causes, the key finding is that the recent upward movement in oil prices is fundamentally due to institutional factors, permitting oil major, producers and speculators (with a pivotal role played by investment banks) to apply continuous upward pressure on prices. Perhaps the most startling finding in this regard is the increase in real profits or oil majors (553%) and revenues of OPEC (435%) accompanying the 478% rise in real oil prices in the post 1998 period. It was argued that strategic and environmental considerations may well have encouraged governments of advanced countries to turn a blind eye to the collusive behavior of these agents. Factors such as the alleged demand pressures emanating from fast growing developing countries such as China were shown to have had little or no impact on prices, and doubt was also cast on the cost-push thesis, whether emanating from peak-oil or other sources. It needs acknowledging that in general these findings are at odds with most of the literature, which sees the driving forces behind the rise in price as economic and within economic either demand or cost push factors, or a combination of the two.

The analysis of the consequences of oil price increases revealed that the rising trend in oil prices had at best only a modest effect on the demand for oil. It was argued that the relatively lower growth in oil demand as compared with world GDP was most likely due to efficiency gains and not reductions in consumption *per se*. It was also argued that the apparent switch in consumption to alternate sources had little to do with the rise in the relative price of oil compared to other energies, since this rise was shown to be quite small. The demand analysis undertaken in chapter 6 in fact confirmed the view of many authors that the price elasticity of oil demand is fairly low.

The supply analysis revealed firstly that oil supply contracted in spite of the rise in oil prices in the post-1998 period, and notwithstanding a rise in non-conventional oil production, suggesting that one reason for the rise in prices was the (deliberate) restriction in supply. It was also shown that there has indeed been some shift in production to alternative sources, but that most of

the shift has been towards (broadly defined) "non-friendly" environmental sources, primarily coal production. This was seen to confirm the general findings of the literature. Although there was no significant rise in the share of alternative environmentally friendly energy production, data was presented which showed that the higher oil prices were accompanied by a sharp increase in investments in alternative energies. However, in keeping with findings of other studies, it was argued that these increases in investments owed far more to state support than the rising oil prices.

What all of this suggests is that higher oil prices in themselves cannot be argued to encourage a shift in demand and supply of energy towards more environmentally friendly sources, and certainly not if the narrower definition of what constitutes "environmentally friendly" is adopted. In this context, one might wonder whether the negative economic consequences of higher relative oil prices, which have been argued above to be at least in part with government consent, justify the meagre gains in terms of the shifts in consumption and production towards alternate energies which have hitherto taken place. Would it not have been better, at least in terms of the environment, to use some of the revenues channelled to the oil majors, producers and speculators, to directly support the expansion of alternative energy production and consumption?

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