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Modelling the Impact of Oil Price Volatility on Investment Decision-Making

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by

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Abstract

The energy industry is transforming from the old, vertically integrated model into a more competitive model in which most companies are exposed to different types of risk. One of the major challenges facing energy companies is making investment decision-making associated with the prices of crude oils. Since 1973, crude oil price behaviour has become more volatile, which suggested that different forces were driving crude oil prices. One of the main factors in generating the behaviour of crude oil prices is the role performed by OPEC and non-OPEC crude oil producers. Several theoretical and empirical analyses suggested that the economics behind OPEC's supply of crude oil is different than those of non-OPEC supply. This study investigates whether prices of OPEC crude oils and prices of non-OPEC crude oils share a common data-generating process. The study empirically tests oil price volatility of OPEC and non-OPEC crude oil prices using GARCH models. It also applies the Johansen Cointegration Model and the Engle-Granger Error Correlation Model (ECM) model to test the long – and short-term relationship between crude prices (OPEC and non-OPEC) and stock prices of different oil companies. Finally, a panel data approach using fixed and random effects is used to estimate the reaction of OPEC and non-OPEC crude oil prices to events and news items that could possibly affect oil supply and prices. The results obtained suggest that the behaviour of crude oil prices is not affected by OPEC or non-OPEC affiliation. This finding suggests that the international oil market is globally integrated market that is able to factor in any possible changes to supply behaviour of OPEC or non-OPEC producers.

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Chapter 1: Introduction

1.1 Motivation and background

Major changes are occurring in the energy industry. The old model of vertically-integrated organizations and monopolistic energy businesses is breaking up and being replaced by competition and privatization (Keppler, 2007). Participants in competitive markets are expected to make better investment decisions because they bear the risk of their decisions (Serletis and Bianchi, 2007). However, Keppler (2007) acknowledged that not all segments of an organization are suitable for privatization or for market competition. Furthermore, Keppler stated that high oil prices combined with environmental constraints are renewing interest in modelling the relationships between technological influence, energy efficacy, energy prices and energy intensity[1]. Nevertheless, modelling energy demand and economic development has been one of the most analyzed relationships in energy-related empirical applications.

Energy companies operate in a very competitive business environment, which means that accurate and timely decisions must be made based on the evaluation of available information. As a result of this competitive nature of the business, decentralization of decision-making became essential for many energy operations

[1]Energy intensity: the ratio of energy inputs to social products at the macroeconomic level (Buenstorf, 2004). It can be used to compare the degree of energy dependency between different countries.

(Chevalier, 2007). Chevalier stated that decentralization of decision-making would benefit from advancements in econometrics. He further suggested that the evolution of the global energy system and the growing complexity of today's energy market would create additional need for more sophisticated econometric applications.

Girod (2007) suggested that the development of econometric modelling, which occurred from the 1970s to the 1990s, has been incorporated rapidly into energy market applications. Decision-makers rely on econometric modelling to solve energy-related problems (Girod, 2007). Econometrics provides the tools needed to meet energy and environmental challenges that businesses face in the 21st century (Keppler, 2007). Keppler (2007) stated that the new energy-related economic issues deal with combining macroeconomics, investment decisions, economy policy, industrial organization and economics of regulation. He suggested that the role of econometrics has become more important for the energy markets due to the increasing emphasis on the decentralization of decision-making. Non-stationary time series, unit root tests and co-integration relationships are examples of econometric techniques that have become "interlocked" with energy economics (Chevalier, 2007).

Econometric applications have become an integrated part of the processes of identifying, assessing and managing risk exposure created by the complex behaviour of the energy market. Huisman (2009) stated that energy finance researchers and practitioners have developed many models that are capable of dealing with the characteristics of energy price behaviour. For example, dynamic hedging benefited from advancements in econometrics, given its need for constant mentoring adjustment to different risk exposure. Amic and Lautard (2005) explained that traders use empirical and mathematical models to form their base estimation of the price of a financial instrument and, then, they add the bid-offer spread.

As different parties became involved in the decision-making process, different risk exposures are expected to face the organization and could have the potential to threaten its financial stability. Risk created by movements in interest rates, foreign exchange rates and commodity prices directly impact the market valuation of some firms (Smithson and Smith, 2001). For example, an unexpected increase in a commodity's price should increase the market value of that commodity's producer and depress the market value of that commodity's buyer (Boyer and Filion, 2005). However, the importance of statistical science in an area such as risk management is now only beginning to be recognized by energy risk mangers (Lewis, 2005). Lewis further stated that the importance of statistical principles covers both empirical and theoretical modelling. Each principle has become an essential tool in identifying relationships between sets of data and as an end in themselves, since they help in explaining the major economic and social issues that face humanity.

Developing corporate plans and strategies requires accurate estimation of expected price volatility. Price volatility influences the risks associated with decisions (Bourbonnais and Méritet, 2007). Forecasting oil price volatility became vital for decisions regarding formulation of hedging strategies, option pricing and the risk assessment of commodities (Aloui, 2008). In the case of energy companies, most of these risks can be placed into five main categories. The first category is market risk, which is the potential to incur losses due to unexpected changes in market prices. Both input and output prices must be forecast and managed. The second category is credit risk (or default), which can be the result of a second party’s inability to make an agreed-upon payment. Third is operational risk, which is caused by inadequate business practises or faulty operational processes due to human error or technological glitches. Fourth is liquidity risk, which can result when a counterparty refuses to trade. Fifth is political (or regulatory) risk, which means that companies are subject to guidelines or actions taken by sovereign nations that could cause expropriation or even nationalization of operations.

In the case of market risk, oil prices, in particular, are important given their role in physical, futures and over-the-counter (OTC) markets. Financial transactions related to crude oils are four times the value of the physical transactions in this area (Chevalier, 2007). In fact, in 2007, the daily averages of futures contracts and OTC swaps were around $300 billion and $800 billion, respectively (James, 2008). James further stated that, between 2000 and 2006, over $100 billion of additional, speculative funds were added to the energy financial market, which could further increase the volatility of oil prices, at least in the short run. Speculators and hedge fund managers use benchmark crudes to track price changes for physical crude sales and deliveries. Garis (2009) estimated that trading of benchmark crude oil in the futures market was approximately 20 times greater than the amount of available physical quantities. However, Serletis and Shahmoradi (2006) suggested that large capital requirements and significant lead times between energy production and delivery increase the sensitivity of energy financial markets to the imbalance of demand and supply, which results in increasing the volatility of oil prices.

Desbrosses and Girod (2007) explained that, in the case of derived energy, units of the primary energy, such as oil or gas, or secondary energy, such as diesel or jet fuel, are used in accounting methods. This accounting practice suggests that the expected price behaviour of these oil-based energy sources has a fundamental effect on the profitability of future (or ongoing) energy-based operations. Thus, energy prices are a key entry in most energy-related econometric models (Chevalier, 2007).

Uncertainty about future energy prices is referred to as energy price risk. Producers and distributors are exposed to an unstable stream of revenue and, on the other hand, consumers are exposed to unpredictable prices (Lewis, 2005). Amic and Lautard (2005) stated that oil price risk is “in the heart” of the oil industry and became the force behind the decisions of many oil companies to use vertical integration. In the case of crude oil producers, they might be concerned about the uncertainty of crude oil prices within the next three to six months, because a general decline in crude oil prices will seriously affect the producers’ revenues.

Refiners, on the other hand, have the concern that future price increases will be translated into higher oil input costs. If these high oil input costs cannot be passed on to customers, the refiners will receive less revenue. In this case, crude oil prices could negatively affect the refiners’ crack spread, which is the risk/reward coefficient for each product that can be aggregated to form a composite refinery margin. As a result, some oil companies have offered specially-structured products to meet the needs of its clients. Refiners, airlines and shipping companies that face this multi-dimensional problem can use swaps agreements, for example, to manage the difference between the weighted sum of products (or services) and the value of reference crude oils, such as Brent or West Texas Intermediate (WTI) (Amic andLautard, 2005). Also, Amic and Lautard suggested that refineries could benefit from different market conditions by selling options on the gas/oil crack spread, which would help to provide adequate cash flow. However, analysis of the correlation between the product margin and crude price is crucial in an effective implementation.

By looking into the cost breakdown of gasoline, a refinery product, we can see that its retail price can be broken down into: costs of crude oil, taxes and seller mark-up. In the case of the U.S., these components are approximately 50, 30 and 20 percent of the total retail price, respectively (Lewis, 2005). Given that the largest proportion of cost is associated with the cost of crude oil and that taxes are relatively stable, seller mark-up observed any unexpected changes in crude prices. Alternatively, the refinery could fix its margin and pass on the higher cost of oil to the final consumer. For example, in May 2004, as a result of political and social events in the Middle East, the price of premium gasoline in Germany reached an all-time, post-war high of €1.6 when spot crude oil prices exceeded $39 per barrel (Lewis, 2005). This example shows that energy risks are often interrelated, in that a risk event that occurs can unleash a series of effects on other risks.

An effective energy risk strategy requires the accurate assessment and control of different risks, especially price risk. Lewis (2005) suggested three steps of an effective energy price risk strategy:

1. Analysis of energy risk through energy price risk modelling

2. Development of projected budgets and potential exposure

3. Identification of risk mitigation options

In all these steps, decisions are made on the basis of the most-likely-to-occur scenarios, that is, on the probability that certain events will take place. Lewis suggested that energy price risk can be quantified by analysing the potential outcomes of an event and its associated likelihood observed in empirical findings. Probabilities and random variables provide us with the tools required to understand the nature of uncertainty associated with energy price risk. In general, energy price risk is caused by movements in the prices of energy-based products. A common factor for most of these products is their relationship to movement in oil prices, which suggests that analysing oil price behaviour provides the cornerstone for further analysis of energy-based products.

1.2 Research Objectives

The main objective of the thesis is to examine whether investment and risk management decision makers should view OPEC and non-OPEC crude oil differently (or similarly) in modelling oil price volatility, evaluating share prices of different oil companies, and estimating the reaction of oil prices to events that could possibly affect the oil supply. For example, in the case of a value-at-risk (VaR) calculation[2], should decision-makers be concerned about whether the crude oil involved in the analysis is an OPEC or a non-OPEC crude oil? Is the stability of expected cash flow streams affected by OPEC or non-OPEC affiliation? Should different discount rates, used in Net Present Value (NPV), Internal Rate of Return (IRR) and other evaluation techniques, be set to reflect OPEC and non-OPEC association? In other words, given that OPEC countries are expected to be subject to a different set of risks than those expected in the case of non-OPEC countries, should this difference be reflected in the discount rate used? These are examples of investment-related questions for which we are seeking to develop

[2]Giot and Laurent (2003) provide examples of (VaR) estimations on spot prices for crude oil, aluminium, copper and nickel.

inputs that can help in developing reasonable, useful answers.

Most oil-related studies use the prices of well-known crude oils, such as Brent or West Texas Intermediate (WTI) crude oils, in modelling oil prices (Agren, 2006; Ballinger and Dwyer, 2004). This thesis contributes to the growing body of literature that seeks to analyze and understand the dynamics behind the price volatility of crude oils. However, the thesis does not focus only on well-benchmarked crudes; instead, it expands the analysis to cover crude oils with different physical and chemical features produced by OPEC and non-OPEC countries. In other words, in order to make more informative and accurate investment and risk management decisions, researchers may need to re-think whether well-known crude oils are the best indicators of global oil prices. The recent decision by Saudi Arabia to stop referencing its crude to Brent and WTI crudes raised the level of concern that well-known crudes may not possibly be the best indicator of other crudes. Garis (2009) suggested that Oman (OMN) crude better reflect Middle Eastern crude oil, given that most crude oils produced in this region are categorised as heavy and sour.

Understanding the volatility patterns of the prices of different types of crude oil and identifying their relationships with different economic and financial factors play an important role in setting and implementing corporate and risk management strategies and in assessing performance toward achieving long-term goals. In fact, the ability to manage, price and hedge term-structure risk in relationship to volatility represents the true value of using derivatives (Amic and Lautard, 2005). They suggested that an effective risk management programme should help in meeting financial liabilities on time, maximizing profits and completing new projects successfully.

Amic and Lautard (2005) suggested that, in the short-term, crude oil prices determine the trends in other energy prices. In addition, most traders look at the price of crude oil as the index for other energy products, given its relatively high liquidity compared to other commodities. Given the importance of crude oil prices in the energy market, most studies use prices of well-known crude oils, such as Brent and West Texas Intermediate (WTI)[3], and build on the assumption that other crudes prices are behaving similarly. Garis (2009) explained this assumption by suggesting that the selling price of crude oil better reflects the value-in-use to the final consumer than its actual marginal cost of production. Garis explained that crude oil produced by Middle Eastern countries, which has a low production margin of around $2 per barrel ($2/bbl), is priced similarly (or closely) to other crudes produced in higher production margin regions ($11/bbl and $14/bbl for Canada and the U.S., respectively).

However, a closer look into crude oil supply suggests that economic incentives and market perception related to the Organization of Petroleum Exporting Countries (OPEC)'s supplies of crude oils are different from those related to non-OPEC supplies. For example, OPEC's decisions provide signals to the global oil market. Market volatility often responds to OPEC conferences prior to the release of information from the conferences (Horan, Peterson and Mahar, 2004). Also, Amic and Lautard (2005) suggested that the crude oil market is responsive to "OPEC rhetoric." Lewis (2005) also suggested that a key determinant of supply is the actions taken by members of OPEC. In case the decision is to increase prices (i.e., by decreasing supply), the market reacts by

[3]Brent is both time and physically blended crude that marks most crude oils in the world. WTI crude represents 18 percent of global crude oil trade; however, it is currently under pressure of decreasing production.

increasing price volatility. On the other hand, if the decision did not specifically recommend price changes, no significant changes in market volatility occur (Wang, Wu and Yang, 2007). This leads to the question of whether the effects of OPEC decisions are limited to OPEC oil prices or do these effects spill over to non-OPEC oil prices.

The relationship between price and production of crude oils can be described as a negative, backward-bending, supply curve. In this relationship, OPEC sets production levels based on non-competitive behaviour (Dees *et al*, 2005). The difficulty of modelling supply of crude oil is in the structure of the supply side, which consists of a set of independent producers and an organization, OPEC. Dees *et al.*, (2005) distinguished between OPEC and non-OPEC production behaviour by indicating that OPEC uses two different behaviours. First, OPEC uses a cartel model in which it acts as a price maker. Second, it uses a competitive model in which OPEC is a price taker. This was also suggested by Gately (1995), who recognized that OPEC's ability to affect oil prices is the result of its double-role as a cartel and as a price taker.

OPEC production levels are usually set to match the difference between global demand for oil and the supply of oil provided by non-OPEC countries. In other words, OPEC acts as a swing producer that has to provide any additional quantity demanded and, in other cases, would have to adjust its production to eliminate any oversupply. Smith (2005) also supported this view of OPEC behaviour when he concluded that OPEC oil production follows various behaviours. However, Smith (2005) also suggested that competitive behaviour exists between non-OPEC producers, given that each producer is subject to its own, unique set of constraints, such as resource depletion, technical changes and political considerations.

An analysis of the relationship indicates that OPEC members, based on their individual and collective productions, "Granger cause" oil prices (Kaufmann *et al*., 2004). Kaufmann *et al*., (2004) also suggested that more recent research shows that OPEC countries increase production in response to higher oil prices. In pricing OPEC's crude oils, the market would take into account any possible 'cheating' in oil production by an OPEC member. Given the track record of some OPEC countries, oil traders can price different crude oils and estimate premiums or discounts more accurately. They also could take exogenous events into account, such as military conflicts or political unrest associated with OPEC countries.

On the other hand, non-OPEC oil producers do not provide such signals to the market about their intentions. For example, a non-OPEC country could make a decision to increase or decrease its production without giving notice to the market. Oil traders would have no lag-time to adjust to new levels of availability of certain types of non-OPEC crudes. As a result, the availability of non-OPEC types would be subject to an individual country's decision, unlike the case of OPEC crudes in which the decisions are made collectively by the member states. Yousefi and Wirjanto (2004) specified other variables, such as the price/exchange rate, prices charged by others and the demand elasticises faced by each producer, as stochastic disturbances that should have an impact on the price differentials of different types of crude oils (Yousefi and Wirjanto, 2004). This might be the result of the time lag the market requires to analyse and account for new information observed from the two sources, i.e., OPEC, on the one hand, and non-OPEC producers on the other.

OPEC's crudes are represented by a basket of crude oils produced by member states. In this basket, a percentage is fixed for every OPEC member, which means that the amount of each OPEC crude oil available on the international market can be estimated. On the other hand, it is possible that the market views non-OPEC members as another group that, by default, produces another basket of crude oils that are governed, not by a collective decision making process, but by the maximum production capacity of each non-OPEC producer[4]. However, the OPEC production level has declined steadily in the real value of crude oil, due to 1) the lack of incentives on the part of OPEC members to stay within their quotas and 2) the use of more efficient oil-burning technologies (Lewis, 2005).

Nourddden (2005) stated that OPEC output reached its all-time high of 34 mbpd in 2004. On the other hand, non-OPEC crude production has been increasing steadily at about 2.2 mbpd, reaching 50 mbpd in 2004. Nevertheless, OPEC's role in the global energy market is still worthy of further investigation, given its members' significant reserves of crude oil and its substantial production capacity. Many participants view OPEC as the dynamic counterweight of the oil market (Amicand Lautard, 2005).

1.3 The importance of the study

The global energy market is going through a major transformation (Bessec and Méritet, 2007). This transformation can be tracked back to the 1970s, when the

[4] Some of the early analyses of the relationship between OPEC and non-OPEC oil producers were done by Adams, Marquez and Jaime (1984), Griffin (1985), Verleger (1987a, b) and Jones (1990).

deregulation of the world's energy markets started a global trend that led to the complete commoditization of energy-based products (Lewis, 2005). The challenge of generating more energy to meet growing global demand is the main driver for the transformation that is taking place in the industry (Chevalier, 2007)[5]. For example, the North American energy industry has undergone major structural changes that significantly affected how energy producers, utilities and industrial customers operate and make decisions (Serletis and Andreadis, 2004). However, these structural changes within the energy industry require the investment of billions of dollars at each stage of the energy supply chain to ensure that no shortage or disruption of supply occurs, especially during the high-demand summer and winter seasons.

To determine the level of investment needed to fulfil future demand, accurate forecasting of long-term energy consumption is required (Girod, 2007). The majority of capital equipment is designed specifically to consume a certain kind and amount of energy. In most cases, input decisions are based on the expected prices of the inputs (Renou-Maissant, 2007). Prices of energy products, such as jet fuel and heating oil, are dependent on the prices of crude oil (Lewis, 2005). For instance, in the case of power generating companies, understanding the relationship of electricity prices and the prices of the underlying primary fuel commodities (oil, gas and coal) is very important in making sound economic decisions (Hinich and Serletis, 2006).

The price of oil is an important input in planning, implementing and evaluating

[5] The International Energy Agency estimates that global energy demand between 2008 and 2030 is expected to grow by 45 percent (IEA, 2008).

most energy-related investments. Among the prices of various sources of energy, the price of oil is probably the most important (Chardon, 2007). Crude oil satisfies the largest share of global energy demand, and it is expected to continue to be the dominant source of energy for at least the next 20 years, surpassing coal, natural gas, renewable energy sources and nuclear energy (Energy Information Administration (EIA), 2006). EIA also expects that the industrial and transportation sectors will continue to consume more oil than other sectors. Currently, oil satisfies 40 percent of all energy demand and nearly 90 percent of transportation fuel needs (IEA report, 2004).

Commoditization of the energy market has increased the importance of real-time information, reduced the product cycle, narrowed margins and contributed to increasing price volatility (Lewis, 2005). For example, crude oil price volatility plays a very important role in decisions regarding inter-fuel substitution. Bourbonnais and Geoffron (2007) suggested that, during periods of increasing global demand, there is a greater economic rationale for the use of crude oils of different qualities, and that could affect the substitution of inter-fuels as well. Given the highly technical specifications of energy-related equipment, inter-fuel substitution becomes a critical issue for various businesses, such as refineries and power generating plants. Inter-fuel substitution can be achieved either by technical flexibility to switch from one fuel to another or by having a diversified portfolio of generating capacities (Chevalier, 2007). In both cases, oil price volatility is a determining factor in deciding which energy investments to pursue and what fuel mix will be used. By analysing the possibility that OPEC and non-OPEC crude oil prices may behave differently, we think a more accurate decision could be made in both cases of portfolio diversification or at the early stages of designing and implementing technical flexibility.

At the national economic level, oil price volatility is used as a guide for U.S. monetary policy (Serletis and Kemp, 1998). Crude oil prices are correlated with both consumer prices and industrial production cycles (Serletis and Shahmoradi, 2005). Serletis and Shahmoradi (2005) showed that the price cycles of crude oil and heating oil coincide with industrial production. On the other hand, prices of unleaded gasoline and natural gas lag the industrial production cycles. Serletis and Shahmoradi (2005) also found that there was a strong, contemporaneous correlation between crude oil, unleaded gasoline prices and U.S. consumer prices. The price cycles of crude oil, heating oil and unleaded gasoline lead the cycle of U.S. consumer prices. These sets of relationships can help economists and policymakers deal with important issues, such as inflation and unemployment. In addition, crude oil prices are critical input for the price-escalation formula that is used to set and implement international, bilateral contracts (Amic and Lautard, 2005).

However, Serletis and Shahmoradi (2005) emphasized that these cyclical relationships are subject to each country's type of energy structure, which includes the degree of energy intensity and oil dependence. For example, following the oil shortages of the 1970s, France adopted a policy of energy diversification in which nuclear power provides 50 percent of the country's total energy consumption (Bourbonnais and Méritet, 2007). In this case, France is less oil-dependent than the U.S., which suggests that oil prices may not be a good indicator of French monetary and economic policies.

Finally, the possibility that OPEC and non-OPEC crude oil prices may behave differently contributes to the ongoing discussion of whether the oil market is a truly integrated global market or not. Adelman (1984) originally stated that the world oil market is one great pool, very similar to the world's oceans. Adelman's idea of the great pool was challenged by Weiner (1991), who used different correlation and regression techniques to test whether long-term contracts would indicate an integrated oil market. His results suggest that the global oil market is far from a "unified" market. He explained that sellers can possibly engage in price discrimination. Bourbonnais and Geoffron (2007) said that Weiner's results are consistent with the long-term strategies of securing energy supply adopted by many oil-importing countries. In other words, the global oil market is far from being a unified market, because many importing countries use long-term contracts to secure energy supply.

However, several studies have pointed to shortcomings in Weiner's findings. Gülen (1997) suggested that the existence of long-term contracts does not preclude the unification of the oil market. He stated that prices do not deviate much for crude oils of the same quality produced in different regions. In a later study, Gülen compared two sub-periods of oil prices to test the idea of a unified oil market. He concluded that local prices tend to deviate more during times of rising global prices, which can be explained by the rational decision to substitute crude oils of varying qualities and features (Gülen, 1999).

Sauer (1994) and Ripple and Wilamoski (1998) also looked into the methodology used by Weiner (1991). Sauer (1994) used a vector error-correction model (VECM) as well as impulse response and variance decomposition to test whether Weiner's price adjustments were for too short a period to determine whether the oil market is integrated or not. He concluded that, indeed, Weiner's findings, which were based on an adjustment period of one month, were not long enough to account for possible market integration. He suggested that adjustments in prices could take up to five months. In addition, Sauer argued that bivariate correlation analysis between two regions might be influenced by effects coming from other regions that were not accounted for, further weakening Weiner's approach because it fails to account for possible feedback effects.

Ripple and Wilamoski (1998) used co-integration analysis as well as a VECM to estimate the speed of adjustment coefficients and variance decomposition. They concluded that the integration of the world's crude oil market is increased as a result of the development of futures and spot oil markets. They suggested that Weiner's findings could be the result of failing to account for a greater degree of price transparency following the development of the crude oil futures market.

1.4 The Global Energy System

Energy markets consist of markets for oil, natural gas, coal and electricity. The oil market, by far, is one of the most developed and sophisticated markets, with financial transactions totalling more than four times the amount of any other physical commodity transactions. In 2007, the daily trading value of oil futures contracts and over-the-counter (OTC) swaps was estimated to be $1.1 trillion[6]. The correlation between natural gas prices and crude oil prices is strong, which suggests the existence of a common trend that drives these prices (Serletis, 1994). In the following two

[6] See Energy Markets- Price Risk Management and Trading, (T. James, 2008).

sections, we will look into the energy markets for natural gas and electricity to identify any interrelationships between prices in these markets and prices in the oil market. Given that energy consumption is dominated by crude oil, electricity and natural gas (Lewis, 2005), we believe that briefly discussing the electricity and natural gas markets should help provide a better understanding of the global energy system.

1.4.1 Natural Gas Market

Natural gas supplies almost 25 percent of global energy demand. The largest consumers are the U.S., Europe and the former Soviet Union, which account for 30, 20 and 15 percent, respectively (Lewis, 2005). On the other hand, major suppliers of natural gas are Russia, Algeria, Iran and Qatar (The World Fact book, 2007).

Keppler (2007) stated that natural gas markets are "very similar in nature" to oil markets, but they are subject to more regional and local influences. In addition, natural gas prices can possibly be a good indicator of crude oil prices (Serletis, 1997). Market participants can use natural gas prices as a form of an early signalling system for crude oil prices. However, a recent study by Serletis and Shahmoradi (2006) explained that a major difference exists between the natural gas market and the crude oil market. Mainly, the natural gas market is more segmented than the crude oil market. The North American natural gas market is less integrated than the North American crude oil market (Serletis and Rangel-Ruiz, 2004).

Most natural gas resources and production facilities are located long distances from the final consumers, which means that there are additional costs for transporting, liquefying and processing the gas. Thus, the prices of natural gas are strongly influenced by its transportation costs and the degree of pipeline accessibility[7]. For example, Western Europe, Eastern North America, Western North America and Southeast Asia are all self-contained markets with different degrees of integration among the markets. Each market has developed its own system of transportation that creates an integrated pricing system.

Serletis and Andreadis (2004) tested random fractal structures in energy markets throughout North America. They used the methods of dynamic systems theory to analyze the price fluctuations in the North American crude oil and natural gas markets. Their results suggested that the prices of West Texas Intermediate (WTI) crude exhibit a random, multi-fractal, turbulent structure[8]. On the other hand, the prices of Henry Hub natural gas[9] do not show such a structure.

Some regions of the world, such as North America and Western Europe, are more integrated within themselves than with each other. Evidence suggests that integration still has not taken place in the trans-Atlantic gas market (Siliverstovs et. al., 2005). These regional markets developed into three main regions, i.e., North America, Europe and Japan/South Korea. Each region has its own developed network of pipelines and liquefied natural gas (LNG) capacity. Siliverstovs et al. (2005) further stated that regional markets in North America and Europe are highly integrated, whereas the

[7] Transportation of natural gas by pipelines is less costly than shipping liquefied natural gas by sea.
[8] See Ghashghaite et al. (1996) for hypothesis of turbulent behaviour in financial markets.
[9] Henry Hub natural gas price in Louisiana.

Japanese and European markets are integrated to a lesser degree.

Bourbonnais and Geoffron (2007) used the Johansen (1988) and Johansen and Juselius (1990) co-integration model to determine and examine the integration of gas markets in Europe. The results presented further evidence that prices in five European countries follow the random-walk model, which means it is not possible to predict future prices in one market given the past prices in other markets. Co-integration of prices between different geographic markets (or product markets) is evidence of market integration in which a common stochastic trend for prices exists. They concluded that natural gas markets do not form any kind of "pool" due to the lack of market mechanisms from both economic and technical perspectives. However, as Bourbonnaisand Geoffron stated, their results must be used with some reservations due to the limited number of observations they obtained. Quoting Bourbonnais and Geoffron (2007):

"Our conclusions are somewhat reserved, because of the amount of data for each period is rather limited (about fifteen observations for each sub-period)."

Chemically, crude oil is made of many different types of molecules. On the other hand, natural gas is made of few molecules. In order to keep natural gas in the gaseous state, pressure must be applied at ambient temperature, which increases the costs for storage and transportation.

1.4.2 Power Market

The recent re-structuring of the power generating sector has attracted the attention of empirical researchers to analyze the relationship between energy prices and the prices of the various underlying fuel commodities (Bunn, 2004) and (Serletis and Dormaar, 2006). For example, 60 percent of the electricity generated in the PJM[10] is based on fossil fuels. On the other hand, almost all electricity of Nord Pool[11] is produced by hydroelectric generators (Bourbonnais and Méritet, 2007). This strong relationship with the underlying commodities creates a direct link between power prices and our main energy source in this study, i.e., crude oil prices. In addition, indirect links are also created between crude oil and other commodities that might compete with crude oil as substitutes for providing the energy needed to generate electricity.

A unique feature of electricity is the fact that it cannot be physically stored at large commercial scale. In large quantities, it must be produced for immediate use by the consumer. However, some economists view storing the commodities used to generate electricity as electricity storage. Pozzi (2007) suggested that power generators can store electricity through their means of production, such as water, oil and uranium. In addition, Pozzi (2007) further suggested that having excess capacity to process more raw materials in response to any additional demand is a form of storing electricity indirectly. Specifying the type of the underlying commodity to be used to generate

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[10] PJM stands for the power exchange market of Pennsylvania, New Jersey and Maryland.
[11] The world's first power exchange market. Consist of Norway, Sweden, Finland and Denmark.

electricity is one of the most important decisions (Keppler, 2007). Hinich and Serletis (2006) suggested that electricity is produced as a commodity, but it is consumed as a service, which means that additional capacity is always needed to provide any additional demand.

Complex econometric tools are required to model and forecast electricity prices in light of such demand conditions. Bourbounais and Meritet (2007) explained that electricity prices are different from other types of prices due to the inelastic response of electricity demand, seasonality of response to cyclical demand fluctuation, and high volatility of prices. Prices in one market are mainly determined by factors and conditions of two other markets. First is the local market in which the product, in this case electrical power, is produced and sold. The second market consists of the markets that are integrated with the local market (Serletis and Bianchi, 2007).

Serletis and Bianchi (2007) tested for a long-term equilibrium relationship between power prices in Western North American markets using the Engle-Granger (1987) co-integration test, an error-correction model and the Granger causality test. Their findings suggested that deregulation in the 1980s led to market integration in this region. These results suggest that these markets share the same process of price formation. In other words, when the price in one market changes, prices in other integrated markets track one another, which means that these prices contain the same information and are likely to be driven by the same underlying, data-generating process.

This is not the case between the two electricity markets that were previously mentioned, i.e., PJM and Nord Pool. Given that Nord Pool is almost totally dependent on hydroelectric power, which suggests that its prices are exposed to a special set of long-term factors, with the main one being average annual rainfall. On the other hand, PJM has a 60-percent dependency on fossil fuels, which means that its electricity prices are exposed to a different set of factors, such as a political crisis among some of the major oil producing countries. Prior to deregulation, electricity price differentials were very minimal due to the monopolistic nature of these businesses resulting from governmental control. However, the new structure of the power generating business has changed the behaviour of all participants (Bourbonnais and Meritet, 2007). As a result, market participants must have "careful and detailed modelling" of prices for both power and other commodities to effectively estimate cashflows and manage risk exposure. Deregulation created demand for more realistic price modelling for planning future investment, optimizing portfolios and pricing derivatives (Robinson and Baniak, 2002). However, given the relatively short period since deregulation occurred, electricity prices have not been thoroughly modelled and analyzed.

1.5 Study data and descriptive statistics

Understanding the data to be used in modelling is a starting point in selecting the applied model (Huisman, 2009). In this thesis, each chapter has its methodological approach. However, data used are crude oil prices in Chapter 2, crude oil and oil companies' stock prices in Chapter 3 and, finally, crude oil prices and oil-related news items in Chapter 4. The remaining part of this section shows an overview of the range, type and sources of data used, as well as descriptive statistics and normality tests:

1. Range: Prices and related data prior to the 1973 Arab oil embargo[12] are not expected to significantly influence my research. Prior to 1973, oil prices were considered stable. Prices were posted by refiners and were almost constant for years. For instance, from 1959 to 1964, the nominal price of a barrel of oil was $2.97 (Ballinger and Dwyer, 2004). However, since 1973, oil prices have become more volatile, which makes it a very fruitful period for research. In addition, Amic and Lautard (2005) explained that, during this period, the industry had witnessed major shifts in ownership of producing assets from oil companies to national oil companies in producing countries.

However, we were confronted with the challenge of finding the longest time series available for the widest possible range of different crude oils. We were able to find very few prices of crude oil types that go back to the 1970s or 1980s. For the purpose of our study and in order to have the largest possible number of crude oil types, we selected a range of weekly data that spans from 03/01/1997 to 29/01/2010. It consists of two different types, i.e., spot crude oil prices of 30 different crude oils (16 crude oils produced by OPEC and 14 crude oils produced by non-OPEC). Appendix 1 provides additional information about our sample of crude oils. In addition, our sample includes stock prices of 32 different, non-integrated oil companies that would be used in Chapter 3. Appendix 2 provides additional information of each company.

[12]Huntington (2009) suggested that significant oil price changes go back to the 1957 Suez crisis.

2. Type: Using futures oil prices is a more suitable choice than using historical spot prices for this type of study, because it eliminates unwanted noise. However, futures oil prices are only available for few well-known crude oils. As a result, we have no choice but to use spot prices.

Thus, for the chapters dealing with crude oil prices, I have used the natural log returns for spot prices, and I have tested for unit root problem. In the case of any gaps, further rearrangement can be done. In the case of stock prices, I have used market capitalisation as the main criterion for selecting eight stocks from each of the following oil-related sectors:

1. Drilling and Exploration (DE) -Upstream
2. Equipment and services (ES) -Upstream
3. Pipelines (PIP) -Downstream
4. Refinery and Marketing (RM) -Downstream

Business organizations in the oil industry can be classified into two broad sectors: upstream and downstream[13]. Typically, integrated oil companies operate in both sectors under one corporate umbrella. For example, companies such as Exxon Mobil and BP explore, transport, refine and market oil and oil-based products in many parts of the world. However, highly technical tasks, such as seismic scanning and offshore

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[13] This classification is based on MSCI and S&P Global Industry Classification Standard (GICS) structure. See Appendix 3 for the full-classification.

drilling, require specialized companies with skilled labour and specialized equipment. Therefore, integrated oil companies often outsource or subcontract technical operations to smaller, non-integrated companies that specialize in those types of operations.

Non-integrated oil companies in upstream and downstream sectors of the oil industry are classified by the types of operations they specialize in and their position in the supply chain. For example, companies in drilling and exploration (DE) and equipment and services (ES) are categorized in the upstream sector. Companies in the downstream sector include those that own and operate pipelines (PIP) and those involved in refining and marketing (RM) oil products.

3. Sources: Historical and current information for this research was obtained from the electronic databases of the U.S. Department of Energy's Energy Information Administration (EIA) and Yahoo Finance. The exact sources of data are specified as follows:

Crude oil prices: http://www.eia.gov/dnav/pet/pet_pri_wco_k_w.htm

Stock prices: http://finance.yahoo.com/

4. Descriptive statistics: I used descriptive statistics to describe key properties of our data sets. These properties should help in selecting the model specifications that best fit the nature of the data at hand. Appendices 4 through 9 provide charts for the time series used in the thesis. Appendices 4 and 5 cover crude oil prices and returns of OPEC and non-OPEC producers, respectively. Appendices 6 and 7 show charts for stock prices of the DE and ES upstream oil sectors. Finally, Appendices 8 and 9 show prices for the stocks of PIP and RM downstream sectors. In addition, summary statistics for each series (mean, standard deviation, skewness and kurtosis) are listed. Standard deviation is a measure of volatility (Huisman, 2009). It can be explained as the amount of variation in price changes. It also can be used in estimating an interval with the likely price change between two consecutive dates, i.e., t and t-1.

We provided descriptive statistics for both level price and returns for both crude oil and stock prices. In addition, we provided visual representations for both prices and returns. Charts of returns provide additional information by showing the amount of randomness in the weekly price changes Huisman (2009). Returns charts are identified by including the letters “LN” to the name of the crude. For example, the chart titled ADM is for the level prices and the chart titled ADM_LN is for returns. Also, histograms are provided to represent the frequency with which several price changes have occurred. Thinner histograms are associated with lower standard deviations that indicate smaller ranges of uncertainty. On the other hand, wider histograms are associated with larger standard deviations (i.e., wider ranges of uncertainty). For our sample of crude oil prices, the histograms indicate a wide range of uncertainty, which led us to think that crude oil prices are subject to a high degree of variation. This feature is modelled and empirically tested by the GARCH model in the following chapter. In the case of oil companies’ stock prices, similar results were obtained. The histograms are investigated further in the following section to determine whether our sample was normally distributed or not.

The degree of skewness provides information about the likelihood of positive (or negative) extreme events occurring in the sample. In case skewness is equal to 0, we can identify a symmetric distribution of values in which large values are about as likely as small values. Negative skewness indicates that large negative values are more likely, (i.e., skew <0). On the other hand, positive skewness indicates that large positive values are more likely than large negative values, (i.e., skew > 0). Kurtosis, on the other hand, measures the size of the tails of a probability distribution, providing one additional measure that provides information regarding the shape or the fatness of the tails. All kurtosis values obtained for crude oil prices indicated that oil prices do suffer from the "fat-tails problem," indicating that extreme observations are present in the sample. This is in line with prices of oil-related commodities. Garis (2009) found that critical events that cause major price changes happened more often in crude oil price time-series than predicted. Assessing both skewness and kurtosis should help in testing the normality assumption, as explained in the following section.

5. Normality assumption: We also tested the series for normality using the Jarque-Bera (JB) test and results are listed as well. The JB test indicates whether observations in the selected sample came from a normally distributed population. The JB test compares skewness and kurtosis estimates to values for a normal distribution. In a normal distribution, skewness and kurtosis estimates are zero and 3, respectively. Thus, any deviation from these values would be an indication of non-normality. Low (high) JB values would be a sign of normality (non-normality).

Results of the JB normality test indicate that crude oil and stock price series, at both price levels and returns, do not resemble a normally distributed function. Thus, these series fail the normality assumption. The p-values are very low (i.e., lower than 0.05), so we can safely reject the null hypothesis of normality. However, this came as no surprise given that the distribution of energy price level and returns are known to be fat-tailed (Huisman, 2009). It is well known that asset returns are commonly found to be leptokurtic (Aloui, 2008). Huisman further stated that the JB test can be used statistically to addresses whether observations are normally distributed or not. However, it offers no information on what distribution should be used. However, several authors have suggested relaxing this assumption and using a Student's-t distribution assumption to deal with the issue of fat-tails exhibited by most financial time series (Lewis, 2005).

In a statement by Alan Greenspan, the former chairman of the U.S. Federal Reserve, "The normality assumptions allow us to drop off a huge amount of complexity in our equations. Because once you start putting in non-normality assumptions, which is unfortunately what characterises the real world, then these issues become extremely difficult." In terms of empirical research, several studies, such as Giot and Laurent (2003) and Marzo and Zagalia (2007), do account for fat tails, heteroskedasticity and normality using different methods, such as applying the Student's-t distribution.

The Student's-t distribution contains an additional parameter to account for tail fatness (i.e., degree of freedom - df) and is not much different from a normal distribution (Huisman, 2009). For example, Wu and Shieh (2007) used normal, Student's-t and skewed Student's-t to test long-term memory behaviour in daily volatility of T-Bond interest rate futures. The idea of using the Student's-t distribution assumption is applied to other times of financial time series as well. For example, Bollerslev (1987), Baillie and Bollerslev (1989) and others stated that the Student's-t distribution fits the fatter-tail series shown in daily exchange rate logarithmic returns. Mandelbrot (2004) suggested that there could be several distribution functions operating simultaneously. This view is also supported by Garis (2009), which suggests that the analysis of crude oil prices is a rather complex task because there is more than a single regime driving crude oil price behaviour. This point will be addressed further in chapter 4 of this thesis.

Lewis (2005) explained that, when the normality assumption fails, three different solutions can be considered. First, stick with the normal distribution, but modify its percentile function. This could be done by adopting the Cornish-Fisher approximation in which the percentiles of the normal probability distribution is adjusted to account for skewness or kurtosis. The second solution involves selecting an alternative probability distribution. The third solution deals with the possibility that a mixture of normal distributions exist. In case of crude oil prices, and as suggested by Lewis (2005), we would list and identify estimations obtained using the Student's-t distribution assumption. The Student's-t distribution is popular for modelling fat-tail prices and returns. In the case of crude oil prices, Appendices 4 and 5, crude oil prices do have similar price behaviour, which was confirmed by summary statistics and the normality test.

1.6 Thesis structure

In this thesis, each chapter deals with a separate research problem and has its own structure of introduction, literature review, data, model specifications, results and conclusions. Yet, the overall research question is how crude oil prices of OPEC and non-OPEC producers should be considered in the decision-making process. Our research focuses on analyzing the relationship of OPEC and non-OPEC crude oil prices in terms of price volatility, stock prices of oil companies and price reaction to possible supply disruption caused by endogenous or exogenesis events. In Chapter 2, I used a univariate Generalised Autoregressive Conditional Heteroskedasticity (GARCH) model to estimate whether OPEC's crude oil prices show a similar (or different) level of volatility compared to the prices for non-OPEC crude oil.

In Chapter 3, I used the Johansen co-integration methodology to examine whether OPEC and non-OPEC crude prices share the same type of relationship with stock prices of companies in different oil sectors. I used stock price level because cointegration analysis requires that time series used need to be non-stationary, which is the case for stock price level as determined by unit root tests. Therefore, there is no need to differentiate these prices.

In Chapter 4, I applied a panel data framework using fixed and random effects models to investigate whether OPEC and non-OPEC crude prices react similarly (or differently) to news and events that could cause supply disruption. Finally, Chapter 5 provides summary of major findings, implications for decision makers, limitation of the study and possible future research recommendations.

Figure 1 represents the structure of the thesis and states the questions and hypotheses to be tested for each chapter. The null hypotheses, as well as alternative hypotheses, are stated to clearly identify our goal in each chapter. In chapter 5, we provide a summary of the principle findings as well as offer implications for decision making, limitations of the thesis and recommendations of future research.

Figure 1: Structure of the thesis:

Chapter 1: Introduction
- Set motivation and background. - Disscuss the behaviour of OPEC and non-OPEC crude oil prices. - Describe data. sample and persents summary statistics of data. - Presents thesis structure

Chapter 2:	Chapter 3:	Chapter 4:
Question: Is the volatility of OPEC crude prices similar to non-OPEC crude prices? Ho: OPEC(vol) - non-OPEC(vol) = 0 H1: OPEC(vol) - non-OPEC(vol) ≠ 0	Question: Do prices of OPEC and non-OPEC crude oils co-integrate with stock prices of upstream and downstream oil companies? Ho: OPEC(rel) - non-OPEC(rel) = 0 H1: OPEC(rel) - non-OPEC(rel) ≠ 0	Question: Do OPEC and non-OPEC crude prices react similarly to possible supply disruption? Ho: OPEC(rect) - non-OPEC (rect) = 0 H1: OPEC(rect) - non-OPEC (rect) ≠ 0

Chapter 5: Conclusion
- Summary of findings - Implications for decision making - Limitations of thesis - Future research recommendations

Chapter 2: Price volatility of OPEC and non-OPEC crude oils

2.1 Introduction

Energy-intensive companies, such as oil refineries and power generators, face a high degree of exposure to price risk for both inputs and outputs. In order to minimize the negative effects of these exposures, financial instruments, such as swaps and options, are being used by risk management teams. However, the effective use of these instruments requires a better understanding of the dynamics that drive crude oil prices. Through managing price risk exposure, companies can establish guidelines for financial commitments that are needed to develop and implement long-term investment plans. One of the major issues facing decision-makers in these companies is how to identify and manage energy price risk exposure.

Among energy prices, the price of oil is probably the most important (Chardon, 2007). Prices are formed by the actions and split-second decisions of market participants under real-time and competitive circumstances. In order to understand the dynamics behind oil price volatility, it is necessary to consider the demand and supply sides of the oil market. Market and price expectations have significant impacts on the behaviour of both suppliers and customers. Given the multi-player nature of the global oil market, the long-term price of crude oil is driven by interaction between supply and demand. In the long run, the interaction between supply and demand creates a mechanism that determines long-term oil price behaviour and the quantity exchanged.

Through this mechanism, individual supply and demand of utility maximizing customers reach an equilibrium state, at which price meets the expectations of both buyers and sellers.

Garis (2009) suggested that individuals, in the short-term, ordinarily act rationally and do not normally repeat errors systematically, whereas groups made up of these individuals often commit systematic errors in judgment. He suggests that future expectation of crude oil prices influence spot market prices even if it is the result of expected events. The role of expectation opens the door to consider sub-emotional constraints in analysing market phenomena, such as self-fulfilling and herding behaviours. Shenk (2007) provided different types of these phenomena and provided examples and discussion of each one. Garis (2009) further stated that these phenomena accelerate crude oil price response to different stimulus events that result in price volatility. He suggested that additional factors that could cause increasing oil price volatility and market instability are falling transition costs, 'Hot Money' following trends and the use of a few advance trading programs by a large number of traders.

Montier (2003) suggested that the behaviour of traders can be described as a quasi-individual, rational behaviour with group restrictions. He further divides traders' behaviour into different groups. First, is the herding behaviour in which individuals retained their individuality but follow decisions taken by well-respected leaders. Failure to trust one's own trading strategy is the main cause of such behaviour. This was clearly seen during the dot-com stock bubble in which most traders did not understand the businesses they were investing in or the full risk and potential of the technologies behind those "New Economy" businesses.

Second is anchoring, which can be described as keeping initial thinking dominant even if the price regime has changed due to changes in market or economic conditions. Enron and the hedge fund Long-Term Capital Management (LTCM) are examples of companies that collapsed financially due to such trading behaviour. The third grouping of trader behaviour occurs when uncertain traders look for good reputations to follow. Shenk (2007) provided an example of how market participants value information provided by well-respected investment firms. In 2006, Goldman Sachs issued a report predicting that oil prices would increase to $105/bbl. The report did not specify any new information, but the market's immediate reaction was a price increase of $2.45/bbl. The fourth and last group of traders occurs when conventional bias leads uncertain traders to make "safe bets" by doing what they have always done, e.g., taking positions based on the released inventory numbers of oil, gas and other oil-related products.

Deviation from the expected equilibrium causes an increase in the level of uncertainty. It is possible for any price deviation to be a random and temporary event, but it could also indicate a long-term shift in supply and demand. Price fluctuations are important because they provide price signals about the "tightness" of the market (Lewis, 2005). Amic and Lautard (2005) suggested that signals expressed by oil prices can be used in trading as well as in managing stocks and process units. In case of trading crude oil, if the market believes that there is sufficient surplus supply capacity to meet possible supply disrupting shortages, then the fundamentals of supply and demand dominate. However, if the market believes the opposite, then fear and greed become dominant (Garis, 2009).

Based on such price fluctuations, market participants must decide whether they should keep (or adjust) their current and future positions according to the same (or a new) supply and demand equilibrium. Furthermore, we discuss the need of new investment in different sectors of the oil supply chain to meet future demand in the global oil market. Oil producers interpret these price signals in two possible ways, i.e., an opportunity to increase production to meet demand or to decrease production due to the overabundance of supply. Crude oil prices are sensitive to expectation levels of inventories (Lewis, 2005). Lewis further stated that issues of overproduction or underproduction, which are driven by global booms, recessions and weather conditions, could be the reasons for price swings.

In this chapter, we investigate whether the pattern of price volatilities of crude oils produced by OPEC are similar (or different) from the price volatilities of crude oils produced by non-OPEC countries. The study sample consists of 30 different types of crude oil, 16 from OPEC countries and 14 from non-OPEC countries. The data consist of weekly free-on-board (FOB) spot prices and span from 03/01/1997 to 29/01/2010. Appendix 1 shows these crudes and provides additional information, including country of origin, American Petroleum Institution (API) number and sulphur content.

We used the univariate GARCH model developed by Bollerslev (1987) to model price volatility of each crude oil. The crudes are grouped into: 1) The OPEC group that consist of 16 different crude oil prices, starting from United Arab Emirates' Murban crude oil (ADM) to Venezuela's Tia Juana Light crude oil (VEN).2) The non-OPEC group, which consists of 14 different crude oil prices starts from Australia's Gippsland crude oil (AUS) to the UK's Brent Blend crude oil (BRT).

We are interested in knowing whether price volatilities are significantly different between these two groups or not. In other words, do prices of crude oil produced by OPEC and non-OPEC producers show similar (or different) levels of volatility. We state the following null hypothesis:

Hypothesis 1: The volatility of the prices of OPEC-produced crude oil is similar to volatility of the prices of non-OPEC-produced crude oil.

Volatility estimation is one of the most important issues in the world of finance; it has significant implications for both policy and risk management (Serletis and Shahmoradi, 2006). In the case of the oil industry, Amic and Lautard (2005) explained that the structure of the oil industry can move violently between backwardation and contango, which would affect risk exposure of both producers and consumers. Given the limited application of advanced models for crude oil prices (Krichene, 2006), we believe this chapter provides useful information on the dynamics of crude oil pricing for decision makers in governments and corporations.

This chapter is organized into five sections. Sections 2.2 and 2.3 provide an analysis of the supply and demand of crude oil, respectively. Section 2.4 addresses the issue of additional investment needed to meet future demand. A section 2.5 discusses the issue of price volatility in the international crude oil markets. 2.6 provide a review of ARCH-type model applications in the area of crude oil price behaviour. Section 2.7 outlines the GARCH model that was used. Section 2.8 provides descriptive statistics of the data set. Section 2.9 and 2.10 present the results of unit root testing and testing and ARCH effects, respectively. In section 2.11, we present and discuss empirical results.

Finally, section 2.12 provides concluding remarks.

2.2 Demand

The demand for oil is closely related to the expected growth in the global gross domestic product (GDP)[14]. This relationship can be modelled using a simple demand curve that links quantities to prices (Dees et al., 2006). However, demand for oil should be examined in the context of total demand for energy, given that different energy sources can, to different degrees, substitute for each other. Girod (2007) suggested that the theoretical work of Nadiri and Rosen (1969), Treadway (1969) and Keenan (1979) contributes to richer energy econometrics formalization because of the inclusion of a dynamic adjustment process. Girod (2007) explained that energy demand is actually a derived demand because the need for energy sources is the result of actual operations that take place in a plant or factory. Girod suggested that dynamic properties on the demand side arise from the fact that energy demand is "double dated," which means the interval of time from when the equipment was bought until the time the demand was fulfilled. This interval of time is an important factor in distinguishing between "captive demand" and "substitutable demand," as well as between long-term and short-term demand.

[14]The first model of possible energy/economy relationship was developed by Hudson and Jorgenson (1974) and others.

The expectation of future economic growth leads to major changes in the prices of oil and energy. In 2004, for example, the prices of oil-based products increased significantly due to the high growth rate of the global economy and due to the fear that a shortage of petroleum products could be a real possibility in the near future (Chardon, 2007). However, there has been a long debate over the issue of whether significant changes in energy prices lead or lag the cycle of economic growth. Hamilton (1983) analyzed pre-1972 energy prices and concluded that energy prices are counter-cyclical.

However, Mork (1988) pointed out that Hamilton's pre-1972 data contain mostly upward price movements, which introduced possible asymmetry in the sense that this correlation between energy prices and economic growth and the conclusion that energy prices are counter-cyclical may not be valid during periods of price declines. Mork (1988) suggested the existence of an asymmetric impact in the correlation between oil prices and gross national product (GNP). He stated that the correlation between decreases in oil prices and the growth of the GNP is significantly different from the correlation between increases in oil prices and the growth of the GNP.

Serletis and Kemp (1998) examined the cyclical behaviour of energy prices. They suggested that Hodrick-Prescott (HP)[15] filtering can produce a reasonable approximation of an ideal business filter. Their results suggested that the prices of crude oil and heating oil are pro-cyclical, which suggests that these two prices are driven by

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[15]Hodrick-Prescott filtering (HP): a mathematical tool used in macroeconomics, especially in real business cycle theory. It is used to obtain a smoothed, non-linear representation of a time series that is more sensitive to long-term fluctuations than to short-term fluctuations. The filter was first applied by economists Robert J. Hodrick and Edward C. Prescott, a recent Nobel Prize winner.

one common trend. On the other hand, the prices of unleaded gasoline and natural gas lag the pro-cyclical indicator, which also suggests the existence of one common trend behind these two prices. Serletis and Shahmoradi (2005) confirmed that the prices of natural gas are pro-cyclical and lag the cycle of industrial production. In addition, Serletis and Kemp (1998) also found that energy prices are positively and contemporaneously correlated with consumer prices, which suggests that energy prices could play a major role in conducting monetary policy. Serletis and Kemp emphasized that data from countries with different industrial structures and different levels of oil dependency may show different results, which were supported by evidences provided by Lee (2005). Lee listed the results of 14 different papers that examined causality between energy and GDP for a set of developing countries at different stages of economic development. The causality test results suggested that there is no single causality direction between GDP and energy.

Countries with developed, industrialized economies are consuming more energy per unit of GDP than other countries (Toman and Jemelkova, 2003). The energy used-GDP ratio, which is the energy required to generate one unit of output (or the elasticity of GDP), provides a measure of energy intensity in an economy (Detais, Fouquau and Hurlin, 2007). For example, the United States and Canada are the most energy-intensive, industrialized countries in the world, due to low prices of fuel, high transportation needs because of their vast geographical locations and high electric consumption in both the business and private sectors (Darmstadter et al., 1977). The elasticity of commercial energy consumption is "consistently higher" for developing countries compared to developed countries (Ang, 1987). It could be the case that commercial energy consumption in developing countries is more allocated toward business and commercial activities because of the focus on exporting goods to developed countries. On the other hand, commercial energy consumption in developed countries can be allocated more toward the services that are needed and consumed by local markets.

The link between energy prices and energy intensity has not been analyzed thoroughly and is not yet strongly established compared to other energy-based relationships (Bessec and Meritet, 2007). Also, they pointed out that technology progress should be included in the examination of energy prices and energy intensity. They used fuel rates (prices) in roads as a proxy for technological advances. They also used co-integration analysis and the Granger causality test to analyze the causal relationship between energy prices, energy intensity and technology progress in 15 different (OECD) countries. They concluded that 12 out of the 15 countries showed evidence of co-integration. The results for the Granger causality test suggested a causal relationship between prices and technology progress in all of the countries. The test also showed a causal relationship between prices, technology progress and oil consumption in most of the 15 (OECD) countries.

2.3 Supply

The supply of energy is going through major transformations to satisfy sustainability concerns (Bessec and Meritet, 2007). However, unlike modelling demand, modelling supply in the oil/energy markets has proven to be a difficult task. This difficulty arises mainly from the complex interactions between many different factors.

In general, these factors can be categorized as endogenous (i.e., industry-specific, such as competition and capacity utilization) and exogenous (i.e., non-industry-specific, such as political crises or natural events).

One of the most important endogenous factors is the dynamic relationship between OPEC and non-OPEC producers. OPEC producers have formed a cartel that determines the level of production by setting a quota for each member. This strategy by OPEC, along with some other market conditions, affects oil prices (Kaufmaan et al., 2004). On the other hand, non-OPEC producers are considered price takers that compete with each other (Dees et al., 2008). Dees further stated that this relationship between OPEC and non-OPEC producers and the negative relationship between production and prices create a backward-sloping supply curve. This idea was introduced by Cramer and Salehi-Isfahani in the 1980s but was not published until 1989 (Krugman, 2000). It forms the basis for Cramer and Salehi-Isfahani's competitive theory that attempts to explain the behaviour of the oil market. Krugman (2000, 2002) reviewed the theory and expressed his surprise that it did not get more attention. Recently, Bernabe et al., (2004) used this competitive view of the oil market to develop a stochastic, multi-model approach to describe the dynamics of the oil market.

2.4 Need for new investment

Most oil producers are operating at maximum capacity utilization, which raises the issue of the need of sufficient new investments. Additional capacity can be added through additional capital investment by exploring for new reserves or developing new technologies. An estimated $2.18 trillion will be required through the year 2030 just for exploring and developing new sources of oil (IEA, 2003). Given the implications of the recent credit crunch, financing became more difficult than before, which put more stress on oil companies, including national oil companies, to have better evaluations of current and future projects.

Historically, Saudi Arabia has maintained a reserve capacity of 2 - 3 million barrels per day (mbpd) to meet any unexpected shortage or disruption of oil supply. However, the Saudi national oil producer, Saudi Aramco, produced oil at almost full capacity from 2005 to 2007 and during much of 2008 and 2009. The Company is working to increase its capacity to 12 mbpd by the end of 2010. However, according to the simulation analysis of the National Energy Modelling Systems (NEMS), that will not be enough. As a result, the U.S. Department of Energy has concluded that OPEC will need to double its production by 2025 to keep the supply and demand in balance (Dees et al., 2006). Dees further stated that much of OPEC's projected increase in production would come from Saudi Arabia. However, the Saudis have stated many times that they will not increase production to those levels and that they are working to increase capacity to 12 mbpd by the end of 2010.

From an investment point of view, an oil producer cannot invest billions of dollars in additional capacity without running the risk of facing decreasing demand once additional capacity is ready for operation. These new investments are capital expenditures and are usually defined as long-term investment in assets, such as machinery and equipment. These assets are expected to generate cashflows after an estimated lag time. Oil producers may have a difficult time estimating the lag time between making the decision to increase capacity and having the additional capacity built and ready for commercial operation. These long-term assets are consumed, on the books, at a pre-determined rate. However, other factors may come into play that may cause inconsistency between book and market values of these assets.

Colacito and Corce (2006) explained that, as the predictable components of consumption become more correlated, stochastic discount factors move in the same way. They further stated that, as variable X is a predictable and persistent component of the consumption growth of a particular asset, X will influence the stream of dividends (or cashflows) generated by the consumption of this asset. Thus, X will be a key factor in estimating the expected value and volatility of this stream of returns.

This relationship can also be recognized by looking into the sensitivity of a stock to a specific factor. Bentz (2003) explained that the sensitivity of a stock, or any other asset, is usually defined by its expected return corresponding to a unit of change in the factor, as represented by the following equation:

$$Y(t) = \alpha + \beta X(t) + \varepsilon(t), \quad (1)$$

$Y(t)$ denotes the returns of the stock at time t, $X(t)$ denotes the simultaneous change in the factor and β is the sensitivity factor. In this case, α is a constant that represents an extra factor of stock performance and $\varepsilon(t)$ is a random variable with a zero mean. Both $Y(t)$ and $X(t)$ are observed from the market, $\varepsilon(t)$ and α are usually estimated using regression techniques. Bentz further explained that once β is estimated, investment can be immunized against unexpected moves in the factor by selling β amounts of the tradable proxy for each unit of the investment undertaken.

This model can be generalized to simultaneously estimate joint sensitivity for a set of several factors (Bentz, 2003). The generalization of the model can be set as follows:

$$\begin{aligned} Y(t) &= \alpha + \sum_{i=1}^{N} \beta_i X_i(t) + \varepsilon(t), \\ &= X(t)\beta + \varepsilon(t) \end{aligned} \tag{2}$$

where $X_i(t)$ denotes the return of the i factor. Bentz explained that the joint sensitivity coefficients β_i measure the "clean" sensitivities by accounting for the intended variable $X_i(t)$ and controlling the effects of other variables. In this case, β_i is estimated as the partial derivative $\partial\overline{Y}(X_i)/\partial(X_i)$ of the expected value of $\overline{Y}$ with respect to the variable X_i. Bentz further explained that the degree of complexity of estimating factor sensitivity depends mostly on the underlying assumption behind the relationship of the returns of the stock, or asset and the factor.

Colacito and Corce (2006) explained that the standard error of an idiosyncratic shock to the predictable component is small compared to the standard error of the idiosyncratic shock to consumption growth rate. This relatively small error term allows the predictable components of the consumption growth rate to be the main determinants of the volatility of consumption growth; see Tallarini (2000) and Colacito and Corce

(2006). Generalization of a model that contains more than one predictable component of the consumption growth law of motion could possibly match key moments of returns. It also provides a relatively lower inter-temporal elasticity of substitution when the coefficient is still higher than that of the reciprocal risk aversion (Colacito and Corce, 2006).

Oil producers need balanced oil supply and demand to ensure that oil remains the most affordable source of energy. This would create equilibrium at some point in the future. However, an imbalance between supply and demand would exist for some time due to the "time-to-build" factor, which is the time lag between the decision to add capacity to (or enter) the market and the time that production begins (Postali and Picchetti, 2006). However, several studies have suggested that the decision of major oil producers not to expand exploration and development of new oil fields contributes to the high oil prices that the global economy endured during the 2005 - 2008 period.

Since 1998, there has been a noticeable decrease in the level of global exploration and development of new wells (Asche et al., 2005). One of the major causes of such a decrease in investment, as suggested by Asche, is the increasing emphasis that oil stock analysts place on short-term profit indicators, such as Return on Average Capital Employed (RoACE). This emphasis causes many oil companies to focus on improving their return on existing operations, rather than on undertaking risky new exploration and development. For example, in 1990, there were more than 650 well explorations in the U.S. This number had decreased to less than 200 by 1999 and was approximately 200 in 2003 (Asche et al., 2005).

2.5 Why does volatility matter?

Capital-intensive projects, such as developing new oil fields or increasing the production capacity of existing fields, depend on the estimations of future cashflows expected from these projects. In the case of oil-field operations, such cashflows are greatly dependent on the market's pricing of the types of crude oil. Given the volatile nature of oil prices, many researchers argue that oil-related cashflows should be discounted at a rate that reflects the expected level of volatility (Regnier, 2007). In other words, if oil prices are expected to become more volatile, a higher discount rate would be used to evaluate potential projects or investments. This means that if the price of crude oil type "X" produced in Project A is more volatile than the price of crude oil type "Y" produced in Project B, then, in the process of evaluating both projects, a higher discount rate should be applied to future cashflows generated by Project A.

This raises the importance of accurate estimation of crude oil price volatility. In fact, the Global Association of Risk Professionals (GARP) states that the price volatility of a commodity is a "key input" in risk management applications, such as option pricing and Value-at-Risk (Var). Amic and Lautard (2005) found that rational decision making can be used in VaR, which takes account of the correlation of the volatilities of the individual components of refinery margins or any of the inputs. Analysis of the relative contribution of the different product margin spread to the composite margin spread is very important in using a VaR application.

Many experts would consider oil as a homogeneous commodity; however, there are more than 160 different types of tradable crude oils in international markets. Each has its own characteristics and qualities, which address the preferences of different buyers in the oil market (Lanza et al., 2003). Classification of these different types of crude oils depends on their density and sulfur content. Each level of density and sulfur requires a different distillation process. Light crude oils can be processed by simple and less-costly distillation processes, which produce high-value products, such as gasoline. Nevertheless, this low processing cost comes at the expense of paying premiums to buy these types of crude oils. On the other hand, heavy crude oils are not rich in high-value products, so more complex and costly distillation processes are required to produce the optimal mix of products from these oils. Because of this costly processing disadvantage, heavy crude oils are sold at a discount compared to light crude oils.

Amic and Lautard (2005) explained that the proportions of the different products produced depend heavily on the type of crude oil being refined. Light crude oils, which produce small amounts of fuel oil, are produced mainly in the U.S., the North Sea and North America. On the other hand, heavy crude oils, which produce relatively more fuel and less gasoline, are mainly produced in the Middle East and South America. In terms of international trade, Europe exports gasoline and gasoil to the U.S. and the Far East, respectively. However, it imports naphtha and fuel oil. The U.S., on the other hand, exports distillates to South America and to the Far East. The Middle East is a net exporter of naphta and fuel oil to Europe and the Far East.

Prior to the Arab oil embargo in 1973, oil was considered to be a stable commodity. Prices were posted by refiners and were almost constant for years. For instance, from 1959 to 1964, the nominal price of a barrel of oil was $2.97 (Ballinger et al., 2004). In addition, from the 1930s to the 1960s, the Texas Railroad Commission (TRC) was the main oil producer in the world, which stabilized the oil market for a long time.[16] However, in the early 1970s, as OPEC countries became the dominant oil producers, prices became more volatile due to the different strategies and agenda pursued by OPEC (Dees et al., 2006).

Regnier (2007) presented evidence that the prices of crude oil, refined petroleum and natural gas are more volatile than the prices of 95% of the products sold domestically in the United States. However, other studies mentioned by Regnier showed that this level of volatility is not a given. For example, during the period of 1975 - 1984, the prices of agricultural commodities were found to be the most volatile (Clem, 1985). During the periods of 1975 - 1984, 1979 - 1984 and 1982 - 1984, prices of crude oil and coal were found to be less volatile than most other non-food commodities (Pindyck, 1999). Crude oil prices only showed more volatility than nine other commodities during the period of 1984 - 1994 (Plourde and Watkins, 1998). Roe and Antonovitz (1985) used the lagged values of the squared innovations as a measure of risk. In financial markets, it is observed that price decreases are often followed by higher volatility than when prices increase by the same magnitude.

In terms of GDP, several studies have suggested that an estimated 10 percent increase in crude oil price volatility would cause a 0.2 - 0.5 percent decrease in GDP

[16] Standard Oil was the major oil producer during the 1880s. It was able to control both price and quality which resulted in introducing North American anti-trust laws. As a result, the company was broken up and more suppliers entered the oil market.

after six quarters (Huntington, 2009). Kilian (2007) analysed real oil price fluncuations from January 2007 to September 2005. He suggested that higher oil prices may be driven by global macroeconomic aggregates. Also, he found that oil price shocks have been driven by combination of both aggregate and precautionary demand shocks, not by supply shocks. This is in line with an early study by Sadorsky (2001), which suggested that both oil price and oil price volatility affect economic activities. However, he suggested that changes in economic activities only have small effects on oil prices.

2.6 Crude oil price behaviour and ARCH-type models

Unlike standard time-series models, the unique strength of ARCH-class models is their ability to allow the conditional variance of underlying processes to vary over time. In addition, the information that is used in forming conditional expectations is similar to that used to predict the conditional mean (i.e., variables observed in previous periods). Hence, the GARCH model maintains the desirable forecasting properties of a traditional, time-series model, but it extends them to the conditional variance (Holt and Aradhyula, 1990).

Differences in the volatility of the price of crude oil compared to the volatility of the prices of other commodities suggest that each commodity is subject to a different set of factors or sources. This set of factors is affected by changes in the macro-conditions of the market, the economy, or micro-economic factors, such as industry competition and capital expenditure. In general, the volatility of commodity prices can be caused by various factors, such as market structure, output elasticity and available substitutes

(Regnier, 2007). Specifically for the volatility of oil prices, these factors are integrated to some degree with each other. However, factors that affect the volatility of the prices of commodities (e.g., oil) can be organized into the four following categories (Sadorsky, 2004). First is Global demand, The United States is by far the largest oil consumer in the world. About 25 percent of the world's demand for oil comes from the U.S. However, China’s and India’s demand for oil has grown substantially in the past few years. For example, China's economic growth has increased its oil demand by one million barrels per day, which accounts for the average annual increase in global demand during the 1990s (RBS, 2004). However, questions about China’s economic growth and ability to sustain such growth are major contributing factors to the volatility of oil prices. Recent recalls of millions of Chinese-made products are just one example of what could slow down an economy. More globally, the recent financial crisis caused by the global credit crash caused a significant slowdown in major economies around the world, suggesting that China and other exporting countries may consume less oil than previously expected because of the decrease in the global demand for exports.

Second, Geopolitics, more than two-thirds of the world’s oil reserves are located in political hotspots. The Middle East, Nigeria and Venezuela are rich in oil reserves, and they are also major producers of natural gas. These areas are in political turmoil due to different ethnic, ideological and political issues. Two major events are believed to have had the most significant contributions to the increase in the volatility of oil prices, i.e., the Arab oil embargo in 1973 and deregulation in 1981. The standard deviation of the log of oil price differences after the embargo and after deregulation increased from about zero to 0.04 and 0.05, respectively. Since then, the standard deviation has fluctuated between 0.065 and 0.125 (Guo and Kliesen, 2006).

Given that increases in the volatility of oil prices could be caused by different factors, the real challenge is to find out if the cause of each increase is economic or non-economic. Guo and Kliesen (2006) specified two methods for such a task. First, they proposed a narrative approach in which they related Wall Street Journal accounts of the 10 largest daily 12-month future oil price movements over the period from 1983 - 2004. They found that the majority of these movements occurred in relation to OPEC or the Middle East. The second approach relies on statistical tests. They tried to answer the question of whether standard macro-variables can forecast the realized variance in oil futures one quarter ahead.

Third are Institutional arrangements. OPEC producers act as a cartel that determines production levels and sets quotas for each member country. Studies suggest that OPEC plays more than one role, depending on market conditions. The first role is a cornering behaviour in which OPEC is a price maker. The second role is to promote competitive behaviours in which OPEC's members compete among themselves and collectively against non-OPEC producers. However, a recent study showed that OPEC actually operates somewhere between these two behaviours (Kauffmann et al., in review). On the other hand, non-OPEC producers are considered price takers that compete with each other and with OPEC (Dees et al., 2006). These different roles of the various oil producers create additional volatility for oil prices.

Finally is speculation in the oil markets. The price volatility of crude oil increased dramatically after the introduction of the futures market for crude oil in March 1983. What caused this increase remains an open area for research. Some studies have considered inventory changes and speculation as possible sources of this increase in spot oil prices (Pindyck, 2002; Smith, 2000).

The International Monetary Fund (IMF) stated that the decline in commercial stocks and the build-up of large, long, speculative positions contributed to the increasing volatility of spot oil prices (IMF outlook, 2004). Ballinger and Gillette (2004) studied the impact of the oil futures market on the (spot) cash prices of crude oil. They presented supporting evidence that information is not aggregated in cash prices as it is in the futures market and that this difference is responsible for some of the increased volatility. However, Huntington (2009) suggested that the oil futures market offers solutions to market participants in diversifying their price risk during times of increasing price volatility or price oscillations.

As a result of low trading costs, excessive speculation causes higher market volatility (Serletis and Shahmoradi, 2006). Increasing oil price volatility has created momentum for speculators to enter the oil market (Schwartz, 2004). This suggests that a bubble could be in the making for oil prices. Furthermore, Schwartz suggested that good news is merely observed by the market, but bad news drives oil prices higher, which implies that the oil market could be subject to further price volatility as oil prices rise. Another study by Lanza, Manera and Giovannini concluded that the behaviour of crude oil prices is close to that of a financial asset. They reached this conclusion after finding that, on average, the coefficient of variation for crude oil prices is double that of product prices (Lanza, et al., 2003b). Basher and Sadorsky (2006) found additional risk premium in the beta values for oil prices in the emerging market returns. Emerging markets suffer to a greater degree from asymmetric information and that could be the cause of the additional risk premium found in the beta values of oil prices.

Several studies have attempted to analyze crude oil volatility empirically (Sadorsky, 2004; Pindyck, 1999; Hamilton, 2003; and Hamilton and Lin, 1996). However, most oil-related studies focus on well-known crude oils, such as Brent or West Texas Intermediate (WTI) (Lanza et al., 2003; Agren, 2006; Ballinger and Dwyer, 2004). These crude oils, known as markers or benchmarks, are often used by oil traders as benchmarks in pricing other less-known crude oils or as bases needed for the much larger paper market of crude oil. The above studies suggest that oil prices exhibit statistical phenomena, such as volatility clustering and fat-tails, which suggests that an ARCH/GARCH-type model is suitable for application to the prices of crude oils. The general GARCH (p,q) model specification can be stated as follow:

$$Y_t = a + \beta X_t + u_t \qquad u_t \left| \Omega_t \sim iid\ N(0, h_t) \right. \tag{3}$$

$$h_t = \gamma_0 + \sum_{i=1}^{p} \delta_i h_{t-i} + \sum_{j=1}^{q} \gamma_j u^2_{t-j} \tag{4}$$

In equation (1), β is a $k \times 1$ vector of coefficients and X is a $k \times 1$ vector of explanatory variables. The term u_t is assumed to be independently distributed with a zero mean and non-constant variance that depends on past lagged squared residual terms and the lagged h_t .

The simplest form of the GARCH (p,q) model is the GARCH (1,1). It says that the value of the variance h_t, at time t, depends on values from both past shocks and past variance estimated from previous period which is $t-1$. The GARCH (1,1) model has the following form:

$$h_t = \gamma_0 + \delta_1 h_{t-1} + \gamma_1 u^2{}_{t-1} \qquad (5)$$

The use of the GARCH model to estimate and forecast the volatility of oil prices has been the focus of several studies. Estimating the length of the model's auto-regressive part, i.e., the p part and estimating the length of the moving average part, which is the q part, are critical steps in empirical applications of the model. However, Sadorsky (2006) used several uni-variate and multi-variate models to forecast the daily volatility of oil prices, and he concluded that a single GARCH (1,1) model outperformed more complex models, such as state space, vector auto-regression and bivariate GARCH models (Sadorsky, 2006). Hall (2007) states that this model speciation perform "very well" and is easy to estimates given that only three parameters (γ_0, δ_1 and γ_1) needs to be estimated.

The GARCH model can capture the following features associated with financial time series:

(i) Volatility Clustering: This statistical phenomenon can be described as large changes in volatility followed by larger changes. Likewise, small changes are followed by smaller changes. Successive volatility can be serially dependent and uncorrelated at the same time.

(ii) Fat Tails: Most of the time, asset returns exhibit a fatter tail curve of observation than the one usually observed in a normally distributed curve. This is known as excess kurtosis and is measured as follows:

$$\kappa = \frac{E(X - EX)^4}{(VX)^2} \tag{6}$$

(iii) Leverage Effect: Decreasing asset returns have a negative impact on the value of equity ownership. Given that long-term debts are usually secured and have first priority over equity ownership, any increase in risk associated with higher volatility is usually bearable by equity shareholders.

Volatility clustering can be explained as follows: shocks, represented by the error term that can be expressed as $e_t = y_t - c$, can either be negative shock associated with bad news or positive shock associated with good news. In case $e_t < 0$, we can see that $y_t < c$, which suggests that returns fall below the mean. The conditional variance $E_{t-1} < (\sigma_t^2)$ would increase after a negative shock, i.e., after the release of bad news to the market that suggests that the risk level is increasing.

The GARCH model allows for a mean-reversion for volatility, which suggests that the volatility mean reverts back to its long-term average, the unconditional volatility of the process (Bourgoin, 2003). Bourgoin's results suggested that the GARCH model reverts back to long-term average volatility quicker than the GJR-GACH model. However, his results for both models reached the same conclusion, forecasting that volatility would increase in the next five months.

Good generalization of the model application requires that unnecessarily complex models not be given preference over simpler ones. On the other hand, more complex models fit the data better (Kingdon, 1997). However, Haykin (1999) and Kingdon (1997) suggested that the solution to these two contradictory objectives is to select a model with the least possible degree of complexity that can still describe the data.

The ARCH model, which is the bedrock of the GARCH model, is capable of estimating the time-varying nature of return volatility, can capture the behaviour of financial time series (Billio and Sartore, 2003). The model can be specified as follows:

$$y_t = \mu_t + \sigma_t \varepsilon_t \,,\ \varepsilon_t \sim IID(0,1),\ t = 1, 2, ..., T \ , \qquad (7)$$

where y_t denotes the return on an asset, and σ_t is a deterministic function of the squares of the lags of the residuals. Billio and Sartore (2003) explained that the ARCH model is a common way of modelling σ_t [17]. On the other hand, they suggested that volatility may be expressed as well by stochastic volatility models, in which the unobserved component follows a latent stochastic process, (i.e., an auto-regression)[18]. Stochastic volatility models have two advantages over ARCH models (Billio and Sartore, 2003). First, they have a solid theoretical foundation that allows interpretation of their results as a discretised version of a stochastic volatility, continuous-time model that is suggested by modern finance theory[19]. Second, in terms of estimation and interpretation, the stochastic volatility model can be generalized from either uni-variate

[17] See Bollerslev et al. (1992) and Bera and Higgins (1993).
[18] See Taylor (1994); Ghysels et al., (1996); Shephard (1996).
[19] See Hull and White (1987).

or multi-variate series. However, Billio and Sartore (2003) stated clearly that the complexity of deriving the exact likelihood function in estimating the stochastic volatility model represents a major challenge in empirical application of the model. However, they suggested that several econometric methods have been developed to solve this problem[20].

Modelling prices of well-known crude oils (e.g., Brent, WTI and Tapis) has been the focal point of most analyses in this area. In fact, out of 16 different papers that we have reviewed, only three covered crude oils other than the benchmark types. Bacon and Tordo (2005) modelled price differentials of 56 different crude oils using a pooled cross-section time series. They examined the relationship between crude oil prices and quality features, such as API, sulfur and total acidity number (TAN). They concluded that each quality feature impacts price differentials of different crude oils. For example, a one-unit increase in API raises the price of a crude oil by $0.007/ barrel when compared to the Brent crude (Bacon and Tordo, 2005). Yousefi and Wirjanto (2004) examined the empirical role of the exchange rate on crude oil price formation by OPEC members and covered crude oils produced by all members except Iraq, Kuwait and Venezuela. They concluded that there is a degree of rivalry among OPEC members in order to obtain more market power. Their results confirmed the idea that OPEC has no unified price and suggested a partial market-sharing model (Yousefi and Wirjanto, 2004).

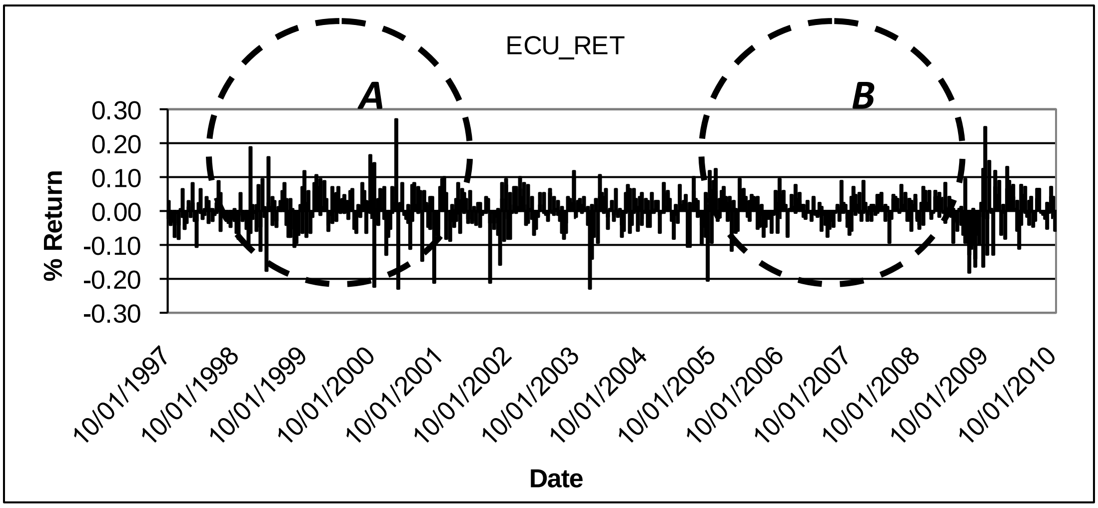
Early researchers assumed that volatility was constant. Nevertheless, by the

[20] See Shephard (1996).

development of the ARCH model, it is now believed widely that volatility changes over time. Volatility clustering, which is a well-known statistical phenomenon, is strong evidence that volatility is not constant. In the application of the ARCH/GARCH models, most studies have suggested that crude oil prices exhibit statistical phenomena, such as volatility clustering and fat-tails, which suggests that ARCH/GARCH models are suitable for modelling the volatility of crude oil prices.

Figure 2 compares two periods of weekly price return fluctuations of a sample of two crude oils, i.e., ECU and RUS, starting from 10/1/1997 until 10/1/2010. In period A, from 10/1/1998 through 10/1/2001, weekly return fluctuations exceeded +20 and -20 per cent several times. On the other hand, in period B, from 10-1-2005 through 10-1-2009, weekly price return fluctuations did not exceed the +10 and -10 per cent.

Figure 2: Volatility clustering of ECU, SAM, RUS and BRT crude oils



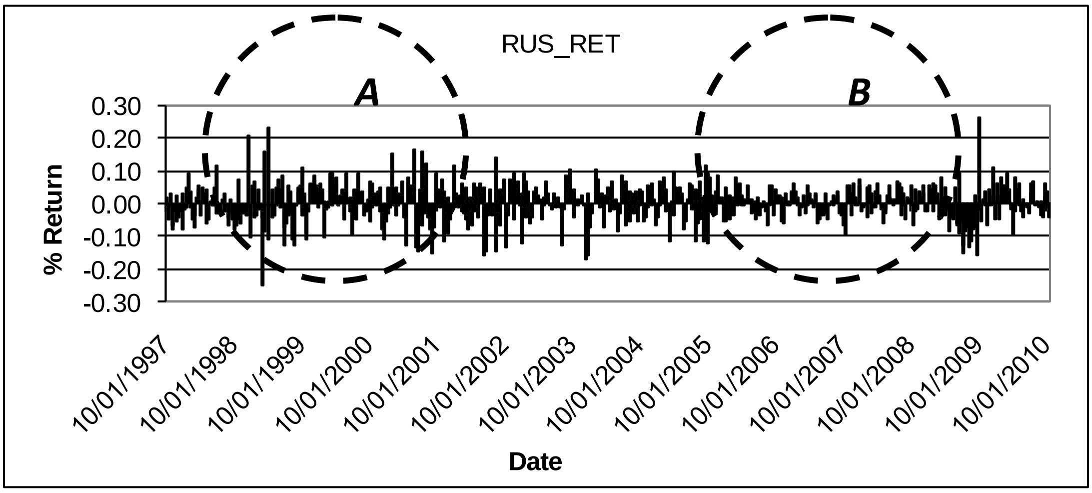


Figure 3: Weekly prices of the SAM crude and its corresponding levels of volatility

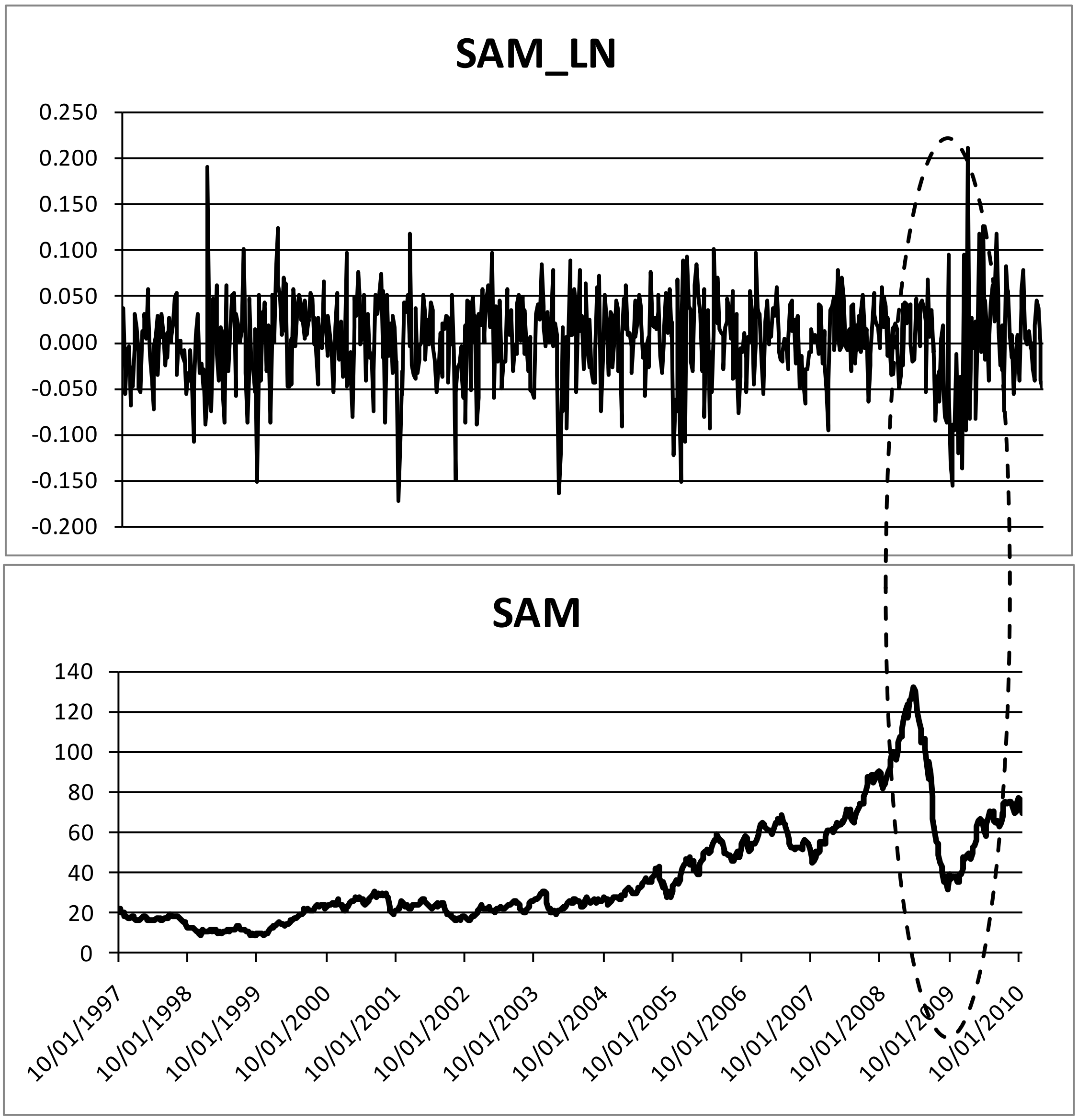


Figure 3 presents a comparison between the weekly prices of the SAM crude and its associated level of weekly returns SAM_LN. Visual inspection reveals that there is a degree of association between price movement and the level of volatility of weekly returns. This relationship is notably visible between 25/09/2008 and 25/01/2009, when the price experienced a major drop and, at the same time, volatility of returns increased significantly.

Figure 4: Visual comparison of volatility behaviour of ECU and RUS crude oils

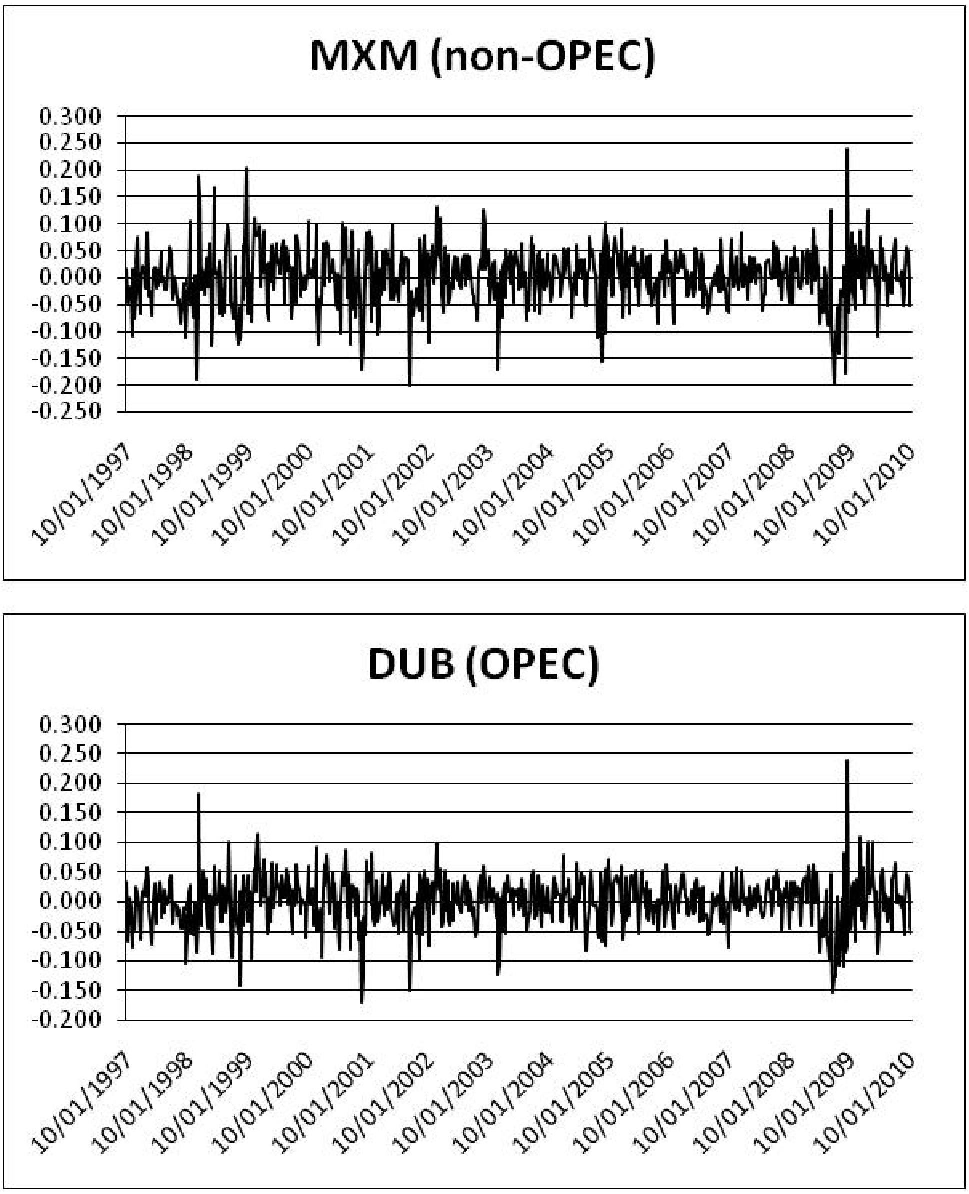


Figure 4 shows that volatility clustering exists in crude oil prices returns. Garis (2009) suggested that periods of calm in crude oil price behaviour are associated, in most cases, with low relative prices and the availability of a large surplus of crude oil. We created visual representations of all crude prices in our sample, but we only included, in Figure 4, two examples to save space. Appendixes 4 and 5 show the complete set. A formal investigation for the existence of an ARCH effect in these series is described in the following section.

Other papers looked at specific relationships between certain crude oil prices and other economic variables. Agren (2006) applied the asymmetric BEKK model of Engle and Kroner (1995) on Brent prices to test the transition of the volatility of crude oil prices to the volatility of the stock market. He concluded that four out of five stock markets, in his sample, showed significant levels of volatility spill over. Andrangi, Chatrath, Rafiee and Ripple (2001) examined the relationship between the price dynamics of Alaska North Slope crude oil and the price of diesel fuel on the U.S. west coast, using both VAR and bivariate-GARCH models. They showed a casual relationship between the two series. Other studies by Asche, Gjolberg and Völker (2005) and Gjolberg and Johnsen (1999) examined the relationship between crude oil prices and refined products in terms of deviations and equilibrium. They found that a long-term price relationship exists between the prices of crude oil and refined products.

2.7 Empirical model and data set

The number of academic research efforts devoted to modelling oil and energy price volatility is legion (Altinay and Karagol, 2004; Regnier, 2007). However, Sadorsky (2006) used different types of uni-variate and multi-variate models to forecast the daily volatility of oil prices. His results showed that a single GARCH model outperformed more complex models, such as state space, vector autoregression and bivariate GARCH models in modelling and forecasting crude oil prices. Therefore, in this chapter we use a uni-variate ARCH-type model, i.e., the GARCH (1,1), to examine the pattern of price volatility for 30 different types of crude oils. The implementation of an ARCH/GARCH model to estimate and forecast the volatility of oil prices has been the focus of several studies.

Since Bollerslev (1986) proposed an extension to Engle's (1982) ARCH model, various hybrids of the GARCH model have emerged over the last decade (Gourieroux, 1997; Engle and Kroner, 1995). Volatility depends on the error term in the preceding periods. The ARCH/GARCH model framework became popular because of its ability to account for and capture any changes of volatility in future forecasts. Conditional heteroscedasticity is explained by the time dependence of information arrival to the market (Lamoureuk and Lastrapes, 1990).

Suppose we wish to outline an ARCH process that is the price of an OPEC or non-OPEC crude in terms of the distribution of the errors of the dynamic, linear-regression model. Then, assuming that the dependent variable, P_t, is generated by the auto-regressive process:

$$\Delta \log P_t = \varphi_0 + \sum_{i=1}^{k} \varphi_i \Delta \log P_{t-i} + \varepsilon_t, \quad \varepsilon_t \mid \Omega_{t-1} \sim N(0, h_t), \tag{8}$$

where h_t^2 denotes the conditional variance of the information set Ω_{t-1} that is available at time t-1. Much work has been done on identifying the information set used to form expectations by agents in the financial market. This has given rise to a variety of models to explore the phenomenon. Bollerslev (1986) developed a framework to generalize the ARCH process in (1) above to give:

$$h_t = \delta + \sum_{i=1}^{p} \alpha_i \varepsilon_{t-i}^2 + \sum_{i=1}^{q} \beta_i h_{t-i}. , \tag{9}$$

where h_t is the conditional variance, ${\varepsilon^2}_{t-1}$ is the volatility information during the last period, and h_{t-i} is the fitted variance during the previous period representing persistence in volatility. In effect, including the lagged conditional variances might capture the "adaptive learning" phenomenon that characterizes the process. This adaptive learning phenomenon is in line with Feutor-O'Crevy et al. (2005), who suggested that market behaviour has memory and that it can remember what events occurred and the reactions to those events. This in line with results obtained by Alvarez-Ramirez et al. (2002), Tabak and Cajueiro (2005a,b; 2007) and Serletis and Andreadis (2004) that concluded that long-term memory does exist in the price volatility of crude oil and other energy markets. For example, Alvarez-Ramirez et al. (2002) used the Hurst analysis for selected samples of different crude oils, including Brent, WTI and Dubai, that span from November 1981 through April 2002. They concluded that crude oil dynamics are driven by a persistent stochastic process, which suggests the existence of long-term memory. Also, Tabak and Cajueiro (2007) estimated the Rescaled Range Hurst (RS) coefficient to identify time-varying degrees of long-term memory. They detected a fractal structure in crude oil prices and other energy markets.

There are significant spreads of premium or discount between the marker price and each of the superior or inferior crude oils. For example, during a period of ten years, starting from January 3, 1997, the price differential between the high quality Canadian Par crude and the low quality Canadian Lloyd crude was a little more than \$7.00 per barrel. By August 17, 2007, this spread had increased to more than \$21.00 per barrel. Table 2.1 shows price differential comparisons between the Brent marker crude and the two top-quality crude oils (Tapis and Par). The Table also shows price differential comparisons between the Brent marker crude and the two lowest-quality crudes (Lloyd and Maya).

Table 2.1: Price differential for four types of crude oils

Crude	API	Sulfur	$Price_{1997}$	$Price_{2007}$	(%)Differential
Brent	38.3	0.4	24.05	69.78	190.14
Tapis	44	0.03	25.7	75.09	192.18
Par	40.02	0.3	25.69	73.63	186.67
Lloyd	22	3.15	18.6	53.94	190
Maya	22.1	3.31	19.33	59.89	209.82

In recent years, newly developed oil fields in the African state of Chad and in the Atlantic basin have produced crude oils that contain high levels of TAN[21](Bacon and Tordo, 2005). Currently, most refineries around the world do not have the technology to process high-TAN crude oils. Therefore, these crude oils are sold at a discount and are often blended with other superior types of crude oil to decrease the TAN concentration before refining. However, the issue of high levels of TAN should not have a major impact on our analysis, given that our crude oil samples had TAN levels that ranged from low to moderate.

2.8 Descriptive statistics

Characteristics of the data can be summarised by looking at the mean, standard deviation, variance, skewness and kurtosis. I applied these measures to the level prices of the selected crudes and obtained the following results. By looking at the mean of OPEC crudes, we notice that it has a value of $40.35 per barrel (/bbl) compared to $41.15/bbl for non-OPEC crudes. This indicates that throughout our sample, non-OPEC crudes were on average sold for an extra of $0.80/bbl.

To test whether these extra costs are due to the quality factors, we calculated the averages for API numbers and the sulphur content for OPEC and non-OPEC crudes. These averages are presented in Appendix 1, and they show that the average sulphur content for the OPEC crudes is 1.25 percent, which is 62 percent higher than the

[21] High TAN refers to a concentration of 1.0 mg KOH/g crude oil or more.

average for the non-OPEC crudes which is 0.77 percent. However, more advanced testing and analysis are presented in following two chapters to test price behaviour of OPEC and non-OPEC crudes. The standard deviations of crude oil prices are presented in the third column of Tables 2.2 and 2.3.

Table 2.2: Summary statistics for OPEC crude oil prices (US $)

Crude	MEAN	ST. DEV	KURTOSIS	SKEWNESS
ADM	42.356	27.302	4.160	1.208
ASB	42.741	27.262	4.030	1.175
ANC	40.696	25.982	4.140	1.204
DUB	39.891	25.877	4.270	1.251
ECU	36.507	23.414	4.660	1.359
IRH	39.114	25.504	4.130	1.238
IRL	40.161	26.092	4.100	1.220
KUT	38.904	25.280	4.250	1.250
LIB	41.669	26.417	4.070	1.195
NGB	43.126	27.883	4.060	1.179
NGE	43.000	27.897	4.080	1.181
DUK	41.754	27.179	4.190	1.221
SAH	37.153	24.742	4.410	1.332
SAL	39.720	25.920	4.340	1.288
SAM	38.363	25.236	4.360	1.306
VEN	40.467	25.874	4.410	1.272
Average	40.351		4.229	1.242

Table 2.3: Summary statistics for non-OPEC crude oil prices (US $)

Crude	MEAN	ST. DEV	KURTOSIS	SKEWNESS
AUS	43.835	27.890	4.070	1.177
CAM	40.808	26.160	4.200	1.219
CAP	42.777	26.624	4.360	1.240
CHI	41.571	26.326	4.320	1.237
COL	41.097	27.046	4.250	1.232
EGS	38.175	25.552	4.240	1.252
INO	42.739	27.694	4.170	1.210
TAP	44.980	28.648	4.090	1.180
MXI	40.265	25.915	4.410	1.270
MXM	34.548	23.743	4.490	1.316
NOE	42.501	27.306	4.140	1.197
OMN	40.304	26.086	4.210	1.229
RUS	40.215	26.009	4.180	1.227
BRT	42.314	27.013	4.100	1.192
Average	41.152		4.231	1.227

2.9 Unit root testing

Testing for a unit root is a critical first step in a sound empirical application of a time series. Most studies have concluded that oil price levels are not stationary (i.e., do have a unit root). For example, Nelson and Plosser (1982) explained that the majority of macroeconomic and financial series have a unit root. They further stated that the first difference of such time series tends to be unit root-free. Furthermore, spot prices of commodity-based futures and options are also found to follow a random walk, that is to say, these series of prices are not stationary (Pindyck, 1999). More recent studies by Serletis and Rangel-Ruiz (2004) and others argued that spot prices of oil are not stationary. In order to obtain meaningful results and to avoid spurious regression, which can lead to the acceptance of a false relationship (Type I error) or the rejection of a true relationship (Type II error), these series must be differenced once in most cases.

A non-stationary series causes spurious regression, which means that the obtained results indicate a statistically significant relationship. However, this relationship can be explained as a contemporaneous correlation, not as a meaningful relationship (Granger and Newbold, 1974). The outcome of spurious regression can be stated as unreliable forecast and conventional hypothesis test or unreliable confidence intervals (Stock and Watson, 2007).

Asteriou and Hall (2006) states that, testing for non-stationarity is equivalent to testing for the existence of a unite-root. In a simple AR(1) process $P_t = \varphi P_{t-1} + u_t$, the unit root test is simply to test the hypothesis that $H_0 : \varphi = 1$, which suggests the existence of a unit root against the null hypothesis that $H_1 : \varphi < 1$, which suggests that a unit root does not exist. The above equation can be re-written as follow: $\Delta P_{t-1} = \gamma P_{t-1} + u_t$, in which $\gamma = (\varphi - 1)$. In case $\varphi = 1, \ \gamma = 0$, which suggest the existence of a unit root. In the case of $\varphi < 1,$ which would cause $\gamma < 0$ and we reach the conclusion that the series is stationary (i. e. has no unit root).

Both a constant term and a time trend can be included. In case of only a constant term, the equation takes the form $\Delta P_{t-1} = \sigma_0 + \gamma P_{t-1} + u_t$, where σ_0 represents a constant term. In the case of both a constant and a non-stochastic time trend in the model, the equation takes the form $\Delta P_{t-1} = \sigma_0 + \alpha_2 t + \gamma P_{t-1} + u_t$ in which the time trend is represented by $\alpha_2 t$. Then, the DF test is simply to test for stationarity using the normal t-test of the coefficients of the lagged dependent variable P_{t-1}. MacKinnon (1991) provides special critical values for this test. The statistical value of the DF test is compared to the critical value. In case the DF test value is smaller than the critical value, the null hypothesis of a unit root is rejected and we reach the conclusion that P_t is a stationary process.

Dickey and Fuller (1981) extended the DF testing procedure to eliminate autocorrelation generated by the assumption that the error term is uncorrelated. They developed the augmented DF test (ADF test) by including an extra lagged term of the dependent variable. The number of lags is determined empirically by using procedures such as AIC and SBC.

Although most studies show that oil prices have unit root problem and point toward differencing these prices, we applied the ADF unit root test to check whether our samples of 30 different crude oil prices series are stationary or not. In testing for unit root, three different cases are possible. First case is a model with no constant term and no linear trend. Second is a model with a constant term but without a liner trend. Finally is a model with both constant term and a deterministic trend. Unless the actual data-generating process is known, the econometricians always face the challenge of identifying the most appropriate case. However, given that the first case of no constant term is extremely restrictive (Davidson and McKinnon, 1993), we focus our modelling in the second and third models, (i. e. a model with a constant term but without a liner trend and a model with both constant term and a deterministic trend).

We use the ADF test for the two cases of only a constant term and for both a constant term and a time trend. These two models can be specified, respectively, as follow:

$$\Delta P_t = \sigma_0 + \gamma P_{t-1} + \sum_{i=1}^{k} \beta_i \Delta P_{t-i} + u_t \quad (10)$$

$$\Delta P_t = \sigma_0 + \gamma P_{t-1} + \alpha_2 t \sum_{i=1}^{k} \beta_i \Delta P_{t-i} + u_t \quad (11)$$

where $\gamma = (\varphi - 1)$, σ_0 is a constant term and $a_2 t$ is a time trend term. We are interested in whether φ is equal to unity which would suggest the existence of a unit root (i. e. non-stationary time series). The null hypothesis is $H_0 : \varphi = 1$ against the alternative hypothesis $H_1 : \varphi < 1$. In case P_t is increasing as a result of the positive trend $\beta > 0$ and $\varphi < 1$ as a result of detrending, then results of the regression are expected to be sound and not expected to suffer from spurious regression. However, in case $\sigma > 0, \beta = 0$ and $\varphi = 1$, then P_t is growing as a result of a random walk with a positive drift, which suggests that detrending would not do away with the problem of non-stationarity, and only working with ΔP_t will result in a sound regression.

The results in Tables 2.4 and 2.5 show that crude oil prices are not stationary at levels and are stationary in the first difference. These results are in line with other studies, such as Bessec and Meritet (2007), which report that a unit root is not generally rejected for variables in level prices, but are rejected in first differences. Table 2.4 contains the results obtained for OPEC crudes, including the lag lengths that were determined by the Akaike information criterion (AIC) plus 2[22]. Furthermore, the data

[22]Pantula et al. (1994) suggests that 2 more lags should be added to the number of lags obtained by AIC to

were tested twice, once by including only an intercept (hence M2) and a second time by including both an intercept and a trend (hence M3). The case of no intercept and no trend (hence M1) has proven to be very restricted and may not be a useful in unit root testing. Davidson and McKinnon (1993) said that testing with a zero intercept is very restrictive and that it is “hard to imagine” using a zero intercept in an economic time series.

Table 2.4 shows that in the case of M2, all OPEC crudes prices are non-stationary at critical values of 5 percent. However, none are statistically significant at 5 percent. In the case of M3, most crude oil prices are non-stationary at critical value of 5 percent. Crude oils ADM, DUB and KUT are non-stationary at critical value of 1 percent. These same crude oil prices are the only ones showing 5 percent level of statistical significant. In the case of M2 for non-OPEC crude oils, Table 2.5 shows all crude oil prices are non-stationary at 5 percent. However, none of these results are significant at 5 percent. On the other hand, most of oil prices in M3 are non-stationary at 5 percent with the exception of MXM and OMN, which are non-stationary at 1 percent. However, the MXM crude is the only one with significant level of 5 percent.

account for settlement dates. In our case, the addition of 2 more lags would equal the addition of two weeks to account for physical delivery of crude oil.

Table 2.4: Results for the ADF unit root test (OPEC crude prices):

Series	M2: With an intercept			M3: With an intercept + trend		
	Number of Lags	t-statistics	p-value	Number of Lags	t-statistics	p-value
	Level of the Series					
ADM	5	-1.716	0.422	5	-3.573*	0.032
ASB	1	-1.102	0.716	1	-2.652	0.257
ANC	1	-1.121	0.708	1	-2.769	0.209
DUB	5	-1.681	0.44	5	-3.568*	0.033
ECU	1	-1.13	0.705	1	-2.888	0.166
IRH	1	-1.067	0.73	1	-2.684	0.243
IRL	1	-1.055	0.734	1	-2.654	0.256
KUT	3	-1.403	0.581	5	-3.611*	0.029
LIB	1	-1.038	0.741	1	-2.611	0.275
NGB	3	-1.432	0.567	3	-2.979	0.138
NGE	1	-1.09	0.721	1	-2.644	0.260
DUK	3	-1.431	0.567	3	-3.022	0.126
SAH	3	-1.454	0.556	3	-3.067	0.115
SAL	3	-1.416	0.575	3	-2.986	0.136
SAM	3	-1.443	0.561	3	-3.028	0.125
VEN	1	-1.060	0.732	1	-2.709	0.232
	Differences of the Series					
ADM	4	-7.619*	0.000	4	-7.618*	0.00
ASB	0	-19.520*	0.000	0	-19.513*	0.00
ANC	0	-19.547*	0.000	0	-19.543*	0.00
DUB	4	-7.8292*	0.000	4	-7.829*	0.00
ECU	0	-20.436*	0.000	0	-20.440*	0.00
IRH	0	-19.507*	0.000	0	-19.503*	0.00
IRL	0	-19.511*	0.000	0	-19.506*	0.00
KUT	2	-10.848*	0.000	2	-10.845*	0.00
LIB	0	-20.436*	0.000	0	-20.430*	0.00
NGB	2	-11.425*	0.000	2	-11.419*	0.00
NGE	0	-19.337*	0.000	0	-19.331*	0.00
DUK	2	-10.368*	0.000	2	-10.364*	0.00
SAH	2	-11.134*	0.000	2	-11.133*	0.00
SAL	2	-11.050*	0.000	2	-11.048*	0.00
SAM	2	-11.092*	0.000	2	-11.090*	0.00
VEN	0	-20.831*	0.000	0	-20.828*	0.00

Note: Tested for the Ho that the stock price at levels (intercept and intercept + trend) have a unit root. Statistically significant levels at: * when $P \leq 0.05$. In the case of M2, the critical values for 1 percent is -3.43, 5 percent is -2.86 and 10 percent is -2.57. In the case of M3, the critical values for 1 percent is -3.97, 5 percent is -3.41 and 10 percent is -3.13. . Critical values are based on MacKinnon (1996).

Table 2.5: Results for the ADF unit root test (non-OPEC crude prices):

	M2: With an intercept			M3: With an intercept + trend		
Series	Number of Lags	t-statistics	p-value	Number of Lags	t-statistics	p-value
	Level of the Series					
AUS	3	-1.46	0.553	3	-3.072	0.113
CAM	1	-1.214	0.670	1	-2.851	0.179
CAP	3	-1.584	0.489	3	-3.001	0.132
CHI	3	-1.452	0.557	3	-3.062	0.116
COL	1	-0.931	0.778	1	-2.645	0.260
EGS	1	-1.074	0.727	1	-2.66	0.253
INO	3	-1.425	0.57	3	-3.169	0.091
TAP	3	-1.412	0.577	3	-3.098	0.107
MXI	1	-1.09	0.721	1	-2.72	0.228
MXM	3	-1.446	0.56	5	-3.843*	0.015
NOE	1	-1.101	0.716	1	-2.679	0.245
OMN	5	-1.698	0.431	5	-3.597*	0.301
RUS	1	-1.052	0.735	1	-2.649	0.258
BRT	1	-1.074	0.727	1	-2.626	0.268
	Differences of the Series					
AUS	2	-10.743*	0.000	2	-10.739*	0.000
CAM	0	-19.982*	0.000	0	-19.975*	0.000
CAP	2	-11.303*	0.000	2	-11.296*	0.000
CHI	2	-11.181*	0.000	2	-11.178*	0.000
COL	0	-20.362*	0.000	0	-20.362*	0.000
EGS	0	-20.551*	0.000	0	-20.546*	0.000
INO	2	-11.088*	0.000	2	-11.087*	0.000
TAP	2	-10.579*	0.000	2	-10.578*	0.000
MXI	0	-20.467*	0.000	0	-20.462*	0.000
MXM	2	-11.316*	0.000	0	-19.897*	0.000
NOE	0	-19.493*	0.000	0	-19.487*	0.000
OMN	4	-7.6939*	0.000	4	-7.6939*	0.000
RUS	0	-21.387*	0.000	0	-21.380*	0.000
BRT	0	-20.590*	0.000	0	-20.583*	0.000

Note: Tested for the Ho that the stock price at levels (intercept and intercept + trend) have a unit root. Statistically significant levels at: * when P ≤ 0.05. In the case of M2, the critical values for 1 percent is -3.43, 5 percent is -2.86 and 10 percent is -2.57. In the case of M3, the critical values for 1 percent is -3.97, 5 percent is -3.41 and 10 percent is -3.13. . Critical values are based on MacKinnon (1996).

2.10 Testing for ARCH effects

In applying ARCH testing, we set the null hypothesis to test whether all the q lags of the squared residuals have coefficients that are not significantly different from zero (Brooks, 2008). As explained by Serletis and Shahmoradi (2006), the squared residuals from the autoregression equation (8) on page 62, $\Delta \log P_t = \varphi_0 + \sum_{i=1}^{k} \varphi_i \Delta \log P_{t-i} + \varepsilon_t, \quad \varepsilon_t \mid \Omega_{t-1} \sim N(0, h_t)$ are regressed. If there are no ARCH effects, both a_1 through a_p will be close to zero, which means little explanatory power for this regression and very low coefficients to determine R^2.

Table 2.6 presents critical values, F-statistics and the test statistic of (T*R^2), which is obtained by running the Engle (1982) ARCH effects test. We test against ARCH (1) up to ARCH (5), and the values of the test statistics are greater than the critical values from the (5) chi-squared distribution, which indicates that these crude oil prices are subject to ARCH effects. Thus, an ARCH-type model is a feasible application for modelling the volatility of these crude oil prices.

Table 2.6: Results of the ARCH (5) test

OPEC	F-statistics	T*R^2	non-OPEC	F-statistics	T*R^2
ADM	9.284	43.789	AUS	47.082	10.035
ASB	6.216	29.963	CAM	46.93	10
ANC	7.295	34.895	CAP	89.906	20.573
DUB	8.847	41.854	CHI	74.031	16.49
ECU	12.737	58.651	COL	21.212	4.341
IRH	5.896	28.484	EGS	188.865	52.04
IRL	5.947	28.72	INO	68.828	15.199
KUT	9.86	46.319	TAP	12.296	2.482
LIB	6.372	30.681	MXI	191.389	53.012
NGB	10.699	49.965	MXM	238.102	73.035
NGE	44.788	169.16	NOE	27.99	5.789
DUK	11.156	51.935	OMN	46.77	9.964
SAH	10.98	51.176	RUS	46.631	9.932
SAL	9.025	42.644	BRT	29.403	6.094
SAM	10.945	51.025			
VEN	4.032	19.744			

2.11 Results and discussion

Estimated coefficients of both the ARCH term, α_i, and the GARCH term, β_i, are positive and significant for all crude oil prices. No significant difference can be found between the averages calculated for the two groups, OPEC and non-OPEC crude oils. Tables 2.7 provides the ARCH and GARCH terms for OPEC and non-OPEC crudes, respectively. The mean values for both groups are essentially the same. Bidding behaviour of market participants seems not to distinguish between whether a crude oil is provided by an OPEC or a non-OPEC producer.

Table 2.7: Results of the GARCH model for OPEC and non-OPEC crude prices

Crude	α_i	β_i	$\alpha_i + \beta_i$
OPEC			
ADM	0.099 (3.19)	0.865 (24.6)	0.965
ASB	0.07 (2.66)	0.888 (21.9)	0.959
ANC	0.073 (2.39)	0.874 (17.9)	0.946
DUB	0.093 (2.85)	0.861 (21.8)	0.954
ECU	0.152 (1.32)	0.724 (4.05)	0.876
IRH	0.042 (0.739)	0.873 (4.45)	0.915
IRL	0.074 (2.42)	0.862 (16.06)	0.937
KUT	0.092 (2.66)	0.859 (21)	0.951
LIB	0.059 (2.30)	0.903 (23.7)	0.963
NGB	0.107 (2.03)	0.826 (12.8)	0.933
NGE	0.062 (2.44)	0.903 (24)	0.966
DUK	0.088 (2.75)	0.868 (20.4)	0.956
SAH	0.092 (2.63)	0.837 (15.2)	0.929
SAL	0.092 (2.76)	0.838 (14.5)	0.931
SAM	0.092 (2.47)	0.839 (15.1)	0.931
VEN	0.054 (1.75)	0.879 (11.9)	0.933
Average			0.9403
non-OPEC			
AUS	0.083 (2.38)	0.861 (17.1)	0.944
CAM	0.094 (2.42)	0.834 (14.6)	0.928
CAP	0.08 (2.51)	0.87 (23.7)	0.950
CHI	0.121 (2.25)	0.79 (10)	0.911
COL	0.075 (2.37)	0.887 (19.6)	0.963
EGS	0.072 (2.66)	0.898 (24.70	0.970
INO	0.121 (2.13)	0.776 (9.39)	0.898
TAP	0.031 (1.53)	0.953 (26.5)	0.984
MXI	0.063 (1.79)	0.872 (13.6)	0.935
MXM	0.089 (2.83)	0.868 (20.8)	0.958
NOE	0.068 (2.39)	0.888 (21.3)	0.956
OMN	0.087 (2.61)	0.864 (18.5)	0.951
RUS	0.054 (1.21)	0.862 (7.65)	0.916
BRT	0.026 (0.776)	0.879 (4.68)	0.906
Average			0.9407

In fact, in terms of volatility persistence, coefficients of crude oil prices show high levels in both groups. For example, the highest $\alpha_i + \beta_i$ coefficient obtained in the OPEC crude was 0.966 for the NGE crude and the lowest is 0.876 for the ECO crude. Likewise, in the non-OPEC group, the highest $\alpha_i + \beta_i$ coefficient was 0.984 for the TAP crude, and the lowest was 0.898 for the INO crude. However, the two groups had an average $\alpha_i + \beta_i$ of 0.94, which means that variations of volatility between different crude prices are due to factors other than OPEC or non-OPEC affiliation.

Analysis of the residuals obtained suggests that the GARCH (1, 1) model is very good fit for the data at hand. Charts of standardized residuals, included in Appendix 10, indicate that no additional information can be extracted from the data. This was also confirmed by the correlogram and partial correlogram performed on the residuals of the GARCH application on each crude oil price series in which ACF and PCF were not significantly different from zero for up to 90 lags. The selection of 90 lags is based on the time-lag estimation of two years between the decision to develop an oil field and actual production[23].

[23] For further discussion and details about time-lag in the oil industry, see Smit (1997)

2.12 Concluding remarks

In this chapter, we presented the results of applying a GARCH-type model to examine whether there is a significant difference between the price volatility of crude oil produced by OPEC and non-OPEC countries. The prices of the 30 different crude oil types span from 03/01/1997 through 29/01/2010. These series were tested for the unit root problem and were found to be stationary at the first differences.

Estimated coefficients of both the ARCH term, α_i, and the GARCH term, β_i, were positive and significant for all crude oil prices. However, no significant difference can be found between the averages of coefficients calculated for the two groups, OPEC and non-OPEC. Our main finding is that variations in volatility of individual crude oil prices are due to factors other than OPEC or non-OPEC affiliation. In other words, OPEC and non-OPEC affiliation has no bearing on the volatility of crude oil prices. Other factors that may cause a different degree of volatility may include causes of possible disruption of supply of a particular type of crude oil.

Market players might think that the availability of some crude oils in the global oil market could be limited due to different exogenous or endogenous factors. In chapter 4, we analyse the impact of different sets of news items and events on the price performance of crude oils. I looked into whether there is a significant difference in the price behaviour of different crude oils toward factors related to supply disruption as a result of industrial action, political unrest, or environmental events.

Chapter 3: Modelling long-term relationship between stock prices of oil companies and crude oil prices: an application of co-integration and Error Correction Models

3.1 Introduction

The estimation of cashflow is a critical starting point in evaluating potential projects. Prior to signing contracts, companies develop scenarios of the expected cashflow (in and out) of a proposed project as an aid for decision making. Based on the current and future conditions of the global economy and the related business environment, the financial manager in charge of developing these scenarios must take into account the possible risks associated with undertaking the project. In the case of an oil company, committing to contractual agreements requires an in-depth analysis to identify, mitigate and manage possible sources of risk that could affect streams of cashflow in and out of the project.

Amic and Lautard (2005) suggested that risk management in the oil industry essentially comes down to managing the relationship between time and price. They specifically stated that risk management can help strategically in transferring near-term cashflow risk generated by short-term moves in crude oil prices. They concluded that the use of risk-management tools is no longer limited to defensive strategies; they are also being used as a proactive means for reducing weighted cost of capital and for changing the allocation of cashflow cycles. In addition, they suggested that analysing risks associated with location and fundamentals, such as price, storage rate and crack spread, products and quality, provide the bases of a sound strategic risk management programme.

However, in light of the complexity of the global energy system, such an analysis is not easily conducted. In fact, a report provided by the U.S. Department of Energy stated that risk management is probably the most difficult task facing management (DOE, 2005). In addition, few oil producers consider completely hedging the risk associated with their exploration programmes (Amic and Lautard, 2005). They found that small U.S. oil companies are more active than large producers. On the consumer side, the explicit purpose of derivative use is to keep plants in constant operation. For example, European utilities do more hedging on both low- and high-sulphur crude oils. Also, they see more hedging from chemical companies on naphtha, but it is still very limited. In addition, Amic and Lautard (2005) saw more hedging taking place in the North American, Asian-Pacific and, less so, in the North Sea areas. This limitation suggests that there is a wide area for research and application of risk management in the oil industry.

Future cashflow estimations can be used as a proxy for the expected profitability of investments and projects[24]. However, these future cashflow estimates can vary greatly due to the degree of variability in the underlying assumptions, such as levels of interest rates and foreign exchange and commodity prices. Cashflows expected from a proposed project should be estimated by applying a discount rate that reflects the expected risk associated with the project. As finance theory suggests, the ultimate goal

[24] A more sophisticated version of the cashflow proxy can be used with time series estimations, in which the variable intended to control investment opportunities is influenced by error measurement; see Ericson and Whited (2000).

of a firm is to maximize shareholders' wealth by undertaking projects and engaging in operations that are expected to generate positive future cashflows enough to cover initial investment and operational costs, as well as meet a pre-specified internal rate of return. Products offered by the derivative markets (i.e., swaps and options) introduced an additional dimension to the task of estimating future cashflows of a proposed project. In case of high uncertainty of future cashflows, a swap agreement can be made with a counterparty to offer funding (or backing) for the development of the project. These agreements can be used as collateral to secure bank loans (Ripple, 2009).

However, using derivatives could be a double-edged sword that may act against the intended goals. For, example, in the early 1990s, the German Refining and Marketing Group (MGRM)[25] agreed to sell 160 million barrels of oil at a fixed price and on a fixed delivery schedule over the coming 10 years. The deal was profitable for the company as long as spot price of crude oil is below its fixed prices. However, in case spot oil prices increase above the fixed price, the company would incur losses. Thus, the Company was facing the risk of increasing crude oil prices above the specified fixed price. As a result, it decided to buy futures contracts to hedge against rising crude prices. Theoretically the problem was solved. However, implementation in real market causes another problem. Given the huge size of MGRM's original position of commuting to sell 160 million barrels, the equivalent of Kuwaiti production for a period of 83 days, 55,000 futures contracts were needed to hedge the risk of increasing oil prices. This number of futures contracts was well-above the daily volume of 15,000 – 30,000 future oil contracts traded in NYMEX. Once other players realized MGRM

[25] See Risk Management in Energy Markets, 2008 by T. James

problem, prices began to move against the company. The end result was a loss of $1.5 billion, because the Company created a situation in which other players bid the price up and it had no choice but to follow their lead.

The MGRM case showed how movement in crude oil prices could have a major implication in a company's profit and, subsequently, in the market's valuation of its stock prices. It emphasised the importance of accurately predicting future oil prices before committing to contractual agreement. It also shows that one decision to deal with a particular risk could initiate a chain reaction that could end-up with raising another type of risk. Thus, market dynamic and its effects in prices need to be understood before making long-term investment decisions.

From the perspective of an oil exploration company, a substantial proportion of its resources are committed to a limited number of carefully selected projects. Concentration of assets raises certain types of risk that must be addressed by involved parties within the organization. Decisions on allocating limited resources must be made by "the firm as a whole" (Medlock, 2009). Given this high concentration of resource allocation and the high level of uncertainty surrounding expected cashflows (i.e., oil prices), constant assessment and evaluation of future value of cashflows are needed to ensure the financial soundness of current and future projects. Medlock states that expected future prices play a major role in assessment of project profitability. Furthermore, the analysis of cashflows plays a major role in stock valuation techniques performed by external parties. Discounted cashflows are used by potential investors to assess the value of a stock investment. Fund managers, stock analysts and private investors develop their own cashflow scenarios with the hope of discovering undervalued and overvalued stocks. The basic idea is that current stock prices should reflect the stream of future cashflows discounted at market interest rate. Any price deviation from the estimated value of the stock creates the opportunity to buy or short the stock. The challenge in these techniques of discounted future cashflows is to accurately predict future discount rates and accordingly adjust expected future cashflows.

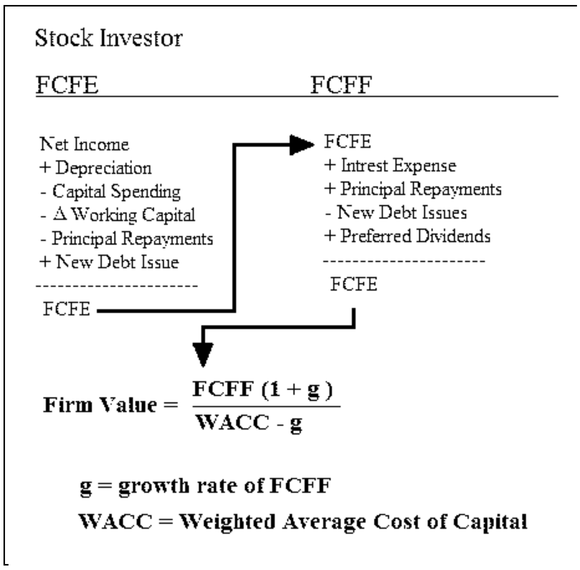
This role of cashflow analysis by both the company's executives to evaluate proposed projects and by potential stock investors to value stock investments suggests a possible integrated relationship between stock prices of companies and crude oil prices. In other words, it suggests that both oil prices and stock prices of oil companies could be driven by a common trend. In theory, stock prices are expected to reflect future cashflows generated by the company's operations, resulting from current and future projects. These cashflows are expected to be influenced significantly by crude oil prices, thus suggesting a possible link between trends in crude oil prices and oil stock prices. Figure 5 shows the steps performed in calculating free cashflows to equity (FCFE)[26] and free cashflows to the firm (FCFF), which are used in stock valuation techniques.

The starting point in these calculations is net income, which is the result of subtracting expenses from revenues. However, estimations of future revenue and costs require accurate prediction of future oil prices, production optimization, capacity utilization, royalties and capitalized cost. In estimating cashflows, internal parties have an edge in estimating all these internally generated accounting items. Outside parties, such as stock investors, may not have similar (or timely) access to the information, with

[26] For further discussion and detail, see A. Damodran, Damodran on Valuation (1994) and F. Reilly and K. Brown, Investment Analysis and Portfolio Management (2003).

the possible exception of oil prices, needed to estimate other contributing items in calculating net income and related cashflows.

Figure 5: Calculations of FCFE and FCFF



Information contained in crude oil prices feeds both parties in developing future cashflow estimates; however, the asymmetry of information used to predict other accounting items may cause stock prices to be driven (or generated) by trends other than the trend that drives oil prices (i.e., generated by another data generating process). Asymmetry of information suggests that estimation of future cashflows may not be examined or conducted similarly by both parties. Assessing related information and estimating its impact on a proposed project by internal parties, such as the company's CEO or CFO, could differ significantly from assessments performed by external parties.

This gap of information goes against the idea that both stock prices and crude oil prices are driven by a common data generating process. Although, both parties use oil prices in determining future net income and future cashflows, not all parties have equal access to the other related information required for making more accurate estimations. The case could be made that the set of information available in determining future cashflows for the purpose of stock price valuation of oil companies is different from the set of information used by managers to accept or reject an energy-related project. In fact, the asymmetry of information in pricing has long being investigated as one of the main cause of market failures (Weyman-Jones, 2009).

The methods incorporated the co-integration and error correction model developed by Engle and Granger (1987) and extended by Johansen (1988) and Johansen and Juselius (1992) can be used to investigate the long-term relationship between two (or more) sets of data. The co-integration method enables researchers to test for integration between geographic (or product) markets (Bourbonnais and Geoffron, 2007). In other words, it allows examining whether there is a common stochastic trend between prices. They suggested that co-integration analysis can be applied by regulators and antitrust authorities to fine tune government policies related to supply securities and analysis of investments between markets. In this chapter, we investigate whether the stock prices of 32 oil companies and the prices of 30 different types of crude oils are co-integrated (i.e., driven by a common trend). We used the co-integration test of Johansen (1988) and Johansen and Juselius (1992) to examine the long-term relationship between share prices of non-integrated upstream and downstream oil companies and the prices of 30 different types of crude oil produced by OPEC and non-OPEC countries. The combination of two non-stationary time series sometimes can lead to stationarity. The two series S1 and S2 are co-integrated if they share a common stochastic trend of the same order of integration or if there is a linear combination of these two series of lower integration order with stationary, long-term residuals. The following hypothesis states the argument:

Hypothesis 2: The prices of OPEC and non-OPEC crude oils have similar long-term relationships with the stock prices of upstream and downstream oil companies.

We used weekly dataset spans from 03/01/1997 through 01/29/2010 for both stocks and crude oil prices with a total of 681 observations for each series. Prices for crude oils are spot prices and are free on board (FOB). The prices were obtained from an online database provided by the U.S. Energy Information Administration at www.eia.doe.gov. Stock prices for the oil companies were obtained from www.Yahoo.Finance.com.

We examined the long-term relationships between the stock prices of each company and the prices of each one of the 30 different crude oils. Once a co-integrated relationship was recognized, I used the bivariate Engle-Grainger co-integration framework to model the error correction model (ECM) for co-integrated series. Modelling ECM and estimating related short-term dynamics should help in developing and forecasting more accurate cashflow scenarios. In other words, the long-run relationship was captured by co-integration, while short-run deviations were described by the ECM estimate. ECM reveals an error-correction term that describes the speed of adjustment of each series back to long-term equilibrium.

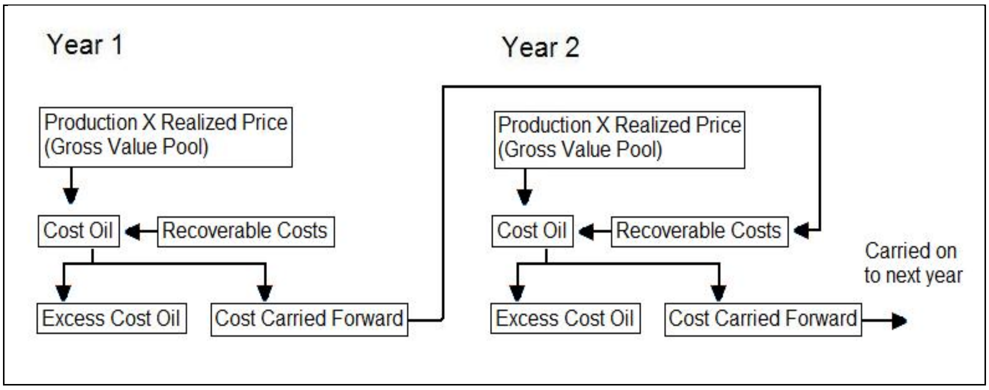
Companies covered in this chapter and key information about each company are provided in Appendix 2. Also, Appendix 1 provides the types of crude oils included in the study, their country of origin and some key information. Tables 3.1 and 3.2 in pages 96 and 97, respectively, provide descriptive statistics for upstream and downstream companies' stocks prices, respectively. The next sections are organized as follows. Section 3.2 provides a review of the types of contracts used in the energy industry and the financial risks associated with these contracts. Section 3.3 reviews the possible impact of asymmetry of information that may exist between company's management and outside investors. Section 3.4 explains the role of OPEC and non-OPEC oil producers as a source of information. Section 3.5 provides literature reviews and sets the framework for the cointegration applications in the field of energy economics. Section 3.6 provides an overview of the dataset and model specifications for the Johansen cointegration test and ECM. Section 3.7 presents and discusses the empirical results. Finally, section 3.8 offers concluding remarks.

3.2 Contracts and cash cycle in the petroleum industry

Most upstream oil companies are engaged in what is known as a production sharing contract (PSC). PSCs represent a major portion of the overall oil exploration and development agreements. An estimated 75 percent of global oil reserve replacements are in the form of PSCs between a host government and a contractor (BP Statistical Review, 2004). In these types of arrangements, contractors are expected to bear all risks and costs of exploration and development (Kretzschmar and Kirchner, 2007). Therefore, the early stages of exploration and development incur high levels of cash outflow due to the capital-intensive nature of the associated engineering and technical tasks. Once commercial production starts, contractors expect to recover their costs plus specified returns. Treynor and Cook (2004) provided examples of PSC production for major oil companies, which show that PSCs are increasing significantly on an annual basis.

Rezk (2006) explained how the mechanism of total revenue, production and cost recovery work under the PSC. He showed how oil prices are the determining factor in terms of cost recovery. The company incur the cost of exploration and drilling at its own risk. However, once a commercial discovery is developed, cost recovery (also known as cost oil) begins. Most contracts pre-specify the percentage of production available for cost recovery. However, in most cases, this percentage is within the range of 30 to 60 percent of gross value. Figure 6 shows the link between oil prices and the mechanism by which PSC recovery cost works. Future oil prices are one of the main factors in determining the period of time needed for cost recovery. The amount of oil remaining after deducting cost oil is split between the company and the host government. Taxes only apply to income received by the company after the split.

Figure 6: PSC recovery cost over a two-year period



This cash flow cycle, in which a relatively long period of time exists between outflows and inflows, suggests that oil companies would be more likely to face high levels of different types of risk exposure. More specifically, price risk and credit risk would be of "particular concern" for both integrated and non-integrated energy companies (GARP, 2009). In the case of price risk (or market risk), prices would be directly linked to profitability, which suggests that inadequate management of energy prices would have a major negative impact on the company's financial status. In case of an oil exploration company, crude oil prices, as a main input in mathematical and statistical risk management applications, provide a good indicator of the type and amount of expected risk exposure.

3.3 Asymmetry of information and project decision-making

Early studies by Leland and Pyle (1977) and Miller and Rock (1985) suggested that managers have more information about future earnings than does the market, which suggests that managers can take actions that help or hurt current and future owners. The issue of asymmetry of information is well documented in empirical studies and can be explained through many real-world business activities. The second-hand car example presented by Akerlof (1970) showed how limited access to quality of a product can alter the market mechanism and introduce imperfections in the market. In the case of a less-than-average-quality car, the seller has incentive to withhold information about the "true" condition of the car. On the other hand, the seller of an above-average-quality car would be faced with the possibility of selling at a discount, because the buyer cannot be sure of the car's condition. In this case, the good-quality car would stay out of the market and only the less-than-average-quality car would be in the market. Some sellers with inside information about the quality of certain assets would be less willing than the average seller to accept offers from buyers with less than average information. In extreme cases, this problem could result in total market failure. However, what happens in most cases is that assets are sold for lower prices than would be paid if all buyers and sellers had access to the same information.

Greenwald, Stiglitz and Weiss (1984) showed how information about the value of the firm's existing assets, combined with stochastic risk about the results of new investment, plays a determining role in making financial decisions. Myers and Majluf (1984) expanded the analysis by including the value of liquid reserves and the capacity to issue risk-free debt.They explained how information reaches managers faster than it reaches potential investors. Once managers became aware of a potential positive outcome of an investment, they would have to choose between acting in the interest of current shareholders or against their interests.

If the manager decided to act in the interest of current shareholders, potential investors would infer from their knowledge of the probability distribution of the returns of current assets-in-place that, for example, a new issue of equity signals a poor outcome. Potential investors may think that the management views the outcome of the new investment as unsatisfactory or not attractive enough to be financed internally or through borrowing. This signal could have a negative impact on the share prices of current investors in the company. New investment and issuing new equity will only take place when management thinks that returns of the new investment will offset the dilution of the outstanding shares held by existing investors.

Myers and Majluf (1984) suggested that two sources of asymmetry of information possibly exist in the above example. The first source is that managers could release the new information to competitors, which would affect the value of current, in-place assets negatively and decrease the potential profit of future investment. The second source is that managers are in a position to acquire full knowledge of the probability distribution of current in-place assets and future investment.

Managers would always have the incentive to hold information and to act either in the interest of current investors or in their own interests. Some motivated project managers, especially in the case of mega-projects, tend to hide inherited risk associated with the project (Flyvbjerg et al., 2002). Hiding (or ignoring) possible risk could cause investors to make decisions based on misguided cashflow estimates.

3.4 The role OPEC and non-OPEC oil producers as sources of information

The anticipation of OPEC's decisions provides signals to the global oil market. For example, market volatility should respond to OPEC conferences prior to information releases (Horan, Peterson and Mahar, 2004). In case the decision is to increase prices (i.e., by decreasing supply), the market reacts by increasing price volatility. On the other hand, if the decision did not specifically recommend price changes, no significant changes in market volatility are noticed (Wang, Wu and Yang, 2007). The relationship between price and production of crude oils can be described as a negative, backward-bending, supply curve. In this relationship, OPEC sets production levels based on non-competitive behaviour (Dees *et al*, 2005). An analysis of the relationship indicates that production of OPEC individually and collectively "Granger cause" oil prices (Kaufmann *et al*., 2004).

In pricing OPEC's crude oils, the market factors in any possible 'cheating' in oil production by an OPEC member. Given the track record of some OPEC countries, oil traders can price different crude oils and estimate premiums or discounts more accurately. They also could factor in exogenous events, such as a military conflict or political unrest, associated with OPEC countries.

Non-OPEC oil producers, on the other hand, do not provide such signals to the market about their intentions. For example, a non-OPEC country could make a decision to increase or decrease its production without giving notice to the market. Oil traders would have no lag time to adjust to new levels of availability of certain types of non-OPEC crudes. As a result, the availability of non-OPEC crude types would be subject to an individual country's decision, unlike in the case of OPEC crudes, where the decisions are made collectively by the member states. Yousefi and Wirjanto (2004) specified other variables, such as the price/exchange rate, prices charged by others and the demand elasticises faced by each producer, as stochastic disturbances that should have an impact on the price differentials of different types of crude oils (Yousefi and Wirjanto, 2004).

OPEC's crudes are represented by a basket of crude oils produced by member states. In this basket, a percentage is fixed for every OPEC member, which means that the amount of each OPEC crude oil available on the international market can be estimated. On the other hand, it is possible that the market views non-OPEC members as another group that, by default, produces another basket of crude oils that are governed by the maximum production capacity of each non-OPEC producer rather than a collective decision making process[27].

3.5 Literature and Methodology

The global energy system consists of several markets, which provide valuable sets of time series for analysis and examination. The evolution of oil prices is one of the most popular time series being analyzed in the energy market (Keppler et. al., 2007). Given that crude oil is the most dominant source of energy, modelling long-term relationship between oil prices and different economic and financial variables has become the focus of a wide range of applications. The co-integration methodology developed originally by Engle and Granger (1987) and enhanced by Johansen (1988) and Johansen and Juselius (1990) provides a framework to identify long-term relationships, including equilibrium and re-adjustment of short-term deviations in energy prices.

Co-integration testing could be viewed as an end by itself with the objective of discovering the presence of an equilibrium relationship between different sets of series (Burgess, 2003). Burgess further stated that a second step could be the use of error-correction models (ECM) to understand the dynamics of any short-term deviation from equilibrium. However, Burgess explained that one of the main weaknesses of the co-

[27] Adams and Marquez (1984), Griffin (1985), Verleger (1987a, b), and Jones (1990) did some of the early analyses of the relationship between OPEC and non-OPEC oil producers.

integration approach is that there are different ways of estimating the co-integration relationship and it is not clear which performs the best in practice. However, many academic researchers prefer using the methodology of Johansen (1988) rather than the the Engle Granger methodology (1987). See Patra and Poshakwale (2008).

Hammodeh et al., (2004) used Johansen's co-integration test to show that price fluctuations of West Texas Intermediate (WTI) crude's 1-month and 4-month futures explain the stock prices of firms that are involved in exploration, refining and marketing businesses. More specifically, they noticed that the degree of co-integration varied between crude oil prices and the type of firm. Giovannini et al., (2004) used multi-variate, co-integration techniques and the vector-error-correction model (VECM) to analyze the long-term financial determinants of stock prices of six of the major integrated oil companies. They analyzed weekly oil prices in relation to stock market index values, exchange rates and spot and future oil prices. The results of their study showed that there is a significant level of association between the performances of major financial variables and the long-term returns of major oil companies.

Lanza, Manera and Giovannini (2003) used multi-variate, co-integration techniques and vector-error-correction models to analyze the long-term financial determents of the stock prices of six major integrated oil companies. Their study analyzed the weekly oil prices in relation to stock market index values, exchange rates and spot and future oil prices. The results of their study showed a significant level of association between the performances of major financial variables and the long-term returns of major oil companies.

Ripple and Wilamoski (1998) used the co-integration test to examine the degree of co-integration between crude oil markets and the development of futures and spot markets. Their results confirmed that there was a high degree of integration and they emphasized the leading role of the U.S. market in influencing prices in other regions of the world. Serletis and Banack (1990) used the co-integration technique developed by Engle and Granger (1987) to test the efficiency of energy prices in the futures and spot petroleum markets. Their findings were consistent with market efficiency. They found evidence that futures prices are an unbiased predictor of future spot prices, which indicates a high degree of integration. Serletis (1991) used the Engle and Granger (1987) model to examine rational expectation, efficiency and risk on spot-month and second-month futures prices of heating oil, unleaded gasoline and crude oil. His results suggested that, for heating oil, futures prices have "reliable power" in forecasting spot prices. Serletis (1994) used the Johansen (1988) co-integration test to estimate the equilibrium relationship between futures prices of crude oil, heating oil and unleaded gasoline. He concluded that all three futures prices are driven by only one common trend. He further suggested that energy futures prices should be modelled as one co-integration system.

Bourbonnais and Geoffron (2007) stated that co-integration can be used in analyzing investments between markets or in forecasting returns within markets. They used the co-integration techniques developed by Engle and Granger (1997) and Johansen (1988) to examine the long-term equilibrium relationship within European gas markets. Their results suggested that a weak degree of co-integration exists within these markets. Serletis and Herbert (1999) used the co-integration test developed by Engle and Granger (1987) to analyze the dynamics behind the prices of natural gas, fuel oil and power prices in the mid-Atlantic region of the U.S. Their results suggested that the random-walk hypothesis cannot be rejected for either natural gas or fuel oil prices. However, power prices were found to be stationary. They further stated that these results indicate that shocks are permanent in the case of integrated series and temporary in the case of stationary series.

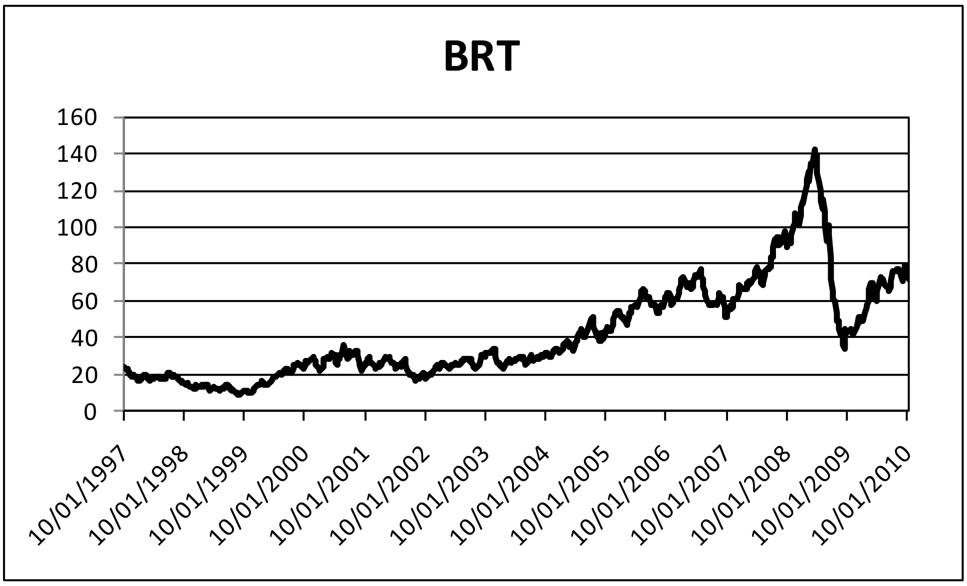
Prices in one market are mainly determined by factors and conditions of the local market in which the product, in this case, the power, is produced and sold. Markets that are integrated with the local market also determine prices (Serletis and Bianchi, 2007). Serletis and Bianchi (2007) tested for a long-term equilibrium relationship between power prices in western North American markets using the Engle-Granger (1987) co-integration test, the error-correction model and the Granger causality test. Their findings suggested that the deregulations of the 1980s have led to the integration of markets in this region.

The progress of model estimation can be summarized in four major steps: 1) selection of lag number in the model using AIC or SC criterion on the VAR; 2) estimation of the matrix rank Π, which allows us to identify the number of co-integration relationships; 3) identification of the long-term relationships between the two variables; and 4) estimation of the vector error-correction model using the maximum likelihood method.

3.6 Data and model specification

Burgess (2003) stated that artificial random-walk series and most asset prices are known as difference stationary. These series are non-stationary, but price differences and returns are stationary. However, we still tested for unit root in crude and stock prices using the Dickey-Fuller (1979) test (ADF)[28] to determine the level of integration without running the risk of biased rejection of the null hypothesis of a unit root. We also used the Philips and Perron unit root test to allow for one structural break on the data. This break can be visually recognised on Figure 7.

Figure 7: Visual identification of price break



The price of the Brent crude oil crashed in less than six months from its highs of $142.45/bbl on 04/07/2008 to $36.30/bbl on 26/12/2008. Garis (2009) also recognized

[28] Zivot unit root test is not required in this case because the assumption for Johansen's multi-variate approach is that the series is not an I(2) process; see Serletis (1994).

this structural break in which the prices of WTI and OMN reference crudes dropped from $ 147.20/bbl and $143.20/bbl on 10/7/2008 to $44.12/bbl and $45.39/bbl, respectively, by the end of February 2009.

We also use a time series data on weekly stock closing prices of thirty-two non-integrated oil companies. We selected the largest and most dominant non-integrated firms in the industry based on its market capitalization. Appendix 2 contains additional information on these firms. Tables 3.1 and 3.2 provide summary statistics for each firm of the upstream and downstream sectors, respectively.

Table 3.1: Summary statistics for upstream stock prices

STOCK	MEAN	ST. DEV	KURTOSIS	SKEWNESS
DE Sector				
DO	53.820	31.050	2.760	0.870
NE	41.890	18.910	3.410	0.910
ESV	35.810	14.290	2.850	0.540
RIG	56.050	31.880	3.910	1.168
ATW	47.230	22.710	3.670	1.090
PKD	5.960	3.040	3.270	0.850
PTEN	23.710	9.970	3.480	0.170
PDE	22.350	8.480	2.530	0.370
Average	35.853		3.235	0.746
ES Sector				
BHI	43.990	18.850	2.960	1.040
BJS	37.150	16.810	3.110	0.780
HAL	37.300	15.490	3.270	0.750
SII	49.680	16.720	1.960	0.220
WFT	42.450	14.400	3.090	-0.100
TESO	12.870	7.020	3.930	1.260
SLB	68.170	19.980	3.430	0.860
RES	13.890	5.570	4.390	1.200
Average	38.188		3.268	0.751

Table 3.2: Summary statistics for downstream stock prices

STOCK	MEAN	ST. DEV	KURTOSIS	SKEWNESS
PIP Sector				
EEP	45.330	5.930	3.860	-0.650
EP	26.080	19.070	2.100	0.730
ETP	36.250	11.670	2.360	0.390
KMP	45.670	9.210	3.240	0.680
WMB	25.930	12.570	2.060	-0.058
TCLP	29.470	7.040	2.120	-0.480
PAA	35.270	12.590	2.010	0.150
OKS	41.670	12.490	2.250	0.420
Average	35.709		2.500	0.148
RM Sector				
HES	68.870	23.770	5.110	1.620
IMO	41.180	20.930	5.170	1.470
MRO	39.650	20.260	5.790	1.790
MUR	60.530	15.740	2.470	0.660
SUN	47.130	21.060	3.660	1.140
TSO	25.160	22.630	5.530	1.700
HOC	30.410	16.350	3.470	1.120
SSL	20.580	14.730	2.550	0.830
Average	41.689		4.219	1.291

Awokuse (2002) explained that, in case unit root is detected, co-integration represents the next step to test whether there is a long-run equilibrium relationship or not. Most studies have concluded that oil prices are not stationary in the level (i.e., do have unit root). For example, Nelson and Plosser (1982) explained that the majority of macroeconomic and financial series have a unit root. They further stated that the first difference of a time series is unit root-free. Furthermore, spot prices of commodity-based futures and options were also found to follow a random walk, that is to say, these series of prices are not stationary (Pindyck, 1999). More recent studies by Serletis and Rangel-Ruiz (2004) and others argued that spot prices of oil are not stationary and showed that, in order to obtain meaningful results (i.e., to avoid spurious regression), these series must be differenced once in most cases.

Non-stationary series cause spurious regression, which means that the results obtained indicate a statistically significant relationship. However, this relationship can be explained as a contemporaneous correlation, not as a meaningful relationship (Granger and Newbold, 1974). The outcome of spurious regression can be stated as unreliable forecast, conventional hypothesis test or unreliable confidence intervals (Stock and Watson, 2007).

Although most studies show that oil prices have unit root problem and point toward differencing these prices, and in addition to using the augmented Dickey-Fuller (ADF) unit root test, we use the non-parametric unit root test of Phillips and Perron (1988) to test my sample of 30 different crude oil price series and 32 different stock prices of oil companies. Results and discussion presented in this chapter are for stock prices of oil companies using the ADF and Phillips Peron unit root tests. Results and related discussions for crude oil prices using the ADF and Phillips Peron unit root test are presented in Chapter 2.

Phillips and Peron (1988) introduced an alternative unit root test to the (ADF) test by adjusting t-statistics of the original Dickey-Fuller test to account for any possible auto-correlation patterns in the error terms (Verbeek, 2000). In using the ADF test we had to ensure that the error terms are uncorrelated and have a constant variance (i.e. the error terms are statically independent and have a constant variance). Phillips and Peron

(1988) (PP test) allows for "fairly mild assumptions" regarding the distribution of errors (Asteriou and Hall, 2006). By looking into stock prices denoted P_t in following equation:

$\Delta P_t = \sigma + \gamma P_{t-1} + \varepsilon_t, \quad \varepsilon_t \mid \Omega_{t-1} \sim N(0, h_t)$, the null hypothesis is $H_0 : \varphi = 1$ against the alternative hypothesis $H_1 : \varphi < 1$. In case P_t is increasing as a result of the positive trend $\beta > 0$ and $\varphi < 1$ as a result of detrending, then, results of the regression are expected to be sound and not expected to suffer from spurious regression. However, in case $\alpha > 0, \beta = 0$ and $\varphi = 1$, then, P_t is increasing as a result of a random walk with a positive drift, which suggests that detrending would not negate the problem of non-stationarity, and working with ΔP_t is the only way to achieve a sound regression.

The ADF and PP tests deal with higher order serial correlation in two different ways. In case of ADF test, higher order serial correlation are corrected by adding lagged differenced terms, again, the number of lags are determined by AIC or SIC. However, in the case of PP test, corrections to the *t*-statistic for the coefficient γ are made to account for serial correlation in the error term.

Results obtained in Tables 2.4–2.5 in Chapter 2 show results of the ADF unit root test for crude oil prices that are not stationary at levels. These results are in line with those of other studies, such as Bessec and Meritet (2007), who reported that a unit root is not generally rejected for variables in level prices but is rejected in first differences. Tables 3.3a-3.4b contained the results of the ADF and PP unit root tests obtained, including the lag length, that were determined by the Akaike information criterion (AIC) plus 2. Furthermore, I tested each series twice, once by including only an intercept and then by including both an intercept and a trend. The case of no intercept and no trend was proven to be very restricted and may not be useful in unit root testing. Davidson and McKinnon (1993) say that testing with a zero intercept is very restrictive and that it is "hard to imagine" using a zero intercept in an economic time series.

3.6.1 Johansen's co-integration technique:

We examined the long-term relationship using the VAR analysis of Johansen (1988) and Johansen and Juselius (1990). This VAR model can be specified as follows:

$$P_t = \mu + \phi_1 P_{t-1} + \ldots + \phi_k P_{t-k} + e_t \, , \qquad (1)$$

After subtracting P_{t-1} from both sides of equation (1), the Johansen test in the vector-error-correction model (VECM) format can be specified as follows:

$$\Delta P_t = \mu + \Pi P_{t-1} + \Gamma_1 \Delta P_{t-1} + \ldots + \Gamma_1 \Delta P_{t-k+1} + e_t \qquad (2)$$

where $P_t = \begin{pmatrix} P_{1t} \\ P_{2t} \\ \vdots \\ P_{mt} \end{pmatrix}$, $\mu_t = \begin{pmatrix} \alpha_{10} \\ \alpha_{20} \\ \vdots \\ \alpha_{m0} \end{pmatrix}$, $\Pi_k = \begin{pmatrix} \alpha_{11k} & \alpha_{12k} \cdots & \alpha_{1mk} \\ \alpha_{21k} & \alpha_{22k} \cdots & \alpha_{2mk} \\ \vdots & \vdots & \vdots \\ \alpha_{m1k} & \alpha_{m2k} \cdots & \alpha_{mmk} \end{pmatrix}$ and $e_t = \begin{pmatrix} e_{1t} \\ e_{2t} \\ \vdots \\ e_{mk} \end{pmatrix}$

where $\Pi = \sum_{j=1}^{k} \phi_i - I$ is interpreted as a long-term coefficient matrix and $\Gamma_i = \sum_{j=1+1}^{k} \phi_j$ is interpreted as the short-term deviation from equilibrium. Testing for deviation from the random-walk process provides a tool to identify the presence of a potentially predictable component in the dynamics that drives the time series (Burgess, 2003).

In the Johansen test, we started by estimating the Π matrix. The cointegration relationship depends on the property of the Π matrix. Next, we examined its rank or the number of columns in β. In examining the rank of the Π matrix, three different scenarios are possible (Wang, 2003):

1. $\Pi = \alpha\beta'$ has a reduced rank $0 < r < k$.

2. $\Pi = \alpha\beta'$ has a rank of zero. Indicates that there is no cointegration relation among the variables in levels.

3. $\Pi = \alpha\beta'$ has a full rank. In this case the variables are stationary.

The ML estimates for β equal to the matrix that contains r eigenvectors, which correspond to the r largest eigenvalues of a $k \times k$ matrix estimated using OLS (Hamilton, 1994). Eigenvalues can be organised in decreasing order, i.e., $\hat{\lambda}_1 \geq \hat{\lambda}_2 \geq \cdots \geq \hat{\lambda}_k$ and, in case we have r co-integrating relationship(s) and Π has a rank of r, then it must be that $\log(1-\lambda_j) = 0$ for the smallest value of $k-r$ eigenvalues. These estimated eigenvalues can be used in testing the hypothesis of Π's rank. The two tests used for estimating the smallest eigenvalue λ_{trace} and the largest eigenvalue $\lambda_{\max}$ are specified as follows:

$$\lambda_{trace}(r_0) = -T \sum_{j=r_0+1}^{k} \log(1-\hat{\lambda}_j) \tag{4}$$

$$\lambda_{\max}(r_0) = -T \log(1-\lambda_{r_0+1}) \tag{5}$$

Brooks (2009) explains that the trace test is a joint test in which the null hypothesis states that the number of cointegrated vectors is less than or equal to *r* co-integrated relationship(s); the alternative hypothesis is that there is more than *r* cointegrated relationship. On the other hand, the maximum eigenvalue test is performed in separate tests for each eigenvalue. The null hypothesis is that the number of cointegrating vectors is *r* against the alternative hypothesis of $r+1$.

The long-term relationship indicates the existence of equilibrium between two (or more) variables. Short-term deviations from this long-term relationship occur, which requires a re-adjusting mechanism back to the long-term equilibrium. In the co-integration framework, this mechanism is represented as an error-correction model (Engle and Granger, 1987), which would be discussed in the following section.

3.6.2 Engle-Granger error correction model

Bourbonnais and Geoffron (2007) suggested that co-integration can be used to distinguish between long-run and short-run relationships between variables. Once a long-run equilibrium relationship (i.e., co-integrated relationship) is identified, a possible extension of the co-integration framework is to apply the Error Correction Model (ECM). The objective behind using ECM is to uncover time paths of these co-integrated variables during periods of deviation from long-run equilibrium. The extent and direction of deviation could be of critical importance in the planning and execution of future strategic and operational risk management programs.

The error-correction model (Engle and Granger, 1987) can be specified as follow:

$$\Delta Y_t = \delta + \sum_{i=1}^{m} A\,\Delta Y_{t-i} + \sum_{j=1}^{n} B\Delta X_{t-i} + \Psi w_{t-1} + \varepsilon_t\,, \qquad (6)$$

where δ is a constant, the terms $A = -[I - \sum_{j=1}^{i} \Pi_j]$ and $B = \sum_{i=1}^{k} \Pi_i$ are used to measure short-term and long-term effects, respectively. The error-correction term is represented by w_{t-1} = $(y_{t-1} - \gamma x_{t-1})$. The term γ is the co-integration coefficient, which defines the long-term relationship between the two variables. The term A measures the short-term relationship, and B measures the proportion of the last-period error that must be adjusted in order to move back to long-term equilibrium. If we have m variables in vector Y_t, then matrix Π will be of order $m \times m$, which is the maximum rank of m that is a full-rank matrix. The number of independent co-integration vectors depends on the rank of matrix Π. When we have the rank of matrix Π equal to zero, we can conclude that no long-term relationship or equilibrium exists. In case the rank of matrix Π is equal to zero, we can conclude that no ECM exists as well (Patra and Poshakwale, 2008).

Engle and Granger's theorem of representation states that short-run dynamics can be described by an error-correction model by relating current and lagged first differences of the co-integrated variables and at least one lagged value of the error term. As stated by Serletis and Herbert (1999), the movements of at least some of the co-integrated variables must be influenced by the magnitude of the deviation from the long-run relationship. They further stated that the gap of short-term deviation must be closed by adjustment in one of the variables or in both. They presented the Engle-Granger (1987) bivariate vector auto-regression (VAR) as follows:

$$\Delta Y_t = \delta_1 + \delta_y \varepsilon_{t-1} + \sum_{j=1}^{r} \delta_{11}(j)\Delta Y_{t-j} + \sum_{j=1}^{n} \delta_{12}(j)\Delta X_{t-j} + \varepsilon_{yt}$$
$$\Delta X_t = \delta_2 + \delta_x \varepsilon_{t-1} + \sum_{j=1}^{r} \delta_{21}(j)\Delta Y_{t-j} + \sum_{j=1}^{n} \delta_{22}(j)\Delta X_{t-j} + \varepsilon_{xt} \quad (7)$$

Both Y_t and X_t are subject to change according to stochastic shocks (i.e., ε_{yt} and ε_{xt}) and to previous deviations represented by ε_{t-1}. In case of a positive error term in the previous period, ε_{t-1} is positive, and given that $Y_{t-1} - \delta - \beta X_{t-1} > 0$, we would expect X_t increase and adjust toward long-term equilibrium. In the other hand, Y_t would be decreasing to adjust to long-term equilibrium. The speeds of adjustment in (7) are represented by δ_y and δ_x. Large and significant values for δ_y and δ_x imply greater response of Y_t and X_t to deviations of previous periods than otherwise. In the other hand, small values of δ_y and δ_x suggest that Y_t and X_t are unresponsive to error from last periods. In other words, the coefficients in (7), as suggested by Serletis and Herbert (1999) are equal to zero.

3.7 Empirical results

The results of augmented Dickey-Fuller (ADF) and Philips-Perron (PP) tests confirmed the existence of a unit root, which suggests that the series are suitable for co-integration testing. The results of the unit root tests for the prices of crude oils using the ADF test are included in Chapter 2. Results of the ADF and PP test for the stock prices are provided in Tables 3.3a-3.4b.

Tables 3.3a-3.4b list stocks in the first column, followed by the values of the optimal number of lags, t-statistics and p-values, respectively. The optimal lag length is selected by the Akaike information criterion (AIC). In the case of intercept only (M2), Table 3.3a shows that most DE stocks are non-stationary at 5 percent, except the ATW price, which is non-stationary at 1 percent. However, only ATW is statistically significant at 5 percent and PTEN at 10 percent. These results lead us to conclude that these stock prices do, in fact, suffer from a unit root problem. In the case of the ES sector, most stocks are non-stationary at 5 percent. However, HAL, WFT and RES are non-stationary at 1 percent and the only stocks statistically significant at 5 percent. Table 3.3a further presents the results of the ADF unit root test for the same stocks under M3. For stocks in both sectors, all coefficients are non-stationary at 5 percent. The only exception is RES of the ES sector, which is non-stationary at 1 percent and is also the only one statically significant at 5 percent.

Table 3.3a: Results for the ADF unit root test for the stock prices of DE and ES upstream sectors

Series	M2: with an intercept			M3: with an intercept + trend		
	Number of Lags	t-statistics	p-value	Number of Lags	t-statistics	p-value
DE Sector						
DO	0	-1.461	0.552	0	-2.534	0.311
NE	1	-2.019	0.278	1	-2.119	0.533
ESV	1	-2.321	0.165	1	-3.040	0.122
RIG	0	-1.623	0.470	0	-2.392	0.383
ATW	0	-2.886*	0.047	0	-2.901	0.162
PKD	1	-2.212	0.202	1	-2.178	0.500
PTEN	1	-2.825	0.055	1	-2.827	0.187
PDE	0	-2.222	0.198	0	-2.823	0.189
ES Sector						
BHI	0	-1.757	0.401	0	-2.068	0.562
BJS	0	-2.570	0.099	0	-2.917	0.157
HAL	0	-3.059*	0.030	0	-3.043	0.121
SII	0	-2.774	0.062	0	-2.891	0.165
WFT	0	-3.168*	0.022	0	-3.189	0.087
TESO	1	-2.115	0.238	1	-2.388	0.385
SLB	1	-1.788	0.388	1	-2.536	0.290
RES	0	-3.430*	0.010	0	-3.471*	0.043

Note: Tested for the Ho that the stock price at levels (intercept and intercept + trend) have a unit root. Statistically significant levels at: * when $P \leq 0.05$. In the case of M2, the critical values for 1 percent is -3.43, 5 percent is -2.86 and 10 percent is -2.57. In the case of M3, the critical values for 1 percent is -3.97, 5 percent is -3.41 and 10 percent is -3.13. Critical values are based on MacKinnon (1996).

Table 3.3b: Results for the ADF unit root test for stock prices of the PIP and RM downstream sectors

Series	M2:with an intercept			M3: with an intercept + trend		
	Number of Lags	t-statistics	p-value	Number of Lags	t-statistics	p-value
PIP Sector						
EEP	0	-3.223*	0.019	0	-3.272	0.071
EP	0	-1.467	0.549	0	-1.924	0.640
ETP	0	-1.238	0.659	0	-2.593	0.284
KMP	0	-3.329*	0.014	0	-3.750*	0.019
WMB	0	-1.978	0.296	0	-2.079	0.556
TCLP	0	-1.784	0.388	0	-2.533	0.295
PAA	0	-1.233	0.659	0	-2.536	0.282
OKS	0	-1.453	0.556	0	-3.176	0.090
RM Sector						
HES	0	-2.843*	0.052	0	-2.896	0.164
IMO	0	-2.360	0.153	0	-2.503	0.326
MRO	0	-2.210	0.202	0	-2.255	0.457
MUR	0	-3.076*	0.028	0	-3.065	0.115
SUN	0	-2.144	0.227	0	-1.962	0.620
TSO	0	-1.655	0.453	0	-1.570	0.803
HOC	0	-2.135	0.230	0	-2.361	0.399
SSL	1	-1.055	0.734	1	-2.557	0.300

Note: Tested for the Ho that the stock price at levels (intercept and intercept + trend) have a unit root. Statistically significant levels at: * when $P \leq 0.05$. In the case of M2, the critical values for 1 percent is -3.43, 5 percent is -2.86 and 10 percent is -2.57. In the case of M3, the critical values for 1 percent is -3.97, 5 percent is -3.41 and 10 percent is -3.13. Critical values are based on MacKinnon (1996).

In the case of downstream stock prices, the ADF results presented in Table 3.3b indicate that most coefficients in M2 are non-stationary at 5 percent. On the other hand, EEP, KMP and MUR are non-stationary at 1 percent, these stocks are the only ones significant at 5 percent. In the case of M3, almost all stock prices are non-stationary at 5 percent, with the exception of KMP, which is non-stationary at 1 percent. In terms of statistical significance, only KMP is significant at 5 percent. The results presented in Tables 3.3a and 3.3b suggest that stock prices do possibly suffer from unit root, which allows for testing them in a co-integration application.

The presence of structural breaks in the data could influence the results obtained by the ADF test. Perron demonstrated that some of the well-known unit root tests fail to account for possible breaks, which could lead to the spurious estimation of the degree of persistence. According to Perron (1989, 1990), the degree of persistence of a time series will be exaggerated when a structural break exists, in either the mean or the trend; however, this was not accounted for. As a result, I applied Perron's methodology in order to test for unit root in both stocks and crude oils with the possibility of a break in the time series.

Results for the upstream (DE and ES) and downstream (PIP and RM) stocks are presented in Tables 3.4a and 3.4b, respectively. In the case of M2, Table 3.4a shows that some stocks are non-stationary at 5 percent; meanwhile others—namely ATW, PTEN, HAL, SII, WFT and RES—are non-stationary at 1 percent. This same group includes those that are statistically significant at 5 percent. The only exception is SLB, which stationary at 5 percent and statistical significance at 1 percent. In the case of M3, all but one stock are non-stationary at 5 percent. The SLB stock is non-stationary at 1 percent and is the only one statically significant at 5 percent.

Table 3.4a: Results for the PP unit root test for the DE and ES upstream sectors

	M2: with an intercept			M3: with an intercept + trend		
Series	Bandwidth	Adjusted t-statistics	p-value	Bandwidth	Adjusted t-statistics	p-value
DE Sector						
DO	4	-1.312	0.625	4	-2.405	0.376
NE	5	-2.202	0.205	6	-2.401	0.378
ESV	12	-2.622	0.088	12	-3.354	0.058
RIG	6	-1.517	0.524	7	-2.307	0.428
ATW	5	-3.039*	0.032	5	-3.055	0.118
PKD	11	-2.553	0.103	11	-2.519	0.318
PTEN	7	-3.130*	0.024	7	-3.134	0.099
PDE	11	-2.508	0.113	11	-3.161	0.093
ES Sector						
BHI	11	-1.921	0.322	11	-2.305	0.43
BJS	4	-2.51	0.113	4	-2.864	0.175
HAL	5	-2.927*	0.042	5	-2.905	0.161
SII	10	-3.097*	0.027	10	-3.213	0.082
WFT	3	-3.099*	0.027	3	-3.12	0.102
TESO	10	-2.300	0.172	10	-2.597	0.281
SLB	2	-3.535*	0.007	2	-3.522*	0.037
RES	9	-3.195*	0.02	9	-3.24	0.077

Note: Tested for the Ho that the stock price at levels (intercept and intercept + trend) have a unit root. Statistically significant levels at: * when $P \leq 0.05$. In the case of M2, the critical values for 1 percent is -3.43, 5 percent is -2.86 and 10 percent is -2.57. In the case of M3, the critical values for 1 percent is -3.97, 5 percent is -3.41 and 10 percent is -3.13. Critical values are based on MacKinnon (1996).

Table 3.4b: Results for the PP unit root test for the PIP and RM downstream sectors

	M2: with an intercept			M3: with an intercept + trend		
Series	Number of Lags	t-statistics	p-value	Number of Lags	t-statistics	p-value
PIP Sector						
EEP	8	-3.063*	0.029	8	-3.114	0.103
EP	1	-1.464	0.551	1	-1.923	0.641
ETP	17	-1.066	0.73	13	-2.336	0.413
KMP	6	-3.366*	0.012	7	-3.837*	0.015
WMB	6	-1.946	0.31	6	-2.048	0.573
TCLP	7	-1.631	0.466	5	-2.317	0.423
PAA	17	-1.067	0.731	13	-2.336	0.411
OKS	14	-1.145	0.699	8	-2.819	0.19
RM Sector						
HES	6	-2.887*	0.047	5	-2.967	0.142
IMO	2	-2.302	0.171	2	-2.443	0.356
MRO	8	-2.008	0.283	8	-2.013	0.592
MUR	9	-2.998*	0.035	9	-2.988	0.136
SUN	15	-1.745	0.408	15	-1.433	0.851
TSO	2	-1.694	0.433	1	-1.607	0.789
HOC	14	-1.945	0.311	13	-2.18	0.499
SSL	6	-1.128	0.706	7	-2.69	0.24

Note: Tested for the Ho that the stock price at levels (intercept and intercept + trend) have a unit root. Statistically significant levels at: * when $P \leq 0.05$. In the case of M2, the critical values for 1 percent is -3.43, 5 percent is -2.86 and 10 percent is -2.57. In the case of M3, the critical values for 1 percent is -3.97, 5 percent is -3.41 and 10 percent is -3.13. Critical values are based on MacKinnon (1996).

Table 3.4b presents the results for the downstream (PIP and RM) stocks. For M2, most coefficients indicate that stock prices are non-stationary at 5 percent. However, in the case of EEP, KMP, HES and MUR, non-stationarity is proven at 1 percent. These same four stocks are the only ones statistically significant at 5 percent. In the case of M3, almost all coefficients of stock prices are non-stationary at 5 percent. However, only the prices of KMP are non-stationary at 1 percent. KMP also is the only one significant at 5 percent.

The results shown in Appendix 11b are summaries of 960 different co-integration tests using the trace and maximum eigenvalue test statistics to determine the number of co-integrating equations. In using the trace test, we use a null hypothesis that there at most r co-integrating equations, in which $r = 0$ or 1. In both tests, the co-integrating vectors, listed as r, were selected beforehand as the null. In the case of the maximum eigenvalue test, the null hypothesis is $r = 0$, and it is tested against the alternative, $r = 1$. Critical values are significant at 95% and are listed as Table A2 in Johansen and Juselius (1990) and MacKinnon (1991).

Given the large number of cointegration tests conducted and the limited space available, actual results obtained for the trace and maximum eigenvalue tests are included in Appendix 11a. However, Tables 3.5a and 3.5b include samples of the actual results of the trace and maximum eigenvalue tests for the two pairs of BRT crude price/DO stock price and BRT crude price/ATW stock price, respectively. In addition, Table 3.5c list all cointegrated relationships identified by comparing the computed values of the test statistics of both the trace and maximum-eigenvalue with the critical values of Johansen and Juselius (1990).

In Table 3.5a, coefficients obtained for the two tests are smaller than the critical values of the trace and maximum eigenvalue tests, thus, the value of 0 is listed to indicate no co-integration relationship between the crude price and the stock price. However, in case the coefficients obtained for the two tests are greater than the related critical values, as shown in Table 3.5b, the value of 1 is written to show that the relationship between crude oil price and stock price is co-integration. In other words, the values of (1)s and (0)s listed in Table 3.5c are based on evaluating results obtained using the trace and maximum eigenvalue test, listed in Appendix 11a and 11b, and comparing each result with its critical values, similar to the evaluation process conducted for the results shown in Tables 3.5a and 3.5b. Again, we only considered and listed results for M1, M2 and M3, which are, respectively, a model with no intercept and no drift, a model with an intercept but no drift and finally a model with both an intercept and a drift.

Table 3.5a: Example of no cointegration relationship

BRT_ DO			Critical values	
	k = 4		Trace	Eg-Max
Ho	Trace	Eg-Max	95%	95%
r=1	21.282	14.948	25.872	19.387
r≤1	6.335	6.335	12.518	12.518

Trace test indicates no cointegration at the 0.05 level. Max-egenvalue test indicates no relationship at the 0.05 level. Listed as 0 on Tables 3.6a - 3.9b

Table 3.5b: Example of cointegrated relationship

BRT_ ATW			Critical values	
	k = 4		Trace	Eg-Max
Ho	Trace	Eg-Max	95%	95%
r=1	37.108	26.813	25.872	19.387
r≤1	10.294	10.294	12.518	12.518

Trace test indicates cointegration at the 0.05 level. Max-egenvalue test indicates no relationship at the 0.05 level. Listed a 1 on Tables 3.6a -3.9b

The main idea behind cointegration analysis is to investigate the possibility of long-term relationship for a set of variables that suffer from unite root problem, i. e. $I(1)$. In our case, we are testing the possible existence of long-term relationship between oil companies' stock prices and crude oil prices. In other words, are these two time-series cointegrated in the long-run? Which suggest the possibility that there is a linear combination of the two series that is $I(0)$.

We first present the cointegrated relationship obtained using similar comparison method to the two examples above. Table 3.5c list the stocks horizontally and the crude oils vertically. It shows cointegrated relationship is obtained in the M2 or M3. As a second step in our analysis, we use the error-correction model (ECM) to estimate speed of adjustment of possible short-term deviation from the long-run equilibrium. Table

3.6a-3.9b would provide the wider picture including both stocks cointegrated with crude oil prices along with the non-integrated ones.

Tables 3.5c: Stocks that show some type of cointegrated relationship with crude oil prices:

STOCK	RIG				ATW				WFT				KMP				TCLP			
	M2		M3		M2		M3		M2		M3		M2		M3		M2		M3	
Oil	T	ME	T	ME	T	ME	T	ME	T	ME	T	ME	T	ME	T	ME	T	ME	T	ME
ADM	0	0	1	1	1	0	1	1	2	0	1	1	1	1	0	0	0	0	1	1
ASB	0	0	0	1	1	0	1	1	1	0	1	1	1	1	0	0	0	0	1	1
ANC	0	0	1	1	1	0	1	1	2	0	1	1	1	1	0	0	0	0	1	1
DUB	0	0	1	1	1	0	1	1	2	0	1	1	1	1	0	0	0	0	1	1
ECU	0	0	1	1	2	0	1	1	2	0	1	1	1	1	1	0	0	0	1	1
IRH	0	0	1	1	1	0	1	1	1	0	1	1	1	1	0	0	0	0	1	1
IRL	0	0	1	1	1	1	1	1	1	0	1	1	1	1	0	0	0	0	1	1
KUT	0	0	1	1	1	0	1	1	2	0	1	1	1	1	0	0	0	0	1	1
LIB	0	0	1	1	1	1	1	1	1	0	1	1	1	1	0	0	0	0	1	1
NGB	0	0	1	1	1	1	1	1	2	0	1	1	1	1	0	0	0	0	1	1
NGE	0	0	0	1	1	1	1	1	2	0	1	1	1	1	0	0	0	0	1	1
DUK	0	0	1	1	1	0	1	1	2	0	1	1	1	1	0	0	0	0	1	1
SAH	0	0	1	1	1	0	1	1	2	0	1	1	1	1	0	0	0	0	1	1
SAL	0	0	1	1	1	0	1	1	2	0	1	1	1	1	0	0	0	0	1	1
SAM	0	0	1	1	1	0	1	1	2	0	1	1	1	1	0	0	0	0	1	1
VEN	0	0	1	1	1	0	1	1	2	0	1	1	1	1	0	0	0	0	1	1
AUS	0	0	0	1	1	0	1	1	2	0	1	1	1	1	0	0	0	0	1	1
CAM	0	0	1	1	1	0	1	1	2	0	1	1	1	1	0	0	0	0	1	1
CAP	0	0	0	0	1	0	1	1	2	0	1	1	1	1	0	0	0	0	1	1
CHI	0	0	1	1	1	0	1	1	2	0	1	1	1	1	0	0	0	0	1	1
COL	0	0	1	1	1	1	1	1	2	0	1	1	1	1	0	0	0	0	1	1
EGS	0	0	1	1	1	1	1	1	2	0	1	1	1	1	0	0	0	0	1	1
INO	0	0	1	1	1	0	1	1	2	0	1	1	1	1	0	0	0	0	1	1
TAP	0	0	1	1	1	0	1	1	2	0	1	1	1	1	0	0	0	0	1	1
MXI	0	0	1	1	1	0	1	1	2	0	1	1	1	1	0	0	0	0	1	1
MXM	0	0	1	1	1	0	1	1	2	0	1	1	1	1	1	0	0	0	1	1
NOE	0	0	0	1	1	1	1	1	2	0	1	1	1	1	0	0	0	0	1	1
OMN	0	0	1	1	1	0	1	1	2	0	1	1	1	1	0	0	0	0	1	1
RUS	0	0	1	1	1	0	1	1	1	0	1	1	1	1	0	0	0	0	1	1
BRT	0	0	0	0	1	0	1	1	2	0	1	1	1	1	0	0	0	0	1	1

Note 1. T and ME stand for Trace and Maximum eigenvalue.
2. 1s and 0s indicates the existence (or not) of a cointegrating relationship.
3. Actual Trace and Maximum eigenvalue are listed in Appendix 11.

Results of the cointegration analysis for the for stock prices of the four oil sectors and crude oil prices of OPEC and non-OPEC producers are listed in appendix 11b. For the upstream drilling and exploration (DE), companies are listed horizontally as DO, NE...PDE, and crude oil prices of OPEC producers are listed vertically as ADM, ASB...VEN. Only two companies, RIG and ATW, show some type of consistent co-integration relationship with different crude oil prices. This occurred only in M3, which is the model that includes the intercept in the co-integrating equation and in VAR and also includes a linear trend in the co-integrating equation but not in the trend. With the exception of the RIG_ASB, RIG_KUT and RIG_NGE pairs, both results of the trace and maximum eigenvalue tests for the RIG stock price with other are crude prices are listed as 1, which is an indication of a co-integration relationship.

In case of the ATW stock price, prices of all crudes are shown to have a co-integrated relationship. However, given that only two out of eight DE stock prices show some type of co-integrated relationship, we would conclude tentatively that stock prices of most DE companies do not share a common trend with OPEC oil prices (i.e., not co-integrated). In other words, DE stock prices and OPEC crude oil prices are driven by two different data generating processes. As a result, we can apply only the ECM to these co-integrated relationships identified in Table 3.5c. Results of the ECM are presented and discussed in the following section. DO and PDE stock prices show few and inconsistent co-integration relationships with a limited number of OPEC crude oil prices, and, as a result, we dropped it from any further analysis.

Tables 3.6a and 3.6b show the results of the error-correction model (ECM) used to model the re-adjustment of the short-term deviation from the equilibrium relationship. These cointegrated relationships were established by Johansen’s co-integration test between the RIG stock prices and OPEC and non-OPEC crude oil prices. The results of the ECM suggest that most stock prices of upstream DE companies move in the opposite direction of crude oil prices. Such an inverse short-term relationship implies that, when a short-term run deviation exists between the stock prices and crude oil prices, stock prices adjust by the ECM coefficients presented in Tables 3.6a and 3.6b. However, t-statistics for the RIG coefficients were not significant, and, thus, we conclude that these coefficients are statistically indistinguishable from zero. As a result, we listed all of the ECM coefficients obtained, but we limited our discussion to the statistically significant coefficients of crude oil prices.

In the case of ECM coefficients of OPEC crude oil prices, the speed of adjustment to long-run equilibrium ranges from 0.012, in the case of SAH and SAM crudes, to 0.007 in the case of the ADM, KUT and DUK crudes. This would suggest that, in each week, 0.7 to 1.2 percent of any divergence from long-term relationship will be eliminated. The Jarque-Bera test is required to determine whether the residuals follow a normal distribution.

Table 3.6b show the results of the ECM for RIG stock prices with crude oils of non-OPEC producers. We still obtained insignificant coefficients for the RIG stock prices in all cases, which led us to consider only the ECM results obtained for the crude oil prices. The speed of adjustment to long-run equilibrium ranges from 0.006 (in the case of CHI crude) to 0.014 (in the case of the RUS crude). In other words, 0.06 to 1.4 percent of any divergence from long-term relationship will be eliminated in a weekly base. The Jarque-Bera test is required to determine whether residuals follow normal distribution.

Table 3.6a: ECM results for prices of RIG stock and crude oils of OPEC

	Coefficient	St. error	t-Statistic
RIG	-0.002	0.004	-0.405
ADM	0.007	0.002	3.024
RIG	-	-	-
ASB	-	-	-
RIG	-0.003	0.005	-0.642
ANC	0.011	0.003	3.53
RIG	-0.001	0.005	-0.227
DUB	0.009	0.003	3.302
RIG	0	0.003	-0.007
ECU	0.011	0.003	3.627
RIG	-0.002	0.004	-0.383
IRH	0.01	0.003	3.421
RIG	-0.002	0.005	-0.502
IRL	0.009	0.003	3.326
RIG	-0.001	0.004	-0.124
KUT	0.007	0.002	3.274
RIG	-0.003	0.005	-0.727
LIB	0.011	0.003	3.446
RIG	-0.003	0.005	-0.71
NGB	0.011	0.003	3.357
RIG	-0.003	0.005	-0.71
NGE	0.011	0.003	3.357
RIG	-0.003	0.005	-0.609
DUK	0.007	0.002	3
RIG	-0.001	0.005	-0.294
SAH	0.012	0.003	3.689
RIG	-0.003	0.005	-0.661
SAL	0.01	0.003	3.344
RIG	-0.003	0.005	-0.552
SAM	0.012	0.003	3.495
RIG	0	0.003	-0.071
VEN	0.008	0.002	3.559

Table 3.6b: ECM results for prices of RIG stocks and crude oils of non-OPEC

	Coefficient	St. error	t-Statistic
RIG	-	-	-
AUS	-	-	-
RIG	-0.002	0.004	-0.531
CAM	0.011	0.003	3.647
RIG	-	-	-
CAP	-	-	-
RIG	-0.001	0.003	-0.268
CHI	0.006	0.002	3.189
RIG	-0.002	0.004	-0.473
COL	0.01	0.003	3.293
RIG	-0.002	0.004	-0.433
EGS	0.012	0.003	3.658
RIG	-0.001	0.003	-0.269
INO	0.007	0.002	3.396
RIG	-0.009	0.006	-1.561
TAP	0.01	0.003	2.776
RIG	-0.001	0.003	-0.351
MXI	0.008	0.002	3.307
RIG	0.000	0.003	0.083
MXM	0.008	0.002	3.66
RIG	-	-	-
NOE	-	-	-
RIG	-0.002	0.005	-0.493
OMN	0.008	0.002	3.144
RIG	-0.003	0.004	-0.601
RUS	0.014	0.003	3.714
RIG	-	-	-
BRT	-	-	-

Tables 3.6c and 3.6d show the results of the error-correction model (ECM) obtained to estimate speed of re-adjustment in short-term deviation from the equilibrium relationship, identified by Johansen's co-integration test between the ATW stock prices

and OPEC and non-OPEC crude prices, respectively. The levels of significance for the ECM coefficients for the ATW stock prices too low to be considered significant. Therefore, we concluded that, similar to the RIG stock case, these coefficients are statistically indistinguishable from zero. As a result, we limited our discussion to crude oil prices.

In the case of ECM coefficients of OPEC crude oil prices, the speed of adjustment to long-run equilibrium ranges from 0.012, in the case of SAH and SAM crudes, to 0.007 in the case of the ADM, KUT and DUK crudes. This suggests that, in each week, 0.07 to 1.2 percent of any divergence from long-term relationship will be eliminated.

Table 3.6c: ECM results for prices of ATW stock and crude oils of OPEC

	Coefficient	St. error	t-Statistic
ATW	-0.001	0.011	-0.115
ADM	0.025	0.004	5.441
ATW	-0.004	0.011	-0.386
ASB	0.031	0.005	5.629
ATW	-0.001	0.01	-0.059
ANC	0.030	0.005	5.522
ATW	0.002	0.01	0.236
DUB	0.025	0.004	5.445
ATW	0.002	0.027	0.306
ECU	0.027	0.005	4.969
ATW	0.001	0.01	0.087
IRH	0.027	0.005	5.401
ATW	0.001	0.01	0.048
IRL	0.027	0.005	5.478
ATW	0	0.01	0.011
KUT	0.024	0.004	5.186
ATW	-0.001	0.011	-0.129
LIB	0.030	0.005	5.58
ATW	-0.003	0.011	-0.283
NGB	0.032	0.006	5.634
ATW	-0.003	0.011	-0.265
NGE	0.031	0.005	5.659
ATW	-0.002	0.011	-0.187
DUK	0.026	0.005	5.543
ATW	0.002	0.009	0.248
SAH	0.026	0.005	5.273
ATW	0	0.01	-0.021
SAL	0.027	0.005	5.469
ATW	0.001	0.01	0.062
SAM	0.027	0.005	5.342
ATW	-0.002	0.01	-0.177
VEN	0.028	0.005	5.321

Table 3.6d: ECM results for prices of ATW stock and crude oils of non-OPEC

	Coefficient	St. error	t-Statistic
ATW	-0.004	0.011	-0.358
AUS	0.024	0.004	5.317
ATW	0.000	0.01	0.039
CAM	0.032	0.005	5.642
ATW	-0.007	0.011	-0.684
CAP	0.032	0.006	5.092
ATW	0	0.01	-0.059
CHI	0.025	0.005	5.443
ATW	-0.001	0.01	-0.091
COL	0.027	0.005	5.082
ATW	-0.001	0.01	-0.137
EGS	0.032	0.006	5.486
ATW	0.001	0.01	0.163
INO	0.026	0.005	5.552
ATW	-0.023	0.012	-1.892
TAP	0.001	0	5.629
ATW	0	0.01	-0.06
MXI	0.027	0.005	5.092
ATW	0.004	0.008	0.499
MXM	0.023	0.005	4.844
ATW	-0.003	0.011	-0.258
NOE	0.032	0.005	5.628
ATW	0	0.011	-0.029
OMN	0.026	0.005	5.51
ATW	0.001	0.01	0.126
RUS	0.034	0.006	5.549
ATW	-0.001	0.011	-0.118
BRT	0.033	0.006	5.492

In the case of upstream equipment and services (ES) companies, only two companies, WFT and SLB show some type of consistent cointegration relationship with different crude oil prices in only M3, which is the model that includes intercept in cointegrating equation and in VAR and also includes a linear trend in the cointegrating equation but not in the trend. Both results of the trace and maximum eigenvalue tests for the WFT stock price with other are crude prices are listed as 1, which is an indication of a cointegration relationship.

In case of the SLB stock price, prices of all crudes are shown to have a cointegrated relationship just in the case of the trace value, but not in the maximum eigenvalue. For this reson we did not include SLB in the ECM analysis and its not listed in Table 3.5c. As a result, and given that only 1 out of 8 ES stock prices show some type of cointegrated relationship, we conclude tentatively that stock prices of most ES companies do not share a common trend with OPEC oil prices. (i. e. Not cointegrated). In other words, ES stock prices and OPEC crude oil prices are driven by two different data generating process. As a result, we only can apply the ECM to WFT. Table 3.7c presents the results of the ECM, which suggest that all coefficients are small and in most cases have similar sign.

Table 3.7a: ECM results for prices of WFT stock and crude oils of OPEC

	Coefficient	St. error	t-Statistic
WFT	0.001	0.01	0.128
ADM	0.022	0.004	5.148
WFT	-0.001	0.01	-0.115
ASB	0.028	0.005	5.447
WFT	0.001	0.009	0.101
ANC	0.027	0.005	5.269
WFT	0.003	0.009	0.004
DUB	0.021	0.004	5.013
WFT	0.009	0.005	1.558
ECU	0.556	0.144	3.853
WFT	0.001	0.009	0.196
IRH	0.023	0.004	5.065
WFT	0.002	0.009	0.2
IRL	0.024	0.004	5.263
WFT	0.001	0.009	0.085
KUT	0.022	0.004	4.941
WFT	0.001	0.009	0.065
LIB	0.027	0.005	5.366
WFT	0	0.01	-0.037
NGB	0.029	0.005	5.423
WFT	0	0.01	-0.045
NGE	0.028	0.005	5.469
WFT	0	0.01	0.022
DUK	0.023	0.004	5.233
WFT	0.002	0.008	0.295
SAH	0.022	0.004	4.885
WFT	0.001	0.009	0.18
SAL	0.023	0.004	5.081
WFT	0.001	0.009	0.185
SAM	0.022	0.004	4.931
WFT	0	0.009	0.048
VEN	0.026	0.005	5.176

Table 3.7b: ECM results for prices of WFT stock and crude oils of non-OPEC

	Coefficient	St. error	t-Statistic
WFT	-0.002	0.01	-0.252
AUS	0.023	0.004	5.218
WFT	0.001	0.009	0.077
CAM	0.03	0.005	5.462
WFT	0	0.011	-0.006
CAP	0.035	0.006	5.41
WFT	-0.002	0.01	-0.261
CHI	0.026	0.004	5.423
WFT	0.001	0.009	0.107
COL	0.024	0.005	4.849
WFT	0	0.009	0.011
EGS	0.029	0.005	5.317
WFT	-0.001	0.01	-0.141
INO	0.025	0.004	5.441
WFT	-0.005	0.01	-0.527
TAP	0.028	0.005	5.529
WFT	0.001	0.009	0.176
MXI	0.026	0.005	5.103
WFT	0.003	0.008	0.455
MXM	0.022	0.004	4.774
WFT	-0.001	0.01	-0.081
NOE	0.029	0.005	5.481
WFT	0.001	0.009	0.091
OMN	0.022	0.004	5.116
WFT	0.003	0.009	0.379
RUS	0.029	0.005	5.17
WFT	0.003	0.01	0.282
BRT	0.031	0.005	5.317

Tables 3.7a and 3.7b show the results of the error-correction model (ECM) used to model the re-adjustment of the short-term deviation from equilibrium relationship is established by Johansen's co-integration test between the WFT stock prices and each of OPEC and non-OPEC crude prices. Results suggest that most stock prices of upstream ES companies move in the opposite direction of crude oil prices. Such an inverse short-term relationship implies that, when a short-term run deviation exists between the stock prices and crude oil prices, stock prices adjust by the ECM coefficients presented in Table 3.7c and 3.7d. Only coefficients of crude oils are statistically significant.

In case of ECM coefficients of OPEC crude oil prices, the speed of adjustment to long-run equilibrium ranges from 0.021, in the case of DUB crude up to 0.556 in the case of the ECU crudes. This would suggest that in each week, in the case of the DUB crude, 0.021 percent of any divergence from long-term relationship will be eliminated. Likewise, in the case of ECU crude, 0.556 of divergence would be eliminated weekly.

Table 3.7b show results of the ECM of the WFT stock prices with crude oils of non-OPEC producers. We still obtained insignificant coefficients for the WFT stock prices in all cases, which let us consider only ECM coefficients obtained for the crude oil prices. The speed of adjustment to long-run equilibrium ranges from 0.022, in the case of MXM and OMN crudes up to 0.035 in the case of the CAP crude. In other words, 2.2 to 3.5 percent of any divergence from long-term relationship will be eliminated in a weekly base.

Co-integration tests for stock prices of downstream companies and OPEC and non-OPEC crude oil prices did not reveal long-term relationships in most cases. Possible explanation of the lack of long-term relationships could be the ability of downstream companies to manage their exposure in more efficient ways over longer periods of time than upstream companies. Further empirical analysis could be conducted in the future to explain these results in more details.

For downstream pipelines (PIP) companies, results of the trace and maximum eigenvalue tests for the KMP and TCLP stock prices with other crude prices are listed as 1 in Table 3.5c, which is an indication of a cointegration relationship. Given that only 2 out of 8 ES stock prices show some type of cointegrated relationship, we would conclude that stock prices of most PIP companies do not share a common trend with OPEC oil prices. (i. e. Not cointegrated). We can apply the ECM to these cointegrated relationship identified.

Tables 3.8c and 3.8d show the results of the error-correction model (ECM) used to model the re-adjustment of the short-term deviation from equilibrium relationship is established by Johansen's co-integration test between the KMP stock prices and each of OPEC and non-OPEC crude prices, respectively. Results suggest that KMP stock prices move in the opposite direction of crude oil prices. Such an inverse short-term relationship implies that, when a short-term run deviation exists between the stock price of KMP and crude oil prices, stock prices adjust by the ECM coefficients presented in Table 3.8c and 3.8d. In case of ECM coefficients of OPEC crude oil prices, the speed of adjustment to long-run equilibrium ranges from 0.008, in the case of VEN crude up to 0.016 in the case of the SAH crude. This would suggest that in each week, in the case of the SAH crude, 1.6 percent of any divergence from long-term relationship will be eliminated. Likewise, in the case of VEN crude, 0.08 of divergence would be eliminated weekly.

Table 3.8a: ECM results for prices of KMP stock and crude oils of OPEC

	Coefficient	St. error	t-Statistic
KMP	-0.046	0.012	-3.799
ADM	0.009	0.01	0.948
KMP	-0.047	0.012	-3.837
ASB	0.01	0.011	0.908
KMP	-0.046	0.012	-3.84
ANC	0.01	0.012	0.858
KMP	-0.046	0.012	-3.788
DUB	0.01	0.01	0.997
KMP	-0.047	0.012	-3.886
ECU	0.013	0.014	0.914
KMP	-0.046	0.012	-3.776
IRH	0.013	0.011	1.157
KMP	-0.046	0.012	-3.81
IRL	0.011	0.011	1.001
KMP	-0.046	0.012	-3.787
KUT	0.011	0.01	1.033
KMP	-0.047	0.012	-3.842
LIB	0.011	0.012	0.947
KMP	-0.046	0.012	-3.823
NGB	0.011	0.012	0.895
KMP	-0.046	0.012	-3.805
NGE	0.01	0.011	0.932
KMP	-0.046	0.012	-3.798
DUK	0.009	0.009	0.961
KMP	-0.046	0.012	-3.795
SAH	0.016	0.012	1.337
KMP	-0.047	0.012	-3.836
SAL	0.012	0.011	1.119
KMP	-0.047	0.012	-3.809
SAM	0.014	0.011	1.268
KMP	-0.048	0.012	-3.87
VEN	0.008	0.012	0.655

Table 3.8b: ECM results for prices of KMP stock and crude oils of non-OPEC

	Coefficient	St. error	t-Statistic
KMP	-0.047	0.012	-3.908
AUS	0.005	0.009	0.538
KMP	-0.046	0.012	-3.811
CAM	0.012	0.012	0.964
KMP	-0.047	0.012	-3.846
CAP	0.008	0.013	0.636
KMP	-0.047	0.012	-3.932
CHI	0.005	0.01	0.525
KMP	-0.047	0.012	-3.874
COL	0.008	0.012	0.637
KMP	-0.045	0.012	-3.778
EGS	0.014	0.013	1.085
KMP	-0.048	0.012	-3.941
INO	0.005	0.01	0.474
KMP	-0.048	0.012	-3.935
TAP	0.005	0.011	0.495
KMP	-0.046	0.012	-3.819
MXI	0.009	0.012	0.761
KMP	-0.043	0.012	-3.653
MXM	0.014	0.012	1.092
KMP	-0.046	0.012	-3.825
NOE	0.01	0.012	0.863
KMP	-0.046	0.012	-3.807
OMN	0.009	0.01	0.954
KMP	-0.046	0.012	-3.744
RUS	0.013	0.014	0.978
KMP	-0.046	0.012	-3.772
BRT	0.011	0.012	0.87

Table 3.8c : ECM results for prices of TCLP stock and crude oils of OPEC

	Coefficient	St. error	t-Statistic
TCLP	-0.011	0.003	-2.918
ADM	-0.005	0.004	-1.207
TCLP	-0.002	0.001	-2.267
ASB	-0.002	0.001	-2.454
TCLP	-0.003	0.001	-2.389
ANC	-0.004	0.002	-2.442
TCLP	-0.011	0.004	-2.937
DUB	-0.006	0.004	-1.426
TCLP	-0.009	0.003	-2.796
ECU	-0.011	0.005	-2.045
TCLP	-0.008	0.003	-2.925
IRH	-0.006	0.003	-1.852
TCLP	-0.007	0.002	-2.848
IRL	-0.005	0.003	-1.834
TCLP	-0.009	0.003	-2.902
KUT	-0.006	0.003	-1.651
TCLP	-0.004	0.001	-2.548
LIB	-0.005	0.002	-2.209
TCLP	-0.002	0.001	-2.399
NGB	-0.003	0.001	-2.295
TCLP	-0.002	0.001	-2.424
NGE	-0.003	0.001	-2.324
TCLP	-0.013	0.004	-2.984
DUK	-0.004	0.004	-0.927
TCLP	-0.009	0.003	-2.974
SAH	-0.008	0.004	-1.907
TCLP	0.001	0.006	0.163
SAL	0.019	0.007	2.672
TCLP	-0.009	0.003	-2.948
SAM	0.007	0.004	-1.754
TCLP	-0.004	0.002	-2.536
VEN	-0.005	0.002	-2.114

Table 3.8d : ECM results for prices of TCLP stock and crude oils of non-OPEC

	Coefficient	St. error	t-Statistic
TCLP	-0.008	0.003	-2.696
AUS	-0.004	0.003	-1.44
TCLP	-0.002	0.001	-2.353
CAM	-0.003	0.001	-2.585
TCLP	0.002	0.001	2.108
CAP	0.003	0.001	2.423
TCLP	-0.007	0.002	-2.624
CHI	-0.005	0.003	-1.609
TCLP	-0.01	0.003	-2.811
COL	-0.008	0.005	-1.657
TCLP	-0.003	0.001	-2.54
EGS	-0.005	0.002	-2.472
TCLP	-0.009	0.003	-2.805
INO	-0.006	0.004	-1.556
TCLP	-0.012	0.004	-2.842
TAP	-0.004	0.004	-0.991
TCLP	-0.004	0.002	-2.531
MXI	-0.005	0.002	-2.123
TCLP	-0.008	0.003	-2.89
MXM	-0.008	0.004	-2.176
TCLP	-0.002	0.001	-2.357
NOE	-0.002	0.001	-2.492
TCLP	-0.012	0.004	-2.945
OMN	-0.005	0.004	-1.23
TCLP	-0.004	0.001	-2.546
RUS	-0.006	0.002	-2.426
TCLP	-0.002	0.001	-2.408
BRT	-0.002	0.001	-2.391

Table 3.8d show results of the ECM of the KMP stock prices with crude oils of non-OPEC producers. We obtained significant coefficients for both coefficients of KMP stock prices and crude oils' prices, which let us consider ECM coefficients obtained for the both. For KMP stock prices, the speed of adjustment to long-run equilibrium ranges from -0.045, in the case of EGS, and -0.048 in the case of OMN crudes. In other words, 2.2 to 3.5 percent of any divergence from long-term relationship will be eliminated in a weekly base.

3.8 Conclusion:

The chapter uses the Johansen co-integration methodology to determine whether oil prices and oil stock prices are following a common trend. In other words, "Are these prices generated by a common data generating process or not?" We have used two sets of data that span from 03/01/1997 to 29/01/2010 (a total of 681 observations): 1) stock prices of 32 different oil companies that cover four different oil sectors and 2) crude oil prices of 30 different crude oils produced by OPEC and non-OPEC countries. Prices of both time series sets were tested for unit root and were found to be stationary after the first difference.

The results suggest that crude oil prices and oil stock prices are not co-integrated in the majority of cases. With the exception of stock prices of five companies, most oils stock prices are being driven by a different data generating process than the one behind crude oil prices. Further investigations of the error-correction model (ECM) were conducted on a small number of oil stock price series that show a co-integrated relationship with crude oil prices. The error-correction model provides an indication of the short-term dynamics of possible deviation from long-term equilibrium.

Overall, we concluded that stock prices of oil companies do not share similar data generating process (DGP) with oil prices, which suggests that there is a set of different factors that influence oil stock prices in different ways and to different degrees than crude oil prices. Future research should look into whether the inclusion of dividends and splits in stock prices (i.e., using adjusted stock prices) would result in a co-integrated relationship with crude oil prices. Furthermore, inflation and interest rates could also be included in testing for co-integration of stock and crude prices.

Chapter 4: Determinants of OPEC and non-OPEC crude oil prices: a panel data analysis of endogenous and exogenous factors

4.1 Introduction

News and events help market participants in forming future expectations. Given the diverse background and experience of parties involved in the decision making process, different interpretations of news add a subjective dimension to the complex dynamics of crude oil prices. Interaction between supply and demand is the main force that drives crude oil price dynamics; however, several studies have suggested that, in some circumstances, traders tend to reject the supply-demand analysis in favour of a fear-and-greed attitude. If the market believes that the level of surplus supply capacity is sufficient to meet additional demand created by unexpected eventualities, then the fundamentals of supply and demand become the dominant analytical framework for pricing crude oil. However, if excess production capacity is below some perceived benchmark, then fear of possible supply disruption and greed to make profit become the driving forces behind crude oil prices (Garis, 2009). Early research by Bhagwati and Srinivasin (1976) and Mayer (1977) suggested that, should unanticipated disruption of crude oil supply occur, producing firms must raise prices due to the adjustment cost of lost goods. So, today's traders have, in the back of their minds, the idea that, in case of a significant disruption in supply, prices would surely increase, which would cause a self-fulfilling prophecy.

This psychological factor increases the complexity of the price discovery process performed by different market participants. In addition, Garis (2009) suggested that the correlated positions in the crude oil market caused by thousands of traders using relatively few computer trading programmes increase the sensitivity of crude oil prices to news, which could very easily cause price shocks to the system and increase market instability. He argued that the situation is worsening for the broad energy market due to the presence of "novice" hedge fund managers who are experienced in the bond and equity markets but are not well prepared for trading in the commodity market.

Till (2007) provided an example of such an ill-prepared venture by Amaranth Advisors, a hedge fund, in which a single trader bid $6 billion on natural gas futures, causing the collapse of the hedge fund and sending waves of concern throughout the energy market. In addition, most of these positions are based on borrowed money, which suggests that losing positions would be closed quickly, further increasing market instability (Garis, 2009). Oil prices provide signals to the people who are in charge of making trading, managerial and operational decisions (Amic and Lautard, 2005). In case of increasing market instability, decision makers would get mixed price signals, meaning that making well-informed investment decisions would be very difficult and could cause unexpected outcomes.

Amic and Lautard (2005) emphasised that strategies and techniques developed by hedge funds, banks and investment houses cannot simply be applied in the commodity market, given its high price volatility, low liquidity and liberal use of leverage. They further stated that the difficulty of modelling and predicting commodity prices is associated with the difficulty of understanding the value that the commodity generates for the user and the importance of timing its position. As a result, they suggested that it is possible for oil and gas trading companies to have an edge over their financial competitors. In other words, industry-specific knowledge could provide oil and gas trading companies with the means of better assessing news and information than the financial companies that are their competitors. This could increase the chances of achieving more accurate estimates, which could be translated into taking profitable positions and eliminating losing positions.

Modelling crude oil prices requires an understanding the influences that different types of related news and events have on oil prices. However, a common concern by most related parties is the impact that any news item (i.e., new information) might have on the expected level of supply in the near future and whether the news item is an indicator of potential supply disruption. Leiby and Bowman (2003) suggested that different assumptions and approaches that were used for estimating the risk of oil disruptions during the 1990s did, in fact, contribute to vicarious estimates, which suggests that a serious investigation is needed before assumptions are acted upon and approaches are implemented.

This chapter contributes to the goal of the thesis by presenting the analysis of the impact of different news and events items on the price performance of 30 different types of crude oils produced by OPEC and non-OPEC countries. We investigated whether crudes produced by OPEC and non-OPEC producers have the same relationship to the specified set of news and events. For example, we can determine whether geopolitical events affect the prices of crude oils produced by OPEC countries, such as Kuwait and Saudi Arabia, in the same way they affect the prices of crude oils produced by non-OPEC countries, such as Mexico and Norway.

We seek to draw a picture of relationships between crude oils produced by OPEC and non-OPEC nations in the hope of identifying possible advantages for parties involved in the global oil markets. In other words, we want to be able to determine whether the prices of crude oils produced by OPEC and non-OPEC countries react similarly (or differently) to new information conveyed by the social and political changes and events taking place all over the world. We test the following hypothesis:

Hypothesis 3: The prices of OPEC and non-OPEC crudes have a similar reaction to different news items and global events.

Guo and Kliesen (2006) proposed a narrative approach in which they considered *Wall Street Journal* accounts of the 10 largest daily 12-month futures oil price movements during the period from 1983 - 2004. They found that most of these movements were related to decisions that OPEC made or to events in the Middle East. We used a similar approach to review 682 oil-related news items during the period from 1997 - 2007 and stated possible relationships with the dummy variables listed in Table 4.1.

Appendix 12 presents these news items as listed by the U.S. Department of Energy and shows our assessment of possible impacts on the prices of different crudes and other variables. We started by identifying the possible impacts of the following events, i.e., military conflicts, social and labour disputes, political unrest, weather and environmental concerns and business and economic factors. We used dummy variables to identify the impact of each news item on selected categories. If we believed that a particular item had an impact on the two categories of social and labour unrest and business and economic factors, a value of "1" was assigned to the dummy variables representing these two categories, and a value of "zero" was assigned for all other dummy variables for political unrest.

4.2 Crude oil supply disrupting events

Huntington (2009) suggested that oil price shocks caused by supply disruption are different from demand-oriented oil price increases that could be described as more gradual. He further stated that empirical evidence suggests that oil price shocks should be considered separately from other oil prices changes. For example, he suggested that the reaction of oil prices to the events of the 1970s (i.e., the Arab oil embargo in 1973 and the Iranian revolution in 1979) was quite different from recent price volatility. In addition, Huntington suggested that oil suppliers and consumers alike do not fully understand the actual risk of another oil disruption. Indeed, Aldy (2007) showed that private entities in OECD countries are far behind in stockpiling oil compared to public stockpiling of oil, which suggests that these private entities are taking inadequate measures to deal with any possible future oil disruption.

Huntington (2009) also stated that the fundamental economic problem facing the global economy is the creation of a reasonable balance between benefits obtained by the use of free and open market policies and oil security issues that may limit dependency on Middle Eastern oil. He summarised the security supply policies in the three following questions: 1) How much should government spend to manage energy security?; 2) Should decision makers use a particular policy, such as stockpiling reserves or tariffs, to offset the impact of price shocks?; and 3) How should the oil environmental premium and the oil security premium be dealt with? Are they complementary or not? Bohi and Toman (1993, 1996) and Toman (1993) researched policies and principles adopted by governments to deal with the issue of supply security, and they provide excellent reviews.

Beccue and Huntington (2005) presented the results of a study conducted by the Energy Modelling Forum (EMF) of Stanford University in which a panel of geopolitical, military and energy economics experts were asked, in a series of three consecutive workshops, to "reflect their individual judgments" in evaluating the likelihood of at least one foreign oil disruption over the next 10 years. The study was performed twice, once in 1996 and again in 2004. In 1996, the study was limited to possible oil disruption in two major oil supply regions, i.e., Saudi Arabia and the other Gulf countries (including Iraq, Iran, Qatar, Kuwait and Oman). In 2004, the study was broadened to cover four major supply regions, i.e., Saudi Arabia, other Gulf countries, countries west of the Suez Canal and Russia and its former Caspian states.

The panel's task was to estimate net disruptions in each region taking into account excess capacity in undisrupted regions. Excess capacity exists mainly in Saudi Arabia and to a lesser extent in other Gulf countries. Russia's excess capacity was not considered in the study, given the U.S.'s limited policy of intervention in Russia. In addition, Russia and most non-OPEC countries were producing at maximum capacity during that time, which suggests that these countries have no additional capacity to meet any unexpected demand caused by disruption. Once the information was collected on different scenarios and events, such as the likelihood and sizes of disruptions, it was assessed using the DPL software package developed by Syncopation Software (2003).

The results of over 20 million scenarios suggested that the probability of any oil disruption taking place within the next 10 years and lasting more than one month is 49 percent for Saudi Arabia, 83 percent for other Gulf States, 72 percent for countries west of Suez and 17 percent for Russia and the Caspian states. These results confirmed the notion that geopolitical events in the Middle East and their linkages to more than one major oil supply area are important factors in oil risk assessment (Huntington, 2009).

4.3 Impacts of Oil disruptions

A major oil supply disruption would cause a shortage in the quantity supplied to meet demand. Once the news of oil-disrupting events came out, the most likely scenario is that the market would react by increasing prices. Garis (2009) stated that the buying behaviour of market participants during times of possible shortage of oil is very likely to cause price increases. However, he also suggested that, in case available production is capable of meeting an expected shortage caused by geopolitical events, prices tend to revert back to their conventional supply and demand relationship.

However, if the market believes that available supply would not be able to address supply disruption, price increases would have major effects on the final users of oil and oil-related products. Petrochemical companies, refineries, plastics companies and others dependent on oil would face two main challenges. The first challenge would be increasing oil prices that lead to increases in the cost of production (or operation) and negatively affect profit. Various risk management techniques can be used to control this challenge, such as futures and options contracts. The second challenge is that increasing oil prices may result in a slowdown of their clients' business activities, leading to a deferral of further investments. As a result, predicting or estimating future cashflows for these companies would be more challenging for current or future investors.

These changes exist throughout different companies and industries, which means that oil price increases would have an effect on overall economic growth that would not be limited to the oil-related companies. Stevens (2000) suggested that oil price increases would have an impact at both national and local levels. At the national level, oil (and energy) importers would face problems in term of balance of payments and resource transfer. At the local level, energy and capital-intensive projects could be "intrusive" on local communities as well as on the environment. In other words, the costs that would be incurred would be passed on to local communities and to the environment. In the case of the U.S., a 10 percent increase in crude oil prices would cause an estimated 0.2 to 0.5 percent decrease in GDP over a six-month period. (See Brown and Yucel, 2002; Brown et al., 2004; and Jones et al., 2004. For international estimates, see Jimenez-Rodrigues and Sanchez, 2005.)

The possibility of an oil supply disruption event increases uncertainty about future oil prices and is likely to put downstream companies under increasing pressure from their suppliers. If we look at the contract arrangement between the two parties, we can see that a continuous flow of feedstock is essential for the functioning of the oil-supply chain. Any disruption of the flows of input materials, especially for gaseous inputs, would be very costly, given that the storage and transportation of such raw materials are very expensive.

Long-term contracts provide mutual benefits to sellers and buyers, which usually span over one to three years with options for automatic renewal or termination. Most of these contracts provide flexibility to both parties through periodic price readjustments (Fan, 2000). The parties who would seek price readjustment are the ones who view current prices as unfavourable to their business operations. In case of increasing oil prices, a supplier of input to a petrochemical company would be in a stronger position to demand higher prices. As a result, the petrochemical company would have no choice but to pay higher prices, because it cannot risk the disruption of its input materials.

In periods of decreasing oil prices, petrochemical companies would be in a stronger position to demand lower prices, because of the existence of a buyers' market, which means that suppliers would be competing strongly to gain more market share. The increasing uncertainty about future oil prices puts downstream companies under increasing pressure to secure a supply of inputs. Long-term contracts, which usually span over 1 to 3 years with options for automatic renewal or termination, provide downstream companies with much-needed time to adjust to the new prices.

4.4 Crude oil price discovery

As a starting point, in the global energy market, crude oil is not exactly a homogeneous commodity. In fact, Energy Intelligence (2007) stated that there are 187 different types of crude oils. Each type has its unique hydrocarbon mixture and different quantities of oxygen, nitrogen, sulphur and salt (Speight and Özüm, 2001). These components make crudes that are high in API[29] number and hydrogen and low in carbon and sulphur[30] more valuable because they contain high percentages of paraffins and usually produce more gasoline. As a result, these crudes command higher prices (premium) on the world markets. On the other hand, crudes with low API numbers and high sulphur content are sold at lower prices (discount). This discount is due to the costs associated with the pollution and corrosion that result from the use of high-sulphur crudes. In addition, more advanced processing techniques (including blending with high quality crude) are required to obtain valuable products from low quality crudes. Premiums and discounts are estimated with reference benchmark crudes, such as Brent crude and West Texas Intermediate (WTI) crude.

Most forecasts are performed using well-known benchmark crudes (i.e., Brent and WTI). Indeed, Brent crude is used as a pricing benchmark for about 67 percent of the crude oil sold globally (Chevillon and Rifflart, 2009). Brent also is a better reflector of free market conditions because it is free of any governmental intervention (Lewis, 2005). Fattouh (2007) presented evidence that the dynamics between the prices of most crude oils are co-integrated, which suggests that following one crude oil would give an idea about the performance of other crudes. According to Dunis and Huang (2003), the profitability of a trading system depends primarily on indicating the direction of market changes and then taking the position that is most compatible with the expected changes. In other words, if the price of a benchmark crude is expected to move in one direction, then estimating how long (or how far) it would take the other less-known crudes to react should be profitable as well. However, it is possible that certain types of factors could

[29] API: unit used to measure gravity of crude oil.
[30] Sulphur: undesirable component of crude oil that causes corrosion to equipment and pipelines.

be associated with shorter (or longer) lag times between the movement of a benchmark price and the movement of the price of the less-known crude oil. As a first step in this chapter, we seek to understand the relationship between crude oil prices and the factors that influence those prices. Risk management teams in energy-intensive companies, such as refineries, airlines and power generators base critical decisions on a clear understanding of the factors behind the dynamics of crude oil prices.

Factors that affect the pricing of crude oils can be categorized as endogenous (i.e., industry-specific, such as physical and chemical features of the crude oil) or exogenous (i.e., non-industry-specific, such as geographic location or political unrest). However, most price forecasting models use quality features of a crude oil (i.e., API gravity number and sulphur content) to adjust the prices of various crude oils (Bacon and Tordo, 2005). Once these relationships between different crude oils are understood, traders can adjust their trading positions to benefit from expected movement in crude prices.

Bacon and Tordo (2005) explained that different approaches have been used to value crude oil. One approach is the assay-based valuation, which is based on linking the properties of a crude oil to the specifications of the final output. In other words, the value of the crude is estimated by determining the value of its optimal product output. It is estimated that gasoline and jet fuel produce high profit margins compared to other products, which suggests that crudes from which the largest possible quantity of these two products can be produced should have the highest prices. In the case of a refinery operation, economic decision analysis is performed to deal with various tasks, including crude oil evaluation, production planning and multi-refinery supply and distribution. These analyses take into consideration crude oil specifications and the features of outputs required, and they try to achieve an optimal match in the most efficient and effective way. Amic and Lautard (2005) suggested that the growth of the global market for refined products is based on the need to balance the composition of demand, mix of refinery capacity and the type of crude oil being used in each geographic region.

A second approach is to use physical and chemical valuation, especially API gravity number and sulphur content, as indicators of the value and quality of the crude. Price differentials of crude oils are estimated in relation to quality differentials based on both API number and sulphur content. Bacon and Tordo (2005) explained that two different approaches can be used to make this estimation, i.e., 1) use pair-wise comparison in which two crudes with similar API numbers or sulphur contents can be compared; for example, if two crudes have the same API number and different sulfur contents, then any differential between the two prices could be linked to the difference in sulphur content and; 2) use a multi-regression analysis by obtaining simultaneous differences in qualities from a large number of crude oils. Then, these simultaneous differences can be incorporated into a single model. The idea is to estimate the impact of quality differentials on price differentials.

4.5 Data and Methodology

The dataset consists of the weekly spot prices of 30 different crude oils, their API numbers and their sulphur contents. The dataset also contains 12 dummy variables that reflect a wide range of information, such as OPEC membership, geographical location and impacts of geopolitical events. The total number of observations was

20460 and these were made up of 10912 observations for OPEC crude oils and 9548 observations for non-OPEC crudes. Each of the 30 different crudes has a total of 682 observations. The observations span from January 1, 1997, to January 29, 2010.

We tested the prices for the existence of unit root using ADF and PP unit root tests, and we found that the prices were stationary at the log returns. Other variables, such as country of origin or sulfur contents, are not time series, and, thus, we do not expect them to suffer from unit root problems. Appendix 12 shows a list of oil related news and events during this time period and their expected impacts on one (or more) of our set of dummy variables. In other words, related news and events were categorized according to their relationship with each of the dummy variables. For example, an explosion in a Nigerian pipeline would be assigned a value of "1" for each of the dummy variables of Sub Saharan, OPEC, Labor and Social, and Economic and Business. All other dummy variables would be assigned the value of zero.

Given the type of our data set and the way it was constructed, neither time series analyses nor cross-sectional analyses are capable of obtaining meaningful results. In the case of time series analysis, models can only track one variable during a sequential time interval. As a result, the same time series model cannot be used to track the group of variables specified. On the other hand, the cross-sectional model lacks the capability to incorporate a sequential time interval. It simply provides a snapshot at a particular time for the variables of interest, which means that we cannot track these variables over sequential time intervals. However, panel data analysis and its fixed and random effects techniques offer an effective set of tools that would fit the type of data we are dealing with.

Table 4.1 lists 15 different variables that can be organized into three different groups. First, Group A consists of the API and SUL variables, which are time invariant because the information they capture is not expected to change over time. Second, Group B lists eight different dummy variables, OPEC, MD, N_AFR, S_AFR, ASA, N_AM, S_AM and EUR. These dummy variables are designed to identify geographic locations of the regions producing crude oils. For example, if a news item contains information regarding a crude oil produced in Venezuela, then values entered in these dummy variables are as follows: 1, 0, 0, 0, 0, 0, 1 and 0. The first time the number "1" is entered, it indicated that this news item impacted a crude oil produced by an OPEC member; for non-OPEC crudes, the value of "0" would be entered. The second time the value of "1" was entered, it indicated that the news item was related to a crude oil producer located in South America, since the value of "1" was entered into the S_AM dummy variables and the other dummy variables received a value of “0.” Finally, Group C consists of five different dummy variables, i.e., M_CONF, LAB_SOC, POLT, ENV_WETH and ECO_BUS. These dummy variables are included to capture the type of information contained in the news item. In Group C, it is possible for one news item to score “1” in more than one dummy variable, unlike Group B in which locations are mutually exclusive (i.e., once one location has been chosen, another location cannot be selected). For example, on December 5, 2003, groups of unarmed Nigerian villagers from the Kula community located in the River State of South Niger Delta took control of three oil-flow stations producing 100,000 barrels per day (bbl/day) and operated by Shell and ChevronTexaco. The villagers claimed that they were protesting these companies’ limited job offerings to the local workforce. Such a news item scored a value of "1" for the dummy variables of LAB_SOC and ECO_BUS, due to the substantial amount of crude oil that was involved.

Table 4.1: Groups and definitions of variables:

Group	Variable	Definition
A*		
	API	To capture the degree of API
	SUL	To capture sulphur contents
B**		
	OPEC_NEWS	To identify news of OPEC
	MD	To identify Middle eastern crude oils
	N_AFR	To identify North African crude oils
	S_AFR	To identify Sub-Saharan crude oils
	N_AM	To identify North American crude oils
	S_AM	To identify South American crude oils
	ASA	To identify Asian crude oils
	EUR	To identify European crude oils
C**		
	M_CONF	To identify military conflict events such as wars, gorilla attacks…
	LAB_SOC	To identify labour and other social events, such as labour strikes….
	POLIT	To identify political events and news, such as UN decisions and governments press releases
		To identify environmental and weather factors and events, decisions on global worming and impacts of hurricane seasons
	ENVO_WETH	To identify economic, business or industrial news such as merger and acquisition and new oil and gas discoveries.
	ECO_BUSI	

* indicates values of physical and chemical features that have been tested
**indicates dummy variables that takes values of "1" or "0"

Oil-related news and events evaluated in this study occurred during the period from January 1, 1997, through January 29, 2010. The total number of news items evaluated was 682, consisting mainly of events that took place in or near the major oil producing regions of the world or in major oil consuming markets. The economic analysis of energy markets considers the effects of policy measures, such as price control and regulation. In most cases, it examines the verity of social, political, legal, environmental and technological issues at regional, national and global levels (Lewis, 2005). Thus, I have organized these news items into five main categories:

1. Military conflict
2. Labour and social
3. Political
4. Environmental and Weather
5. Economic and Business

In the category of "military conflict," news items covered major events taking place around the world. Perhaps, the events of September 11, 2001, and the subsequent pre-emptive war waged by the United States against Iraq present major events in this category, given that Iraq is a major oil producer and adjoins other major oil producing regions, such as Saudi Arabia, the Gulf states and Iran. Nevertheless, other major military conflicts were evaluated in this study. For example, on April 4, 2002, the Angolan army signed a ceasefire accord with the Unita rebels. This news item was expected to have an impact on oil prices, given Angola’s substantial oil production and exportation. Particular attention was paid to military conflicts taking place outside of the Middle East area, given that Middle Eastern military conflicts were (and still are) dominating news broadcasts, which suggests that it has already being factored in oil price behaviour. Of course, we still account for new events taking place in the Middle East.

In the labour and social categories, we look to identify news items related to the human and social aspects of the oil industry. In other words, we look into news being made by the workforce of the oil industry or the communities surrounding (or located in) major oil producers and consumers. For example, on August 15, 2005, local protestors of Ecuador's northeast oil producing states shut down 210,000 bbl/day of the country's oil production by blocking roads and occupying oil production facilities. Other news items include worker's industrial actions in major oil producing or consuming countries. For example, on May 20, 2005, a workers' strike in France shut down five major refineries operated by Total over a dispute regarding the number of vacation days. The strike affected an estimated 930,000 bbl/day of crude oil refining capacity.

Political unrest in major oil producing and consuming regions can be divided into Middle East-related and non-Middle East-related. In case of the Middle East and pre-9/11 events, the news of the Arab/Israeli conflict dominated Middle Eastern news. However, given that this part of the world does not contribute significantly to the global energy supply, we did not include political news or events taking place in this part of the world. However, the only exception is the news regarding the Suez Canal, given its close proximity to the area of the Israeli/Palestinian conflict and its relative importance to global trading routes. However, post-9/11, the types of political news items and events have shifted toward the issues of terrorism, Iraq and Afghanistan.

Iraq is a major oil producing country and is viewed by many energy experts as the most promising land in the Middle East for further significant oil discoveries. However, years of war and the lack of the presence of major international oil companies have made Iraq's share of the oil export market less significant than its actual potential. However, the United Nations' (UN's) oil-for-food programme and other types of UN-based programmes did provide some news items that were of marginal interest for the analysis of global oil and energy markets. For example, on February 20, 1998, the UN Security Council voted unanimously to allow Iraq to more than double its crude oil exports under the oil-for-food programme. This increase allowed Iraq to export more than $5.26 billion worth of crude oil over a period of six months; however, the Iraqi authority stated that it only had the capacity to produce up to $4 billion worth of crude. As a result, on June 19 of that same year, the UN Security Council unanimously agreed to allow Iraq to spend $300 million on buying spare parts for its oil facilities. These news items, and others, provide signals that could influence the pricing behaviour of different market participants.

Political news and events taking place in other major oil exporting or importing regions have been considered and analysed in this study. Russia and its former states have been major sources of political news. Given its vast natural resources and its political, social and economic unrest, Russia is viewed by many energy experts as an unstable energy partner. For example, in early January 2009, the state-owned Russian company, Gazprom, cut off the gas supply to Ukraine. The effects of this shut down expanded to parts of Europe, given that Ukraine is a pivotal transit state for Russian oil and gas for major parts of continental Europe. This was not the first time this had happened, since Russia did the same thing in January 2006, and many observers called on the European Union to reduce reliance on the Russian energy supply. I should mention that some of the stories related to political news have escalated into military conflict, and, once that happens, we score it under the M_CONF dummy variable.

Most environmental and weather news items covered in this study took place in the Gulf of Mexico. Perhaps the most important news event in this category was the oil supply disruption caused by Hurricane Katrina. On August 28, 2005, based on the estimation of the U.S. Interior Minerals Management Service (MMS), an estimated 95 percent of oil and 88 percent of natural gas produced in the Gulf of Mexico were shut down as a result of Hurricane Katrina striking the U.S. near New Orleans. Several other hurricanes also struck the Gulf region, some of which caused major oil and gas supply disruptions. Two examples are Hurricane Lili (October 3, 2002), which caused a shut down of an estimated 1.5 million bbl/d of oil production, and Hurricane Claudette (July 1, 2003), which passed 80 miles southeast of Texas, causing a supply disruption of 330,000 bbl/d.

In term of crude oil price returns, we used several test to better understand the nature of the data we are using. We start by testing for heteroskedasticity, unequal variances, using the Breusch-Pagan (BP) test. The null hypothesis for homoskedasticity, which is equal variances, being tested in the BP test is as follow:

$$H_0 : \alpha_1 = \alpha_2 = ... = \alpha_p = 0$$

In which the α (s) stand for the coefficients of the set of variables that we think determine the variance of the error term. The alternative is that at least one of the α (s) does not equal zero (Asteriou and Hall, 2007). The residuals obtained by running a regression of the prices series and the different news items. Then, we run auxiliary regression of the variables that we think cause the variance of the error term. The results are then compared the LM-statistics obtained with Chi-distribution.

Table 4.2 suggest that most crude oils do exhibit some form of heteroskedasticity. This is also supported by the ARCH-effect test we used in Chapter 2, which clearly indicates the existence of heteroskedasticity. However, since we are dealing with polled data, we apply the BP tested as well to the three groups (i. e. OPEC, non-OPEC and All sample). The results are then compared to the LM-statistics obtained with chi-distribution and with degrees of freedom equal to the number of slope coefficients in the regression (Asteriou and Hall, 2009).

As suggested by Baltagi (2008), before pooling the data, and in case there is a concern of the stability of the regression equation across prices of crude oil returns. By looking into Figure 7 on page 100, we can see a major drop of crude prices during the period of late 2008 and early 2009. We used the Chow breakpoint test to see if this drop can be identified as a breakpoint in the data set. The hypothesis to be tested is that no structural break in the sample.

4.2 Results of the Breusch-Pagan test:

OPEC	LM_CRIT		non-OPEC	LM_CRIT	
ADM	6.11	Reject Ho	AUS	13.89	-
ASB	15.96	-	CAM	7.461	Reject Ho
ANC	14.18	-	CAP	11.38	-
DUB	5.087	Reject Ho	CHI	10.09	Reject Ho
ECO	8.11	Reject Ho	COL	15.39	-
IRH	6.72	Reject Ho	EGS	10.82	Reject Ho
IRL	6.49	Reject Ho	INO	8.32	Reject Ho
KUT	3.12	Reject Ho	TAP	14.697	-
LIB	13.64	-	MXI	13.38	-
NGB	8.3	Reject Ho	MXM	5.22	Reject Ho
NGE	16.29	-	NOE	11.45	-
DUK	6.61	Reject Ho	OMN	5.115	-
SAH	6.41	Reject Ho	RUS	3.49	-
SAL	15.617	-	BRT	6.31	Reject Ho
SAM	9.138	Reject Ho			
VEN	11.18	-			
All OPEC	**9.56**	**Reject Ho**			
All non-OPEC	**9.786**	**Reject Ho**			
All sample	**9.673**	**Reject Ho**			

Note: 11.07 is the Maximum likelihood-statistic value used in hypothesis testing. Ho: The case for homoskedasticity; Ha: the case of heteroskedasticity.

We also used The Chow breakpoint test to examine whether structural break on data has affected parameters stability. By looking into Figure 3 on page 59, we can see a major drop of crude prices during the period of late 2008 and early 2009. We used the Chow breakpoint test to see if this drop can be identified as a breakpoint in the data set. The hypothesis to be tested is that no structural break in the sample.

Table 4.3: Results of the Chow Breakpoint Test:

OPEC				non-OPEC			
	F-stat	Log L R	Wald		F-stat	Log L R	Wald
ADM	463.800	587.340	927.509	AUS	442.515	569.061	885.030
ASB	464.100	587.610	928.141	CAM	456.179	580.874	912.357
ANC	470.000	592.610	939.975	CAP	390.218	521.856	780.436
ECO	457.300	581.820	914.568	CHI	444.816	571.064	889.631
IRH	507.600	623.610	1015.257	COL	487.421	607.140	974.842
IRL	492.700	611.470	985.374	EGS	480.370	601.300	960.739
KUT	445.400	571.590	890.832	INO	699.950	763.139	1399.899
LIB	475.800	597.450	951.520	TAP	449.167	574.838	898.335
NGB	466.800	589.900	933.556	MXI	639.412	722.216	1278.823
NGE	397.000	528.150	793.975	MXM	501.029	618.273	1002.059
DUK	463.200	586.840	926.333	NOE	456.117	580.821	912.234
SAH	533.800	644.370	1067.626	RUS	467.947	590.888	935.895
SAL	492.400	611.270	984.881	BRT	439.626	566.537	879.252
SAM	509.900	625.400	1019.729				
VEN	458.300	582.730	916.698				

Results are reported in Table 4.3. In all cases, we are able to reject the null hypothesis. This would suggests that any results obtained should be analysed taking these results in consideration. However, given that this breakpoint in data did take place recently, not enough observations are available at this point to further deal with this break.

4.6 Model specification

We tested the prices for the existence of unit root using the augmented Dickey-Fuller (ADF) approach proposed by Dickey and Fuller (1981). Tables 2.4 and 2.5 of Chapter 2 list unit root tests conducted on crude oil prices of OPEC and non-OPEC, respectively. The results indicate that prices are non-stationary at price level and are stationary after taking the first differences. In case one of the series under examination fails the ADF unit root, the following Im, Pesaran and Shin (1997) (IPS) panel unit root test would be applied. The IPS unit root test is more powerful because it can deal with several features (Luintel, 2000). First, it allows for heterogeneity of dynamics and error variances across the different groups under analysis. Second, in case errors in different regressions contain common time-specific components, IPS tests based on cross-sectional regressions are valid. Third, it allows for a fraction of the individual groups to have a unit root, which makes the test more general than other alternative panel data unit root tests, such as the Levin and Lin test (1992). Finally, the test has better small sample properties.

Appendix 12 summarizes the oil-related news and events we covered during this period and their expected impacts on one (or more) of our set of dummy variables. In other words, related news and events were categorized according their relationship with each of the dummy variables. For example, an explosion in a Nigerian pipeline would be assigned a value of “1” for each of the dummy variables of Sub-Saharan, OPEC, Labour and Social and Economic and Business. All other dummy variables would be assigned the value of “0.” Given the type of our dataset and the way it was constructed, neither time series analyses nor cross-sectional analyses are capable of obtaining meaningful results. In the case of time series analysis, models can only track one variable during a sequential time interval. As a result, the same time series model cannot be used to track the group of variables specified. On the other hand, the cross-sectional model lacks the capability to incorporate a sequential time interval. It simply provides a snapshot at a particular time for the variables of interest, which means that we cannot track these variables over sequential time intervals. However, panel data analysis and its fixed and random effects techniques offer an effective set of tools that would fit the type of data we are dealing with. Thus, we use the Fixed Effects (FE) and the Random Effects (RE) models to examine the reaction of stock prices returns of OPEC and non-OPEC producers to different news and events. However, we also use the Hausman test to the appropriateness of the RE model compared to the FE model.

The RE model specifies the individual effects as a random draw from the underlying population of individuals. In other words, the RE model identifies the population parameter that can describes the individual-level heterogeneity (Baum, 2006). On the other hand, the FE model can not estimates a parameter that can describes the individual-level heterogeneity. As a result, inference from the FE model in limited on the fixed effects in the selected sample.

In the fixed effects model (FE), the intercept can have a different value across sectors, but, for each sector, the intercept is time invariant (does not vary over time). In other words, the model allows for different intercepts for each group or sector. The FE can be specified as follows:

$$P_{it} = \beta_{1i} + \beta_2 V_{2it} + \beta_3 V_{3it} .... + u_{it} , \qquad (2)$$

where P is the log return of crude oil prices, V_1 is the API number and V_2 is the sulphur content. The number of items (*i*) starts from 1 and goes to 30 because we have 30 different crude oils. The number of time periods (*t*) starts from 1 and goes to 681, which is the number of weekly price observations for each crude oil.

Given that a high API number and low sulphur content are preferable in crude oils, we assume a priori that P is expected to have a positive relationship with API number and a negative relationship with sulphur content. The FX model is also known as the least-squares dummy variables (LSDV) estimator because including dummy variable for each group allows for using different intercept for each group. The addition of dummy variables causes the (FE) equation to take the following form:

$$P_{it} = \alpha_1 + \alpha_2 D_{2i} + \alpha_3 D_{3i} + \alpha_4 D_{4i} .... + \alpha_{13} D_{13i} + \beta_2 X_{2it} + \beta_3 X_{3it} + u_{it}, \quad (3)$$

where D_{2i} represents the identification of OPEC members by assigning “1” for crude oils produced by OPEC producers and “0” for crude oils produced by non-OPEC producers. The next six dummy variables, i.e., D_{3i} to D_{8i}, are used to locate the crude producers. For example, if a South American country produced the crude oil, D_{7i} would be assigned a value of “1,” and all the other dummy variables (i.e., $D_{3i}, D_{4i}, D_{5i}, D_{6i}$ and D_{8i}) would be assigned a value of “0.” The next set of dummy variables consists of five variables, i.e., D_{9i} to D_{13i}, which are included to capture the expected impact of news and events on the prices of related crude oil. For instance, if a major disruption to U.S. oil and gas production is expected due to a major storm, e.g., Hurricane Katrina, then, this would mean that the corresponding dummy variables, D_{12i} for environmental and weather factors and D_{13i} for economic and business factors, would be assigned a value of “1,” and the other dummy variables would be assigned a value of “0.” Table 4.1 provides a complete list of dummy variables and their assigned areas of interest. As summarized by Asteriou and Hall (2006), the FE model has the following properties:

1. It can capture all time-invariant effects that are specific to an individual parameter.

2. It would take full account of things like geographic location and natural

resources. These things do vary between individual entities but not over time.

3. It allows for the use of large number of dummy constraints.

4. It can be extended by including time dummies as well, which is known as two-way fixed effects model. Two-way FE model capture any effects that vary over time but are common across sections.

Panel data analysis offers the error-components model (ECM), also known as the random-effects model (RE). This technique deals more effectively with the issue of including dummy variables. As stated by Gujarati (2003), dummy variables show "a lack of knowledge about the (true) model," and expressing this limitation is better done through the disturbance term. The difference between FE and RE models is the ability of the RE model to deal with the intercepts for each sector as a random parameter. This suggests that we need to make specific assumptions about the distribution of the random component. In other words, the FE model assumes hat each individual differs in the intercept, on the other hand, the RE model assumes that each individual differs in its error term (Asteriou and Hall, 2006). The RE specifications are stated as follows:

$$P_{it} = \beta_{1i} + \beta_2 X_{2it} + \beta_3 X_{3it} + u_{it} \qquad (4)$$

In this case, β_{1i} is treated as a random variable with a mean value of β_1. The individual intercept for each crude would be in the form of $\beta_{1i} = \beta_1 + \varepsilon_i$. The term ε_i is the random error with a zero mean value and a variance of σ_ε^2. The basic idea is that we have the prices of 30 different crude oils, which are a sample of a larger population of crude oil prices. These 30 crudes have common mean values for their intercepts and individual differences in the intercepts are captured by the error term, ε_i. Then, both u_{it} and ε_i would be embedded into a composite error term, ω_{it}. The term u_{it} is the combined cross-sectional and time series error term, and ε_i is the individual specific error term. Gujarati stated that individual error components are assumed not to be correlated together and are not auto-correlated across any cross-sectional or time series unites.

4.7 Empirical results and discussion

We started by running descriptive statistics for crude oils and news items organized as the OPEC group (10,912 observations), non-OPEC (10,230 observations) and the complete sample (20,460 observations). Results suggest that only six dummy variables should be included in the analysis given that other dummy variables did not yield a "with in standard deviation" greater than zero. As suggested by Baum (2006), any variable showing a within standard deviation of zero will not be included in the FE model. Only variables opec, m_conf, lab_soc, polotic, envo_weth and eco_bus are the ones included.

Results for the fixed-effects model and the random-effects model are presented in Table 4.4, panels A and B, respectively. The results are organized as follows: column 1 contains variables included in the estimations. Fixed and random results of the whole sample (20460 observations), including both OPEC and non-OPEC crude prices, are presented in columns 4 and 7. Columns 2 and 5 contain the results of the OPEC sample of crude prices (10912 observations) for both cases of fixed and random effects, respectively. Results of the non-OPEC crudes prices (10230 observations) are presented in columns 3 and 6, for fixed effects and random effects, respectively. The results were similar for both fixed effects and random effects, which indicate a similar relationship with each type of the news items specified in Table 4.1. However, within each model, estimates of different variables are behaving in way that is, in most cases, consistent with economic reasoning and theory. In the case of the fixed effects model, the results of OPEC and non-OPEC crude prices show estimation differences worthy of more discussion. In the case of the OPEC_news variable, estimation suggests that OPEC-related news has a positive impact on the price of crude oils produced by OPEC countries. On the other hand, OPEC news had a negative impact on the price of non-OPEC crudes; however, neither estimate was significant at the 5 percent level.

Table 4.4: Estimations of the Fixed and Random effects:

	Panel A: Fixed Effects			Panel B: Random Effects		
Variables	OPEC	Non-OPEC	All crudes	OPEC	Non-OPEC	All crudes
OPEC_news	0.907	-0.917	-0.014	0.382	-0.246	-0.001
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.931)
M_Conf	0.238	0.441	0.322	0.242	0.454	0.322
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Lab_Soc	0.844	0.781	0.847	0.859	0.8	0.848
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Polit	-0.031	0.088	0.02	-0.034	0.091	0.019
	(0.150)	(0.00)	(0.243)	(0.120)	(0.00)	(0.261)
Envo_Weth	0.005	0.011	0.01	0.004	0.011	0.01
	(0.850)	(0.598)	(0.598)	(0.856)	(0.683)	(0.598)
Eco_Bus	-0.086	-0.076	-0.072	10.081	-0.071	-0.072
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
API*	-	-	-	0.002	-0.032	0.004
	-	-	-	(0.409)	(0.00)	(0.05)
Sul*	-	-	-	-0.063	-0.26	-0.196
	-	-	-	(-0.002)	(0.00)	(0.169)
MD*	-	-	-	-0.117	-0.118	-0.264
	-	-	-	(0.00)	(0.00)	(0.34)
N_AFR*	-	-	-	-0.168	0.075	-0.034
	-	-	-	(0.00)	(0.02)	(0.223)
S_AFR*	-	-	-	-0.166	-0.278	0.006
	-	-	-	(0.00)	(0.00)	(0.82)
ASA*	-	-	-	omit	0.078	0.026
	-	-	-	omit	(0.00)	(0.321)
N_Am*	-	-	-	omit	0.037	0.024
	-	-	-	omit	(0.00)	(0.509)
S_Am*	-	-	-	omit	0.071	-0.006
	-	-	-	omit	(0.00)	(0.817)
EUR*	-	-	-	omit	omit	omit
	-	-	-	omit	omit	omit

Notes: *Variables were dropped from the Fixed Effects model due to zero-standard within standard deviation. P-values are in ( ).
omit = variable due to collinearity.

In the case of the random-effect model, this relationship still exists and is significant at 5 percent. Several studies have suggested that non-OPEC producing countries produce at maximum capacity and that it is up to OPEC producers to adjust their production in order to maintain equilibrium in the market. OPEC producers are in a cartel that determines the level of production by setting a quota for each member. This strategy, along with some other market conditions, affects oil prices (Kaufman et al., 2004). On the other hand, non-OPEC producers are considered price takers that compete with each other (Dees et al., 2006).

The basic idea for the Hausman test is to determine the difference between the two estimates—namely, the fixed effects and the random effects. The null hypothesis, H_o, states: There are no fixed effects in which both FE and RE are consistent, but only RE is efficient. In other words, according to the null hypothesis of no correlation, no differences should exist between the two estimates. On the other hand, the alternative hypothesis, H_a, is that fixed effects do exist. Thus, in the case of no correlation between regressors and effects, both FE and RE are consistent, but FE is inefficient. However, if correlation does exist, then FE is consistent and RE is inconsistent. In the Hausman test, we used a χ^2 with k-1 degrees of freedom, where *k* is the number of regressors.

Table 4.5 provides the results of the Hausman test, demonstrating that the different point estimates generated by the FE and RE in the three cases of OPEC, non-OPEC, and all crudes soundly reject the null hypothesis that the RE estimator is consistent. If no significant difference is found between the FE and RE estimates, we could apply the RE model. However, as the results in Table 4.5 suggest, a significant difference exists between the two models, leading to the conclusion that we should limit our analysis to the FE model only. As a result, we continue the interpretation and discussion of the results of the FE model.

Table 4.5: Results of the Hausman test:

	OPEC			non-OPEC			All		
News Item	FE (b)	RE(B)	b-B	FE (b)	RE(B)	b-B	FE (b)	RE(B)	b-B
OPEC_NEWS	0.907	0.382	0.525	-0.092	-0.246	-0.671	-0.014	-0.001	-0.013
M_CONF	0.238	0.242	-0.003	0.441	-0.455	-0.013	0.322	0.322	0.000
LAB_SOC	0.844	0.859	-0.015	0.781	0.801	-0.019	0.840	0.840	0.000
POLIT	-0.032	-0.035	0.003	0.088	0.091	-0.003	0.020	0.195	0.001
ENVO_WETH	0.005	0.004	0.000	0.011	0.011	-0.001	0.010	0.010	0.000
ECO_BUSI	-0.086	-0.081	-0.004	-0.076	-0.071	-0.005	-0.072	-0.072	0.000
S.E.			0.048			0.050			0.038
chi^2			115.84			179			68.33

Notes: b = consistent under both Ho and Ha
B = inconsistant under Ha, efficient under Ho, respectivly.

However, it is worth mentioning that Baltagi (2005) suggested that the nature of the data could provide a good indication for making the decision to use the FE or RE models. He explained that, if the data were randomly selected from the population, using the RE model is preferable. On the other hand, if the data generally represent the population, then it is preferable to use FE. However, by looking into the type of data we are using (i.e., oil price returns), we can see that it is not randomly selected, which confirms our earlier conclusion that estimates of the FE are consistent and of the RE are inconsistent.

The results in Table 4.4 indicate that different news items do have different impacts on price returns of OPEC and non-OPEC crude oils. However, estimates of different news item variables behave in a way that is—in most cases—consistent with economic reasoning and theory. In the case of the fixed effects model, the results of the

OPEC_news variable suggest that OPEC-related news has a positive impact on the price returns of crude oils produced by OPEC countries. On the other hand, OPEC news had a negative impact on the price returns of non-OPEC crudes. These estimates are 0.907 and -0.917, respectively; both estimates are statistically significant at the 5 percent level.

Inverse estimates can be explained by looking into the nature of these news items related to OPEC, which primarily deal with positive information about the OPEC organization. For example, regular OPEC meetings provide the markets of new information through carefully written press releases that would positively reflect on the image of the organization in the international arena as a major and trust-worthy suppler of crude oil. Non-OPEC producing countries produce at maximum capacity, which makes market participants eager to hear from OPEC regarding the adjustment of its production in order to maintain equilibrium in the market. OPEC producers are in a cartel that determines the level of production by setting a quota for each member. This strategy, along with several other market conditions, affects oil prices (Kaufman et al., 2004).

In the case of military conflict news, results for the fixed-effect model for both OPEC and non-OPEC crude price returns are significant, with non-OPEC crude prices being more sensitive than OPEC crude prices. It is possible that the market has already factored in a possible military conflict in OPEC countries (i.e., Middle Eastern countries). For example, the military conflict in Iraq is a longstanding issue, so any news development or escalation of events may not be surprising for the market. However, news of a military conflict taking place in a non-OPEC oil-producing region, such as Russia or its neighbouring oil-producing regions, might surprise the market and have a greater impact on oil prices.

Our preliminary expectation was that the prices of OPEC crudes would be more sensitive to military conflicts, given that most OPEC crude oils come from the Middle East, which is known to be a geo-political hotspot. However, neither the results of the fixed-effects model nor the results of the random-effects model showed significant differences between the coefficients obtained for OPEC and non-OPEC groups. For example, in the case of the military conflicts, under the fixed-effects model, the coefficient for the overall sample was estimated to be 0.322, which means that crude prices—both OPEC and non-OPEC—are positively affected by military conflicts. The same can be said about political unrest, which has an estimated coefficient value of 0.02. However, for military conflict events, coefficients for the OPEC and non-OPEC crude prices were similar to the coefficients obtained for the whole sample and indicate a similar relationship. One would think that, if OPEC crude prices are more sensitive, their coefficients would be larger than both the whole sample and the non-OPEC crude prices; however, this was not the case.

Major portions of non-OPEC crudes are produced in areas with stringent environmental standards and regulations, such as the US, Canada, Norway, and the UK. On the other hand, most OPEC producers operate under less stringent environmental regulations. Furthermore, most operation sites in these countries are subject to harsh weather systems (e.g., the Gulf of Mexico, the North Atlantic, and the North Sea). On the other hand, most oil-producing sites in the Middle East do not face such weather systems that cause disruptions in supplies.

These two situations suggest that non-OPEC crude prices might be more sensitive to environmental and weather-related news and events than crude oil prices of OPEC. However, the results of the whole sample show a coefficient estimation of 0.010. On the other hand, the coefficients for both OPEC and non-OPEC crude prices were smaller—0.005 and 0.011, respectively—which suggests that non-OPEC crude prices are more sensitive to environmental and weather news given that the coefficient is much larger than the coefficient of the OPEC crude oils.

Finally, price returns of OPEC and non-OPEC crude oils show similar reactions toward economic and business-related news items. The results indicate that the coefficients of the two groups (OPEC and non-OPEC) are similar in terms of direction and magnitude. For OPEC and non-OPEC crude, the FX results are -0.086 and -0.076, respectively. This similar reaction can be explained by the possibility that economic and business news tends to focus on the future expectations of global economic growth. Most of these news items are dominated by alarming numbers of slowing growth and the possibilities of recession. For example, prices of different oil-based products could easily be affected by the release of the manufacturing numbers in the US or China. This could be attributed to the high level of global integration in terms of both business and communication.

4.8 Conclusion

In this investigation, I used a panel data approach to identify whether OPEC and non-OPEC prices react differently to news and events that have the potential to cause oil supply disruptions of considerable size. Our weekly data covers a wide range of 30 different types of crude oils, 16 crude oils produced by OPEC countries and 14 produced by non-OPEC countries. It spans from 03/01/1997through 29/01/2010, a total of 681 observations for each crude oil. Each time series was tested for unit root and was found to be non-stationary. We also tested the natural logarithm of the price returns and found it to be stationary. Thus, we have used the LN (prices) in fixed- and random-effects models to estimate the impact of different news items and to determine whether OPEC or non-OPEC affiliation makes any significant difference.

The findings suggest that estimations obtained by the fixed- and random-effects models are similar, but, within each model, the variables show different degrees of reaction toward different news items. For example, both models suggested that news of military conflict and political events have different degrees of influence on OPEC and non-OPEC crude prices.

However, given the subjective nature of evaluating the impact of news items on the price behaviour of crude oils, we should consider these finding with some scepticism. A possible future improvement to this current chapter would be to follow the suggestion made by Huntington (2005), i.e., to ask a panel of experts to create and evaluate dummy variables. This panel of experts should provide comprehensive recommendations concerning how each news item should be translated to related dummy variables.

Chapter 5: Conclusions

5.1 Summary of findings

Empirical results suggest that the price behaviour of different types of crude oils is not affected by affiliation with OPEC or non-OPEC producers. It can be said that market participants do not put much weight on whether a crude oil is produced by an OPEC country or a non-OPEC country. This conclusion agrees with the findings of Garis (2009) that suggested that the selling price of crude oil actually reflects the value-in-use to the final consumer more than its actual marginal cost of production. Bacon and Tordo (2005) explained that the value of crude oil is estimated by the value that is placed on its optimal product output. For example, gasoline and jet fuel produce high profit margins compared to other products, which suggests that crudes from which the largest possible quantity of these two products can be produced should have the highest prices.

Our findings also support the theory of "the great pool" presented by Adelman (1984), which suggested that the world oil market is one great pool. It also presented supporting evidence that the global crude oil market is increasingly integrated, which, according to Ripple and Wilamoski (1998), is the result of the developments occurring in the both spot and futures crude oil markets. Lanza et al. (2003) explained that each crude oil has its own characteristics and qualities that meet the preferences of different buyers in the oil market. Nevertheless, our findings suggest that the prices of these crude oils are subject to similar market conditions, which makes them behave similarly as well.

We arrived at this conclusion by empirically testing three main features of crude oil price behaviour, i.e., price volatility (Chapter 2), the relationship to stock prices of oil companies (Chapter 3), and reaction to possible supply disruption news (Chapter 4). First, in terms of price volatility, we examined whether price volatilities of crude oil produced by OPEC members exhibit different patterns from those of crude oil produced by non-OPEC producers. The results indicated that the prices of both OPEC and non-OPEC producers show similar volatility patterns. This suggests that investment and risk management decision makers should not be concerned about whether their crude oil is produced by OPEC or non-OPEC producers. In other words, market-pricing mechanisms take into account any potential differences that may exist between OPEC or non-OPEC crudes. No significant differences of volatility persistence were deduced between OPEC and non-OPEC crude oil prices, which suggests that shocks to crude oil prices behave similarly regardless of OPEC or non-OPEC affiliation.

Second, we tested whether there is a long-term relationship between the crude prices of OPEC (and non-OPEC) crudes and the stock prices of oil companies from different oil sectors. We reviewed how crude oil prices influence estimates of expected cash in-flows used by both managers and potential stock investors. We proceeded by making the case that crude oil prices and oil companies' stock prices possibly are linked via the double-use of expected cashflows as an evaluation technique. However, our findings suggested that there is little evidence of the possible co-integration relationship between oil prices and stock prices of oil companies. In fact, only five out of 32 oil stock prices showed a long-term relationship with crude oil prices. These five stock prices were examined further using an error-correction model (ECM) to estimate the signs and sizes of short-term deviations from long-term equilibrium suggested by the co-integration analysis. Estimations of the ECM did not reveal significant differences in the dynamics of short-term deviations between stock prices of the five companies and OPEC and non-OPEC crude oil prices.

Third, in examining the reaction of crude oil prices to news of a possible disruption of crude oil supply, we tested whether the crude oil prices of OPEC suppliers have different reactions to news items from non-OPEC suppliers. Our findings suggested that there are no significant differences between the reaction of OPEC crude oil prices and the reaction of non-OPEC crude prices. Initial thoughts were that crude oils produced in the Gulf of Mexico (a non-OPEC, oil-producing region) would be more sensitive to environmental or weather-related news items, given its geographical location where seasonal hurricanes are expected. On the other hand, we initially thought that crude oil produced in the Middle East (an OPEC region) would be more sensitive to political or military news items, given its location in a rather dangerous neighbourhood. However, the results showed that there were no significant differences between OPEC and non-OPEC crude oil prices in reacting to various news items and events. This suggested that news that could result in a possible supply disruption would have similar impacts on the prices of OPEC and non-OPEC crudes.

In this study, we used different econometric models to examine whether crude oil price behaviour is affected by OPEC or non-OPEC membership. In other words, we sought to determine whether there is a significant difference in the price behaviour of crude oil produced by an OPEC member compared to the price behaviour of crude oil produced by a non-OPEC member. The argument that the prices of OPEC crude oils could behave differently from the prices of non-OPEC crude oils is driven by the different supply role performed by OPEC and non-OPEC producers. Each group plays a different role in the global crude oil supply chain that could convey different signals to the markets. In terms of supply role, OPEC sets production levels based on non-competitive behaviour (Dees *et al.,* 2005). This type of supply-side structure increases the difficulty of modelling supply. Dees *et al.* (2005) distinguished between OPEC and non-OPEC production behaviour; OPEC uses two behaviours, i.e., first, it follows a cartel model in which OPEC is a price maker and, second, it follows a competitive model in which OPEC is a price taker. This was also suggested by Gately (1995) who recognized that OPEC's ability to affect oil prices is the result of its double-role as a cartel and as a price taker.

In the case of market signals, Horan, Peterson, and Mahar (2004) suggested that market volatility should respond to OPEC conferences prior to information releases. This was also supported by Amic and Lewis (2005), who suggested that the crude oil market is responsive to "OPEC rhetoric." Lewis (2005) also suggested that a key determinant of supply is the actions taken by members of OPEC. On the other hand, non-OPEC countries can make decisions to increase or decrease production without providing prior notice. Market participants would have no lag-time to adjust to new levels of availability of certain types of non-OPEC crudes. As a result, the availability of non-OPEC crude types would be subject to an individual country's decision making, unlike the case of OPEC crudes in which the decisions are made collectively by the member states.

We tested the behaviour of OPEC and non-OPEC crude oil prices in terms of volatility, co-integration, fixed effects, and random effects. The OPEC sample consisted of 16 different crude oils, and the non-OPEC sample consisted of 14 different crudes.

The crude oils in the two samples were of varying quality and were produced in different regions of the world. Chapter 1 addresses the motivation for studying this research topic and the related background information. In addition, it states the objectives of the research and provides the structure of the thesis. It also offers some discussion of the importance of the study, today's global energy markets, and the sources of the data and information that were used.

In chapter 2, we used a univariate GARCH model developed by Bollerslev (1987) to estimate the volatility that is present in each of the crude oil prices. We started by testing for unit root using the Augmented Dickey Fuller (ADF) unit root test . The results of the ADF unit root test showed that crude oil prices do suffer from unit root problem, which suggested that further treatments (e.g., taking the log and/or first difference) are needed in order to have the series ready for the GARCH application. Then, we proceeded to test for the possible existence of ARCH effects, which was confirmed. The estimated coefficients of both the ARCH term, α_i, and the GARCH term, β_i, are positive and significant for all crude oil prices. No significant difference was found between the averages calculated for OPEC and non-OPEC crude oil prices. Our main finding is that variations in volatility of individual crude oil prices are due to factors that are not related to OPEC or non-OPEC affiliation. In other words, OPEC and non-OPEC affiliations have no bearing on the volatility of crude oil prices.

Given the impact of crude oil prices on the financial performance of oil-related companies, in chapter 3, we tested whether the prices of crude oils produced by OPEC and non-OPEC and the stock prices of oil companies are driven by a common, data-generating process. A critical first step is to examine whether each series of crude oil and stock prices is non-stationary, i.e., not I(0). In chapter 2, it was found that crude oil prices are not stationary. Thus, we only tested the oil stock prices for unit root using the ADF unit root test. The results of the ADF test suggested that all oil stock price series are not stationary at level prices, which indicated that it is reasonable to proceed with our estimation of co-integration. We used the Johansen co-integration test to determine whether two series of prices (i.e., oil prices and oil companies' stock prices) are driven by a common data-generating process (DGP) and whether there is a unit-free, linear combination of the two series.

Trace and maximum eigenvalue test statistics were used to determine the number of co-integrating equations. In the trace test, we used the null hypothesis that there are, at most, *r* co-integrating equations, in which *r* is either 0 or 1. In both tests, the co-integrating vectors, listed as r, were selected beforehand as the null. In the case of the maximum eigenvalue test, the null hypothesis is r = 0, and it is tested against the alternative, r = 1. The results of the co-integration analysis suggested that prices of crude oil and prices of oil stock companies are not integrated. In fact, less than 20 percent of stocks under investigation showed a co-integrated relationship (i.e., stationary linear combination of the two series) with crude prices. OPEC and non-OPEC membership had no bearing on the co-integration relationship. In other words, stocks co-integrated with all crude oils regardless of whether the crudes were produced by OPEC or non-OPEC countries. For these co-integrated stocks with crude oil prices, we applied the Error-Correction Model (ECM) to identify the signs and sizes of short-term, dynamic adjustments. Analysing short-term deviation away from long-term equilibrium can help in developing and executing corporate plans and strategies, as well as national and international policies.

In chapter 4, we used a panel-data framework to estimate the impacts of different news items on the prices of OPEC and non-OPEC crude oils. The news items were categorised in five categories: 1) military conflict, 2) labour and social, 3) environmental and weather, and 4) economic and business. However, all news items included in these categories embody the possibility of causing disruption to global crude oil supply. We tested whether prices of OPEC crudes react differently to each of these news categories than prices of non-OPEC crudes. The results suggested that all crude prices react similarly to various news items.

5.2 Implications for the decision-making process

Recent development and restructuring of the energy market have increased the need for a more accurate decision-making process. Advanced econometric techniques were used to understand the different relationships between various economic and financial variables and market conditions. Understanding such relationships can improve estimations of key inputs in the decision-making process. In our case, understanding the relationship between the prices of OPEC and non-OPEC crude oils should provide decision makers and policy makers with an important part of the framework needed to improve their outcomes. The results based on our empirical analysis suggested that effects of OPEC production behaviour, as a possible source (or factor) of price volatility in the crude oil market, as identified by Sadorsky (2004), is not limited to its own crude price behaviour. Effects are transmitted to other non-OPEC crude oil prices. In other words, decision-makers should look into OPEC production behaviour have an impact on the volatility of all crude oil types regardless of its source.

The results obtained provide decision makers with better understanding of the relationships between the prices of OPEC and non-OPEC crude oils. In evaluating different oil-based projects using discounted future cashflows, decision makers should not be concerned, in terms of price behaviour, about whether the source of their crude oil is an OPEC country or a non-OPEC country. Instead, they should focus on improving their own operations to optimize their use of the crude oil. As suggested by Garis (2009), the selling price of crude oil actually reflects the value-in-use to the final consumer rather than its actual marginal cost of production. In other words, the value of crude oil depends on what products it can be used to produce. For example, the same barrel of oil is worth more to a user with advanced technology that can extract a higher percentage of high-quality products (e.g., gasoline) at a lower cost than it is to a user with outdated technology that produces less valuable products at higher production cost.

The price of crude oil is one of the key inputs in the evaluation of an energy project. Most energy companies either produce or consume oil-based products, which suggest that understanding oil price behaviour is a critical first step in developing plans for future expansion or replacement of current operations or for laying the foundation for completely new projects. In the case of a power generator, understanding the relationship of electricity prices and the prices of the underlying primary fuel commodities, such as oil or gas, is very important in making decisions (Hinich and Serletis, 2006).

5.3 Limitations of the thesis

Given that we used spot prices for OPEC and non-OPEC crude oils, the results obtained should be used with caution. It could be the case that the prices of crude oil futures tell a different story. Given that the futures market of crude oils represents approximately 20 times the amount of available physical quantities (Garis, 2009), differences between the price behaviour of OPEC and non-OPEC crude oils could be overwhelmed by the dynamics of prices taking place in the futures market. However, accessing the futures prices of a large number of OPEC and non-OPEC crude oils is not an easy task. I am not sure if futures prices for our sample of 16 OPEC crudes and 14 non-OPEC crudes exist, because most traders in the oil market use reference crude oils, such as Brent or WTI, to price other, less-known crudes. For example, Brent crude is used as a pricing reference for about 67% of the crude oil that is sold globally (Chevillon and Rifflart, 2009).

Another limitation of the thesis is that chemical and physical characteristics (e.g., API and sulphur content) were not considered in the grouping of crude oils. We considered sub-grouping OPEC and non-OPEC crude oils according to the degree of API (i.e., heavy, medium, and light) and sulphur content (sweet and sour). Then, we further examined the behaviour of each sub-group and compared it to its counterpart in the other group. Yet, this approach further complicated the analysis, especially for chapter x on co-integration, which lists results of more than 2800 regressions. However, it will be possible to consider this sub-grouping application in the future, as is discussed in more detail in the following section.

5.4 Recommendations for future research

There are limitless opportunities for future research in energy economics and finance. However, a few possible future research areas that relate to our findings and to the broad subject of energy economics are presented. First, in relationship to our findings, the results of chapter 2 suggested that OPEC and non-OPEC prices experience similar levels of volatility. However, we could further sub-group OPEC and non-OPEC crude oils according to the degree of API (i.e., heavy, medium, and light) and sulphur content (sweet and sour). Then, we would be able to examine the behaviour of each sub-group further and compare it to its counterpart in the other groups. Bacon and Tordo (2005) stated that the price differentials of crude oils are estimated based on the quality differences as indicated by the API gravity number and the sulphur content. This relationship between quality features and price differential can be modelled by using the sub-grouping techniques discussed above and the price differential of each crude oil and one of the benchmark crudes. For example, for the OPEC Light Sour group, we could estimate the price differential of each crude price in the group and each of the four benchmark crudes (Brent, WTI, Dubai, and Oman). This calculation could be repeated for other sub-groups. Then, we could estimate the volatility of each group and make comparisons to determine whether the combination of OPEC, Light and Sour crudes, for example, exhibit a significantly different pattern of volatility than other sub-groups.

The results obtained in chapter 3 suggest that there is very little evidence of a long-term, co-integration relationship between oil prices and the stock prices of oil companies. However, only a few companies (five out of the 32 studied) exhibited a co-integration relationship. Stocks that showed a long-term relationship with crude oil prices can be further investigated by looking into their annual and semi-annual reports to identify common corporate strategies, risk management techniques, or financial leverage decisions that might lead to a co-integrated relationship with crude oil prices. The analysis can be further expanded by looking into other stock prices of different energy-intensive industries, such as shipping and industrial companies, to determine whether adopting certain corporate strategies and risk management techniques would result in a co-integration relationship with crude oil prices.

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Appendix 1: Types of crude oil covered in this study

	Type	Simple	Origin	API*	Sulphur**
1	Murban	ADM	UAE	39	0.78
2	Saharan Blend	ASB	Algeria	44	0.09
3	Cabinda	ANC	Angola	32.5	0.11
4	Fateh	DUB	UAE	32	2
5	Oriente	ECO	Ecuador	30	0.88
6	Iranian Heavy	IRH	Iran	34	1.78
7	Iranian Light	IRL	Iran	30.9	1.68
8	Kuwait Blend	KUT	Kuwait	31.4	2.52
9	Es Sider	LIB	Libya	37	0.45
10	Bonny Light	NGB	Nigeria	37	0.14
11	Forcados	NGE	Nigeria	31	0.14
12	Dukhan	DUK	Qatar	40.9	1.27
13	Arab Heavy	SAH	Saudi Arabia	27.4	2.80
14	Arab Light	SAL	Saudi Arabia	33.4	1.77
15	Arab Medium	SAM	Saudi Arabia	31	2.49
16	Tia Juana Light	VEN	Venezuela	31.8	1.16
Average				33.95	1.25
17	Gippsland	AUS	Australia	42	0.10
18	Kole	CAM	Cameroon	31.7	0.37
19	Par	CAP	Canada	40.02	0.30
20	Daqing	CHI	China	32.7	0.10
21	Cano Limon	COL	Colombia	30	0.88
22	Suez Blend	EGS	Egypt	33	1.85
23	Minas	INO	Indonesia	34	0.11
24	Tapis	TAP	Malaysia	44	0.03
25	Isthmus	MXI	Mexico	32	1.22
26	Maya	MXM	Mexico	22.1	3.31
27	Ekofisk	NOE	Norway	42.1	0.17
28	Oman Blend	OMN	Oman	34	0.76
29	Urals	RUS	Russia	32.5	1.25
30	Brent Blend	BRT	U.K	38.3	0.40
Average				34.88	0.77

*API (American Petroleum Institute): a measure of gravity that quantifies the weight of the particular crude oil (Foundation of energy Risk Management).

** Crude oil with sulfur content below 0.5 percent is considered sweet and is sold at premium. In addition, crude oil with sulfur content greater than 1.0 percent is sold at discount and is considered sour.

Appendix 2: Summary of financial information for the companies as of 31/12/2009 in US $):
***note: As listed in NYSE**

Sector	Stock*	Company	MKT Cap (Billion)	Revenue (Billion)	Profit Margin %
Upstream					
DE	DO	Dimon Offshore Drilling Inc	9.96	3.63	2.31
	NE	Noble Corp.	9.19	3.64	2.53
	ESV	Ensco plc.	6.80	1.94	1.22
	RIG	Transoceanic Inc	21.39	11.55	6.41
	ATW	Atood Oceanics, Inc	2.08	0.58	0.36
	PKD	Parker Drilling	0.561	0.75	0.08
	PTEN	Patterson-UTI Energy, Inc.	2.99	0.78	0.30
	PDE	Pride International, Inc.	5.61	1.59	0.73
ES	BHI	Baker Hughes, Inc.	19.67	9.66	2.26
	BJS	BJ Services	-	-	-
	HAL	Halliburton Co.	32.51	14.67	2.19
	SII	Smith International, Inc.	-	-	-
	WFT	Weatherford International	13.78	-	-
	TESO	Tesco Corporation	0.49	0.35	0.03
	SLB	Schlumberger Limt.	76.90	22.70	5.30
	RES	RPC, Inc.	2.35	0.58	0.19
Downstream					
PIP	EEP	Enbridge Energy Partners L.P.	7.09	5.73	1.42
	EP	El Paso Corp.	9.26	4.63	3.16
	ETP	Energy Transfer Partners, L.P.	8.93	5.41	1.61
	KMP	Kunder Morgan Energy	21.86	7.00	2.79
	WMB	Williams Companies Inc	12.42	8.25	2.17
	TCLP	TC Pipelines, L.P.	2.22	0.62	0.53
	PAA	Plains All American Pipeline	8.66	18.52	1.22
	OKS	Oneok Partners, L.P.	7.99	6.47	1.12
RM	HES	Hess Corporation	20.96	29.79	7.03
	IMO	Imperial Oil Ltd	33.18	21.39	5.36
	MRO	Marathon Oil Corp.	25.37	54.13	13.57
	MUR	Murphy Oil Corporation	12.58	19.01	4.46
	SUN	Sunco, Inc.	53.61	31.30	3.94
	TSO	Tesoro Corporation	2.01	16.87	0.66
	HOC	Holly Corporation	1.76	4.83	0.59
	SSL	Sasol Ltd.	27.7	12.84	5.61

Note: (-) indicates missing information due to merger and acquisition.

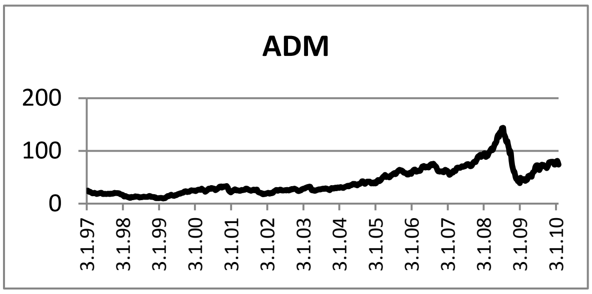
Appendix 3: Energy Sectors as listed by MSCI and S&P Global Industry Classification Standard (GICS) structure:

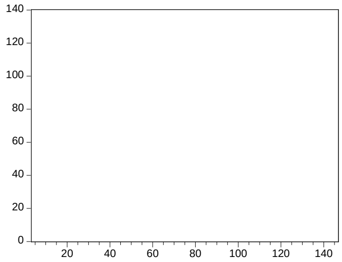
10 Energy (Sector)	Industry	Sub-Industry
1010 Energy (Industry Group)	101010 Energy Equipment & Services	10101010 Oil & Gas Drilling
		10101020 Oil & Gas Equipment & Services
		10102010 Integrated Oil & Gas
	101020 Oil, Gas & Consumable Fuels	10102020 Oil & Gas Exploration & Production
		10102030 Oil & Gas Refining & Marketing
		10102040 Oil &Gas Storage & Transportation
		10102050 Coal & Consumable Fuels

Appendix 4: Charts and descriptive statistics for OPEC crude oils

	Crude Type	Price level	Price returns
1	Murban	ADM	ADMLN
2	Saharan Blend	ASB	ASBLN
3	Cabinda	ANC	ANCLN
4	Fateh	DUB	DUBLN
5	Oriente	ECO	ECOLN
6	Iranian Heavy	IRH	IRHLN
7	Iranian Light	IRL	IRLLN
8	Kuwait Blend	KUT	KUTLN
9	Es Sider	LIB	LIBLN
10	Bonny Light	NGB	NGBLN
11	Forcados	NGE	NGELN
12	Dukhan	DUK	DUKLN
13	Arab Heavy	SAH	SAHLN
14	Arab Light	SAL	SALLN
15	Arab Medium	SAM	SAMLN
16	Tia Juana Light	VEN	VENLN

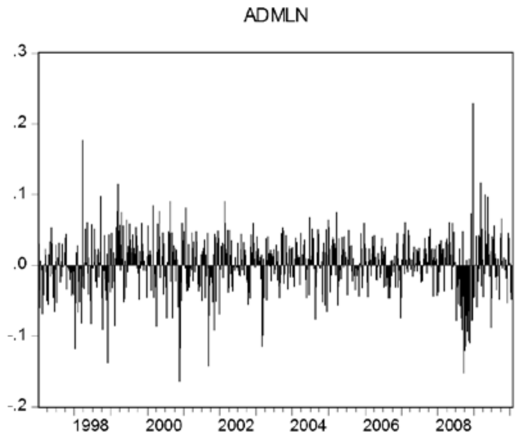
Note: Price levels are the actual closing prices as listed in Energy Information Administration. Price returns are computed according to the following formula:

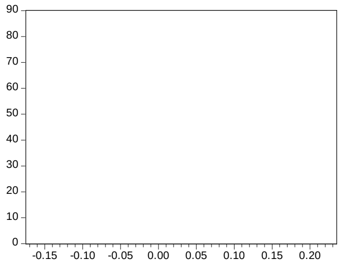




Series: ADM
Sample 1/03/1997 1/23/2010
Observations 681

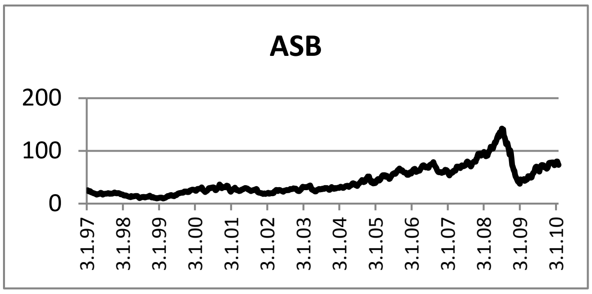
Mean	42.35
Median	30.03
Maximum	143.40
Minimum	9.83
Std. Dev.	27.30
Skewness	1.20
Kurtosis	4.16
Jarque-Bera	203.63
Probability	0.00

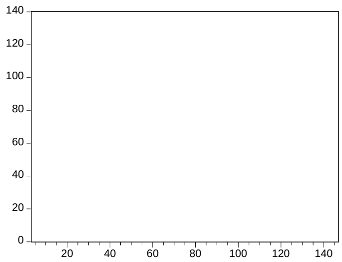




Series: ADMLN
Sample 1/10/1997 1/29/2010
Observations 680

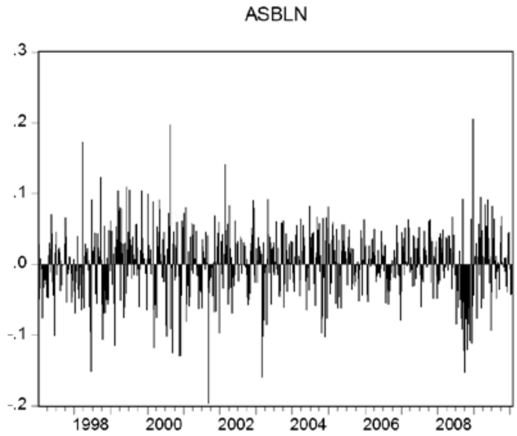
Mean	0.001657
Median	0.005405
Maximum	0.228824
Minimum	-0.163798
Std. Dev.	0.040095
Skewness	-0.206463
Kurtosis	5.824811
Jarque-Bera	230.9185
Probability	0.000000

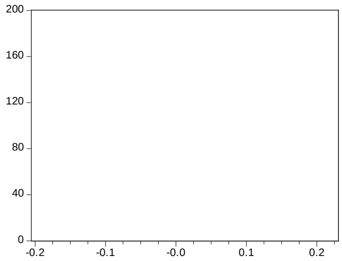




Series: ASB
Sample 1/03/1997 1/23/2010
Observations 681

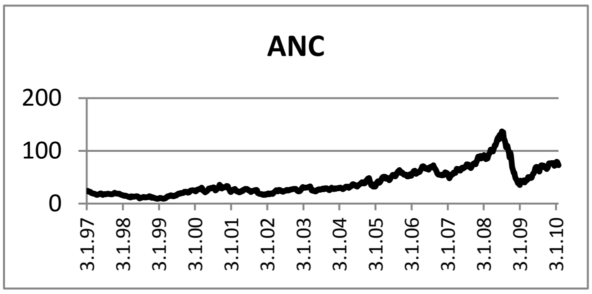
Mean	42.74
Median	30.88
Maximum	142.51
Minimum	9.75
Std. Dev.	27.26
Skewness	1.17
Kurtosis	4.03
Jarque-Bera	186.20
Probability	0.00

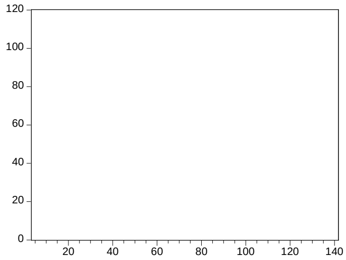




Series: ASBLN
Sample 1/10/1997 1/29/2010
Observations 680

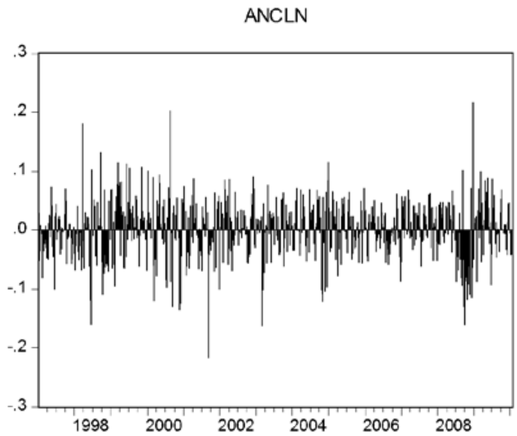
Mean	0.001596
Median	0.004739
Maximum	0.205684
Minimum	-0.196356
Std. Dev.	0.047229
Skewness	-0.186489
Kurtosis	4.506126
Jarque-Bera	68.21332
Probability	0.000000

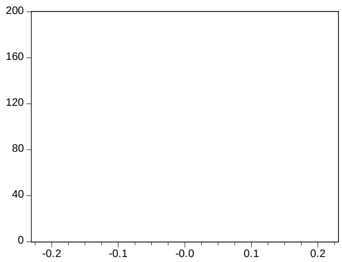




Series: ANC
Sample 1/03/1997 1/23/2010
Observations 681

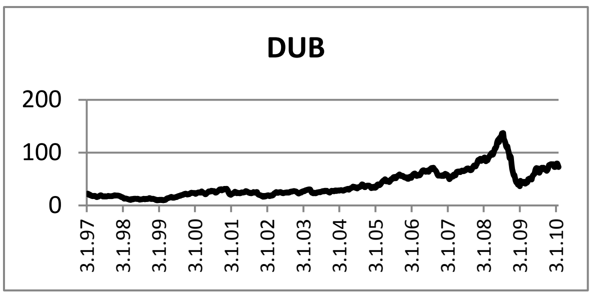
Mean	40.69
Median	29.70
Maximum	137.09
Minimum	8.95
Std. Dev.	25.98
Skewness	1.20
Kurtosis	4.14
Jarque-Bera	201.08
Probability	0.00

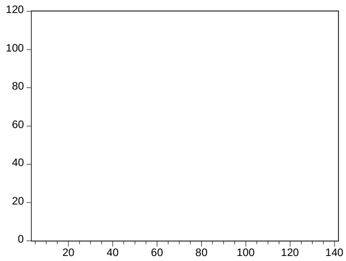




Series: ANCLN
Sample 1/10/1997 1/29/2010
Observations 680

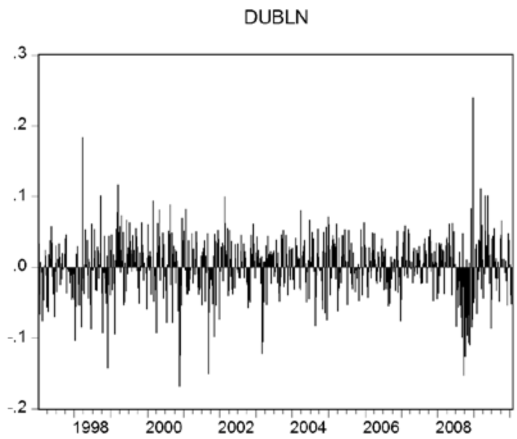
Mean	0.001648
Median	0.004719
Maximum	0.217879
Minimum	-0.217244
Std. Dev.	0.049149
Skewness	-0.214879
Kurtosis	4.597507
Jarque-Bera	77.54044
Probability	0.000000





Series: DUB
Sample 1/03/1997 1/23/2010
Observations 681

Mean	39.89
Median	28.26
Maximum	136.82
Minimum	9.60
Std. Dev.	25.87
Skewness	1.24
Kurtosis	4.27
Jarque-Bera	222.96
Probability	0.00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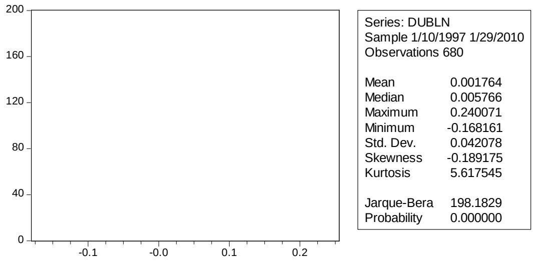
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Median 0.005766
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Kurtosis 5.617545
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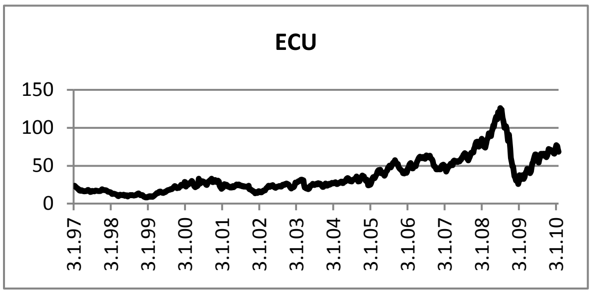
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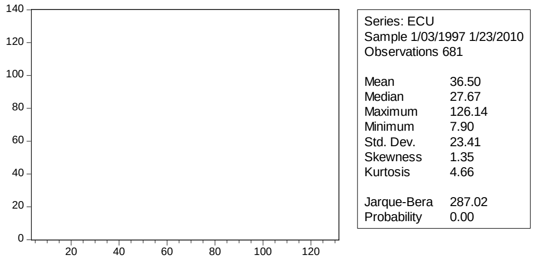
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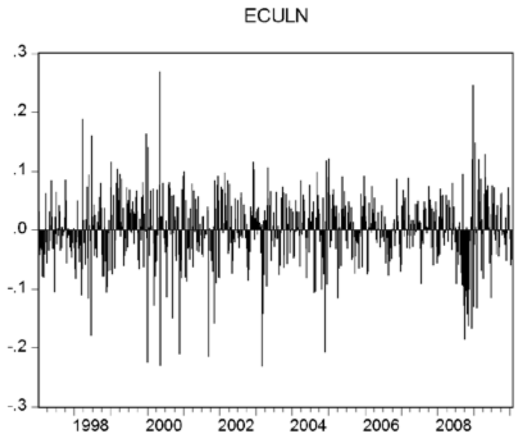
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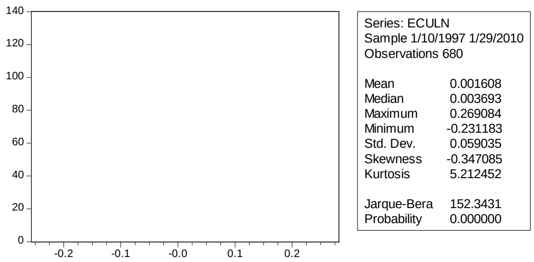
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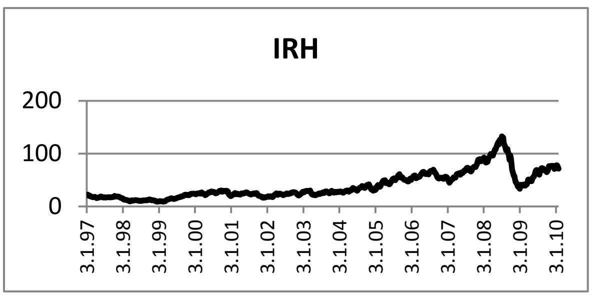
Kurtosis 5.212452
Jarque-Bera 152.3431
Probability 0.000000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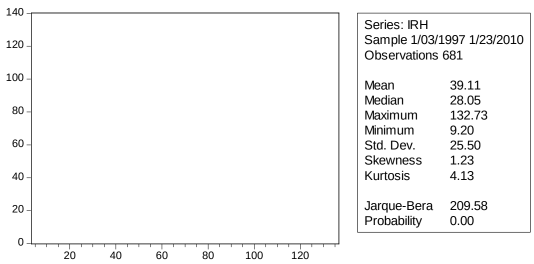
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Median 28.05
Maximum 132.73
Minimum 9.20
Std. Dev. 25.50
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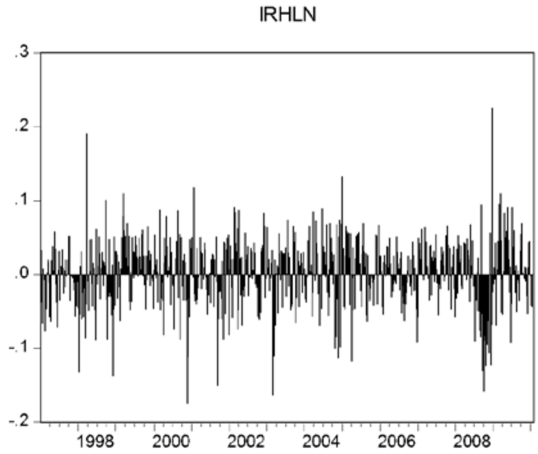
Kurtosis 4.13
Jarque-Bera 209.58
Probability 0.00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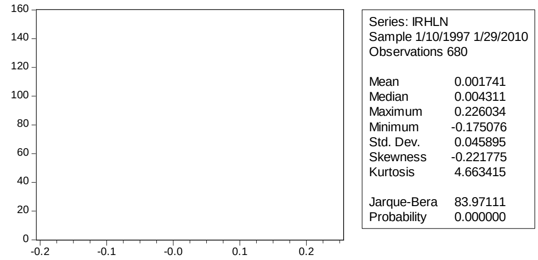
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Median 0.004311
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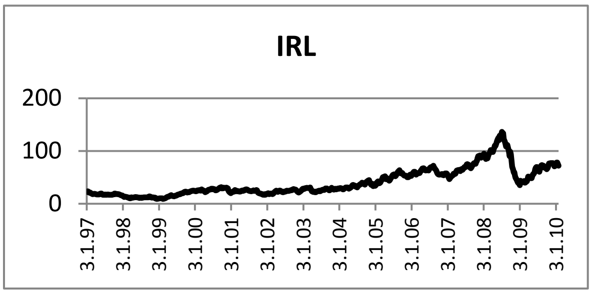
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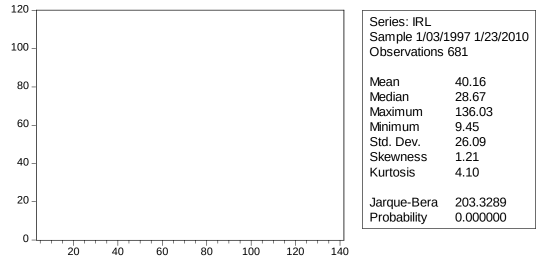
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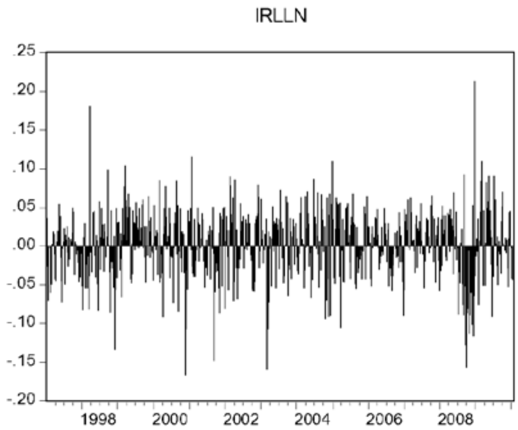
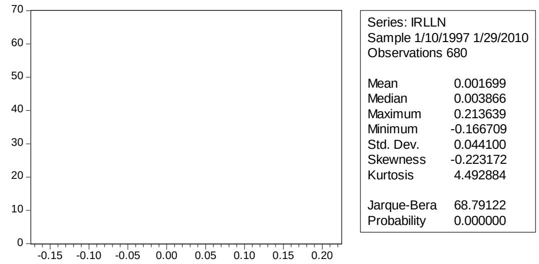
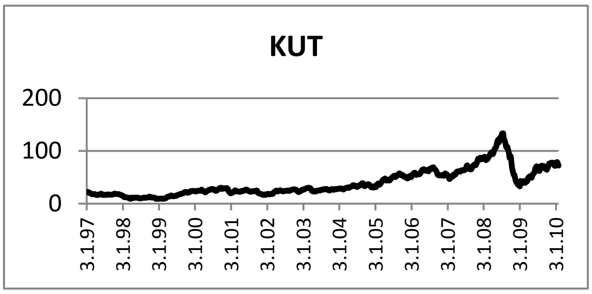
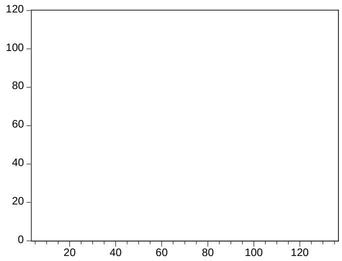
Median 28.67
Maximum 136.03
Minimum 9.45
Std. Dev. 26.09
Skewness 1.21
Kurtosis 4.10
Jarque-Bera 203.3289
Probability 0.000000


IRLLN

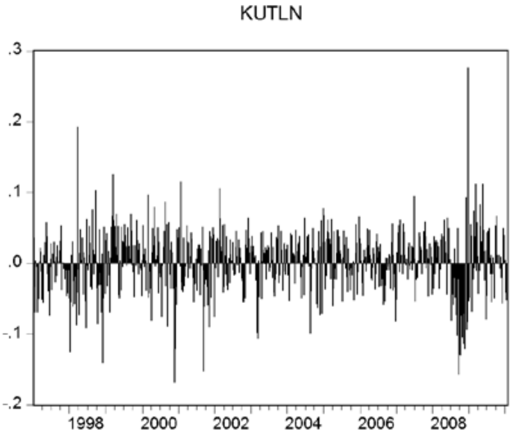

Series: IRLLN
Sample 1/10/1997 1/29/2010
Observations 680
Mean 0.001699
Median 0.003866
Maximum 0.213639
Minimum -0.166709
Std. Dev. 0.044100
Skewness -0.223172
Kurtosis 4.492884
Jarque-Bera 68.79122
Probability 0.000000

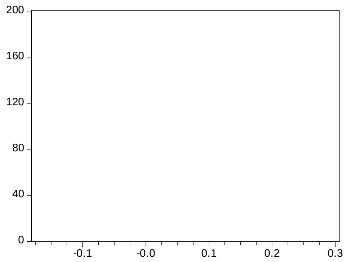




Series: KUT
Sample 1/03/1997 1/23/2010
Observations 681

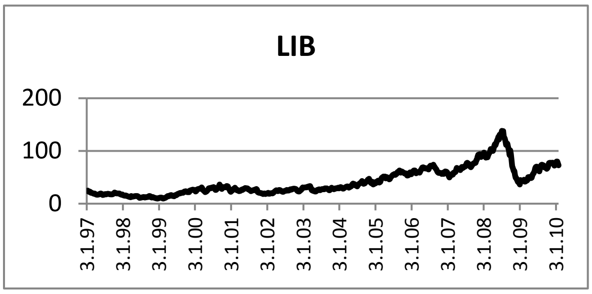
Mean	38.90
Median	28.00
Maximum	133.04
Minimum	9.00
Std. Dev.	25.28
Skewness	1.24
Kurtosis	4.25
Jarque-Bera	221.08
Probability	0.00

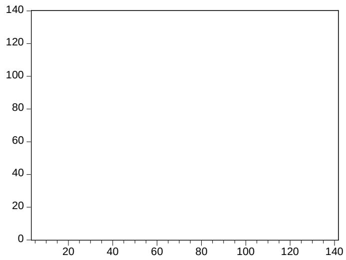




Series: KUTLN
Sample 1/10/1997 1/29/2010
Observations 680

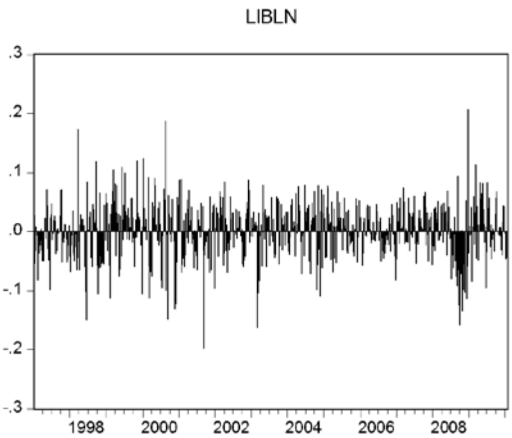
Mean	0.001755
Median	0.004390
Maximum	0.276589
Minimum	-0.167992
Std. Dev.	0.043420
Skewness	-0.018951
Kurtosis	6.369581
Jarque-Bera	321.7395
Probability	0.000000

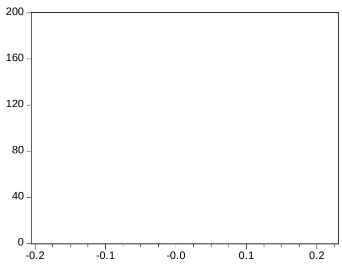




Series: LIB
Sample 1/03/1997 1/23/2010
Observations 681

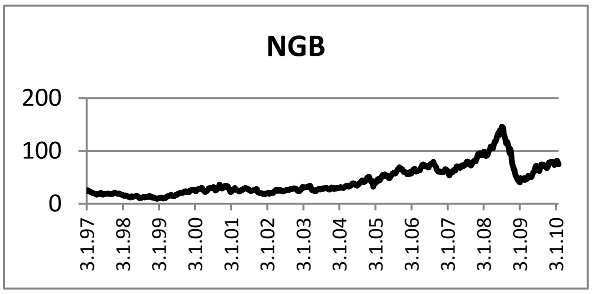
Mean	41.66
Median	30.35
Maximum	138.14
Minimum	9.65
Std. Dev.	26.41
Skewness	1.192
Kurtosis	4.07
Jarque-Bera	194.39
Probability	0.00





Series: LIBLN
Sample 1/10/1997 1/29/2010
Observations 680

Mean	0.001630
Median	0.005404
Maximum	0.208083
Minimum	-0.197999
Std. Dev.	0.047532
Skewness	-0.227501
Kurtosis	4.506031
Jarque-Bera	70.12936
Probability	0.000000


NGB
200
100
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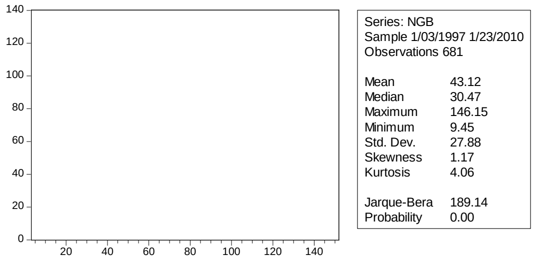
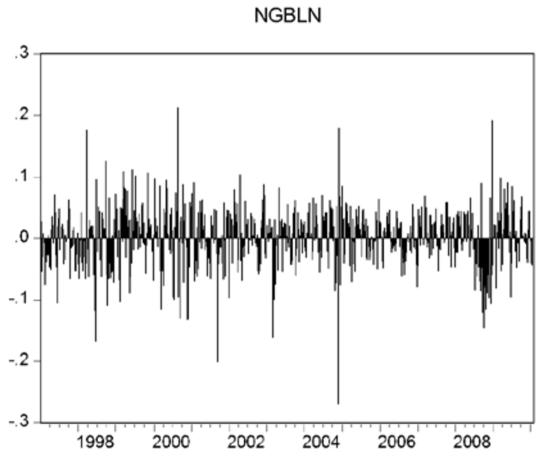
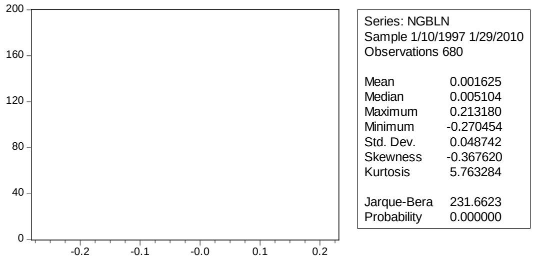
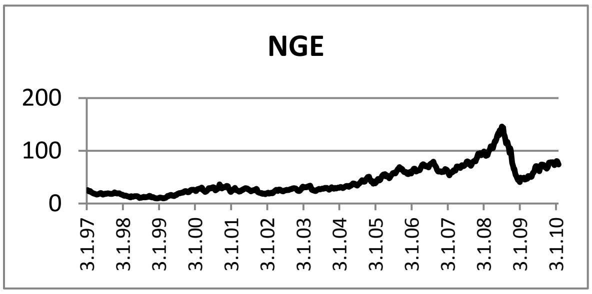
3.1.97
3.1.98
3.1.99
3.1.00
3.1.01
3.1.02
3.1.03
3.1.04
3.1.05
3.1.06
3.1.07
3.1.08
3.1.09
3.1.10


Series: NGB
Sample 1/03/1997 1/23/2010
Observations 681
Mean 43.12
Median 30.47
Maximum 146.15
Minimum 9.45
Std. Dev. 27.88
Skewness 1.17
Kurtosis 4.06
Jarque-Bera 189.14
Probability 0.00


NGBLN
1998
2000
2002
2004
2006
2008


Series: NGBLN
Sample 1/10/1997 1/29/2010
Observations 680
Mean 0.001625
Median 0.005104
Maximum 0.213180
Minimum -0.270454
Std. Dev. 0.048742
Skewness -0.367620
Kurtosis 5.763284
Jarque-Bera 231.6623
Probability 0.000000


NGE
200
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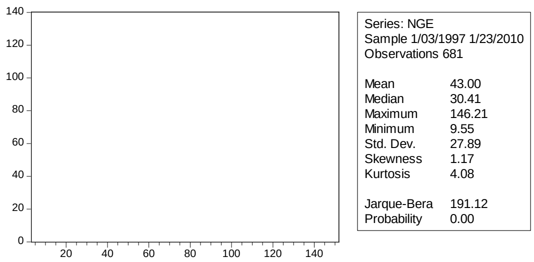
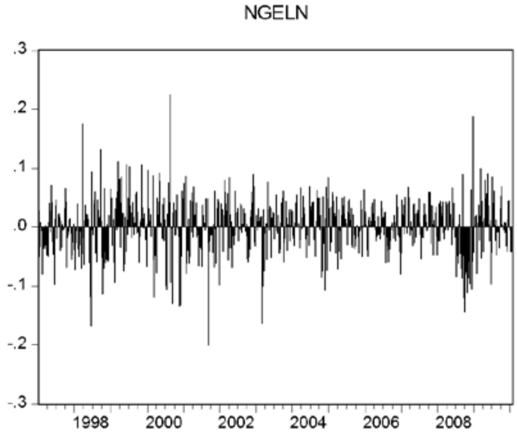
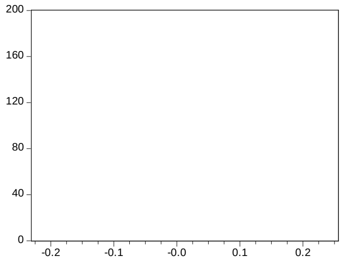
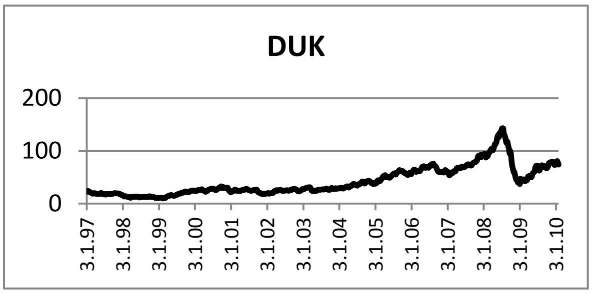
3.1.97
3.1.98
3.1.99
3.1.00
3.1.01
3.1.02
3.1.03
3.1.04
3.1.05
3.1.06
3.1.07
3.1.08
3.1.09
3.1.10

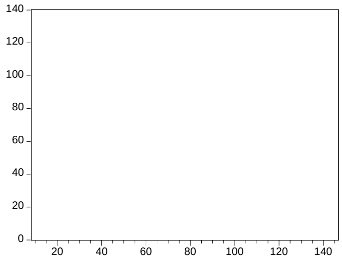

Series: NGE
Sample 1/03/1997 1/23/2010
Observations 681
Mean 43.00
Median 30.41
Maximum 146.21
Minimum 9.55
Std. Dev. 27.89
Skewness 1.17
Kurtosis 4.08
Jarque-Bera 191.12
Probability 0.00



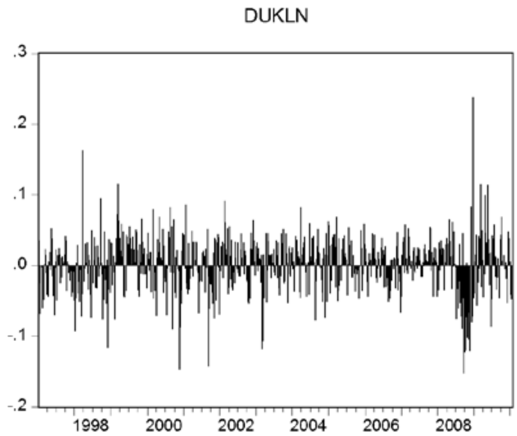


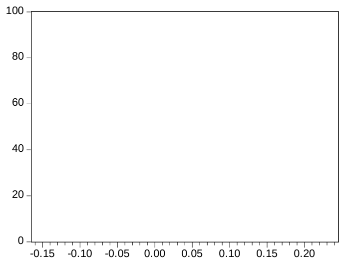
Series: NGELN	
Sample 1/10/1997 1/29/2010	
Observations 680	
Mean	0.001604
Median	0.005067
Maximum	0.225567
Minimum	-0.200671
Std. Dev.	0.047103
Skewness	-0.204903
Kurtosis	4.765058
Jarque-Bera	93.02889
Probability	0.000000



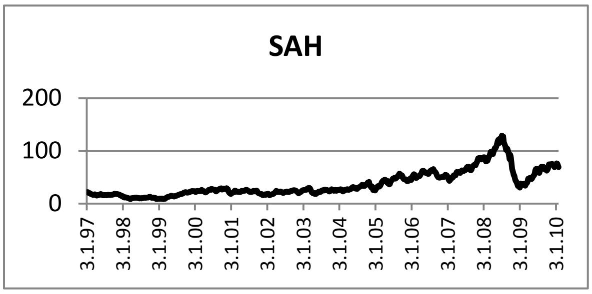


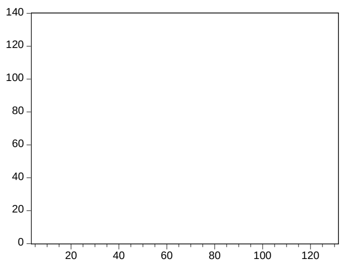
Series: DUK	
Sample 1/03/1997 1/23/2010	
Observations 681	
Mean	41.75
Median	29.04
Maximum	142.80
Minimum	10.11
Std. Dev.	27.179
Skewness	1.218
Kurtosis	4.19
Jarque-Bera	208.80
Probability	0.00



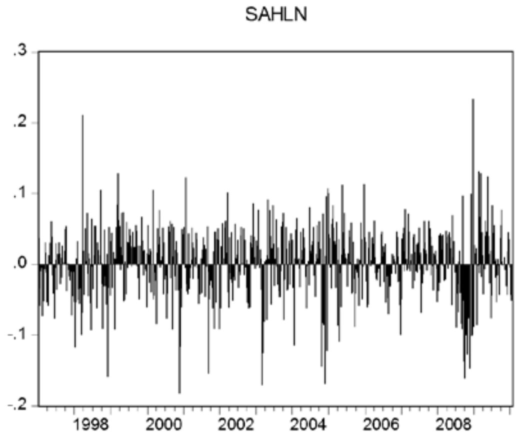


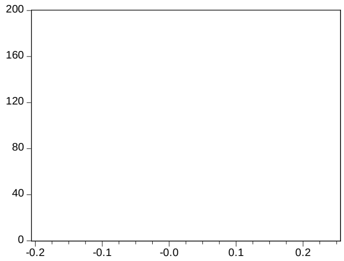
Series: DUKLN	
Sample 1/10/1997 1/29/2010	
Observations 680	
Mean	0.001701
Median	0.004882
Maximum	0.238484
Minimum	-0.151823
Std. Dev.	0.039436
Skewness	-0.104577
Kurtosis	5.938413
Jarque-Bera	245.8771
Probability	0.000000





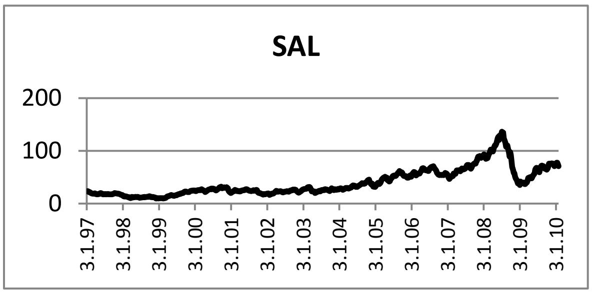
Series: SAH	
Sample 1/03/1997 1/23/2010	
Observations 681	
Mean	37.15
Median	26.27
Maximum	128.72
Minimum	8.50
Std. Dev.	24.74
Skewness	1.32
Kurtosis	4.41
Jarque-Bera	257.92
Probability	0.00

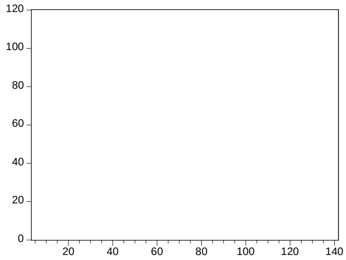




Series: SAHLN
Sample 1/10/1997 1/29/2010
Observations 680

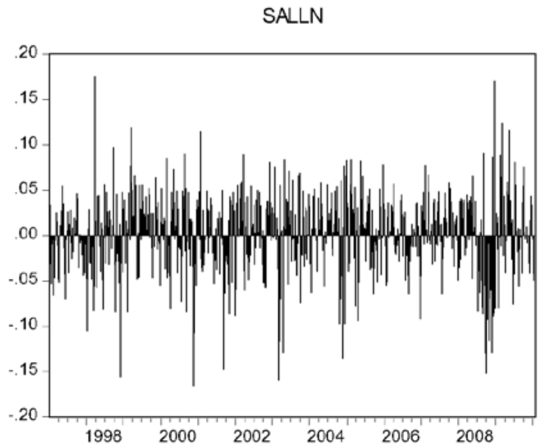
Mean	0.001747
Median	0.005667
Maximum	0.233960
Minimum	-0.182102
Std. Dev.	0.049222
Skewness	-0.253039
Kurtosis	4.802802
Jarque-Bera	99.34262
Probability	0.000000

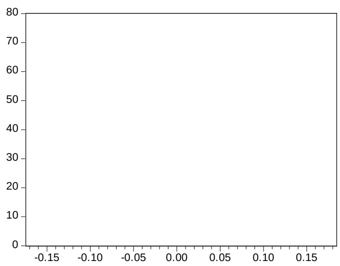




Series: SAL
Sample 1/03/1997 1/23/2010
Observations 681

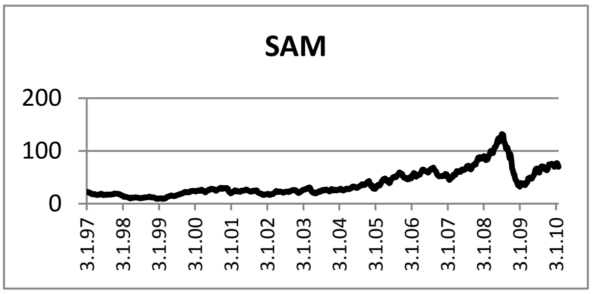
Mean	39.72
Median	28.03
Maximum	136.02
Minimum	9.65
Std. Dev.	25.92
Skewness	1.28
Kurtosis	4.34
Jarque-Bera	239.27
Probability	0.00





Series: SALLN
Sample 1/10/1997 1/29/2010
Observations 680

Mean	0.001654
Median	0.004919
Maximum	0.175891
Minimum	-0.166085
Std. Dev.	0.044469
Skewness	-0.382641
Kurtosis	4.309715
Jarque-Bera	65.19532
Probability	0.000000


SAM
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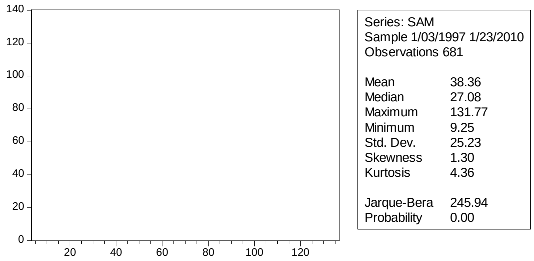
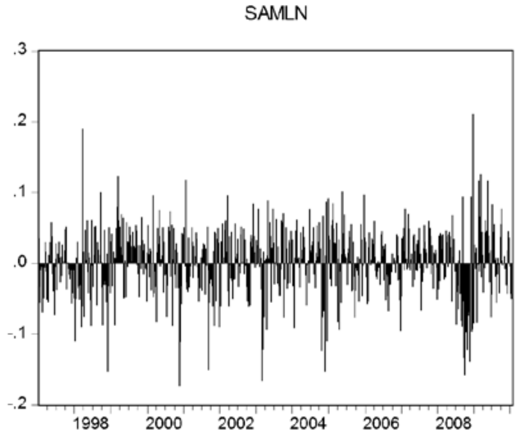
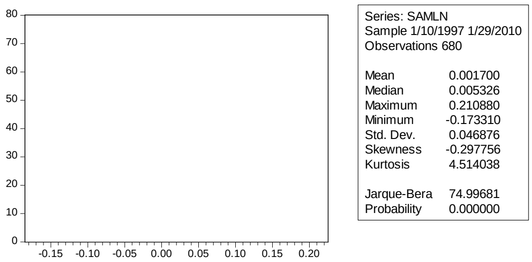
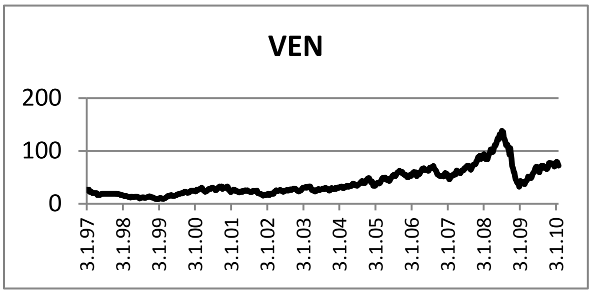
3.1.97 3.1.98 3.1.99 3.1.00 3.1.01 3.1.02 3.1.03 3.1.04 3.1.05 3.1.06 3.1.07 3.1.08 3.1.09 3.1.10


Series: SAM
Sample 1/03/1997 1/23/2010
Observations 681
Mean 38.36
Median 27.08
Maximum 131.77
Minimum 9.25
Std. Dev. 25.23
Skewness 1.30
Kurtosis 4.36
Jarque-Bera 245.94
Probability 0.00


SAMLN
1998 2000 2002 2004 2006 2008


Series: SAMLN
Sample 1/10/1997 1/29/2010
Observations 680
Mean 0.001700
Median 0.005326
Maximum 0.210880
Minimum -0.173310
Std. Dev. 0.046876
Skewness -0.297756
Kurtosis 4.514038
Jarque-Bera 74.99681
Probability 0.000000


VEN
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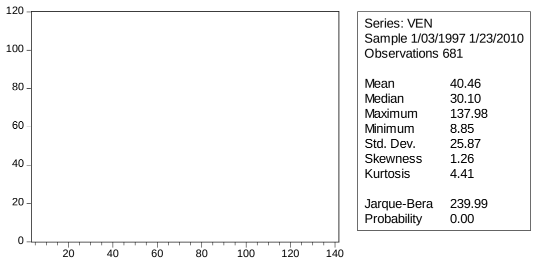
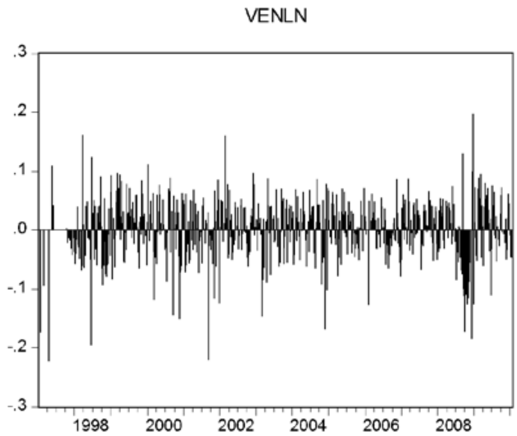
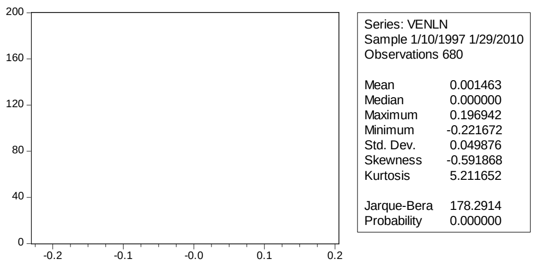
3.1.97 3.1.98 3.1.99 3.1.00 3.1.01 3.1.02 3.1.03 3.1.04 3.1.05 3.1.06 3.1.07 3.1.08 3.1.09 3.1.10

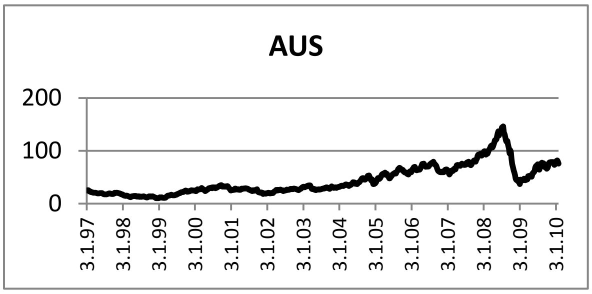

Series: VEN
Sample 1/03/1997 1/23/2010
Observations 681
Mean 40.46
Median 30.10
Maximum 137.98
Minimum 8.85
Std. Dev. 25.87
Skewness 1.26
Kurtosis 4.41
Jarque-Bera 239.99
Probability 0.00

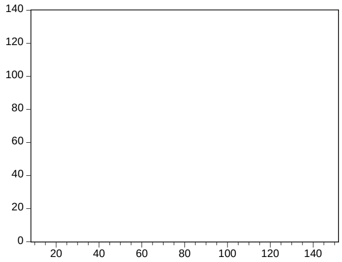

VENLN
1998 2000 2002 2004 2006 2008


Series: VENLN
Sample 1/10/1997 1/29/2010
Observations 680
Mean 0.001463
Median 0.000000
Maximum 0.196942
Minimum -0.221672
Std. Dev. 0.049876
Skewness -0.591868
Kurtosis 5.211652
Jarque-Bera 178.2914
Probability 0.000000

Appendix 5: Charts and descriptive statistics for non-OPEC crude oils

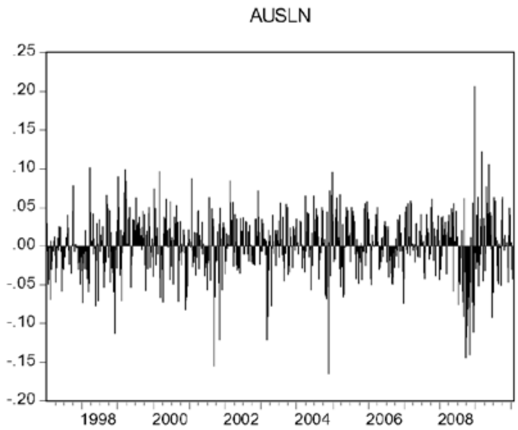
	Type	Price level	Price returns
17	Gippsland	AUS	AUSLN
18	Kole	CAM	CAMLN
19	Par	CAP	Canada
20	Daqing	CHI	CHILN
21	Cano Limon	COL	COLLN
22	Suez Blend	EGS	EGSLN
23	Minas	INO	INOLN
24	Tapis	TAP	TAPLN
25	Isthmus	MXI	MXILN
26	Maya	MXM	MXMLN
27	Ekofisk	NOE	NOELN
28	Oman Blend	OMN	OMNLN
29	Urals	RUS	RUSLN
30	Brent Blend	BRT	BRTLN

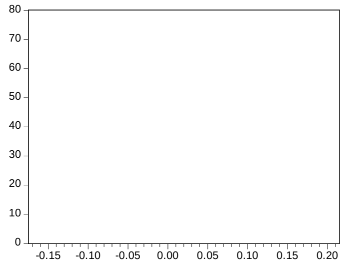




Series: AUS
Sample 1/03/1997 1/23/2010
Observations 681

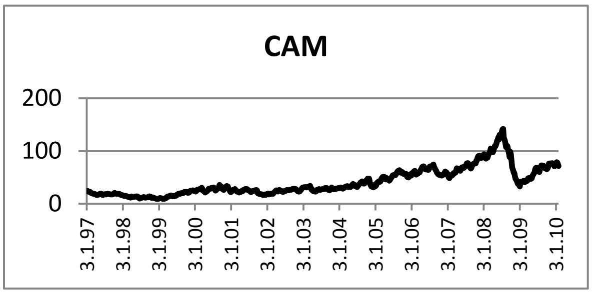
Mean	43.83
Median	32.05
Maximum	145.95
Minimum	10.25
Std. Dev.	27.89
Skewness	1.17
Kurtosis	4.07
Jarque-Bera	189.14
Probability	0.00

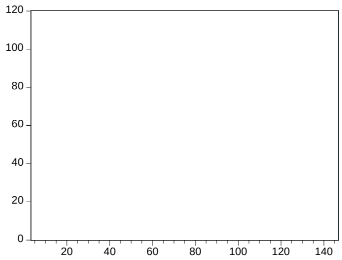




Series: AUSLN
Sample 1/10/1997 1/29/2010
Observations 680

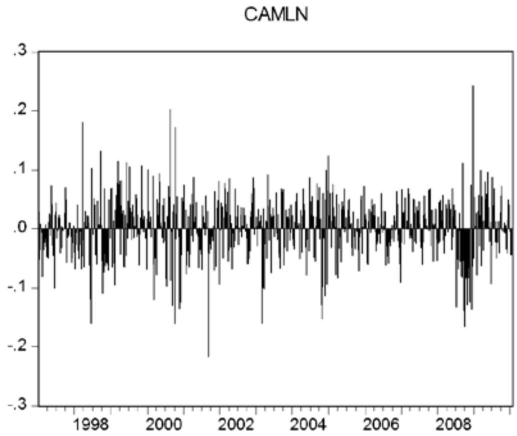
Mean	0.001639
Median	0.003435
Maximum	0.207032
Minimum	-0.165174
Std. Dev.	0.039693
Skewness	-0.302562
Kurtosis	4.967766
Jarque-Bera	120.0845
Probability	0.000000

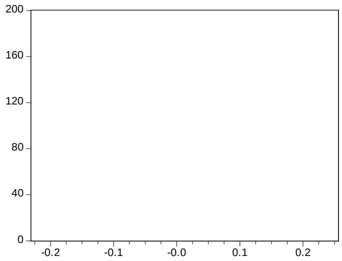




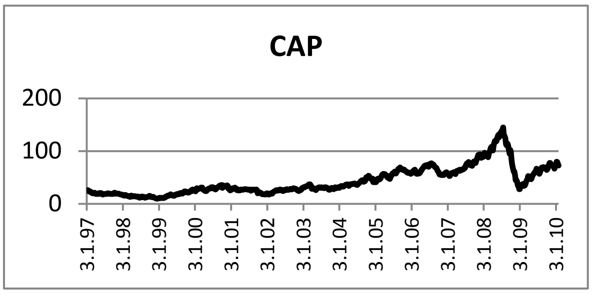
Series: CAM
Sample 1/03/1997 1/23/2010
Observations 681

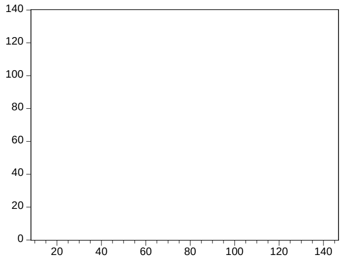
Mean	40.80
Median	30.10
Maximum	141.91
Minimum	8.95
Std. Dev.	26.16
Skewness	1.21
Kurtosis	4.20
Jarque-Bera	208.96
Probability	0.00



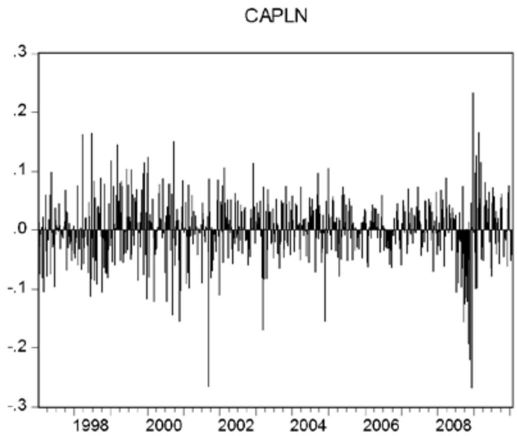


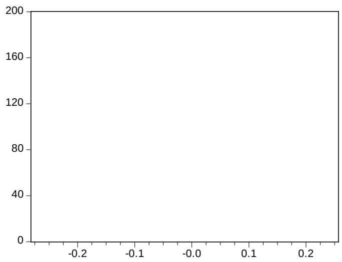
Series: CAMLN	
Sample 1/10/1997 1/29/2010	
Observations 680	
Mean	0.001630
Median	0.005304
Maximum	0.242413
Minimum	-0.217244
Std. Dev.	0.051652
Skewness	-0.197753
Kurtosis	4.701492
Jarque-Bera	86.45917
Probability	0.000000



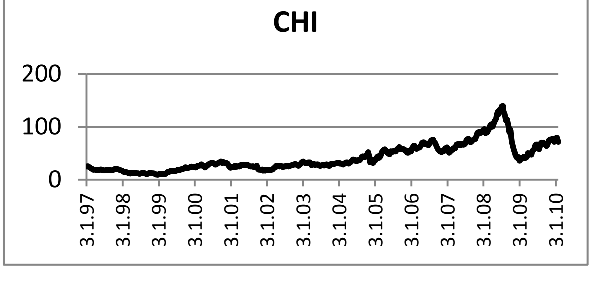


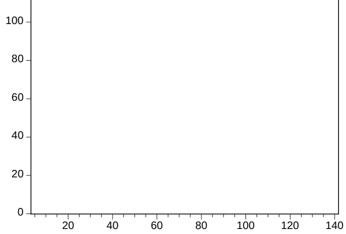
Series: CAP	
Sample 1/03/1997 1/23/2010	
Observations 681	
Mean	42.77
Median	31.70
Maximum	144.93
Minimum	10.06
Std. Dev.	26.62
Skewness	1.23
Kurtosis	4.36
Jarque-Bera	226.42
Probability	0.00



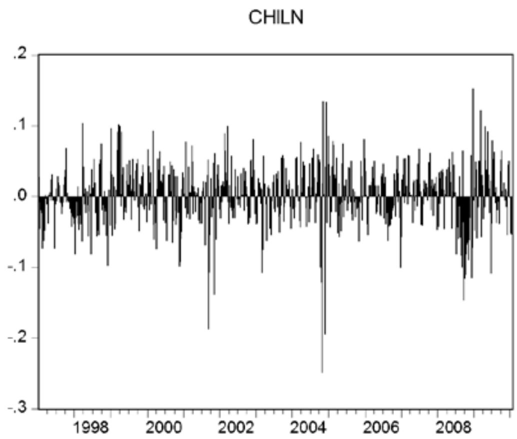


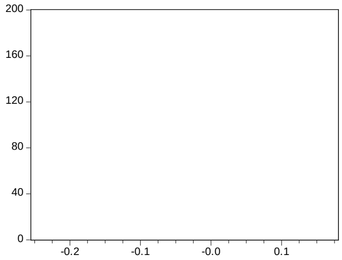
Series: CAPLN	
Sample 1/10/1997 1/29/2010	
Observations 680	
Mean	0.001525
Median	0.003188
Maximum	0.233585
Minimum	-0.267483
Std. Dev.	0.052556
Skewness	-0.508447
Kurtosis	6.120267
Jarque-Bera	305.1540
Probability	0.000000



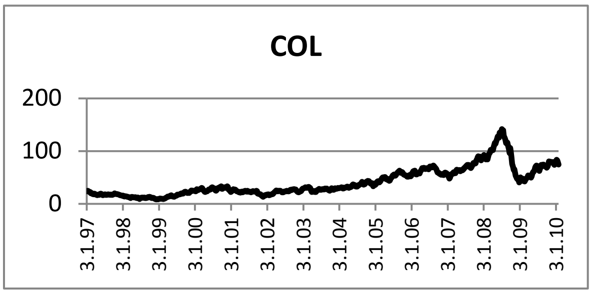


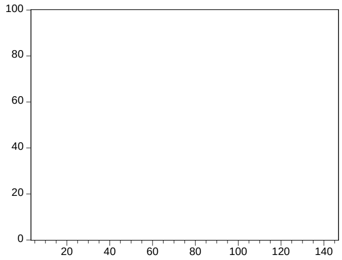
Series: CHI	
Sample 1/03/1997 1/23/2010	
Observations 681	
Mean	41.57
Median	30.90
Maximum	139.45
Minimum	9.50
Std. Dev.	26.32
Skewness	1.23
Kurtosis	4.32
Jarque-Bera	222.51
Probability	0.00



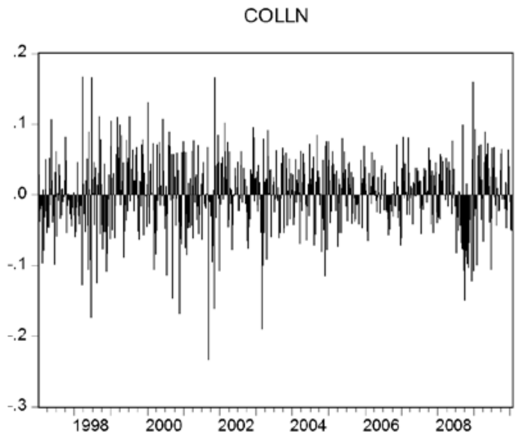


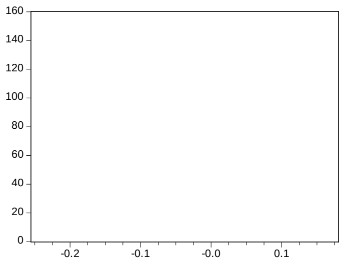
Series: CHILN	
Sample 1/10/1997 1/29/2010	
Observations 680	
Mean	0.001543
Median	0.003382
Maximum	0.151944
Minimum	-0.248886
Std. Dev.	0.043108
Skewness	-0.614349
Kurtosis	5.909647
Jarque-Bera	282.6461
Probability	0.000000



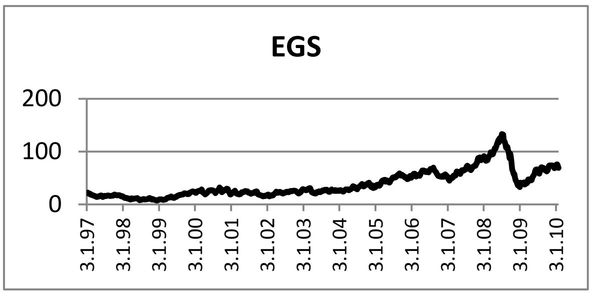


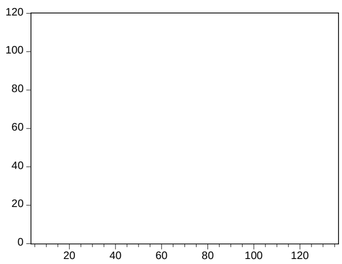
Series: COL	
Sample 1/03/1997 1/23/2010	
Observations 681	
Mean	41.09
Median	29.85
Maximum	141.44
Minimum	8.45
Std. Dev.	27.04
Skewness	1.23
Kurtosis	4.25
Jarque-Bera	216.58
Probability	0.00



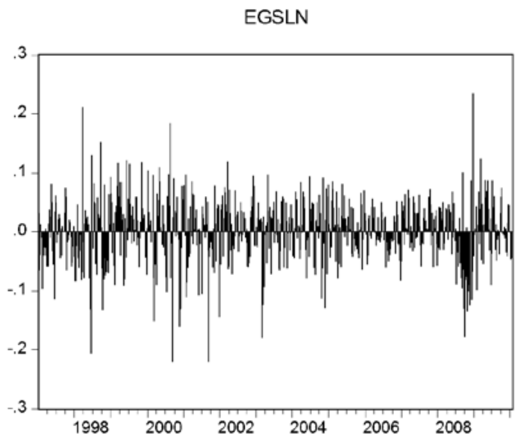


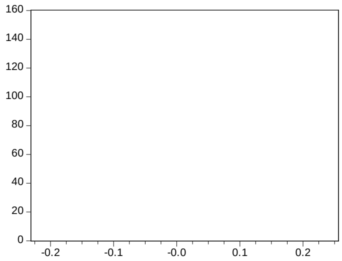
Series: COLLN	
Sample 1/10/1997 1/29/2010	
Observations 680	
Mean	0.001675
Median	0.002151
Maximum	0.167054
Minimum	-0.233551
Std. Dev.	0.050292
Skewness	-0.368782
Kurtosis	4.365675
Jarque-Bera	68.25692
Probability	0.000000



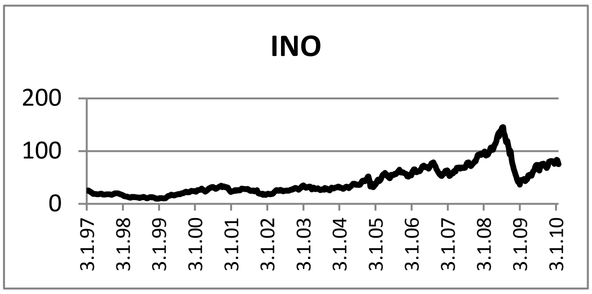


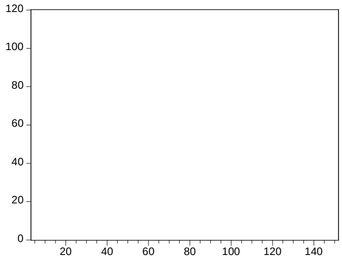
Series: EGS	
Sample 1/03/1997 1/23/2010	
Observations 681	
Mean	38.17
Median	26.85
Maximum	133.15
Minimum	7.60
Std. Dev.	25.55
Skewness	1.24
Kurtosis	4.24
Jarque-Bera	221.08
Probability	0.000



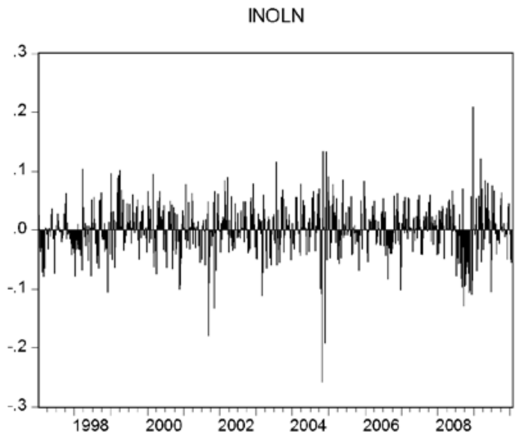


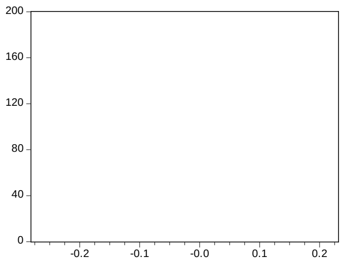
Series: EGSLN	
Sample 1/10/1997 1/29/2010	
Observations 680	
Mean	0.001701
Median	0.005915
Maximum	0.234889
Minimum	-0.220570
Std. Dev.	0.054421
Skewness	-0.322624
Kurtosis	4.694618
Jarque-Bera	93.16215
Probability	0.000000



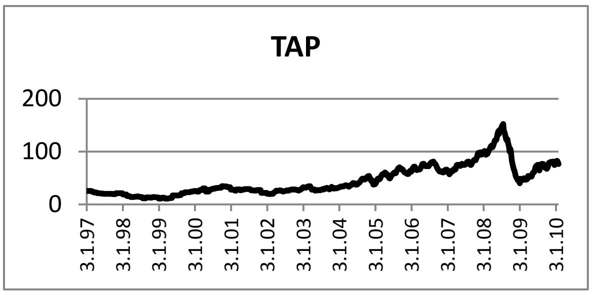


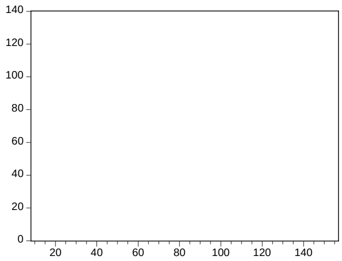
Series: INO	
Sample 1/03/1997 1/23/2010	
Observations 681	
Mean	42.73
Median	30.90
Maximum	145.51
Minimum	9.65
Std. Dev.	27.69
Skewness	1.20
Kurtosis	4.17
Jarque-Bera	204.97
Probability	0.00



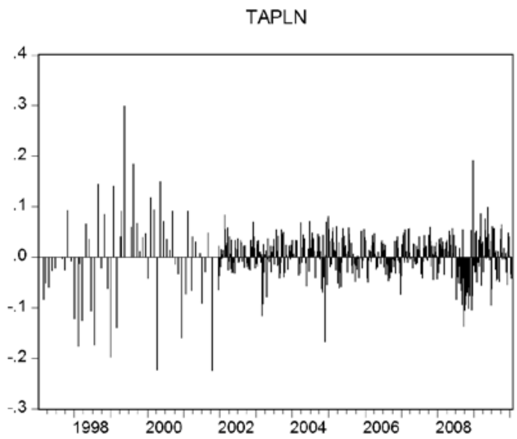


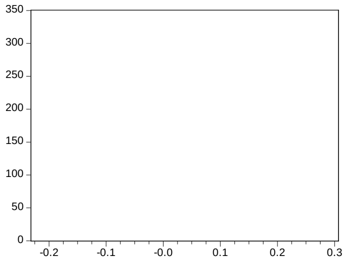
Series: INOLN	
Sample 1/10/1997 1/29/2010	
Observations 680	
Mean	0.001616
Median	0.003001
Maximum	0.209787
Minimum	-0.257995
Std. Dev.	0.043913
Skewness	-0.467836
Kurtosis	6.092249
Jarque-Bera	295.7287
Probability	0.000000





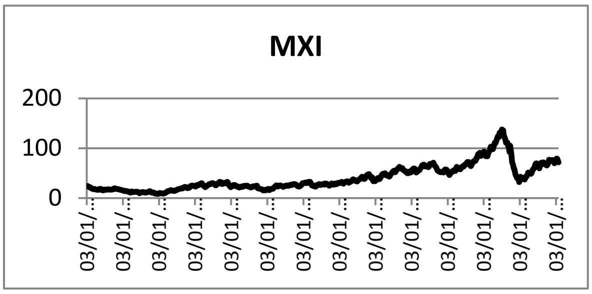
Series: TAP	
Sample 1/03/1997 1/23/2010	
Observations 681	
Mean	44.98
Median	31.94
Maximum	151.97
Minimum	10.95
Std. Dev.	28.64
Skewness	1.17
Kurtosis	4.09
Jarque-Bera	191.19
Probability	0.00

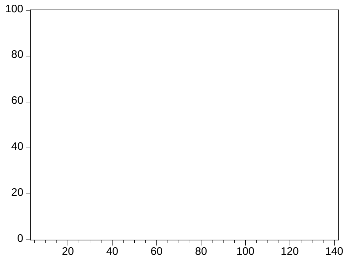




Series: TAPLN
Sample 1/10/1997 1/29/2010
Observations 680

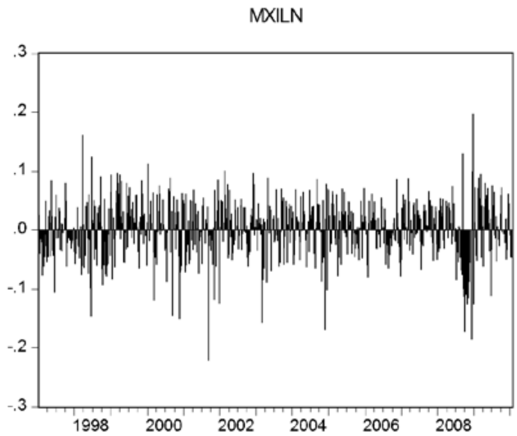
Mean	0.001603
Median	0.000000
Maximum	0.298622
Minimum	-0.224987
Std. Dev.	0.043000
Skewness	-0.278822
Kurtosis	11.36095
Jarque-Bera	1989.467
Probability	0.000000

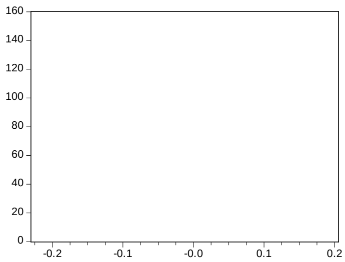




Series: MXI
Sample 1/03/1997 1/23/2010
Observations 681

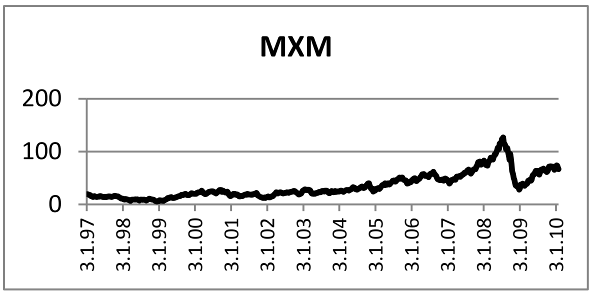
Mean	40.26
Median	29.94
Maximum	137.87
Minimum	8.78
Std. Dev.	25.91
Skewness	1.26
Kurtosis	4.41
Jarque-Bera	239.11
Probability	0.00

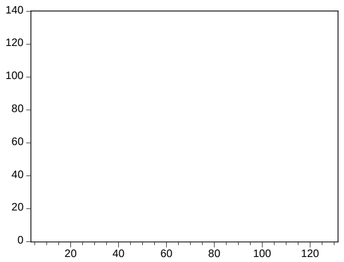




Series: MXILN
Sample 1/10/1997 1/29/2010
Observations 680

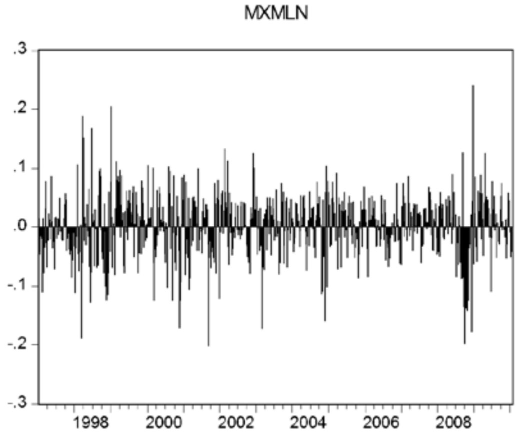
Mean	0.001624
Median	0.003575
Maximum	0.197499
Minimum	-0.221042
Std. Dev.	0.049403
Skewness	-0.428829
Kurtosis	4.283202
Jarque-Bera	67.49522
Probability	0.000000

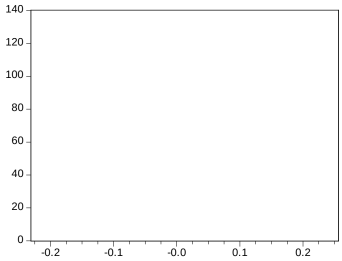




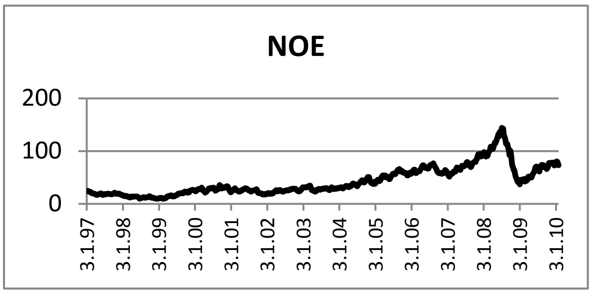
Series: MXM
Sample 1/03/1997 1/23/2010
Observations 681

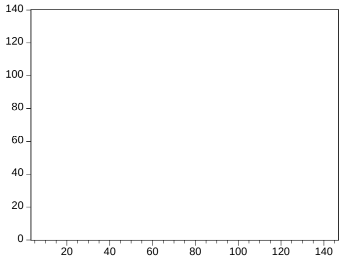
Mean	34.54
Median	25.17
Maximum	126.58
Minimum	5.80
Std. Dev.	23.74
Skewness	1.31
Kurtosis	4.49
Jarque-Bera	259.02
Probability	0.00



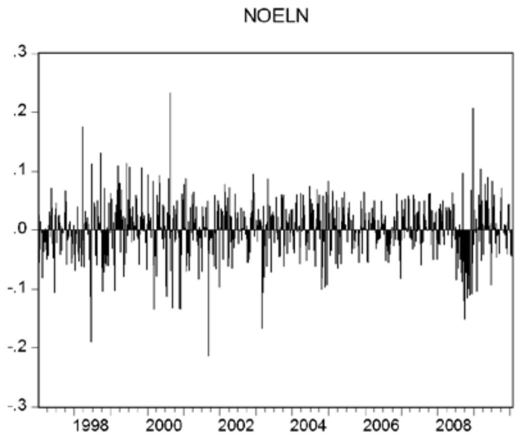


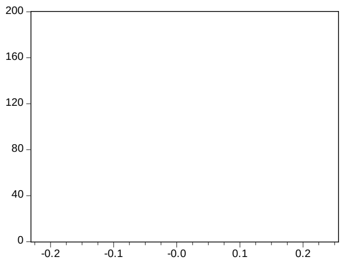
Series: MXMLN	
Sample 1/10/1997 1/29/2010	
Observations 680	
Mean	0.001826
Median	0.004879
Maximum	0.240799
Minimum	-0.201941
Std. Dev.	0.054110
Skewness	-0.226640
Kurtosis	4.617176
Jarque-Bera	79.92045
Probability	0.000000



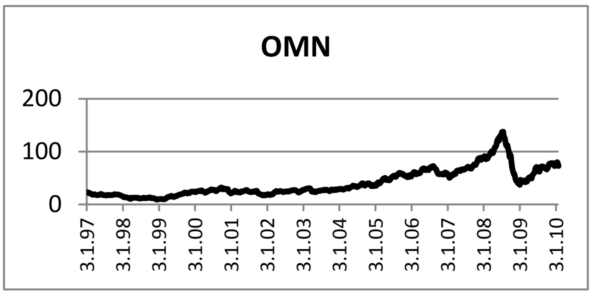


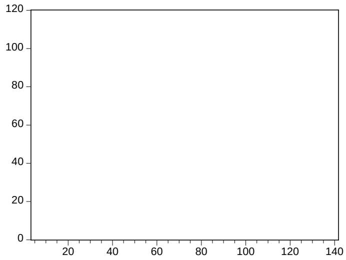
Series: NOE	
Sample 1/03/1997 1/23/2010	
Observations 681	
Mean	42.50
Median	30.47
Maximum	143.94
Minimum	9.55
Std. Dev.	27.30
Skewness	1.19
Kurtosis	4.14
Jarque-Bera	199.10
Probability	0.00



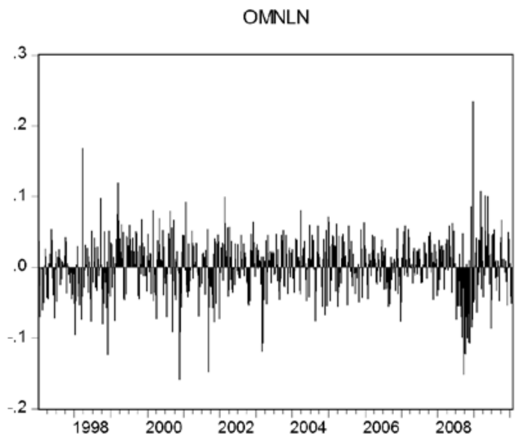


Series: NOELN	
Sample 1/10/1997 1/29/2010	
Observations 680	
Mean	0.001628
Median	0.004935
Maximum	0.233024
Minimum	-0.213396
Std. Dev.	0.048490
Skewness	-0.219685
Kurtosis	4.998136
Jarque-Bera	118.5918
Probability	0.000000





Series: OMN	
Sample 1/03/1997 1/23/2010	
Observations 681	
Mean	40.30
Median	28.50
Maximum	137.45
Minimum	9.50
Std. Dev.	26.08
Skewness	1.22
Kurtosis	4.21
Jarque-Bera	212.48
Probability	0.00


OMNLN
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.1
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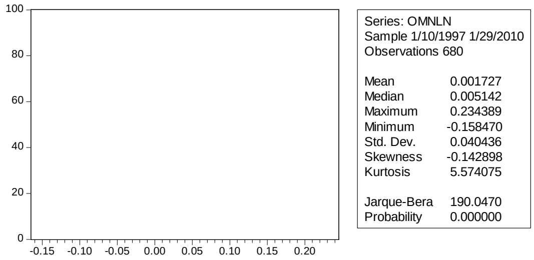
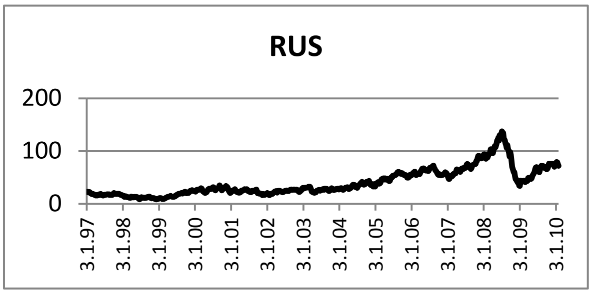
-.1
-.2
1998
2000
2002
2004
2006
2008


Series: OMNLN
Sample 1/10/1997 1/29/2010
Observations 680
Mean 0.001727
Median 0.005142
Maximum 0.234389
Minimum -0.158470
Std. Dev. 0.040436
Skewness -0.142898
Kurtosis 5.574075
Jarque-Bera 190.0470
Probability 0.000000


RUS
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3.1.97
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3.1.99
3.1.00
3.1.01
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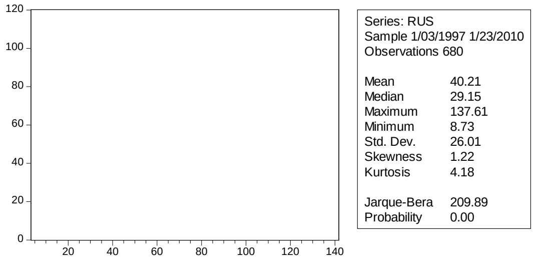
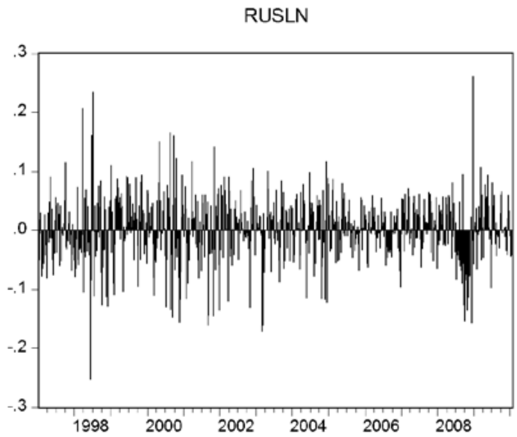
3.1.05
3.1.06
3.1.07
3.1.08
3.1.09
3.1.10


Series: RUS
Sample 1/03/1997 1/23/2010
Observations 680
Mean 40.21
Median 29.15
Maximum 137.61
Minimum 8.73
Std. Dev. 26.01
Skewness 1.22
Kurtosis 4.18
Jarque-Bera 209.89
Probability 0.00


RUSLN
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-.2
-.3
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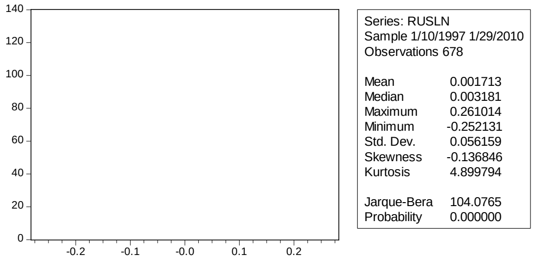
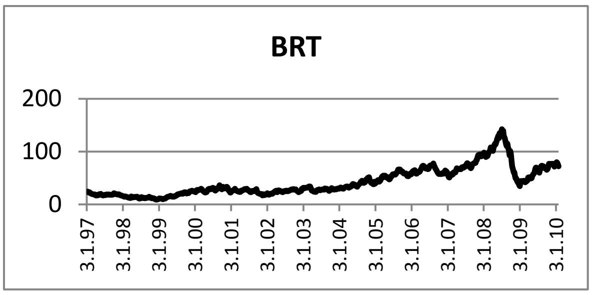
2000
2002
2004
2006
2008


Series: RUSLN
Sample 1/10/1997 1/29/2010
Observations 678
Mean 0.001713
Median 0.003181
Maximum 0.261014
Minimum -0.252131
Std. Dev. 0.056159
Skewness -0.136846
Kurtosis 4.899794
Jarque-Bera 104.0765
Probability 0.000000


BRT
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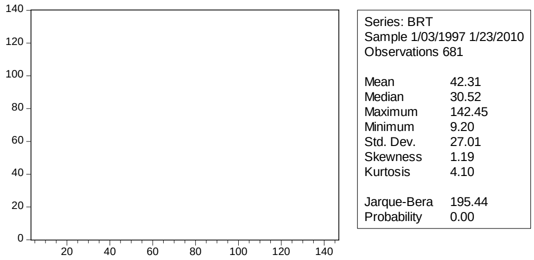
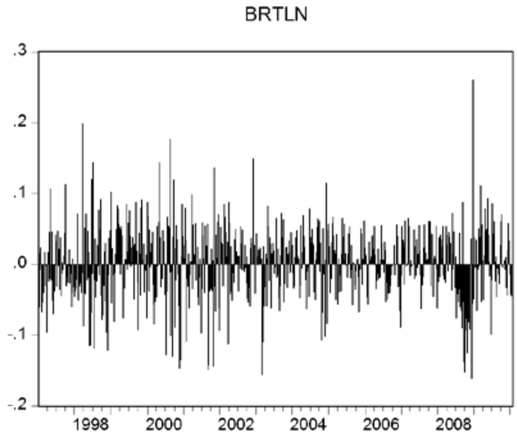
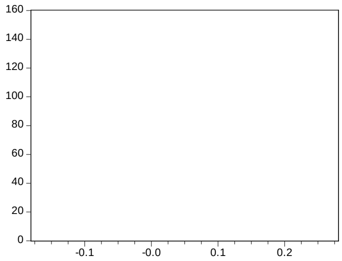
3.1.10


Series: BRT
Sample 1/03/1997 1/23/2010
Observations 681
Mean 42.31
Median 30.52
Maximum 142.45
Minimum 9.20
Std. Dev. 27.01
Skewness 1.19
Kurtosis 4.10
Jarque-Bera 195.44
Probability 0.00



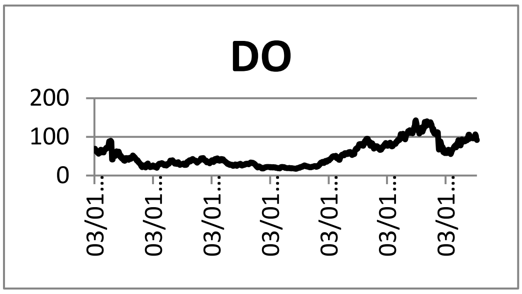


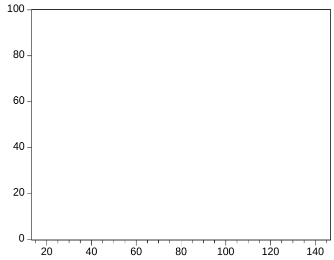
Series: BRTLN
Sample 1/10/1997 1/29/2010
Observations 680

Mean	0.001619
Median	0.003399
Maximum	0.259919
Minimum	-0.161637
Std. Dev.	0.050759
Skewness	-0.011264
Kurtosis	4.660857
Jarque-Bera	78.17030
Probability	0.000000

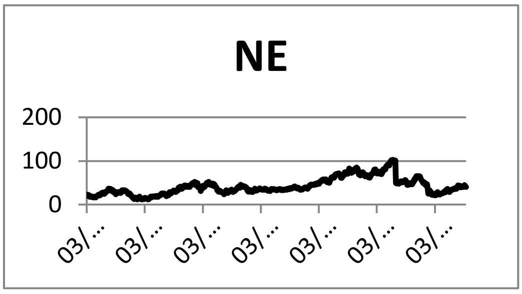
Appendix 6: Charts and descriptive statistics for Drilling and Exploration (DE) upstream stocks

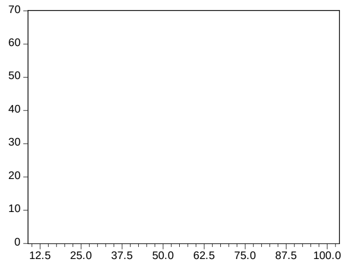
Sector	Stock*	Company
Upstream		
DE	DO	Dimon Offshore Drilling Inc
	NE	Noble Corp.
	ESV	Ensco plc.
	RIG	Transoceanic Inc
	ATW	Atood Oceanics, Inc
	PKD	Parker Drilling
	PTEN	Patterson-UTI Energy, Inc.
	PDE	Pride International, Inc.



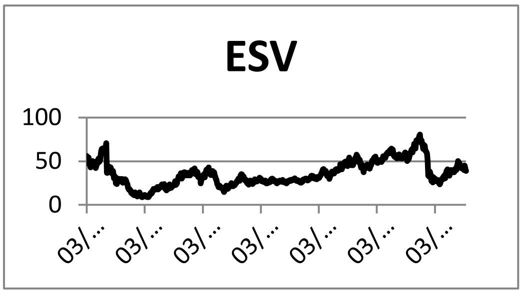


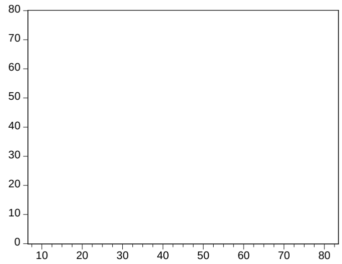
Series: DO	
Sample 1/03/1997 1/23/2010	
Observations 681	
Mean	53.82
Median	42.46
Maximum	143.07
Minimum	17.42
Std. Dev.	31.05
Skewness	0.87
Kurtosis	2.76
Jarque-Bera	88.04
Probability	0.00



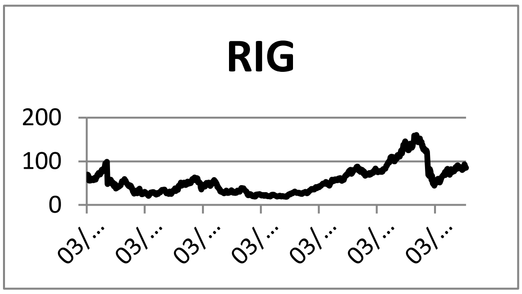


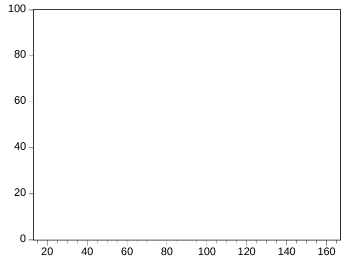
Series: NE	
Sample 1/03/1997 1/23/2010	
Observations 681	
Mean	41.89
Median	36.96
Maximum	102.46
Minimum	12.00
Std. Dev.	18.91
Skewness	0.91
Kurtosis	3.41
Jarque-Bera	100.04
Probability	0.00



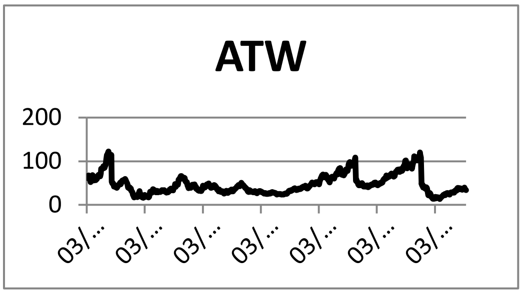


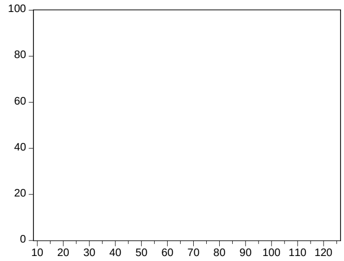
Series: ESV	
Sample 1/03/1997 1/23/2010	
Observations 681	
Mean	35.81
Median	32.62
Maximum	80.68
Minimum	8.81
Std. Dev.	14.29
Skewness	0.54
Kurtosis	2.85
Jarque-Bera	34.11
Probability	0.00



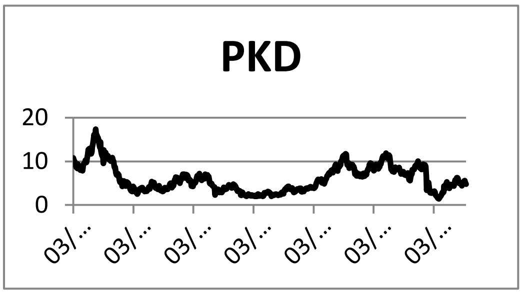


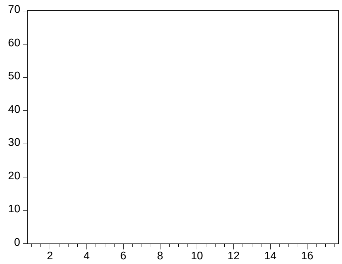
Series: RIG	
Sample 1/03/1997 1/23/2010	
Observations 681	
Mean	56.05
Median	49.31
Maximum	160.54
Minimum	18.74
Std. Dev.	31.88
Skewness	1.168
Kurtosis	3.91
Jarque-Bera	178.98
Probability	0.00



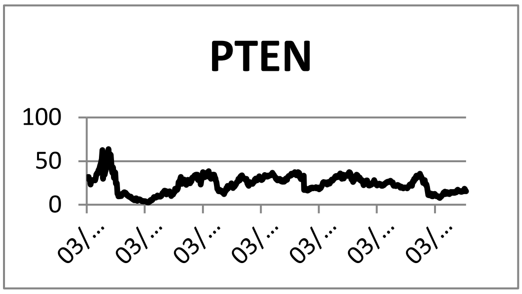


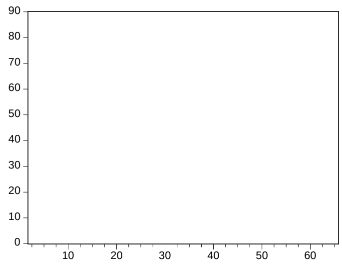
Series: ATW	
Sample 1/03/1997 1/23/2010	
Observations 681	
Mean	47.23
Median	41.58
Maximum	121.94
Minimum	13.57
Std. Dev.	22.71
Skewness	1.09
Kurtosis	3.67
Jarque-Bera	147.48
Probability	0.00



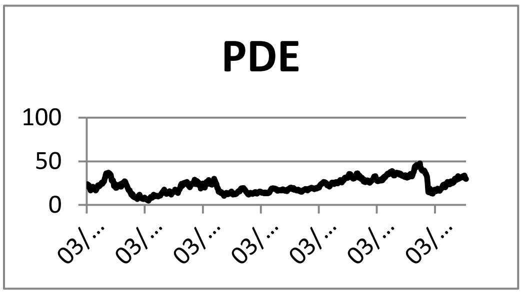


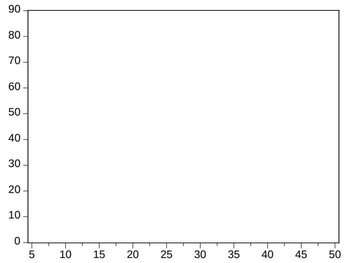
Series: PKD	
Sample 1/03/1997 1/23/2010	
Observations 681	
Mean	5.96
Median	5.19
Maximum	17.38
Minimum	1.40
Std. Dev.	3.04
Skewness	0.85
Kurtosis	3.27
Jarque-Bera	84.82
Probability	0.00





Series: PTEN	
Sample 1/03/1997 1/23/2010	
Observations 681	
Mean	23.71
Median	24.90
Maximum	63.88
Minimum	2.81
Std. Dev.	9.97
Skewness	0.17
Kurtosis	3.48
Jarque-Bera	10.33
Probability	0.00



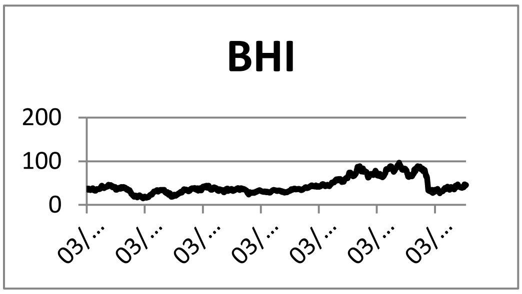


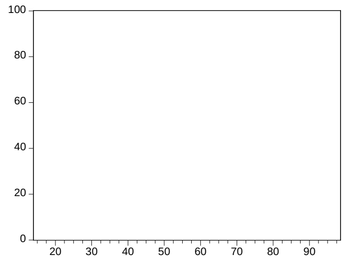
Series: PDE
Sample 1/03/1997 1/23/2010
Observations 681

Mean	22.35
Median	21.69
Maximum	47.79
Minimum	5.00
Std. Dev.	8.48
Skewness	0.37
Kurtosis	2.53
Jarque-Bera	22.16
Probability	0.00

Appendix 7: Charts and descriptive statistics for Equipment and Services (ES) upstream stocks

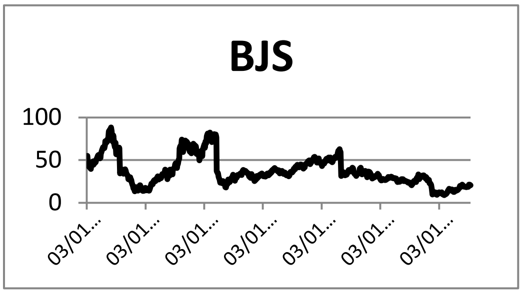
Sector	Stock	Company
Upstream		
ES	BHI	Baker Hughes, Inc.
	BJS	BJ Services
	HAL	Halliburton Co.
	SII	Smith International, Inc.
	WFT	Weatherford International
	TESO	Tesco Corporation
	SLB	Schlumberger Limt.
	RES	RPC, Inc.

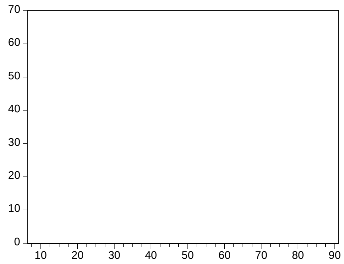




Series: BHI
Sample 1/03/1997 1/23/2010
Observations 681

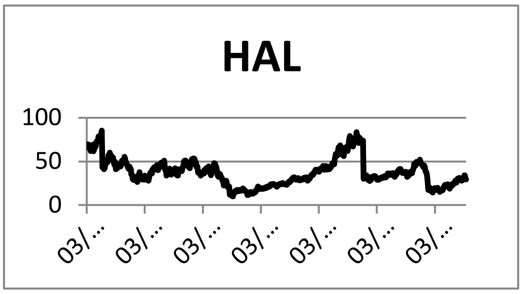
Mean	43.99
Median	36.94
Maximum	96.60
Minimum	15.03
Std. Dev.	18.58
Skewness	1.04
Kurtosis	2.96
Jarque-Bera	124.13
Probability	0.00

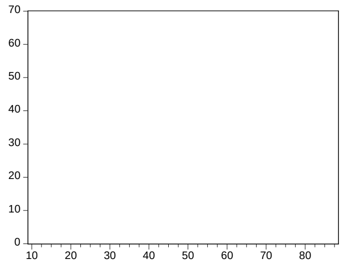




Series: BJS
Sample 1/03/1997 1/23/2010
Observations 681

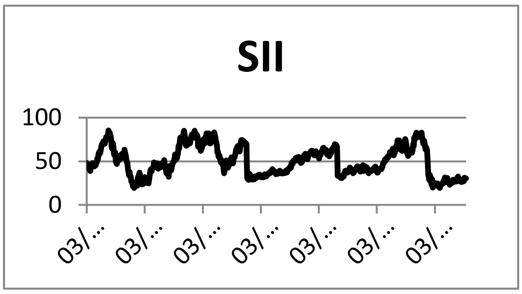
Mean	37.15
Median	33.59
Maximum	88.13
Minimum	9.07
Std. Dev.	16.81
Skewness	0.78
Kurtosis	3.11
Jarque-Bera	69.99
Probability	0.00

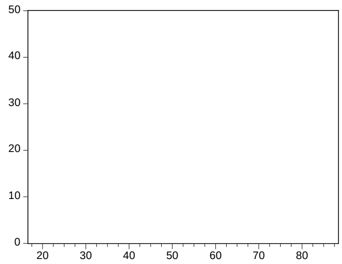




Series: HAL
Sample 1/03/1997 1/23/2010
Observations 681

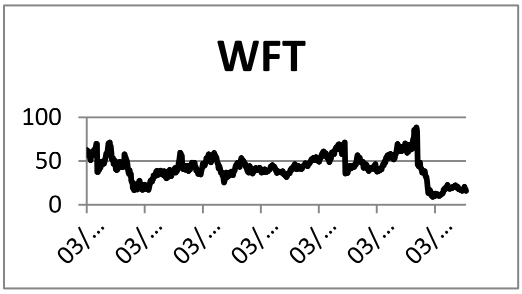
Mean	37.30
Median	35.51
Maximum	85.27
Minimum	10.06
Std. Dev.	15.49
Skewness	0.75
Kurtosis	3.27
Jarque-Bera	67.36
Probability	0.00

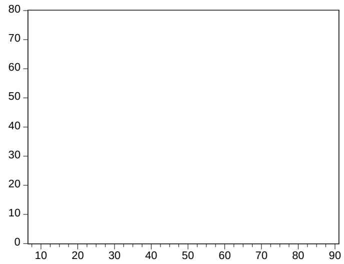




Series: SII
Sample 1/03/1997 1/23/2010
Observations 681

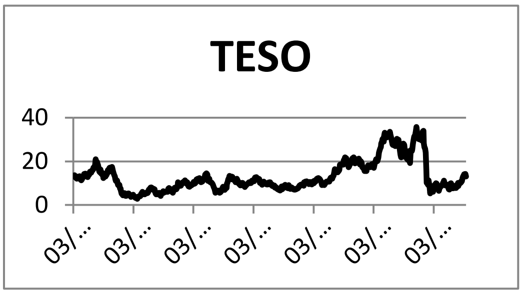
Mean	49.68
Median	48.00
Maximum	85.25
Minimum	19.55
Std. Dev.	16.72
Skewness	0.22
Kurtosis	1.96
Jarque-Bera	35.95587
Probability	0.000000

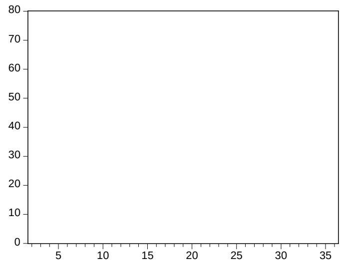




Series: WFT
Sample 1/03/1997 1/23/2010
Observations 681

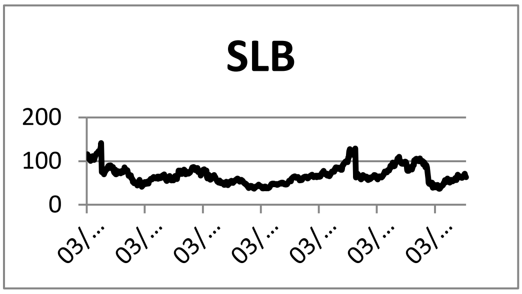
Mean	42.45
Median	42.40
Maximum	88.60
Minimum	8.98
Std. Dev.	14.4
Skewness	-0.10
Kurtosis	3.09
Jarque-Bera	1.48
Probability	0.47

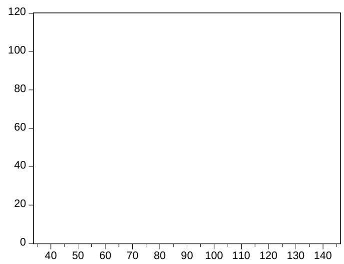




Series: TESO
Sample 1/03/1997 1/23/2010
Observations 681

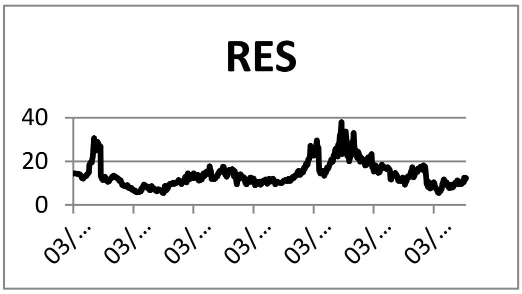
Mean	12.87
Median	10.50
Maximum	35.64
Minimum	2.87
Std. Dev.	7.02
Skewness	1.26
Kurtosis	3.93
Jarque-Bera	205.06
Probability	0.00

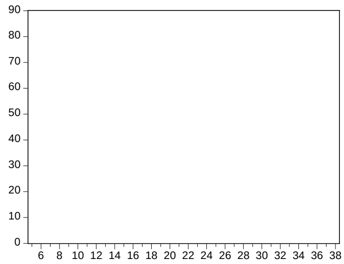




Series: SLB
Sample 1/03/1997 1/23/2010
Observations 681

Mean	68.17
Median	64.31
Maximum	141.50
Minimum	36.67
Std. Dev.	19.98
Skewness	0.86
Kurtosis	3.43
Jarque-Bera	90.34
Probability	0.00



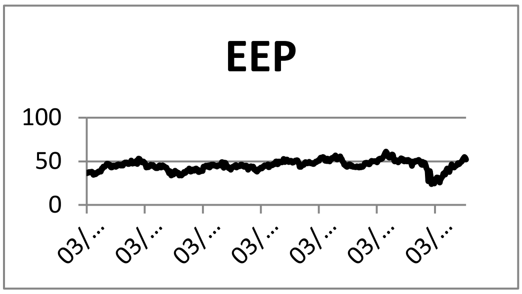


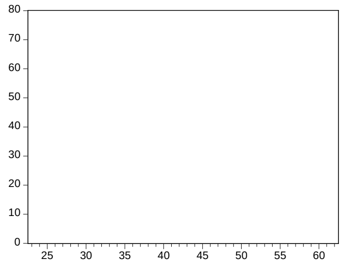
Series: RES
Sample 1/03/1997 1/23/2010
Observations 681

Mean	13.89
Median	12.57
Maximum	37.90
Minimum	5.41
Std. Dev.	5.57
Skewness	1.20
Kurtosis	4.39
Jarque-Bera	220.37
Probability	0.00

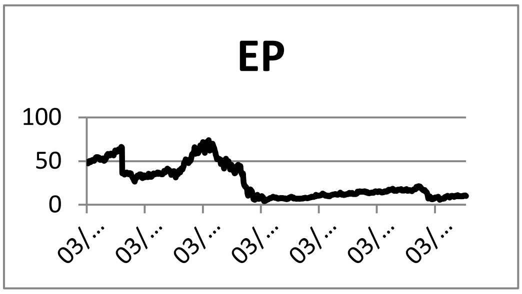
Appendix 8: Charts and descriptive statistics for Pipeline (PIP) downstream stocks

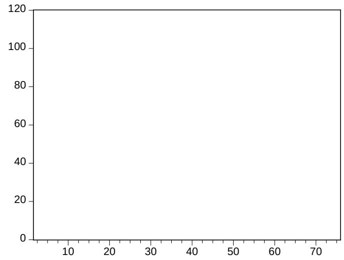
Sector	Stock	Company
Downstream		
PIP	EEP	Enbridge Energy Partners L.P.
	EP	El Paso Corp.
	ETP	Energy Transfer Partners, L.P.
	KMP	Kunder Morgan Energy
	WMB	Williams Companies Inc
	TCLP	TC Pipelines, L.P.
	PAA	Plains All American Pipeline
	OKS	Oneok Partners, L.P.



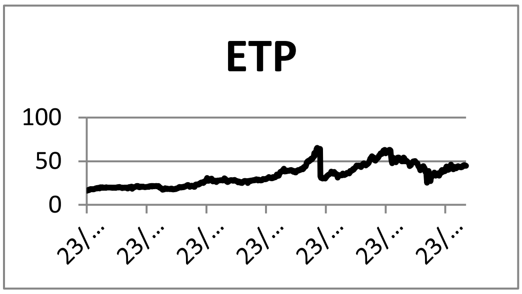


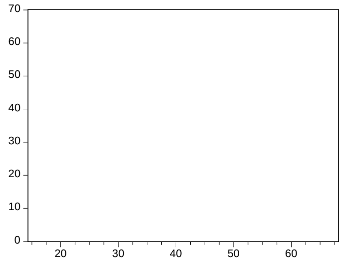
Series: EEP	
Sample 1/03/1997 1/23/2010	
Observations 681	
Mean	45.33
Median	45.49
Maximum	61.19
Minimum	23.78
Std. Dev.	5.93
Skewness	-0.65
Kurtosis	3.86
Jarque-Bera	69.86
Probability	0.00



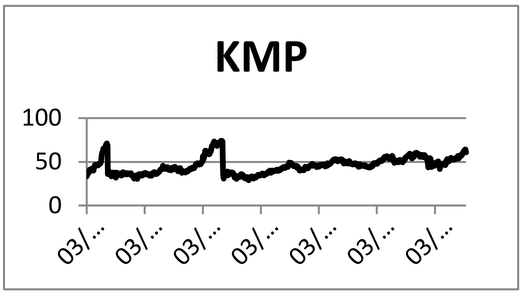


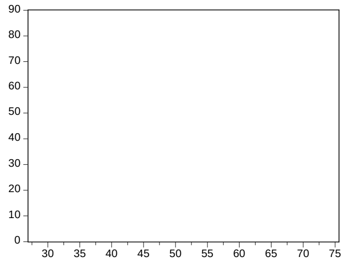
Series: EP	
Sample 1/03/1997 1/23/2010	
Observations 681	
Mean	26.08
Median	16.29
Maximum	73.93
Minimum	4.19
Std. Dev.	19.07
Skewness	0.73
Kurtosis	2.16
Jarque-Bera	81.68
Probability	0.00



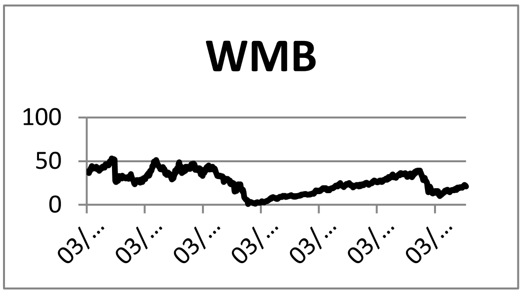


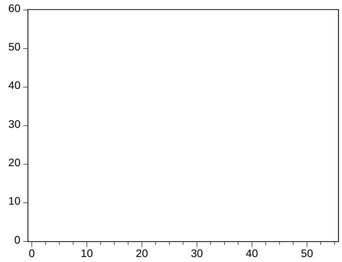
Series: ETP	
Sample 5/21/1999 1/23/2010	
Observations 557	
Mean	36.25
Median	35.20
Maximum	65.10
Minimum	17.45
Std. Dev.	11.67
Skewness	0.39
Kurtosis	2.36
Jarque-Bera	23.70
Probability	0.00





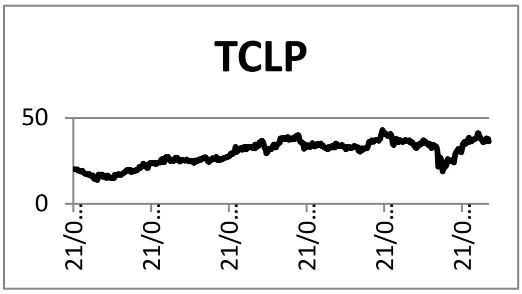
Series: KMP	
Sample 1/03/1997 1/23/2010	
Observations 681	
Mean	45.67
Median	45.31
Maximum	74.06
Minimum	29.15
Std. Dev.	9.21
Skewness	0.68
Kurtosis	3.24
Jarque-Bera	54.90
Probability	0.00

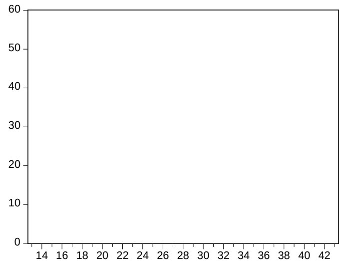




Series: WMB
Sample 1/03/1997 1/23/2010
Observations 681

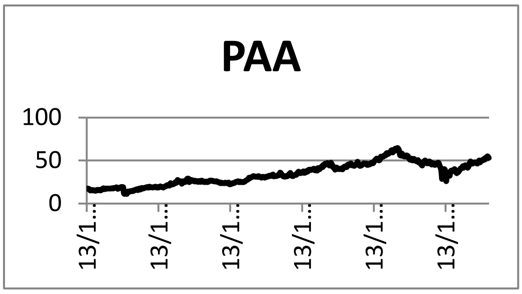
Mean	25.93
Median	26.24
Maximum	53.06
Minimum	0.99
Std. Dev.	12.57
Skewness	-0.058
Kurtosis	2.06
Jarque-Bera	25.53
Probability	0.00

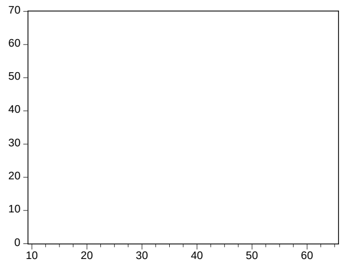




Series: TCLP
Sample 5/21/1999 1/23/2010
Observations 557

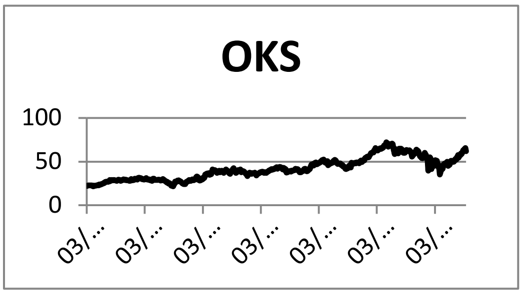
Mean	29.47
Median	32.11
Maximum	42.83
Minimum	13.75
Std. Dev.	7.04
Skewness	-0.48
Kurtosis	2.12
Jarque-Bera	39.44
Probability	0.00

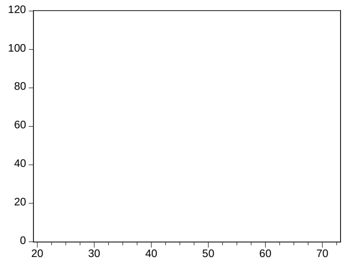




Series: PAA
Sample 5/21/1999 1/23/2010
Observations 557

Mean	35.27
Median	34.01
Maximum	64.73
Minimum	10.91
Std. Dev.	12.59
Skewness	0.15
Kurtosis	2.01
Jarque-Bera	24.67
Probability	0.00



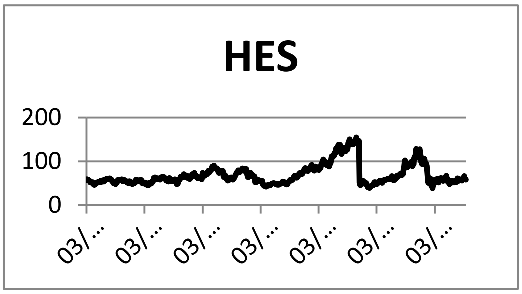


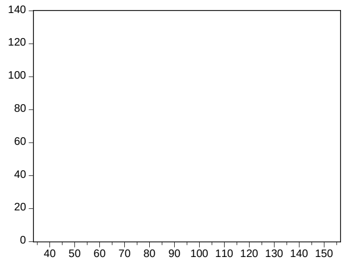
Series: OKS
Sample 1/03/1997 1/23/2010
Observations 681

Mean	41.67
Median	39.86
Maximum	71.93
Minimum	21.73
Std. Dev.	12.49
Skewness	0.42
Kurtosis	2.25
Jarque-Bera	36.35
Probability	0.00

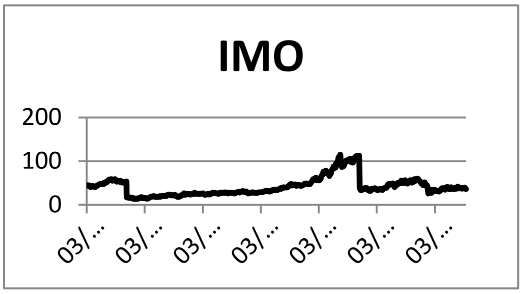
Appendix 9: Charts and descriptive statistics for Refinery and Marketing (RM) downstream stocks

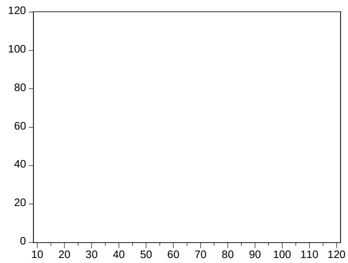
Sector	Stock*	Company
Downstream		
RM	HES	Hess Corporation
	IMO	Imperial Oil Ltd
	MRO	Marathon Oil Corp.
	MUR	Murphy Oil Corporation
	SUN	Sunco, Inc.
	TSO	Tesoro Corporation
	HOC	Holly Corporation
	SSL	Sasol Ltd.



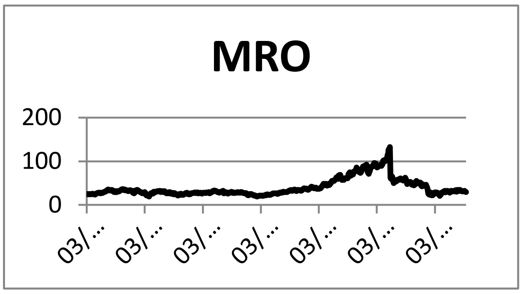


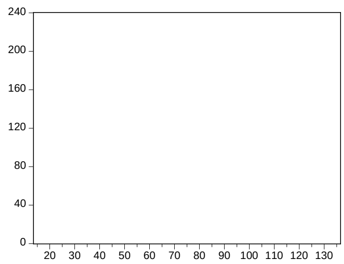
Series: HES	
Sample 1/03/1997 1/23/2010	
Observations 681	
Mean	68.87
Median	59.87
Maximum	154.45
Minimum	38.49
Std. Dev.	23.77
Skewness	1.62
Kurtosis	5.11
Jarque-Bera	427.88
Probability	0.00



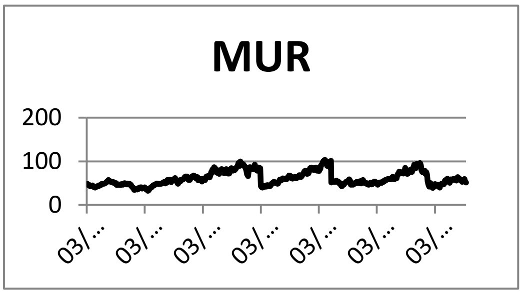


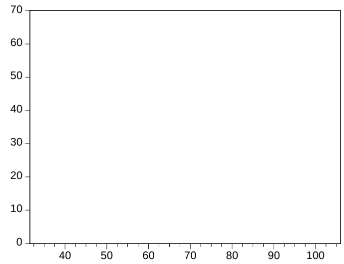
Series: IMO	
Sample 1/03/1997 1/23/2010	
Observations 681	
Mean	41.18
Median	37.05
Maximum	115.06
Minimum	13.42
Std. Dev.	20.93
Skewness	1.47
Kurtosis	5.17
Jarque-Bera	380.04
Probability	0.00





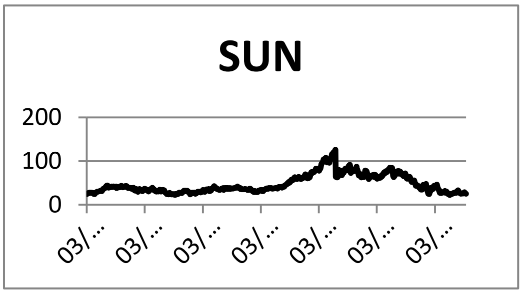
Series: MRO	
Sample 1/03/1997 1/23/2010	
Observations 681	
Mean	39.65
Median	31.08
Maximum	132.51
Minimum	19.00
Std. Dev.	20.26
Skewness	1.79
Kurtosis	5.79
Jarque-Bera	586.88
Probability	0.00

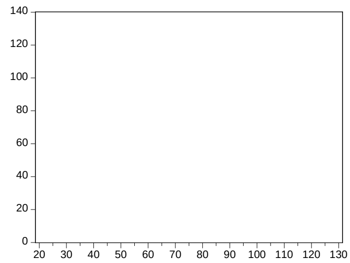




Series: MUR
Sample 1/03/1997 1/23/2010
Observations 681

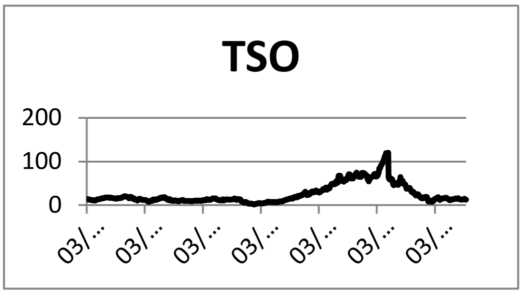
Mean	60.53
Median	56.58
Maximum	103.37
Minimum	32.78
Std. Dev.	15.74
Skewness	0.66
Kurtosis	2.47
Jarque-Bera	57.21
Probability	0.00

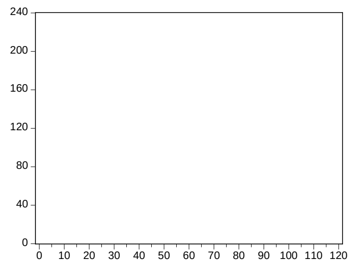




Series: SUN
Sample 1/03/1997 1/23/2010
Observations 681

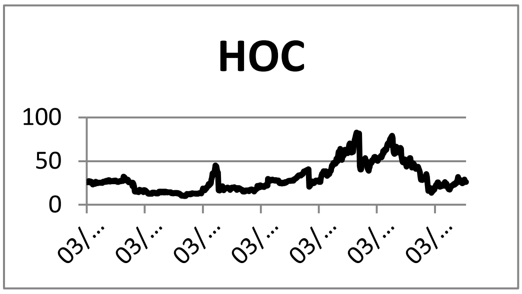
Mean	47.13
Median	38.16
Maximum	125.73
Minimum	22.09
Std. Dev.	21.06
Skewness	1.14
Kurtosis	3.66
Jarque-Bera	162.05
Probability	0.00

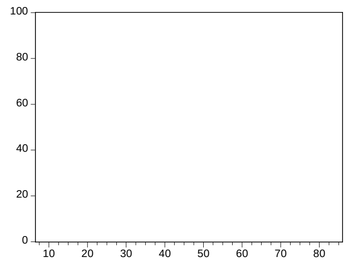




Series: TSO
Sample 1/03/1997 2/23/2010
Observations 681

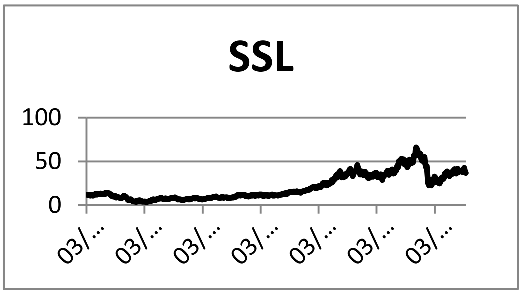
Mean	25.16
Median	15.12
Maximum	119.79
Minimum	1.71
Std. Dev.	22.63
Skewness	1.70
Kurtosis	5.53
Jarque-Bera	513.03
Probability	0.00

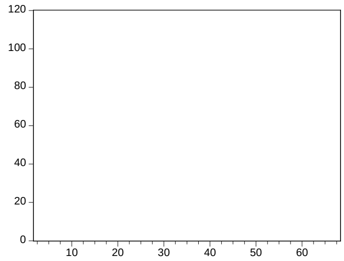




Series: HOC
Sample 1/03/1997 1/23/2010
Observations 681

Mean	30.41
Median	26.10
Maximum	82.72
Minimum	9.88
Std. Dev.	16.35
Skewness	1.12
Kurtosis	3.47
Jarque-Bera	149.33
Probability	0.00





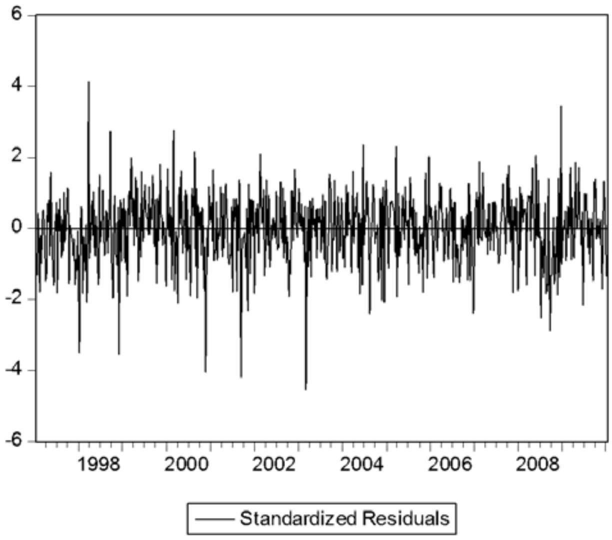
Series: SSL
Sample 1/03/1997 1/23/2010
Observations 681

Mean	20.58
Median	12.88
Maximum	65.94
Minimum	3.56
Std. Dev.	14.73
Skewness	0.83
Kurtosis	2.55
Jarque-Bera	84.91
Probability	0.00

Appendix 10: Residual analysis for the GARCH application to crude oil prices

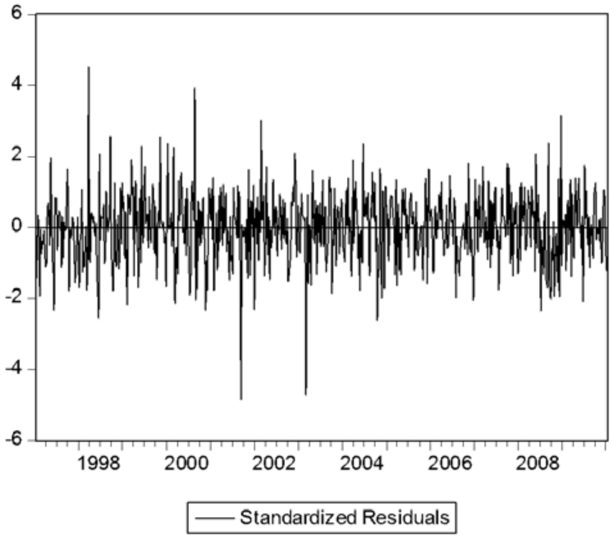
ADM: 1/17/1997 1/15/2010
Included observations: 679

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
.|. |	.|. |	1	0.019	0.019	0.2375	0.626
.|. |	.|. |	2	-0.049	-0.05	1.8911	0.388
.|* |	.|* |	3	0.094	0.096	7.8925	0.048
.|. |	.|. |	4	-0.029	-0.036	8.4705	0.076
.|. |	.|. |	5	0.059	0.071	10.851	0.054
.|. |	.|. |	6	-0.036	-0.053	11.736	0.068
.|. |	.|. |	7	0.006	0.022	11.757	0.109
.|. |	.|. |	8	0.008	-0.012	11.802	0.16
.|. |	.|. |	9	0.038	0.055	12.825	0.171
.|. |	.|. |	21	0.02	0.013	17.461	0.683
.|. |	.|. |	22	0.04	0.046	18.584	0.671
.|. |	.|. |	23	-0.029	-0.029	19.195	0.69
.|. |	.|. |	24	-0.016	-0.007	19.38	0.731
.|. |	.|. |	25	-0.016	-0.025	19.556	0.77
.|. |	.|. |	26	0.024	0.028	19.971	0.793
.|. |	*|. |	27	-0.062	-0.073	22.729	0.699
.|. |	.|. |	88	-0.033	-0.045	99.75	0.184
.|. |	.|. |	89	-0.055	-0.059	102.08	0.162
.|. |	.|. |	90	0.017	0.004	102.32	0.177



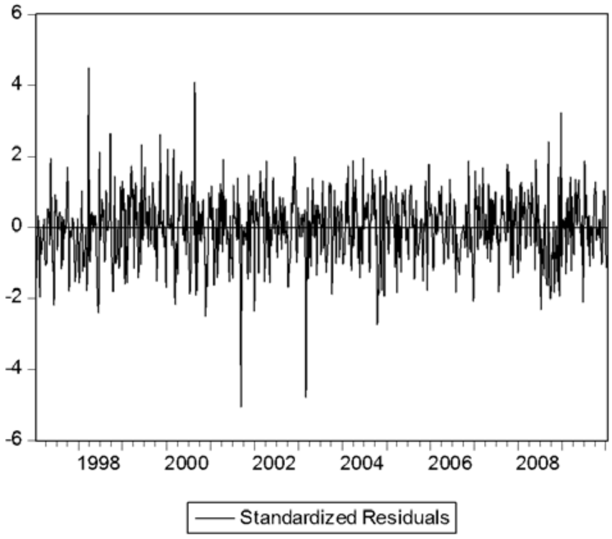
ASB: 1/17/1997 1/15/2010
Included observations: 679

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
.|. |	.|. |	1	0.028	0.028	0.5486	0.459
.|. |	.|. |	2	-0.048	-0.049	2.1283	0.345
.|. |	.|. |	3	0.053	0.056	4.029	0.258
*|. |	*|. |	4	-0.075	-0.081	7.8781	0.096
.|. |	.|. |	5	-0.016	-0.005	8.0447	0.154
.|. |	.|. |	6	-0.05	-0.061	9.7746	0.134
.|. |	.|. |	7	-0.059	-0.048	12.188	0.095
.|. |	.|. |	8	0.014	0.006	12.318	0.138
.|. |	.|. |	9	0.036	0.034	13.191	0.154
.|. |	.|. |	21	0.046	0.043	17.719	0.667
.|. |	.|. |	22	0.068	0.067	20.977	0.522
.|. |	.|. |	23	-0.035	-0.036	21.845	0.53
.|. |	.|. |	24	-0.028	-0.026	22.386	0.556
.|. |	.|. |	25	-0.004	-0.008	22.395	0.613
.|. |	.|. |	26	0.011	0.018	22.484	0.662
.|. |	.|. |	27	-0.045	-0.049	23.908	0.635
.|. |	.|. |	88	-0.014	-0.035	93.943	0.313
.|. |	.|. |	89	-0.017	-0.005	94.166	0.334
.|. |	.|. |	90	-0.011	-0.011	94.268	0.358



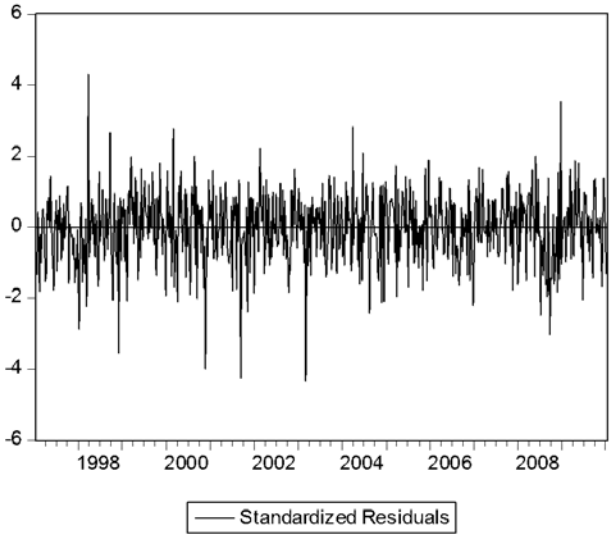
ANC: 1/17/1997 1/15/2010
Included observations: 679

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
.|. |	.|. |	1	0.03	0.03	0.6094	0.435
.|. |	.|. |	2	-0.058	-0.059	2.9197	0.232
.|. |	.|. |	3	0.048	0.051	4.4672	0.215
*|. |	*|. |	4	-0.07	-0.078	7.8695	0.096
.|. |	.|. |	5	-0.009	0.003	7.92	0.161
.|. |	*|. |	6	-0.054	-0.067	9.9419	0.127
.|. |	.|. |	7	-0.064	-0.053	12.725	0.079
.|. |	.|. |	8	0.036	0.028	13.632	0.092
.|. |	.|. |	9	0.03	0.026	14.259	0.113
.|. |	.|. |	21	0.043	0.037	19.996	0.521
.|. |	.|. |	22	0.072	0.071	23.668	0.365
.|. |	.|. |	23	-0.054	-0.053	25.736	0.313
.|. |	.|. |	24	-0.011	-0.005	25.827	0.362
.|. |	.|. |	25	-0.004	-0.013	25.836	0.416
.|. |	.|. |	26	-0.005	0.002	25.854	0.471
.|. |	.|. |	27	-0.055	-0.063	27.986	0.412
.|. |	.|. |	88	-0.012	-0.035	96.1	0.26
.|. |	.|. |	89	-0.003	0.01	96.107	0.285
.|. |	.|. |	90	-0.021	-0.021	96.454	0.302



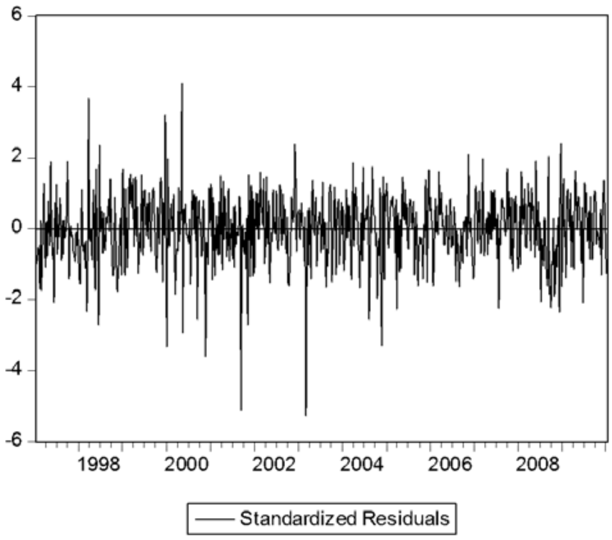
DUB: 1/17/1997 1/15/2010
Included observations: 679

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
.|. |	.|. |	1	0.02	0.02	0.261	0.609
.|. |	.|. |	2	-0.056	-0.056	2.3748	0.305
.|* |	.|* |	3	0.083	0.086	7.1408	0.068
.|. |	.|. |	4	-0.038	-0.045	8.1043	0.088
.|. |	.|. |	5	0.053	0.065	10.004	0.075
.|. |	.|. |	6	-0.048	-0.065	11.596	0.072
.|. |	.|. |	7	-0.002	0.017	11.599	0.115
.|. |	.|. |	8	0.014	-0.006	11.738	0.163
.|. |	.|. |	9	0.054	0.071	13.729	0.132
.|. |	.|. |	21	0.037	0.021	21.045	0.456
.|. |	.|. |	22	0.031	0.042	21.725	0.476
.|. |	.|. |	23	-0.025	-0.024	22.156	0.511
.|. |	.|. |	24	-0.018	-0.008	22.389	0.556
.|. |	.|. |	25	-0.025	-0.033	22.831	0.587
.|. |	.|. |	26	0.026	0.025	23.295	0.616
.|. |	*|. |	27	-0.061	-0.071	25.957	0.521
.|. |	*|. |	88	-0.051	-0.069	100.97	0.163
.|. |	.|. |	89	-0.041	-0.038	102.27	0.159
.|. |	.|. |	90	0.014	-0.006	102.42	0.175



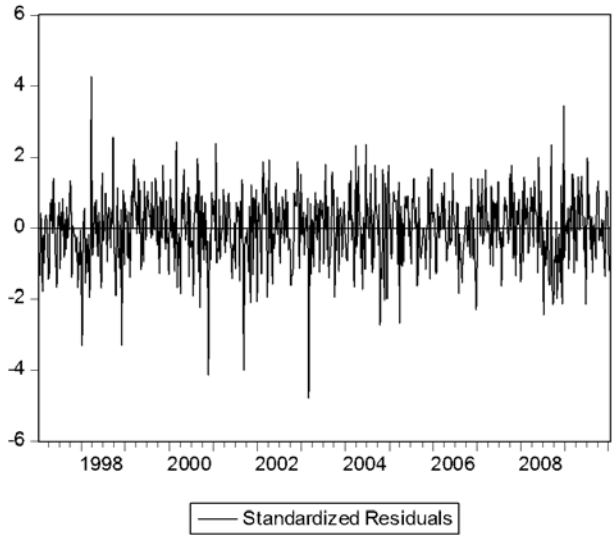
ECU: 1/17/1997 1/15/2010
Included observations: 679

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
.|. |	.|. |	1	0.015	0.015	0.158	0.691
*|. |	*|. |	2	-0.074	-0.074	3.8606	0.145
.|* |	.|* |	3	0.076	0.078	7.7603	0.051
.|. |	.|. |	4	0.008	0	7.8064	0.099
.|. |	.|. |	5	0.039	0.051	8.8321	0.116
.|. |	.|. |	6	-0.037	-0.045	9.7952	0.134
*|. |	*|. |	7	-0.101	-0.095	16.872	0.018
.|. |	.|. |	8	0.067	0.06	19.988	0.01
.|. |	.|. |	9	0.058	0.048	22.328	0.008
.|. |	.|. |	21	0.018	0.03	34.071	0.036
.|* |	.|. |	22	0.092	0.072	40.012	0.011
.|. |	.|. |	23	-0.033	-0.048	40.784	0.013
.|. |	.|. |	24	0.002	0.028	40.787	0.018
.|. |	.|. |	25	-0.027	-0.035	41.29	0.021
.|. |	.|. |	26	0.044	0.051	42.682	0.021
*|. |	*|. |	27	-0.071	-0.101	46.258	0.012
.|. |	.|. |	88	0.016	-0.005	111.15	0.048
.|. |	.|. |	89	-0.008	-0.024	111.2	0.056
.|. |	.|. |	90	-0.001	-0.004	111.2	0.064



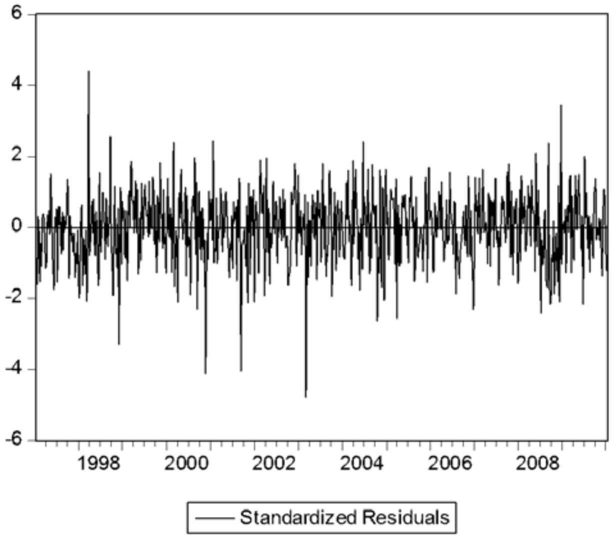
IRH: 1/17/1997 1/15/2010
Included observations: 679

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
.|. |	.|. |	1	0.023	0.023	0.3474	0.556
.|. |	.|. |	2	-0.046	-0.047	1.7999	0.407
.|* |	.|* |	3	0.092	0.094	7.5297	0.057
.|. |	*|. |	4	-0.06	-0.068	10.035	0.04
.|. |	.|. |	5	0.028	0.041	10.568	0.061
.|. |	.|. |	6	-0.039	-0.058	11.622	0.071
.|. |	.|. |	7	-0.012	0.008	11.713	0.11
.|. |	.|. |	8	0.028	0.012	12.245	0.141
.|. |	.|. |	9	0.021	0.033	12.536	0.185
.|. |	.|. |	21	0.063	0.045	20.444	0.493
.|. |	.|. |	22	0.018	0.034	20.674	0.541
.|. |	.|. |	23	-0.006	-0.015	20.699	0.599
.|. |	.|. |	24	0.001	0.003	20.7	0.656
.|. |	.|. |	25	-0.045	-0.049	22.151	0.627
.|. |	.|. |	26	0.007	0.013	22.184	0.679
*|. |	*|. |	27	-0.072	-0.077	25.828	0.528
.|. |	*|. |	88	-0.047	-0.069	95.795	0.267
.|. |	.|. |	89	-0.033	-0.005	96.636	0.272
.|. |	.|. |	90	0.013	-0.025	96.774	0.294



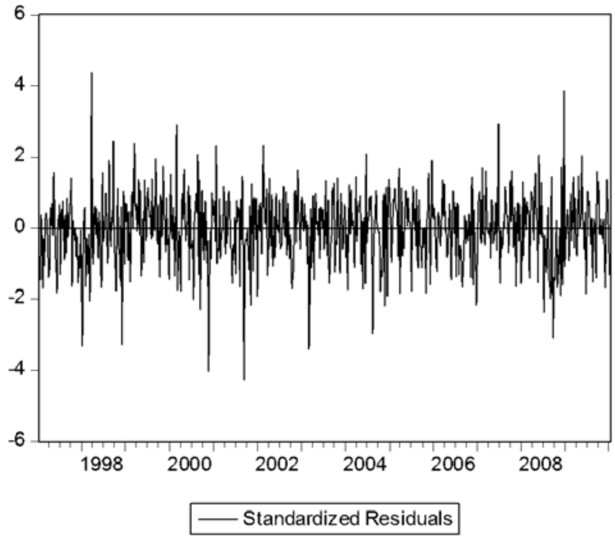
IRL: 1/17/1997 1/15/2010
Included observations: 679

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
.|. |	.|. |	1	0.02	0.02	0.2743	0.6
.|. |	.|. |	2	-0.043	-0.043	1.5267	0.466
.|* |	.|* |	3	0.097	0.099	7.9067	0.048
*|. |	*|. |	4	-0.069	-0.076	11.127	0.025
.|. |	.|. |	5	0.032	0.045	11.81	0.037
.|. |	.|. |	6	-0.044	-0.064	13.145	0.041
.|. |	.|. |	7	-0.021	0.001	13.448	0.062
.|. |	.|. |	8	0.035	0.017	14.298	0.074
.|. |	.|. |	9	0.029	0.044	14.893	0.094
.|. |	.|. |	21	0.063	0.05	21.871	0.407
.|. |	.|. |	22	0.03	0.04	22.498	0.431
.|. |	.|. |	23	-0.006	-0.011	22.525	0.489
.|. |	.|. |	24	0.004	0	22.533	0.547
.|. |	.|. |	25	-0.044	-0.044	23.884	0.526
.|. |	.|. |	26	0.007	0.012	23.918	0.581
*|. |	*|. |	27	-0.073	-0.078	27.687	0.427
.|. |	.|. |	88	-0.038	-0.065	97.697	0.225
.|. |	.|. |	89	-0.029	-0.007	98.358	0.233
.|. |	.|. |	90	0.005	-0.022	98.378	0.256



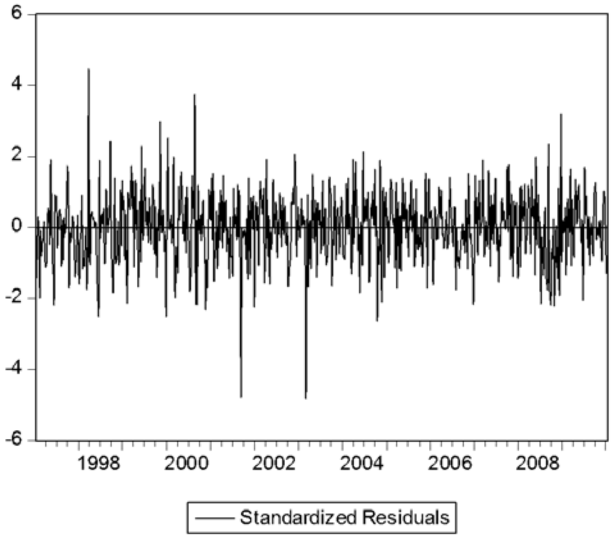
KUT: 1/17/1997 1/15/2010
Included observations: 679

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
.|. |	.|. |	1	0.019	0.019	0.2446	0.621
.|. |	.|. |	2	-0.055	-0.056	2.3306	0.312
.|* |	.|* |	3	0.095	0.097	8.4582	0.037
.|. |	.|. |	4	-0.034	-0.042	9.263	0.055
.|. |	.|* |	5	0.061	0.075	11.814	0.037
.|. |	.|. |	6	-0.041	-0.06	12.989	0.043
.|. |	.|. |	7	-0.005	0.015	13.007	0.072
.|. |	.|. |	8	0.018	-0.004	13.233	0.104
.|. |	.|. |	9	0.051	0.068	15.015	0.091
.|. |	.|. |	21	0.039	0.026	21.299	0.441
.|. |	.|. |	22	0.018	0.028	21.52	0.489
.|. |	.|. |	23	-0.013	-0.013	21.639	0.542
.|. |	.|. |	24	-0.032	-0.028	22.349	0.558
.|. |	.|. |	25	-0.021	-0.021	22.649	0.598
.|. |	.|. |	26	0.015	0.01	22.804	0.644
.|. |	*|. |	27	-0.064	-0.066	25.713	0.535
.|. |	.|. |	88	-0.033	-0.04	101.65	0.152
.|. |	.|. |	89	-0.043	-0.064	103.09	0.146
.|. |	.|. |	90	0.012	-0.002	103.2	0.161



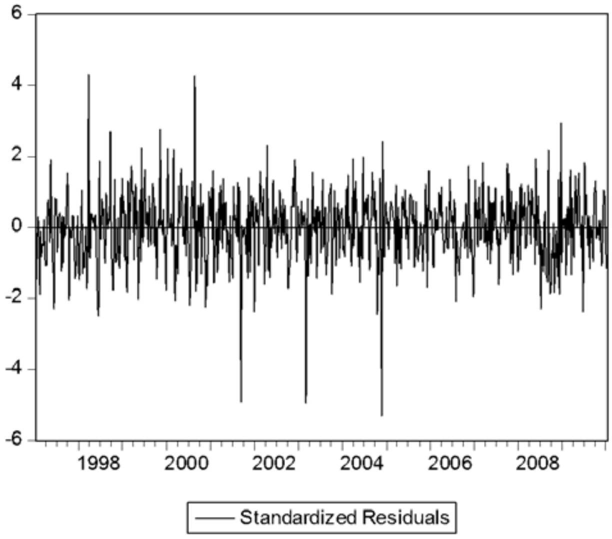
LIB: 1/17/1997 1/15/2010
Included observations: 679

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
.|. |	.|. |	1	0.028	0.028	0.5419	0.462
.|. |	.|. |	2	-0.048	-0.048	2.0892	0.352
.|. |	.|. |	3	0.044	0.047	3.4133	0.332
*|. |	*|. |	4	-0.075	-0.08	7.2254	0.124
.|. |	.|. |	5	0.003	0.013	7.2338	0.204
.|. |	.|. |	6	-0.034	-0.045	8.0156	0.237
*|. |	*|. |	7	-0.078	-0.068	12.171	0.095
.|. |	.|. |	8	0.032	0.026	12.869	0.116
.|. |	.|. |	9	0.041	0.037	14.042	0.121
.|. |	.|. |	21	0.028	0.024	18.271	0.632
.|. |	.|. |	22	0.062	0.062	20.944	0.524
.|. |	.|. |	23	-0.03	-0.034	21.57	0.546
.|. |	.|. |	24	0.004	0.009	21.581	0.604
.|. |	.|. |	25	-0.019	-0.023	21.83	0.646
.|. |	.|. |	26	-0.019	-0.014	22.074	0.685
.|. |	.|. |	27	-0.04	-0.052	23.214	0.673
.|. |	.|. |	88	-0.016	-0.041	95.051	0.285
.|. |	.|. |	89	0.012	0.028	95.167	0.308
.|. |	.|. |	90	-0.012	-0.015	95.277	0.332



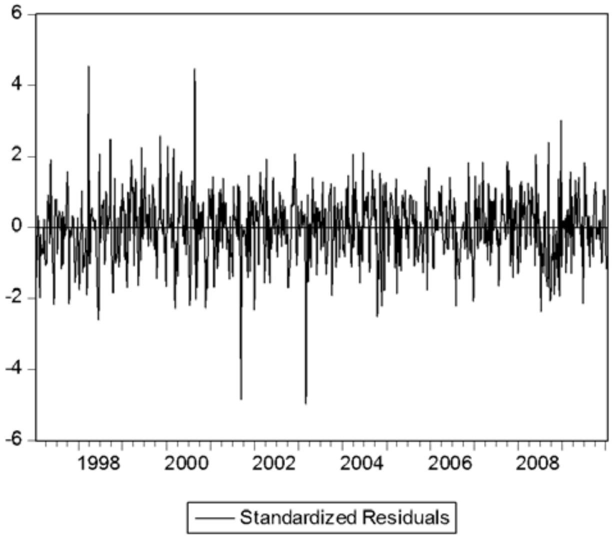
NGB: 1/17/1997 1/15/2010
Included observations: 679

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
.|. |	.|. |	1	0.019	0.019	0.2407	0.624
.|. |	.|. |	2	-0.056	-0.057	2.4192	0.298
.|. |	.|. |	3	0.047	0.05	3.9492	0.267
.|. |	.|. |	4	-0.057	-0.062	6.1383	0.189
.|. |	.|. |	5	0.003	0.012	6.1447	0.292
*|. |	*|. |	6	-0.083	-0.093	10.844	0.093
.|. |	.|. |	7	-0.055	-0.044	12.934	0.074
.|. |	.|. |	8	0.016	0.003	13.119	0.108
.|. |	.|. |	9	0.039	0.043	14.165	0.117
.|. |	.|. |	21	0.047	0.037	22.439	0.375
.|* |	.|* |	22	0.077	0.08	26.654	0.225
.|. |	.|. |	23	-0.055	-0.053	28.82	0.186
.|. |	.|. |	24	-0.004	0.005	28.829	0.227
.|. |	.|. |	25	0.001	-0.011	28.83	0.271
.|. |	.|. |	26	0.003	0.009	28.839	0.318
.|. |	.|. |	27	-0.051	-0.063	30.666	0.285
.|. |	.|. |	88	-0.007	-0.025	92.3	0.356
.|. |	.|. |	89	0.009	0.023	92.361	0.383
.|. |	.|. |	90	0.004	0.013	92.377	0.411



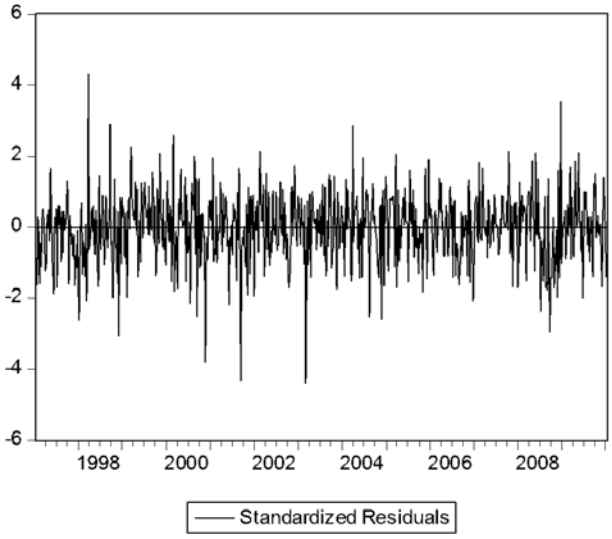
NGE: 1/17/1997 1/15/2010
Included observations: 679

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
.|. |	.|. |	1	0.034	0.034	0.7722	0.38
.|. |	.|. |	2	-0.057	-0.058	2.9553	0.228
.|. |	.|. |	3	0.054	0.058	4.9454	0.176
.|. |	.|. |	4	-0.051	-0.059	6.7415	0.15
.|. |	.|. |	5	-0.003	0.008	6.7497	0.24
*|. |	*|. |	6	-0.072	-0.083	10.316	0.112
*|. |	.|. |	7	-0.067	-0.054	13.359	0.064
.|. |	.|. |	8	0.03	0.022	13.963	0.083
.|. |	.|. |	9	0.028	0.028	14.515	0.105
.|. |	.|. |	21	0.05	0.044	20.944	0.462
.|* |	.|* |	22	0.075	0.076	24.938	0.3
.|. |	.|. |	23	-0.064	-0.061	27.784	0.224
.|. |	.|. |	24	0.004	0.014	27.794	0.269
.|. |	.|. |	25	-0.002	-0.017	27.796	0.317
.|. |	.|. |	26	0.006	0.013	27.825	0.367
.|. |	.|. |	27	-0.054	-0.065	29.904	0.318
.|. |	.|. |	88	-0.015	-0.037	96.688	0.247
.|. |	.|. |	89	-0.001	0.024	96.689	0.271
.|. |	.|. |	90	-0.015	-0.018	96.865	0.292



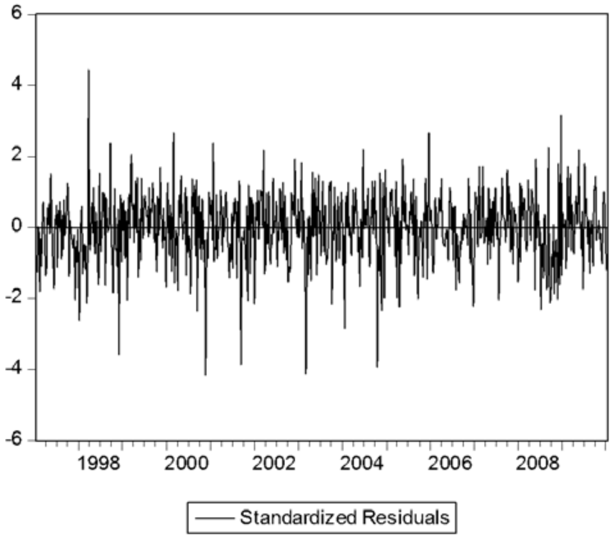
DUK: 1/17/1997 1/15/2010
Included observations: 679

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
.|. |	.|. |	1	0.021	0.021	0.3109	0.577
.|. |	.|. |	2	-0.051	-0.051	2.0769	0.354
.|* |	.|* |	3	0.103	0.106	9.3323	0.025
.|. |	.|. |	4	-0.032	-0.041	10.048	0.04
.|. |	.|. |	5	0.043	0.057	11.326	0.045
.|. |	.|. |	6	-0.019	-0.038	11.564	0.072
.|. |	.|. |	7	-0.01	0.006	11.631	0.113
.|. |	.|. |	8	0.017	0.002	11.829	0.159
.|. |	.|. |	9	0.048	0.058	13.445	0.143
.|. |	.|. |	21	0.021	0.01	18.251	0.633
.|. |	.|. |	22	0.038	0.042	19.254	0.63
.|. |	.|. |	23	-0.026	-0.023	19.748	0.657
.|. |	.|. |	24	-0.021	-0.015	20.054	0.694
.|. |	.|. |	25	-0.025	-0.033	20.492	0.721
.|. |	.|. |	26	0.027	0.033	21.014	0.741
.|. |	.|. |	27	-0.044	-0.053	22.396	0.717
.|. |	.|. |	88	-0.045	-0.043	94.104	0.309
.|. |	.|. |	89	-0.034	-0.057	95.023	0.312
.|. |	.|. |	90	0.016	0.013	95.219	0.333



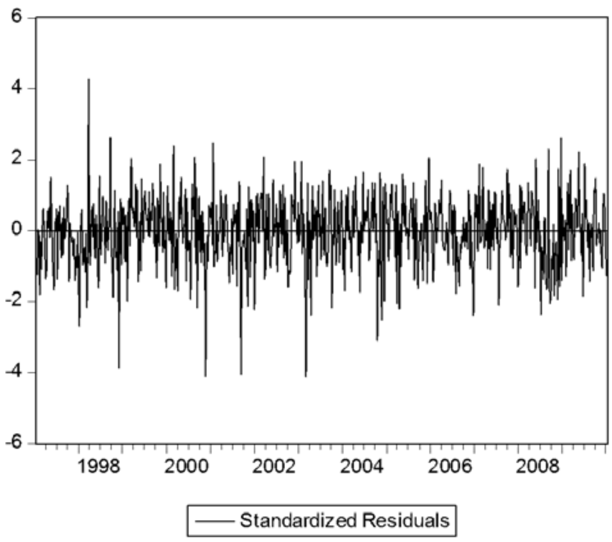
SAH: 1/17/1997 1/15/2010
Included observations: 679

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
.|. |	.|. |	1	0.016	0.016	0.1731	0.677
.|. |	.|. |	2	-0.029	-0.03	0.7663	0.682
.|* |	.|* |	3	0.095	0.096	6.8867	0.076
.|. |	.|. |	4	-0.054	-0.059	8.8726	0.064
.|. |	.|. |	5	0.036	0.045	9.7438	0.083
.|. |	.|. |	6	-0.047	-0.062	11.234	0.081
.|. |	.|. |	7	-0.031	-0.015	11.901	0.104
.|. |	.|. |	8	0.022	0.008	12.227	0.141
.|. |	.|. |	9	0.009	0.022	12.277	0.198
.|. |	.|. |	21	0.053	0.043	20.505	0.489
.|. |	.|. |	22	0.022	0.024	20.838	0.531
.|. |	.|. |	23	-0.005	-0.009	20.855	0.59
.|. |	.|. |	24	-0.023	-0.029	21.234	0.625
.|. |	.|. |	25	-0.027	-0.018	21.746	0.65
.|. |	.|. |	26	0.029	0.025	22.323	0.671
.|. |	.|. |	27	-0.051	-0.05	24.175	0.621
.|. |	.|. |	88	-0.029	-0.064	97.873	0.221
.|. |	.|. |	89	-0.027	-0.03	98.458	0.231
.|. |	.|. |	90	0.008	-0.022	98.514	0.253



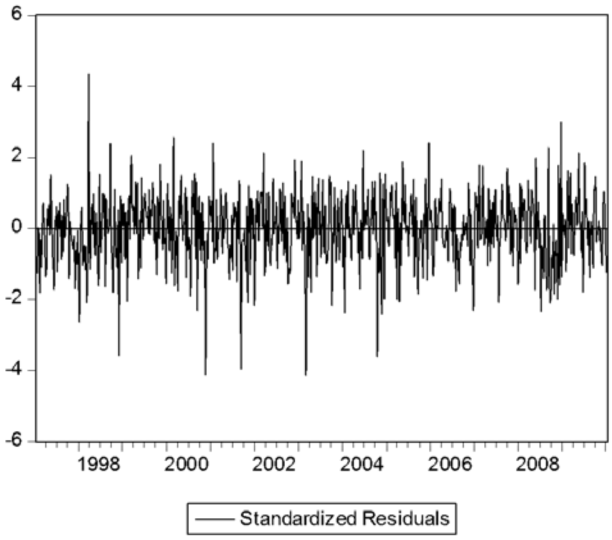
SAL: 1/17/1997 1/15/2010
Included observations: 679

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
.|. |	.|. |	1	0.015	0.015	0.1437	0.705
.|. |	.|. |	2	-0.038	-0.038	1.1173	0.572
.|* |	.|* |	3	0.095	0.097	7.3292	0.062
.|. |	.|. |	4	-0.058	-0.063	9.6034	0.048
.|. |	.|. |	5	0.033	0.044	10.364	0.066
.|. |	.|. |	6	-0.037	-0.054	11.326	0.079
.|. |	.|. |	7	-0.012	0.006	11.418	0.121
.|. |	.|. |	8	0.025	0.009	11.835	0.159
.|. |	.|. |	9	0.007	0.02	11.865	0.221
.|. |	.|. |	21	0.044	0.035	19.314	0.565
.|. |	.|. |	22	0.041	0.044	20.496	0.552
.|. |	.|. |	23	-0.024	-0.028	20.902	0.587
.|. |	.|. |	24	-0.017	-0.018	21.113	0.632
.|. |	.|. |	25	-0.021	-0.02	21.425	0.669
.|. |	.|. |	26	0.035	0.039	22.272	0.674
.|. |	*|. |	27	-0.06	-0.067	24.858	0.582
.|. |	*|. |	88	-0.031	-0.07	96.844	0.243
.|. |	.|. |	89	-0.034	-0.031	97.74	0.247
.|. |	.|. |	90	0.016	-0.003	97.946	0.266



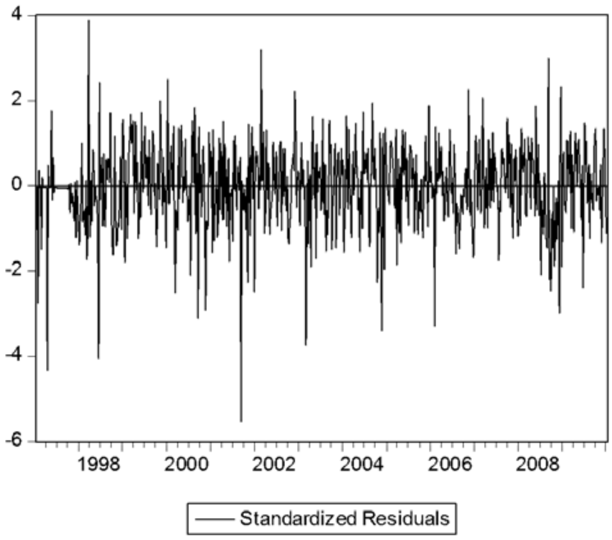
SAM: 1/17/1997 1/15/2010
Included observations: 679

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
.|. |	.|. |	1	0.016	0.016	0.1759	0.675
.|. |	.|. |	2	-0.033	-0.034	0.9398	0.625
.|* |	.|* |	3	0.096	0.098	7.3019	0.063
.|. |	.|. |	4	-0.057	-0.063	9.5612	0.049
.|. |	.|. |	5	0.036	0.046	10.44	0.064
.|. |	.|. |	6	-0.043	-0.06	11.724	0.068
.|. |	.|. |	7	-0.024	-0.005	12.104	0.097
.|. |	.|. |	8	0.025	0.01	12.524	0.129
.|. |	.|. |	9	0.009	0.023	12.584	0.182
.|. |	.|. |	21	0.048	0.036	20.658	0.48
.|. |	.|. |	22	0.028	0.032	21.22	0.507
.|. |	.|. |	23	-0.009	-0.014	21.274	0.564
.|. |	.|. |	24	-0.025	-0.028	21.728	0.596
.|. |	.|. |	25	-0.026	-0.02	22.208	0.624
.|. |	.|. |	26	0.029	0.028	22.8	0.644
.|. |	.|. |	27	-0.055	-0.055	24.939	0.578
.|. |	*|. |	88	-0.031	-0.067	96.574	0.249
.|. |	.|. |	89	-0.031	-0.032	97.328	0.256
.|. |	.|. |	90	0.013	-0.012	97.459	0.277



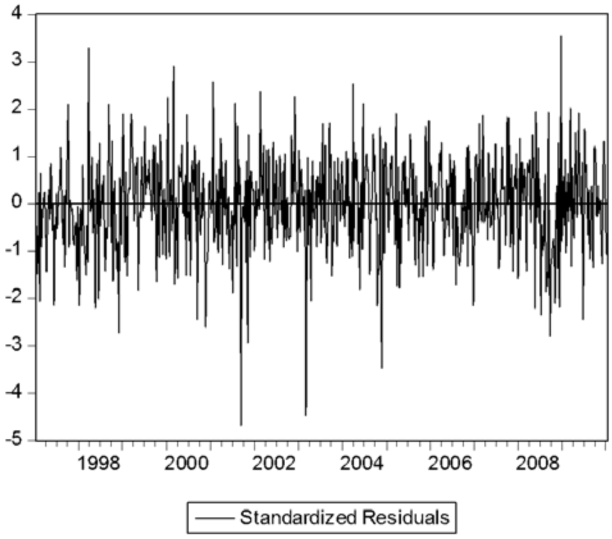
VEN: 1/17/1997 1/15/2010
Included observations: 679

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
.|. |	.|. |	1	0.003	0.003	0.0073	0.932
.|. |	.|. |	2	-0.027	-0.027	0.5048	0.777
.|* |	.|* |	3	0.094	0.094	6.5385	0.088
.|. |	.|. |	4	-0.061	-0.063	9.0538	0.06
.|. |	.|. |	5	0.006	0.013	9.0805	0.106
.|. |	.|. |	6	-0.03	-0.043	9.7069	0.138
*|. |	*|. |	7	-0.08	-0.068	14.156	0.048
.|* |	.|* |	8	0.079	0.074	18.467	0.018
.|. |	.|. |	9	0.038	0.041	19.464	0.022
.|. |	.|. |	21	0.021	0.034	26.434	0.19
.|* |	.|. |	22	0.078	0.073	30.703	0.102
.|. |	.|. |	23	-0.012	-0.013	30.804	0.128
.|. |	.|. |	24	-0.024	-0.025	31.219	0.148
.|. |	.|. |	25	-0.044	-0.059	32.575	0.142
.|. |	.|. |	26	0.037	0.038	33.539	0.147
*|. |	*|. |	27	-0.076	-0.078	37.688	0.083
.|. |	.|. |	88	-0.014	-0.02	94.403	0.301
.|. |	.|. |	89	-0.009	-0.031	94.462	0.326
.|. |	.|. |	90	-0.036	-0.043	95.464	0.327



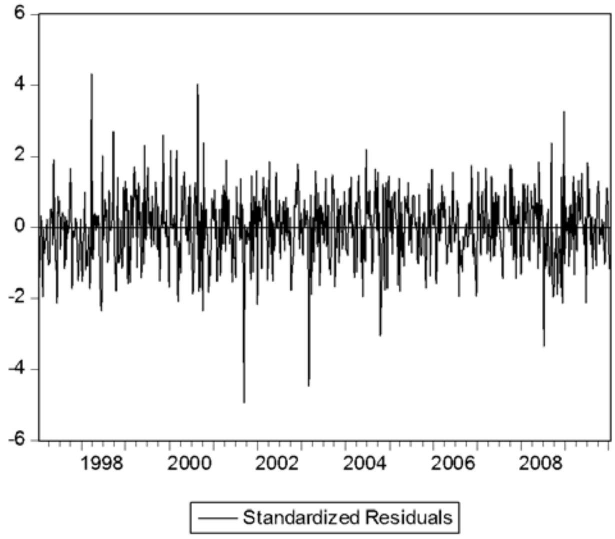
ASU: 1/17/1997 1/15/2010
Included observations: 679

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
.|. |	.|. |	1	0.019	0.019	0.2377	0.626
.|. |	.|. |	2	-0.045	-0.045	1.6204	0.445
.|* |	.|* |	3	0.121	0.123	11.593	0.009
.|. |	*|. |	4	-0.062	-0.071	14.242	0.007
.|. |	.|. |	5	-0.029	-0.014	14.816	0.011
.|. |	.|. |	6	0.006	-0.014	14.844	0.022
.|. |	.|. |	7	-0.016	-0.001	15.015	0.036
.|. |	.|. |	8	0.016	0.017	15.191	0.056
.|. |	.|. |	9	0.011	0.007	15.269	0.084
.|. |	.|. |	21	-0.033	-0.029	21.674	0.419
.|. |	.|. |	22	0.071	0.067	25.211	0.287
.|. |	.|. |	23	-0.008	-0.012	25.258	0.337
.|. |	.|. |	24	0.01	0.021	25.33	0.388
.|. |	.|. |	25	0.03	0.004	25.958	0.41
.|. |	.|. |	26	0.019	0.031	26.203	0.452
.|. |	.|. |	27	-0.028	-0.026	26.762	0.477
*|. |	*|. |	88	-0.074	-0.093	99.225	0.194
.|. |	.|. |	89	-0.01	-0.018	99.298	0.214
.|. |	.|. |	90	0.003	-0.003	99.304	0.236



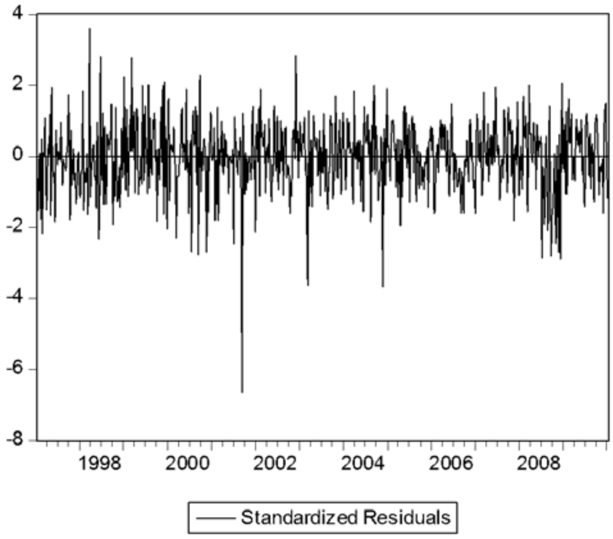
CAM: 1/17/1997 1/15/2010
Included observations: 679

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
.|. |	.|. |	1	0.019	0.019	0.242	0.623
.|. |	.|. |	2	-0.05	-0.051	1.9777	0.372
.|. |	.|. |	3	0.062	0.064	4.5676	0.206
*|. |	*|. |	4	-0.072	-0.078	8.1396	0.087
.|. |	.|. |	5	-0.021	-0.011	8.4469	0.133
*|. |	*|. |	6	-0.089	-0.102	13.922	0.031
.|. |	.|. |	7	-0.03	-0.017	14.524	0.043
.|. |	.|. |	8	0.004	-0.01	14.534	0.069
.|. |	.|. |	9	0.024	0.032	14.93	0.093
.|. |	.|. |	21	0.043	0.036	21.632	0.421
.|. |	.|. |	22	0.067	0.07	24.755	0.309
.|. |	.|. |	23	-0.04	-0.034	25.905	0.305
.|. |	.|. |	24	-0.03	-0.027	26.525	0.327
.|. |	.|. |	25	-0.004	-0.012	26.538	0.379
.|. |	.|. |	26	0.005	0.011	26.555	0.433
.|. |	.|. |	27	-0.049	-0.049	28.246	0.398
.|. |	.|. |	88	-0.02	-0.033	98.249	0.214
.|. |	.|. |	89	-0.003	0.017	98.258	0.236
.|. |	.|. |	90	-0.019	-0.007	98.533	0.253



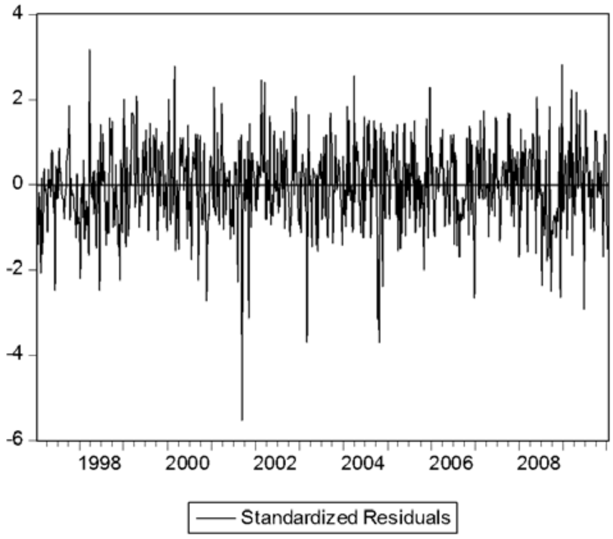
CAP: 1/17/1997 1/15/2010
Included observations: 679

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
.|. |	.|. |	1	-0.009	-0.009	0.05	0.823
.|. |	.|. |	2	-0.023	-0.023	0.4081	0.815
.|* |	.|. |	3	0.074	0.074	4.1662	0.244
.|. |	.|. |	4	-0.041	-0.041	5.3322	0.255
.|. |	.|. |	5	0.05	0.053	7.041	0.218
.|. |	.|. |	6	0.017	0.01	7.2461	0.299
.|. |	.|. |	7	-0.057	-0.049	9.477	0.22
.|. |	.|. |	8	0.022	0.013	9.8097	0.279
.|* |	.|* |	9	0.08	0.081	14.219	0.115
.|. |	.|. |	21	0.024	0.025	20.446	0.493
.|. |	.|. |	22	0.041	0.039	21.62	0.483
.|. |	.|. |	23	0.008	0.022	21.671	0.54
.|. |	.|. |	24	-0.008	-0.01	21.716	0.596
.|. |	.|. |	25	-0.039	-0.039	22.784	0.59
.|. |	.|. |	26	0.056	0.056	24.996	0.519
*|. |	*|. |	27	-0.123	-0.126	35.684	0.122
.|. |	.|. |	88	-0.038	-0.042	134.65	0.001
.|. |	.|. |	89	0.033	0.013	135.48	0.001
.|. |	.|. |	90	-0.015	-0.001	135.66	0.001



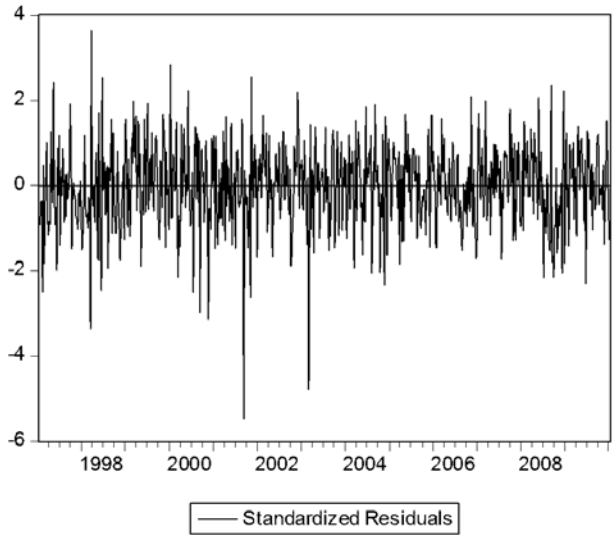
CHI: 1/17/1997 1/15/2010
Included observations: 679

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
.|. |	.|. |	1	0.034	0.034	0.7702	0.38
.|. |	.|. |	2	-0.054	-0.055	2.7578	0.252
.|. |	.|. |	3	0.064	0.068	5.5346	0.137
.|. |	.|. |	4	-0.026	-0.034	5.9929	0.2
.|. |	.|. |	5	-0.01	0	6.0552	0.301
.|. |	.|. |	6	-0.021	-0.029	6.3639	0.384
.|. |	.|. |	7	0.003	0.008	6.3695	0.497
.|. |	.|. |	8	0.052	0.049	8.2495	0.409
.|. |	.|. |	9	-0.016	-0.017	8.4351	0.491
.|. |	.|. |	21	-0.029	-0.037	16.577	0.736
.|. |	.|. |	22	0.038	0.038	17.592	0.73
.|. |	.|. |	23	-0.026	-0.04	18.053	0.755
.|. |	.|. |	24	-0.001	0.009	18.054	0.8
.|. |	.|. |	25	-0.031	-0.046	18.715	0.811
.|. |	.|. |	26	-0.015	-0.001	18.879	0.841
.|. |	.|. |	27	0.017	0.015	19.075	0.867
.|. |	.|. |	88	-0.052	-0.062	85.508	0.555
.|. |	.|. |	89	-0.039	-0.035	86.727	0.548
.|. |	.|. |	90	-0.002	-0.029	86.731	0.578



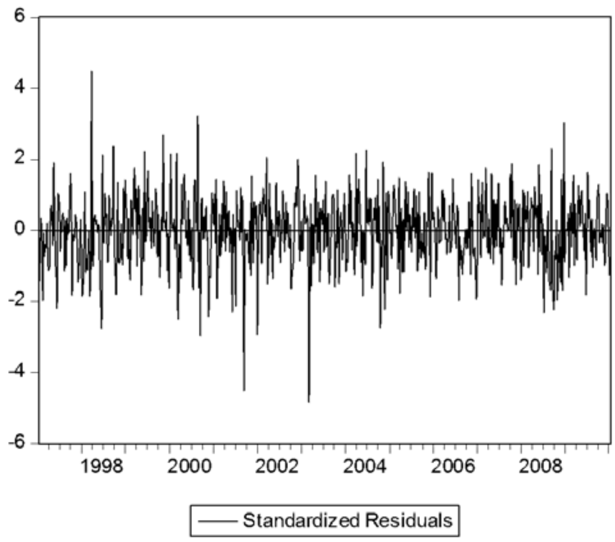
COL: 1/17/1997 1/15/2010
Included observations: 679

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat
.|. |	.|. |	1	0.014	0.014	0.125
*|. |	*|. |	2	-0.081	-0.082	4.6409
.|. |	.|. |	3	0.07	0.072	7.9553
.|. |	.|. |	4	-0.019	-0.028	8.1999
.|. |	.|. |	5	0.043	0.057	9.4794
.|. |	.|. |	6	-0.044	-0.056	10.79
*|. |	*|. |	7	-0.103	-0.09	18.059
.|* |	.|* |	8	0.094	0.085	24.172
.|. |	.|. |	9	0.065	0.056	27.114
.|. |	.|. |	21	0.056	0.047	41.603
.|* |	.|. |	22	0.086	0.07	46.821
.|. |	.|. |	23	-0.041	-0.04	48.009
.|. |	.|. |	24	-0.007	0.019	48.041
.|. |	.|. |	25	-0.044	-0.048	49.39
.|. |	.|. |	26	0.05	0.04	51.172
*|. |	*|. |	27	-0.066	-0.099	54.252
.|. |	.|. |	88	-0.017	-0.048	116.46
.|. |	.|. |	89	-0.014	-0.025	116.62
.|. |	.|. |	90	-0.012	-0.014	116.73



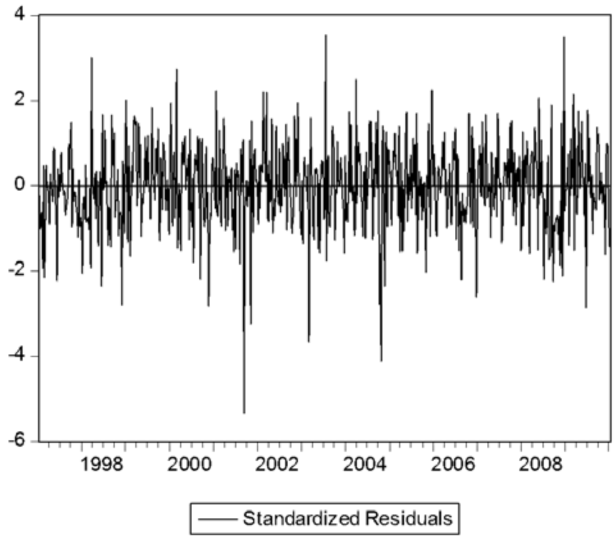
EGS: 1/17/1997 1/15/2010
Included observations: 679

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
.|. |	.|. |	1	0.034	0.034	0.7923	0.373
.|. |	*|. |	2	-0.066	-0.067	3.7264	0.155
.|. |	.|. |	3	0.038	0.043	4.7142	0.194
.|. |	.|. |	4	-0.051	-0.059	6.5207	0.163
.|. |	.|. |	5	-0.002	0.008	6.5245	0.258
.|. |	.|. |	6	-0.049	-0.059	8.1797	0.225
*|. |	*|. |	7	-0.084	-0.076	13.046	0.071
.|. |	.|. |	8	0.023	0.019	13.409	0.099
.|. |	.|. |	9	0.033	0.025	14.168	0.116
.|. |	.|. |	21	0.054	0.043	21.908	0.405
.|. |	.|. |	22	0.073	0.068	25.66	0.267
.|. |	.|. |	23	-0.06	-0.065	28.206	0.208
.|. |	.|. |	24	-0.007	0.002	28.245	0.25
.|. |	.|. |	25	-0.01	-0.019	28.318	0.293
.|. |	.|. |	26	0.01	0.013	28.388	0.34
.|. |	.|. |	27	-0.047	-0.057	29.986	0.315
.|. |	.|. |	88	-0.04	-0.064	97.8	0.223
.|. |	.|. |	89	-0.006	0.017	97.828	0.245
.|. |	.|. |	90	-0.02	-0.031	98.133	0.262



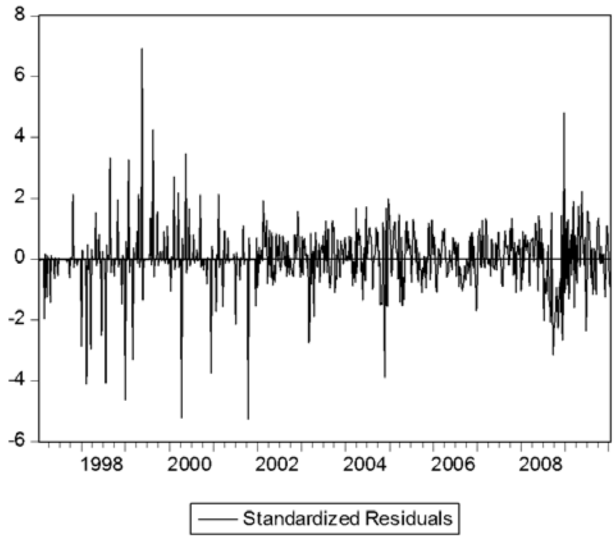
INO: 1/17/1997 1/15/2010
Included observations: 679

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
.|. |	.|. |	1	0.022	0.022	0.3387	0.561
.|. |	.|. |	2	-0.033	-0.033	1.0777	0.583
.|* |	.|* |	3	0.092	0.094	6.8819	0.076
.|. |	.|. |	4	-0.048	-0.054	8.4285	0.077
.|. |	.|. |	5	-0.018	-0.009	8.6612	0.123
.|. |	.|. |	6	-0.031	-0.043	9.3108	0.157
.|. |	.|. |	7	-0.002	0.009	9.3142	0.231
.|. |	.|. |	8	0.056	0.054	11.463	0.177
.|. |	.|. |	9	-0.029	-0.027	12.054	0.21
.|. |	.|. |	21	-0.007	-0.015	18.332	0.628
.|. |	.|. |	22	0.019	0.02	18.593	0.67
.|. |	.|. |	23	-0.017	-0.032	18.794	0.713
.|. |	.|. |	24	-0.015	-0.009	18.95	0.755
.|. |	.|. |	25	-0.037	-0.045	19.91	0.752
.|. |	.|. |	26	-0.026	-0.014	20.403	0.772
.|. |	.|. |	27	0.006	0.009	20.431	0.812
.|. |	*|. |	88	-0.049	-0.078	83.523	0.615
*|. |	.|. |	89	-0.066	-0.051	86.918	0.543
.|. |	.|. |	90	0.017	-0.022	87.15	0.565



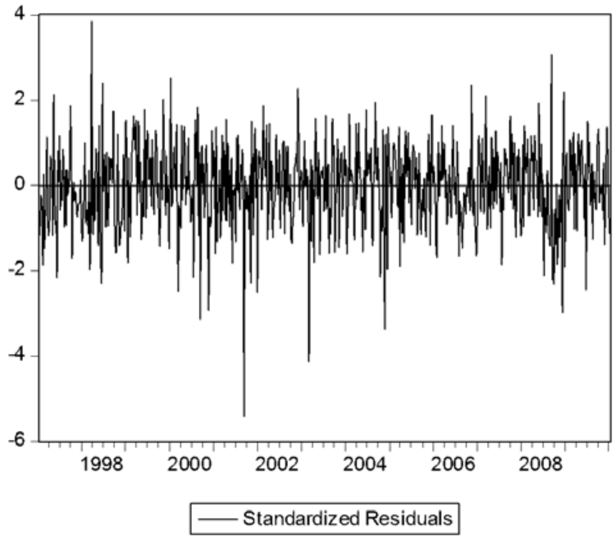
TAP: 1/17/1997 1/15/2010
Included observations: 679

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
.|. |	.|. |	1	0.016	0.016	0.1705	0.68
*|. |	*|. |	2	-0.077	-0.078	4.2546	0.119
.|* |	.|* |	3	0.078	0.081	8.3839	0.039
.|. |	.|. |	4	-0.041	-0.051	9.5549	0.049
.|. |	.|. |	5	0.022	0.037	9.8742	0.079
.|. |	.|. |	6	-0.043	-0.059	11.142	0.084
*|. |	*|. |	7	-0.085	-0.071	16.098	0.024
.|* |	.|. |	8	0.078	0.069	20.323	0.009
.|. |	.|. |	9	0.031	0.026	21	0.013
.|. |	.|. |	21	0.022	0.023	28.376	0.13
.|* |	.|. |	22	0.082	0.07	33.07	0.061
.|. |	.|. |	23	-0.046	-0.05	34.577	0.057
.|. |	.|. |	24	-0.01	0.005	34.651	0.074
.|. |	.|. |	25	-0.039	-0.054	35.733	0.076
.|. |	.|. |	26	0.042	0.05	37.01	0.075
*|. |	*|. |	27	-0.085	-0.111	42.14	0.032
.|. |	.|. |	88	-0.012	-0.049	99.581	0.188
.|. |	.|. |	89	0.005	-0.001	99.598	0.208
.|. |	.|. |	90	-0.014	-0.021	99.761	0.226



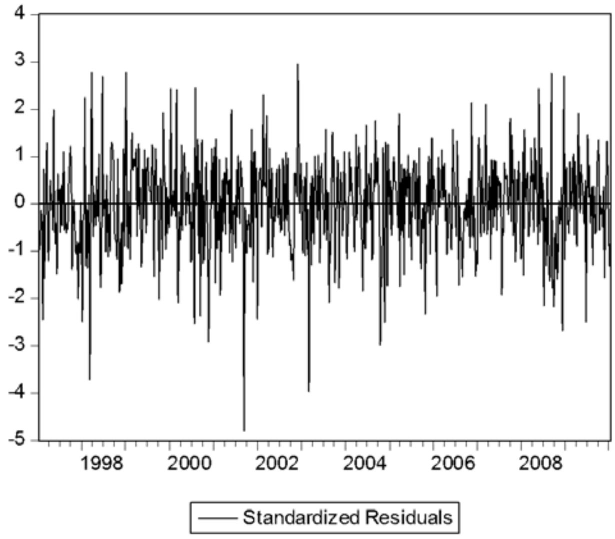
MXI: 1/17/1997 1/15/2010
Included observations: 679

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
.|. |	.|. |	1	0.016	0.016	0.1705	0.68
*|. |	*|. |	2	-0.077	-0.078	4.2546	0.119
.|* |	.|* |	3	0.078	0.081	8.3839	0.039
.|. |	.|. |	4	-0.041	-0.051	9.5549	0.049
.|. |	.|. |	5	0.022	0.037	9.8742	0.079
.|. |	.|. |	6	-0.043	-0.059	11.142	0.084
*|. |	*|. |	7	-0.085	-0.071	16.098	0.024
.|* |	.|. |	8	0.078	0.069	20.323	0.009
.|. |	.|. |	9	0.031	0.026	21	0.013
.|. |	.|. |	21	0.022	0.023	28.376	0.13
.|* |	.|. |	22	0.082	0.07	33.07	0.061
.|. |	.|. |	23	-0.046	-0.05	34.577	0.057
.|. |	.|. |	24	-0.01	0.005	34.651	0.074
.|. |	.|. |	25	-0.039	-0.054	35.733	0.076
.|. |	.|. |	26	0.042	0.05	37.01	0.075
*|. |	*|. |	27	-0.085	-0.111	42.14	0.032
.|. |	.|. |	88	-0.012	-0.049	99.581	0.188
.|. |	.|. |	89	0.005	-0.001	99.598	0.208
.|. |	.|. |	90	-0.014	-0.021	99.761	0.226



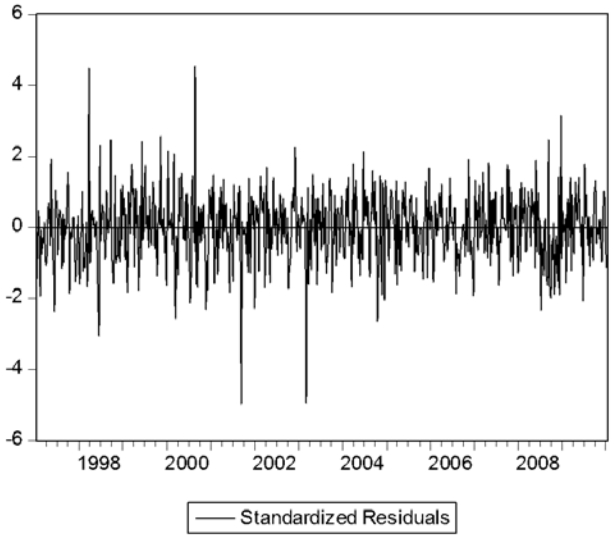
MXM: 1/17/1997 1/15/2010
Included observations: 679

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
.|. |	.|. |	1	0.028	0.028	0.5427	0.461
.|. |	.|. |	2	-0.061	-0.062	3.0946	0.213
.|* |	.|* |	3	0.089	0.093	8.5388	0.036
.|. |	.|. |	4	-0.043	-0.054	9.808	0.044
.|. |	.|. |	5	0.023	0.039	10.171	0.071
.|. |	.|. |	6	-0.047	-0.065	11.661	0.07
.|. |	.|. |	7	-0.046	-0.028	13.099	0.07
.|. |	.|. |	8	0.03	0.017	13.71	0.09
.|. |	.|. |	9	-0.024	-0.018	14.111	0.118
.|. |	.|. |	21	0.005	0.016	24.721	0.259
.|. |	.|. |	22	0.067	0.05	27.913	0.179
.|. |	.|. |	23	-0.032	-0.014	28.644	0.192
.|. |	.|. |	24	0.007	0.002	28.676	0.233
.|. |	.|. |	25	-0.025	-0.03	29.124	0.259
.|. |	.|. |	26	0.01	0.006	29.189	0.303
.|. |	*|. |	27	-0.063	-0.078	32	0.232
.|. |	*|. |	88	-0.043	-0.088	98.928	0.2
.|. |	.|. |	89	-0.015	-0.008	99.114	0.217
.|. |	.|. |	90	-0.014	-0.041	99.263	0.237



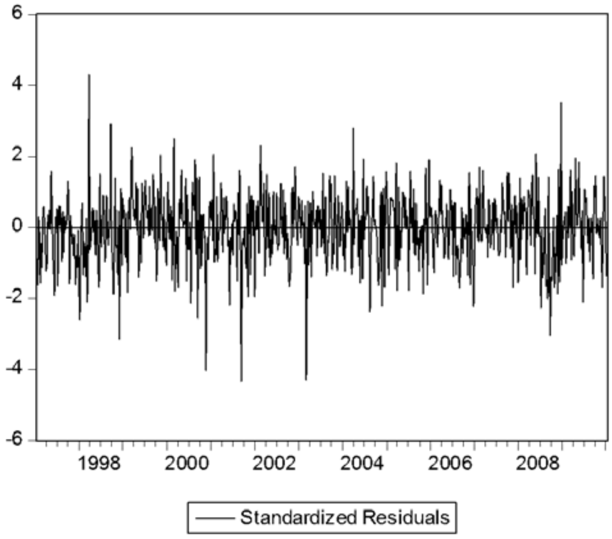
NOE: 1/17/1997 1/15/2010
Included observations: 679

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
.|. |	.|. |	1	0.028	0.028	0.5445	0.461
.|. |	.|. |	2	-0.064	-0.065	3.3159	0.191
.|. |	.|. |	3	0.051	0.055	5.1052	0.164
.|. |	*|. |	4	-0.062	-0.07	7.7305	0.102
.|. |	.|. |	5	-0.012	-0.001	7.8344	0.166
*|. |	*|. |	6	-0.068	-0.08	10.995	0.089
.|. |	.|. |	7	-0.059	-0.048	13.353	0.064
.|. |	.|. |	8	0.019	0.009	13.599	0.093
.|. |	.|. |	9	0.025	0.025	14.045	0.121
.|. |	.|. |	21	0.051	0.046	20.891	0.466
.|* |	.|* |	22	0.075	0.077	24.902	0.302
.|. |	.|. |	23	-0.064	-0.062	27.832	0.222
.|. |	.|. |	24	-0.012	-0.003	27.934	0.263
.|. |	.|. |	25	-0.001	-0.014	27.934	0.311
.|. |	.|. |	26	-0.002	0.005	27.937	0.362
.|. |	.|. |	27	-0.052	-0.061	29.881	0.32
.|. |	.|. |	88	-0.011	-0.035	93.949	0.313
.|. |	.|. |	89	-0.018	0.008	94.196	0.333
.|. |	.|. |	90	-0.012	-0.01	94.311	0.357



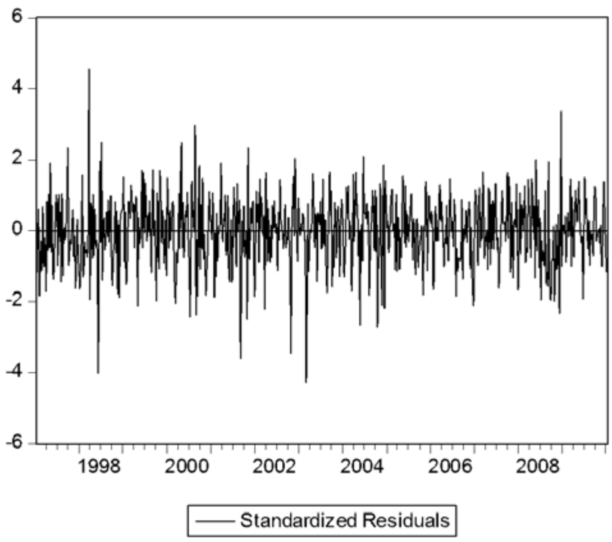
OMN: 1/17/1997 1/15/2010
Included observations: 679

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
.|. |	.|. |	1	0.019	0.019	0.2465	0.62
.|. |	.|. |	2	-0.055	-0.056	2.3383	0.311
.|* |	.|* |	3	0.092	0.095	8.1445	0.043
.|. |	.|. |	4	-0.041	-0.049	9.2747	0.055
.|. |	.|. |	5	0.053	0.067	11.185	0.048
.|. |	.|. |	6	-0.026	-0.045	11.649	0.07
.|. |	.|. |	7	-0.018	0	11.873	0.105
.|. |	.|. |	8	0.022	0.005	12.209	0.142
.|. |	.|. |	9	0.055	0.066	14.285	0.113
.|. |	.|. |	21	0.024	0.008	18.998	0.585
.|. |	.|. |	22	0.032	0.043	19.727	0.6
.|. |	.|. |	23	-0.02	-0.022	19.996	0.642
.|. |	.|. |	24	-0.024	-0.015	20.402	0.674
.|. |	.|. |	25	-0.02	-0.027	20.678	0.71
.|. |	.|. |	26	0.031	0.035	21.341	0.724
.|. |	.|. |	27	-0.055	-0.065	23.466	0.66
.|. |	.|. |	88	-0.043	-0.052	92.818	0.342
.|. |	.|. |	89	-0.033	-0.053	93.684	0.346
.|. |	.|. |	90	0.011	0.007	93.787	0.371



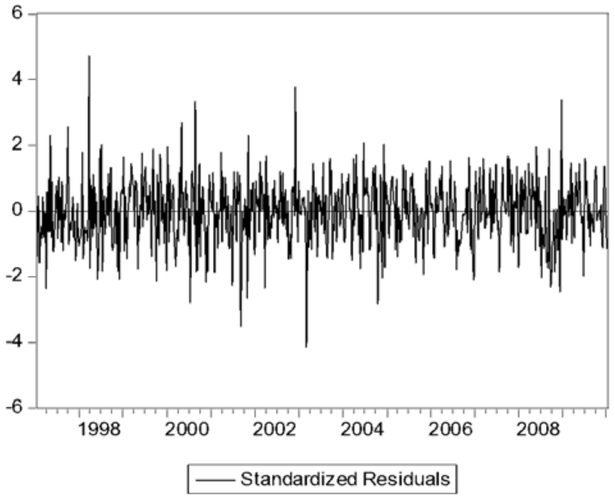
RUS: 1/17/1997 1/15/2010
Included observations: 679

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
.|. |	.|. |	1	0.008	0.008	0.0444	0.833
.|. |	.|. |	2	-0.003	-0.003	0.0515	0.975
.|. |	.|. |	3	-0.003	-0.003	0.0585	0.996
*|. |	*|. |	4	-0.106	-0.106	7.7213	0.102
.|. |	.|. |	5	0.003	0.005	7.7286	0.172
.|. |	.|. |	6	-0.033	-0.034	8.4651	0.206
.|. |	.|. |	7	-0.061	-0.062	11.014	0.138
.|. |	.|. |	8	0.035	0.025	11.867	0.157
.|. |	.|. |	9	0.026	0.026	12.344	0.195
.|. |	.|. |	21	0.046	0.056	21.205	0.446
.|. |	.|. |	22	0.04	0.045	22.333	0.44
.|. |	.|. |	23	-0.038	-0.038	23.365	0.44
.|. |	.|. |	24	0.023	0.019	23.737	0.477
.|. |	.|. |	25	-0.043	-0.03	25.041	0.46
.|. |	.|. |	26	0.009	0.006	25.103	0.513
*|. |	*|. |	27	-0.075	-0.094	29.093	0.356
.|. |	.|. |	88	-0.014	-0.009	89.14	0.446
.|. |	.|. |	89	-0.004	-0.006	89.15	0.476
.|. |	.|. |	90	-0.025	-0.033	89.629	0.491



BRT: 1/17/1997 1/15/2010
Included observations: 679

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
.|. |	.|. |	1	0.007	0.007	0.0345	0.853
.|. |	.|. |	2	0.031	0.031	0.6727	0.714
.|. |	.|. |	3	0.032	0.032	1.3859	0.709
*|. |	*|. |	4	-0.074	-0.076	5.1413	0.273
.|. |	.|. |	5	-0.018	-0.019	5.3557	0.374
.|. |	.|. |	6	-0.041	-0.038	6.5354	0.366
.|. |	.|. |	7	-0.064	-0.058	9.3326	0.23
.|. |	.|. |	8	0.017	0.016	9.5374	0.299
.|. |	.|. |	9	0.037	0.041	10.487	0.313
.|. |	.|. |	21	0.059	0.065	17.688	0.669
.|. |	.|. |	22	0.023	0.024	18.069	0.702
.|. |	.|. |	23	-0.022	-0.023	18.418	0.734
.|. |	.|. |	24	-0.001	-0.011	18.419	0.782
.|. |	.|. |	25	-0.031	-0.021	19.085	0.793
.|. |	.|. |	26	0.017	0.017	19.297	0.824
*|. |	*|. |	27	-0.089	-0.092	24.954	0.577
.|. |	.|. |	88	-0.011	-0.002	86.26	0.533
.|. |	.|. |	89	-0.003	-0.014	86.266	0.562
.|. |	.|. |	90	-0.023	-0.028	86.698	0.579



Appendix 11a: Trace and Maximum eigenvalue for each stock of different oil sectors and OPEC and non-OPEC crude oils

Notes:
1. Stocks and crude oils are listed horizontally and vertically, respectively.
2. M1: no constant and no drift; M2: a constant only; M3: both a constant and a drift.
3. Critical values are as follow:

		Trace	Max_Eig
M1	None	20.262	15.892
	At most 1	9.165	9.165
M2	None	15.495	14.265
	At most 1	3.841	3.841
M3	None	25.872	19.387
	At most 1	12.518	12.518

MacKinnon-Haug-Michelis (1999) p-values

Stock: DO Sector: DE

	M1				M2				M3			
	TRACE		MAX_EIG		TRACE		MAX_EIG		TRACE		MAX_EIG	
Oil	r=0	r≤1	r=0	r=1	r=0	r≤1	r=0	r=1	r=0	r≤1	r=0	r=1
ADM	11.680	1.900	9.782	1.903	11.427	1.759	9.668	1.759	24.834	6.699	18.134	6.699
ASB	10.773	1.658	9.115	1.658	10.480	1.467	9.012	1.467	21.647	6.469	15.179	6.469
ANC	11.134	1.682	9.452	1.682	10.821	1.504	9.317	1.504	23.460	6.460	17.041	6.460
DUB	12.192	1.853	10.339	1.853	11.890	1.707	10.183	1.707	26.447	6.815	19.632	6.814
ECU	13.216	1.612	11.604	1.612	12.962	1.492	11.470	1.492	26.938	6.319	20.619	6.319
IRH	11.585	1.681	9.904	1.681	11.232	1.502	9.730	1.502	24.367	6.746	17.620	6.747
IRL	11.100	1.689	9.411	1.689	10.760	1.505	9.255	1.505	23.087	6.711	16.375	6.711
KUT	12.111	1.839	10.272	1.839	11.816	1.693	10.123	1.693	26.478	6.588	19.387	6.589
LIB	11.136	1.612	9.524	1.612	10.816	1.420	9.395	1.420	22.985	6.526	16.459	6.526
NGB	10.964	1.665	9.299	1.665	10.677	1.486	9.191	1.486	22.828	6.526	16.302	6.526
NGE	10.667	1.666	9.001	1.666	10.383	1.489	8.894	1.489	22.228	6.542	15.686	6.542
DUK	11.953	1.914	10.039	1.914	11.698	1.775	9.924	1.775	25.210	6.679	18.530	6.679
SAH	12.707	1.698	11.009	1.698	12.409	1.548	10.861	1.548	25.608	6.657	18.952	6.657
SAL	11.825	1.707	10.118	1.706	11.541	1.548	9.993	1.548	23.487	6.671	16.816	6.671
SAM	12.358	1.703	10.655	1.703	12.068	1.548	10.520	1.548	24.593	6.677	17.917	6.677
VEN	11.655	1.638	10.017	1.638	11.36	1.482	9.885	1.482	23.86	6.448	17.421	6.448
AUS	11.273	1.853	9.420	1.853	10.991	1.683	9.308	1.683	22.494	6.596	15.898	6.596
CAM	11.804	1.636	10.168	1.636	11.528	1.469	10.059	1.469	24.531	6.385	18.146	6.385
CAP	10.992	1.673	9.319	1.673	10.727	1.503	9.225	1.503	20.394	6.438	13.956	6.438
CHI	11.310	1.819	9.492	1.819	11.092	1.683	9.408	1.683	23.176	6.372	16.804	6.372
COL	10.985	1.544	9.440	1.545	10.653	1.362	9.291	1.362	24.191	6.490	17.701	6.490
EGS	11.685	1.598	10.087	1.598	11.375	1.421	9.954	1.421	24.327	6.539	17.788	6.539
INO	11.140	1.800	9.339	1.800	10.897	1.662	9.235	1.662	24.531	6.466	18.065	6.466
TAP	11.242	1.769	9.473	1.769	11.010	1.612	9.398	1.612	22.896	6.486	16.510	6.486
MXI	11.241	1.614	9.627	1.614	10.962	1.457	9.506	1.457	23.717	6.306	17.411	6.306
MXM	12.902	1.701	11.200	1.701	12.624	1.571	11.053	1.571	28.969	6.403	22.566	6.403
NOE	10.799	1.640	9.159	1.640	10.504	1.454	9.049	1.454	22.106	6.474	15.632	6.474
OMN	12.038	1.897	10.141	1.897	11.753	1.750	10.014	1.750	26.047	6.724	19.323	6.724
RUS	11.097	1.357	9.740	1.357	10.852	1.216	9.636	1.216	23.230	6.256	16.974	6.256
BRT	10.424	1.664	8.760	1.664	10.151	1.491	8.660	1.492	21.282	6.335	14.948	6.335

Stock: NE Sector: DE

	M1				M2				M3			
	TRACE		MAX_EIG		TRACE		MAX_EIG		TRACE		MAX_EIG	
Oil	r=0	r≤1	r=0	r=1	r=0	r≤1	r=0	r=1	r=0	r≤1	r=0	r=1
ADM	11.740	4.099	7.641	4.099	11.456	3.845	7.611	3.845	18.840	7.557	11.283	7.557
ASB	11.440	3.699	7.751	3.699	11.134	3.419	7.715	3.419	17.758	7.667	10.090	7.667
ANC	11.197	3.765	7.432	3.765	10.860	3.459	7.400	3.459	18.115	7.400	10.715	7.400
DUB	11.538	4.077	7.460	4.077	11.207	3.781	7.421	3.781	18.797	7.426	11.371	7.426
ECU	11.551	4.865	6.686	4.865	11.283	4.618	6.666	4.618	19.241	6.665	12.576	6.665
IRH	11.465	3.777	7.687	3.777	11.083	3.437	7.646	3.437	18.139	7.553	10.586	7.553
IRL	11.578	3.745	11.210	3.423	11.210	3.423	7.787	3.423	18.053	7.750	10.303	7.750
KUT	11.174	4.095	7.078	4.096	10.850	3.799	7.054	3.799	18.843	7.054	11.788	7.054
LIB	11.419	3.718	7.701	3.718	11.075	3.414	7.661	3.414	17.912	7.656	10.256	7.656
NGB	11.612	3.804	7.808	3.804	11.304	3.530	7.774	3.530	18.243	7.744	10.499	7.744
NGE	11.543	3.719	7.824	3.719	11.237	3.446	7.791	3.446	17.976	7.766	10.210	7.766
DUK	11.370	4.107	7.263	4.107	11.088	3.848	7.239	3.848	18.551	7.209	11.342	7.209
SAH	11.196	4.138	7.059	4.138	10.869	3.836	7.032	3.836	17.842	7.002	10.840	7.002
SAL	11.360	3.981	7.385	3.981	11.053	3.699	7.354	3.699	17.581	7.351	10.230	7.351
SAM	11.334	4.082	7.252	4.082	11.015	3.793	7.221	3.790	17.718	7.213	10.505	7.213
VEN	11.113	4.182	6.931	4.182	10.803	3.891	6.912	3.890	18.182	6.890	11.292	6.890
AUS	11.260	3.859	7.401	3.859	10.945	3.574	7.371	3.574	17.910	7.328	10.582	7.328
CAM	11.500	4.134	7.366	4.134	11.204	3.864	7.340	3.864	18.785	7.339	11.445	7.339
CAP	12.308	4.353	7.955	4.353	12.017	4.113	7.904	4.113	18.422	7.656	10.765	7.656
CHI	11.674	4.376	7.297	4.376	11.435	4.152	7.283	4.152	19.035	7.283	11.752	7.283
COL	11.159	3.661	7.498	3.661	10.801	3.347	7.454	3.347	17.851	7.442	10.409	7.442
EGS	11.359	3.845	7.514	3.845	11.024	3.544	7.480	3.544	18.026	7.477	10.549	7.477
INO	11.693	4.214	7.479	4.214	11.427	3.967	7.460	3.967	19.339	7.435	11.903	7.435
TAP	11.844	4.015	7.829	4.015	11.588	3.791	7.797	3.791	18.655	7.548	11.108	7.548
MXI	11.024	4.078	6.946	4.078	10.723	3.801	6.922	3.801	18.161	6.917	11.245	6.917
MXM	11.346	4.579	6.767	4.578	11.042	4.287	6.755	4.287	20.072	6.697	13.375	6.697
NOE	11.374	3.730	7.644	3.730	11.056	3.447	7.610	3.447	17.823	7.590	10.233	7.590
OMN	11.421	4.040	7.381	4.040	11.108	3.753	7.356	3.753	18.824	7.355	11.469	7.355
RUS	10.951	3.521	7.430	3.521	11.242	3.802	7.440	3.802	17.568	7.390	10.178	7.390
BRT	11.242	3.802	7.440	3.802	10.951	3.537	7.414	3.537	17.814	7.405	10.409	7.405

Stock: ESV Sector: DE

	M1				M2				M3			
	TRACE		MAX_EIG		TRACE		MAX_EIG		TRACE		MAX_EIG	
Oil	r=0	r≤1	r=0	r=1	r=0	r≤1	r=0	r=1	r=0	r≤1	r=0	r=1
ADM	13.425	3.121	10.303	3.121	12.583	2.804	9.779	2.804	21.991	8.925	13.065	8.925
ASB	13.109	2.703	10.406	2.703	12.284	2.373	9.910	2.374	20.880	8.230	12.658	8.230
ANC	12.853	2.776	10.077	2.777	11.978	2.426	9.551	2.426	21.340	8.432	12.907	8.433
DUB	13.175	3.048	10.127	3.048	12.236	2.699	9.537	2.699	21.727	8.957	12.770	8.957
ECU	12.985	3.267	9.718	3.267	12.288	3.111	9.177	3.111	22.496	8.110	14.386	8.110
IRH	12.781	2.625	10.156	2.625	11.826	2.260	9.566	2.260	20.540	8.547	11.992	8.547
IRL	12.810	2.612	10.197	2.612	11.883	2.247	9.636	2.246	20.295	8.477	11.818	8.477
KUT	13.052	3.180	9.872	3.180	12.160	2.840	9.320	2.840	22.251	8.747	13.504	8.747
LIB	12.924	2.621	10.303	2.621	12.065	2.299	9.767	2.299	20.971	8.384	12.587	8.384
NGB	13.156	2.731	10.424	2.731	12.361	2.432	9.929	2.432	21.457	8.389	13.068	8.389
NGE	13.055	2.683	10.372	2.683	12.253	2.379	9.874	2.379	20.995	8.426	12.568	8.426
DUK	13.551	3.263	10.287	3.263	12.708	2.955	9.753	2.955	22.268	8.965	13.304	8.965
SAH	12.909	2.945	9.963	2.945	12.062	2.666	9.396	2.666	20.771	8.523	12.248	8.523
SAL	8.523	2.861	10.236	2.861	12.270	2.572	9.698	2.572	20.487	8.525	11.961	8.525
SAM	13.097	2.909	10.188	2.909	12.265	2.629	9.636	2.629	20.747	8.530	12.217	8.530
VEN	12.878	3.017	9.860	3.017	12.027	2.740	9.287	2.740	21.084	8.251	12.833	8.251
AUS	13.024	2.959	10.065	2.959	12.800	2.781	10.020	2.781	21.868	8.709	13.160	8.709
CAM	13.170	2.901	10.270	2.901	12.402	2.643	9.759	2.643	22.379	8.296	14.083	8.296
CAP	13.886	2.972	10.914	2.972	13.201	2.763	10.439	2.763	21.556	8.240	13.316	8.240
CHI	13.591	3.358	10.233	3.358	12.872	3.131	9.741	3.131	22.690	8.908	13.781	8.908
COL	12.252	2.493	9.758	2.493	11.355	2.161	9.194	2.161	20.462	8.409	12.053	8.409
EGS	12.768	2.652	10.116	2.652	11.946	2.359	9.586	2.359	20.973	8.363	12.610	8.363
INO	13.287	3.126	10.161	3.126	12.529	2.886	9.643	2.886	22.834	8.997	13.837	8.997
TAP	13.534	2.989	10.546	2.989	12.801	2.727	10.074	2.727	22.285	8.697	13.589	8.697
MXI	12.698	2.915	9.782	2.915	11.930	2.670	9.259	2.670	21.476	8.294	13.182	8.294
MXM	12.646	3.207	9.439	3.207	11.831	2.993	8.838	8.838	23.012	8.369	14.642	8.369
NOE	13.004	2.704	10.301	2.704	12.190	2.387	9.802	2.387	20.947	8.286	12.661	8.286
OMN	13.298	3.138	10.160	3.138	12.397	2.786	9.611	2.786	22.119	8.970	13.149	8.970
RUS	12.199	2.370	9.830	2.370	11.362	2.120	9.242	2.120	20.199	7.820	12.380	7.820
BRT	12.859	2.797	10.062	2.797	12.058	2.492	9.566	2.492	20.653	8.248	12.405	8.248

Stock: RIG Sector: DE

	M1				M2				M3			
	TRACE		MAX_EIG		TRACE		MAX_EIG		TRACE		MAX_EIG	
Oil	r=0	r≤1	r=0	r=1	r=0	r≤1	r=0	r=1	r=0	r≤1	r=0	r=1
ADM	10.767	2.606	8.161	2.606	10.413	2.464	7.949	2.464	27.221	5.615	21.606	5.615
ASB	10.479	2.226	8.252	2.226	10.107	2.030	8.078	2.030	24.854	5.274	19.580	5.274
ANC	10.599	2.271	8.328	2.271	10.200	2.084	8.116	2.084	26.649	5.256	21.393	5.256
DUB	11.055	2.560	8.495	2.560	10.638	2.414	8.223	2.414	29.020	5.666	23.354	5.666
ECU	12.136	2.378	9.758	2.378	11.828	2.293	9.535	2.293	29.230	5.013	24.217	5.013
IRH	10.810	2.235	8.575	2.235	10.349	2.043	8.307	2.043	27.542	5.461	22.081	5.461
IRL	10.530	2.227	8.303	2.227	10.086	2.029	8.057	2.029	26.069	5.459	20.610	5.459
KUT	10.931	2.583	8.348	2.583	10.530	2.438	8.092	2.438	29.005	5.431	23.574	5.431
LIB	10.562	2.199	8.363	2.199	10.153	2.009	8.144	2.009	26.165	5.350	20.814	5.350
NGB	10.695	2.246	8.448	2.246	10.335	2.067	8.268	2.067	26.329	5.358	20.971	5.358
NGE	10.481	2.233	8.248	2.233	10.122	2.054	8.068	2.054	25.488	5.393	20.095	5.393
DUK	11.046	2.668	8.379	2.668	10.700	2.536	8.164	2.536	27.845	5.604	22.241	5.604
SAH	11.794	2.337	9.457	2.337	11.407	2.192	9.216	2.192	28.999	5.330	23.670	5.329
SAL	11.315	2.327	8.988	2.327	10.946	2.171	8.775	2.171	26.696	5.416	21.281	5.416
SAM	11.636	2.329	9.306	2.329	11.259	2.177	9.081	2.177	27.953	5.370	22.584	5.370
VEN	11.103	2.314	8.789	2.314	10.742	2.175	8.566	2.175	26.574	5.192	21.383	5.192
AUS	10.818	2.604	8.214	2.604	10.449	2.436	8.013	2.436	25.220	5.608	19.612	5.608
CAM	11.247	2.261	8.986	2.261	10.904	2.097	8.807	2.097	27.845	5.123	22.722	5.123
CAP	10.649	2.401	8.248	2.401	10.315	2.255	8.060	2.255	21.648	5.330	16.318	5.330
CHI	11.196	2.674	8.522	2.674	10.919	2.559	8.360	2.559	26.548	5.424	21.124	5.424
COL	10.472	2.125	8.346	2.125	10.049	1.955	8.095	1.955	27.833	5.386	22.447	5.386
EGS	10.959	2.214	8.745	2.214	10.569	2.046	8.523	2.046	27.313	5.342	21.971	5.342
INO	11.152	2.622	8.530	2.622	10.841	2.501	8.340	2.501	29.217	5.586	23.631	5.586
TAP	11.027	2.549	8.478	2.549	10.735	2.412	8.323	2.412	26.729	5.614	21.115	5.614
MXI	10.710	2.259	8.450	2.259	10.360	2.121	8.240	2.121	26.375	5.123	21.252	5.123
MXM	11.652	2.552	9.100	2.552	11.301	2.458	8.843	2.458	31.543	5.292	26.251	5.292
NOE	10.571	2.213	8.358	2.213	10.202	2.027	8.174	2.028	25.408	5.304	20.104	5.304
OMN	10.999	2.626	8.372	2.626	10.607	2.478	8.129	2.478	28.689	5.638	23.051	5.638
RUS	10.722	1.966	8.756	1.966	10.407	1.837	8.570	1.837	27.300	5.113	22.187	5.113
BRT	10.397	2.323	8.073	2.323	10.056	2.159	7.897	2.159	24.620	5.277	19.343	5.277

Stock: ATW Sector: DE

	M1				M2				M3			
	TRACE		MAX_EIG		TRACE		MAX_EIG		TRACE		MAX_EIG	
Oil	r=0	r≤1	r=0	r=1	r=0	r≤1	r=0	r=1	r=0	r≤1	r=0	r=1
ADM	17.808	3.436	14.372	3.436	17.295	3.265	14.030	3.265	37.574	10.616	26.958	10.616
ASB	17.546	3.043	14.504	3.043	16.985	2.850	14.135	2.850	36.448	10.047	26.401	10.047
ANC	17.546	3.043	14.504	3.043	16.985	2.850	14.135	2.850	36.448	10.047	26.401	10.047
DUB	17.314	3.106	14.208	3.106	16.703	2.880	13.823	2.880	35.783	10.706	25.077	10.706
ECU	17.349	4.160	13.189	4.160	16.882	4.007	12.875	4.007	34.714	11.027	23.687	11.027
IRH	17.713	3.039	14.674	3.039	17.062	2.804	14.257	2.804	34.936	10.636	24.300	10.636
IRL	17.815	3.001	14.814	3.001	17.184	2.781	14.403	2.781	35.445	10.433	25.012	10.433
KUT	17.093	3.443	13.650	3.443	16.530	3.228	13.302	3.228	35.551	10.871	24.680	10.871
LIB	17.747	3.065	14.681	3.065	17.159	2.864	14.295	2.864	36.412	10.298	26.114	10.298
NGB	17.799	3.126	14.673	3.126	17.235	2.932	14.303	2.932	36.829	10.543	26.286	10.543
NGE	17.910	3.076	14.833	3.076	17.345	2.888	14.457	2.888	36.688	10.532	26.156	10.532
DUK	17.529	3.509	14.020	3.509	17.008	3.326	13.682	3.326	36.904	10.697	26.206	10.697
SAH	17.159	3.386	13.773	3.386	16.583	3.175	13.408	3.175	32.812	10.683	22.129	10.683
SAL	17.659	3.286	14.373	3.286	17.105	3.100	14.004	3.100	34.546	10.369	24.177	10.369
SAM	17.487	3.353	14.134	3.353	16.923	3.158	13.765	3.158	33.852	10.516	23.336	10.516
VEN	16.905	3.477	13.428	3.477	16.357	3.287	13.070	3.287	34.534	10.235	24.299	10.235
AUS	17.653	3.323	14.330	3.323	17.085	3.116	13.968	3.116	36.825	10.481	26.344	10.481
CAM	17.089	3.377	13.712	3.377	16.557	3.181	13.376	3.181	35.965	10.535	25.430	10.535
CAP	17.614	3.467	14.147	3.467	17.134	3.316	13.817	3.316	35.984	9.369	26.615	9.368
CHI	17.812	3.727	14.084	3.727	17.351	3.579	13.772	3.579	37.623	10.959	26.664	10.959
COL	17.780	3.053	14.727	3.053	17.182	2.855	14.327	2.856	35.722	10.768	24.953	10.768
EGS	17.988	3.246	14.742	3.246	17.433	3.062	14.371	3.062	36.608	10.538	26.070	10.538
INO	17.908	3.525	14.382	3.525	17.406	3.363	14.043	3.363	37.401	11.335	26.066	11.335
TAP	17.736	3.397	14.339	3.397	17.286	3.256	14.030	3.256	38.901	10.094	28.808	10.094
MXI	17.291	3.509	13.782	3.509	16.774	3.332	13.442	3.331	35.633	10.709	24.924	10.709
MXM	16.611	3.771	12.839	3.771	16.093	3.569	12.524	3.569	34.232	11.046	23.187	11.046
NOE	17.762	3.116	14.646	3.116	17.199	2.924	14.274	2.924	36.803	10.371	26.431	10.371
OMN	17.404	3.352	14.053	3.352	16.833	3.140	13.693	3.140	36.139	10.866	25.273	10.866
RUS	17.505	2.973	14.531	2.973	17.024	2.846	14.179	2.846	36.430	10.084	26.346	10.084
BRT	17.643	3.237	14.406	3.237	17.116	3.066	14.050	3.066	37.108	10.294	26.813	10.294

Stock: PKD Sector: DE

	M1				M2				M3			
	TRACE		MAX_EIG		TRACE		MAX_EIG		TRACE		MAX_EIG	
Oil	r=0	r≤1	r=0	r=1	r=0	r≤1	r=0	r=1	r=0	r≤1	r=0	r=1
ADM	9.514	3.171	6.343	3.171	8.696	2.369	6.327	2.369	17.214	6.060	11.154	6.060
ASB	8.990	2.908	6.082	2.908	8.180	2.135	6.045	2.135	16.017	5.995	10.022	5.994
ANC	9.059	2.920	6.138	2.920	8.205	2.096	6.110	2.096	16.604	5.956	10.648	5.956
DUB	9.378	3.092	6.286	3.092	8.467	2.201	6.267	2.201	16.882	5.923	10.958	5.923
ECU	9.476	3.440	6.035	3.440	8.747	2.723	6.024	2.723	17.744	5.561	12.182	5.561
IRH	8.992	2.810	6.182	2.810	8.047	1.908	6.139	1.908	15.679	5.923	9.756	5.923
IRL	8.982	2.804	6.177	2.804	8.060	1.926	6.134	1.926	15.490	5.957	9.533	5.957
KUT	9.420	3.190	6.230	3.190	8.550	2.331	6.219	2.331	17.509	5.856	11.653	5.856
LIB	8.888	2.832	6.057	2.832	8.020	2.010	6.015	2.010	15.840	5.916	9.924	5.916
NGB	9.020	2.958	6.067	2.958	8.230	2.198	6.032	2.198	16.359	5.974	10.385	5.974
NGE	8.964	2.893	6.072	2.893	8.163	2.128	6.034	2.128	15.955	5.964	9.991	5.964
DUK	9.617	3.306	6.311	3.306	8.813	2.517	6.296	2.517	17.670	6.050	11.620	6.050
SAH	9.105	3.031	6.073	3.031	8.250	2.215	6.035	2.215	15.975	5.739	10.235	5.739
SAL	9.127	2.997	6.131	2.997	8.302	2.211	6.091	2.211	15.722	5.910	9.812	5.910
SAM	9.129	3.028	6.101	3.028	8.290	2.229	6.061	2.229	15.871	5.843	10.027	5.843
VEN	9.422	3.361	6.061	3.361	8.615	2.572	6.043	2.572	16.841	5.823	11.018	5.823
AUS	9.606	3.205	6.401	3.205	8.765	2.385	6.380	2.386	16.966	6.178	10.788	6.177
CAM	9.103	3.133	5.970	3.133	8.332	2.393	5.939	2.393	17.160	5.830	11.330	5.830
CAP	9.523	3.365	6.158	3.365	8.818	2.688	6.131	2.688	16.351	6.076	10.275	6.076
CHI	9.667	3.385	6.282	3.385	8.974	2.707	6.267	2.707	17.646	5.969	11.677	5.969
COL	8.723	2.753	5.970	2.753	7.857	1.922	5.934	1.922	15.841	5.810	10.031	5.810
EGS	8.843	2.837	6.006	2.837	8.011	2.052	5.959	2.052	15.984	5.839	10.145	5.839
INO	9.413	3.190	6.224	3.190	8.667	2.466	6.200	2.466	17.448	5.919	11.530	5.919
TAP	9.246	3.103	6.143	3.103	8.542	2.437	6.104	2.437	17.392	6.041	11.352	6.041
MXI	9.197	3.179	6.018	3.179	8.426	2.427	5.970	2.427	16.839	5.747	11.092	5.747
MXM	9.623	3.264	6.359	3.264	8.813	2.465	6.348	2.465	18.377	5.600	12.777	5.600
NOE	8.968	2.916	6.052	2.916	8.173	2.160	6.014	2.160	16.107	5.958	10.149	5.958
OMN	9.518	3.147	6.371	3.147	8.657	2.301	6.355	2.301	17.449	6.046	11.403	6.046
RUS	8.237	2.625	5.613	2.625	7.453	1.933	5.520	1.933	15.522	5.483	10.039	5.483
BRT	9.033	3.003	6.031	3.003	8.242	2.238	6.004	2.238	16.097	5.863	10.234	5.863

Stock: PTEN Sector: DE

	M1				M2				M3			
	TRACE		MAX_EIG		TRACE		MAX_EIG		TRACE		MAX_EIG	
Oil	r=0	r≤1	r=0	r=1	r=0	r≤1	r=0	r=1	r=0	r≤1	r=0	r=1
ADM	12.343	2.446	9.897	2.446	11.791	1.935	9.856	1.935	18.561	7.576	10.985	7.576
ASB	11.862	2.293	9.570	2.292	11.322	1.804	9.518	1.804	17.640	7.767	9.874	7.766
ANC	11.901	2.301	9.601	2.301	11.325	1.763	9.562	1.763	18.226	7.921	10.305	7.921
DUB	12.293	2.406	9.888	2.406	11.684	1.837	9.846	1.837	18.596	7.476	11.121	7.476
ECU	12.510	2.859	9.651	2.859	12.033	2.407	9.627	2.407	19.888	8.123	11.766	8.123
IRH	11.962	2.229	9.733	2.229	11.331	1.647	9.684	1.647	17.793	7.450	10.340	7.450
IRL	11.919	2.226	9.693	2.226	11.311	1.669	9.641	1.669	17.610	7.451	10.159	7.451
KUT	12.385	2.482	9.903	2.482	11.801	1.932	9.869	1.932	19.274	7.790	11.485	7.790
LIB	11.856	2.261	9.595	2.261	11.280	1.740	9.540	1.740	17.749	7.753	9.995	7.753
NGB	11.937	2.332	9.605	2.332	11.405	1.851	9.554	1.851	17.917	7.887	10.030	7.887
NGE	11.882	2.289	9.593	2.289	11.353	1.813	9.540	1.813	17.702	7.754	9.948	7.754
DUK	12.561	2.552	10.010	2.552	12.023	2.053	9.970	2.053	18.983	7.668	11.314	7.668
SAH	12.177	2.453	9.724	2.453	11.617	1.928	9.689	1.927	18.223	7.411	10.812	7.411
SAL	12.115	2.394	9.721	2.394	11.572	1.895	9.677	1.895	17.769	7.364	10.406	7.364
SAM	12.147	2.431	9.715	2.431	11.595	1.921	9.674	1.921	17.958	7.407	10.551	7.407
VEN	12.306	2.659	9.647	2.659	11.767	2.159	9.607	2.159	18.801	8.148	10.653	8.148
AUS	12.462	2.473	9.989	2.473	11.888	1.944	9.945	1.944	18.456	7.724	10.731	7.724
CAM	12.055	2.508	9.547	2.508	11.544	2.038	9.506	2.038	18.767	8.352	10.415	8.352
CAP	12.236	2.626	9.610	2.626	11.734	2.170	9.564	2.170	18.016	8.166	9.834	8.166
CHI	12.611	2.621	9.989	2.621	12.131	2.175	9.956	2.175	19.283	7.950	11.333	7.950
COL	11.734	2.180	9.555	2.180	11.139	1.633	9.507	1.633	17.906	7.637	10.269	7.637
EGS	11.844	2.314	9.530	2.314	11.294	1.817	9.477	1.817	17.979	7.938	10.040	7.938
INO	12.456	2.473	9.983	2.473	11.942	2.000	9.942	2.000	19.166	7.791	11.375	7.791
TAP	12.455	2.434	10.022	2.434	11.966	2.002	9.964	2.002	18.770	7.970	10.800	7.970
MXI	12.125	2.562	9.563	2.562	11.616	2.093	9.523	2.093	18.962	8.260	10.702	8.260
MXM	12.651	2.710	9.941	2.710	12.121	2.211	9.910	2.211	20.573	8.068	12.505	8.068
NOE	11.883	2.318	9.566	2.318	11.345	1.831	9.514	1.831	17.815	7.898	9.917	7.898
OMN	12.477	2.436	10.041	2.436	11.889	1.888	10.001	1.888	18.972	7.616	11.356	7.616
RUS	11.861	2.071	9.791	2.071	11.350	1.632	9.718	1.632	17.977	7.991	9.986	7.991
BRT	11.883	2.358	9.524	2.358	11.362	1.880	9.482	1.880	17.890	7.813	10.076	7.813

Stock: PDE Sector: DE

	M1				M2				M3			
	TRACE		MAX_EIG		TRACE		MAX_EIG		TRACE		MAX_EIG	
Oil	r=0	r≤1	r=0	r=1	r=0	r≤1	r=0	r=1	r=0	r≤1	r=0	r=1
ADM	15.681	3.153	12.528	3.153	15.350	2.858	12.493	2.858	24.960	10.938	14.022	10.938
ASB	15.902	2.846	13.057	2.846	15.567	2.549	13.018	2.549	25.040	9.556	15.484	9.556
ANC	15.586	2.917	12.670	2.917	15.221	2.596	12.625	2.596	25.449	9.975	15.475	9.975
DUB	15.571	3.120	12.451	3.120	15.180	2.782	12.397	2.782	25.008	11.060	13.948	11.060
ECU	15.862	3.765	12.097	3.765	15.583	3.540	12.042	3.540	26.585	10.123	16.462	10.123
IRH	15.887	2.848	13.039	2.848	15.468	2.500	12.968	2.500	25.058	10.151	14.908	10.151
IRL	15.847	2.802	13.045	2.802	15.446	2.464	12.982	2.464	24.721	9.984	14.737	9.984
KUT	15.273	3.239	12.034	3.239	14.903	2.912	11.991	2.912	25.335	10.969	14.366	10.969
LIB	16.132	2.830	13.302	2.830	15.762	2.517	13.245	2.517	25.775	9.749	16.025	9.749
NGB	16.029	2.921	13.108	2.921	15.704	2.634	13.070	2.634	25.603	9.834	15.769	9.834
NGE	15.775	2.842	12.933	2.842	15.449	2.554	12.895	2.554	24.874	9.711	15.163	9.711
DUK	15.814	3.306	12.508	3.306	15.491	3.019	12.472	3.019	25.351	11.123	14.228	11.123
SAH	15.423	3.180	12.243	3.180	15.068	2.880	12.189	2.880	24.292	10.233	14.059	10.233
SAL	15.750	3.051	12.699	3.051	15.415	2.762	12.652	2.762	24.226	9.934	14.291	9.935
SAM	15.677	3.124	12.552	3.124	15.332	2.831	12.502	2.831	24.364	10.066	14.298	10.066
VEN	15.062	3.219	11.844	3.219	14.731	2.932	11.799	2.932	24.384	9.772	14.612	9.772
AUS	15.957	3.148	12.808	3.148	15.610	2.841	12.769	2.841	25.093	10.581	14.513	10.581
CAM	16.074	3.221	12.853	3.221	15.769	2.954	12.814	2.954	26.653	10.008	16.645	10.008
CAP	16.119	3.276	12.844	3.276	15.819	3.011	12.808	3.011	24.400	9.591	14.809	9.591
CHI	15.834	3.514	12.320	3.514	15.578	3.284	12.295	3.284	25.552	11.112	14.441	11.112
COL	15.373	2.722	12.651	2.722	14.986	2.399	12.587	2.399	24.988	9.916	15.072	9.916
EGS	16.081	2.937	13.144	2.937	15.727	2.640	13.087	2.640	25.740	9.906	15.834	9.906
INO	15.951	3.347	12.605	3.347	15.669	3.100	12.569	3.100	26.299	11.306	14.993	11.306
TAP	16.033	3.091	12.941	3.091	15.759	2.849	12.910	2.849	25.802	10.131	15.671	10.131
MXI	15.216	3.182	12.033	3.182	14.901	2.911	11.990	2.911	25.124	9.889	15.235	9.889
MXM	15.092	3.646	11.446	3.646	14.767	3.375	11.392	3.375	26.244	10.749	15.495	10.749
NOE	16.034	2.887	13.147	2.887	15.700	2.596	13.105	2.596	25.497	9.674	15.824	9.674
OMN	15.809	3.186	12.623	3.186	15.444	2.865	12.579	2.865	25.526	11.231	14.295	11.231
RUS	14.916	2.525	12.391	2.525	14.586	2.310	12.276	2.310	24.642	8.627	16.015	8.627
BRT	15.235	2.925	12.310	2.925	14.920	2.643	12.277	2.643	24.300	9.560	14.739	9.561

Stock: BHI Sector: ES

	M1				M2				M3			
	TRACE		MAX_EIG		TRACE		MAX_EIG		TRACE		MAX_EIG	
Oil	r=0	r≤1	r=0	r=1	r=0	r≤1	r=0	r=1	r=0	r≤1	r=0	r=1
ADM	10.066	3.406	6.659	3.406	9.627	3.158	6.469	3.157	19.482	6.299	13.183	6.299
ASB	10.190	3.007	7.183	3.007	9.746	2.768	6.977	2.768	19.167	6.184	12.983	6.184
ANC	9.464	3.027	6.438	3.027	8.994	2.748	6.247	2.748	18.474	5.870	12.604	5.870
DUB	9.770	3.392	6.378	3.392	9.263	3.097	6.167	3.097	18.958	6.112	12.846	6.112
ECU	9.584	3.930	5.654	3.930	9.215	3.802	5.413	3.802	18.711	5.114	13.596	5.114
IRH	10.005	3.133	6.872	3.133	9.476	2.852	6.624	2.852	18.492	6.346	12.146	6.346
IRL	10.185	3.086	7.099	3.086	9.674	2.821	6.852	2.821	18.642	6.451	12.191	6.451
KUT	9.448	3.440	6.001	3.440	8.971	3.139	5.832	3.139	19.007	5.793	13.215	5.793
LIB	10.146	3.078	7.068	3.078	9.663	2.828	6.835	2.828	19.028	6.283	12.745	6.283
NGB	10.386	3.085	7.301	3.085	9.959	2.863	7.096	2.863	19.726	6.239	13.487	6.239
NGE	10.395	3.056	7.340	3.056	9.967	2.833	7.134	2.833	19.519	6.325	13.195	6.325
DUK	10.246	3.551	6.695	3.551	9.818	3.320	6.497	3.320	20.005	6.271	13.734	6.271
SAH	10.018	3.515	6.503	3.515	10.288	3.331	6.957	3.331	9.855	3.118	6.737	3.118
SAL	10.288	3.331	6.957	3.331	9.855	3.118	6.737	3.118	18.436	6.274	12.161	6.274
SAM	10.209	3.422	6.788	3.422	9.771	3.211	6.561	3.211	18.450	6.158	12.293	6.158
VEN	9.750	3.494	6.256	3.494	9.320	3.296	6.025	3.296	18.556	5.711	12.846	5.711
AUS	10.158	3.310	6.848	3.310	9.701	3.035	6.667	3.035	19.554	6.374	13.180	6.374
CAM	10.303	3.295	7.008	3.295	9.909	3.114	6.795	3.114	20.112	5.823	14.289	5.823
CAP	10.957	3.472	7.485	3.472	10.582	3.302	7.280	3.302	19.401	6.222	13.178	6.222
CHI	10.362	3.600	6.762	3.600	10.027	3.431	6.596	3.431	20.223	6.007	14.215	6.007
COL	9.646	3.004	6.641	3.004	9.160	2.747	6.412	2.747	18.249	6.083	12.167	6.083
EGS	10.170	3.224	6.946	3.224	9.710	3.004	6.706	3.004	19.006	6.167	12.839	6.167
INO	10.377	3.529	6.848	3.529	10.005	3.344	6.661	3.344	20.503	6.221	14.282	6.221
TAP	10.982	3.438	7.545	3.438	10.624	3.268	7.355	3.268	21.151	6.547	14.605	6.547
MXI	9.853	3.455	6.397	3.455	9.443	3.271	6.172	3.271	18.972	5.747	13.225	5.747
MXM	9.762	4.084	5.677	4.084	9.322	3.856	5.466	3.856	20.136	5.455	14.681	5.455
NOE	10.314	3.074	7.241	3.074	9.880	2.851	7.029	2.851	19.326	6.197	13.129	6.197
OMN	9.827	3.399	6.428	3.399	9.616	2.770	6.846	2.770	19.317	6.180	13.137	6.180
RUS	9.232	2.647	6.584	2.647	10.120	3.133	6.987	3.133	18.273	5.661	12.612	5.661
BRT	9.712	2.932	6.780	2.932	10.493	2.093	8.401	2.093	19.223	5.965	13.258	5.965

Stock: BJS Sector: ES

	M1				M2				M3			
	TRACE		MAX_EIG		TRACE		MAX_EIG		TRACE		MAX_EIG	
Oil	r=0	r≤1	r=0	r=1	r=0	r≤1	r=0	r=1	r=0	r≤1	r=0	r=1
ADM	10.650	2.119	8.531	2.119	10.157	1.630	8.527	1.630	17.796	8.168	9.628	8.168
ASB	10.274	1.961	8.313	1.961	9.736	1.435	8.301	1.435	16.936	8.284	8.652	8.284
ANC	10.305	1.946	8.359	1.946	9.743	1.388	8.354	1.388	17.459	8.191	9.268	8.191
DUB	10.741	2.065	8.676	2.065	10.188	1.514	8.674	1.514	17.782	8.086	9.696	8.086
ECU	11.081	2.313	8.767	2.313	10.635	1.868	8.767	1.868	19.258	8.088	11.169	8.088
IRH	10.396	1.938	8.457	1.938	9.796	1.344	8.452	1.344	16.992	8.212	8.779	8.212
IRL	10.307	1.957	8.350	1.957	9.730	1.388	8.342	1.388	16.865	8.292	8.573	8.292
KUT	10.943	2.087	8.856	2.087	10.406	1.551	8.855	1.551	18.488	8.106	10.381	8.106
LIB	10.360	1.953	8.407	1.953	9.794	1.401	8.394	1.401	17.164	8.360	8.804	8.360
NGB	10.441	2.006	8.435	2.006	9.919	1.498	8.421	1.498	17.320	8.360	8.960	8.360
NGE	10.321	1.971	8.350	1.971	9.799	1.464	8.335	1.464	17.015	8.301	8.713	8.301
DUK	10.919	2.173	8.746	2.173	10.430	1.688	8.742	1.688	18.152	8.170	9.983	8.170
SAH	10.796	2.077	8.719	2.077	10.268	1.551	8.717	1.551	17.503	8.062	9.441	8.062
SAL	10.540	2.074	8.465	2.074	10.033	1.575	8.458	1.575	17.104	8.256	8.848	8.256
SAM	10.668	2.084	8.585	2.084	10.152	1.572	8.580	1.572	17.280	8.174	9.106	8.174
VEN	10.696	2.239	8.457	2.239	10.185	1.730	8.455	1.730	18.068	8.178	9.890	8.178
AUS	10.493	2.093	8.401	2.093	9.944	1.548	8.396	1.548	17.371	8.198	9.173	8.198
CAM	10.593	2.074	8.519	2.074	10.084	1.570	8.514	1.570	18.031	8.225	9.806	8.225
CAP	10.531	2.284	8.247	2.284	10.064	1.829	8.235	1.829	17.707	8.229	9.478	8.229
CHI	10.941	2.158	8.783	2.158	10.480	1.702	8.779	1.702	18.391	8.216	10.175	8.216
COL	10.172	1.910	8.262	1.910	9.620	1.364	8.256	1.364	17.327	8.199	9.128	8.199
EGS	10.574	1.951	8.623	1.951	10.028	1.415	8.613	1.415	17.406	8.297	9.109	8.297
INO	10.993	2.066	8.928	2.066	10.492	1.572	8.920	1.572	18.327	8.229	10.098	8.229
TAP	10.348	2.135	8.214	2.135	9.900	1.699	8.201	1.699	17.844	8.171	9.673	8.171
MXI	10.614	2.140	8.474	2.140	10.129	1.658	8.471	1.658	18.358	8.203	10.154	8.203
MXM	11.193	2.232	8.961	2.232	10.707	1.747	8.960	1.747	19.631	8.049	11.582	8.049
NOE	10.347	1.962	8.385	1.962	9.810	1.436	8.374	1.436	17.111	8.297	8.814	8.297
OMN	10.821	2.077	8.743	2.077	10.284	1.544	8.741	1.544	18.043	8.133	9.910	8.133
RUS	9.964	1.822	8.142	1.822	9.457	1.351	8.106	1.351	17.086	8.104	8.982	8.104
BRT	10.402	2.018	8.383	2.018	9.904	1.530	8.373	1.530	17.419	8.281	9.138	8.281

Stock: HAL Sector: ES

	M1				M2				M3			
	TRACE		MAX_EIG		TRACE		MAX_EIG		TRACE		MAX_EIG	
Oil	r=0	r≤1	r=0	r=1	r=0	r≤1	r=0	r=1	r=0	r≤1	r=0	r=1
ADM	12.354	2.879	9.475	2.879	11.462	2.365	9.097	2.365	21.554	9.070	12.485	9.070
ASB	11.671	2.551	9.119	2.552	10.798	2.064	8.734	2.064	20.466	8.392	12.074	8.392
ANC	11.691	2.617	9.074	2.617	10.764	2.048	8.716	2.048	20.775	8.599	12.177	8.599
DUB	12.324	2.815	9.509	2.815	11.371	2.255	9.115	2.255	21.375	9.110	12.266	9.110
ECU	12.365	3.238	9.128	3.238	11.523	2.718	8.804	2.718	21.807	8.712	13.096	8.712
IRH	11.868	2.509	9.359	2.509	10.882	1.929	8.953	1.929	20.145	8.835	11.310	8.835
IRL	11.837	2.495	9.342	2.495	10.861	1.926	8.935	1.926	20.059	8.734	11.325	8.734
KUT	12.223	2.925	9.299	2.925	11.307	2.355	8.951	2.355	21.655	8.950	12.705	8.950
LIB	11.591	2.512	9.079	2.512	10.674	1.984	8.690	1.984	20.290	8.430	11.860	8.430
NGB	11.760	2.597	9.163	2.597	10.892	2.112	8.780	2.112	20.862	8.519	12.343	8.519
NGE	11.733	2.548	9.185	2.548	10.864	2.065	8.798	2.065	20.563	8.518	12.045	8.518
DUK	12.462	3.003	9.459	3.003	11.579	2.490	9.089	2.490	21.951	9.071	12.880	9.071
SAH	11.947	2.806	9.140	2.806	11.062	2.282	8.780	2.282	20.028	8.766	11.261	8.766
SAL	11.953	2.713	9.240	2.713	11.079	2.226	8.853	2.226	20.224	8.678	11.546	8.678
SAM	11.972	2.766	9.206	2.766	11.096	2.269	8.827	2.269	20.216	8.732	11.484	8.732
VEN	12.010	3.019	8.991	3.019	11.129	2.491	8.637	2.491	20.968	8.582	12.386	8.582
AUS	12.349	2.854	9.495	2.854	11.419	2.315	9.104	2.315	21.337	8.985	12.352	8.985
CAM	11.714	2.805	8.909	2.805	10.885	2.325	8.560	2.325	21.428	8.438	12.990	8.438
CAP	12.063	2.936	9.127	2.936	11.244	2.497	8.747	2.497	20.742	8.383	12.358	8.383
CHI	12.466	3.119	9.347	3.119	11.690	2.671	9.019	2.671	22.016	9.014	13.002	9.014
COL	11.595	2.442	9.153	2.442	10.683	1.929	8.754	1.929	20.824	8.601	12.223	8.601
EGS	11.555	2.557	8.997	2.557	10.671	2.047	8.624	2.047	20.220	8.470	11.750	8.470
INO	12.362	2.909	9.452	2.909	11.556	2.463	9.093	2.463	22.283	9.083	13.200	9.083
TAP	12.106	2.778	9.329	2.778	11.330	2.381	8.950	2.381	22.241	8.769	13.472	8.769
MXI	11.777	2.895	8.881	2.895	10.951	2.400	8.551	2.400	21.140	8.504	12.636	8.504
MXM	12.297	3.123	9.174	3.123	11.438	2.578	8.860	2.578	22.233	8.741	13.492	8.741
NOE	11.610	2.579	9.031	2.579	10.746	2.087	8.659	2.087	20.471	8.352	12.119	8.352
OMN	12.365	2.862	9.503	2.862	11.426	2.302	9.124	2.302	21.718	9.119	12.599	9.119
RUS	11.041	2.295	8.746	2.295	10.228	1.904	8.323	1.904	20.045	8.024	12.021	8.024
BRT	11.667	2.672	8.995	2.672	10.829	2.202	8.628	2.202	20.692	8.398	12.295	8.398

Stock: SII Sector: ES

	M1				M2				M3			
	TRACE		MAX_EIG		TRACE		MAX_EIG		TRACE		MAX_EIG	
Oil	r=0	r≤1	r=0	r=1	r=0	r≤1	r=0	r=1	r=0	r≤1	r=0	r=1
ADM	12.309	2.000	10.310	2.000	11.835	1.532	10.303	1.532	23.163	9.225	13.938	9.225
ASB	11.728	1.958	9.770	1.958	11.254	1.493	9.761	1.493	23.015	7.949	15.066	7.949
ANC	11.751	1.899	9.853	1.899	11.240	1.392	9.848	1.392	23.218	8.519	14.699	8.519
DUB	12.313	1.924	10.389	1.924	11.768	1.385	10.383	1.385	22.802	9.404	13.398	9.404
ECU	12.052	2.290	9.762	2.290	11.636	1.875	9.761	1.875	24.267	9.397	14.870	9.396
IRH	11.916	1.881	10.035	1.881	11.350	1.324	10.026	1.324	22.553	8.336	14.218	8.336
IRL	11.945	1.906	10.039	1.906	11.400	1.373	10.026	1.373	22.574	8.153	14.421	8.153
KUT	12.415	1.945	10.470	1.945	11.891	1.424	10.467	1.424	23.544	9.844	13.699	9.844
LIB	11.811	1.937	9.875	1.937	11.299	1.437	9.862	1.437	23.091	8.079	15.012	8.079
NGB	11.971	2.021	9.950	2.021	11.508	1.570	9.938	1.570	23.370	8.223	15.147	8.223
NGE	11.903	1.987	9.916	1.987	11.441	1.539	9.901	1.539	23.085	8.061	15.024	8.061
DUK	12.597	2.067	10.530	2.067	12.130	1.606	10.524	1.606	23.549	9.621	13.928	9.621
SAH	12.122	2.059	10.063	2.059	11.633	1.576	10.057	1.576	22.894	8.857	14.037	8.857
SAL	12.134	2.052	10.082	2.052	11.664	1.593	10.070	1.593	22.756	8.443	14.313	8.443
SAM	12.128	2.065	10.064	2.065	11.650	1.595	10.055	1.595	22.801	8.627	14.174	8.627
VEN	11.952	2.223	9.729	2.223	11.483	1.759	9.724	1.759	23.464	8.766	14.698	8.766
AUS	12.320	2.002	10.318	2.002	11.814	1.501	10.313	1.501	23.362	8.988	14.373	8.988
CAM	11.815	2.127	9.688	2.127	11.372	1.690	9.683	1.690	23.938	8.554	15.384	8.554
CAP	12.110	2.214	9.896	2.214	11.668	1.780	9.888	1.780	23.471	8.266	15.204	8.266
CHI	12.569	2.120	10.448	2.120	12.162	1.718	10.445	1.718	24.604	9.628	14.976	9.628
COL	11.690	1.878	9.812	1.878	11.170	1.372	9.799	1.372	22.797	8.242	14.555	8.242
EGS	11.818	1.972	9.846	1.972	11.325	1.490	9.835	1.490	22.878	8.284	14.595	8.284
INO	12.588	2.022	10.566	2.022	12.139	1.582	10.557	1.582	24.240	9.654	14.586	9.654
TAP	20.262	9.165	15.892	9.165	11.890	1.699	10.191	1.699	24.116	8.794	15.323	8.794
MXI	11.915	2.186	9.729	2.186	11.476	1.754	9.722	1.754	24.122	8.722	15.401	8.722
MXM	12.565	2.215	10.350	2.215	12.102	1.755	10.347	1.755	24.740	10.098	14.642	10.098
NOE	11.767	1.979	9.788	1.979	11.292	1.514	9.778	1.514	23.171	8.055	15.116	8.055
OMN	12.526	1.937	10.589	1.937	12.004	1.421	10.584	1.421	23.264	9.681	13.582	9.681
RUS	11.080	1.735	9.345	1.735	10.629	1.305	9.325	1.305	22.336	7.744	14.592	7.744
BRT	11.638	1.946	9.691	1.946	11.172	1.489	9.684	1.489	23.018	8.232	14.786	8.232

Stock: WFT Sector: ES

	M1				M2				M3			
	TRACE		MAX_EIG		TRACE		MAX_EIG		TRACE		MAX_EIG	
Oil	r=0	r≤1	r=0	r=1	r=0	r≤1	r=0	r=1	r=0	r≤1	r=0	r=1
ADM	17.713	4.251	13.462	4.251	16.967	4.167	12.800	4.167	33.973	11.416	22.557	11.416
ASB	17.378	3.873	13.505	3.873	16.600	3.799	12.801	3.799	33.844	10.522	23.322	10.522
ANC	16.828	3.836	12.992	3.835	16.007	3.716	12.291	3.716	32.493	10.971	21.522	10.971
DUB	17.608	4.191	13.417	4.191	16.815	4.080	12.735	4.080	32.953	11.652	21.300	11.652
ECU	17.035	4.903	12.132	4.903	16.323	4.764	11.559	4.764	32.251	11.403	20.848	11.403
IRH	17.478	3.838	13.641	3.838	16.629	3.726	12.903	3.726	32.357	11.172	21.185	11.172
IRL	17.899	3.879	14.119	3.879	17.158	3.787	13.371	3.787	33.458	11.267	22.191	11.267
KUT	16.658	4.146	12.512	4.146	15.879	4.010	11.869	4.010	31.998	11.199	20.799	11.199
LIB	17.609	3.895	13.714	3.895	16.793	3.807	12.986	3.807	33.582	10.993	22.589	10.993
NGB	17.823	4.003	13.820	4.003	17.052	3.932	13.120	3.932	34.628	11.007	23.620	11.007
NGE	17.964	3.958	14.005	3.959	17.194	3.894	13.300	3.894	34.603	10.997	23.606	10.997
DUK	17.602	4.358	13.245	4.358	16.853	4.263	12.591	4.263	33.814	11.478	22.336	11.478
SAH	16.896	4.191	12.705	4.191	16.119	4.076	12.042	4.076	30.670	11.059	19.611	11.059
SAL	17.771	4.221	13.550	4.221	17.010	4.146	12.864	4.146	32.675	11.068	21.607	11.068
SAM	17.285	4.208	13.077	4.208	16.517	4.116	12.401	4.116	31.592	10.995	20.597	10.995
VEN	17.890	4.584	13.307	4.584	17.110	4.488	12.622	4.488	33.955	11.576	22.379	11.576
AUS	17.839	4.135	13.705	4.135	17.017	4.026	12.991	4.026	34.278	11.434	22.845	11.434
CAM	16.623	4.184	12.439	4.184	15.888	4.099	11.789	4.099	33.311	10.474	22.837	10.474
CAP	18.846	4.592	14.254	4.592	18.064	4.524	13.540	4.524	36.468	11.516	24.952	11.516
CHI	17.333	4.528	12.805	4.528	16.636	4.448	12.188	4.448	34.482	11.133	23.349	11.133
COL	18.323	3.989	14.334	3.989	17.512	3.899	13.612	3.899	33.792	12.061	21.731	12.061
EGS	17.135	3.977	13.158	3.977	16.357	3.889	12.468	3.889	32.560	10.792	21.768	10.792
INO	17.633	4.358	13.275	4.358	16.913	4.281	12.631	4.281	34.364	11.486	22.879	11.486
TAP	17.940	4.312	13.628	4.312	17.234	4.260	12.974	4.260	35.735	11.118	24.617	11.118
MXI	17.201	4.370	12.830	4.370	16.456	4.278	12.178	4.278	33.577	11.187	22.390	11.187
MXM	17.018	4.674	12.344	4.674	16.288	4.540	11.748	4.540	32.902	11.554	21.348	11.554
NOE	17.653	3.991	13.662	3.991	16.884	3.922	12.962	3.922	34.455	10.754	23.701	10.754
OMN	17.468	4.157	13.311	4.157	16.675	4.035	12.640	4.035	33.008	11.712	21.296	11.712
RUS	16.325	3.610	12.716	3.610	15.551	3.569	11.982	3.569	31.858	10.019	21.841	10.019
BRT	16.993	3.989	13.003	3.989	16.232	3.918	12.314	3.918	33.690	10.448	23.241	10.448

Stock: TESO Sector: ES

	M1				M2				M3			
	TRACE		MAX_EIG		TRACE		MAX_EIG		TRACE		MAX_EIG	
Oil	r=0	r≤1	r=0	r=1	r=0	r≤1	r=0	r=1	r=0	r≤1	r=0	r=1
ADM	12.396	2.774	9.622	2.774	11.908	2.358	9.550	2.358	21.739	9.185	12.554	9.185
ASB	12.466	2.538	9.928	2.538	11.987	2.138	9.849	2.138	21.814	8.335	13.479	8.335
ANC	12.256	2.611	9.645	2.611	11.748	2.180	9.568	2.180	21.936	8.818	13.118	8.818
DUB	17.608	4.191	13.417	4.191	16.815	4.080	12.735	4.080	32.953	11.652	21.300	11.652
ECU	11.691	3.302	8.390	3.302	11.278	2.959	8.319	2.959	21.404	8.178	13.226	8.178
IRH	12.222	2.504	9.718	2.504	11.652	2.042	9.610	2.042	20.998	8.722	12.276	8.722
IRL	12.239	2.471	9.768	2.471	11.683	2.020	9.662	2.020	20.811	8.643	12.168	8.643
KUT	12.060	2.841	9.219	2.841	11.534	2.388	9.146	2.388	21.882	9.041	12.841	9.041
LIB	12.184	2.488	9.696	2.488	11.652	2.053	9.599	2.053	21.227	8.553	12.674	8.553
NGB	12.614	2.612	10.002	2.612	12.151	2.227	9.924	2.227	22.315	8.535	13.780	8.535
NGE	12.631	2.563	10.068	2.563	12.175	2.188	9.988	2.188	22.100	8.466	13.634	8.466
DUK	12.490	2.901	9.589	2.901	12.005	2.480	9.525	2.480	22.108	9.245	12.863	9.245
SAH	12.184	2.824	9.360	2.824	11.704	2.443	9.262	2.443	21.023	8.508	12.515	8.508
SAL	12.329	2.708	9.621	2.708	11.860	2.334	9.526	2.334	20.762	8.510	12.253	8.510
SAM	12.293	2.774	9.519	2.774	11.819	2.396	9.423	2.396	20.945	8.491	12.454	8.491
VEN	12.030	2.946	9.084	2.946	11.563	2.563	9.000	2.563	21.202	8.577	12.625	8.577
AUS	12.603	2.791	9.812	2.791	12.092	2.338	9.754	2.338	21.948	9.095	12.853	9.095
CAM	12.907	2.898	10.009	2.898	12.494	2.573	9.922	2.573	23.851	8.450	15.401	8.450
CAP	13.030	3.042	9.987	3.042	12.619	2.705	9.914	2.705	21.587	8.563	13.023	8.563
CHI	12.742	3.112	9.631	3.112	12.354	2.788	9.565	2.788	23.023	9.109	13.914	9.109
COL	11.269	2.318	8.951	2.318	10.693	1.832	8.861	1.832	19.737	8.496	11.241	8.496
EGS	12.265	2.583	9.681	2.584	11.764	2.184	9.580	2.184	21.574	8.588	12.986	8.588
INO	12.756	2.961	9.795	2.961	12.344	2.636	9.708	2.636	23.272	9.208	14.064	9.208
TAP	12.938	2.797	10.140	2.797	12.539	2.464	10.074	2.464	23.325	8.849	14.476	8.849
MXI	11.877	2.859	9.018	2.859	11.428	2.494	8.934	2.494	21.356	8.503	12.853	8.503
MXM	11.732	3.125	8.607	3.125	11.233	2.720	8.512	2.720	22.285	8.505	13.780	8.505
NOE	12.653	2.594	10.059	2.594	12.197	2.226	9.971	2.226	22.284	8.299	13.985	8.298
OMN	12.385	2.777	9.608	2.777	11.852	2.314	9.537	2.314	21.878	9.408	12.469	9.408
RUS	11.682	2.274	9.408	2.273	11.261	1.944	9.317	1.944	20.822	8.306	12.516	8.306
BRT	12.403	2.699	9.704	2.699	11.957	2.331	9.626	2.331	21.847	8.563	13.284	8.563

Stock: SLB Sector: ES

	M1				M2				M3			
	TRACE		MAX_EIG		TRACE		MAX_EIG		TRACE		MAX_EIG	
Oil	r=0	r≤1	r=0	r=1	r=0	r≤1	r=0	r=1	r=0	r≤1	r=0	r=1
ADM	14.932	2.906	12.026	2.906	14.146	2.532	11.613	2.532	28.147	9.550	18.596	9.550
ASB	14.374	2.546	11.828	2.546	13.599	2.171	11.428	2.171	27.274	8.481	18.793	8.481
ANC	14.251	2.606	11.644	2.606	13.424	2.183	11.241	2.183	27.424	8.862	18.562	8.862
DUB	14.870	2.839	12.031	2.839	14.017	2.425	11.591	2.425	27.659	9.704	17.955	9.704
ECU	14.830	3.321	11.510	3.321	14.168	3.048	11.120	3.048	28.494	9.624	18.870	9.624
IRH	14.375	2.480	11.895	2.480	13.484	2.039	11.445	2.039	26.570	8.889	17.681	8.889
IRL	14.414	2.463	11.951	2.463	13.533	2.030	11.503	2.030	26.620	8.776	17.843	8.776
KUT	14.745	2.958	11.787	2.958	13.918	2.540	11.378	2.540	27.979	9.810	18.169	9.810
LIB	14.330	2.509	11.821	2.509	13.511	2.105	11.406	2.105	27.171	8.637	18.534	8.637
NGB	14.406	2.582	11.824	2.582	13.648	2.225	11.423	2.225	27.753	8.650	19.103	8.650
NGE	14.365	2.530	11.836	2.530	13.605	2.175	11.430	2.175	27.288	8.621	18.667	8.621
DUK	15.140	3.043	12.097	3.043	14.364	2.679	11.684	2.679	28.842	9.711	19.131	9.711
SAH	14.602	2.804	11.799	2.804	14.602	2.804	11.799	2.804	26.549	9.175	17.374	9.175
SAL	14.702	2.702	12.027	2.702	13.925	2.354	11.571	2.354	26.937	8.876	18.061	8.876
SAM	14.691	2.758	11.933	2.758	13.912	2.408	11.504	2.408	26.863	8.993	17.870	8.993
VEN	14.662	2.951	11.711	2.951	13.889	2.602	11.287	2.602	28.043	8.981	19.063	8.981
AUS	15.050	2.895	12.155	2.895	14.232	2.495	11.737	2.495	28.272	9.201	19.071	9.203
CAM	14.345	2.771	11.574	2.771	13.617	2.431	11.186	2.431	28.490	8.756	19.734	8.756
CAP	15.025	2.890	12.135	2.890	14.362	2.609	11.752	2.609	28.115	8.378	19.737	8.377
CHI	15.051	3.159	11.892	3.159	14.375	2.859	11.516	2.858	28.616	9.631	18.984	9.631
COL	14.165	2.421	11.744	2.421	13.346	2.029	11.317	2.029	27.222	9.029	18.192	9.029
EGS	14.302	2.566	11.736	2.565	13.510	2.182	11.328	2.182	26.841	8.852	17.988	8.852
INO	14.931	2.925	12.005	2.925	14.214	2.613	11.600	2.613	28.886	9.806	19.080	9.806
TAP	15.063	2.807	12.256	2.807	14.359	2.513	11.846	2.513	29.810	9.376	20.435	9.376
MXI	14.431	2.860	11.572	2.860	13.718	2.535	11.183	2.535	28.193	9.085	19.108	9.085
MXM	14.548	3.173	11.375	3.173	13.786	2.811	10.976	2.811	28.382	9.963	18.419	9.963
NOE	14.355	2.546	11.809	2.546	13.590	2.183	11.406	2.183	27.468	8.557	18.911	8.557
OMN	14.945	2.904	12.042	2.904	14.116	2.496	11.620	2.496	28.245	9.771	18.474	9.771
RUS	13.217	2.271	10.945	2.271	12.385	1.957	10.428	1.957	25.481	8.000	17.481	8.000
BRT	14.250	2.645	11.605	2.645	13.500	2.287	11.214	2.287	27.043	8.596	18.448	8.596

Stock: RES Sector: ES

	M1				M2				M3			
	TRACE		MAX_EIG		TRACE		MAX_EIG		TRACE		MAX_EIG	
Oil	r=0	r≤1	r=0	r=1	r=0	r≤1	r=0	r=1	r=0	r≤1	r=0	r=1
ADM	11.936	2.746	9.190	2.746	11.603	2.437	9.166	2.437	19.051	9.019	10.032	9.019
ASB	11.680	2.430	9.250	2.430	11.316	2.083	9.233	2.083	18.102	8.552	9.550	8.552
ANC	11.630	2.467	9.162	2.467	11.243	2.096	9.147	2.096	18.594	9.087	9.507	9.087
DUB	11.802	2.675	9.126	2.675	11.417	2.314	9.103	2.314	18.919	9.093	9.826	9.093
ECU	12.188	3.251	8.937	3.251	11.893	2.967	8.925	2.967	20.165	8.902	11.262	8.902
IRH	11.530	2.375	9.155	2.375	11.099	1.963	9.136	1.963	17.969	8.739	9.231	8.739
IRL	11.561	2.360	9.201	2.360	11.145	1.962	9.183	1.962	17.858	8.675	9.183	8.675
KUT	11.927	2.798	9.128	2.799	11.564	2.454	9.110	2.454	19.614	9.095	10.518	9.095
LIB	11.600	2.403	9.199	2.403	11.208	2.024	9.185	2.024	18.121	8.797	9.324	8.797
NGB	11.742	2.481	9.261	2.481	11.388	2.146	9.242	2.146	18.402	8.663	9.739	8.663
NGE	11.669	2.428	9.241	2.428	11.317	2.095	9.222	2.095	18.162	8.516	9.646	8.516
DUK	12.131	2.888	9.242	2.888	11.807	2.590	9.217	2.590	19.483	9.040	10.443	9.040
SAH	11.744	2.709	9.035	2.709	11.384	2.365	9.019	2.365	18.443	8.860	9.583	8.860
SAL	11.777	2.615	9.162	2.615	11.431	2.286	9.145	2.286	18.098	8.833	9.265	8.833
SAM	18.098	8.833	9.265	8.833	11.417	2.333	9.084	2.333	18.225	9.077	9.149	9.077
VEN	12.164	2.934	9.230	2.934	11.811	2.586	9.224	2.586	19.352	9.220	10.132	9.220
AUS	12.106	2.718	9.388	2.718	11.745	2.384	9.361	2.384	18.936	8.854	10.082	8.853
CAM	11.947	2.716	9.231	2.716	11.611	2.398	9.213	2.398	19.253	9.125	10.128	9.124
CAP	12.378	2.859	9.519	2.859	12.056	2.550	9.506	2.550	18.866	8.631	10.235	8.631
CHI	12.330	3.021	9.308	3.021	12.062	2.778	9.284	2.778	19.857	9.016	10.841	9.016
COL	11.338	2.326	9.012	2.326	10.936	1.938	8.998	1.938	18.125	8.975	9.150	8.975
EGS	11.565	2.463	9.101	2.464	11.190	2.104	9.086	2.104	18.250	8.938	9.312	8.938
INO	12.052	2.802	9.250	2.802	11.750	2.528	9.222	2.528	19.585	9.095	10.490	9.095
TAP	12.198	2.723	9.475	2.723	11.903	2.455	9.448	2.455	19.410	9.052	10.358	9.052
MXI	11.928	2.792	9.136	2.792	11.594	2.466	9.128	2.466	19.392	9.125	10.267	9.125
MXM	12.032	3.038	8.994	3.038	11.688	2.703	8.988	2.700	20.706	8.739	11.967	8.739
NOE	11.718	2.461	9.256	2.461	11.358	2.1153	9.242	2.115	18.288	8.639	9.648	8.639
OMN	11.916	2.728	9.187	2.728	11.550	2.384	9.165	2.384	19.249	9.164	10.085	9.164
RUS	11.205	2.216	8.989	2.216	10.872	1.916	8.956	1.916	17.894	8.921	8.973	8.921
BRT	11.831	2.560	9.271	2.560	11.489	2.236	9.253	2.236	18.562	9.078	9.484	9.078

Stock: EEP Sector: PIP

	M1				M2				M3			
	TRACE		MAX_EIG		TRACE		MAX_EIG		TRACE		MAX_EIG	
Oil	r=0	r≤1	r=0	r=1	r=0	r≤1	r=0	r=1	r=0	r≤1	r=0	r=1
ADM	15.384	2.676	12.709	2.676	15.104	2.464	12.640	2.464	23.572	7.423	16.149	7.423
ASB	14.544	2.729	11.815	2.729	14.211	2.450	11.761	2.450	21.872	8.051	13.821	8.051
ANC	14.074	2.719	11.355	2.719	13.722	2.427	11.296	2.427	21.905	8.223	13.682	8.223
DUB	15.044	2.602	12.442	2.602	14.729	2.349	12.380	2.349	23.306	7.360	15.945	7.360
ECU	14.115	3.221	10.894	3.221	13.820	3.029	10.791	3.029	22.843	7.926	14.917	7.926
IRH	15.192	2.683	12.509	2.683	14.820	2.348	12.472	2.348	22.919	8.019	14.901	8.019
IRL	15.467	2.708	12.760	2.708	15.106	2.382	12.725	2.382	23.117	8.051	15.066	8.051
KUT	14.396	2.604	11.793	2.604	14.083	2.366	11.717	2.366	22.946	7.419	15.526	7.420
LIB	14.888	2.741	12.147	2.741	14.534	2.431	12.103	2.431	22.519	8.183	14.337	8.183
NGB	14.749	2.809	11.940	2.809	14.420	2.536	11.884	2.536	22.496	8.170	14.327	8.170
NGE	14.913	2.793	12.120	2.793	14.585	2.519	12.067	2.519	22.553	8.114	14.439	8.114
DUK	15.317	2.746	12.571	2.746	15.041	2.545	12.497	2.545	23.655	7.438	16.217	7.438
SAH	14.539	2.894	11.645	2.894	14.207	2.627	11.580	2.627	22.256	7.854	14.402	7.854
SAL	15.181	2.894	12.287	2.894	14.863	2.633	12.231	2.633	22.670	7.887	14.783	7.887
SAM	14.851	2.902	11.949	2.902	14.527	2.638	11.889	2.638	22.405	7.857	14.548	7.857
VEN	14.214	3.054	11.160	3.054	13.876	2.790	11.086	2.790	22.306	7.951	14.355	7.951
AUS	15.404	2.845	12.559	2.845	15.096	2.594	12.501	2.594	23.391	7.977	15.414	7.977
CAM	14.111	2.986	11.124	2.986	13.784	2.732	11.052	2.732	22.288	8.466	13.822	8.466
CAP	16.093	3.362	12.730	3.362	15.790	3.116	12.674	3.116	23.879	8.828	15.051	8.828
CHI	16.093	3.362	12.730	3.362	15.790	3.116	12.674	3.116	23.879	8.828	15.051	8.828
COL	14.973	3.086	11.887	3.086	14.713	2.914	11.799	2.914	23.470	8.144	15.327	8.144
EGS	12.204	2.608	12.204	2.608	14.455	2.295	12.160	2.295	22.876	7.897	14.979	7.897
INO	14.938	2.823	12.115	2.823	14.590	2.524	12.067	2.524	22.800	8.285	14.516	8.285
TAP	14.632	2.820	11.812	2.820	14.353	2.621	11.733	2.621	23.278	7.798	15.480	7.798
MXI	15.643	3.122	12.521	3.122	15.364	2.902	12.461	2.902	24.065	8.880	15.185	8.880
MXM	14.479	3.060	11.419	3.060	14.152	2.802	11.350	2.802	22.949	8.389	14.561	8.389
NOE	15.142	3.057	12.085	3.057	14.835	2.826	12.009	2.826	25.173	8.018	17.155	8.018
OMN	14.574	2.802	11.772	2.802	14.235	2.515	11.719	2.515	22.119	8.239	13.880	8.239
RUS	15.192	2.630	12.562	2.630	14.891	2.394	12.497	2.394	23.626	7.454	16.171	7.454
BRT	14.179	2.541	11.638	2.541	13.924	2.309	11.614	2.309	21.812	8.289	13.523	8.289

Stock: EP Sector: PIP

	M1				M2				M3			
	TRACE		MAX_EIG		TRACE		MAX_EIG		TRACE		MAX_EIG	
Oil	r=0	r≤1	r=0	r=1	r=0	r≤1	r=0	r=1	r=0	r≤1	r=0	r=1
ADM	7.097	1.298	5.799	1.298	7.850	2.466	5.384	2.466	14.248	3.504	10.744	3.504
ASB	7.850	2.466	5.384	2.466	6.583	1.290	5.293	1.290	13.186	3.534	9.652	3.534
ANC	8.037	2.468	5.569	2.468	6.743	1.290	5.453	1.290	14.089	3.537	10.552	3.537
DUB	8.184	2.492	5.691	2.492	6.855	1.257	5.598	1.257	14.327	3.472	10.855	3.472
ECU	8.865	2.486	6.378	2.486	7.651	1.391	6.260	1.391	16.137	3.446	12.691	3.446
IRH	7.681	2.482	5.199	2.482	6.330	1.237	5.093	1.237	13.425	3.499	9.926	3.499
IRL	7.699	2.476	5.223	2.476	6.360	1.235	5.125	1.235	13.107	3.507	9.600	3.507
KUT	8.364	2.483	5.881	2.483	7.060	1.273	5.787	1.273	15.054	3.457	11.597	3.457
LIB	7.716	2.468	5.248	2.468	6.407	1.248	5.158	1.248	13.358	3.500	9.858	3.500
NGB	7.826	2.467	5.359	2.466	6.581	1.303	5.278	1.303	13.404	3.499	9.905	3.500
NGE	7.848	2.455	5.393	2.455	6.591	1.273	5.318	1.273	13.151	3.510	9.641	3.510
DUK	8.545	2.489	6.055	2.489	7.277	1.312	5.965	1.312	14.511	3.480	11.030	3.480
SAH	7.889	2.492	5.398	2.492	6.616	1.316	5.300	1.316	14.181	3.458	10.722	3.458
SAL	7.899	2.482	5.417	2.482	6.636	1.313	5.323	1.313	13.443	3.505	9.938	3.505
SAM	7.908	2.490	5.418	2.490	6.635	1.316	5.320	1.316	13.780	3.488	10.293	3.488
VEN	8.574	2.505	6.069	2.505	7.304	1.369	5.935	1.369	14.458	3.498	10.960	3.498
AUS	8.501	2.498	6.003	2.498	7.160	1.287	5.873	1.287	13.705	3.527	10.178	3.527
CAM	8.211	2.474	5.737	2.474	6.992	1.351	5.641	1.351	14.515	3.494	11.021	3.494
CAP	8.258	2.495	5.762	2.495	7.058	1.393	5.665	1.393	13.167	3.494	9.673	3.494
CHI	8.876	2.469	6.407	2.469	7.663	1.354	6.310	1.354	14.808	3.500	11.308	3.500
COL	7.957	2.454	5.503	2.454	6.606	1.216	5.389	1.216	13.800	3.539	10.260	3.539
EGS	7.708	2.453	5.255	2.453	6.433	1.249	5.184	1.249	13.470	3.438	10.032	3.438
INO	8.574	2.466	6.108	2.466	7.312	1.296	6.015	1.296	14.679	3.495	11.184	3.495
TAP	8.422	2.456	5.966	2.456	7.163	1.285	5.879	1.285	13.978	3.511	10.468	3.511
MXI	8.472	2.476	5.997	2.476	7.231	1.343	5.888	1.343	14.669	3.478	11.191	3.478
MXM	8.713	2.480	6.232	2.480	7.483	1.342	6.141	1.342	16.130	3.387	12.743	3.387
NOE	7.846	2.465	5.381	2.465	6.586	1.287	5.299	1.287	13.270	3.501	9.769	3.501
OMN	8.361	2.485	8.361	2.485	7.047	1.268	5.779	1.268	14.516	3.483	11.033	3.483
RUS	7.101	2.449	4.653	2.449	5.882	1.283	4.599	1.283	13.380	3.162	10.217	3.162
BRT	8.056	2.471	5.585	2.471	6.831	1.337	5.495	1.337	13.643	3.519	10.124	3.519

Stock: ETP Sector: PIP

	M1				M2				M3			
	TRACE		MAX_EIG		TRACE		MAX_EIG		TRACE		MAX_EIG	
Oil	r=0	r≤1	r=0	r=1	r=0	r≤1	r=0	r=1	r=0	r≤1	r=0	r=1
ADM	13.963	3.803	10.160	3.803	13.357	3.261	10.095	3.261	20.054	9.443	10.611	9.443
ASB	13.409	3.643	9.766	3.643	12.734	3.039	9.695	3.039	18.435	7.989	10.446	7.989
ANC	12.989	3.722	9.267	3.722	12.304	3.119	9.186	3.119	18.720	8.508	10.212	8.508
DUB	13.494	3.770	9.724	3.770	12.859	3.206	9.652	3.206	19.954	9.326	10.628	9.326
ECU	12.875	4.020	8.855	4.020	12.282	3.499	8.784	3.499	19.478	8.767	10.711	8.767
IRH	12.872	3.658	9.215	3.658	12.156	3.032	9.124	3.032	18.785	8.208	10.577	8.208
IRL	13.022	3.640	9.382	3.640	12.311	3.018	9.294	3.018	18.710	8.104	10.606	8.104
KUT	13.387	3.743	9.644	3.743	12.724	3.154	9.570	3.154	19.748	9.519	10.228	9.519
LIB	13.177	3.561	9.616	3.561	12.439	2.903	9.536	2.903	18.178	7.961	10.216	7.961
NGB	13.500	3.658	9.84256	3.658	12.831	3.062	9.770	3.062	18.835	8.365	10.470	8.365
NGE	13.419	3.639	9.780	3.639	12.742	3.035	9.706	3.035	18.633	8.113	10.520	8.113
DUK	14.057	3.764	10.293	3.764	13.454	3.218	10.236	3.218	19.971	9.599	10.372	9.599
SAH	12.879	3.684	9.195	3.684	12.212	3.086	9.126	3.086	18.646	8.629	10.017	8.629
SAL	13.183	3.634	9.550	3.634	12.510	3.029	9.481	3.029	18.527	8.285	10.242	8.285
SAM	12.970	3.658	9.312	3.658	12.302	3.057	9.245	3.057	18.485	8.421	10.064	8.421
VEN	13.042	3.708	9.334	3.708	12.386	3.113	9.273	3.113	18.719	9.030	9.689	9.030
AUS	14.182	3.828	10.355	3.828	13.561	3.285	10.275	3.285	19.794	9.014	10.779	9.014
CAM	13.407	3.850	9.556	3.850	12.775	3.297	9.478	3.297	19.325	9.102	10.223	9.102
CAP	15.079	3.994	11.085	3.994	14.472	3.485	10.987	3.485	20.710	9.078	11.632	9.078
CHI	14.551	3.839	10.712	3.839	13.941	3.303	10.638	3.303	20.113	9.386	10.727	9.386
COL	12.776	3.633	9.143	3.633	12.053	2.993	9.060	2.993	18.874	8.323	10.550	8.323
EGS	13.111	3.600	9.511	3.600	12.394	2.964	9.429	2.964	18.482	8.311	10.171	8.311
INO	14.075	3.812	10.264	3.812	13.453	3.266	10.187	3.266	20.283	9.704	10.578	9.704
TAP	14.015	3.767	10.248	3.767	13.403	3.224	10.179	3.224	19.499	8.959	10.540	8.959
MXI	13.054	3.706	9.348	3.706	12.393	3.111	9.282	3.111	18.704	9.000	9.704	9.000
MXM	13.333	3.857	9.476	3.857	12.724	3.316	9.408	3.316	20.597	9.324	11.274	9.324
NOE	13.440	3.637	9.803	3.637	12.752	3.025	9.727	3.025	18.532	8.134	10.398	8.134
OMN	13.633	3.774	9.859	3.774	13.003	3.211	9.792	3.211	19.993	9.529	10.463	9.529
RUS	13.328	3.642	9.685	3.642	12.678	3.056	9.622	3.056	19.042	8.431	10.611	8.431
BRT	13.845	3.743	10.102	3.743	13.205	3.177	10.028	3.177	19.165	8.560	10.605	8.560

Stock: KMP Setor: PIP

	M1				M2				M3			
	TRACE		MAX_EIG		TRACE		MAX_EIG		TRACE		MAX_EIG	
Oil	r=0	r≤1	r=0	r=1	r=0	r≤1	r=0	r=1	r=0	r≤1	r=0	r=1
ADM	17.478	2.771	14.707	2.771	17.109	2.483	14.626	2.483	24.403	9.598	14.804	9.598
ASB	17.175	2.447	14.727	2.447	16.773	2.133	14.640	2.133	23.314	8.545	14.769	8.545
ANC	17.305	2.498	14.807	2.498	16.887	2.162	14.725	2.162	24.133	9.207	14.927	9.207
DUB	17.466	2.703	14.763	2.703	17.055	2.365	14.690	2.365	24.522	9.618	14.904	9.618
ECU	18.489	3.191	15.298	3.191	18.133	2.892	15.242	2.892	26.369	10.491	15.879	10.491
IRH	17.343	2.378	14.965	2.378	16.879	1.975	14.904	1.975	23.713	8.558	15.155	8.558
IRL	17.235	2.364	14.871	2.364	16.785	1.983	14.802	1.983	23.412	8.421	14.991	8.421
KUT	17.723	2.800	14.923	2.800	17.317	2.468	14.849	2.468	25.329	10.072	15.257	10.072
LIB	17.338	2.400	14.938	2.400	16.904	2.044	14.860	2.044	23.667	8.560	15.106	8.560
NGB	17.166	2.495	14.671	2.495	16.770	2.184	14.587	2.184	23.542	8.818	14.724	8.818
NGE	17.026	2.449	14.577	2.449	16.634	2.142	14.492	2.142	23.237	8.644	14.593	8.644
DUK	17.640	2.912	14.727	2.912	17.280	2.629	14.652	2.629	24.782	9.949	14.832	9.949
SAH	17.880	2.680	15.200	2.680	17.465	2.327	15.139	2.327	24.487	8.986	15.501	8.986
SAL	17.614	2.603	15.011	2.603	17.215	2.274	14.941	2.274	23.769	8.613	15.155	8.613
SAM	17.757	2.647	15.110	2.647	17.350	2.305	15.046	2.305	24.093	8.765	15.327	8.765
VEN	17.615	2.878	14.737	2.878	17.216	2.549	14.667	2.549	24.522	9.634	14.888	9.634
AUS	17.405	2.714	14.690	2.714	17.011	2.401	14.611	2.401	23.949	9.238	14.711	9.238
CAM	17.462	2.698	14.764	2.698	17.075	2.394	14.680	2.394	24.529	9.589	14.940	9.589
CAP	17.602	2.799	14.803	2.799	17.227	2.477	14.750	2.477	23.626	8.795	14.830	8.795
CHI	17.784	3.019	14.766	3.019	17.464	2.782	14.682	2.782	25.066	10.233	14.833	10.233
COL	17.137	2.350	14.787	2.350	16.701	1.981	14.720	1.981	23.871	8.933	14.938	8.933
EGS	17.197	2.457	14.740	2.457	16.771	2.104	14.668	2.104	23.708	8.847	14.861	8.847
INO	17.575	2.796	14.779	2.796	17.227	2.531	14.696	2.531	24.938	10.048	14.890	10.048
TAP	17.897	2.633	15.264	2.633	17.536	2.330	15.206	2.330	24.709	9.057	15.651	9.057
MXI	17.503	2.771	14.732	2.771	17.117	2.457	14.661	2.457	24.750	9.814	14.936	9.814
MXM	17.658	3.023	14.636	3.023	17.271	2.686	14.584	2.686	26.167	11.064	26.167	11.064
NOE	17.140	2.472	14.668	2.472	16.738	2.155	14.583	2.155	23.422	8.713	14.710	8.713
OMN	17.580	2.768	14.813	2.768	17.188	2.448	14.741	2.448	24.825	9.867	14.959	9.867
RUS	16.969	2.232	14.737	2.232	16.616	1.952	14.664	1.952	23.544	8.696	14.849	8.696
BRT	17.276	2.598	14.678	2.598	16.904	2.311	14.593	2.311	23.763	9.052	14.711	9.052

Stock: WMB Sector: PIP

	M1				M2				M3			
	TRACE		MAX_EIG		TRACE		MAX_EIG		TRACE		MAX_EIG	
Oil	r=0	r≤1	r=0	r=1	r=0	r≤1	r=0	r=1	r=0	r≤1	r=0	r=1
ADM	7.501	2.343	5.157	2.343	6.816	1.663	5.154	1.663	17.965	4.754	13.211	4.754
ASB	7.075	2.231	4.844	2.231	6.378	1.541	4.838	1.541	16.687	4.659	12.028	4.659
ANC	7.178	2.234	4.944	2.234	6.444	1.504	4.941	1.504	17.630	4.685	12.946	4.685
DUB	7.457	2.335	5.123	2.335	6.703	1.586	5.117	1.586	18.407	4.762	13.644	4.762
ECU	7.674	2.579	5.095	2.579	7.078	1.983	5.095	1.983	20.474	4.575	15.899	4.575
IRH	7.093	2.213	4.879	2.213	6.298	1.434	4.864	1.434	17.578	4.713	12.865	4.713
IRL	7.065	2.201	4.864	2.201	6.291	1.442	4.849	1.442	17.062	4.705	12.356	4.705
KUT	7.551	2.368	5.182	2.368	6.830	1.649	5.181	1.649	19.175	4.739	14.435	4.739
LIB	7.084	2.201	4.883	2.201	6.336	1.464	4.871	1.464	17.206	4.692	12.514	4.692
NGB	7.147	2.251	4.896	2.251	6.465	1.577	4.887	1.577	17.198	4.685	12.513	4.685
NGE	7.104	2.213	4.891	2.213	6.418	1.536	4.882	1.536	16.706	4.681	12.025	4.681
DUK	7.605	2.420	5.185	2.420	6.934	1.749	5.185	1.749	18.351	4.732	13.619	4.732
SAH	7.268	2.376	4.892	2.376	6.570	1.687	4.883	1.687	18.804	4.669	14.135	4.669
SAL	7.209	2.316	4.893	2.316	6.518	1.635	4.883	1.635	17.452	4.688	12.764	4.688
SAM	7.238	2.355	4.883	2.355	6.544	1.671	4.873	1.671	18.128	4.675	13.453	4.675
VEN	7.462	2.488	4.975	2.488	6.787	1.813	4.974	1.813	17.674	4.597	13.077	4.597
AUS	7.463	2.368	5.095	2.368	6.741	1.647	5.094	1.647	16.935	4.740	12.195	4.740
CAM	7.277	2.375	4.902	2.375	6.631	1.730	4.901	1.730	18.280	4.602	13.678	4.602
CAP	7.445	2.472	4.972	2.472	6.833	1.864	4.970	1.864	16.223	4.696	11.527	4.696
CHI	7.747	2.394	5.352	2.394	7.139	1.787	5.352	1.787	17.915	4.726	13.190	4.726
COL	6.974	2.158	4.816	2.158	6.234	1.430	4.803	1.430	17.703	4.637	13.066	4.637
EGS	7.145	2.204	4.942	2.204	6.414	1.484	4.929	1.484	17.396	4.697	12.699	4.697
INO	7.590	2.308	5.282	2.308	6.928	1.648	5.280	1.648	18.218	4.754	13.463	4.754
TAP	7.334	2.335	5.000	2.335	6.747	1.754	4.992	1.754	17.786	4.700	13.085	4.700
MXI	7.375	2.381	4.994	2.381	6.730	1.738	6.730	1.738	18.097	4.610	13.487	4.610
MXM	7.766	2.472	5.293	2.472	7.111	1.818	5.293	1.818	20.402	4.683	15.719	4.683
NOE	7.113	2.237	4.876	2.237	6.419	1.551	4.868	1.551	16.823	4.667	12.156	4.667
OMN	7.542	2.347	5.195	2.347	6.815	1.623	5.192	1.623	18.496	4.783	13.713	4.783
RUS	6.600	2.094	4.505	2.094	5.920	1.467	4.453	1.467	17.747	4.336	13.412	4.336
BRT	7.234	2.272	4.962	2.272	6.577	1.622	4.955	1.622	17.119	4.689	12.430	4.689

Stock: TCLP Sector: PIP

	M1				M2				M3			
	TRACE		MAX_EIG		TRACE		MAX_EIG		TRACE		MAX_EIG	
Oil	r=0	r≤1	r=0	r=1	r=0	r≤1	r=0	r=1	r=0	r≤1	r=0	r=1
ADM	12.516	4.641	7.876	4.641	11.909	4.589	7.319	4.589	28.955	5.784	23.171	5.784
ASB	12.776	4.802	7.974	4.802	12.106	4.707	7.398	4.707	27.430	6.407	21.022	6.407
ANC	12.660	4.708	7.952	4.708	11.983	4.642	7.341	4.642	27.512	6.062	21.450	6.062
DUB	12.238	4.641	7.597	4.641	11.613	4.607	7.006	4.607	28.550	5.536	23.014	5.536
ECU	13.341	4.264	9.077	4.264	12.712	4.210	8.502	4.210	28.088	5.400	22.688	5.400
IRH	13.177	5.247	7.930	5.247	12.494	5.220	7.275	5.220	30.051	6.240	23.811	6.240
IRL	13.370	5.338	8.031	5.338	12.694	5.302	7.392	5.302	30.471	6.450	24.021	6.450
KUT	12.168	4.386	7.782	4.386	11.513	4.334	7.179	4.334	27.490	5.441	22.048	5.441
LIB	12.980	4.903	8.077	4.903	12.287	4.815	7.472	4.815	28.123	6.490	21.633	6.490
NGB	12.886	4.790	8.095	4.790	12.215	4.687	7.529	4.687	28.147	6.458	21.688	6.458
NGE	12.922	4.862	8.060	4.862	12.250	4.762	7.489	4.762	28.522	6.512	22.010	6.512
DUK	12.742	4.642	8.100	4.642	12.141	4.585	7.556	4.585	29.143	5.819	23.324	5.819
SAH	12.544	4.642	7.902	4.642	11.897	4.610	7.287	4.610	27.903	5.571	22.332	5.571
SAL	13.066	4.949	8.117	4.949	12.418	4.901	7.517	4.901	28.951	6.144	22.807	6.144
SAM	12.775	4.779	7.996	4.779	12.129	4.741	7.388	4.741	28.327	5.829	22.499	5.829
VEN	13.227	4.615	8.612	4.615	12.584	4.548	8.036	4.548	28.976	6.022	22.954	6.022
AUS	12.644	4.673	7.971	4.673	12.021	4.609	7.412	4.609	27.508	5.985	21.523	5.985
CAM	12.882	4.419	8.464	4.419	12.193	4.299	7.894	4.299	26.680	6.204	20.476	6.204
CAP	14.729	5.077	9.652	5.077	14.099	4.992	9.107	4.992	29.503	7.232	22.270	7.232
CHI	13.270	4.481	8.789	4.481	12.644	4.383	8.261	4.383	27.744	6.152	21.592	6.152
COL	12.817	5.034	7.783	5.034	12.135	4.988	7.147	4.988	29.982	6.157	23.825	6.157
EGS	13.107	4.881	8.226	4.881	12.407	4.790	7.618	4.790	28.318	6.466	21.852	6.466
INO	12.609	4.500	8.110	4.500	11.970	4.411	7.560	4.411	28.180	5.871	22.309	5.871
TAP	12.771	4.602	8.169	4.602	12.136	4.515	7.621	4.515	27.932	6.145	21.787	6.145
MXI	13.174	4.602	8.572	4.602	12.526	4.529	7.997	4.529	28.635	6.051	22.584	6.051
MXM	13.592	4.635	8.957	4.635	12.995	4.601	8.394	4.601	32.345	5.607	26.738	5.607
NOE	12.702	4.669	8.033	4.669	12.011	4.553	7.458	4.553	26.936	6.414	20.522	6.414
OMN	12.502	4.684	7.818	4.684	11.889	4.645	7.244	4.645	29.117	5.673	23.444	5.673
RUS	12.268	4.561	7.707	4.561	11.685	4.454	7.230	4.454	26.349	6.308	20.041	6.308
BRT	12.975	4.612	8.362	4.612	12.310	4.499	7.811	4.499	27.050	6.473	20.577	6.473

Stock: PAA Sector: PIP

	M1				M2				M3			
	TRACE		MAX_EIG		TRACE		MAX_EIG		TRACE		MAX_EIG	
Oil	r=0	r≤1	r=0	r=1	r=0	r≤1	r=0	r=1	r=0	r≤1	r=0	r=1
ADM	16.459	2.628	13.831	2.628	14.357	1.480	12.877	1.480	24.624	7.249	17.375	7.249
ASB	16.968	2.606	14.362	2.606	14.643	1.425	13.218	1.425	23.635	7.948	15.687	7.948
ANC	16.574	2.634	13.940	2.634	14.286	1.489	12.797	1.489	23.535	7.372	16.163	7.372
DUB	16.336	2.706	13.629	2.706	14.230	1.596	12.634	1.596	24.686	7.154	17.533	7.154
ECU	17.477	2.712	14.765	2.712	15.122	1.463	13.659	1.463	23.801	6.306	17.495	6.306
IRH	17.344	2.784	14.560	2.784	15.093	1.764	13.330	1.764	25.746	8.274	17.471	8.274
IRL	17.285	2.745	14.540	2.745	15.028	1.709	13.320	1.709	25.620	8.415	17.204	8.415
KUT	17.285	2.745	14.540	2.745	15.028	1.709	13.320	1.709	25.620	8.415	17.204	8.415
LIB	17.236	2.650	14.586	2.650	14.867	1.494	13.373	1.494	24.083	8.028	16.055	8.028
NGB	17.034	2.611	14.423	2.611	14.712	1.410	13.302	1.410	23.989	7.793	16.196	7.793
NGE	16.882	2.598	14.284	2.598	14.553	1.416	13.137	1.416	24.025	7.938	16.087	7.938
DUK	16.907	2.661	14.246	2.661	14.766	1.450	13.316	1.450	24.633	7.098	17.535	7.098
SAH	17.402	2.778	14.624	2.778	15.133	1.678	13.455	1.678	24.924	7.610	17.314	7.610
SAL	17.332	2.731	14.601	2.731	15.066	1.625	13.441	1.625	24.910	8.038	16.873	8.038
SAM	17.396	2.753	14.643	2.753	15.131	1.652	13.480	1.652	24.911	7.844	17.067	7.844
VEN	17.067	2.647	14.898	2.647	15.117	1.410	13.707	1.410	24.382	7.137	17.246	7.137
AUS	16.937	2.616	14.321	2.616	14.780	1.476	13.304	1.476	24.259	7.628	16.631	7.628
CAM	17.937	2.634	15.303	2.634	15.589	1.430	14.159	1.430	24.534	7.421	17.112	7.421
CAP	19.393	2.659	16.734	2.659	17.097	1.561	15.536	1.561	26.482	8.685	17.797	8.685
CHI	17.593	2.635	14.958	2.635	15.404	1.417	13.987	1.417	24.429	7.272	17.157	7.272
COL	15.834	2.664	13.170	2.664	13.487	1.526	13.487	1.526	23.641	7.329	16.313	7.329
EGS	17.619	2.703	14.917	2.703	15.267	1.579	13.687	1.579	24.931	8.027	16.905	8.027
INO	16.935	2.664	14.270	2.664	14.732	1.478	13.254	1.478	24.689	7.225	17.464	7.225
TAP	17.395	2.578	14.816	2.578	15.186	1.377	13.809	1.377	24.549	7.676	16.873	7.676
MXI	17.638	2.652	14.985	2.652	15.224	1.434	13.789	1.434	24.627	7.220	17.406	7.220
MXM	18.027	2.774	15.253	2.774	15.814	1.695	14.120	1.695	27.807	6.742	21.065	6.742
NOE	17.054	2.607	14.447	2.607	14.720	1.437	13.284	1.437	23.899	7.920	15.980	7.920
OMN	16.405	2.688	13.717	2.688	14.298	1.545	12.753	1.545	24.657	7.044	17.612	7.044
RUS	16.671	2.363	14.309	2.363	14.707	1.384	13.323	1.384	23.766	7.833	15.933	7.833
BRT	17.198	2.584	14.614	2.584	14.911	1.385	13.526	1.385	23.829	7.707	16.122	7.707

Stocks: OKS Sector: PIP

	M1				M2				M3			
	TRACE		MAX_EIG		TRACE		MAX_EIG		TRACE		MAX_EIG	
Oil	r=0	r≤1	r=0	r=1	r=0	r≤1	r=0	r=1	r=0	r≤1	r=0	r=1
ADM	13.439	2.863	10.576	2.863	11.689	1.126	10.563	1.126	18.327	7.344	10.983	7.344
ASB	12.817	2.825	9.992	2.825	11.010	1.033	9.977	1.033	17.112	7.048	10.064	7.048
ANC	12.764	2.824	9.940	2.824	10.951	1.023	9.928	1.023	17.407	7.143	10.264	7.143
DUB	13.126	2.858	10.268	2.858	11.348	1.089	10.260	1.089	18.072	7.295	10.777	7.295
ECU	13.804	2.897	10.907	2.897	12.009	1.104	10.904	1.104	18.833	7.048	11.785	7.048
IRH	12.669	2.863	9.806	2.863	10.853	1.047	9.806	1.047	17.357	7.359	9.998	7.359
IRL	10.732	1.067	9.665	1.067	10.732	1.067	9.665	1.067	17.232	7.410	9.822	7.410
KUT	13.577	2.840	10.738	2.840	11.744	1.017	10.727	1.017	18.410	7.054	11.356	7.054
LIB	12.899	2.836	10.063	2.836	11.061	1.004	10.058	1.004	17.294	7.107	10.186	7.107
NGB	12.973	2.854	10.119	2.854	11.161	1.050	10.111	1.050	17.466	7.181	10.285	7.181
NGE	12.699	2.858	9.841	2.858	10.892	1.060	9.832	1.060	17.221	7.225	9.995	7.225
DUK	13.815	2.866	10.948	2.866	12.048	1.111	10.937	1.111	18.616	7.246	11.370	7.246
SAH	13.252	2.879	10.373	2.879	11.483	1.112	10.372	1.112	17.989	7.356	10.633	7.356
SAL	12.853	2.881	9.972	2.881	11.093	1.123	9.970	1.123	17.519	7.395	10.124	7.395
SAM	13.047	2.880	10.167	2.880	11.284	1.119	10.165	1.119	17.720	7.367	10.353	7.367
VEN	12.722	2.860	9.862	2.860	10.917	1.056	9.861	1.056	17.631	7.142	10.490	7.142
AUS	13.228	2.857	10.371	2.857	11.499	1.135	10.364	1.135	18.025	7.403	10.623	7.403
CAM	13.619	2.849	10.770	2.849	11.780	1.018	10.762	1.018	18.112	7.020	11.092	7.020
CAP	14.044	2.893	11.150	2.893	12.285	1.135	11.150	1.135	18.633	7.431	11.202	7.431
CHI	14.051	2.866	11.185	2.866	12.321	1.147	11.174	1.147	18.929	7.322	11.607	7.322
COL	12.260	2.838	9.422	2.838	10.443	1.024	9.419	1.024	17.207	7.333	9.873	7.333
EGS	13.090	2.857	10.232	2.857	11.249	1.018	10.231	1.018	17.579	7.163	10.416	7.163
INO	13.198	2.838	10.359	2.838	11.467	1.122	10.345	1.122	18.357	7.332	11.024	7.332
TAP	13.716	2.825	10.891	2.825	11.946	1.072	10.874	1.072	18.251	7.149	11.101	7.149
MXI	13.076	2.880	10.196	2.880	11.239	1.046	10.193	1.046	17.886	7.091	10.795	7.091
MXM	13.685	2.967	10.718	2.967	11.954	1.238	10.716	1.238	19.815	7.422	12.393	7.422
NOE	12.892	2.846	10.045	2.846	11.065	1.028	10.037	1.028	17.260	7.091	10.169	7.091
OMN	13.385	2.856	10.528	2.856	11.635	1.115	10.519	1.115	18.448	7.372	11.076	7.372
RUS	12.804	2.709	10.095	2.709	11.069	0.985	10.084	0.985	17.354	7.089	10.265	7.089
BRT	13.108	2.839	10.269	2.839	11.298	1.045	10.252	1.045	17.489	7.059	10.430	7.059

Stock: HES   Sector: RM

	M1				M2				M3			
	TRACE		MAX_EIG		TRACE		MAX_EIG		TRACE		MAX_EIG	
Oil	r=0	r≤1	r=0	r=1	r=0	r≤1	r=0	r=1	r=0	r≤1	r=0	r=1
ADM	12.082	2.797	9.285	2.797	11.719	2.483	9.236	2.483	19.511	8.952	10.560	8.952
ASB	12.034	2.615	9.419	2.615	11.654	2.298	9.356	2.298	18.893	9.347	9.547	9.347
ANC	12.123	2.606	9.517	2.606	11.703	2.250	9.453	2.250	19.570	9.135	10.435	9.135
DUB	12.128	2.755	9.373	2.755	11.711	2.393	9.319	2.393	19.642	8.748	10.894	8.748
ECU	12.033	3.394	8.638	3.394	11.713	3.111	8.602	3.111	20.323	8.294	12.029	8.294
IRH	12.080	2.538	9.542	2.538	11.618	2.147	9.471	2.147	18.965	8.821	10.144	8.821
IRL	12.175	2.538	9.637	2.538	11.731	2.167	9.563	2.167	18.962	9.090	9.872	9.090
KUT	11.941	2.769	9.172	2.769	11.537	2.406	9.131	2.406	19.970	8.486	11.484	8.486
LIB	12.058	2.634	9.424	2.634	11.659	2.299	9.360	2.299	19.136	9.327	9.809	9.327
NGB	12.202	2.643	9.559	2.643	11.821	2.325	9.496	2.325	19.323	9.411	9.911	9.411
NGE	12.307	2.616	9.691	2.616	11.929	2.306	9.623	2.306	19.285	9.507	9.778	9.507
DUK	12.118	2.856	9.262	2.856	11.757	2.537	9.220	2.537	19.724	8.793	10.931	8.793
SAH	11.661	2.729	8.931	2.729	11.266	2.375	8.891	2.375	18.650	8.091	10.559	8.091
SAL	11.979	2.727	9.252	2.727	11.604	2.404	9.201	2.404	18.677	8.760	9.917	8.760
SAM	11.844	2.745	9.100	2.745	11.460	2.407	9.052	2.407	18.641	8.439	10.203	8.439
VEN	11.798	3.016	8.783	3.016	11.426	2.694	8.732	2.694	19.325	8.688	10.638	8.688
AUS	12.554	2.781	9.773	2.781	12.148	2.439	9.710	2.439	19.747	9.250	10.497	9.250
CAM	12.183	2.928	9.255	2.928	11.826	2.629	9.198	2.629	19.975	9.154	10.821	9.154
CAP	11.946	3.019	8.926	3.019	11.615	2.740	8.875	2.740	18.812	8.343	10.469	8.343
CHI	12.071	2.951	9.120	2.951	11.763	2.680	9.083	2.680	19.800	8.762	11.038	8.762
COL	11.716	2.538	9.178	2.538	11.296	2.188	9.108	2.188	18.982	9.082	9.900	9.082
EGS	12.037	2.720	9.317	2.720	11.650	2.395	9.255	2.395	19.241	9.239	10.002	9.239
INO	12.107	2.806	9.301	2.806	11.765	2.512	9.253	2.512	19.955	8.831	11.124	8.831
TAP	12.568	2.857	9.712	2.857	12.247	2.596	9.651	2.596	20.106	9.596	10.510	9.596
MXI	11.767	2.958	8.809	2.958	11.416	2.657	8.759	2.657	19.645	8.752	10.893	8.752
MXM	11.902	3.123	8.779	3.123	11.540	2.794	8.746	2.794	20.889	8.202	12.688	8.202
NOE	12.214	2.698	9.516	2.698	11.835	2.388	9.447	2.388	19.320	9.388	9.932	9.388
OMN	12.238	2.764	9.473	2.764	11.836	2.414	9.423	2.414	19.959	8.825	11.134	8.825
RUS	11.633	2.434	9.199	2.434	11.297	2.177	9.120	2.177	18.773	9.120	9.653	9.120
BRT	12.165	2.734	9.431	2.734	11.804	2.437	9.367	2.437	19.372	9.361	9.361	9.361

Stock: IMO Sector: RM

	M1				M2				M3			
	TRACE		MAX_EIG		TRACE		MAX_EIG		TRACE		MAX_EIG	
Oil	r=0	r≤1	r=0	r=1	r=0	r≤1	r=0	r=1	r=0	r≤1	r=0	r=1
ADM	10.319	3.230	7.089	3.230	9.963	3.082	6.881	3.082	18.385	6.851	11.534	6.851
ASB	10.335	2.967	7.368	2.967	9.943	2.803	7.140	2.803	17.745	7.124	10.621	7.124
ANC	10.442	3.123	7.319	3.123	10.015	2.931	7.084	2.931	18.642	7.074	11.568	7.074
DUB	10.349	3.237	7.112	3.237	9.941	3.055	3.055	3.055	18.648	6.886	11.762	6.886
ECU	10.571	3.984	6.587	3.984	10.244	3.839	6.405	3.839	19.685	6.399	13.286	6.399
IRH	10.143	2.933	7.210	2.933	9.669	2.708	6.961	2.708	17.701	6.927	10.775	6.927
IRL	10.216	2.898	7.318	2.898	9.760	2.692	7.068	2.692	17.602	7.062	10.540	7.062
KUT	10.107	3.315	6.792	3.315	9.709	3.120	6.589	3.120	18.807	6.581	12.226	6.581
LIB	10.202	2.912	7.290	2.912	9.791	2.729	7.062	2.729	17.755	7.045	10.711	7.045
NGB	10.420	3.043	7.377	3.043	10.030	2.879	7.151	2.879	18.155	7.147	11.008	7.147
NGE	10.436	3.000	7.436	3.000	10.049	2.839	7.210	2.839	18.021	7.207	10.814	7.207
DUK	10.428	3.376	7.051	3.376	10.076	3.230	6.846	3.230	18.699	6.824	11.875	6.824
SAH	9.931	3.258	6.672	3.258	9.517	3.035	6.481	3.035	17.658	6.307	11.351	6.307
SAL	10.179	3.167	7.012	3.167	9.787	2.985	6.802	2.985	17.470	6.770	10.700	6.770
SAM	10.096	3.232	6.864	3.232	9.693	3.033	6.660	3.033	17.562	6.574	10.988	6.574
VEN	10.223	3.370	6.853	3.370	9.842	3.204	6.638	3.204	18.213	6.622	11.591	6.622
AUS	10.407	3.205	7.202	3.205	9.996	3.029	6.967	3.029	18.120	6.966	11.154	6.966
CAM	10.653	3.363	7.289	3.363	10.283	3.221	7.062	3.221	19.150	7.041	12.109	7.041
CAP	10.482	3.163	7.319	3.163	10.145	3.035	7.110	3.035	17.536	6.784	10.752	6.784
CHI	10.308	3.473	6.834	3.473	10.005	3.348	6.657	3.348	18.539	6.637	11.902	6.637
COL	9.969	2.859	7.110	2.859	9.541	2.661	6.881	2.661	17.912	6.881	11.032	6.881
EGS	10.096	2.990	7.105	2.990	9.696	2.808	6.888	2.808	17.790	6.883	10.907	6.883
INO	10.164	3.270	6.894	3.270	9.826	3.120	6.706	3.120	18.590	6.705	11.885	6.705
TAP	10.406	3.206	7.200	3.206	10.077	3.076	7.001	3.076	18.412	6.968	11.444	6.968
MXI	10.158	3.309	6.849	3.309	9.796	3.151	6.645	3.151	18.542	6.634	11.909	6.634
MXM	10.098	3.611	6.487	3.611	9.733	3.429	6.305	3.429	19.772	6.299	13.473	6.299
NOE	10.371	3.002	7.369	3.002	9.977	2.839	7.137	2.839	17.958	7.117	10.840	7.117
OMN	10.438	3.304	7.134	3.304	10.044	3.130	6.914	3.130	18.935	6.914	12.021	6.914
RUS	9.754	2.744	7.010	2.744	9.408	2.607	6.801	2.607	17.419	6.801	10.619	6.801
BRT	10.588	3.188	7.400	3.188	10.223	3.046	7.177	3.046	18.452	7.162	11.290	7.162

Stock: MRO Sector: RM

	M1				M2				M3			
	TRACE		MAX_EIG		TRACE		MAX_EIG		TRACE		MAX_EIG	
Oil	r=0	r≤1	r=0	r=1	r=0	r≤1	r=0	r=1	r=0	r≤1	r=0	r=1
ADM	8.695	3.476	5.219	3.476	8.391	3.351	5.040	3.351	15.629	4.550	11.078	4.550
ASB	9.006	3.264	5.743	3.264	8.674	3.137	5.536	3.137	15.273	4.685	10.588	4.685
ANC	8.558	3.310	5.248	3.310	8.201	3.149	5.053	3.149	15.259	4.592	10.667	4.592
DUB	8.511	3.510	5.002	3.510	8.156	3.338	4.818	3.338	15.464	4.575	10.888	4.575
ECU	9.348	3.904	5.443	3.904	9.079	3.863	5.215	3.863	16.828	4.442	12.385	4.442
IRH	8.860	3.427	5.434	3.427	8.459	3.245	5.215	3.245	15.187	4.900	10.287	4.900
IRL	8.822	3.310	5.512	3.310	8.437	3.140	5.297	3.140	14.969	4.837	10.132	4.837
KUT	9.002	3.628	5.374	3.628	8.670	3.518	5.151	3.518	16.477	4.599	11.878	4.599
LIB	9.099	3.321	5.778	3.321	8.740	3.184	5.556	3.184	15.482	4.799	10.683	4.799
NGB	8.916	3.273	5.644	3.273	8.590	3.145	5.444	3.145	15.389	4.649	10.740	4.649
NGE	8.888	3.234	5.653	3.234	8.564	3.105	5.459	3.105	15.200	4.669	10.531	4.669
DUK	8.788	3.552	5.235	3.552	8.490	3.444	5.047	3.444	15.904	4.498	11.406	4.498
SAH	9.063	3.824	5.239	3.824	8.721	3.699	5.022	3.699	15.520	4.771	10.749	4.771
SAL	8.997	3.551	5.446	3.551	8.671	3.432	5.239	3.432	15.019	4.746	10.273	4.746
SAM	9.052	3.683	5.369	3.683	8.719	3.566	5.153	3.566	15.254	4.762	10.492	4.762
VEN	8.676	3.471	8.676	3.471	8.352	3.366	4.986	3.366	15.251	4.362	10.889	4.362
AUS	8.655	3.474	5.180	3.474	8.316	3.325	4.991	3.325	15.275	4.613	10.663	4.613
CAM	8.956	3.529	5.426	3.529	8.641	3.423	5.218	3.423	15.934	4.592	11.343	4.592
CAP	9.414	3.204	6.210	3.204	9.120	3.110	6.010	3.110	15.161	4.339	10.822	4.339
CHI	9.299	3.599	5.700	3.599	9.053	3.534	5.519	3.534	16.383	4.520	11.863	4.520
COL	8.514	3.077	5.437	3.077	8.152	2.910	5.242	2.910	15.015	4.528	10.487	4.528
EGS	9.122	3.410	5.713	3.410	8.775	3.284	5.490	3.284	15.606	4.765	10.842	4.765
INO	9.028	3.521	5.507	3.521	8.750	3.427	5.323	3.427	16.213	4.614	11.599	4.614
TAP	9.083	3.470	5.612	3.470	8.815	3.378	5.437	3.378	15.975	4.652	11.323	4.652
MXI	8.705	3.461	5.243	3.461	8.398	3.356	5.042	3.356	15.595	4.413	11.183	4.413
MXM	8.882	3.961	4.921	3.961	8.568	3.878	4.690	3.878	17.126	4.448	12.678	4.448
NOE	8.926	3.260	5.666	3.260	8.592	3.134	5.458	3.134	15.220	4.631	10.589	4.631
OMN	8.488	3.488	5.000	3.488	8.152	3.330	4.822	3.330	15.602	4.516	11.086	4.516
RUS	8.872	3.162	5.710	3.162	8.591	3.063	5.528	3.063	15.319	4.685	10.634	4.685
BRT	8.855	3.302	5.553	3.302	8.550	3.188	5.363	3.188	15.296	4.545	10.751	4.545

Stock: MUR Sector: RM

	M1				M2				M3			
	TRACE		MAX_EIG		TRACE		MAX_EIG		TRACE		MAX_EIG	
Oil	r=0	r≤1	r=0	r=1	r=0	r≤1	r=0	r=1	r=0	r≤1	r=0	r=1
ADM	12.131	2.542	9.589	2.542	11.813	2.230	9.583	2.230	19.250	7.537	11.713	7.537
ASB	11.452	2.316	9.135	2.316	11.107	1.979	9.128	1.979	17.646	7.513	10.133	7.513
ANC	11.459	2.315	9.144	2.315	11.083	1.947	9.136	1.947	18.264	7.597	10.667	7.597
DUB	12.045	2.496	9.549	2.496	11.677	2.134	9.543	2.134	19.307	7.533	11.774	7.533
ECU	11.889	3.121	8.768	3.121	11.609	2.842	8.767	2.842	19.785	8.004	11.781	8.004
IRH	11.614	2.317	9.297	2.317	11.198	1.912	9.286	1.912	18.039	7.612	10.427	7.612
IRL	11.780	2.346	9.434	2.346	11.379	1.960	9.419	1.960	18.031	7.651	10.380	7.651
KUT	12.080	2.588	9.492	2.588	11.731	2.242	9.488	2.242	19.915	7.773	12.142	7.773
LIB	11.491	2.362	9.129	2.362	11.118	1.999	9.119	1.999	17.818	7.755	10.063	7.755
NGB	11.603	2.390	9.213	2.390	11.265	2.060	9.206	2.060	18.040	7.620	10.419	7.620
NGE	11.612	2.344	9.268	2.344	11.275	2.016	9.259	2.016	17.873	7.514	10.359	7.514
DUK	12.027	2.593	9.434	2.593	11.714	2.283	9.431	2.283	19.303	7.484	11.819	7.484
SAH	11.369	2.451	8.918	2.451	11.019	2.103	8.917	2.103	18.103	7.413	10.690	7.413
SAL	11.605	2.447	9.158	2.447	11.271	2.118	9.153	2.118	17.886	7.407	10.478	7.407
SAM	11.488	2.459	9.029	2.459	11.147	2.121	9.026	2.121	17.952	7.395	10.558	7.395
VEN	11.385	2.727	8.658	2.727	11.045	2.393	8.652	2.393	18.236	7.707	10.529	7.707
AUS	12.046	2.432	9.614	2.432	11.698	2.088	9.610	2.088	18.831	7.391	11.440	7.391
CAM	11.579	2.567	9.012	2.567	11.258	2.251	9.008	2.251	18.672	7.821	10.851	7.821
CAP	11.704	2.789	8.915	2.789	11.400	2.491	8.909	2.491	17.711	8.135	9.576	8.135
CHI	12.051	2.545	9.506	2.545	11.781	2.277	9.504	2.277	19.387	7.443	11.944	7.443
COL	11.484	2.384	9.100	2.384	11.102	2.016	9.087	2.016	18.170	7.950	10.220	7.950
EGS	11.506	2.423	9.084	2.423	11.146	2.071	9.075	2.071	18.065	7.791	10.274	7.791
INO	12.222	2.415	9.807	2.415	11.916	2.115	9.801	2.115	19.742	7.362	12.379	7.362
TAP	12.578	2.634	9.944	2.634	12.305	2.370	9.935	2.370	19.610	8.020	11.590	8.020
MXI	11.384	2.686	8.699	2.686	11.063	2.369	8.694	2.369	18.517	8.024	10.493	8.024
MXM	11.748	2.916	8.832	2.916	11.422	2.593	8.829	2.593	8.829	7.947	12.261	7.947
NOE	11.585	2.401	9.184	2.401	11.241	2.066	9.175	2.066	17.925	7.783	10.142	7.783
OMN	12.123	2.508	9.615	2.508	11.775	2.164	9.610	2.164	19.580	7.549	12.031	7.549
RUS	10.982	2.227	8.755	2.227	10.681	1.949	8.733	1.949	17.438	7.987	9.451	7.987
BRT	11.485	2.421	9.064	2.421	11.167	2.108	9.058	2.108	17.952	7.739	10.213	7.739

Stock: SUN Sector: RM

	M1				M2				M3			
	TRACE		MAX_EIG		TRACE		MAX_EIG		TRACE		MAX_EIG	
Oil	r=0	r≤1	r=0	r=1	r=0	r≤1	r=0	r=1	r=0	r≤1	r=0	r=1
ADM	11.448	4.249	7.199	4.249	11.160	4.249	6.911	4.249	17.871	4.589	13.282	4.589
ASB	10.876	4.096	6.780	4.096	10.551	4.090	6.461	4.090	16.484	4.512	11.973	4.512
ANC	10.966	4.434	6.532	4.434	10.620	4.433	6.188	4.433	17.259	4.764	12.496	4.764
DUB	11.271	4.523	6.748	4.523	10.936	4.523	6.412	4.523	17.889	4.818	13.071	4.818
ECU	11.652	4.444	7.208	4.444	11.383	4.435	6.948	4.435	18.826	4.517	14.308	4.517
IRH	11.413	4.649	6.764	4.649	11.024	4.646	6.378	4.646	17.415	5.112	12.303	5.112
IRL	11.415	4.495	6.919	4.495	11.040	4.490	6.550	4.490	17.211	5.018	12.193	5.018
KUT	11.183	4.522	6.662	4.522	10.859	4.521	6.338	4.521	18.298	4.723	13.575	4.723
LIB	10.685	4.176	6.509	4.176	10.330	4.168	6.162	4.168	16.398	4.599	11.799	4.599
NGB	11.343	4.197	7.146	4.197	11.025	4.193	6.832	4.193	17.285	4.643	12.642	4.643
NGE	11.350	4.165	7.185	4.165	11.036	4.160	6.876	4.160	17.122	4.642	12.481	4.642
DUK	11.505	4.182	7.323	4.182	11.222	4.182	7.040	4.182	18.066	4.466	13.599	4.466
SAH	11.446	4.660	6.786	4.660	11.119	4.659	6.460	4.659	17.547	4.911	12.636	4.911
SAL	11.555	4.435	7.120	4.435	11.243	4.434	6.809	4.434	17.181	4.830	12.351	4.830
SAM	11.630	4.576	7.053	4.576	11.311	4.576	6.734	4.576	17.462	4.916	12.546	4.916
VEN	10.698	4.104	6.594	4.104	10.380	4.103	6.276	4.103	16.900	4.298	12.601	4.298
AUS	10.952	4.093	6.859	4.093	10.630	4.092	6.538	4.092	16.985	4.386	12.599	4.386
CAM	10.950	4.437	6.513	4.437	10.645	4.437	6.208	4.437	17.460	4.637	12.823	4.637
CAP	11.844	3.881	7.963	3.881	11.551	3.878	7.673	3.878	17.246	4.181	13.065	4.181
CHI	11.185	4.040	7.145	4.040	10.945	4.040	6.905	4.040	17.657	4.259	13.397	4.259
COL	10.742	4.127	6.616	4.127	10.380	4.114	6.266	4.114	16.760	4.634	12.127	4.634
EGS	11.015	4.359	6.656	4.359	10.673	4.356	6.317	4.356	16.966	4.745	12.221	4.745
INO	11.358	4.152	7.206	4.152	11.088	4.151	6.937	4.151	18.007	4.497	13.510	4.497
TAP	11.208	3.985	7.223	3.985	10.951	3.983	6.968	3.983	17.376	4.298	13.079	4.298
MXI	10.893	4.183	6.710	4.183	10.592	4.183	6.409	4.183	17.396	4.411	12.985	4.411
MXM	10.270	4.334	5.936	4.334	9.962	4.311	5.651	4.311	18.066	4.322	13.743	4.322
NOE	10.944	4.194	6.749	4.194	10.618	4.189	6.429	4.189	16.718	4.603	12.116	4.603
OMN	11.183	4.415	6.768	4.415	10.863	4.415	6.449	4.415	17.887	4.690	13.197	4.690
RUS	10.430	4.466	5.964	4.466	10.148	4.453	5.695	4.453	16.398	4.846	11.552	4.846
BRT	10.866	4.210	6.656	4.210	10.568	4.208	6.359	4.208	16.765	4.530	12.235	4.530

Stock: TSO Sector: RM

	M1				M2				M3			
	TRACE		MAX_EIG		TRACE		MAX_EIG		TRACE		MAX_EIG	
Oil	r=0	r≤1	r=0	r=1	r=0	r≤1	r=0	r=1	r=0	r≤1	r=0	r=1
ADM	9.724	3.419	6.305	3.419	9.416	3.369	6.047	3.369	16.872	4.732	12.140	4.732
ASB	9.714	3.404	6.310	3.404	9.372	3.334	6.038	3.334	16.297	5.007	11.290	5.007
ANC	9.620	3.540	6.080	3.540	9.258	3.464	5.794	3.464	16.776	5.016	11.760	5.016
DUB	9.521	3.538	5.983	3.538	9.161	3.470	5.691	3.470	16.794	4.851	11.943	4.851
ECU	9.923	3.808	6.115	3.808	9.644	3.791	5.853	3.791	17.666	4.581	13.085	4.581
IRH	10.115	3.724	6.390	3.724	9.704	3.641	6.063	3.641	17.089	5.463	11.626	5.463
IRL	10.015	3.596	6.419	3.596	9.619	3.515	6.104	3.515	16.739	5.384	11.355	5.384
KUT	9.335	3.629	5.706	3.629	8.985	3.565	5.420	3.565	17.046	4.739	12.307	4.739
LIB	9.702	3.358	6.344	3.358	9.331	3.278	6.054	3.278	16.378	5.015	11.363	5.015
NGB	9.738	3.361	6.378	3.361	9.405	3.295	6.110	3.295	16.506	4.923	11.583	4.923
NGE	9.704	3.322	6.382	3.322	9.375	3.254	6.120	3.254	16.303	4.937	11.366	4.937
DUK	9.651	3.476	6.176	3.476	9.347	3.431	5.916	3.431	16.935	4.645	12.290	4.645
SAH	9.821	3.812	6.009	3.812	9.471	3.761	5.711	3.761	16.704	5.034	11.670	5.034
SAL	9.752	3.558	6.194	3.558	9.419	3.501	5.917	3.501	16.124	4.984	11.140	4.984
SAM	9.866	3.697	6.168	3.697	9.524	3.646	5.879	3.646	16.466	5.037	11.428	5.037
VEN	9.529	3.514	6.014	3.514	9.197	3.469	5.728	3.469	16.519	4.692	11.827	4.692
AUS	9.518	3.573	5.945	3.573	9.171	3.511	5.661	3.511	16.442	4.874	11.568	4.874
CAM	10.105	3.735	6.370	3.735	9.789	3.692	6.097	3.692	17.627	5.039	12.589	5.039
CAP	9.980	3.293	6.687	3.293	9.676	3.248	6.428	3.248	15.916	4.558	11.358	4.558
CHI	9.674	3.777	5.897	3.777	9.413	3.748	5.665	3.748	17.029	4.764	12.265	4.764
COL	9.287	3.151	6.137	3.151	8.914	3.058	5.856	3.058	16.061	4.803	11.258	4.803
EGS	9.910	3.536	6.374	3.536	9.553	3.469	6.085	3.469	16.813	5.114	11.699	5.114
INO	9.476	3.712	5.764	3.712	9.183	3.663	5.520	3.663	17.006	4.875	12.130	4.875
TAP	9.651	3.549	6.101	3.549	9.375	3.502	5.874	3.502	16.780	4.853	11.927	4.853
MXI	9.549	3.515	6.034	3.515	9.237	3.464	5.773	3.464	16.827	4.730	12.097	4.730
MXM	9.617	3.917	5.700	3.917	9.292	3.889	5.404	3.889	18.285	4.700	13.585	4.700
NOE	9.780	3.339	6.441	3.339	9.441	3.270	6.171	3.270	16.411	4.940	11.471	4.940
OMN	9.445	3.527	5.918	3.527	9.103	3.463	5.640	3.463	16.860	4.784	12.075	4.784
RUS	9.619	3.431	6.188	3.431	9.327	3.354	5.973	3.354	16.478	5.170	11.307	5.170
BRT	9.610	3.400	6.209	3.400	9.293	3.344	5.949	3.344	16.271	4.799	11.472	4.799

Stock: HOC Sector: RM

	M1				M2				M3			
	TRACE		MAX_EIG		TRACE		MAX_EIG		TRACE		MAX_EIG	
Oil	r=0	r≤1	r=0	r=1	r=0	r≤1	r=0	r=1	r=0	r≤1	r=0	r=1
ADM	12.657	3.598	9.059	3.598	12.354	3.567	8.787	3.567	21.591	6.852	14.739	6.852
ASB	13.067	3.596	9.470	3.596	12.729	3.561	9.168	3.561	21.563	7.355	14.208	7.355
ANC	12.747	3.901	8.846	3.901	12.380	3.862	8.518	3.862	21.978	7.473	14.505	7.473
DUB	12.599	3.738	8.861	3.738	12.248	3.702	8.546	3.702	21.804	7.089	14.716	7.089
ECU	12.436	4.254	8.182	4.254	12.150	4.245	7.905	4.245	22.011	6.490	15.520	6.490
IRH	13.306	3.983	9.323	3.983	12.900	3.939	8.961	3.939	22.408	8.033	14.375	8.033
IRL	13.290	3.837	9.453	3.837	12.900	3.794	9.106	3.794	22.121	7.965	14.156	7.965
KUT	12.055	3.835	8.220	3.835	11.707	3.799	7.908	3.799	21.646	6.798	14.848	6.798
LIB	12.714	3.550	9.164	3.550	12.348	3.506	8.842	3.506	21.270	7.304	13.966	7.304
NGB	12.829	3.644	9.185	3.644	12.492	3.608	8.885	3.608	21.563	7.340	14.223	7.340
NGE	12.943	3.637	9.306	3.637	12.611	3.601	9.011	3.601	21.561	7.454	14.107	7.454
DUK	12.924	3.723	9.201	3.723	12.627	3.698	8.929	3.698	22.148	6.875	15.273	6.875
SAH	13.080	4.346	8.734	4.346	12.730	4.320	8.411	4.320	22.172	7.619	14.553	7.619
SAL	13.292	4.007	9.285	4.007	12.965	3.980	8.985	3.980	21.814	7.663	14.151	7.663
SAM	13.241	4.182	9.059	4.182	12.903	4.157	8.746	4.157	22.000	7.679	14.321	7.679
VEN	12.734	3.850	8.884	3.850	12.404	3.828	8.576	3.828	21.794	6.992	14.802	6.992
AUS	9.295	0.767	8.528	0.767	12.788	3.794	8.994	3.794	12.444	3.760	8.684	3.760
CAM	13.386	4.171	9.216	4.171	13.063	4.150	8.913	4.150	23.099	7.524	15.575	7.524
CAP	13.976	3.552	10.424	3.552	13.677	3.530	10.147	3.530	21.996	6.880	15.117	6.880
CHI	12.951	3.870	9.082	3.870	12.702	3.853	8.849	3.853	22.207	6.825	15.383	6.825
COL	12.172	3.399	8.773	3.399	11.796	3.3473	8.449	3.3473	20.957	7.123	13.834	7.123
EGS	12.968	3.826	9.143	3.826	12.613	3.789	8.824	3.789	21.885	7.514	14.371	7.514
INO	12.895	3.842	9.053	3.842	12.615	3.820	8.795	3.820	22.554	7.150	15.404	7.150
TAP	12.836	3.622	9.214	3.622	12.566	3.596	8.970	3.596	21.754	6.908	14.846	6.908
MXI	12.889	3.926	8.963	3.926	12.578	3.904	8.674	3.904	22.384	7.114	15.271	7.114
MXM	12.489	4.333	8.156	4.333	12.171	4.316	7.856	4.316	23.468	6.839	16.629	6.839
NOE	13.348	3.740	9.608	3.740	13.007	3.707	9.300	3.707	22.155	7.585	14.569	7.585
OMN	12.638	3.801	8.837	3.801	12.303	3.767	8.536	3.767	22.052	7.095	14.957	7.095
RUS	12.467	3.745	8.723	3.745	12.180	3.716	8.464	3.716	21.413	7.530	13.883	7.530
BRT	13.046	3.797	9.249	3.797	12.729	3.769	8.960	3.769	21.822	7.362	14.460	7.362

Stock: SSL Sector: RM

	M1				M2				M3			
	TRACE		MAX_EIG		TRACE		MAX_EIG		TRACE		MAX_EIG	
Oil	r=0	r≤1	r=0	r=1	r=0	r≤1	r=0	r=1	r=0	r≤1	r=0	r=1
ADM	27.545	2.504	25.041	2.504	27.214	2.260	24.954	2.260	36.498	11.228	25.270	11.228
ASB	27.431	2.256	25.174	2.256	27.049	1.965	25.084	1.965	35.242	10.111	25.130	10.111
ANC	26.316	2.313	24.004	2.313	25.932	2.044	23.889	2.044	34.231	10.066	24.165	10.066
DUB	27.815	2.605	25.211	2.605	27.469	2.390	25.079	2.390	37.040	11.468	25.572	11.468
ECU	24.651	2.183	22.467	2.183	24.248	1.922	22.326	1.922	31.965	9.065	22.900	9.065
IRH	25.982	2.338	23.645	2.338	25.578	2.080	23.497	2.080	33.969	10.337	23.632	10.337
IRL	26.261	2.345	23.916	2.345	25.867	2.082	23.784	2.082	34.378	10.504	23.874	10.504
KUT	26.506	2.541	23.965	2.541	26.167	2.321	23.845	2.321	35.504	10.857	24.647	10.857
LIB	27.454	2.353	25.100	2.353	27.063	2.084	24.979	2.084	35.590	10.485	25.104	10.485
NGB	28.340	2.241	26.099	2.241	27.959	1.947	26.012	1.947	36.279	10.132	26.147	10.132
NGE	28.074	2.301	25.773	2.301	27.699	2.013	25.687	2.013	36.222	10.438	25.784	10.438
DUK	28.561	2.443	26.118	2.443	28.229	2.194	26.035	2.194	37.332	11.009	26.323	11.009
SAH	23.678	2.306	21.371	2.306	23.299	2.055	21.244	2.055	31.324	9.958	21.366	9.958
SAL	25.353	2.314	23.038	2.314	24.982	2.046	22.935	2.046	33.182	10.241	22.941	10.241
SAM	24.718	2.300	22.417	2.300	24.343	2.039	22.304	2.039	32.419	10.087	22.331	10.087
VEN	26.315	2.057	24.258	2.057	25.897	1.758	24.139	1.758	33.836	9.396	24.440	9.396
AUS	26.303	2.353	23.950	2.353	25.953	2.091	23.863	2.091	34.649	10.636	24.014	10.636
CAM	29.786	2.203	27.583	2.203	29.396	1.912	27.484	1.912	37.360	9.660	27.700	9.660
CAP	25.737	2.183	23.554	2.183	25.360	1.881	23.479	1.881	33.287	9.803	23.485	9.803
CHI	24.507	2.356	22.150	2.356	24.175	2.085	22.091	2.085	32.878	22.482	10.396	22.482
COL	27.334	2.354	24.979	2.354	26.909	2.091	24.818	2.091	35.738	10.437	25.301	10.437
EGS	27.832	2.343	25.488	2.343	27.436	2.074	25.361	2.074	35.782	10.291	25.491	10.291
INO	27.589	2.431	25.158	2.431	27.255	2.172	25.082	2.172	36.559	10.761	25.798	10.761
TAP	29.124	2.337	26.787	2.337	28.780	2.052	26.728	2.052	37.332	10.500	26.833	10.500
MXI	25.997	2.135	23.862	2.135	25.582	1.842	23.740	1.842	33.761	9.539	24.222	9.539
MXM	27.324	2.353	24.970	2.353	26.922	2.124	24.798	2.124	36.396	9.932	26.465	9.932
NOE	28.249	2.215	26.034	2.215	27.858	1.918	25.940	1.918	35.925	9.909	26.016	9.909
OMN	28.433	2.614	25.819	2.614	28.102	2.394	25.708	2.394	37.660	11.453	26.206	11.453
RUS	28.675	2.290	26.384	2.290	28.370	2.071	26.299	2.071	36.592	10.167	26.426	10.167
BRT	27.594	2.360	25.234	2.360	27.236	2.088	25.148	2.088	25.270	10.466	25.270	10.466

Appendix 11b: Identification of cointegrated relationship for each stock of different oil sectors and OPEC and non-OPEC crude oils

Notes: 1. Stocks and crude oils are listed horizontally and vertically, respectively. 2. M1: no constant and no drift; M2: a constant only; M3: both a constant and a drift. 3. 1s and 0s are used to indicate the existence of a cointegration relationship or not, respectively. 4. Actual values of the Trace and Maximum Eigenvalue tests are provided in Appendix 11a.

Trace and Max-Eig values for DE stock prices and OPEC crude prices

	STOCK	DO		NE		ESV		RIG	
CRUDE		Trace	Max-Eig	Trace	Max-Eig	Trace	Max-Eig	Trace	Max-Eig
ADM	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	0	0
	M3	0	0	0	0	0	0	1	1
ASB	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	0	0
	M3	0	0	0	0	0	0	0	1
ANC	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	0	0
	M3	0	0	0	0	0	0	1	1
DUB	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	0	0
	M3	1	1	0	0	0	0	1	1
ECU	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	0	0
	M3	1	1	0	0	0	0	1	1
IRH	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	0	0
	M3	0	0	0	0	0	0	1	1
IRL	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	0	0
	M3	0	0	0	0	0	0	1	1
KUT	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	0	0
	M3	1	1	0	0	0	0	1	1
LIB	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	0	0
	M3	0	0	0	0	0	0	1	1
NGB	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	0	0
	M3	0	0	0	0	0	0	1	1
NGE	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	0	0
	M3	0	0	0	0	0	0	0	1
DUK	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	0	0
	M3	0	0	0	0	0	0	1	1
SAH	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	0	0
	M3	0	0	0	0	0	0	1	1
SAL	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	0	0
	M3	0	0	0	0	0	0	1	1
SAM	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	0	0
	M3	0	0	0	0	0	0	1	1
VEN	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	0	0
	M3	0	0	0	0	0	0	1	1

Continued

	STOCK	ATW		PKD		PTEN		PDE	
CRUDE		Trace	Max-Eig	Trace	Max-Eig	Trace	Max-Eig	Trace	Max-Eig
ADM	M1	0	0	0	0	0	0	0	0
	M2	1	0	0	0	0	0	0	0
	M3	1	1	0	0	0	0	0	0
ASB	M1	0	0	0	0	0	0	0	0
	M2	1	0	0	0	0	0	1	0
	M3	1	1	0	0	0	0	0	0
ANC	M1	0	0	0	0	0	0	0	0
	M2	1	0	0	0	0	0	0	0
	M3	1	1	0	0	0	0	0	0
DUB	M1	0	0	0	0	0	0	0	0
	M2	1	0	0	0	0	0	0	0
	M3	1	1	0	0	0	0	0	0
ECU	M1	0	0	0	0	0	0	0	0
	M2	2	0	0	0	0	0	1	0
	M3	1	1	0	0	0	0	1	0
IRH	M1	0	0	0	0	0	0	0	0
	M2	1	0	0	0	0	0	0	0
	M3	1	1	0	0	0	0	0	0
IRL	M1	0	0	0	0	0	0	0	0
	M2	1	1	0	0	0	0	0	0
	M3	1	1	0	0	0	0	0	0
KUT	M1	0	0	0	0	0	0	0	0
	M2	1	0	0	0	0	0	0	0
	M3	1	1	0	0	0	0	0	0
LIB	M1	0	0	0	0	0	0	0	0
	M2	1	1	0	0	0	0	1	0
	M3	1	1	0	0	0	0	0	0
NGB	M1	0	0	0	0	0	0	0	0
	M2	1	1	0	0	0	0	1	0
	M3	1	1	0	0	0	0	0	0
NGE	M1	0	0	0	0	0	0	0	0
	M2	1	1	0	0	0	0	0	0
	M3	1	1	0	0	0	0	0	0
DUK	M1	0	0	0	0	0	0	0	0
	M2	0	1	0	0	0	0	0	0
	M3	1	1	0	0	0	0	0	0
SAH	M1	0	0	0	0	0	0	0	0
	M2	1	0	0	0	0	0	0	0
	M3	1	1	0	0	0	0	0	0
SAL	M1	0	0	0	0	0	0	0	0
	M2	1	0	0	0	0	0	0	0
	M3	1	1	0	0	0	0	0	0
SAM	M1	0	0	0	0	0	0	0	0
	M2	1	0	0	0	0	0	0	0
	M3	1	1	0	0	0	0	0	0
VEN	M1	0	0	0	0	0	0	0	0
	M2	1	0	0	0	0	0	0	0
	M3	1	1	0	0	0	0	0	0

Trace and Max-Eig values for DE stock prices and non-OPEC crude prices

	STOCK	DO		NE		ESV		RIG	
CRUDE		Trace	Max-Eig	Trace	Max-Eig	Trace	Max-Eig	Trace	Max-Eig
AUS	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	0	0
	M3	0	0	0	0	0	0	0	1
CAM	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	0	0
	M3	0	0	0	0	0	0	1	1
CAP	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	0	0
	M3	0	0	0	0	0	0	0	0
CHI	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	0	0
	M3	0	0	0	0	0	0	1	1
COL	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	0	0
	M3	0	0	0	0	0	0	1	1
EGS	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	0	0
	M3	0	0	0	0	0	0	1	1
INO	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	0	0
	M3	0	0	0	0	0	0	1	1
TAP	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	0	0
	M3	0	0	0	0	0	0	1	1
MXI	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	0	0
	M3	0	0	0	0	0	0	1	1
MXM	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	0	0
	M3	1	1	0	0	0	0	1	1
NOE	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	0	0
	M3	0	0	0	0	0	0	0	1
OMN	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	0	0
	M3	1	0	0	0	0	0	1	1
RUS	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	0	0
	M3	0	0	0	0	0	0	1	1
BRT	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	0	0
	M3	0	0	0	0	0	0	0	0

Continued

	STOCK	ATW		PKD		PTEN		PDE	
CRUDE		Trace	Max-Eig	Trace	Max-Eig	Trace	Max-Eig	Trace	Max-Eig
AUS	M1	0	0	0	0	0	0	0	0
	M2	1	0	0	0	0	0	1	0
	M3	1	1	0	0	0	0	0	0
CAM	M1	0	0	0	0	0	0	0	0
	M2	1	0	0	0	0	0	1	0
	M3	1	1	0	0	0	0	1	0
CAP	M1	0	0	0	0	0	0	0	0
	M2	1	0	0	0	0	0	1	0
	M3	1	1	0	0	0	0	0	0
CHI	M1	0	0	0	0	0	0	0	0
	M2	1	0	0	0	0	0	1	0
	M3	1	1	0	0	0	0	0	0
COL	M1	0	0	0	0	0	0	0	0
	M2	1	1	0	0	0	0	0	0
	M3	1	1	0	0	0	0	0	0
EGS	M1	0	0	0	0	0	0	0	0
	M2	1	1	0	0	0	0	1	0
	M3	1	1	0	0	0	0	0	0
INO	M1	0	0	0	0	0	0	0	0
	M2	1	0	0	0	0	0	1	0
	M3	1	1	0	0	0	0	1	0
TAP	M1	0	0	0	0	0	0	0	0
	M2	1	0	0	0	0	0	1	0
	M3	1	1	0	0	0	0	0	0
MXI	M1	0	0	0	0	0	0	0	0
	M2	1	0	0	0	0	0	0	0
	M3	1	1	0	0	0	0	0	0
MXM	M1	0	0	0	0	0	0	0	0
	M2	1	0	0	0	0	0	0	0
	M3	1	1	0	0	0	0	1	0
NOE	M1	0	0	0	0	0	0	0	0
	M2	1	1	0	0	0	0	1	0
	M3	1	1	0	0	0	0	0	0
OMN	M1	0	0	0	0	0	0	0	0
	M2	1	0	0	0	0	0	0	0
	M3	1	1	0	0	0	0	0	0
RUS	M1	0	0	0	0	0	0	0	0
	M2	1	0	0	0	0	0	0	0
	M3	1	1	0	0	0	0	0	0
BRT	M1	0	0	0	0	0	0	0	0
	M2	1	0	0	0	0	0	0	0
	M3	1	1	0	0	0	0	0	0

Trace and Max-Eig values for ES stock prices and OPEC crude prices

	STOCK	BHI		BJS		HAL		SII	
CRUDE		Trace	Max-Eig	Trace	Max-Eig	Trace	Max-Eig	Trace	Max-Eig
ADM	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	0	0
	M3	0	0	0	0	0	0	0	0
ASB	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	0	0
	M3	0	0	0	0	0	0	0	0
ANC	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	0	0
	M3	0	0	0	0	0	0	0	0
DUB	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	0	0
	M3	0	0	0	0	0	0	0	0
ECU	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	0	0
	M3	0	0	0	0	0	0	0	0
IRH	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	0	0
	M3	0	0	0	0	0	0	0	0
IRL	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	0	0
	M3	0	0	0	0	0	0	0	0
KUT	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	0	0
	M3	0	0	0	0	0	0	0	0
LIB	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	0	0
	M3	0	0	0	0	0	0	0	0
NGB	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	0	0
	M3	0	0	0	0	0	0	0	0
NGE	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	0	0
	M3	0	0	0	0	0	0	0	0
DUK	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	0	0
	M3	0	0	0	0	0	0	0	0
SAH	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	0	0
	M3	0	0	0	0	0	0	0	0
SAL	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	0	0
	M3	0	0	0	0	0	0	0	0
SAM	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	0	0
	M3	0	0	0	0	0	0	0	0
VEN	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	0	0
	M3	0	0	0	0	0	0	0	0

Continued

	STOCK	WFT		TESO		SLB		RES	
CRUDE		Trace	Max-Eig	Trace	Max-Eig	Trace	Max-Eig	Trace	Max-E
ADM	M1	0	0	0	0	0	0	0	0
	M2	2	0	0	0	0	0	0	0
	M3	1	1	0	0	1	0	0	0
ASB	M1	0	0	0	0	0	0	0	0
	M2	1	0	0	0	0	0	0	0
	M3	1	1	0	0	1	0	0	0
ANC	M1	0	0	0	0	0	0	0	0
	M2	1	0	0	0	0	0	0	0
	M3	1	1	0	0	1	0	0	0
DUB	M1	0	0	0	0	0	0	0	0
	M2	2	0	0	0	0	0	0	0
	M3	1	1	0	0	1	0	0	0
ECU	M1	0	0	0	0	0	0	0	0
	M2	2	0	0	0	0	0	0	0
	M3	1	1	0	0	1	0	0	0
IRH	M1	0	0	0	0	0	0	0	0
	M2	1	0	0	0	0	0	0	0
	M3	1	1	0	0	1	0	0	0
IRL	M1	0	0	0	0	0	0	0	0
	M2	1	0	0	0	0	0	0	0
	M3	1	1	0	0	1	0	0	0
KUT	M1	0	0	0	0	0	0	0	0
	M2	2	0	0	0	0	0	0	0
	M3	1	1	0	0	1	0	0	0
LIB	M1	0	0	0	0	0	0	0	0
	M2	1	0	0	0	0	0	0	0
	M3	1	1	0	0	1	0	0	0
NGB	M1	0	0	0	0	0	0	0	0
	M2	2	0	0	0	0	0	0	0
	M3	1	1	0	0	1	0	0	0
NGE	M1	0	0	0	0	0	0	0	0
	M2	2	0	0	0	0	0	0	0
	M3	1	1	0	0	1	0	0	0
DUK	M1	0	0	0	0	0	0	0	0
	M2	2	0	0	0	0	0	0	0
	M3	1	1	0	0	1	0	0	0
SAH	M1	0	0	0	0	0	0	0	0
	M2	2	0	0	0	0	0	0	0
	M3	1	1	0	0	1	0	0	0
SAL	M1	0	0	0	0	0	0	0	0
	M2	2	0	0	0	0	0	0	0
	M3	1	1	0	0	1	0	0	0
SAM	M1	0	0	0	0	0	0	0	0
	M2	2	0	0	0	0	0	0	0
	M3	1	1	0	0	1	0	0	0
VEN	M1	0	0	0	0	0	0	0	0
	M2	2	0	0	0	0	0	0	0
	M3	1	1	0	0	1	0	0	0

Trace and Max-Eig values for ES stock prices and non-OPEC crude prices

	STOCK	BHI		BJS		HAL		SII	
CRUDE		Trace	Max-Eig	Trace	Max-Eig	Trace	Max-Eig	Trace	Max-Eig
AUS	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	0	0
	M3	0	0	0	0	0	0	0	0
CAM	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	0	0
	M3	0	0	0	0	0	0	0	0
CAP	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	0	0
	M3	0	0	0	0	0	0	0	0
CHI	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	0	0
	M3	0	0	0	0	0	0	0	0
COL	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	0	0
	M3	0	0	0	0	0	0	0	0
EGS	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	0	0
	M3	0	0	0	0	0	0	0	0
INO	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	0	0
	M3	0	0	0	0	0	0	0	0
TAP	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	0	0
	M3	0	0	0	0	0	0	0	0
MXI	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	0	0
	M3	0	0	0	0	0	0	0	0
MXM	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	0	0
	M3	0	0	0	0	0	0	0	0
NOE	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	0	0
	M3	0	0	0	0	0	0	0	0
OMN	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	0	0
	M3	0	0	0	0	0	0	0	0
RUS	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	0	0
	M3	0	0	0	0	0	0	0	0
BRT	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	0	0
	M3	0	0	0	0	0	0	0	0

Continued

	STOCK	WFT		TESO		SLB		RES	
CRUDE		Trace	Max-Eig	Trace	Max-Eig	Trace	Max-Eig	Trace	Max-Eig
AUS	M1	0	0	0	0	0	0	0	0
	M2	2	0	0	0	0	0	0	0
	M3	1	1	0	0	1	0	0	0
CAM	M1	0	0	0	0	0	0	0	0
	M2	2	0	0	0	0	0	0	0
	M3	1	1	0	0	1	1	0	0
CAP	M1	0	0	0	0	0	0	0	0
	M2	2	0	0	0	0	0	0	0
	M3	1	1	0	0	1	1	0	0
CHI	M1	0	0	0	0	0	0	0	0
	M2	2	0	0	0	0	0	0	0
	M3	1	1	0	0	1	0	0	0
COL	M1	0	0	0	0	0	0	0	0
	M2	2	0	0	0	0	0	0	0
	M3	1	1	0	0	1	0	0	0
EGS	M1	0	0	0	0	0	0	0	0
	M2	2	0	0	0	0	0	0	0
	M3	1	1	0	0	1	0	0	0
INO	M1	0	0	0	0	0	0	0	0
	M2	2	0	0	0	0	0	0	0
	M3	1	1	0	0	1	0	0	0
TAP	M1	0	0	0	0	0	0	0	0
	M2	2	0	0	0	0	0	0	0
	M3	1	1	0	0	1	1	0	0
MXI	M1	0	0	0	0	0	0	0	0
	M2	2	0	0	0	0	0	0	0
	M3	1	1	0	0	1	0	0	0
MXM	M1	0	0	0	0	0	0	0	0
	M2	2	0	0	0	0	0	0	0
	M3	1	1	0	0	1	0	0	0
NOE	M1	0	0	0	0	0	0	0	0
	M2	2	0	0	0	0	0	0	0
	M3	1	1	0	0	1	0	0	0
OMN	M1	0	0	0	0	0	0	0	0
	M2	2	0	0	0	0	0	0	0
	M3	1	1	0	0	1	0	0	0
RUS	M1	0	0	0	0	0	0	0	0
	M2	1	0	0	0	0	0	0	0
	M3	1	1	0	0	0	0	0	0
BRT	M1	0	0	0	0	0	0	0	0
	M2	2	0	0	0	0	0	0	0
	M3	1	1	0	0	1	0	0	0

Trace and Max-Eig values for PIP stock prices and OPEC crude prices

	STOCK	EEP		EP		ETP		KMP	
CRUDE		Trace	Max-Eig	Trace	Max-Eig	Trace	Max-Eig	Trace	Max-Eig
ADM	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	1	1
	M3	0	0	0	0	0	0	0	0
ASB	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	1	1
	M3	0	0	0	0	0	0	0	0
ANC	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	1	1
	M3	0	0	0	0	0	0	0	0
DUB	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	1	1
	M3	0	0	0	0	0	0	0	0
ECU	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	1	1
	M3	0	0	0	0	0	0	1	0
IRH	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	1	1
	M3	0	0	0	0	0	0	0	0
IRL	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	1	1
	M3	0	0	0	0	0	0	0	0
KUT	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	1	1
	M3	0	0	0	0	0	0	0	0
LIB	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	1	1
	M3	0	0	0	0	0	0	0	0
NGB	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	1	1
	M3	0	0	0	0	0	0	0	0
NGE	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	1	1
	M3	0	0	0	0	0	0	0	0
DUK	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	1	1
	M3	0	0	0	0	0	0	0	0
SAH	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	1	1
	M3	0	0	0	0	0	0	0	0
SAL	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	1	1
	M3	0	0	0	0	0	0	0	0
SAM	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	1	1
	M3	0	0	0	0	0	0	0	0
VEN	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	1	1
	M3	0	0	0	0	0	0	0	0

Continued

	STOCK	WMB		TCLP		PAA		OKS	
CRUDE		Trace	Max-Eig	Trace	Max-Eig	Trace	Max-Eig	Trace	Max-Eig
ADM	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	0	0
	M3	0	0	1	1	0	0	0	0
ASB	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	0	0
	M3	0	0	1	1	0	0	0	0
ANC	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	0	0
	M3	0	0	1	1	0	0	0	0
DUB	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	0	0
	M3	0	0	1	1	0	0	0	0
ECU	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	0	0
	M3	0	0	1	1	0	0	0	0
IRH	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	0	0
	M3	0	0	1	1	0	0	0	0
IRL	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	0	0
	M3	0	0	1	1	0	0	0	0
KUT	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	0	0
	M3	0	0	1	1	0	0	0	0
LIB	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	0	0
	M3	0	0	1	1	0	0	0	0
NGB	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	0	0
	M3	0	0	1	1	0	0	0	0
NGE	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	0	0
	M3	0	0	1	1	0	0	0	0
DUK	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	0	0
	M3	0	0	1	1	0	0	0	0
SAH	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	0	0
	M3	0	0	1	1	0	0	0	0
SAL	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	0	0
	M3	0	0	1	1	0	0	0	0
SAM	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	0	0
	M3	0	0	1	1	0	0	0	0
VEN	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	0	0
	M3	0	0	1	1	0	0	0	0

Trace and Max-Eig values for PIP stock prices and non-OPEC crude prices

	STOCK	EEP		EP		ETP		KMP	
CRUDE		Trace	Max-Eig	Trace	Max-Eig	Trace	Max-Eig	Trace	Max-Eig
AUS	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	1	1
	M3	0	0	0	0	0	0	0	0
CAM	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	1	1
	M3	0	0	0	0	0	0	0	0
CAP	M1	0	0	0	0	0	0	0	0
	M2	1	0	0	0	0	0	1	1
	M3	0	0	0	0	0	0	0	0
CHI	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	1	1
	M3	0	0	0	0	0	0	0	0
COL	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	1	1
	M3	0	0	0	0	0	0	0	0
EGS	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	1	1
	M3	0	0	0	0	0	0	0	0
INO	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	1	1
	M3	0	0	0	0	0	0	0	0
TAP	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	1	1
	M3	0	0	0	0	0	0	0	0
MXI	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	1	1
	M3	0	0	0	0	0	0	0	0
MXM	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	1	1
	M3	0	0	0	0	0	0	1	0
NOE	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	1	1
	M3	0	0	0	0	0	0	0	0
OMN	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	1	1
	M3	0	0	0	0	0	0	0	0
RUS	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	1	1
	M3	0	0	0	0	0	0	0	0
BRT	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	1	1
	M3	0	0	0	0	0	0	0	0

Continued

	STOCK	WMB		TCLP		PAA		OKS	
CRUDE		Trace	Max-Eig	Trace	Max-Eig	Trace	Max-Eig	Trace	Max-Eig
AUS	M1	0	0	0	0	1	1	0	0
	M2	0	0	0	0	0	0	0	0
	M3	0	0	1	1	0	0	0	0
CAM	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	1	0	0	0
	M3	0	0	1	1	0	0	0	0
CAP	M1	0	0	0	0	0	1	0	0
	M2	0	0	0	0	1	1	0	0
	M3	0	0	1	1	1	0	0	0
CHI	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	0	0
	M3	0	0	1	1	0	0	0	0
COL	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	0	0
	M3	0	0	1	1	0	0	0	0
EGS	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	0	0
	M3	0	0	1	1	0	0	0	0
INO	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	0	0
	M3	0	0	1	1	0	0	0	0
TAP	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	0	0
	M3	0	0	1	1	0	0	0	0
MXI	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	0	0
	M3	0	0	1	1	0	0	0	0
MXM	M1	0	0	0	0	1	0	0	0
	M2	0	0	0	0	1	1	0	0
	M3	0	0	1	1	0	0	0	0
NOE	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	0	0
	M3	0	0	1	1	0	0	0	0
OMN	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	0	0
	M3	0	0	1	1	0	0	0	0
RUS	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	0	0
	M3	0	0	1	1	0	0	0	0
BRT	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	0	0
	M3	0	0	1	1	0	0	0	0

Trace and Max-Eig values for RM stock prices and non-OPEC crude prices

	STOCK	HES		IMO		MRO		MUR	
CRUDE		Trace	Max-Eig	Trace	Max-Eig	Trace	Max-Eig	Trace	Max-Eig
AUS	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	0	0
	M3	0	0	0	0	0	0	0	0
CAM	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	0	0
	M3	0	0	0	0	0	0	0	0
CAP	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	0	0
	M3	0	0	0	0	0	0	0	0
CHI	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	0	0
	M3	0	0	0	0	0	0	0	0
COL	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	0	0
	M3	0	0	0	0	0	0	0	0
EGS	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	0	0
	M3	0	0	0	0	0	0	0	0
INO	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	0	0
	M3	0	0	0	0	0	0	0	0
TAP	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	0	0
	M3	0	0	0	0	0	0	0	0
MXI	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	0	0
	M3	0	0	0	0	0	0	0	0
MXM	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	0	0
	M3	0	0	0	0	0	0	0	0
NOE	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	0	0
	M3	0	0	0	0	0	0	0	0
OMN	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	0	0
	M3	0	0	0	0	0	0	0	0
RUS	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	0	0
	M3	0	0	0	0	0	0	0	0
BRT	M1	0	0	0	0	0	0	0	0
	M2	0	0	0	0	0	0	0	0
	M3	0	0	0	0	0	0	0	0

Continued

	STOCK	SUN		TSO		HOC		SSL	
CRUDE		Trace	Max-Eig	Trace	Max-Eig	Trace	Max-Eig	Trace	Max-Eig
AUS	M1	0	0	0	0	0	0	1	1
	M2	0	0	0	0	0	0	1	1
	M3	0	0	0	0	0	0	1	1
CAM	M1	0	0	0	0	0	0	1	1
	M2	0	0	0	0	0	0	1	1
	M3	0	0	0	0	0	0	1	1
CAP	M1	0	0	0	0	0	0	1	1
	M2	0	0	0	0	0	0	1	1
	M3	0	0	0	0	0	0	1	1
CHI	M1	0	0	0	0	0	0	1	1
	M2	0	0	0	0	0	0	1	1
	M3	0	0	0	0	0	0	1	1
COL	M1	0	0	0	0	0	0	1	1
	M2	0	0	0	0	0	0	1	1
	M3	0	0	0	0	0	0	1	1
EGS	M1	0	0	0	0	0	0	1	1
	M2	0	0	0	0	0	0	1	1
	M3	0	0	0	0	0	0	1	1
INO	M1	0	0	0	0	0	0	1	1
	M2	0	0	0	0	0	0	1	1
	M3	0	0	0	0	0	0	1	1
TAP	M1	0	0	0	0	0	0	1	1
	M2	0	0	0	0	0	0	1	1
	M3	0	0	0	0	0	0	1	1
MXI	M1	0	0	0	0	0	0	1	1
	M2	0	0	0	0	0	0	1	1
	M3	0	0	0	0	0	0	1	1
MXM	M1	0	0	0	0	0	0	1	1
	M2	0	0	0	0	0	0	1	1
	M3	0	0	0	0	0	0	1	1
NOE	M1	0	0	0	0	0	0	1	1
	M2	0	0	0	0	0	0	1	1
	M3	0	0	0	0	0	0	1	1
OMN	M1	0	0	0	0	0	0	1	1
	M2	0	0	0	0	0	0	1	1
	M3	0	0	0	0	0	0	1	1
RUS	M1	0	0	0	0	0	0	1	1
	M2	0	0	0	0	0	0	1	1
	M3	0	0	0	0	0	0	1	1
BRT	M1	0	0	0	0	0	0	1	1
	M2	0	0	0	0	0	0	1	1
	M3	0	0	0	0	0	0	1	1

Appendix 12: Summary of news items covered.

Notes: the actual list of the news items covered can be downloaded from the Energy Information Administration's website at: www.eia.doe.gov.

◄ Numbers represents the major oil producing regions:
(2) Middle East. (3) North Africa. (4) Sub-Saharan Africa. (5) North America. (6) South America. (7) Asia. (8) Europe.

* Litters indicate news categories as follow:
Military conflicts. (B) Labour and social. (C) Political. (D) Environmental and Weather. (E) Economic and Business.

‡ Sources of news are represented as follow:
Associated Press (AP). Bloomberg. Deutsche Welle (DW). Down Jones (DJ). Dep. of interior Mineral Management Service (MMS). Financial Times (FT). Global Insight (GI). International Oil Daily (IOD). Lloyd's List. Los Angeles Times (LAT). The New York Times (NYT). The Wall Street Journal (WSJ). The Washington Post (WP). World Markets Research Centre (WMRC).

Date	Topic	Key words	Region◄	Category*	Source‡
1997					
Feb. 5	Japan Oil Import	Japan - Oil -Tariffs	2, 7	E	DJ
Feb. 24	Qatar Natural Gas	Qatar-LNG	2	E	DJ
Apr. 1	Shell Oil Company	Nigeria- Bony crude - protest	4, 8	E	DJ
May. 16	Caspian Pipeline	Russia - British Gas - Black Sea	8	E	DJ
May. 20	US energy investment	Burma- oil -gas- power	7, 5	E	DJ
Jun. 4	UN's oil for food program	Iraq-UN -Food- Oil	2, 5	C, E	WP
Jul. 22	Kazakstan's oil export	Russia - Black Sea- Export	7, 8	E	DJ
Jul. 23	Turkey's purchase of Iran's Gas	Iran-Turkey- Sanction	2, 8	C, E	DJ
Aug. 4	Colombia National Oil Company	force majeure- oil- attacks	6	A, E	DJ
Aug. 8	UN's oil for food program	Price-Iraq-Gulf	2	C, E	DJ
Sep. 12	UN Security council	Iraq-US- UN	2	C, E	DJ
Oct. 29	Iraqi Government	US - UN - Iraq	2	C, E	DJ
Nov. 20	Iraqi Government	US - UN - Iraq	2	C, E	DJ
Nov. 29	OPEC production increase	OPEC-quota- Saudi - Iran	2, 3, 6	E	NYT
Dec. 4	Iraq-UN relationship	Oil-food-Kofi Annan	2	C, E	WP, NYT
Dec. 11	Kyoto Climate Conference	greenhouse- US-Japan	1	D	DJ
1998					
Jan. 7	Asian Economic crisis	S. Korea- refiner - oil supply	7	E	DJ
Jan. 15	Antarctic protection	fresh water- oil - exploration	5, 8	D, E	WP

Feb. 5	US oil exploration	native American - judge - oil	5	D, E	DJ
Feb. 20	UN oil-for-food program	Iraq- oil- export	2	C, E	DJ
Mar. 31	OPEC meeting	production cut- Saudi - Iran	1	E	DJ, WSJ, NYT
May. 4	Atlantic Richfield Company	acquire- Kazakhstan- oil-gas	2, 5, 8	E	NYT, WSJ
May. 11	India Nuclear Tests	Pakistan- India- underground	2, 7	C	WP, DJ
Jun. 19	UN oil-for-food program	Iraq- oil production- spare parts	2	C, E	NYT, DJ
Jun. 24	OPEC meeting	oil production- Russia- Oman	1	E	WSJ, NYT
Aug. 11	BP acquires Amoco	largest oil merger-take over	all	E	NYT, WSJ, WP
Oct. 1	S. Korea's oil refining sector	deregulation- foreign investment	7	E	DJ
Oct. 7	EU and car makers relationship	emission- carbon dioxide	8	D, E	WP
Oct. 28	Nippon Oil Company	Japan - Oil -merger	7	E	WSJ
Dec. 2	Exxon buys Mobil	Oil- Largest- profit	all	E	DJ
Dec. 23	Colombian gasoline pricing	float-gasoline-diesel-price fixing	6	E	DJ
1999					
Jan. 1	BP-Amoco merger	US- Largest- gasoline stations	all	E	DJ
Feb. 4	Eni and Gazprom build pipeline	Russia-Turkey-Italy-Black Sea	2, 8	E	Asian WSJ
Feb. 10	US energy	US- Saudi - gas- oil - investment	2, 5	C, E	DJ, WSJ
Mar. 23	Oil prices	OPEC- non OPEC - oil out put	1	E	NYT
Mar. 31	BP Amoco buys Arco	merger- energy company - US	all	E	DJ, WSJ
Apr. 5	Pan Am Flight 103	Libya- UN - oil production	2, 5, 8	C, E	DJ
Apr. 15	US Energy	strategic reserve - Gulf - Mexico	5	E	DJ
Apr. 17	Oil Pipeline	Azerbaijan - Georgia - Caspian Sea	2, 8	E	DJ
Apr. 28	US-Iran relationship	Mobil- crude swap - Treasury Office	2, 5	C, E	DJ, WP
May. 1	US emission cuts	emission- US- SUV – EPA	5, 8	D	DJ
May. 10	YPF Oil Company	Argentina - Spanish - oil - Repsol	6, 8	E	WSJ
May. 12	Caspian Pipeline	Novorossisk - Russian - capacity	2, 8	E	DJ
May. 17	Environmental issues	EPA- emission- sulfur	5, 8	D	DJ
May. 27	Exxon-Mobil merger	shareholder-European-Chairman	all	E	DJ
Jun. 1	Sudan oil exports	Kordofan-pipeline-Red Sea	2, 3, 4	E	DJ

Aug. 9	US Dep. Of Commerce	Saudi- ani-dumping - investigation	2, 5	E	DJ, WP, NYT
Sep. 14	Total Fina and Elf Aquitaine merger	merger- oil - takeover	all	E	WP, WSJ
Sep. 22	OPEC meeting	crude oil - Lukman – Saudi	1	C, E	DJ
Sep. 28	Iranian oil industry	oilfield - crude oil – barrel	2	C, E	DJ
Sep. 30	Japan nuclear accidents	uranium - processing plant	7	D	DJ, WSJ
Oct. 4	UN-Iraqi oil-for-food program	UN - calling-adjustment	2	C, E	DJ
Nov. 18	Caspian Pipeline	Turkey - Azerbajan – Georgia	2, 8	E	WP, NYT
Nov. 30	Exxon Mobil merger	approval - FTC – refinery	all	E	DJ
Dec. 10	Environmental issues	California - sulfur – gasoline	9, 8	D	WSJ
Dec. 21	Export-Import Bank	Russia- oil - bankruptcy	8	E	DJ
Dec. 31	Panama Canal Zone	petroleum - American - sovereignty	6	C, E	DJ
Dec. 31	The Sable Offshore Project	ExxonMobil - gas - Nova Scotia	5	E	DJ
Dec. 31	Russian Politics	Yeltsin - resign - Putin - State Duma	8	C, E	DJ
2000					
Jan. 7	Y2K Bug	Energy - control system - problem	all	E	DJ, WP
Jan. 26	UN appointment of Blix	Iraq- IAEA - weapon inspection	2	C	DJ
Feb. 2	BP Amoco merger	restrict competition - west cost	all	E	WSJ, WP
Feb. 9	Interstate natural gas pipeline	FERC - policy changes - deregulation	5	E	DJ
Mar. 6	Regulations	US - Supreme Court - oil tankers	5	E	WP, NYT
Mar. 7	Oil futures market	WTI - NYMEX - highest - barrel	all	E	WSJ
Mar. 15	Phillips Petroleum purchase	Atlantic Richfield - Alaska - BP Amoco	all	E	DJ, NYT, WSJ
Mar. 20	US Energy policy	Clinton - MTBE - gasoline -additive	5	D	DJ
Mar. 26	Russian Politics	Putin - Yeltsin - resignation	8	C	DJ
Mar. 28	OPEC meeting	Saudi - UN - Mexico - Norway	1	E	DJ
Apr. 12	Saudi and major oil firms meeting	tax rate - package - ownership	all	E	WP
Apr. 14	BP Amoco	FTC - Atlantic Richfield - approval	all	E	WP, WSJ
May. 16	Major oil find in Kazakhstan	Kashagan - offshore - Baku-Ceyhan	5, 8	E	WP, DJ
May. 17	Environmental issues	EPA - sulfur - diesel	5, 8	D	DJ

		fuel			
May. 17	Arctic oil reserves	National Wildlife Refuge - recoverable	5, 8	D, E	WSJ
Jun. 6	Chad-Cameroon pipeline loan	World Bank - oil - project	4	B, E	DJ
Jun. 8	Brazilian oil exploration	oil - production - auction - books	6	E	NYT
Jun. 9	US and Mexico cooperation	Gulf of Mexico - deepwater - doughnut	5, 6	E	DJ
Jun. 15	German Energy plans	nuclear - utilities - fossil fuel	8	E	DJ
Jun. 19	Prices of gasoline	EIA - Midwest - price rise	all	E	DJ
Jun. 21	OPEC meeting	Vienna - production quotas - NYMEX	1	E	DJ
Jul. 12	Saudi-Kuwaiti treaty	offshore - mineral rights - Khafji - Dorra	2	C, E	DJ
Jul. 27	ENI and Iranian deal	South Pars gas field - operational	2	C, E	DJ
Jul. 30	Venezuelan politics	Chavez - reelection - vote	6	C	DJ
Aug. 10	Iraqi -Venezuelan relationship	Chavez - Saddam - Baghdad - OPEC	1	C, E	NYT, WP
Aug. 23	EIA reporting on oil stock levels	US - crude oil - lowest - NYMEX	all	E	DJ
Aug. 30	US Dep. of Energy	contracts - heating oil - Woodbridge	5	E	DJ
Sep. 8	Britain truck drivers	blockade - oil refineries - France	8	B, E	DJ
Sep. 10	OPEC meeting	OPEC - Vienna - production - quota	1	E	DJ
Sep. 20	Oil price raise	NYMEX - Iraq - Kuwait - tensions	all	E	DJ
Sep. 22	US strategic Petroleum Reserve	Clinton - swap - heating oil - delivery	5	E	DJ
Sep. 26	OPEC meeting	OPEC - production - quota	1	E	DJ
Sep. 28	Iraq-Kuwait relationship	UN - invasion - claim - oil sale	2	C, E	DJ
Oct. 12	Oil prices	US - warship - Yemeni - NYMEX	all	E	WSJ
Oct. 15	Chevron purchase of Texaco	deal - merger - oil - gas - antitrust	all	E	WSJ
Oct. 30	OPEC production increase	price band - quota - spare production	1	E	DJ, WP, WSJ
Oct. 31	UN - Iraqi oil-for-food program	Euro - oil - invasion - Kuwait	2	C, E	DJ
Nov. 3	Lukoil company	Russia - Getty Petroleum - takeover	8	E	DJ
Nov. 12	OPEC meeting	OPEC - price band - Basket of crudes	1	E	NYT, WSJ
Nov. 16	Iraq oil production	oil - marketing - cargoes - UN	2	B, E	DJ
Nov. 26	Kyoto Protocol	carbon - the Hague -	5, 7, 8	D	WP, WSJ,

		emissions trading			NYT
Dec. 1	Mexico politics	Fox- Petroleum - Ernesto Martens	6	C	DJ
Dec. 4	Energy shortages in California	utilities - hydroelectric - nuclear	5	B, E	DJ
Dec. 5	UN oil-for-food program	six month extension - Security Council	2	C	DJ
Dec. 16	Chernobyl nuclear power plant	Ukraine - major accident - damaged	8	D	DJ
Dec. 21	Sulfur content in fuel	diesel - EPA - new regulation - Oil	5, 8	D	DJ
Dec. 27	Natural gas prices in the US	cold weather- stock draws - US	5	D, E	DJ
Dec. 27	Venezuelan politics	Chavez - Calderon - Minister - Petroleum	6	C	DJ
Dec. 31	OPEC production cuts	Naimi - Vienna - inflation - basket	1	E	DJ
2001					
Jan. 10	Arctic oil reserves	Clinton - White House - ANWR - drilling	8, 5	D, E	DJ
Jan. 17	OPEC meeting	Vienna - production quotas - capacity	1	E	NYT, WP
Jan. 20	US Politics	Bush - sworn - President - Energy	5	C	WP
Feb. 20	Environmental issues	Supreme court - major oil companies	5	D	DJ, WSJ
Feb. 28	Environmental issues	EPA - Clinton - sulfur - diesel fuel	5	D	DJ
Mar. 4	Kashagan oil field	Caspian Sea - tests - Tengiz field	2, 8	E	WSJ
Mar. 6	US Energy	US - heating oil - Abraham - reserve	5	E	US Dep. of Energy
Mar. 15	Brazilian oil exploration	oil rig - offshore - explosion - platform	6	D, E	WSJ
Mar. 17	OPEC meeting	cut - price collapse - weakening demand	1	E	WSJ
Mar. 26	Kazakstan's oil export	Prime Minister - pipeline - Tengiz field	2, 8	E	NYT
Apr. 17	US oil exploration	seabed - Gulf of Mexico - auction	5	E	USAT
Apr. 30	US Energy policy	fossil fuels - nuclear power - coal -oil	5	E	WSJ, USAT
May. 17	US Energy policy	Bush - oil -gas - electricity grid	5	E	LAT, WP, WSJ
May. 18	Saudi and major oil firms meeting	gas initiative - ExxonMobil - BP	all	E	WMO
May. 21	Enron Corporation	India - power generating - venture	5, 7	E	WSJ
May. 29	Natural gas futures market	plunge - growth - British thermal unit	all	E	LAT
Jun. 3	Iraqi Government	crude oil export - UN - OPEC	1	E	NYT
Jun. 5	OPEC meeting	OPEC - oil - quota -	1	E	LAT

		suspension			
Jun. 7	BP oil exploration	Trinidad - platform - offshore	6	E	DJ
Jun. 11	Saudi oil industry	ownership - Red Sea - asset - pipeline	2	E	DJ
Jun. 15	ExxonMobil and Qatar Petroleum	sign - letter of intent - plant	all	E	OD
Jun. 30	Eni oil exploration	Iran - Darquain - foreign	2	E	LAT
Jul. 2	UN and Iraq	Security Council - Russian - export	2	C	WSJ
Jul. 3	OPEC meeting	OPEC - quota - cut - production	1	E	WP
Jul. 5	Australia and East Timor	oil - gas -royalties - Indonesia	7	E	WSJ
Jul. 10	Amerada Hess acquire Triton Energy	West Africa - Latin America - exploration	all	E	DJ
Jul. 11	Iraq oil production	food - oil – halt	2	C, E	NYT
Jul. 24	Iranian threaten BP	warship - Caspian - vessels - Baku	2	A	NYT
Jul. 25	OPEC meeting	price - basket - declining - futures	1	E	DJ
Jul. 26	Indonesian politics	Wahid - successor - Sukarnoputri	7	C	AP
Aug. 3	US Sanctions on Libya and Iran	investment - Act - Bush - petroleum	2, 5	C, E	NYT
Aug. 10	UN - Iraqi relationship	capacity - oil - Annan - investment	2	C, E	WMO
Sep. 7	Chevron purchase of Texaco	approves - Equilon - Motiva	all	E	DJ
Sep. 11	9-11 terrorist attack	World Trade Center - Pentagon - aviation	all	A, C, E	NYT
Sep. 13	Crude Oil Market	gasoline - Brent - energy - Houston	all	E	WMO
Sep. 17	Crude Oil Market	NYMEX - trading - reopen	all	E	NYT
Sept. 24	Oil futures market	crude oil - demand - NYMEX - delivery	all	E	NYT, DJ
Sep. 27	OPEC meeting	OPEC - Vienna - production - quota	1	E	NYT
Oct. 7	Crude Oil Market	trans-Alaska - pipeline - mischief	all	E	DJ
Oct. 15	Kazakstan's oil export	tanker - loading - pipeline - Caspian	2	E	Reuters
Oct. 16	US Energy politics	Coast Guard - ban - LNG - tanker	5	E	Reuters
Oct. 18	Oil Market	delivery - NYMEX - London - Light - sweet	all	E	OD
Oct. 29	Russian oil fields development	ExxonMobil - offshore - oil -gas	5, 8	E	WSJ, NYT
Nov. 6	Crude Oil Market	NYMEX - OPEC-exporters - spiral	1	E	NYT
Nov. 9	Enron Corporation	electricity -natural gas – Dynegy	5	E	WMO

Nov. 10	Kyoto implementation	Morocco - agreement - climate change	5, 7, 8	D	OD
Nov. 13	US strategic Petroleum Reserve	Bush - capacity - shortages - disruption	5	E	Reuters
Nov. 14	OPEC meeting	OPEC - Vienna - production - quota	1	E	DJ
Nov. 18	Phillips-Conoco merger	US - gasoline - reserves – refiner	all	E	NYT
Nov. 29	UN Security council	dual use - Iraq - oil-for-food	2		WP, DJ
Dec. 2	Enron bankruptcy	Chapter 11 - Dynegy - merger - lawsuit	5		DJ
Dec. 26	Crude Oil Market	NYMEX - weekend - OPEC -price	all	C, E	NYT
Dec. 28	OPEC meeting	Cairo -output -Oman – Norway	1	E	DJ, Reuters
2002					
Jan. 1	OPEC meeting	OPEC - production – quota	1	E	Reuters
Jan. 9	US Energy policy	Abraham - vehicles - new generation	5	D	WP, NYT
Jan. 22	US Energy dep.	bidding - royalty-in-kind - Bush	5	E	Reuters
Jan. 29	US Politics	Bush - union - Iran - Iraq	5	C	NYT
Feb. 13	UN - Iraqi relationship	inspection - weapons - action	2, 5	C	Reuters
Mar. 6	non-OPEC meeting	Mexico - Norway - Oman - Gulf	1	E	Reuters
Mar. 7	Crude Oil Market	NYMEX - Light - sweet - OPEC - Sep. 11	all	E	OD
Mar. 12	Phillips-Conoco merger	shareholder- oil - refiner - equivalent	all	E	AP
Mar. 15	OPEC meeting	Vienna - quota - restriction	1	E	NYT
Mar. 20	Russia oil production	oil - cut - non-OPEC - cooperative	8	E	NYT
Apr. 1	India energy sector	natural gas - kerosene - downstream	7	E	Reuters
Apr. 2	Royal Dutch/Shell	Enterprise Oil -cash - North Sea	8	E	NYT
Apr. 3	Venezuela Oil Production	shipment - synthetic crude - refinery	6	E	Reuters
Apr. 4	Angola stability	National Union - Army - demobilization	4	A	NYT
Apr. 5	Venezuela Oil Production	workers - terminals - Chavez -refining	6	C, E	AP
Apr. 8	Iraqi oil-for-food program	OPEC - exports - Palestinians' struggle	1, 2	C, E	WSJ
Apr. 9	Venezuela Politics	military - factories - Chavez - strike	6	A, C, E	WP, WSJ, Reuters, AP
Apr. 24	Caspian Pipeline	summit - leaders -five states	2, 8	E	Reuters
May. 8	Iraq oil production	crude oil - export	2	C, E	Reuters

		terminals - proposals			
May. 14	Iraqi oil-for-food program	Council - UN - suppliers - revenues	2	C, E	Reuters
May. 17	Russian Politics	OPEC - export cut - quarter	1, 8	C, E	WMRC
May. 24	US-Russian relationship	Bush - Putin - energy - partnership	5, 8	C, E	NYT
May. 28	US Energy Policy	buy back lease - oil -gas	5	E	OD
Jun. 20	Norway oil production	restriction - oil - OPEC	1, 8	E	Reuters
Jun. 25	Russian oil production	OPEC - oil - capacity	1, 8	E	Reuters
Jun. 26	OPEC meeting	Vienna - Iraq - quota	1	E	NYT, DJ
Jun. 27	OPEC and Mexico cooperation	agreement - exports - national	2, 6	E	Reuters
Jun. 29	non-OPEC oil production	Oman - oil -gas - production	1, 2	E	Reuters
Jul. 1	Environmental issues	California - dioxide - automobile	5	D	LAT
Jul. 3	Oil tanker Astro Lupus	Yukos - Houston - Russia - crude	8	E	NYT, WMRC, OD
Jul. 26	US strategic Petroleum Reserve	royalty-in-kind - leases - Energy	5	C, E	OD
Jul. 31	ChevronTexaco oil production	Nigeria - force majeure - protests	4	E	DJ
Aug. 2	US environmental issues	diesel engines - new rules - trucks - buses	5	D	NYT
Aug. 7	Mexico Energy Policy	non-OPEC - limit -cartel	6	E	Reuters
Aug. 20	Crude Oil Market	NYMEX - conflict -OPEC	all	E	Reuters
Aug. 29	US -UN -Iraq relationships	Cheney - weapons – chemical	2	C, E	WP
Sep. 11	Global oil stock level	IEA - monthly - low – higher	all	E	DJ
Sep. 11	EU crude oil reserves	Plan - Energy - Commission	8	E	Reuters
Sep. 12	US -UN -Iraq relationships	Council - UN - Bush – demands	2	C, E	Reuters
Sep. 13	World Bank	pipeline -Chad - Cameroon	4	B, E	Reuters
Sep. 18	Baku-Ceyhan Pipeline	BP - Caspian Sea – Turkey	2, 8	B, E	Reuters
Sep. 18	US -UN -Iraq relationships	oil-for-food - surcharges - illegal	2	C, E	DJ
Sep. 19	OPEC meeting	Osaka - Basket -Nigeria –quotas	4	B	DJ
Oct. 3	Environmental issues	Hurricane Lili - Gulf – offshore	5	D	Reuters
Oct. 6	Terrorist attack	French - tanker - Malaysian - boat	2, 8	A	Reuters, DJ
Oct. 9	US energy	EIA - information – Inventory	5	E	Reuters
Oct. 11	US Politics	Bush - senate - Saddam - biological	5, 2	C, E	Reuters
Nov. 1	Trans-Balkan Pipeline	Russia - Greece - Bulgaria	8	B, E	Reuters

Nov. 8	UN - Iraqi relationship	Council - weapons - resolution 1441	2	C, E	Reuters
Nov. 13	UN - Iraqi relationship	UN - Kofi - Council - weapons	2	C, E	AP
Nov. 14	ChevronTexaco oil production	TengizChevroil - Kazakhstan - project	2, 8	E	WMRC
Nov. 15	US strategic Petroleum Reserve	stockpile - energy - crude oil	5	E	Reuters
Nov. 18	Environmental issues	tanker -splits - Russian fuel oil	8	D	WSJ, WP
Nov. 26	Murphy Oil	Kikeh field - Asia - Borneo	7	E	WMRC
Nov. 27	Russia oil production	Lukoil - Yukos - agreement	8	E	WSJ
Dec. 2	Venezuela oil production	strike - PdVSA - Chavez	6	B, E	Reuters
Dec. 4	UN-Iraqi oil-for-food program	renewed - six months - oil	2	C, E	Reuters
Dec. 12	Iraqi oil production	cancel - contract – Russian	2	C, E	NYT
Dec. 12	OPEC meeting	OPEC - Vienna - production - quota	1	E	LAT
Dec. 16	Crude Oil Market	NYMEX - Venezuela – strike	all	B, E	WSJ, AP
Dec. 17	US Dep. of Energy	Energy - reserve - oil	5	E	Reuters
Dec. 19	UN-US-Iraq relationship	Powell - material breach - mass	2, 5	C, E	Reuters
Dec. 28	Venezuela Oil Production	Brazil - gasoline - strike	6	B,E	WSJ
2003					
Jan. 6	Venezuela Oil Production	split - energy - power – strike	6	B, E	NYT
Jan. 12	OPEC meeting	Vienna -quota - raise	1	E	NYT
Jan. 16	Chicago Climate Exchange	US -emission - reduction	5	D	WP
Jan. 21	Oil futures market	NYMEX - Venezuela – stock	all	B, E	USAT
Jan. 28	US Dep. of Energy	delivery - shipments – energy	5	E	Reuters
Jan. 29	Venezuela Oil Production	PdVSA - striking - surpassed	6	B, E	NYT, Reuters
Jan. 29	US Energy politics	Bush - hydrogen-powered - union	5	D, E	Reuters
Feb. 3	Indian Energy	boost - reserves - crude -strategic	7	E	Reuters
Feb. 6	Iranian Natural Gas Production	Pars natural gas field - cubic - on-line	2	E	DJ
Feb. 11	BP oil exploration	Russia - TNK - Sidanco	8	E	Reuters
Feb. 12	US Energy data	oil stocks - inventory - shortages	5	E	Reuters
Feb. 18	ExxonMobil and Angolan project	Kizomba B - offshore - stakeholders	4	E	Reuters
Feb. 28	Oil futures market	NYMEX - heating oil -	all	E	Reuters

		price - fuel			
Mar. 5	Venezuela oil production	PdVSA - striking - bottlenecks	6	B, E	Reuters
Mar. 6	Venezuela oil production	Chavez - exports – strike	6	B, E	Reuters
Mar. 7	Oil futures market	NYMEX - light - sweet - MMBtu	all	E	Reuters
Mar. 7	Environmental issues	EPA - regulation – water	5, 7, 8	D	NYT
Mar. 11	OPEC meeting	Vienna - crude oil - Saudi - capacity	1	E	NYT, Reuters
Mar. 12	Oil futures market	NYMEX - barrels - shortages	all	E	WSJ
Mar. 19	Iraqi military action	Kuwait - Saddam - regime - US	2	C, E	Reuters
Mar. 23	Violence in Niger Delta	soldiers - Shell - militants	4	A, C, E	NYT, Reuters
Mar. 24	US-Iraqi war	coalition - wellhead - Kuwaiti	2, 5	A, C, E	Reuters, DJ
Apr. 4	US-Iraqi war	coalition - Baghdad - airport -facilities	2, 5	A, C, E	Reuters
Apr. 8	Syrian oil production	crude oil - shut down - Lebanon	2	C	WMRC
Apr. 14	Iraqi oil production	Turkish - Kirkuk - oilfield	2	E	Reuters
Apr. 14	Japan Energy Market	inspection - shuts down - reactor	7	D, E	Japan Times
Apr. 15	US-Iraqi war	Rumsfeld - Syria - pipeline	2	A	Reuters
Apr. 22	Yukos Oil company	merge - gas - major	8	E	NYT, WSJ
Apr. 23	Iraq oil production	American - restarting - crude oil	2	E	WSJ
Apr. 24	OPEC meeting	reduce - excess - quota	1	E	LAT
Apr. 29	Brazilian oil exploration	Petrobras - discovery - gas	6	E	Reuters
May. 22	US-Iraq relationship	sanctions - invasion - Treasury	2	B, C	WP
May. 28	Russia and China relationship	Yukos - CNPC - China - Siberia	7, 8	C, E	Reuters
Jun. 2	Russia's natural gas production	Japanese - TEPCO - Sakhalin	7, 8	E	NYT
Jun. 10	US energy industry	Greenspan - natural gas - Prices	5	E	Reuters
Jun. 11	OPEC meeting	Qatar - energy - industry	1	E	Reuters, DJ
Jun. 12	Iraqi oil production	explosions - Kirkuk-Ceyhan oil pipeline	2	A, C, E	Reuters, AP
Jun. 14	ConocoPhillips natural gas production	Bayu-Undan fields - Timor Sea - LNG	7	E	WSJ, NYT
Jun . 17	Iraqi oil production	Qazzaz - pipeline - pumping station	2	E	WSJ
Jun. 22	Iraqi oil production	Saddam - oil - Ceyhan - refiners	2	E	WP
Jul. 2	Environmental issues	Kyoto -dioxide -	5, 7, 8	D	Reuters

		ceramics - emissions			
Jul. 9	Chad-Cameroon pipeline loan	crude - project - pipeline	4	B, E	Reuters
Jul. 12	Russia and Japan relationship	Sakhalin - Investment - drilling - gas	7, 8	C, E	DJ
Jul. 15	Eilat-Ashkelon pipeline	Russian - tanker - Red Sea	2, 8	C, E	Reuters
Jul. 15	Hurricane Claudette	Texas - Mexico - Minerals	6	D, E	Reuters
Jul. 16	Eni oil exploration	Black Sea -pipeline - Karachaganak	2, 8	E	DJ
Jul. 16	Saudi Natural Gas production	Empty Quarter - western - core ventures	2, 5, 7, 8	E	Reuters
Jul. 25	Natural gas	LNG - Dominion - facility - owner	all	E	WP
Jul. 31	OPEC meeting	keep - quota - regime - Iraq	1	A, C, E	WSJ
Aug. 7	Iraqi oil production	sector -war - exports	2	A, C, E	LAT
Aug. 14	Lockerbi airplane bombing	Libya - US - sanctions	2, 5, 8	C	WMRC
Aug. 14	US power blackout	northeastern - New York - Abraham	5	E	NYT, WSJ, AP
Aug. 14	Yukos and Sibneft merger	supermajor - Russia - oil	8	E	WMRC
Aug. 15	Iraqi oil production	Kirkuk - Ceyhan - pipeline	2	A, C, E	WMRC
Sep. 1	Iraqi oil production	exile - post-war - Council	2	A, C, E	Reuters
Sep. 10	Natural Gas Project	Bank - Peru - Camisea fields	6	B, E	DJ, WP, WMRC, EIA
Sep. 11	Cameron natural gas production	Energy - commission - Louisiana	4	B,E	NYT
Sep. 12	UN sanction in Libya	11-year - oil - sizeable - resources	2	C, E	AP
Sep. 19	Iran oil production	Japanese - Iran - deal - Azadegan	2	E	Platts
Sep. 24	OPEC meeting	cut - members -world - oil	1	E	Reuters
Sep. 30	Emission trading	Chicago - Exchange - allowances	5, 7, 8	D	WMRC
Oct. 3	Chad-Cameroon pipeline	onstream - World Bank - Sub-Saharan	4	B, E	NYT
Oct. 4	Yukos and Sibneft merger	producer - creating - deal	all	E	WP
Oct. 14	Bolivians protests	natural gas- export - cubic feet	6	E	WSJ, WP, NYT
Nov. 4	Baku-Tbilisi-Ceyhan Pipeline	lending -private - Turkish	2, 8	B, E	WSJ, EIA, WMRC
Nov. 18	ChevronTexaco oil production	deepwater - liquefied - Gulf - terminal	5, 6	E	WMRC
Nov. 21	UN-Iraqi oil-for-food program	medicine - finance - US - projects	2	C, E	USAT, WMRC
Nov. 24	US Energy	Senate - legislative -	5	C	NYT, WP,

		bill			WSJ
Nov. 28	Yukos - Sibneft merger	suspending - oil - technical	all	E	WP, WSJ
Dec. 2	US nuclear waste	Bush - Yucca - Nevada	5	C, E	AP
Dec. 4	OPEC meeting	Vienna - quota - unchanged	1	E	DJ
Dec. 15	Crude Oil Market	fall - price - Saddam - Tikrit	all	A, C, E	CBS, WMRC
Dec. 18	BP natural gas deal	Sempra - Tangguh - Mexico - Baja	6	E	DJ
Dec. 22	US -Libya relationship	weapons - Treaty - destruction	3	C, E	WMRC , NYT
2004					
Jan. 18	Saudi oil industry	Aramco - Haradh - oil –gas	1, 2	E	Reuters, LAT, Platts
Jan. 22	Alaska's oil reserve	US - Petroleum - production	5	D, E	WP
Feb. 11	OPEC meeting	Algiers - output - ceiling	1, 3	E	NYT, WSJ
Feb. 19	SEC investigate Royal Dutch/Sheel	formal - overstated - reserves	all	E	NYT
Feb. 25	Total and Petronas deal	Iranian - LNG - Russia	2, 8	C, E	WMRC
Feb. 26	US ban on traveling to Libya	sanctions - Rome - oil	3, 5	C	WSJ
Feb. 31	OPEC meeting	cut - members -world – oil	1	E	Reuters
Apr. 21	Saudi oil industry	Riyadh - explodes - producer	1, 2	A, C, E	Reuters, Platts, EIA
May. 22	OPEC meeting	Amsterdam - Saudi - raise	1	E	Reuters
May. 30	Saudi oil industry	attack - Khobar - security	1, 2	A, C, E	Reuters
Jun. 1	Oil futures market	NYMEX - crude - settlement - price	all	E	WSJ
Jun. 3	OPEC meeting	Beirut - production - quotas	1	E	AP
Jun. 4	Libya oil shipment	Lash - secretary - resumption	3, 5	C, E	AP
Jun. 15	French energy industry	Electricite de France - LNG - protest	8	B, E	Reuters
Jul. 15	OPEC meeting	crude oil - raise - target - high	1	E	WSJ
Jul. 22	Yukos Oil company	Russia - bankrupt - exports - oil	8	E	WP
Aug. 9	Russian Energy sector	Yukos - illegal - Yuganskneftegaz	8	E	WP, WSJ
Sep. 14	Hurricane Ivan	Shell - Mexico - tankers - deliveries	6	D, E	Bloomberg, DJ, Reuters
Sep. 20	US Sanctions on Libya	oil - reserves - lifts	3, 5	C	NYT
Sep. 24	Hurricane Ivan	energy -sector - NYMEX	5, 6	D, E	NYT, MMS
Oct. 22	Oil futures market	NYMEX - oil - crude - energy - heating oil	all	E	NYT, CNN

Oct. 28	Russian Politics	cabinet - lower - protocol	8	C	WP, USA Today
Nov. 2	Iraq oil production	infrastructure - Turkey - attack	2	A, C, E	Reuters
Nov. 16	US Politics	senate - illegally - figure	5	C, E	WP
Nov. 22	Ukraine politics	run-off - Kiev - Europe - Russia	8	C, E	NYT, AP
Dec. 5	Nigerian oil industry	Shell - community - spokesman	4	E	WMRC
Dec. 10	OPEC meeting	official - cut - quarterly	1	E	NYT, AP, WP
Dec. 18	Russian oil industry	Yukos - Yugansкneftegaz - subsidiary	8	E	WSJ, NYT
Dec. 20	US nuclear power	Exelon - PSEG - stock - utility	5	E	Reuters
Dec. 26	Tsunami	ocean - tourists - Sri Lanke	7	B, D	NYT, WP, AP, Reuters
Dec. 31	Russian oil industry	approval - pipeline - major - port	8	E	Reuters
2005					
Jan. 5	Nigerian oil industry	Bonny - Shell - deal	4	B, C, E	WMRC, Reuters
Jan. 30	OPEC meeting	production cut- Saudi - Iran	1	E	NYT, AP
Jan. 30	Iraqi oil production	Electoral - bombers - election	2	A, C, E	WP, NYT
Feb. 14	BP oil production	Azerbaijan - pipeline - Turkey	2, 8	E	Reuters, WMRC
Feb. 16	Kyoto Protocol	climate - Bush - Russia	5, 7, 8	D	Reuters, NYT, LATimes
Mar. 1	Iraqi oil production	crude- pipeline - Ceyhan	2, 8	E	WMRC, Reuters
Mar. 16	OPEC meeting	Isfahan - Saudi - Naimi	2	E	OPEC, Reuters, EIA
Mar. 24	BP explosion	blast - WTI - NYMEX	all	D, E	NYT, DJ
May. 20	French energy industry	strike - shuts - Total	8	B, E	DJ
Jun. 15	OPEC meeting	Vienna - quota - production	1	E	FT
Jun. 24	Chinese energy industry	Cnooc - Unocal - acquisition	7	E	DJ, WSJ
Jun. 25	Iran politics	Ahmadinejad - mayor - NIOC	2	C, E	WP
Jun. 27	Oil futures market	NYMEX - WTI - settlement	all	E	Reuters
Jul. 5	Tropical storm Cindy	US - Mexico - WTI	5	D	Bloomberg, MMS
Jul. 8	Angola oil production	strike - offshore - negotiate	4	A, C	Reuters
Jul. 11	Hurricane Dennis	damage - Thunder	5	D, E	DJ

		House - platform			
Jul. 18	Angola oil production	Kizomba B - offshore - oil	4	E	Reuters
Jul. 19	Hurricane Emily	offshore - Mexico - terminals	5	D, E	Reuters, DJ
Jul. 27	Indian Energy	offshore - platform - field	7	E	Lloyd's List, Reuters
Aug. 1	Saudi oil industry	Crown Prince - king-policy	1, 2	C, E	Reuters, DJ, AP
Aug. 5	BP oil production	shuts - sector - facilities - fire	all	E	Reuters
Aug. 15	Ecuador oil production	Protests - shut - occupy - EnCana	6	B, E	WSJ, Reuters, AP, DJ
Aug. 28	Hurricane Katrina	Orleans - MMS - strikes	5	D, E	Reuters, AP, DJ
Sep. 2	US Energy dep.	Bush - Mexico - energy	5	C	DOE, IEA
Sep. 24	Hurricane Rita	landfall - Gulf - Katrina	5	D	DJ, Reuters, AP, DOE
Sep. 27	French energy industry	strike - refinery - complex	8	B	Reuters
Oct. 21	Nigerian oil industry	strike - Brass - shuts	4	B, E	Reuters
Oct. 31	Royal Dutch/Shell	shutdowns - labor - dispute	all	B, E	Reuters
Nov. 3	Royal Dutch/Shell	agreement - stoppage - refinery	all	B, E	Reuters
Nov. 28	Royal Dutch/Shell	Bonga - offshore - natural gas	4	B, E	EIA, Reuters
Dec. 4	Venezuela Oil Production	explosion - pipeline - Paraguana	6	C, E	AP
Dec. 9	OPEC meeting	Kuwait - cut - organization	1	E	Reuters, EIA
Dec. 14	Bosporus Straits	Russia - Asia - world	8	E	Reuters, EIA
Dec. 20	Nigerian oil industry	Niger Delta - bomb - Shell	6	A, E	DJ, EIA
2006					
Jan. 1	Russian Gas supply	Ukraine - cuts - Europe	8	C, E	DJ, Reuters, Eurostat
Jan. 4	US Energy dep.	Katrina - reserve - drawdown	5	D, E	DJ
Jun. 31	OPEC meeting	refining - bottlenecks - quota - EIA	1	E	Reuters, OPEC, EIA
Feb. 8	Saudi oil industry	Haradh - Aramco – capacity	1, 2	E	Reuters, EIA
Feb. 21	Royal Dutch/Shell	force majeure- oil-attacks	4	A, C, E	Reuters, EIA
Feb. 24	Saudi oil industry	attack - Abqaiq – NYMEX	1, 2	A, C, E	CNN, AP
Mar. 2	Alaska's oil reserve	pipeline - Trans-Alaskan - GC-2	5	D, E	DJ, AP

Mar. 8	OPEC meeting	Petroleum - bottlenecks - Vienna	1	E	EIA, Reuters
Apr. 21	Oil futures market	WTI - NYMEX - highest – barrel	all	E	Reuters, DJ, AP
Jun. 1	OPEC meeting	Petroleum - capacity – Iran	1	E	Reuters, EIA
Jun. 19	Environmental issues	Louisiana - Ship – shutoff	5	D, E	DJ, Reuters
Jul. 13	Baku-Tbilisi-Ceyhan Pipeline	Turkish - Caspian Sea – Georgia	2, 8	E	AP, Reuters
Jul. 24	Royal Dutch/Shell	Nigeria -attacks – pipeline	4	A, C, E	EIA, Reuters, GI
Jul. 29	Leak in Russian pipeline	mid-sized - pipeline - Europe	8	D, E	DJ, Reuters, EI
Aug. 7	BP oil production	shuts - Alaska – TAPS	5	D, E	AP, GI
Aug. 29	ExxonMobil oil production	Russia - Japan – DeKastri	7, 8	E	EIA, Reuters
Sep. 5	Chevron deepwater operation	tests - Gulf - ultra-deep	5, 6	D, E	EI, OGJ
Sep. 11	OPEC meeting	Vienna - peak - maintain – ceiling	1	E	EIA, Reuters
Oct. 19	OPEC meeting	cut - Qatar - reduce – output	1	E	Reuters
Dec. 14	OPEC meeting	Abuja - cut –allow	1	E	GI, MEES
Dec. 26	Nigerian oil industry	blast - Lagos – pipeline	4	B, C, E	Reuters
Dec. 31	Nigerian oil industry	EIA - attacks – infrastructure	4	B, C, E	EIA
2007					
Jan. 3	Russian's oil exports	halts - Druzhba – pipeline	8	E	EIA, Reuters
Jan. 7	UK oil production	Buzzard - weather - North Sea	8	E	EIA, GI, IHS Energy
Jan. 23	US Energy	Bush - SPR - Congress – reserve	5	B, E	DOE, Reuters
Feb. 1	OPEC meeting	cuts - Vienna – crude	1	E	EIA, GI
Feb. 6	Canadian oil production	Hibernia - shut down - maintenance	5	E	Reuters
Feb. 6	Occidental Petroleum	natural gas -force majeure - California	5	B, E	Occidentl Petro, DJ
Feb. 16	US Energy	explosion - McKee – refinery	5	D, E	Reuters, GI
Feb. 17	BP oil production	unexpectedly - shuts - Northstar	8	E	Reuters, GI
Mar. 4	Shell Oil Company	shuts -spill- Nigeria	4	B, E	EIA, GI, Reuters
Mar. 8	Australia oil production	cyclones - shut - disrupt	7	D, E	EIA, GI, Reuters
Mar. 14	France energy sector	Marseille - output - natural gas	8		GI, Reuters
Mar. 15	OPEC meeting	Vienna - Angola - quota - unchange	1	E	EIA, GI
Mar. 23	Iranian vessels	British - Gulf -price	2	A	EIA, Reuters

Apr. 4	Iranian vessels	Iraq -Iran - crude - British	2	A	EIA, GI
Apr. 15	Canadian oil production	leak - Enbridge - pipeline	8	D, E	EIA, Reuters, Enbridge
Apr. 23	Nigerian oil industry	Yar'Adua - winner - oil - price	4	C, E	EIA, Reuyers
Apr. 26	Norway oil production	shut - WTI - Kvitebjoern	8	E	EIA, Rigzone
May. 1	Nigerian oil industry	Chevron - shuts - offshore	4	A, C, E	EIA, DJ,GI, Platts, Reuters
May. 4	Nigerian oil industry	Saipem - force majeure - oil	4	A, C, E	EIA, DJ,GI, Platts, Reuters
May. 7	Nigerian oil industry	Protests - Chevron - shut	4	A, C, E	EIA, DJ,GI, Platts, Reuters
May. 8	Nigerian oil industry	Agip - shut - BrassRiver	4	A, C, E	EIA, DJ,GI, Platts, Reuters
May. 10	Nigerian oil industry	Protests - Bomu - pipeline	4	A, C, E	EIA, DJ,GI, Platts, Reuters
May. 28	Nigerian oil industry	Protests - Bomu - pipeline	4	A, C, E	EIA, DJ,GI, Platts, Reuters
May. 28	Nigerian oil industry	Shell - Nigeria - Creek	4	A, C, E	EIA, DJ,GI, Platts, Reuters
May. 10	Total oil production	force majeure- oil-attacks	4	A, C, E	EIA, Reuters
May. 22	Alaska's oil reserve	leak - TAPS - pipeline	8	D, E	Reuters
Jun. 1	Dubai Mercantile Exchange	DME - Oman - Middle East	2	E	Reuters
Jun. 5	Tropical storm Gonu	Oman - Sur - Mina	2	D, E	DJ, Argus Media
Jun. 14	Nigerian oil industry	Gunmen - hostage - force majeure	4	A, C, E	EIA, Reuters
Jun. 26	Iranian gasoline rationing	riots - EIA - importer - domestic	2	E	EIA, Reuters
Jun. 28	Chevron oil production	Gulf of Mexico - deepwater - platform	5, 6	E	Chevron, Houston Ch.
Jul. 1	North Sea oil production	CATS pipeline - UK - oil	8	E	BP, EIA, EI, Reuters
Jul. 13	Russian Ntural Gas Production	Gazprom - Total - Shtokman	8	E	EI, OGJ, Reuters
Jul. 16	Japan Energy Sector	reactor - shuts - plant	7	D, E	EIA, FACTS, Reuters
Aug. 21	Hurricane Dean	struck - Mexico - shutting - oil	7	D, E	EIA
Sep. 11	OPEC meeting	Vienna - raise - Angola - Iraq	1	E	OPEC Press Release
Nov. 18	OPEC meeting	Riyadh - declining -	1	E	Reuters

		heads			
Dec. 5	OPEC meeting	Abu Dhabi - unchanged - allocations	1	E	OPEC Press Release
Dec. 19	US energy industry	Bush - act - independence - RFS	5	C, E	White House
2008					
Jan. 1	Ecuador rejoined OPEC	1992 - Angola - barrels	4	E	EIA
Feb. 1	OPEC meeting	Vienna - allocations - unchanged	1	E	OPEC
Feb. 14	Venezuela Oil Production	PdVSA - cut - ExxonMobil	6	B, C, E	EIA
Feb. 19	Oil futures market	NYMEX - WTI - surplus	all	E	EIA
Mar. 5	OPEC meeting	Vienna - unchanged - output	1	E	EIA, Reuters
Mar. 13	Oil futures market	WTI - NYMEX - highest - barrel	all	E	EIA, Reuters
Mar. 27	Iraq oil production	pipeline - Basra - exports	2	E	Reuters
Apr. 6	Iraq oil production	southern - shipping - Basra	2	E	Reuters
Apr. 25	Scotland's refinery	walked off - closure - shut-in	8	B, E	Reuters
May. 1	Nigerian oil industry	militant - attacks - West African	4	A, E	Reuters
May. 6	Oil futures market	NYMEX - WTI - barrel	all	E	Reuters
May. 7	ExxonMobil oil production	force majeure - oil-crude - export	4	B, E	Reuters
May. 19	US Energy policy	halts - gasoline - Congress	5	C, E	Reuters
May. 21	Oil futures market	NYMEX - WTI - gallon	all	E	Reuters
May. 23	Mexican oil production	fell sharply - output - field	6	E	EIA, Reuters
May. 27	Arctic oil reserves	US - Norway - Russia	5, 8	D, E	Reuters
May. 28	Indonesia quits OPEC	lack - investment - net importer	2, 7	E	Reuters
Jun. 7	Gasoline prices	gallon - retail - average	all	E	EIA, Reuters
Jun. 15	Saudi oil industry	boost - highest - rise	1, 2	E	EIA, Reuters
Jun. 19	Gasoline prices	China - retail - fuel	7	B, E	Reuters
Jun. 19	Shell Oil Company	shut-in - Bonga - Nigeria	4	B, E	Bloomberg
Jun. 20	Chevron oil production	force majeure - oil-crude - export	4	B, E	AP
Jun. 22	Oil executives meeting	Jeddah - investment - top oil company	2	E	Reuters
Jun. 27	Oil futures market	NYMEX - WTI - oil - price	all	E	Reuters
Jul. 18	Oil prices	EIA - peak - demand	all	E	Reuters
Jul. 23	Hurricane Dolly	Gulf - natural gas - oil	5	D, E	Reuters
Jul. 28	Gasoline prices	retail - week - fuel	all	E	Reuters

Jul. 15	Chevron oil production	repair - pipeline - Nigeria	4	B, E	Reuters
Jul. 15	Shell Oil Company	force majeure - oil-crude - export	4	E	Reuters
Jul. 17	Nigerian oil industry	Villagers - pipeline - Bayelsa	4	B, E	AFT
Jul. 29	The Niger Delta oil production	pipeline - Kula - Rumuekpe	4	B, E	Reuters
Jul. 29	Chevron oil production	Star Deep - Agbami - field	4	B, E	Chevron
Aug. 4-7	US Minerals	offshore - oil - gas	5	E	Minerals Manag.
Aug. 7	Baku-Tbilisi-Ceyhan Pipeline	Turkey - Azerbajan - Georgia	2, 8	B, E	EIA, Reuters
Aug. 14	BP oil production	Baku-Supsa - pipeline - Russia	2, 8	B, E	EIA, Reuters
Aug. 20	China oil production	halt - diesel - PetroChina	7	E	Reuters
Aug. 25	BTC pipeline	Turkish - energy - Baku-Supsa	2, 8	B, E	Reuters
Aug. 29 - Sep. 7	Oil and natural gas production	offshore - Mexico - Gulf	5, 6	E	Reuters Minerals Manag.
Sep. 8	Hurricane Gustav	Gulf - Ike - natural gas	5	D, E	Reuters
Sept. 10	OPEC meeting	abide - Iraq - Indonesia	1	E	Reuters
Sep. 10-15	Iraqi oil production	export - Turkey - Exports - storm	2	D, E	EIA, Reuters
Sep. 15	Oil futures market	Ike - Lehman - settled	5	D, E	Reuters
Sep. 22	Oil Market	WTI - highest - barrel	all	E	Reuters
Sep. 24	US gasoline inventories	1967 - Gustav - fuel	5	D, E	Reuters
Oct. 24	OPEC meeting	Vienna - cuts - barrels	1	E	Reuters
Oct. 30	US oil demand	EIA - slowdown - lagged effect	5	E	Dow Jones
Nov. 18	Somali pirates	Saudi - Sirius - supertanker	2	A, C, E	Reuters
Nov. 21	Gasoline prices	regular - national - fell	all	E	DJ, Reuters
Nov. 29	OPEC meeting	Cairo - supply - cut	1	E	Reuters
2009					
Jan. 1	Russian Gas supply	cut off - Ukraine - dispute - Russia	8	A, D, E	Reuters
Jan. 2	US Energy Dep.	Katrina - Rita - refiners - Gustav	5	D, E	Reuters
Feb. 6	Iraqi oil production	Export - Turkey - disrupting	2	A, C, E	Reuters
Feb. 23	Global oil storage	largest - despite - Frontline	all	E	Reuters
Mar. 9	Royal Dutch/Shell	Nigeria - attack - force majeure	4	A, C, E	DJ
Mar. 12	EU anti-dumping	anti-subsidy - duties - trading	8	B, E	Reuters

Mar. 16	OPEC meeting	Vienna - OPEC - supply - targets	1	E	Reuters
Mar. 24	US oil production	rig - drilling - Hughes	5	E	Reuters
Apr. 2	Mexican oil production	forecast - capacity - lost - barrels	6	E	Reuters
Apr. 15	US oil and gas production	declining - Institute - quarter	5	E	Houston Chronicle
May. 22	US oil production	oil - gas - rigs - exploring	5	E	Bloomberg
May. 28	OPEC meeting	quotas - unchanged - New York	1	E	Bloomberg
Jun. 12	China oil production	agricultural - jump - fuel - industrial	7	B, E	Bloomberg
Jul. 31	Iraqi oil production	reserves - exports - highest	2	E	Bloomberg
Sep. 2	BP oil production	giant - Tiber - discovery	7	B, E	Bloomberg
Sep. 9	OPEC meeting	Vienna - maintain - quotas - urge	1	E	Bloomberg
Oct. 2	Russian Energy sector	petroleum - ministry - start-up	8	E	Nete Compass
Nov. 9-12	Tropical storm Ida	offshore - shut-in - Minerals	5, 6	D, E	US Minerals Manag.
Nov. 13	US oil production	Baker Hughes -rigs - consecutive	5	E	Bloomberg
Dec. 2	Russia oil production	Saudi - Rosneft - Arctic	8	D, E	EIA, Reuters
Dec. 22	OPEC meeting	Angola - unchanged - Luanda	1	B, E	Bloomberg
Dec. 27	US oil reserve	SPR - Energy - buffer - IEA	5	E	DJ