Oil Prices and Terms of Trade
-A comparison between Saudi Arabia and the United States -

Master Thesis in Economics
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Abstract

One of the central issues in international macroeconomics is relative price movements and their sources. One such price is the price of crude oil. An increase in oil price leads to a transfer of income from importing to exporting countries through a shift in terms of trade. The general mechanism by which oil prices affect the economic performance is well understood. However, the dynamics of these effects – especially the adjustment to the terms of trade – are uncertain.

The purpose of this paper is to analyse the impact of an increase in oil price on the terms of trade during the time period 1970 to 2004. The relationship between oil price and world business cycle as well as the relationship between oil price, GWP and Saudi Arabia’s export is also examined in this paper.

The regression results show that an increase in oil price has a negative impact on terms of trade for the net importing country. Whether an increase in oil price has a positive or no effect at all on terms of trade for the net exporting country cannot be told from the regression results.
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**Titel:** Oljepriser och handelsvillkor – en jämförelse mellan Saudiarabien och USA

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**Sammanfattning**


Regressionsresultaten visar att en ökning av oljepriset har en negativ inverkan på handelsvillkoren för ett nettoimporterande land. Huruvida en ökning av oljepriser har en positiv inverkan eller ingen inverkan alls på ett nettoexporterande land går inte att svara på genom de utförda regressionerna.
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**Appendix I** Crude Oil Production – Non-OPEC Countries

**Appendix II** Crude Oil Production – OPEC Countries
1 Introduction

One of the central issues in international macroeconomics is relative price movements and their sources are continuing to be an object of speculation and debate. One such price is the price of crude oil. Price reporting has become an important part of the oil industry. Every day deals worth hundreds of millions of dollars ride on the published assessments, and the nature and structure of oil reporting creates trading opportunities and new markets and affect the behaviour of oil traders (Hornsnell and Mabro, 1993).

Oil prices still matter to the health of the world economy and remain important determinants of the global economic performance. Fears of OPEC (Organisation of Petroleum Exporting Countries) supply cuts, political tension in Venezuela and tight stocks have all driven up the international crude oil and product prices even further. Current market conditions are more unstable than usual, mostly because of geopolitical uncertainties and tight product markets reinforcing upward pressure in crude oil.

Many believe that a new oil price shock is to be expected, although there are some disagreement regarding the potential effects of a oil price shock. Some argue that these increases in oil prices will lead to a recession like to those that followed the 1973 and 1979 energy crises or a potentially worse situation such as a global oil crash. However, most economists view this as an unlikely scenario, partly due to the high fuel taxes all developed countries have, which decrease as oil prices increase and can be removed in the event of a dramatic price hike. Nevertheless, that loss of revenue would put a strain on government balance sheets.

Some economists believe that peak oil soon will be reached and others argue that the level has been past already. Peak oil is the point in time when the extractions of oil from the fields have reached its highest point and is declining, which can create a global oil crisis. Crude oil price doubled between 2001 and 2005, but oil companies have only increased their budget for exploring new fields by a small fraction. Even as established oil fields have reached their maximum capacity, there has been disappointing production from new fields. Globally, according to some geologists' estimates, we have discovered 94 percent of all available oil. No one is suggesting that the world oil industry is close to pumping its last drop. However, the question now being raised is whether new reserves can be discovered fast enough to both replace depleted oil fields and keep up with growing demand.

If price elasticity were low, an increase in oil price would lead to a transfer of income from importing to exporting countries through a shift in the terms of trade. For net importing countries, increase in the oil prices lead to a reduction in real national income, due to the increase of spending on oil. For net exporting countries, a price increase will directly improve the real national income.(Birol, 2003)

The general mechanism by which oil price affect the economic performance is well understood. However, the dynamics and magnitude of these effects, especially the adjustment to the shift in terms of trade, are uncertain.

The purpose of this paper is to analyse the impact of an increase in oil prices on the terms of trade during an extended period. This relationship will be examined for Saudi Arabia, a net exporter of crude oil, and the United States, a net importer of crude oil. The aim is to see how the effect of terms of trade differs between net exporting and net importing countries.

1
The empirical analysis covers the period 1970 to 2004, using yearly time-series data. The regression model used to estimate the relationship mentioned above is by Ordinary Least Square (OLS).

The organisation of this paper is as follows. Section two begins with a discussion of some relevant theories of energy prices and supplies. In section three the history of oil prices, volatility and the business cycles are discussed. Section four gives a brief presentation of the chosen countries economies and their dependency of oil. Section five clarifies the concept of terms of trade. In section six the data is presented, followed by the regression function in section seven and the results and the analysis in section eight. The last section presents the conclusion drawn in this paper.

2 The Theory of Energy Prices and Supplies

The section below will present and discuss different theories that are relevant to energy prices and their supplies.

2.1 Competition Theory

The concept of competition carries within it the notion of rivalry for the possession of a not easily divisible object or the achievement of an exclusive outcome. Competition theories are many. Starting with the classical views of competition developed by Adam Smith, David Ricardo and Thomas Malthus and continuing with more modern models including the neoclassical theory developed and written by Marshall, Jevons and Walras among others.

An interesting part of the competition theory for this paper is the theories of monopolistic competition and oligopoly.

2.1.1 The Theory of Monopolistic Competition and Oligopoly

Chamberlain (1933) developed the theory of monopolistic competition. Monopolistic competition is a situation where the provider has a temporary or spatially delimited monopoly position. Monopoly, on the other hand, is defined as a persistent market situation where there exists only one provider for each product or service to a spatially enclosed market. Monopolies are characterized by a lack of economic competition for the good or service that they provide and a lack of viable substitute goods. It applies on markets situations where a few firms are a selling similar but differentiated product. (Burke, Genn-Bash and Haines, 1991)

The figure below show the mechanism of monopolistic competition, where P denotes the price, Q the quantity, D the demand and AC the average cost for the firm. The seller in this market faces a downward sloping demand curve. At equilibrium point E, the average cost equals the average revenue (demand), average profit is equal to zero and so is total profit. Price will be at P* and the quantity sold at Q*.
If the demand curve shifts from $D$ to $D_1$ the permanent equilibrium $E$ will shift to $E_1$. At this point, a higher price can be demanded for the same quantity sold. This extra income is known as a monopoly rent. This monopoly rent will attract new smaller firms into the market and $D_1$ will shift back to $D$. This behaviour is typical for the distribution of oil in local markets, where usually a few larger firms, with monopoly power, supply the market with oil.

Monopolies are often differentiated based on the circumstances under which they arise. The broadest distinction is between monopolies that arise due to government intervention and those that arise due to sole access to a resource, economies of scale, or consistently outcompeting all other firms. (Hunt, 2000)

It is often argued that monopolies most likely will become less efficient and innovative as time passes. That they will become "complacent giants", because they do not have to be efficient or innovative to compete in the marketplace. This very loss of efficiency can sometimes raise the potential value of a competitor enough to overcome market entry barriers, or provide incentive for research and investment into new alternatives. (Hunt, 2000)

Although monopolistically competitive firms are inefficient, the cost of price regulation for every product sold in monopolistic competition exceed the benefits by far: the government would have to regulate all firms that sold heterogeneous products - an impossible proposition in a market economy. (Hunt, 2000)

It has been argued that monopoly or market power constitute a major problem for society, because the result is a transfer of wealth from buyers to sellers and misallocation of resources. (Hunt, 2000)

Given economies of scale and effective barriers to contestability, the alternative to monopoly in many markets is not perfect competition but a market form where only a small number of firms are able to survive. Oligopoly has always created problems in economic theory because it is difficult to model the behaviour of firms under such conditions. (Fishwick, 1993)
Oligopolistic markets are characterised by interactivity. The decisions of one firm are influenced by the decisions of other firms. The four-firm concentration ratio is often used as a quantitative description of oligopoly. This measure expresses the market share of the four largest firms in an industry as a percentage. The definition for an oligopoly is a market in which the four-firm concentration ratio is above 40 percent, using this measure. (http://en.wikipedia.org)

Figure 2.2 below shows the kinked demand curve under oligopoly, where P is the price, Q is the quantity and D is the demand. Each firm faces a demand curve that is more elastic above price P' than below price P'. At equilibrium E the price is P' and quantity sold is Q'.

![Figure 2.2 Kinked demand curve under oligopoly](image)

If firm A in an oligopolistic market decides to lower its price from P' to P₁ the quantity will increase from Q' to Q₁. The profit for firm A will be equal to the change in price times the change in quantity (-ΔP*ΔQ). However, the competitors will react quickly to the price decrease made by firm A and will lower there price as well. On the other hand if firm A increase its price from P' to P₃ the quantity will decrease from Q' to Q₂. The profit for the firm will be equal to the change of the price increase multiplied by the change in quantity (ΔP*-ΔQ). This will be smaller than if the firm keeps the price at the equilibrium. Whichever strategy firm A chose it will be a worsening in the firm’s situation, so the price will return to the equilibrium price at E. However, if the stable oligopoly price gives low profitability to all oligopolists in the market there will be an incentive to create a cartel.

Oligopoly is common on wholesale markets, where the sellers and buyer are professionals and know what they are buying or selling.

Oligopolistic competition can lead to a variety of different outcomes. One outcome is when firms get together to raise prices and restrict production in the same way as a monopoly. Such collusion is often referred to as a cartel when there is some kind of a formal agreement. The main reason for firms to collude is the attempt to stabilise unstable markets, to reduce the risks inherent in these markets for investment and product development. In most countries, there are legal restrictions for such collusions to take place.
However, a formal agreement does not have to exist for a collusion to take place, although for the act to be illegal there must be some sort of communication between companies. Still, in some industries, there may be an acknowledged market leader that informally sets prices to which other producers respond, known as price leadership.

### 2.1.2 Variational Inequalities Theory

Equilibrium is the central concept in various areas including management, engineering and economics. Methodologies that have been used for the formulation, qualitative analysis and computation of equilibria have included system of equations, optimisation theory, complementary theory and fixed point theory. Variational inequality theory is a powerful and unifying theory for the study of equilibrium problems.

Variational inequalities are used as well for the analysis of competitive global trade equilibrium. For a competitive global trade equilibrium to hold the following condition is required: $P_j - P_i = C_{ij}$.

Where $P$ is the price per ton petroleum, $C$ is the transport and transaction cost per ton petroleum, $i$ is the export market and $j$ is the import market. That is, in order for competitive global trade equilibrium to hold the difference in price between the importing and exporting market must equal the costs of transport and transaction between the two markets.

At cartel pricing however, a mark-up cost is added to the equation above in order to profit from trade. The equilibrium will look as follows: $P_j - P_i = C_{ij} + m_i$. Mark-up pricing is an aspect of average cost pricing in which firms calculate the average cost of a product and add on a mark-up, or profit. That is, the price difference should not only cover the transportation and transaction costs, but also provide the firm with some extra profit. One way of getting a positive mark-up $m_i$ is by cartelisation or by price discrimination between monopolised markets $j$.

### 2.2 Price Discrimination

Price discrimination is defined as a seller chagrin competing buyers different price for the same commodity. The ideal from the seller’s point of view is to charge each buyer the maximum amount that the buyers are willing to pay. Every seller would price discriminate if there were not two major obstacles standing in their way. First, the seller must be able to distinguish between those buyers who are willing to pay a high price from those who are not. Second, there must be substantial difficulty for a low-price buyer to resell to those willing to buy at a high price. (Krugman and Obstfeld, 2003)

In order to profitably set different prices in two markets the elasticity of demand in the two markets must differ. Secondly, the price discriminator must prevent arbitrage by third parties. That is, prevent others from buying in the low price market and reselling in the higher priced market.

In the figure below the price elasticity in market $A$ differ from market $B$. Oil is traded to a lower price in market $B$ compared to market $A$. A buyer can therefore buy the oil in market $B$ and sell it in market $A$ and make a profit equal to $P^*_{\lambda} - P^*_{\mu}$. As long as the transport costs and transactions costs are less than $P^*_{\lambda} - P^*_{\mu}$ this kind a behavior will occur.
Figure 2.3 The elasticity of demand

In order for a seller of petroleum to price discriminate the following condition must be met; \( P'_A - P'_B < C_{fA} \). That is the transportation and transaction costs must be higher than the price difference in market A and B. If this condition holds then price discrimination can take place.

Oil is a fungible commodity that can be resold easily among buyers. Therefore, sellers who try to deny oil to buyer A will find other buyers purchasing more oil, some of which will be resold by them to buyer A.

The law of one price is an economic law stated as; in absence of transportation and transactions costs competitive markets will equalise the price of an identical good in two countries when then price is expressed in the same currency. The intuition for this law is that all sellers will flock to the highest prevailing price, and all buyers to the lowest current market price. In an efficient market, the convergence on one price is instant. (Krugman and Obstfeld, 2003)

In the long run, real prices of natural resources and commodities usually fall, largely because of technological advances. Crude oil is no exception. Technological advances in seismic exploration have dramatically reduced the cost of finding new reserves, thus increasing oil reserves greatly. Horizontal drilling and other new techniques have reduced the cost of recovering known reserves. In addition, improvements in technology provide both substitutes for oil and ways to use less oil to achieve given goals.

Moreover, advances in technology will reduce prices for such substitute fuels as natural gas, thus exerting continuing downward pressure on crude oil prices. In addition, increasing willingness to devote resources toward environmental improvement suggests that the market for crude oil will decline relative to those for such "cleaner" energy sources as natural gas and nuclear technology, unless other technical advances yield substantial improvement in the ability to use oil cleanly. Thus, the demand for crude oil is likely to decline, over the long term, relative to the demand for competing fuels and other sources of energy. This has been the experience of mankind, as wood gradually gave way to coal, which in turn de-
clined as the use of oil expanded. These facts suggest that the economic power of OPEC unavoidably will fade.

2.3 Cartels – a consequence of oligopolistic kinked demand curve

A fully profit-maximising cartel can be described as follows: the cartel will maximise profit by making each producer a member, and then allocating production among producers so that the marginal production costs are equalised among members. The cartel will then produce that output at which the common level of marginal cost for each producer equals the marginal revenue derived from aggregate industry demand. Since this might mean that closing in production in various periods for some producers, it will usually be necessary to arrange payments from one member of the cartel to another. (Griffin and Teece, 1982)

The existence of cartels is in opposition to classic theories of economic competition and the free market, and law in many nations forbids them. However, they continue to exist nationally and internationally, formally and informally.

Generally, cartels are economically unstable in that there is a great incentive for members to cheat and to sell more that the quotas set by the cartel. This has caused many cartels that attempt to set product prices to be unsuccessful in the end. However, if a cartel is successful it could behave exactly like a monopolist in maximizing its total profits. (Salvatore, 1998)

Empirical studies from the 20th century cartels have shown that the mean duration of a discovered cartel range from five to eight years. However, once a cartel is broken, the incentives to form the cartel return and the cartel may be re-established. The Prisoners’ Dilemma game suggests that all collusive agreements tend to fall eventually because although price fixing is in the joint interests of all members of a cartel, it is not a profit maximising equilibrium for each individual member. There are some publicly known cartels that do not follow this cycle including De Beers Diamond cartel and the Organisation of Petroleum Exporting Countries (Salvatore, 1998).

OPEC is a cartel—a group of producers that attempts to restrict output in order to keep prices higher than the competitive level. The heart of OPEC is the Conference, which consists of national delegations, generally represented by oil minister. The Conference have meeting twice a year in order to assign output quotas, which are the upper limit on the amount of oil each member is allowed to produce. The Conference may also meet at special occasions when considered necessary, especially when downward pressure on prices becomes acute. (Rauscher, 1989)

The problem that faces OPEC is the classical problem of all cartels: overproducing and cheating by member countries. At a higher cartel price, less oil is demanded. That is why OPEC assigns output quotas. Every member of the OPEC cartel has the incentive to produce more than its quotas and shave or cut this price. The reason for this is that the cost of producing an additional barrel of crude oil is typically lower than the cartel price. The methods available to cut official OPEC prices are many. Credit can be extended to buyers for periods longer than the standard thirty days. Higher grade of oil can be sold for prices applicable to lower grades. Transportation credits can be given. Buyers can be offered side payments or rebates. (Al-Otaiba, 1975)
However, unlike many other cartels, OPEC has been successful at increasing the price of oil for extended periods. Much of this success has been due to Saudi Arabia’s flexibility. Saudi Arabia is known as the “swing” producer of OPEC. It has tolerated cheating on the part of other cartel members, and cut its own production to compensate for other members having exceeded their production quotas. This gives the country good control, because with most members at full production, Saudi Arabia is the only member with spare capacity and the ability to increase supply if necessary. (Dibootlu and Aleisa, 2004)

OPEC’s policy has been successful, causing the price of crude oil to rise to levels that only at one time, been reached by redefined products. However, OPEC’s ability to raise prices has some limits. Increase in oil prices decrease consumption and could therefore cause a net decrease in revenue. Furthermore, an extended rise in price could encourage systematic change in behaviour, such as increased usage of alternative energy.

2.3.1 Leader and Follower – OPEC and Non-OPEC Producers

For long periods, the oil market has been close to a perfectly competitive market. However, since the 1970’s the production policy of the OPEC cartel has influenced the oil price. The high price regime of OPEC has turned the focus towards cost saving research and development among the outside OPEC producers. The new technology showed to be successful causing the marginal cost for outside OPEC producers to slowly fall to levels closer to the low levels of the efficient Arabian producers. This technology was gradually implemented during the 1990’s. As a result, the marginal cost of producing non-OPEC oil has been reduced and the global commercially available oil resources have increased. (Tvedt, 1999)

For the moment, somewhat above 40 percent of the total world consumption of crude oil is produced by OPEC (see appendix I and II). In the mid 1980’s the OPEC market share was only marginally above 30 percent, which was a decrease from above 50 percent in the first part of 1970’s. The market share of OPEC is in strong contrast with OPEC’s share of known reserves, which is about 77 percent and the Middle East OPEC countries alone stand for 65 percent. The production cost of OPEC and in particular that of the Middle East is significantly below that of the rest of the oil producing world. Some rough estimates of production cost of oil, including costs related to finding and field development, show that the cost is about US$2 per barrel in the Middle East in contrast to US$ 10 in the US-Gulf and US$11 in the North Sea. Thus, OPEC functions as a leader in the crude oil market and control production to a significant degree in order to keep prices at a level preferable from an OPEC perspective. (Tvedt, 1999)

2.3.2 History of OPEC

OPEC consists of thirteen nations, Iran, Iraq, Kuwait, Saudi Arabia, Venezuela Qatar, Indonesia, Libya, the United Arab Emirates, Algeria, Nigeria, Ecuador, and Gabon (OPEC.org). It was created on September 17, 1960 as a protest against the US imposition of import quotas on oil. In 1959, the US government established a Mandatory Oil Import Quota Program (MOIP) restricting the amount of crude oil that could be imported into the United States. The MOIP gave preferential treatment to oil imports from Mexico and Canada. This partial exclusion of the U.S. market to Persian Gulf producers depressed prices for their oil. As a result, oil prices "posted" (paid to the selling nations) by the major oil companies were reduced in February 1959 and August 1960. In its early years the U.S. import quota program also discriminated against oil from Venezuela. (Al-Otaiba, 1975)
At first, OPEC functioned as an informal bargaining unit for the sale of oil. The whole decade 1960-1970 was spent just increasing their share of a price that was slowly dropping. The 1960’s witnessed a strong economic growth in the key oil consuming countries, which was shown in rapidly expanding oil consumption. Gradually, there were a shift from a market characterized by oversupply to one characterized by excess demand with the virtual disappearance of excess productive capacity outside OPEC countries. (Griffin and Teece, 1982)

3 Oil Price History

The impact of high oil prices on the economic performance in OPEC countries would depend on a variety of factors. However, in the long run OPEC’s oil revenues and GDP are likely to be lower, as higher prices would not fully compensate for lower productivity. The high oil prices in the past four years are mainly due to OPEC’s success in implementing its policy of collectively constraining production. There is a risk that this policy, which has lead to a fall of OPEC’s market share since 1999, may continue in the future. This would limit the extent to which OPEC producers, notably those in the Middle East, will contribute to meeting rising demand on the world oil market. (Tvedt, 1999)

The section below will start by discussing the pricing and volatility of oil and continue with the effects on the world economy and the business cycle.

3.1 Pricing of Oil

The pricing of oil is not very simple since there exist a variety of oil prices. Crude oil is not a homogenous commodity. From the different types of oil that differ from each other by specific gravities and their sulphur contents, one has been chosen as the marker. Due to its abundance in both production and reserves the Saudi-Arabian Light oil has be chosen for this purpose. However, the importance of the Arabian light has decline substantially and other crudes such as North Sea crude Brent has taken over this role. (Rauscher, 1989)

One important part of the oil industry is oil price reporting. The nature and structure of oil reporting create trading opportunities, new markets and affect the behaviour of oil traders. Although oil price reporting began in the 1920’s, daily assessments of crude oil prices are more recent, only becoming important with the growth of the spot market for crude oil in the 1970’s. Up until the 1960’s the major oil companies were their own price assessors, calling out prices unilaterally, a role taken on by OPEC through the end of 1970’s. The need for price assessment was created with the growth of the spot market, at the beginning simply as a contribution to price transparency and as a service for those within the market. However, the assessed price began to be used gradually in trade rather than merely as an aid to trade. (Hornsnell and Mabro, 1993)

As mentioned earlier crude oil is sold in spot transactions but also through a variety of contract arrangements. Oil is also traded on futures markets but not generally to supply physical volumes of oil, more as a mechanism to distribute risk. These mechanisms play an important role in providing pricing information to markets. (www.aip.com.au)

A futures contract for crude oil is a promise to deliver a given quantity of crude oil, but this rarely occurs as participants are more interested in taking a position on the price of the crude oil. Futures markets are a financial instrument to distribute risk among participants with the side effect of providing transparency on the pricing of crude oil. (www.aip.com.au)
Real-world future markets are far from being perfect and complete. Petroleum futures contracts stretch only 15 to 18 months. This implies that oil producers, usually having a time horizon for more than a decade, cannot hedge all their production. Hence, the existences of petroleum futures markets do not solve the problem of intertemporal uncertainty that arises from the exhaustibility of resources. (Rauescher, 1989)

However, futures markets are useful for hedging short-term risks. Furthermore, they have a major role in the process of oil price development. Futures markets prices are available from minute to minute, while spot prices are lagged one day. Therefore, the futures markets provide price information that is not available from the spot market. (Rauescher, 1989)

Future market prices tend to show great volatility in the closing minutes of trading. Increasing the volumes of oil priced off exchange closing prices leads to even greater incentives for agents to attempt to move the market significantly in the last few minutes, leading to a series of distorted final prices, which may be highly wary of using as a basis for spot trades. (Hornsnell and Mabro, 1993)

In 1983, the New York Mercantile Exchange (NYMEX) began to trade oil futures on its commodity market. Over time, commodity market trading would become the price marker. Regulators controlling supply, by refiniers stating what they would pay, or by OPEC oil ministers setting production quotas, would not set petroleum prices. Instead, the oil market will be defined on the tumultuous and volatile trading floors of the NYMEX. (Hornsnell and Mabro, 1993)

The pricing of crude oil has become increasingly transparent from the 1990's onwards through the use of marker cruded such as West Texas Intermediate (WTI – USA), Brent (Europe and Africa), Dubai and Oman (Middle East), and Tapis and Dubai (in Asia). The main criteria for a marker crude is for it to be sold in sufficient volumes to provide liquidity (many buyers and sellers) in the physical market as well as having similar physical qualities of alternative crudes. In addition, the marker crude should provide pricing information. (www.aip.com.au)

WTI does this through its use on the New York Metals Exchange as the basis of a futures contract where trade is equivalent to many hundreds of millions of barrels per day, even though physical WTI production is less than 1 million barrels per day

Brent offers pricing information based more on the physical trading of oil through spot trading, and forward trading but also offers futures trading but not to the same extent as WTI.

Dubai and Oman pricing is based more on the physical trades of Dubai and Oman but due to falling production levels questions are being raised about the appropriateness of Dubai as marker crude.

In Asia, there is no futures exchange where crude oil is traded and which would provide pricing information to the same extent as WTI and Brent. In Asia the pricing mechanism for say Tapis, a marker for light sweet crudes in the region, is based on an independent panel approach where producers, refiners and traders are asked for information on actual trades and where there have been none, their best guess. (Any estimates that are wildly high or low are discarded and the quoted price is then an average of views on the market price for Tapis.)
3.2 Oil Price Volatility

Oil, being a vital commodity to most developed economies, plays a central and important role in both economics and politics. The price of oil often reflects the political environment in the economy.

Figure 2.1 below shows the oil price trend since the 1970’s. One of the most important events in the history of oil price is the OPEC embargo in October 1973. This was a response to the United States and other western countries support for Israel in the Yom Kippur war. The Arab nations of OPEC cut production by 5 million barrels per day. Prices went from $3 per barrel in 1972 to $12 per barrel in 1974. This was the cause of the oil crises in 1973/74 and the following recession. From 1974 to 1978 world crude oil prices was relatively flat ranging from $12.21 per barrel to $13.55 per barrel. (www.wtrg.com)

In 1979, the Iranian revolution took place and the following year in October 1980, Iraq invaded Iran. This and the political tumult that followed caused a reduction of oil production in both countries. Oil prices piked $35 per barrel in 1981. Following this, the non-OPEC countries increased their production at the same time as the OPEC price controls started to lose their effectiveness. Twenty-five years later Iran's production is only two-thirds of the level reached under the government of Reza Pahlavi the former Shah of Iran. (www.wtrg.com)

By 1986, the price of crude oil had fallen below $15 per barrel. The Iraqi invasion of Kuwait in 1990 caused a new price hike followed by a recession. After the Gulf War, the price of oil has been highly volatile. A weak OPEC, higher production from non-OPEC countries, like Norway, and more recently the war in Iraq and the nuclear program of Iran has created much uncertainty and high volatility in the oil market.
Figure 3.1 Average IEA Crude Oil Import Price. Source: www.iea.org

Table 3.1 show the percentage change in world oil price between 1970 and 2004. As shown in the table during the oil crises of 1973/1974 the price of oil increased by 252 percent. 1978-1979 was the only other period when the oil price increased with over 100 percent, to 133 percent. Otherwise, the trend has been stable with vicissitudes during the years.

The mean value is an estimator of the central tendency. The mean value of the observations in table 3.1 lies around 16 percent. That is, the average increase in oil prices for the examined period is 16 percent.

Standard deviation may serve as a measure of uncertainty, here used to explain the volatility in oil prices. It is used to explain how the observations differ from the mean value. The standard deviation in this set of observations is quite low, which means that most of the observations are around the mean value. The data set shows that oil price volatility raised in periods when oil prices increased rapidly (1973 early 1979 and 1990) and when oil prices fell rapidly (late 1979 and 1985).
### Table 3.1 Percentage change in world oil price

<table>
<thead>
<tr>
<th>Year</th>
<th>Percentage Change</th>
<th>Year</th>
<th>Percentage Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>1971-1972</td>
<td>12%</td>
<td>1988-1989</td>
<td>21%</td>
</tr>
<tr>
<td>1972-1973</td>
<td>34%</td>
<td>1989-1990</td>
<td>28%</td>
</tr>
<tr>
<td>1973-1974</td>
<td>252%</td>
<td>1990-1991</td>
<td>-16%</td>
</tr>
<tr>
<td>1974-1975</td>
<td>0%</td>
<td>1991-1992</td>
<td>-2%</td>
</tr>
<tr>
<td>1975-1976</td>
<td>1%</td>
<td>1992-1993</td>
<td>-12%</td>
</tr>
<tr>
<td>1976-1977</td>
<td>8%</td>
<td>1993-1994</td>
<td>-5%</td>
</tr>
<tr>
<td>1977-1978</td>
<td>2%</td>
<td>1994-1995</td>
<td>8%</td>
</tr>
<tr>
<td>1978-1979</td>
<td>133%</td>
<td>1995-1996</td>
<td>18%</td>
</tr>
<tr>
<td>1979-1980</td>
<td>20%</td>
<td>1996-1997</td>
<td>-5%</td>
</tr>
<tr>
<td>1981-1982</td>
<td>-7%</td>
<td>1998-1999</td>
<td>38%</td>
</tr>
<tr>
<td>1982-1983</td>
<td>-7%</td>
<td>1999-2000</td>
<td>57%</td>
</tr>
<tr>
<td>1983-1984</td>
<td>-3%</td>
<td>2000-2001</td>
<td>-14%</td>
</tr>
<tr>
<td>1984-1985</td>
<td>-4%</td>
<td>2001-2002</td>
<td>3%</td>
</tr>
<tr>
<td>1985-1986</td>
<td>-48%</td>
<td>2002-2003</td>
<td>16%</td>
</tr>
<tr>
<td>1986-1987</td>
<td>28%</td>
<td>2003-2004</td>
<td>31%</td>
</tr>
</tbody>
</table>

**Mean Value**: 16%  **Standard Deviation**: 51%

**Note**: Both the mean value and standard deviation are based on the percentage change in world oil price and are unweighted.

### 3.3 Higher Oil Prices and the Effect on the Global Economy

Oil prices are an important determinant of global economic performance. An increase in oil prices leads to a transform of income from importing to exporting countries. The magnitude of the direct effect of a given price increase depends on the share of cost of oil in national income, the degree of dependence on imported oil and the ability of end-user to reduce their consumption and switch away from oil. It is also dependent on the extent to which the prices of gas increase in response to an increase in oil prices. The higher the price increase and the longer higher prices sustain, the bigger the macroeconomic impact. (Birol, 2003) For net exporting countries, a price increase has a direct positive impact on the real national income through higher export earnings. However, parts of the gain will
later be offset by losses from lower demand for exports. These are generally due to the economic recession suffered by trading partners.

### 3.4 Oil Prices and Business Cycles

The business cycle or economic cycle refers to the ups and downs seen somewhat simultaneously in most parts of an economy. The cycle involves shifts over time between periods of relatively rapid growth of output (recovery and prosperity), alternating with periods of relative stagnation or decline (contraction or recession). These fluctuations are often measured using the real gross domestic product (GDP).

Table 3.2 shows the percentage growth in GWP (Gross World Product) over the period 1970-2004.

**Table 3.2 Percentage growth in GWP**

<table>
<thead>
<tr>
<th>Year</th>
<th>Percentage Change</th>
<th>Year</th>
<th>Percentage Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>1971-1972</td>
<td>15%</td>
<td>1988-1989</td>
<td>5%</td>
</tr>
<tr>
<td>1972-1973</td>
<td>22%</td>
<td>1989-1990</td>
<td>7%</td>
</tr>
<tr>
<td>1973-1974</td>
<td>13%</td>
<td>1990-1991</td>
<td>5%</td>
</tr>
<tr>
<td>1975-1976</td>
<td>8%</td>
<td>1992-1993</td>
<td>2%</td>
</tr>
<tr>
<td>1976-1977</td>
<td>11%</td>
<td>1993-1994</td>
<td>7%</td>
</tr>
<tr>
<td>1977-1978</td>
<td>18%</td>
<td>1994-1995</td>
<td>10%</td>
</tr>
<tr>
<td>1978-1979</td>
<td>15%</td>
<td>1995-1996</td>
<td>2%</td>
</tr>
<tr>
<td>1979-1980</td>
<td>12%</td>
<td>1996-1997</td>
<td>0%</td>
</tr>
<tr>
<td>1981-1982</td>
<td>-1%</td>
<td>1998-1999</td>
<td>4%</td>
</tr>
<tr>
<td>1982-1983</td>
<td>2%</td>
<td>1999-2000</td>
<td>3%</td>
</tr>
<tr>
<td>1983-1984</td>
<td>3%</td>
<td>2000-2001</td>
<td>-1%</td>
</tr>
<tr>
<td>1984-1985</td>
<td>3%</td>
<td>2001-2002</td>
<td>4%</td>
</tr>
<tr>
<td>1985-1986</td>
<td>18%</td>
<td>2002-2003</td>
<td>12%</td>
</tr>
<tr>
<td>1986-1987</td>
<td>15%</td>
<td>2003-2004</td>
<td>12%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Mean Value</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>8%</td>
<td>6%</td>
</tr>
</tbody>
</table>

**Note:** Both the mean value and standard deviation are based on the percentage change in GWP and are un-weighted.
In the table above the mean value lies around eight percent. The development in GWP has shown a positive trend during the examined period with only one negative drop. The standard deviation is very low in this set of data. That is, most of the observations are clustered around the mean value.

Since World War II, oil prices have peaked before nearly every US recession, including the most recent one. However, this relationship seems to have weakened since the 1990’s. Economists have found that oil price shocks seem to have a disproportional effect on economic activity. In addition, the economy appears to respond asymmetrically to oil price movements – that is the gains in economic activity that follows a fall in oil prices are not proportionate with the losses in economic activity that follows a rise in oil prices. (Brown, Yücel and Thompson, 2003)

Many economists argue that oil costs alone are too small relative to output to explain such severe business cycle response to energy price spikes. They suggest that imperfection in the adjustment process or some other mechanism must interact with oil prices to leverage such shocks into full-scale economic downturns.

Economists suggest a number of explanations for why an increase in oil price hurt economic activity. The most basic one is the classic supply shock in which rising oil prices are indicative of the reduced availability of an important input in production. Another explanation is the transfer of income from oil importing countries to oil exporting countries as a cause of rising oil prices. This transfer reduces aggregated demand and slows economic activity. (Brown, Yücel and Thompson, 2003)

Remaining explanations sought to attribute the effects of rising oil price shock to developments in the financial markets. One is that the monetary authorities react to rising oil prices with a contrary monetary policy that boost interest rates. Another explanation is that rising oil prices increase the money demand as people sought to rebalance their portfolios towards liquidity. A failure by the monetary authorities to meet growing money demand with an increased money supply boosted interest rate. In either case, rising interest rate, worsen economic activity. (Brown, Yücel and Thompson, 2003)

4 Oil dependence of the economies of Saudi Arabia and the United States

In this section, a short economic review over the chosen countries is presented, based on their dependency of oil.

4.1 Saudi Arabia

The Kingdom of Saudi Arabia is by far the largest producer of oil in the world and the most prominent member of OPEC. As such, Saudi Arabia has the power to influence the world economy, and because it is dependent of oil revenues, the country is vulnerable to developments in the global oil market. (Dibooglu and Aleisa, 2004)

For the past two decades and more Saudi Arabia has been a swing producer of crude oil that has influence OPEC’s output and global oil prices. The country typically produces around 10 to 10.5 million barrels of oil per day, but it has the capacity to surge production to over 15 million barrels per day. That swing capacity is what gives it power within OPEC, Saudi Arabia can and does discipline the cartel. (countrywatch.com)
The petroleum sector accounts for nearly 75 percent of government budget revenues, 40 percent of GDP and over 90 percent of export earnings. Except of the late 1980’s, Saudi Arabia’s share of crude oil production has been stable in the past two decades, providing about one-eighth of world’s crude oil. Growth has been moderate, except for the beginning of the 1990’s when the economy recorded a respectable growth due to increase in the oil production relative to previous years. (Diboğlu and Aleisa, 2004)

The figure below shows the export pattern for Saudi Arabia during the period 1970 to 2004. As shown, the exports of crude petroleum and refined petroleum make approximately 90 percent of export earnings.

![Export Pattern Saudi Arabia 1970-2004](image)

**Figure 4.1** Export pattern for Saudi Arabia between 1970-2004.

The strong fluctuations in oil prices over the past six years – from US$ 10/barrel in February 1999 to US$ 30/barrel in October 2000, then down to about US$ 20/barrel in 2002, then up to over US$ 50/barrel in 2004, and up to around US$ 60/barrel in June 2005-clearly show Saudi Arabia’s vulnerable economic base. (countrywatch.com)

Table 4.1 shows the percentage change in Saudi Arabia’s petroleum export during the period 1970 to 2004. Since Saudi Arabia is the swing producer of OPEC, the fluctuations in export are large. From a top of 279 percent during the oil crises of 1973/1974 to a low of -42 percent in the early 1980’s.

As shown in the table 4.1 below the mean value lies around 20 percent, showing the average percentage change in petroleum exports. The standard deviation is somewhat low around 55 percent. Indicating that the data set is quite normally distributed with most of the observed values around the mean.
Table 4.1 Percentage change in Saudi Arabia's export

<table>
<thead>
<tr>
<th>Year</th>
<th>Percentage Change</th>
<th>Year</th>
<th>Percentage Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>1971-1972</td>
<td>15%</td>
<td>1988-1989</td>
<td>16%</td>
</tr>
<tr>
<td>1972-1973</td>
<td>68%</td>
<td>1989-1990</td>
<td>56%</td>
</tr>
<tr>
<td>1973-1974</td>
<td>279%</td>
<td>1990-1991</td>
<td>8%</td>
</tr>
<tr>
<td>1974-1975</td>
<td>-17%</td>
<td>1991-1992</td>
<td>5%</td>
</tr>
<tr>
<td>1975-1976</td>
<td>29%</td>
<td>1992-1993</td>
<td>-16%</td>
</tr>
<tr>
<td>1976-1977</td>
<td>10%</td>
<td>1993-1994</td>
<td>1%</td>
</tr>
<tr>
<td>1978-1979</td>
<td>54%</td>
<td>1995-1996</td>
<td>21%</td>
</tr>
<tr>
<td>1979-1980</td>
<td>70%</td>
<td>1996-1997</td>
<td>0%</td>
</tr>
<tr>
<td>1981-1982</td>
<td>-33%</td>
<td>1998-1999</td>
<td>31%</td>
</tr>
<tr>
<td>1982-1983</td>
<td>-42%</td>
<td>1999-2000</td>
<td>53%</td>
</tr>
<tr>
<td>1983-1984</td>
<td>-16%</td>
<td>2000-2001</td>
<td>-12%</td>
</tr>
<tr>
<td>1984-1985</td>
<td>-25%</td>
<td>2001-2002</td>
<td>7%</td>
</tr>
<tr>
<td>1985-1986</td>
<td>-25%</td>
<td>2002-2003</td>
<td>29%</td>
</tr>
<tr>
<td>1986-1987</td>
<td>16%</td>
<td>2003-2004</td>
<td>35%</td>
</tr>
</tbody>
</table>

Mean Value 20% Standard Deviation 55%

Note: Both the mean value and standard deviation are based on the percentage change in the Saudi export and are unweighted.

The political climate in Saudi Arabia has changed significantly since the mid 1990’s, mostly because of the increase in Islamic orthodoxy and fundamentalism. Several terrorist attacks have been linked to the country. The countries former King Fahad, claimed that these terrorist acts violated all religious values and ethical principles. However, the Kingdom has stated that the best was to fight terrorism effectively is through international actions within the framework of the United Nations. (www.countrywatch.com)

The terrorist attacks on the United States on Sept. 11, 2001, have roots in and consequences for Saudi Arabia’s domestic and foreign policy, and put pressure on the current Saudi system. The Kingdom is also the birthplace of Usama bin Laden, and several thousand so-called "Afghan Arabs", Arabs that were recruited to fight the Soviets in Afghanistan. The Saudi government maintained that there were no al-Qaida terrorist cells in Saudi Arabia following the September 11 attacks. (www.countrywatch.com)
The Saudi regime has suffered criticism from different internal groups for its support for the United States. The royal family has been criticized for corruption, the country’s large debt to the West and the American influence on their oil field, in the aftermath of September 11.

Due to the authoritarian nature of the Saudi system, religion is the only way to express political dissatisfaction. Internally, the criticism concern authoritarianism and repression, unfair distribution and inequity. External complaints concern the close Saudi-American relationship, and in particular, United States bases on Saudi ground, United States support for Israel as well as United States-led sanctions on Iraq. A strong cooperation with the United States on the ongoing war against terrorism would only fuel the domestic opposition further. First of all the Saudi government most respond to their domestic voters. (www.countrywatch.com)

### 4.2 The United States

The United States has a powerful, diverse and technologically advanced economy, which is by far the world's largest and is a major driver of the global economy. The American firms are at or near the forefront of technological advances, especially in regards to computers and medical, aerospace and military equipment. The country’s financial services, media, and entertainment sectors have true global presence. More significantly, for the global economy, the United States has been serving as the source of aggregate demand for the world economy, as the world’s export-oriented economies sell record amounts in the United States. While this has helped sustain aggregate demand in many countries where it would otherwise have been even weaker, the United States has run large current account deficits in trade with its major trading partners. (www.countrywatch.com)

From 1991 to 2000, the United States enjoyed the longest economic expansion in its history. However, the nine years of strong growth ended in the second quarter of 2001, as technology shares plunged, and the economy was in recession before the terrorist attacks of Sept. 11, 2001. At the same time, and perhaps led by the deceleration in the United States, the world economy also began to slow dramatically, making 2001 the first year of global synchronization of recession since the mid 1970s. Nevertheless, the U.S. economy rebounded and growth picked up in 2002 and continued in 2003 and 2004, with a recovery of the jobs market as well. Both monetary and fiscal policies provided significant support to the economic recovery, with household spending remaining robust and business investment rebounding supported by low interest rates. In the meantime, productivity growth remained strong, supporting corporate profits. (www.sourceoecd.org)

Regardless of a favourable outlook for the economy in the short term, the United States faces some uncertainties and challenges ahead. The large fiscal and current account deficits, as well as low national saving rate, are causes of concerns for the long-term economic prospects. Moreover, with rising interest rates and softening home prices, the cooling down of consumer spending, which fuels about two-thirds of the U.S. economy, might have tremendous impact on the economy as home loan refinancing activity, contributed about seven percent of total disposable income in 2004. (www.countrywatch.com)

The figure below shows the import and export pattern of petroleum for the United States during 1990 to 2004. As shown in the figure the United States imported nearly six times more petroleum than it exported in the beginning of the 1990’s. The imports have had a
constant increase and reached a level of ten times the exports during the 2000’s and is still increasing. The sudden increase in petroleum import in year 2000 might partly be due to the Bush administration and the new petroleum policy that they implemented when elected. The exports on the other hand, have held a stable level during this period.

![Export and Import of Petroleum - The United States](image)

Figure 4.2 Export and Import pattern of Petroleum for the United States between 1990 and 2004

The oil production in the United States peak in 1970 and has since then declined. Since the United States stands for a quarter of the world consumption of oil and will therefore suffer greatly if oil supply is decreasing.

# 5 Terms of Trade

In this section, the definition and general mechanism of terms of trade are presented. Furthermore, the welfare effects of terms of trade are discussed.

## 5.1 Terms of Trade

There are a number of different concepts, definitions and associated statistical measures of the terms of trade. Some of them are listed below:

(i) The *commodity or net barter* terms of trade. This is the most common meaning of the term. Basically this is the relative price of the “exportable” in terms of the “importable”, that is the number of units of the latter that one can achieve for each unit of the former.

(Salvatore, 1998) In practice, the commodity terms of trade is calculated as changes in the ratio of an export price index to an import price index relative to a base year.

(ii) The *gross barter* terms of trade. This is the ratio of the volume of imports to the volume of exports. It coincides with the commodity terms of trade when trade is balanced. That is,
when there are no international loans or unrequited transfers. (Eatwell, Milgate and Newman, 1987)

(iii) The *income* terms of trade. This concept is sometimes referred to as “the purchasing power of exports”. It corresponds to the commodity terms of trade multiplied by the volume of exports. (Salvatore, 1998)

(iv) The *single factorial* terms of trade. This refers to the marginal or average productivity of a factor in the export sector. It is evaluated in terms of the imported good at the commodity terms of trade. (Salvatore, 1998)

(v) The *double factorial* terms of trade. This approach tries to go behind the international exchange of commodities to the productive factors that are “embodied” in them. Hence, if units are chosen so that for example a unit of labour in England produce a unit of cloths and a unit of labour in Portugal produce a unit of wine, commodity terms of trade of say five wine to one cloth would mean that a unit in English labour exchanges for five units of Portuguese labour in international trade. (Eatwell, Milgate and Newman, 1987)

The first three concepts of the terms of trade are all measurable in practice. The commodity terms of trade is continuously measured for most of the countries in the world by international agencies such as IMF (International Monetary Fund), World Bank and the UN (United Nations).

### 5.2 General Mechanism

The volatility and co-movements of the terms of trade depend on the nature of trade and sources of disturbance. One such source is an oil supply shock. Backus and Crucin found that changes in the terms of trade in major industrialised countries during 1972 and 1987 were primarily driven by the dramatic change in the relative price of one single commodity – oil.

An oil price increase changes the balance of trade between countries. Most oil importing countries normally experience weakening in their balance of payment, putting downward pressure on exchange rate. The result of this is that import becomes more expensive and exports less valuable, leading to a drop in national income and worsens terms of trade. (Birol, 2003)

The figure below shows the price elasticity of demand, a concept that Alfred Marshall developed. Where P and Q denote price and quantity respectively.

![Figure 5.1 Price elasticity of demand](image-url)
If price elasticity is, low a rise in oil prices lead to a transfer of income for importing to exporting countries. The price elasticity determines how large the gain of an oil price rise will be for producing countries. The less a price increase affects demand the more firms will gain by increasing prices. In other words, the lower the elasticity the larger the incentive to increase price. In market B the gains of a price increase are larger than the loss and vice versa in market A. The steeper the demand function the greater the incentive to increase price.

Although the general mechanism by which oil prices affect economic performance is well understood the dynamics and magnitude of these effects are still uncertain, especially the adjustment in the shift in terms of trade. The quantitative estimate of the overall macroeconomic effect caused by previous oil shocks and the gains from 1986 price collapse to the economies of oil importing countries varies significantly. (Birol, 2003) This could be due to the different models used, but overall the result were certainly significant: economic growth fell sharply in most oil importing countries in the two years following the price hikes of 1973/1974 and 1979/1980.

The boost in economic growth in oil exporting countries caused by higher oil prices in the past has always been less than the loss of economic growth in importing countries, creating a negative net effect. (Birol, 2003)

### 5.3 Welfare Effects

The changes in the terms of trade have of course welfare consequences for both trading partners. The general statement is that a rise in the terms of trade improve a country’s welfare, while a decline in the terms of trade worsen its welfare. (Krugman and Obstfeld, 2003)

Terms of trade can be considered as an instrument of policy, when a country have some degree of monopoly power in international markets, the case of the oil exporting countries. As a policy tool the oil exporting countries, ignoring the likelihood of retaliation, could restrict trade to such an extent as to equate at the margin the benefit resulting from the improvement in the terms of trade with the loss on welfare resulting from the fall in the traded volume. This is called the ‘optimum tariff’ argument, the level of which varies inversely with the elasticity of foreign demand for imports. (Eatwell, Milgate and Newman, 1987)

### 6 Data

This section will provide an examination of the relation between fluctuation in oil prices and the terms of trades of the chosen countries. The hypothesis is that there exists a relationship between these variables.

The aim of this paper is to test if there is any relation between oil prices and the change in the terms of trades during a certain time period in the United States and Saudi Arabia. The correlation between fluctuations in the terms of trade and output generated by oil price shocks are in theory assumed and proved negative. This is assumed for oil importing countries. However, this correlation should be the averse for oil exporting countries. The aim is to apply this theoretical assumption on the collected data and analyse the outcome to see if it supports that view.
To perform the analysis yearly data on oil prices have been collected from the International Monetary Fund’s (IMF) International Financial Statistics (IFS) database. Yearly data on import and export has been collected from United Nations Commodity Trade Statistics Database as well as data for GWP.

### 6.1 Terms of Trade and Oil Price

In international economics and international trade, terms of trade are the ratio of the price of the exported commodity to the price of the imported commodity. Sometimes terms of trade are used as a proxy for a nation’s social welfare, but this heuristic is technically questionable and should be used carefully. An improvement in a nation’s terms of trade is good for that country in the sense that it has to give up less export for the imports it receives and it pays less for the products it imports. (Baxter and Koupalitsas, 2000)

The collected data are all in current prices and denotes the value, the price multiplied by the quantity, of export and import for the chosen countries. All values are converted into US dollars using exchange rates. Terms of trade for Saudi Arabia and the United States have been calculated as follows: the value of the country’s exports divide by the value of the country’s imports.

The terms of trade value for Saudi Arabia and the United States differ somewhat from each other. During the examined period Saudi Arabia have a much higher exports values than imports values and vice versa for the United States.

The oil prices used in this paper is the world average price measured in US dollars.

### 7 Regression Equation

In this section, the different regression models used are presented. The different tests that are performed on the data are also provided here.

The first regression is made through the Ordinary Least Square (OLS) model and is used to test the effects of the independent variable GWP on the dependent variable world oil price. The regression model that examines the relationship between world oil price and GWP is as follows:

\[
\text{PRICE}_t = \alpha + \beta_1 G_t + u_t
\]

(7.1)

Where:

- \( \text{PRICE} \): the percentage change in world oil price which is calculated as follows: \((\text{WOP}_t - \text{WOP}_{t-1})/\text{WOP}_t\); where percentage change in world oil price is calculated between year \( t-1 \) and \( t \).
- \( G \): the percentage change in G, which is calculated as follows: \((\text{GWP}_t - \text{GWP}_{t-1})/\text{GWP}_t\); where percentage growth is the percentage change in GWP calculated between year \( t-1 \) and \( t \).
- \( \alpha \): the intercept
- \( u \): the standard error term

The hypothesis is:
$H_0: \beta_1 = 0$

$H_1: \beta_1 \neq 0$

The null hypothesis states that there exist no relationship between GWP and price of oil. The alternative hypothesis states that there exist a relationship between GWP and price of oil.

The estimation for the second regression is as well made through the OLS model. This regression tests the effect of the independent variables world oil price and GWP on the dependent variable Saudi Arabia’s export. The regression model that examines the relationship between the Saudi export, world oil price and GWP, is as follows:

$$\text{EXP}_t = \alpha + \beta_1 \text{PRICE}_t + \beta_2 G_t + u_t \quad (7.2)$$

Where:

\text{EXP}: the percentage change in Saudi Arabia’s export, which is calculated as follows: \((\text{Export}_{t} - \text{Export}_{t-1})/\text{Export}_{t-1}\); where \text{EXP}_t is the percentage change in export calculated between year \(t-1\) and \(t\).

The hypothesis is:

$H_0: \beta_1 = \beta_2 = 0$

$H_1: \beta_1 \neq \beta_2$

The null hypothesis states that there exist no relationship between GWP, price of oil and Saudi Arabia’s export. The alternative hypothesis states that there exist a relationship between GWP, price of oil and Saudi Arabia’s export. The hypothesis stated above is an F-test where only one variable need to be significant for the hypothesis to hold.

The two following regression are made through the OLS model. They test the effect of the independent variable world oil price on the dependent variable terms of trade. One OLS regression is run for each country during the given time period. The regression model that examines the relationship between terms of trade and world oil price, is as follows:

$$\text{ToT}_\text{USA} = \alpha + \beta_1 \text{PCWOP}_t + e_t \quad (7.3)$$

$$\text{ToT}_\text{SA} = \alpha + \beta_1 \text{PCWOP}_t + e_t \quad (7.4)$$

Where:

\text{ToT}: terms of trade for each country, which is calculates as the value of export divided by the value of import.

The hypothesis is:

$H_0: \beta_1 = 0$

$H_1: \beta_1 \neq 0$

The null hypothesis states that there exist no relationship between price of oil and terms of trade. The alternative hypothesis states that there exist a relationship between the price of oil and terms of trade. This relationship is by theory assumed to be positive for Saudi Arabia and negative for the United States.
The results will be analysed based on the F-value, R² and the beta value. The F-value shows an overall significance of the estimated regression. The F-test is also a test for the significance of the R² value. The greater the R² is the larger will the F-value be. If the F-value is significant according to the F-test and the R² is not equal to zero the independent variables are explaining the variation in the dependent variable. If this is the case we can reject our null hypothesis (H₀). The unstandardised (β) coefficients are the coefficients of the estimated regression model and are used as an attempt to make the regression coefficients more comparable.

8 Regression Results

This section provides the results of the regression.

In table 8.1 the results from the OLS regression on the impact of world oil price on GWP are presented.

**Table 8.1 Regression analysis for World Business Cycle, with World Oil Price as the dependent variable and GWP as the independent variables.**

<table>
<thead>
<tr>
<th>Variables</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>-0.019 (-0.135)</td>
</tr>
<tr>
<td>GWP</td>
<td>2.296 (1.638)***</td>
</tr>
<tr>
<td>F-value</td>
<td>2.682***</td>
</tr>
<tr>
<td>R-square</td>
<td>0.077</td>
</tr>
</tbody>
</table>

Note: The values in the parentheses represent the t-statistics and the other values represent the Beta-values. The significance level is shown by: * 1% level, **5% level, ***10% level.

The results show that GWP does affect world oil price. The beta value is positive in this case which means that when there is an upswing in the world business cycle there will be an increase in the price of oil. The results indicate that if GWP increase with one percent the average world oil price would increase with 2.3 percent. This makes sense, since if the demand for oil increases then it is natural that the price of oil would increase as well in order for producers to gain larger profit.

The R² value for this regression is very low. The GWP can only explain the fluctuation in world oil price by 7.7 percent. Many other different factors play an important part when it comes to the fluctuation in both oil prices and the world business cycle. Those factors need to be taken under consideration when such analysis is made. However, the results here indicate that there is a significant positive relationship, as suggested in theory, and therefore the null hypothesis can be rejected.

Below in table 8.2 the results for the OLS regression made on Saudi Arabia’s petroleum export is presented.

**Table 8.2 Regression analysis on Saudi Arabia’s petroleum export, with petroleum export value as the dependent variable and World oil price and GWP as the independent variables.**
<table>
<thead>
<tr>
<th>Variables</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>-0.028 (-0.417)</td>
</tr>
<tr>
<td>World Oil Price</td>
<td>0.928 (10.952)*</td>
</tr>
<tr>
<td>GWP</td>
<td>0.943 (1.348)***</td>
</tr>
<tr>
<td>F-value</td>
<td>70.440*</td>
</tr>
<tr>
<td>R-square</td>
<td>0.820</td>
</tr>
</tbody>
</table>

Note: The values in the parentheses represent the t-statistics and the other values represent the Beta-values. The significance level is shown by: * 1% level, **5% level, ***10% level.

The results indicate that both world oil price and GWP are significant for Saudi Arabia petroleum export. The beta value of world oil price shows that if the oil price would increase with one percent the value of the Saudi export would increase with 0.928 percent. The same is true for the GWP. If GWP increase with one percent the Saudi export would increase with 0.943 percent. When GWP increases the demand for oil, which is an important input in production for most countries, increases as well. Since both variables are positively significant the null hypothesis can be rejected.

The beta-values in this regression also indicate the price and income elasticity. Both the beta-value for world oil price and GWP are close to one, which denotes normal elasticity. Positive price elasticity, as in this case, shows that petroleum is a source of income for Saudi Arabia.

The figure below shows the price elasticity for petroleum. Where; P is the price and Q is quantity.

![Figure 8.1 Elasticity for petroleum price](image)

With low price elasticity, area A shows the income loss and area B shows the income gain followed by an increase in petroleum price. If the income gain is larger than the income
loss it indicates low price elasticity and with low price elasticity there will be an incentive to increase price.

The F-value for this regression is significant at one percentage level. This indicates that world oil prices and GWP can explain the variations in Saudi Arabia’s petroleum export. The $R^2$ value for this regression is high at 0.820. This means that the variables world oil price and GWP explains the petroleum export of Saudi Arabia with 82 percent. The remaining 18 percent are due to other factors.

In table 8.3 the results of the OLS regression on terms of trade are presented for the respective countries

Table 8.3 Regression analysis for the Saudi Arabia and the United States, with terms of trade as the dependent variable and world oil price as the independent variables.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Saudi Arabia</th>
<th>The United States</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>3.872</td>
<td>0.927</td>
</tr>
<tr>
<td></td>
<td>(2.680)***</td>
<td>(18.176)*</td>
</tr>
<tr>
<td>World Oil Price</td>
<td>-0.018</td>
<td>-0.002</td>
</tr>
<tr>
<td></td>
<td>(-0.930)</td>
<td>(-3.136)*</td>
</tr>
<tr>
<td>F-value</td>
<td>0.866</td>
<td>9.833*</td>
</tr>
<tr>
<td>R-square</td>
<td>0.035</td>
<td>0.241</td>
</tr>
</tbody>
</table>

Note: The values in the parentheses represent the t-statistics and the other values represent the Beta-values. The significance level is shown by: * 1% level, **5% level, ***10% level.

When analysing the overall results for the variable world oil price for the two countries, both significant and insignificant, the beta values show a negative impact on terms of trade. According to theory the negative impact should only be true for the United States, since it is a net importing country. The reverse should be true for Saudi Arabia. However, the results show that if world oil price would increase with one percent the terms of trade of the United States would worsen with 0.002 percent. This means that the null hypothesis can be rejected in this case, since there exist a negative relationship between a rise in oil price and terms of trade for the United States.

The result for Saudi Arabia is not significant therefore the null hypothesis cannot be rejected. However, theory shows that since Saudi Arabia is a net exporting country there should be an improvement in terms of trade when there is an increase in oil price. One reason to why the beta value for Saudi Arabia is negative might be the fact that the import and export values are reported by the country itself and might not be in accordance to the real values. In addition, some missing values can have caused this relationship.

However, in this case the alternative hypothesis is two-sided and we need to use the two-tail t-value. The degrees of freedom (df) in this regression are 31. Using a t-table there is no data corresponding to 31 df and therefore 30 df is used since it is the closest. In this case if the computed t-value exceeds the critical t-value at the chosen level of significance, the null hypothesis can be rejected; otherwise, it cannot be rejected. If 30 df is used and the level of significance is five percent, the critical t-value is 2.042 for a two-tail test.

Since the computed t-value for the United States, 3.136 (in absolute terms) exceeds the critical t-value of 2.042 the null hypothesis that world oil prices have no effect on terms of
trade can be rejected. In the case of Saudi Arabia the computed $t$ value is 0.930 (in absolute terms), that does not exceed the critical $t$ value, hence the null hypothesis cannot be rejected.

Another value that explains the significance of the regression is the F-values. If the F-value is not significant, as in Saudi Arabia’s case, world oil price cannot explain the variation of the terms of trade. However, in the case of the United States this value is significant and therefore the null hypothesis can be rejected. The $R^2$ explain how well the sample regression line fits the data. The $R^2$ values for both countries are very low. In the case of the United States the $R^2$ value is 0.241 which indicates that world oil price explains the fall in terms of trade only with 24 percent, the remaining 76 percent are due to other factors. If the values would have been significant for Saudi Arabia the $R^2$ would show that world oil price only explains terms of trade with 3.5 percent.
9 Conclusion

This paper attempts to describe the effect of a change in oil prices on terms of trade. The aim has been to provide some historical and empirical facts about the relationship between a change in oil prices and the terms of trade of a net importing and a net exporting country. The subject is large and indeed complicated and this is just a minor step to analyse the relationship mentioned above. In order to observe this relationship OLS regressions have been made.

There are numbers of reasons why oil traders feel that oil supplies might be reduced and cause price to rise. One of the most important reasons is growing turbulence in the Middle East, the world’s largest oil producing region. The continuing war in Iraq, the threats of an unpeaceful Iranian nuclear program and the internal instability of Saudi Arabia could all in the future lead to a dramatic fall in oil supply. Outside the Middle East other oil producers have worried investors such as Venezuela, with its political problems, the instable region of West Africa.

The Iranian nuclear program has become political in two ways: domestic and international. The Iranian politicians use this as a part of the populist platform and the possible use of Iran’s nuclear technology is speculated and debated internationally. Iran is a member of the Nuclear Non-Proliferation Treaty (NPT), which was signed in 1970. However, the International Atomic Energy Agency (IAEA) believes that the recent non-cooperation from Iran’s side makes it impossible to conduct sufficient inspections to ensure that the technology is not developed for weapon use. The Iranian public views this nuclear power as a way to modernize and diversify the sources of energy. However, the western countries believe that this peaceful nuclear program has hidden intentions, such as development of nuclear weapons. This debate and disagreement between nations creates instability in oil prices and any new development could cause fluctuations in the price of oil.

The short-term price of oil is partly controlled by OPEC and the oligopoly of major oil companies. This price control creates a leader and follower game. Where OPEC is the leader and other oil producing countries will follow OPEC price decision. The United States also being an oil producer will be a follower of OPEC price policy. Another reason to the increase in oil prices is the United States dollar’s slump against the Euro. Since oil is traded in dollars, the price must increase in order for OPEC to maintain purchasing power in Europe.

The conclusion that can be drawn based on the regression results performed in this paper is that oil prices do have an effect on a country’s terms of trade. However, whether this effect is negative or positive is hard to tell from these regression results. In the case of the United States there is a clear negative relationship between a rise in oil prices and the country’s terms of trade. The dependency of oil is also a factor that might affect the outcome. Since the United States is an industrialised country, that use oil as a major input in production, the country is highly dependent on the supply of oil and the fluctuations in oil prices. As the price of oil increases the productions costs increase and so will the price of the product. Exports will become more expensive than imports and hence worsen terms of trade.

According to theory an increase in oil price should have a positive impact on the terms of trade for a net oil exporting country, which Saudi Arabia is. The regression results for Saudi Arabia are not significant and therefore it cannot be concluded whether a rise in oil prices would have a positive or negative effect on the country’s terms of trade.
The regression results also showed that oil prices are important for the export pattern of Saudi Arabia. Petroleum is by far the largest export of Saudi Arabia and an increase in the price of oil would automatically increase the value of exports. Also, the world business cycle is important for Saudi Arabia’s export. When the world economy is moving upward the demand for oil will increase leading to an improvement in petroleum export for Saudi Arabia.

Further the relationship between world business cycle and oil prices was examined. The results indicate that an upswing in the world economy would lead to an increase in oil prices. This is a natural cause since a rise in demand will push prices upward.

While total oil consumption has increased, the western economies are less reliant on oil than they were twenty-five years ago, due to substantial growth in energy productivity. However, new markets are developing a dependency for oil, such as India and China. Despite the rapid increase in the price of oil, neither the stock markets nor the growth of the global economy have been noticeably affected. Whether this will hold is yet to see.

Further research on this area can include a larger sample of countries with diverse economical structure. One can also compare the impact of an oil price increase on developing, such as India and China, and developed economies. The level of development can be used as an independent variable. In addition, more variables can be included in the research, such as exchange rate, interest rate and dependency on oil.
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Appendix I

The figure above shows the crude oil production of non-OPEC producers during 1973 to 2005. The have had a stable pattern of production. The figure also shows the price development during the same time period. The price development has not followed the smooth production pattern. Most likely due to the OPEC cartel that partly control the prices. These non-OPEC producers will follow the price decision of OPEC, since OPEC is more powerful and control larger parts of the petroleum supply, than the non-OPEC producers’ control. OPEC will lead and the non-OPEC countries will follow.
Appendix II

The figure above shows the crude oil production of all the OPEC member countries during 1973 to 2005. It also shows how the prices have developed during the same period. There is a large volatility in both production and price. If the figure is compared to the one above one can tell that the OPEC production policy differs a lot from the non-OPEC producers. However, OPEC has the power to set the price and control the supply of crude oil to the rest of the world.