SHORT-TERM FORECASTING OF CRUDE OIL PRICES IN KENYA

By

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DECLARATION

This research project is my original work and has not been presented for a degree in any university.

Candidate: Mwangi N. Simon.

Signature ..... Date 06/11/2006.....

This research project has been submitted with my approval as the university supervisor.

Supervisor: Dr. Gituro Wainaina

Signature ..... Date November 7, 2006

DEDICATION

To all my friends.

I have but one lamp by which my feet are guided, and that is the lamp of experience. I know no way of judging the future but by the past.

Patrick Henry (March 23, 1775)

ACKNOWLEDGEMENT

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TABLE OF CONTENTS

Declaration ii

Dedication iii

Acknowledgements iv

Table of Contents v

List of Tables vii

List of Figures viii

Abstract ix

INTRODUCTION

1.1 Background 1

1.2 Research Problem 4

1.3 Objectives of the Study 5

1.4 Importance of the Study 5

LITERATURE REVIEW

2.1 Forecasting 6

2.2 Univariate Box-Jenkins Auto-Regressive Integrated Moving Average... 6

2.3 Existing Studies 10

2.4 Economic Importance of Oil 10

2.5 The Nature of Oil as a Commodity 11

2.6 Effects of Supply and Demand on Crude Oil Prices 12

2.7 Aspects of the Oil Futures Market 14

RESEARCH DESIGN AND METHODOLOGY

3.1 Population and Sampling Procedure 16

3.2 Data Analysis Procedure 16

3.3 Forecasting Accuracy Measurement 17

DATA ANALYSIS

4.1 Model Identification 19

4.2 Model Estimation 21

4.3 Model Checking 22

4.4 Forecasting with the Model 27

CONCLUSION, LIMITATIONS AND FURTHER RESEARCH

5.1 Conclusion 30

5.2 Limitations and Further Research 31

REFERENCES 32

LIST OF TABLES

Table		Page
1	Model Parameter Estimates	21
2	Parameters Correlation Matrix	22
3	Residuals Diagnostics	22
4	Box-Ljung Q Statistic	24
5	Murban Crude Spot Price Forecasts for the Month of July 2005	28
6	Forecasting Error	29

LIST OF FIGURES

Figure		
1	Crude Oil Annual Average Price Movement	2
2	Basis Ratio Versus Time Plot	19
3	Basis Ratio Autocorrelation Function Plot	20
4	Basis Ratio Partial Autocorrelation Function Plot	21
5	Residuals Autocorrelation Function Plot	23
6	Residual Partial Autocorrelation Function Plot	24
7	Basis Ratio Residuals Versus Time in Weeks Plot	25
8	Residuals Histogram	26
9	Normal Probability Plot	27
10	Actual Spot Prices Versus Forecasted Spot Prices and Futures Prices	28

ABSTRACT

Today the world has become more complex, more fast-paced and more competitive than ever before. Forecasting has, therefore, become necessary in order to meet conditions of the future for which we have imperfect knowledge. Of late, crude oil prices have risen significantly thus attracting a lot of attention from consumers and the general public at large. There are, of course, considerable risks posed by the volatile crude oil prices to the importing entities as well to the economy as a whole.

Hedging on futures is one of the effective risk management strategies available to reduce the risks associated with volatile crude oil prices. Scholars have, however, acknowledged the dilemma faced by the oil importing entities in the use of futures and options as this could lead to criticism and negative publicity if the importing entity was to "lock in" the price of the crude oil and then later the spot price went down. The challenge that exists, therefore, is to convert the information present in futures prices into specific spot price forecast. Most of the market participants understand that current futures prices provide important information about cash prices on the future dates. However, these participants need to be able to forecast a cash or spot price at a location and time when they plan to buy or sell.

This study set out to develop a model that could be used in the short-term forecasting of crude oil spot prices in Kenya. The study involved analyzing the basis time series utilizing the Univariate Box-Jenkins Auto-Regressive Integrated Moving Average (UBJ-ARIMA) methodology. The weekly Murban crude spot prices and the West Texas Intermediate (WTI) weekly futures prices were used for the study. Approximately 80 percent of the crude oil imported into Kenya is the Murban crude. For this reason, its weekly prices were preferred. The WTI futures were used since it is the most traded crude and its futures prices are easily available.

The study found out that it was possible to utilize the basis to prepare forecasts of the Murban crude oil spot prices. However, forecasts would have to be interpreted in the context of the existing market conditions since the accuracy of the forecasts could rapidly

decrease as more information become available. Further research work is recommended in looking into how local currency fluctuations against the US dollar affects crude oil prices in Kenya.

INTRODUCTION

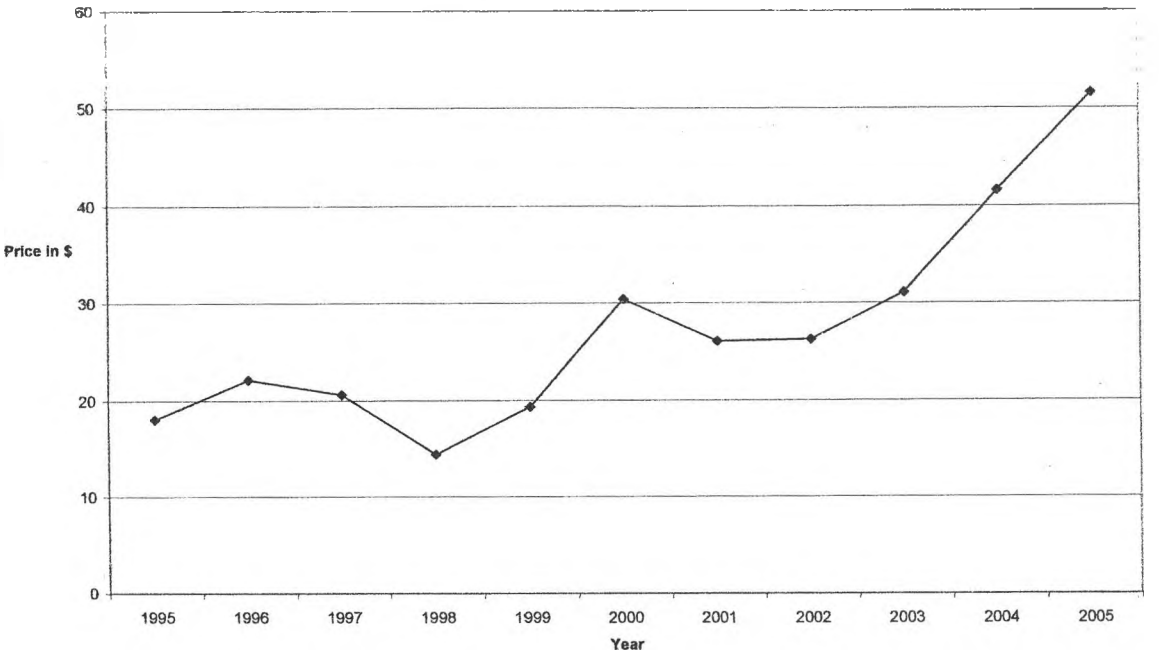
1.1 Background

Today, governments and organizations operate in an environment of uncertainty and in spite of this fact, decisions must be made which affect the future of these institutions. The world has always been changing hence forecasts have always been necessary. The environment has become more complex, more fast-paced and more competitive than ever before. Organizations which cannot react quickly to changing conditions and cannot foresee the future with any degree of accuracy are doomed to extinction. Forecasting is therefore necessary in order to plan to meet conditions of the future for which we have imperfect knowledge (Hanke et al., 2003).

In business, forecasts are the basis for budgeting and planning for capacity, sales, production, inventory, manpower, purchasing and price. Forecasts play an important role in the planning process because they enable managers to anticipate the future so they can plan accordingly. Planning is of course an integral part of managing organizations. If uncertainties cloud the planning horizon, managers will find it difficult to plan effectively. Forecasts help managers by reducing some of the uncertainties, thereby enabling them to develop more meaningful plans. A forecast is therefore a statement about the future (Stevenson, 1999).

Over the recent past, the price of crude oil has risen sharply, thus drawing a lot of attention from the general public since these increases affect almost all sectors of the economy. Oil companies have been heavily criticised for raising pump prices unnecessarily. However, since December 2001, the world crude oil prices have been on an upward trend, moving from a low of United States Dollars ($) 20 per barrel to $ 60 per barrel by June 2005 (see Figure 1). High oil prices in the world markets affect economic activities in Kenya directly since Kenya relies entirely on oil imports. High crude oil prices translate to high transport costs, which have a ripple effect on all sectors of the economy. This upward trend in crude oil prices is expected to have a negative impact on the anticipated Gross Domestic Product (GDP) growth of 6 percent by the year 2006 in Kenya.

Figure 1 Crude Oil Annual Average Price Movement



Source: www.eia.doe.gov

Note: Averages for 1995 and 2005 are for six months of June to December and January to June respectively

High oil prices effectively transfers income from oil-importing countries to oil-exporting countries. Higher energy and related costs add to the business costs and adversely affect business activities. Higher business costs are eventually passed on in terms of output prices to the consumers. This in turn results to lower consumer demand as consumer price inflation rises.

According to the Kenya Economic Survey 2005, approximately 80 percent of the total crude oil imported in Kenya for the last four years was Murban crude. The total import bill for crude oil nearly doubled from KShs 25.4 billion recorded in 2003 to KShs 46 billion in 2004. This is despite the fact that the quantity imported went down by 33 percent from 3 million tonnes to 2 million tonnes during the same period. This can be explained by the significant increase in the unit cost per tonne from KShs 8,414 in 2003

to KShs 22,485 in 2004, an equivalent of 167 percent increase. The impact of the crude oil prices on the total cost spent on the oil import bill in Kenya can not therefore be overemphasized.

There is considerable risk posed by the volatile crude oil prices to the importing companies and the economy as a whole. Claessens and Varangis (1991) identified two types of risks which importing companies are particularly exposed to, these are; transaction risk and long-term risks. Transaction risk occurs because the crude oil importing company commits to purchase crude oil within a considerable period of time before the actual loading is done whereas the price of crude is determined at the time of loading. According to industrial players in Kenya, this period may be between 20 to 60 days. If crude oil prices increase during this period then the importing company will have to incur the extra costs since it cannot change or cancel the order.

The long-term risk concerns the efficiency of transmission of the changes in the international crude oil prices from the importing company to the domestic economy over a given planning period. The current situation in Kenya is such that the upward international price volatility is transmitted to the final consumers immediately, whereas the downward movement takes time. The importing companies in Kenya do not therefore suffer from this risk but the whole economy does.

The oil-importing companies are the logical place to manage these risks. This is because they have the exposure of purchasing oil and can therefore match the physical with futures or options trading. They also have a good knowledge of the oil markets.

Oil-importing companies in Kenya may use market-based risk management instruments to hedge against price fluctuations of crude oil. The main benefit of risk management is reducing the uncertainty of the price that the oil-importing companies would pay for crude oil and by extension the price that consumers would have to shoulder. According to Claessens and Varangis (1991), the use of risk management instruments provide scope for smoother adjustments of developing countries to oil price shocks and thus enhances their ability to plan. They further suggest that oil-importing developing countries could

gain considerably from using financial risk management instruments since short-term (less than 60 days) hedge has the potential of reducing oil price volatility by 78 percent while the mid-term (six months) hedge has the potential of reducing oil price volatility by about 72 percent. Hedging on futures is one of the effective risk management strategies available to reduce the associated risks that producers and traders are exposed to (Arshad & Mohamed, 1994). Options and swaps are the other risk management instruments, which can be used.

1.2 Research Problem

While supporting the hedging of crude oil imports in developing countries, Claessens and Varangis (1991) also acknowledge the dilemma faced by the state-owned oil-importing companies in that, within the governments in developing countries, there is concern for the use of options and futures since they could lead to criticism and negative publicity especially if the state-owned oil-importing companies 'locks in' the price of crude using futures and then later the spot price goes down. The situation in Kenya would even be more disastrous to the importing entity as the oil industry is liberalised and importation is done by private companies. There is, therefore, a need to be able to forecast the spot price so as to be able to gain any benefits from hedging. Satyanarayan and Somensatto (1997) cautions that before turning to the issue of hedging effectiveness, the time series properties of the spot prices and futures prices need to be investigated and understood.

The importance of futures markets arise from their ability to predict spot prices at a specified future date, thus providing the market participants with a means of managing the risks associated with trading a commodity (Omar & Majid, 2004). The question then becomes; how can we convert the information present in futures prices into useful specific cash price forecast? Most market participants understand that current futures prices provide important information about cash prices on future dates. However, these participants need to be able to forecast a cash or spot price at a location and time when they plan to buy or sell. There is, therefore, the need to predict the basis which is basically the relationship between a specific cash price and the futures price. The basis can either be expressed as a difference; basis = cash price – futures price or as a ratio; basis = futures price/cash price (Sanders and Manfredo, 2004). In either case, the basis

serves as the connector between the futures price and the cash commodity price being forecast. In this study, the basis has been taken to be the arithmetic ratio of the futures price to the cash price. The basis is never fully predictable, but even so, it can generally be predicted with far greater precision than the level of prices. The relative stability and predictability of basis means that hedging in futures generally reduces, but does not fully eliminate price risk (Wainaina, 1993). This view is also supported by Hoffman and Balagtas (2003) who posit that the basis tends to be more stable or predictable than either the cash price or futures price.

According to Wainaina (1993), prediction of basis can be combined with futures price quotations to forecast the cash price. The key step, therefore, is to first establish the relationship between the futures price and the commodity price under consideration and then use the relationship to prepare a forecast.

1.3 Objectives of the Study

The general objective of this study was to develop a short-term (30 days) forecasting model for the Murban crude oil spot prices using weekly average West Texas Intermediate (WTI) crude oil futures from 1 January 1997 to 30 June 2005. The specific objectives of this study were to:

1. Identify the forecasting model;
2. Develop a short-term forecasting model; and
3. Cross-validate the developed model.

1.4 Importance of the Study

The results of this study will be important to the oil industry players in planning for their procurement needs, thus enable them to forecast spot prices and hence be able to hedge against adverse effects of the volatility and rise in the cost of crude and in the process manage their cash flows as well. In addition, the results of this study will stimulate interest for further research work on the crude oil prices and other petroleum products within this region.

LITERATURE REVIEW

2.1 Forecasting

All formal quantitative forecasting techniques involve extending the experience of the past into the uncertain future. Thus, they involve the assumption that the conditions that generated past data are indistinguishable from the conditions of the future except for those variables explicitly recognized by the forecasting model (Hanke et al., 2003). Forecasting procedures are therefore based on one of the following assumptions (Jazayeri and Yahyai, 2002);

- The underlying variable of the time-series in question is independent and there are sufficient reasons to believe that the past trend continuous in the future. Therefore, one can reasonably estimate future values of the time-series through analyzing historical data. This may be referred to as the self-projecting approach.
- The underlying variable of the time-series in question is dependent on a number of independent variables. A mathematical algorithm can be found to define the nature of this dependency. One must, therefore, estimate the future values of the time-series in question through forecasting the future behaviour of the variables on which the underlying variables depends. This may be referred to as the cause and effect approach.
- A combination of the above-mentioned methods, whereby, the time-series in question depends on historical data and is a function of current and past values of some independent variables.

In this study, the first assumption was taken into account. Analysis of the historical time-series data was therefore carried out in the forecasting process. In their study on Short-term Forecasting of non-OPEC Supply – a Statistical Analysis, Jazayeri and Yahyai (2002) also adopted the first assumption.

2.2 Univariate Box-Jenkins Auto-Regressive Integrated Moving Average

One of the forecasting techniques which can produce accurate forecasts based on a description of historical patterns in data is the UBJ-ARIMA model (Hanke et al., 2003). A UBJ-ARIMA model is an algebraic statement that depicts how observations on a

variable are statistically related to past observations on the same variable (Wainaina, 1993). The model does not involve independent variables in its construction; rather, the model makes use of the information in the series itself to generate forecasts. The term univariate refers to the use of a single data series. The methodology does not assume any particular pattern in the historical data of the series to be forecast. It uses an iterative approach to identify a possible model from a general class of models.

The UBJ-ARIMA models rely heavily on autocorrelation patterns in the data (Hanke et al., 2003). The statistical concept of correlation is used to measure relationships between observations within the series. The goal of UBJ-ARIMA analysis is therefore to find, through correlation analysis, a better way of stating that the observations in a time series may be statistically related to other observations in the same series (Wainaina, 1993).

The UBJ-ARIMA models combine as many as three types of processes which are autoregressive (AR), differencing to strip off the integration (I) of the series, and moving averages (MA). All the three are based on the simple concept of random disturbances or shocks. The most general UBJ-ARIMA model involves all the three processes and each is described by a small integer. The general model is written as ARIMA (p, d, q) where *p* is the order of autoregression, *d* is the degree of differencing, and *q* is the order of moving average involved. Detailed discussions of the UBJ-ARIMA mechanics can be found in Hanke and others (2003) and Wainaina (1993).

According to Wainanina (1993), in the most general form, the UBJ-ARIMA model is defined as:

$$(1 + \varphi_1 B + \varphi_2 B^2 + ...+ \varphi_p B^p)(1 + \varphi_d B^d)X_t = (1 - \Theta_1 B - \Theta_2 B^2 -...- \Theta_q B^q)(1 - \Theta_d B^d)\varepsilon_t$$

where,

$BX_t = X_{t-1}$

$B^2X_t = X_{t-2}$

$B^3X_t = X_{t-3}$

$B^m X_t = X_{t-m}$

p is degree of the auto-regressive part.

q is degree of moving average part.

d is degree of differencing.

ε_t is random shock or 'white noise' and $\varepsilon_t \sim N(0, I\sigma^2)$ i.i.d.

Specifically, the mathematical model is written as:

$$W_t = \mu + \Sigma \Psi_i(B) X_{i,t} + \theta(B)/\varphi(B)\varepsilon_t$$

where,

t indexes time

B is the backshift operator; that is, $BX_t = X_{t-1}$.

W_t is the response series or a difference of the response series.

$\varphi(B)$ is the autoregressive operator,

$\varphi(B) = 1 - \varphi_1 B - ..... - \varphi_p B^p$.

μ is the constant term.

$\theta(B)$ is the moving average operator,

$\theta(B) = 1 - \theta_1 B - ..... - \theta_q B^q$.

$X_{i,t}$ is the ith input time series or a difference of the ith input time series at time t.

$\Psi_i(B)$ is the transfer function for the ith input series modeled as a ratio of polynomials.

ε_t is defined as above.

This model expresses the data as a combination of past values of the random shocks, which is basically the moving average part of the analysis, and the past values of other series, which is the autoregressive part. The methodology of the UBJ_ARIMA analysis can be carried out in four steps. Different scholars refer to these steps in different ways,

albeit with a lot of similarities. Steps proposed by Hanke and others (2003) are preferred in this study. These steps are;

Model Identification

The first task under this step is to determine whether the series is stationary or not. If the series is not stationary, it can often be converted to a stationary series by differencing, that is, the original series is replaced by a series of differences thus changing the modelling from levels to changes. Once a stationary series has been obtained, the form of the model to be used is then identified. This is done by comparing the autocorrelations and the partial autocorrelations computed from the data to the theoretical autocorrelations and partial autocorrelations for the various UBJ-ARIMA models. Simple models are preferred to complex models ceteris paribus. This is in line with the principle of parsimony, which is the belief that one should select the simplest model that gets the job done adequately (Leveine et al., 2003).

Model Estimation

Once the tentative model has been selected, the parameters for that model must be estimated. This is done by minimizing the sum of squares of the fitting errors. The residual mean square error is of particular importance here.

Model Checking

Before the model is used for forecasting, there is need to check for its accuracy. A model is considered adequate if the residuals cannot be used to improve the forecasts, that is, the residuals should be small and random. An overall check of the model is provided by a chi-square (χ^2) test based on the Ljung-Box Q statistic.

Forecasting Using the Model

Once an adequate model has been obtained, forecast for one period or several periods into the future can be made.

2.3 Existing Studies

Crude oil prices have drawn significant attention in the past few years due to the public concern over the substantial movements in energy prices, which have macroeconomic repercussions. Different forecasting techniques have been used in these studies and results have tended to take a contradictory path. Lanza and others (2003) investigated crude oil price dynamics considering distinct market areas over the period of 1994 – 2002 using cointegration and error correction models and found out that, the differences in quality are crucial in understanding the behaviour of crudes, and more significantly that the price of the marker was the driving variable of the crude price in the short-run irrespective of the specific geographical area and quality of the crude under analysis. Banks (2004) looked at economic theory regarding supply of oil with particular attention to the theory on exhaustible resources and concluded that oil is a commodity whose value either below of above ground is steadily and irreversibly increasing with time.

Coimbra and Esteves (2004) noted that it was very difficult to identify any kind of systematic behaviour in oil prices as they tended to follow a random-walk process. On the other hand, Chinn and others (2005) observed that a random walk characterization of energy commodity prices is not particularly a good one.

Other studies have focussed on individual petroleum products. For example, Sanders and Manfredo (2004) used heating oil futures to forecast the on-highway retail diesel prices. The study found out that if futures contract prices were available for a particular commodity, forecasts for the cash price could then be easily prepared by utilizing the basis. This kind of study has not been conducted here in Kenya as a way of forecasting spot prices of the Murban crude, which is the most used crude in Kenya. The ability to forecast spot prices is vital as it enables hedgers to create some room for flexibility and explore the possibility of having instruments tailored to their needs.

2.4 Economic Importance of Oil

Crude oil is the world's most actively traded commodity, accounting for about 10 percent of total world trade (Sharma, 1998). The economic importance of oil derives not only

from the sheer size of the market, but also from crucial, almost strategic, role it plays in the economies of oil-exporting and oil-importing countries. Oil prices drive revenues to oil-exporting countries and on the other hand, costs of oil imports have a substantial impact on the growth initiatives in oil-importing countries, especially to the developing countries. For example, according to the Kenya Economic Survey (2005), crude oil accounted for 12.6 percent of the total imports for the year 2004. The net cost of petroleum products as a whole accounted for 7.5 percent of the GDP at market price in the same year.

The global oil demand has generally been on the increase. For example, it grew from an average of 80.4 million barrels per day in 2003 to an average of 84.5 million barrels per day (International Energy Agency, 2005). This has mainly been attributed to the growth in the Chinese, Indian and the US economies. Several scholars (Shihab-Eldin et al., 2003) have also observed that transportation sector, especially within the Organization for Economic Cooperation and Development (OECD) countries contributes a lot to the growth in demand. For the developing countries, other non-transportation sectors, such as the industrial sector are also important contributors to the growth in demand and this trend is set to continue.

In Kenya, the number of newly registered vehicles, during the year 2004 were 42,482 as compared to 33,768 in 2003. The total consumption of petroleum products by the power generating sector was 204,2000 tonnes in 2004 as compared to 151,500 tonnes in 2003 as per the Kenya Economic Survey (2005), hence underlining the critical importance of oil to the economy as well as to the world in general.

2.5 The Nature of Oil as a Commodity

Oil is not a homogeneous commodity as there are over 160 different internationally traded crude oils, all of which vary in terms of characteristics, quality and market penetration (Lanza et. al., 2003). Crude oils are classified by density and sulphur content. Lighter crudes generally tend to produce higher value products as they have a higher share of the desirable light hydrocarbons which can be produced by simple distillation.

On the other hand, heavy crude oils such as the Iranian heavy, give a greater share of lower-valued products through simple distillation and require additional processing to produce the desired range of products. Sulphur is an undesirable content in the crude and the higher the sulphur content, the lower the quality of the crude and the higher the strain on processing requirements.

2.6 Effects of Supply and Demand on Crude Oil Futures

The future price of a storable commodity such as crude oil is determined by the spot price and cost incurred while the commodity is stored awaiting delivery some time in the future. The cost associated with holding the commodity until the delivery date is known as the cost-of-carry. The cost-of-carry consists of the cost of storing oil in a tank, insurance, the financial cost in the form of the opportunity cost of holding oil or the cost of funding and perhaps a risk premium.

Fluctuation in oil prices are generally caused by supply and demand imbalances arising from events such wars, changes in political regimes, economic crises, formation and breakdown of trade agreements and unexpected weather patterns. Forward and futures prices embed the expectations of the market participants about how demand will evolve and how quickly the supply side can react to events to restore the balance. A dynamic market model based on expectations would predict that prices for immediate delivery will exceed prices for longer delivery horizons, when stocks are low or are anticipated to be insufficient to meet short-term needs (Sharma, 1998). This pattern of prices is characteristic of a market in backwardation. In contrast, when stocks are high and the probability of stock-out is low, forward prices exceed spot prices, a situation which describes a market in contango.

Sharma (1998) posits that a fundamental driver of volatility in oil prices is the fact that current stocks can be stored for consumption in the future but future production cannot be 'borrowed' to meet immediate needs. This market asymmetry implies that the magnitude of a price increases in a given period due to a disruption in current supplies is likely to be

larger as compared to a price drop in response to oversupply. Important factors, which have a significant impact on crude futures, are;

- Commercial and governments controlled stocks – governments, and especially the OECD countries will hold oil stocks for strategic reasons. According to the International Energy Agency (IEA) (2005), the government controlled stocks have been fairly constant in the past five years. The OECD commercial stocks generally have an impact on crude oil futures. The relationship had been fairly stable in the near past (IEA, 2005).
- Speculators – the common assumption is that traders and speculators create price hikes. However, it must be noted that speculators on their own can not significantly alter the prices but rely on other factors to aid them. For example, in 2005, speculators have been focussing on potential shortage of crude in the high demand fourth quarter, given strong global demand, low commercial inventories, a lack of spare capacity within the Organization of Petroleum Exporting Countries (OPEC) and huge geopolitical uncertainties as discussed below.
- Geopolitical uncertainty – the most significant event within the period between 1995 and 2005 that has brought geopolitical uncertainty to the fore is the September 11, 2001 terrorists attack in the US (Cambridge Energy Research Institute, 2005). The subsequent war on terror including the Iraq war has increased instability in the Middle East, where, by the year 2004, it was estimated that 62 percent of the conventional crude oils reserves were located according to the British Petroleum Statistical Review of World Energy (2005).
- Political instability in other areas such as Venezuela and in Nigeria, has had a negative impact on the prices. In addition, acts of God sometimes lead to major disruptions. For example hurricane Ivan took up to two million barrels per day of the US Gulf Coast production off the market in the second half of 2004 (CERI, 2005) as a result of the ensuing damage and closure of some of the production facilities.
- Supply flexibility – unfavourable supply flexibility in the world oil markets will manifest itself in several ways such as relatively low levels of spare production capacity within the oil producing countries; a shortage of conversion capacity in the

global refining industry more so to allow the processing of lower quality crude; and low commercial oil inventories.

To be able to achieve the best result of any forecasting model, the model must be augmented with an in-depth knowledge and analysis of marketplace fundamentals and geopolitical relationships highlighted above.

2.7 Aspects of the Oil Futures Market

According to the Chicago Board of Trade (2004) a futures contract is a legally binding agreement to buy or sell a commodity or financial instrument sometime in the future at a price agreed upon at the time of the trade. While actual physical delivery of the underlying commodity seldom takes place, futures contracts are nonetheless standardized according to the delivery specifications, including the quality, quantity, time and location. The only variable is price, which is discovered through the trading process.

Among the most important aspects in futures markets are:

- Derivative – according to the Investment Research (2000) Guide to Business and Financial terminology, a derivative is an investment vehicle, the value of which is based on the value of another security. Futures contracts, forward contracts and options are among the most common types of derivatives and are exchange-traded or sold over-the- counter. They are called derivatives because their value is derived from underlying assets such as oil and natural gas, which are generally referred to as the underlying. Exchange-traded derivatives are standardized products traded on the floor of an organized exchange, or auction-type market where all prices and other information relating to the asset are fully transparent.
- Futures market – Banks (2004) indicates that futures market operates as follows; that against a background of speculators 'betting' on the direction and size of commodity price movements by buying and selling futures contracts, an impersonal agency is created which permits producers, consumers , inventory-holders and other traders in physical products to reduce, that is, hedge, undesirable price risks.

The success of a futures market depends on its satisfying several criteria:

- The commodity should be traded in bulk and should be homogeneous, although different grades can be traded at a premium or a discount.
- Production and consumption should be widely distributed.
- Trade should take place at an exchange organized as an auction market.

Traders in a physical commodity can employ futures market to reduce price risk only if other traders such as speculators are willing to accept this risk. The social gain from futures trading mainly derives from the voluntary redistribution of risk between speculators and risk-averse dealers in physical products. The way speculators operate is that if they believe that the price of a commodity is going to rise, they buy a futures contract that has a given maturity. If the price of the physical commodity actually rise, then the price of the futures contract should also rise, sooner of later, and, by selling the contract, the speculators will make a profit. Hedgers on the other hand are the people who want to avoid exposure to undesirable risk. They buy and sell futures contracts depending upon whether they want to guard against price increases or price falls.

RESEARCH DESIGN AND METHODOLOGY

3.1 Population and Sampling Procedure

The study utilized secondary data sourced from www.eia.doe.gov. The weekly average Murban crude spot prices and the West Texas Intermediate (WTI) crude weekly average futures prices were the population of this study. The sample size was judgementally selected to be the weekly average prices for the above two crude oils for the period between 01 January 1997 and 30 June 2005. The judgemental selection of the study period facilitates the selection of a study period which is relevant to the study.

The basic assumption underlying time series analysis is the assumption that factors that have influenced patterns of the activity under research in the past and present will continue to do so in more or less the same manner in the future. The major goals of any time series analysis, therefore, are to identify and isolate the influencing pattern for predictive purposes (Levine et al., 2003). For this reason, the more current the time series data is, the more relevant it is in forecasting into the immediate future. The sample period was, therefore, selected with this in mind and captured the most recent data over the past nine years.

The most important aspect of a model is how well it can predict the future (Makridakis, 1990). To enable the testing of the forecasting ability of a model, it is important to use independent test sets consisting of time series which have not been involved in the modelling process. The weekly average Murban crude oil spot prices for the month of July 2005 were thus used as an out-of sample data to test the predictive ability of the forecasting model.

Futures and options on crude oil are available on several exchanges throughout the world. The leading such exchange is the New York Mercantile Exchange (NYMEX) where the above are written on West Texas Intermediate (WTI). For this reason the WTI futures prices have been used in this study due to the availability of its time-series data.

As explained before, forecasting using the basis is preferred as it tends to be more stable or predictable than either the spot price or the futures price. The basis in this study is computed as the arithmetic ratio of the futures price to the spot price.

3.2 Data Analysis Procedure

The UBJ-ARIMA methodology was used in this study to forecast the basis. The basis was then used to produce the spot price forecasts. The UBJ-RIMA methodology of forecasting is different from most methods because it does not assume any particular pattern in the historical data of the series to be forecast. It uses an iterative approach of identifying a possible model from a general class of models. The chosen model is then checked against the historical data to see whether it accurately describes the series. The model fits well if the residuals are generally small, randomly distributed, and, in general, contains no useful information (Hanke et al., 2003). The model is also suitable because serial correlation between data points is often encountered when using economic time-series data (Hallquist et al., 1998). The SPSS software version 13 was used to carry out the data analysis.

3.3 Forecasting Accuracy Measurement

Various methods for computing, measuring and interpreting errors exist. The most commonly used are the mean absolute percentage error (MAPE), and mean absolute deviation (MAD) (Hanke et al., 2003). The two methods were selected for this study. MAD measures forecast accuracy by averaging the magnitudes of the forecast errors, that is, the absolute values. MAD is most useful when it is necessary to measure forecast error in the same units as the original series (Hanke et al. 2003). It is computed as;

$$\text{MAD} = \frac{1}{n}\sum_{t=1}^{n} \left| A_t - F_t \right|$$

Where;

A_t = actual value in period *t*,

F_t = forecast value in period *t*, and

n = number of periods in the calculation.

MAPE, on the other hand, provides an indication of how large the forecast errors are in comparison to the actual values of the series. It is computed as;

$$\text{MAPE} = \frac{1}{n}\sum_{t=1}^{n}\left| (A_t - F_t)/A_t \right| \text{ x } 100\ \%$$

Where;

A_t = actual value in period *t*,

F_t = forecast value in period *t*, and

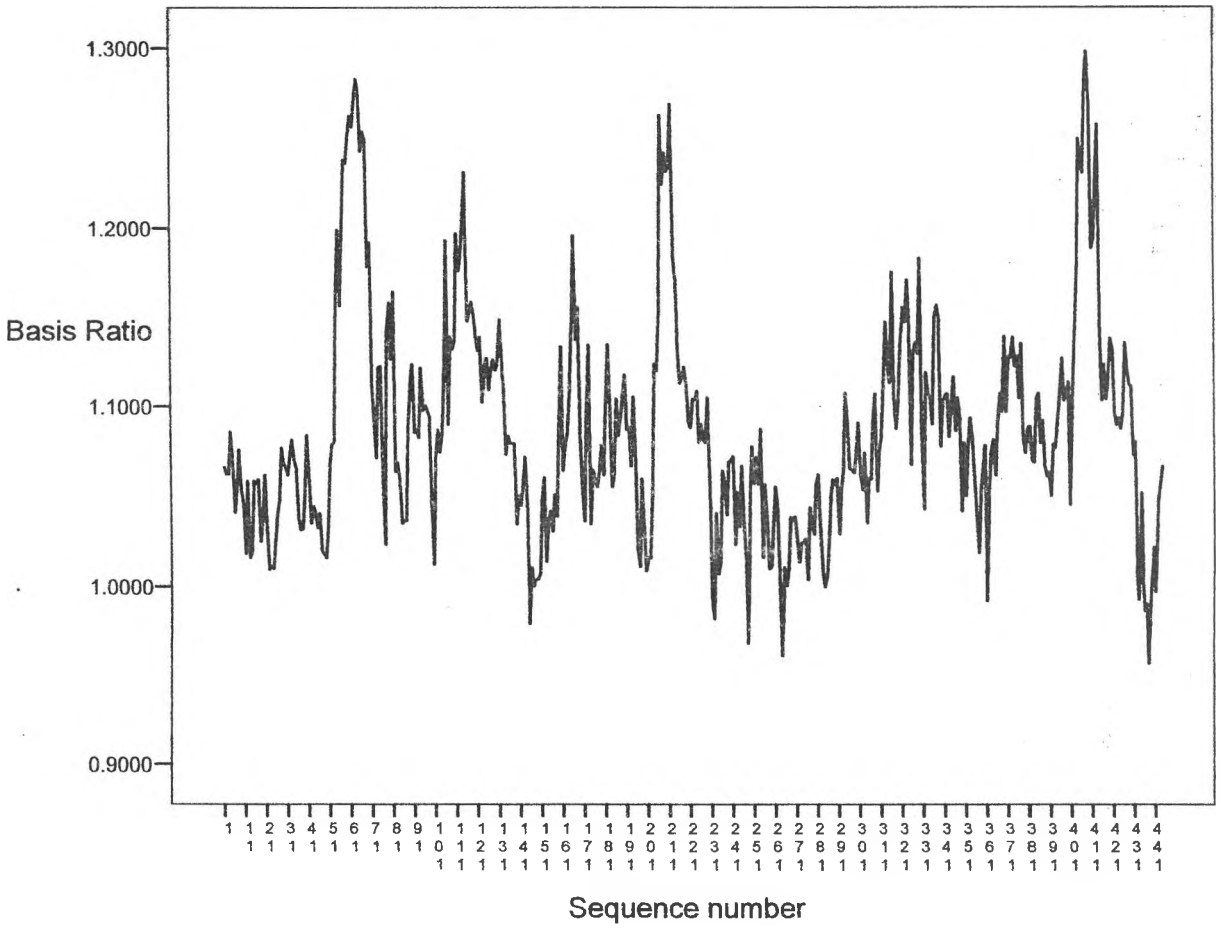
n = number of periods in the calculation.

DATA ANALYSIS

4.1 Model Identification

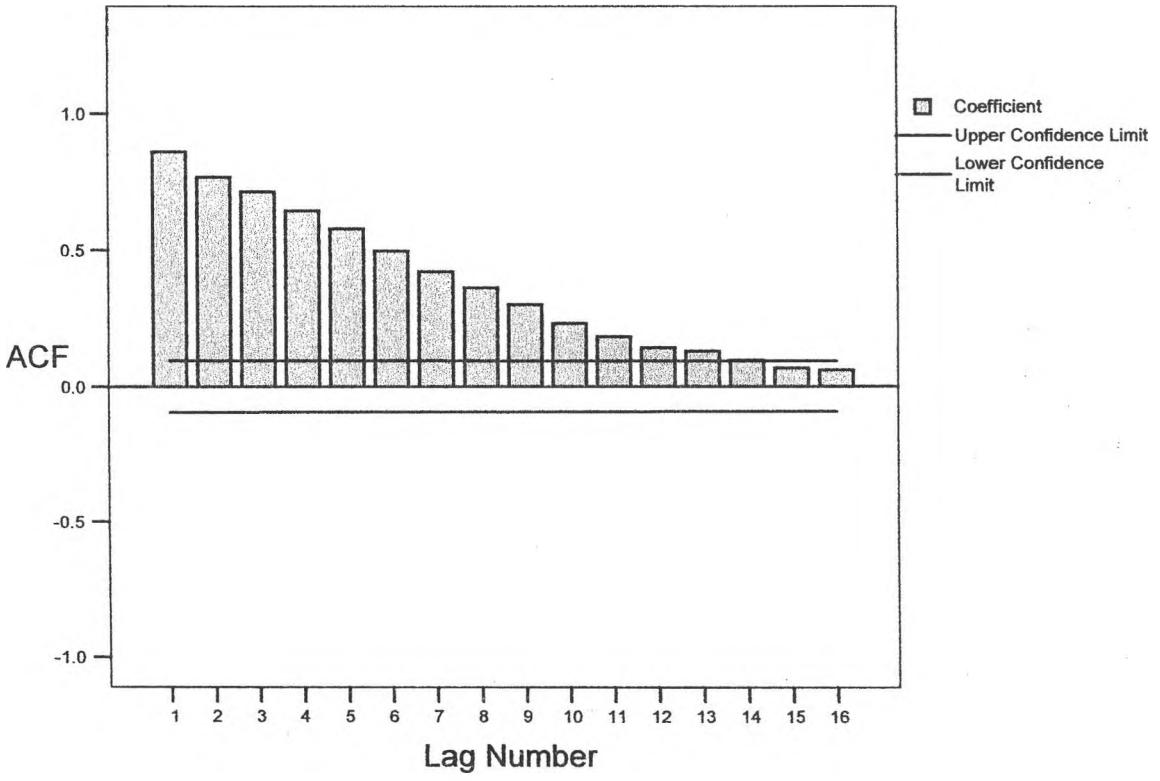
The first step in the analysis was to develop a graph of the basis over time to determine if the series was stationary, that is, if the series appear to vary about a fixed level.

Figure 2 Basis Ratio Versus Time



The series appears to vary about a fixed level. It is, however, useful to look at the series along with the autocorrelation function and the partial autocorrelation function.

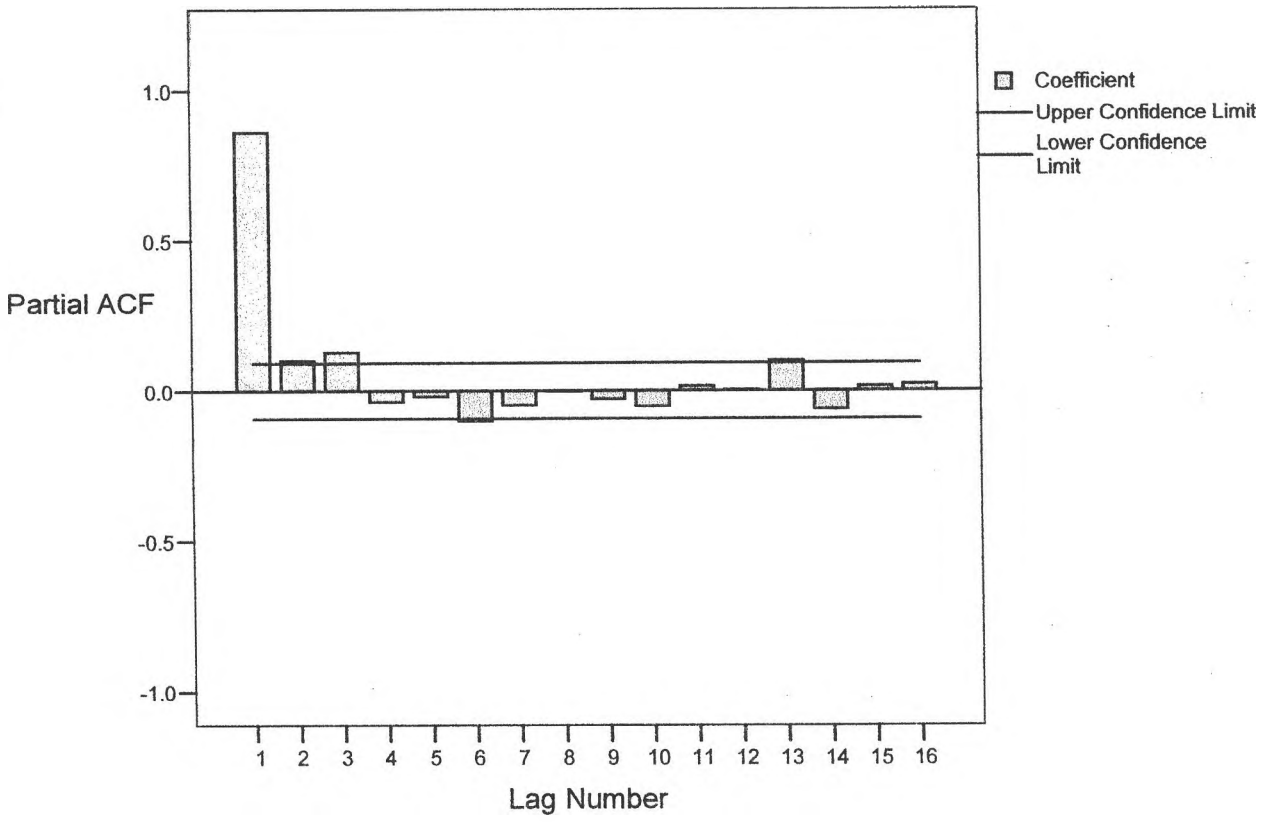
Figure 3 Basis Ratio Autocorrelation Function Plot



The autocorrelation function shows that the series appears to die out rapidly thus confirming that the time series is stationary. This indicates that the series does not require differencing but an autoregressive term is, however, needed.

Considering the partial autocorrelation function as shown in Figure 4, the model identified was ARIMA (3,0,0) as can be inferred from the first 3 spikes on the left end of the figure. A partial autocorrelation function is generally more useful in determining the structure of the model. It is basically an extension of autocorrelation where the dependence on the intermediate elements, that is, those within the lag is removed. In a sense, the partial autocorrelation function provides a cleaner picture of serial dependencies for individual lags not confounded by other serial dependencies.

Figure 4 Basis Ratio Partial Autocorrelation Function Plot



4.2 Model Estimation

An ARIMA (3,0,0) model produced the following results;

Table 1 Model Parameter Estimates

		Estimates	Std Error	T	Approx Sig
Non-Seasonal Lags	AR1	.756	.047	16.016	.000
	AR2	.002	.059	.033	.974
	AR3	.131	.047	2.778	.006
Constant		1.087	.013	83.420	.000

Melard's algorithm was used for estimation.

The first and the third coefficients are significant while the second coefficient is not. The constant is also significant as shown in Table 1. A correlation matrix was further used to determine the useful coefficients.

Table 2 Parameters Correlation Matrix

		Non-Seasonal Lags			Constant
		AR1	AR2	AR3	
Non-Seasonal Lags	AR1	1.000	-.613	-.104	0(a)
	AR2	-.613	1.000	-.612	0(a)
	AR3	-.104	-.612	1.000	0(a)
Constant		0(a)	0(a)	0(a)	1.000

Melard's algorithm was used for estimation.
a The ARMA parameter estimate and the regression parameter estimate are asymptotically uncorrelated.

As Table 2 shows, there was a high correlation between the second term and the rest of the terms thus the second term was left out of the model. The model is therefore summarized as:

$$\hat{Y}_t = 1.087 + 0.756Y_{t-1} + 0.131Y_{t-3}$$

4.3 Model Checking

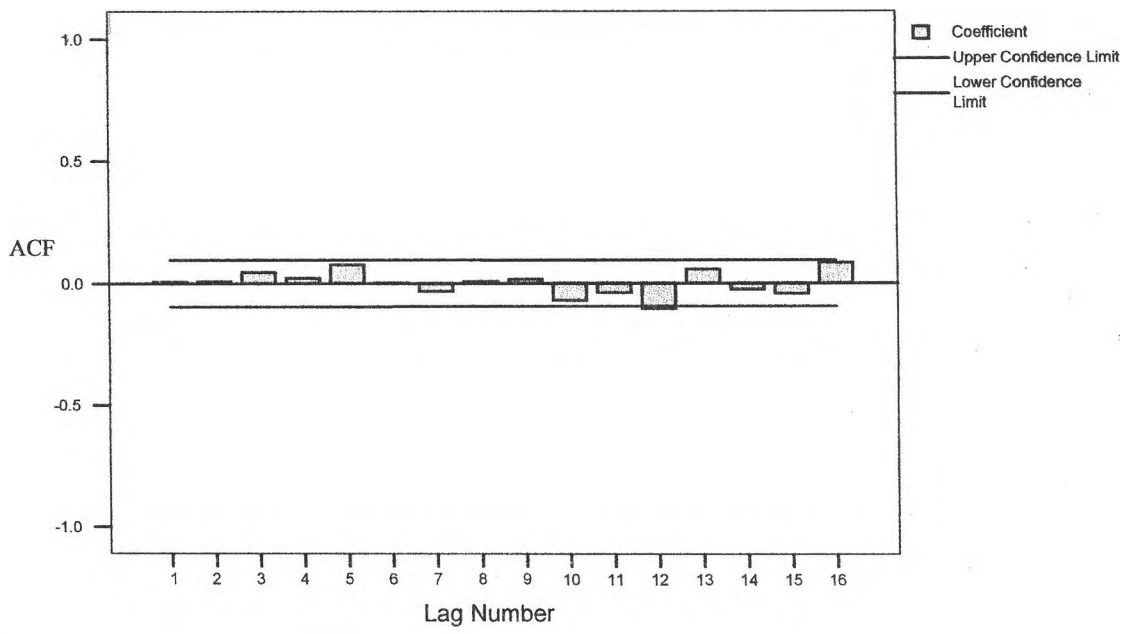
Table 3 Residuals Diagnostics

Number of Residuals	444
Number of Parameters	3
Residual df	440
Adjusted Residual Sum of Squares	.431
Residual Sum of Squares	.431
Residual Variance	.001
Model Std. Error	.031
Log-Likelihood	910.352
Akaike's Information Criterion	-1812.703
Schwarz's Bayesian Criterion	-1796.320

As Table 3 indicates, the residual sum of squares is low and suggested that the model was appropriate. In addition the autocorrelation function and the partial autocorrelation function of the residuals confirmed the adequacy of the model as the residual series was

not significantly different from zero as none of the correlations exceeded the 95 percent confidence level.

Figure 5 Residual Autocorrelation Plot



When a series is random, the autocorrelation between two consecutive values for any lag are close to zero. This implies that the successive values of the time series are not related to each other as seen in Figure 5.

Partial autocorrelation function removes the indirect effect of all intervening lags, thus providing the best measure of a direct relationship between time series values separated by a given lag. The partial autocorrelation function shown in Figure 6 provided definitive proof that the residuals of the model contained no significant relationship.

An overall check of the model adequacy was further provided by a chi-square test based on the Ljung-Box Q statistic. This test examines the sizes of the residual autocorrelations as a group. None of the values of Q were found to be significant (see Table 4), thus confirming that the model was adequate.

Figure 6 Residuals Partial Autocorrelation Function Plot

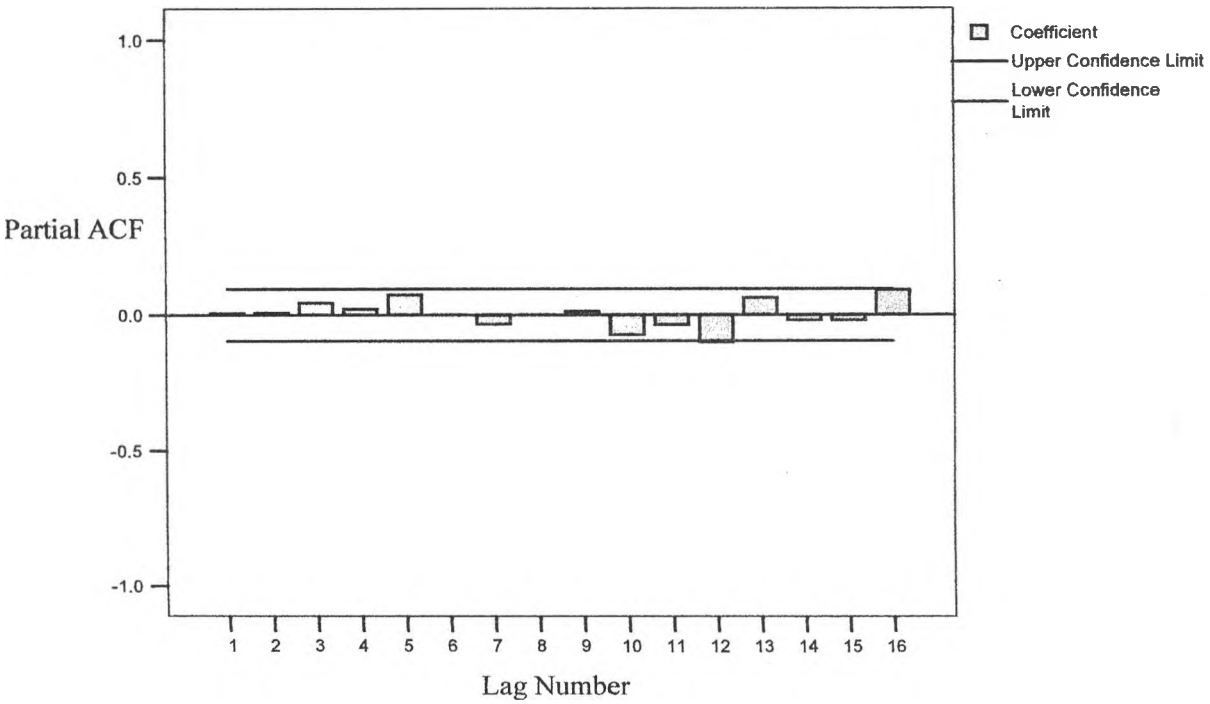


Table 4 Box-Ljung *Q* statistic

Lag	Autocorrelation	Std. Error[a]	Box-Ljung Statistic		
			Value	Df	Sig.[b]
1	.006	.047	.018	1	.893
2	.007	.047	.042	2	.979
3	.045	.047	.962	3	.810
4	.022	.047	1.179	4	.882
5	.075	.047	3.707	5	.592
6	.002	.047	3.709	6	.716
7	-.032	.047	4.167	7	.760
8	.007	.047	4.191	8	.840
9	.016	.047	4.305	9	.890
10	-.069	.047	6.493	10	.772
11	-.038	.047	7.143	11	.787
12	-.103	.047	12.046	12	.442
13	.056	.047	13.498	13	.410
14	-.024	.047	13.770	14	.467
15	-.041	.047	14.561	15	.483
16	.083	.046	17.726	16	.340

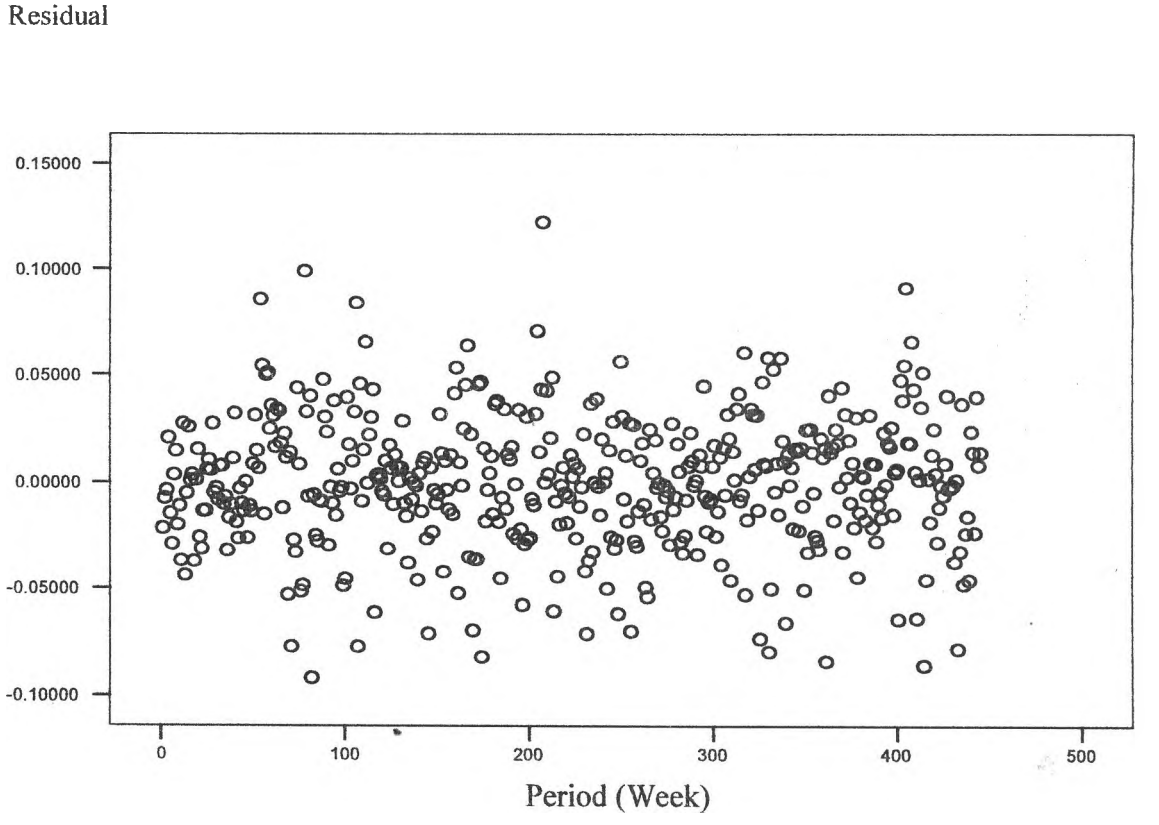
a The underlying process assumed is independence (white noise).

b Based on the asymptotic chi-square approximation.

The aptness of the selected model can be evaluated by plotting the residuals on the vertical axis against time on the horizontal axis. If the fitted model is appropriate for the data, there will be no apparent pattern in the plot. A plot of the residuals against time as seen in Figure 7 further confirmed that the residuals were without any pattern.

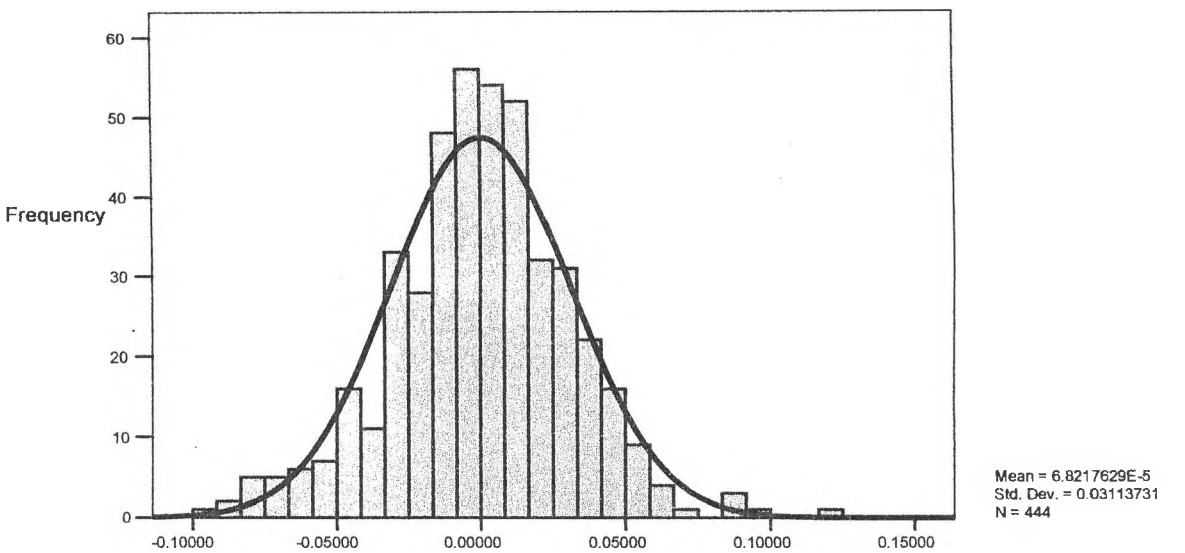
The assumption of homoscedasticity can also be evaluated from the plot of residuals against time. Homescedasticity refers to the constance of variance of the residuals with time which is a desirable feature. The major concern here is that the residuals may contain some serial dependency which may suggest that the UBJ-ARIMA model identified is inadequate.

Figure 7 Basis Ratio Residuals Versus Time in Weeks



The model selection procedure assumes that the residuals are also normally distributed. For this reason, it is also necessary to carry out a test, or tests, of normality. This can be done using a histogram or a normal probability plot. Both the normal probability plot and a histogram were used to check for the normality of the residuals in this study. The normal distribution function takes the form of a bell-shaped curve, which is symmetrical about the mean. A histogram, which basically condenses data by grouping similar values into classes, fitted over the normal distribution curve, helps in determining whether the residuals fit the normal distribution assumption.

Figure 8 Residuals Histogram

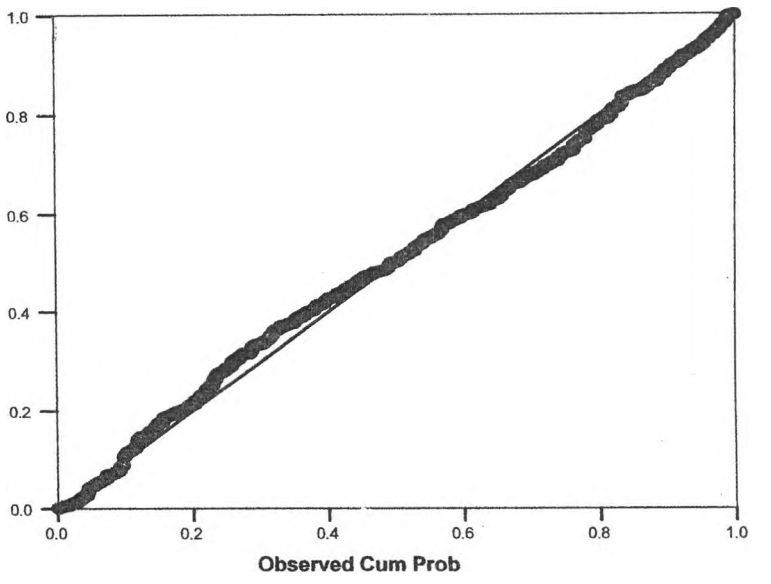


The histogram fitted the normal distribution function curve properly as shown in Figure 8. This implies that the normality assumption in relation to the residuals was not violated.

The other approach of evaluating the assumption of normality in data is through the use of a normal probability plot. If the plotted points in a normal probability plot lie on, or close to an imaginary straight line rising from the lower-left corner of the figure to the upper-right corner, then the residuals are normally distributed. On the other hand, if the plotted points deviate from this imaginary line in some patterned fashion, then the residuals are not normally distributed (Levine et al., 2003). As seen in Figure 9, the

plotted points were close to the imaginary line further confirming that the assumption of normality of the residuals was not violated.

Figure 9 Normal Probability Plot



4.4 Forecasting with the Model

It is important to point out that the ARIMA model identified is not used to directly forecast the spot price, but rather, the model is used to forecast the basis, which in turn is related to the spot price by the help of the WTI futures. The SPSS uses the ARIMA (3,0,0) model identified to forecast the basis for the month of July automatically. The forecasted basis is then used to forecast the spot price using the equation:

Spot price = Futures price/Forecasted basis

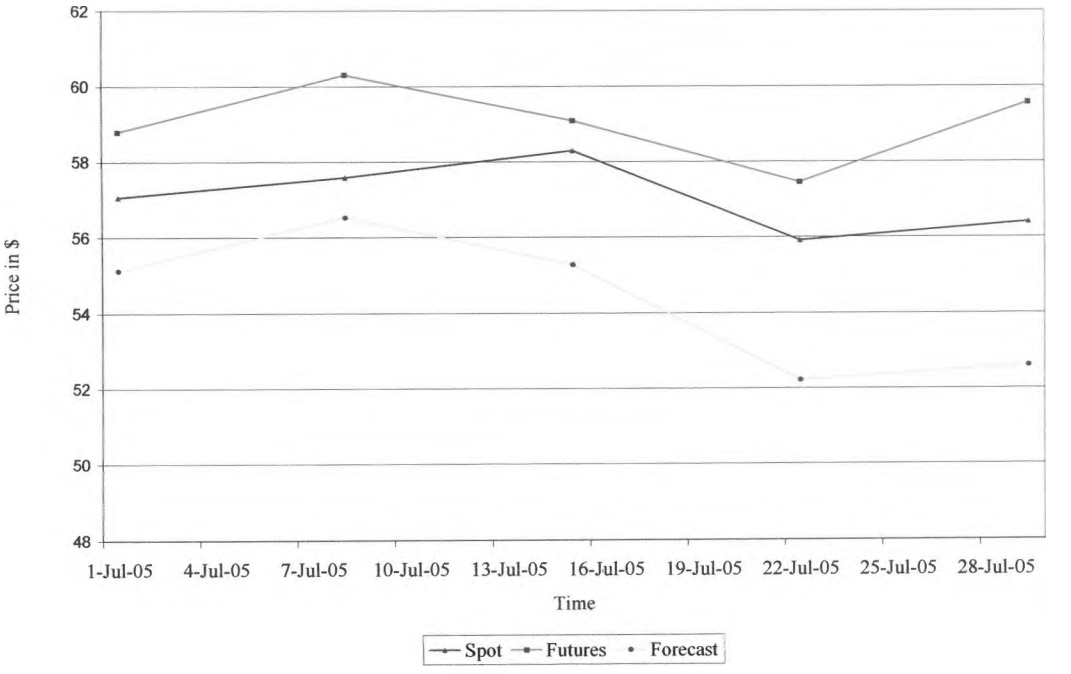
As shown in Figure 10 below, the futures prices were consistently above the spot prices. The reason for this being the uncertainties surrounding future supplies. It was, however, not clear why the forecasted prices were consistently below the spot prices. For this reason it was necessary to review the forecasting error to determine whether margin was acceptable or not.

Table 5 Murban Crude Spot Price Forecast for the Month of July 2005

Date	WTI Futures	Forecasted Basis	Forecasted Murban Crude Spot Prices
	USD per Barrel		USD per Barrel
1-July-2005	58.7900	1.06576	55.123
8-July-2005	60.3075	1.06687	56.530
15-July-2005	59.0880	1.06897	55.280
22-July-2005	57.4560	1.70550	52.220
29-July-2005	59.5640	1.07189	52.610

Figure 10 shows the forecasted Murban crude prices against the actual prices and the WTI futures prices.

Figure 10:Actual Spot Prices Versus Forecasted and Futures Prices for the Month of July 2005



As seen from Table 6, the forecasted prices are consistently lower than the spot prices. The mean absolute deviation (MAD) for the month of July was $ 2.70. MAD is useful in this case as it indicates the size of the error in the same units as the original series. The size of the error seems to be growing with time. For closer periods, the underestimation is

approximately $1 while for longer periods the gap seems to grow to about $3. This illustrates the difficulties of forecasting prices over long periods of time.

Table 6 Forecasting Error

Date	Murban Crude Spot Prices in $ per Barrel	WTI Futures Prices in $ per Barrel	Forecasted Murban Crude Spot Price	Forecasting Error
1-Jul	57.06	58.7900	55.12	1.94
8-Jul	57.59	60.3075	56.53	1.06
15-Jul	58.29	59.0880	55.28	3.01
22-Jul	55.91	57.4560	52.22	3.69
29-Jul	56.40	59.5640	52.61	3.79
MAD ($)				2.6974
MAPE (Percent)				4.74

The magnitude of the error is however small. This assertion is confirmed by the mean absolute percentage error (MAPE). This measure (MAPE) provides an indication of how large the forecast errors are in comparison to the actual values of a series. The rule of the thumb is that if the MAPE is lower that 10 percent then the results are satisfactory. As shown in Table 6, the value for MAPE is 4.74 percent, thus indicating that the size of the error is acceptable.

CONCLUSION, LIMITATIONS AND FURTHER RESEARCH

5.1 Conclusion

The petroleum oil sector is of critical importance to the Kenyan economy as well as to the whole world in general. Movements in the crude oil prices are of major concern to the oil-importing companies, the government, consumers and the general public at large. This is because the oil price shocks have repercussions touching on all sectors of the economy. To avoid the adverse effects of the crude oil price fluctuations, oil-importing companies in Kenya should be encouraged to use financial risk management instruments such as futures and options. The primary benefit derived from the use of such financial risk management instruments, is the reduction on the uncertainty regarding the crude oil prices that the oil-importing companies, and by extension the consumers, would have to pay rather than lower the average crude oil prices. However, for the oil-importing companies to be able to utilize these instruments effectively and realize any benefits, it is necessary that accurate forecasts of the Murban crude oil spot prices are obtained.

The ability to predict the spot price at a given location and time when companies plan to buy crude oil is desirable. For this reason, the information present in futures prices can be put into useful use. This would be achieved by using the basis, which serves as the connector between the futures price and the spot price being forecasted. The basis, though never fully predictable, can generally be predicted with far greater precision than the level of prices. Therefore, utilizing the time series properties of the basis, forecast of the same could be obtained and in turn the forecasted basis would be used to generate the spot price forecasts. Forecasting using time series data is based on the assumption that the future values of the series can be estimated from the past values. The goal of this study, therefore, was to develop a model that could be used in forecasting short-term (thirty days) Murban crude oil prices in Kenya. Specific objectives were to (1) identify a forecasting model; (2) develop the short-term forecasting model; and (3) cross-validate the developed model.

From the analysis carried out, an UBJ-ARIMA (3,0,0) model was identified as the most ideal. Identification of the model involved an examination of the plot of the basis time

series and its autocorrelations for several time lags. The autocorrelations and the partial autocorrelations of the series were found to match those of the UBJ-ARIMA (3,0,0) model. A short-term forecasting model for the basis, from which spot price forecasts were made, was then developed. Out-of-sample spot prices for the month of July 2005 were used to cross-validate the developed model. Cross-validation evaluates the forecasting accuracy of the model over a portion of the original sample data not used in the development of the model. The predictive ability of the model was found to be adequate. The mean absolute percent error of the model was at 4.74 percent. This was within the acceptable level of 10 percent. However, the model consistently underestimated the actual price. This problem was more pronounced for longer periods of time, thus, care should be exercised when using the model.

Although the model gives fairly good forecasts, it is important to note that available information can decrease the accuracy of forecast rapidly as information can change significantly over time. It is, therefore, necessary to interpret the forecasts in the context of the existing market conditions.

5.2 Limitations and Further Research

This study had the limitation of the availability of price data locally. For this reason, weekly data was obtained from the US department of energy website. The local industry players were also not willing to share information about the industry freely.

Further research work is recommended in looking at how local currency fluctuations against the US dollar could affect the crude oil prices in Kenya. Further research is also required in analyzing the basis risk. Basis risk arises since there is no perfectly matching hedging tool for a particular commodity. This is because of differences in quality, location and other characteristics between the hedging instrument and the underlying assets or from the differences in maturity. The results of the study also found out that the model identified was consistently underestimating the spot price. Further research is necessary to establish the reasons for this behaviour.

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Appendix

Period in Weeks	Date	Murban Crude Spot Price in USD per Barrel	WTI Futures Prices in USD per Barrel	Basis Ratio	Forecasted Basis Ratio	Residuals	95% Lower Confidence Level	95% Upper Confidence Level	Standard Error of Forecast
1	03-Jan-97	24.060	25.640	1.0657	1.08698	-0.02128	0.96336	1.2106	0.0629
2	10-Jan-97	24.810	26.336	1.0615	1.06874	-0.00724	1.00638	1.13109	0.03173
3	17-Jan-97	23.960	25.436	1.0616	1.06519	-0.00359	1.00319	1.12719	0.03155
4	24-Jan-97	22.560	24.500	1.086	1.06496	0.02104	1.00351	1.12641	0.03126
5	31-Jan-97	22.710	24.266	1.0685	1.08285	-0.01435	1.0214	1.1443	0.03126
6	07-Feb-97	22.560	23.482	1.0409	1.06968	-0.02878	1.00824	1.13113	0.03126
7	14-Feb-97	21.060	22.234	1.0557	1.05199	0.00371	0.99055	1.11344	0.03126
8	21-Feb-97	20.610	22.170	1.0757	1.06083	0.01487	0.99938	1.12227	0.03126
9	28-Feb-97	19.760	20.802	1.0527	1.07235	-0.01965	1.0109	1.1338	0.03126
10	07-Mar-97	19.810	20.724	1.0461	1.05695	-0.01085	0.9955	1.1184	0.03126
11	14-Mar-97	20.280	20.642	1.0179	1.05454	-0.03664	0.99309	1.11599	0.03126
12	21-Mar-97	20.580	21.770	1.0578	1.0302	0.0276	0.96875	1.09165	0.03126
13	28-Mar-97	20.380	20.700	1.0157	1.05943	-0.04373	0.99799	1.12088	0.03126
14	04-Apr-97	19.380	19.750	1.0191	1.02399	-0.00489	0.96255	1.08544	0.03126
15	11-Apr-97	18.330	19.390	1.0578	1.03172	0.02608	0.97027	1.09316	0.03126
16	18-Apr-97	18.630	19.682	1.0565	1.05545	0.00105	0.994	1.11689	0.03126
17	25-Apr-97	18.880	19.990	1.0588	1.05499	0.00381	0.99354	1.11643	0.03126
18	02-May-97	19.530	20.014	1.0248	1.0618	-0.037	1.00035	1.12324	0.03126
19	09-May-97	19.220	19.936	1.0373	1.03594	0.00136	0.97449	1.09738	0.03126
20	16-May-97	20.270	21.512	1.0613	1.04562	0.01568	0.98417	1.10707	0.03126
21	23-May-97	20.920	21.626	1.0337	1.05932	-0.02562	0.99788	1.12077	0.03126
22	30-May-97	20.670	20.858	1.0091	1.04015	-0.03105	0.9787	1.1016	0.03126
23	06-Jun-97	19.750	19.976	1.0114	1.02465	-0.01325	0.96321	1.0861	0.03126
24	13-Jun-97	18.500	18.680	1.0097	1.02272	-0.01302	0.96128	1.08417	0.03126
25	20-Jun-97	18.400	18.850	1.0245	1.01822	0.00628	0.95677	1.07966	0.03126
26	27-Jun-97	18.500	19.248	1.0404	1.0297	0.0107	0.96825	1.09115	0.03126
27	04-Jul-97	19.050	19.955	1.0475	1.04152	0.00598	0.98008	1.10297	0.03126
28	11-Jul-97	18.070	19.452	1.0765	1.04886	0.02764	0.98741	1.11031	0.03126
29	18-Jul-97	18.270	19.514	1.0681	1.07287	-0.00477	1.01143	1.13432	0.03126
30	25-Jul-97	18.320	19.510	1.065	1.06751	-0.00251	1.00607	1.12896	0.03126
31	01-Aug-97	18.920	20.076	1.0611	1.06896	-0.00786	1.00751	1.1304	0.03126
32	08-Aug-97	18.950	20.330	1.0728	1.0649	0.0079	1.00346	1.12635	0.03126
33	15-Aug-97	18.500	20.004	1.0813	1.07333	0.00797	1.01188	1.13478	0.03126
34	22-Aug-97	18.600	19.890	1.0694	1.07927	-0.00987	1.01782	1.14071	0.03126
35	29-Aug-97	18.300	19.492	1.0651	1.07182	-0.00672	1.01038	1.13327	0.03126
36	05-Sep-97	18.860	19.573	1.0378	1.06967	-0.03187	1.00822	1.13111	0.03126
37	12-Sep-97	18.810	19.396	1.0312	1.04747	-0.01627	0.98602	1.10891	0.03126
38	19-Sep-97	18.810	19.406	1.0317	1.04186	-0.01016	0.98041	1.10331	0.03126
39	26-Sep-97	19.160	20.118	1.05	1.03865	0.01135	0.9772	1.10009	0.03126
40	03-Oct-97	19.930	21.604	1.084	1.05161	0.03239	0.99016	1.11306	0.03126
41	10-Oct-97	20.830	22.058	1.059	1.07741	-0.01841	1.01596	1.13885	0.03126
42	17-Oct-97	20.130	20.830	1.0348	1.06098	-0.02618	0.99953	1.12243	0.03126
43	24-Oct-97	20.080	20.970	1.0443	1.0471	-0.0028	0.98565	1.10855	0.03126
44	31-Oct-97	20.080	20.908	1.0412	1.05095	-0.00975	0.98951	1.1124	0.03126
45	07-Nov-97	19.980	20.626	1.0323	1.04546	-0.01316	0.98401	1.1069	0.03126
46	14-Nov-97	19.820	20.620	1.0404	1.03997	0.00043	0.97852	1.10142	0.03126
47	21-Nov-97	19.420	19.804	1.0198	1.04567	-0.02587	0.98422	1.10711	0.03126
48	28-Nov-97	19.220	19.570	1.0182	1.02895	-0.01075	0.9675	1.0904	0.03126
49	05-Dec-97	18.420	18.706	1.0155	1.02876	-0.01326	0.96732	1.09021	0.03126
50	12-Dec-97	17.820	18.402	1.0327	1.02402	0.00868	0.96257	1.08546	0.03126
51	19-Dec-97	17.120	18.288	1.0682	1.0368	0.0314	0.97535	1.09825	0.03126
52	26-Dec-97	16.970	18.300	1.0784	1.06331	0.01509	1.00186	1.12475	0.03126
53	02-Jan-98	16.270	17.573	1.0801	1.07334	0.00676	1.01189	1.13479	0.03126
54	09-Jan-98	14.460	16.844	1.1649	1.0793	0.0856	1.01785	1.14075	0.03126
55	16-Jan-98	13.710	16.440	1.1991	1.14473	0.05437	1.08328	1.20617	0.03126
56	23-Jan-98	13.960	16.140	1.1562	1.17096	-0.01476	1.10951	1.23241	0.03126
57	30-Jan-98	14.360	17.228	1.1997	1.14973	0.04997	1.08828	1.21117	0.03126
58	06-Feb-98	13.440	16.640	1.2381	1.18701	0.05109	1.12556	1.24845	0.03126
59	13-Feb-98	13.140	16.238	1.2358	1.21048	0.02532	1.14904	1.27193	0.03126
60	20-Feb-98	12.840	16.055	1.2504	1.21452	0.03588	1.15308	1.27597	0.03126

Period in Weeks	Date	Murban Crude Spot Price in USD per Barrel	WTI Futures Prices in USD per Barrel	Basis Ratio	Forecasted Basis Ratio	Residuals	95% Lower Confidence Level	95% Upper Confidence Level	Standard Error of Forecast
61	27-Feb-98	12.190	15.384	1.262	1.23059	0.03141	1.16914	1.29204	0.03126
62	06-Mar-98	12.130	15.234	1.2559	1.23908	0.01682	1.17764	1.30053	0.03126
63	13-Mar-98	11.180	14.206	1.2707	1.23641	0.03429	1.17496	1.29786	0.03126
64	20-Mar-98	10.830	13.892	1.2827	1.2491	0.0336	1.18766	1.31055	0.03126
65	27-Mar-98	12.930	16.500	1.2761	1.2574	0.0187	1.19596	1.31885	0.03126
66	03-Apr-98	12.730	15.818	1.2426	1.25438	-0 01178	1.19293	1.31582	0.03126
67	10-Apr-98	12.320	15.445	1.2537	1.23062	0.02308	1.16918	1.29207	0.03126
68	17-Apr-98	12.370	15.460	1.2498	1.23808	0.01172	1.17663	1.29953	0.03126
69	24-Apr-98	13.020	15.336	1.1779	1.23076	-0.05286	1.16931	1.29221	0.03126
70	01-May-98	13.070	15.580	1.192	1.17787	0.01413	1.11643	1.23932	0.03126
71	08-May-98	13.890	15.432	1.111	1.18788	-0.07688	1.12643	1.24932	0.03126
72	15-May-98	13.740	14.982	1.0904	1.11726	-0.02686	1.05581	1.17871	0.03126
73	22-May-98	13.190	14.124	1.0708	1.10338	-0.03258	1.04194	1.16483	0.03126
74	29-May-98	13.340	14.965	1.1218	1.07791	0.04389	1.01646	1.13936	0.03126
75	05-Jun-98	13.330	14.960	1.1223	1.11371	0.00859	1.05227	1.17516	0.03126
76	12-Jun-98	12.680	13.444	1.0603	1.11162	-0.05132	1.05017	1.17306	0.03126
77	19-Jun-98	11.680	11.950	1.0231	1.07145	-0.04835	1.01001	1.1329	0.03126
78	26-Jun-98	12.380	14.142	1.1423	1.04328	0.09902	0.98184	1.10473	0.03126
79	03-Jul-98	12.330	14.280	1.1582	1.12516	0.03304	1.06372	1.18661	0.03126
80	10-Jul-98	12.280	13.828	1.1261	1.13253	-0.00643	1.07109	1.19398	0.03126
81	17-Jul-98	12.340	14.366	1.1642	1.12394	0.04026	1.06249	1.18538	0.03126
82	24-Jul-98	12.990	13.808	1.063	1.15475	-0.09175	1.09331	1.2162	0.03126
83	31-Jul-98	13.290	14.200	1.0685	1.07414	-0.00564	1.01269	1.13558	0.03126
84	07-Aug-98	12.980	13.738	1.0584	1.0831	-0.0247	1.02165	1.14454	0.03126
85	14-Aug-98	12.580	13.016	1.0347	1.0622	-0.0275	1.00075	1.12365	0.03126
86	21-Aug-98	12.770	13.238	1.0366	1.04499	-0.00839	0.98354	1.10644	0.03126
87	28-Aug-98	13.070	13.544	1.0363	1.04506	-0.00876	0.98361	1.1065	0.03126
88	04-Sep-98	12.850	14.000	1.0895	1.04173	0.04777	0.98028	1.10317	0.03126
89	11-Sep-98	12.900	14.355	1.1128	1.08218	0.03062	1.02073	1.14363	0.03126
90	18-Sep-98	13.150	14.774	1.1235	1.09985	0.02365	1.0384	1.1613	0.03126
91	25-Sep-98	14.500	15.740	1.0855	1.11496	-0.02946	1.05351	1.17641	0.03126
92	02-Oct-98	14.500	15.766	1.0873	1.08932	-0.00202	1.02787	1.15077	0.03126
93	09-Oct-98	13.850	14.990	1.0823	1.09201	-0.00971	1.03056	1.15346	0.03126
94	16-Oct-98	12.650	14.184	1.1213	1.08325	0.03805	1.0218	1.1447	0.03126
95	23-Oct-98	12.550	13.776	1.0977	1.11295	-0.01525	1.0515	1.1744	0.03126
96	30-Oct-98	13.100	14.420	1.1008	1.09453	0.00627	1.03309	1.15598	0.03126
97	06-Nov-98	12.850	14.108	1.0979	1.10195	-0.00405	1.0405	1.16339	0.03126
98	13-Nov-98	12.400	13.572	1.0945	1.09667	-0.00217	1.03522	1.15811	0.03126
99	20-Nov-98	11.800	12.340	1.0458	1.0945	-0.0487	1.03305	1.15594	0.03126
100	27-Nov-98	12.000	12.143	1.0119	1.05731	-0.04541	0.99586	1.11875	0.03126
101	04-Dec-98	10.450	11.190	1.0708	1.03115	0.03965	0.9697	1.09259	0.03126
102	11-Dec-98	10.200	11.088	1.0871	1.06921	0.01789	1.00776	1.13065	0.03126
103	18-Dec-98	10.650	11.440	1.0742	1.07719	-0.00299	1.01575	1.13864	0.03126
104	25-Dec-98	10.250	11.123	1.0852	1.0752	0.01	1.01375	1.13665	0.03126
105	01-Jan-99	10.500	11.745	1.1186	1.08563	0.03297	1.02418	1.14707	0.03126
106	08-Jan-99	10.610	12.658	1.193	1.1092	0.0838	1.04775	1.17064	0.03126
107	15-Jan-99	11.110	12.110	1.09	1.16693	-0.07693	1.10548	1.22838	0.03126
108	22-Jan-99	10.760	12.260	1.1394	1.09361	0.04579	1.03217	1.15506	0.03126
109	29-Jan-99	10.960	12.404	1.1318	1.14051	-0.00871	1.07906	1.20195	0.03126
110	05-Feb-99	10.710	12.174	1.1367	1.12135	0.01535	1.0599	1.1828	0.03126
111	12-Feb-99	9.830	11.766	1.1969	1.13152	0.06538	1.07007	1.19296	0.03126
112	19-Feb-99	9.930	11.675	1.1757	1.17602	-0.00032	1.11458	1.23747	0.03126
113	26-Feb-99	10.480	12.400	1.1832	1.16076	0.02244	1.09932	1.22221	0.03126
114	05-Mar-99	10.680	12.866	1.2047	1.17428	0.03042	1.11284	1.23573	0.03126
115	12-Mar-99	11.530	14.194	1.231	1.18777	0.04323	1.12632	1.24921	0.03126
116	19-Mar-99	12.930	14.840	1.1477	1.20867	-0.06097	1.14722	1.27011	0.03126
117	26-Mar-99	13.580	15.638	1.1515	1.14859	0.00291	1.08714	1.21003	0.03126
118	02-Apr-99	14.380	16.660	1.1586	1.15475	0.00385	1.0933	1.21619	0.03126
119	09-Apr-99	14.280	16.438	1.1511	1.14919	0.00191	1.08775	1.21064	0.03126
120	16-Apr-99	14.700	16.758	1.14	1.14404	-0.00404	1.08259	1.20548	0.03126
121	23-Apr-99	15.850	17.924	1.1309	1.13657	-0.00567	1.07512	1.19801	0.03126
122	30-Apr-99	16.000	18.222	1.1389	1.12868	0.01022	1.06724	1.19013	0.03126

Period in Weeks	Date	Murban Crude Spot Price in USD per Barrel	WTI Futures Prices in USD per Barrel	Basis Ratio	Forecasted Basis Ratio	Residuals	95% Lower Confidence Level	95% Upper Confidence Level	Standard Error of Forecast
123	07-May-99	16.930	18.658	1.1021	1.13326	-0.03116	1.07181	1.1947	0.03126
124	14-May-99	16.080	18.040	1.1219	1.10427	0.01763	1.04282	1.16571	0.03126
125	21-May-99	15.330	17.274	1.1268	1.12021	0.00659	1.05876	1.18166	0.03126
126	28-May-99	15.430	17.112	1.109	1.11912	-0.01012	1.05768	1.18057	0.03126
127	04-Jun-99	14.950	16.763	1.1213	1.10828	0.01302	1.04683	1.16972	0.03126
128	11-Jun-99	15.950	17.958	1.1259	1.11818	0.00772	1.05674	1.17963	0.03126
129	18-Jun-99	16.250	18.200	1.12	1.11935	0.00065	1.0579	1.18079	0.03126
130	25-Jun-99	16.100	18.088	1.1235	1.11651	0.00699	1.05506	1.17796	0.03126
131	02-Jul-99	16.550	19.008	1.1485	1.11975	0.02875	1.0583	1.18119	0.03126
132	09-Jul-99	17.550	19.800	1.1282	1.13787	-0.00967	1.07643	1.19932	0.03126
133	16-Jul-99	18.200	20.152	1.1073	1.12304	-0.01574	1.06159	1.18449	0.03126
134	23-Jul-99	18.650	20.006	1.0727	1.11048	-0.03778	1.04904	1.17193	0.03126
135	30-Jul-99	19.000	20.588	1.0836	1.08163	0.00197	1.02019	1.14308	0.03126
136	06-Aug-99	19.020	20.526	1.0792	1.08706	-0.00786	1.02562	1.14851	0.03126
137	13-Aug-99	19.870	21.448	1.0794	1.07922	0.00018	1.01777	1.14067	0.03126
138	20-Aug-99	20.020	21.608	1.0793	1.08079	-0.00149	1.01935	1.14224	0.03126
139	27-Aug-99	20.520	21.222	1.0342	1.08014	-0.04594	1.01869	1.14159	0.03126
140	03-Sep-99	20.870	21.920	1.0503	1.04608	0.00422	0.98464	1.10753	0.03126
141	10-Sep-99	22.020	23.005	1.0447	1.05815	-0.01345	0.9967	1.1196	0.03126
142	17-Sep-99	22.970	24.286	1.0573	1.04803	0.00927	0.98659	1.10948	0.03126
143	24-Sep-99	22.870	24.500	1.0713	1.05966	0.01164	0.99821	1.1211	0.03126
144	01-Oct-99	23.520	24.536	1.0432	1.06953	-0.02633	1.00808	1.13097	0.03126
145	08-Oct-99	23.250	22.766	0.9792	1.04997	-0.07077	0.98852	1.11142	0.03126
146	15-Oct-99	22.150	22.380	1.0104	1.00339	0.00701	0.94194	1.06483	0.03126
147	22-Oct-99	22.600	22.602	1.0001	1.02316	-0.02306	0.96171	1.0846	0.03126
148	29-Oct-99	22.500	22.578	1.0035	1.00704	-0.00354	0.94559	1.06848	0.03126
149	05-Nov-99	22.630	22.720	1.004	1.01368	-0.00968	0.95223	1.07513	0.03126
150	12-Nov-99	24.030	24.202	1.0072	1.01271	-0.00551	0.95127	1.07416	0.03126
151	19-Nov-99	24.780	25.958	1.0475	1.01558	0.03192	0.95413	1.07703	0.03126
152	26-Nov-99	25.280	26.793	1.0598	1.04611	0.01369	0.98466	1.10755	0.03126
153	03-Dec-99	25.090	25.436	1.0138	1.0559	-0.0421	0.99445	1.11735	0.03126
154	10-Dec-99	25.240	26.160	1.0365	1.02645	0.01005	0.965	1.08789	0.03126
155	17-Dec-99	25.160	26.208	1.0417	1.04512	-0.00342	0.98368	1.10657	0.03126
156	24-Dec-99	25.240	26.011	1.0305	1.04307	-0.01257	0.98162	1.10451	0.03126
157	31-Dec-99	25.040	26.305	1.0505	1.03759	0.01291	0.97614	1.09903	0.03126
158	07-Jan-00	23.940	24.865	1.0386	1.05336	-0.01476	0.99192	1.11481	0.03126
159	14-Jan-00	24.240	26.286	1.0844	1.04294	0.04146	0.98149	1.10439	0.03126
160	21-Jan-00	25.640	29.063	1.1335	1.08015	0.05335	1.01871	1.1416	0.03126
161	28-Jan-00	26.040	27.698	1.0637	1.11579	-0.05209	1.05434	1.17723	0.03126
162	04-Feb-00	26.010	28.052	1.0785	1.06914	0.00936	1.00769	1.13058	0.03126
163	11-Feb-00	26.560	28.822	1.0852	1.08663	-0.00143	1.02518	1.14807	0.03126
164	18-Feb-00	26.960	29.866	1.1078	1.08257	0.02523	1.02112	1.14401	0.03126
165	25-Feb-00	26.010	29.833	1.147	1.1016	0.0454	1.04015	1.16305	0.03126
166	03-Mar-00	26.010	31.106	1.1959	1.13215	0.06375	1.0707	1.19359	0.03126
167	10-Mar-00	28.320	32.204	1.1371	1.17214	-0.03504	1.11069	1.23359	0.03126
168	17-Mar-00	27.070	31.286	1.1557	1.13294	0.02276	1.07149	1.19439	0.03126
169	24-Mar-00	25.870	28.044	1.084	1.1533	-0.0693	1.09185	1.21474	0.03126
170	31-Mar-00	25.570	26.986	1.0554	1.09143	-0.03603	1.02999	1.15288	0.03126
171	07-Apr-00	24.790	25.688	1.0362	1.07212	-0.03592	1.01067	1.13357	0.03126
172	14-Apr-00	22.740	24.870	1.0937	1.04815	0.04555	0.98671	1.1096	0.03126
173	21-Apr-00	23.190	26.308	1.1345	1.08782	0.04668	1.02637	1.14927	0.03126
174	28-Apr-00	24.590	25.436	1.0344	1.11625	-0.08185	1.0548	1.17769	0.03126
175	05-May-00	25.140	26.756	1.0643	1.04822	0.01608	0.98677	1.10966	0.03126
176	12-May-00	27.140	28.714	1.058	1.07597	-0.01797	1.01452	1.13742	0.03126
177	19-May-00	28.290	29.838	1.0547	1.05814	-0.00344	0.99669	1.11959	0.03126
178	26-May-00	27.790	29.566	1.0639	1.05955	0.00435	0.99811	1.121	0.03126
179	02-Jun-00	27.790	29.963	1.0782	1.06567	0.01253	1.00423	1.12712	0.03126
180	09-Jun-00	28.150	29.876	1.0613	1.07607	-0.01477	1.01462	1.13751	0.03126
181	16-Jun-00	29.500	32.486	1.1012	1.06453	0.03667	1.00308	1.12598	0.03126
182	23-Jun-00	28.300	32.110	1.1346	1.09653	0.03807	1.03508	1.15797	0.03126
183	30-Jun-00	29.200	32.162	1.1014	1.11963	-0.01823	1.05818	1.18107	0.03126
184	07-Jul-00	28.740	30.313	1.0547	1.09983	-0.04513	1.03839	1.16128	0.03126

Period in Weeks	Date	Murban Crude Spot Price in USD per Barrel	WTI Futures Prices in USD per Barrel	Basis Ratio	Forecasted Basis Ratio	Residuals	95% Lower Confidence Level	95% Upper Confidence Level	Standard Error of Forecast
185	14-Jul-00	28.740	30.516	1.0618	1.06886	-0.00706	1.00741	1.13031	0.03126
186	21-Jul-00	27.840	30.736	1.104	1.06978	0.03422	1.00833	1.13123	0.03126
187	28-Jul-00	25.840	27.996	1.0834	1.09556	-0.01216	1.03411	1.15701	0.03126
188	04-Aug-00	25.970	28.420	1.0943	1.081	0.0133	1.01956	1.14245	0.03126
189	11-Aug-00	27.270	30.148	1.1055	1.09474	0.01076	1.03329	1.15618	0.03126
190	18-Aug-00	28.520	31.868	1.1174	1.10052	0.01688	1.03907	1.16197	0.03126
191	25-Aug-00	29.320	31.874	1.0871	1.11097	-0.02387	1.04952	1.17241	0.03126
192	31-Aug-00	30.320	33.013	1.0888	1.08956	-0.00076	1.02811	1.15101	0.03126
193	08-Sep-00	32.100	34.226	1.0662	1.09235	-0.02615	1.0309	1.15379	0.03126
194	15-Sep-00	31.350	34.650	1.1053	1.0713	0.034	1.00985	1.13274	0.03126
195	22-Sep-00	32.850	35.454	1.0793	1.10102	-0.02172	1.03958	1.16247	0.03126
196	29-Sep-00	30.500	31.142	1.021	1.07849	-0.05749	1.01704	1.13993	0.03126
197	06-Oct-00	31.080	31.414	1.0107	1.0395	-0.0288	0.97806	1.10095	0.03126
198	13-Oct-00	31.980	33.868	1.059	1.0282	0.0308	0.96675	1.08964	0.03126
199	20-Oct-00	32.230	33.210	1.0304	1.05703	-0.02663	0.99559	1.11848	0.03126
200	27-Oct-00	33.030	33.308	1.0084	1.03416	-0.02576	0.97272	1.09561	0.03126
201	03-Nov-00	32.280	32.802	1.0162	1.02382	-0.00762	0.96237	1.08526	0.03126
202	10-Nov-00	32.980	33.488	1.0154	1.02592	-0.01052	0.96447	1.08736	0.03126
203	17-Nov-00	33.280	35.098	1.0546	1.02244	0.03216	0.961	1.08389	0.03126
204	24-Nov-00	31.380	35.260	1.1236	1.05309	0.07051	0.99164	1.11453	0.03126
205	01-Dec-00	30.380	34.014	1.1196	1.1052	0.0144	1.04376	1.16665	0.03126
206	08-Dec-00	25.790	29.678	1.1508	1.10746	0.04334	1.04601	1.1689	0.03126
207	15-Dec-00	22.940	28.956	1.2622	1.14008	0.12212	1.07863	1.20152	0.03126
208	22-Dec-00	22.390	27.404	1.2239	1.2238	0.0001	1.16235	1.28525	0.03126
209	29-Dec-00	21.290	26.440	1.2419	1.19916	0.04274	1.13772	1.26061	0.03126
210	05-Jan-01	22.600	27.825	1.2312	1.2273	0.0039	1.16586	1.28875	0.03126
211	12-Jan-01	23.300	28.780	1.2352	1.21423	0.02097	1.15278	1.27568	0.03126
212	19-Jan-01	24.150	30.633	1.2684	1.21959	0.04881	1.15815	1.28104	0.03126
213	26-Jan-01	25.350	29.988	1.183	1.24329	-0.06029	1.18184	1.30473	0.03126
214	02-Feb-01	25.250	29.558	1.1706	1.17934	-0.00874	1.11789	1.24078	0.03126
215	09-Feb-01	27.400	30.958	1.1299	1.17415	-0.04425	1.11271	1.2356	0.03126
216	16-Feb-01	26.700	29.708	1.1127	1.13217	-0.01947	1.07072	1.19362	0.03126
217	23-Feb-01	25.750	28.743	1.1162	1.11747	-0.00127	1.05602	1.17891	0.03126
218	02-Mar-01	24.850	27.880	1.1219	1.11474	0.00716	1.05329	1.17619	0.03126
219	09-Mar-01	25.600	28.464	1.1119	1.1168	-0.0049	1.05535	1.17825	0.03126
220	16-Mar-01	24.800	27.058	1.091	1.10971	-0.01871	1.04827	1.17116	0.03126
221	23-Mar-01	24.400	26.550	1.0881	1.09465	-0.00655	1.0332	1.15609	0.03126
222	30-Mar-01	24.300	26.830	1.1041	1.0911	0.013	1.02966	1.15255	0.03126
223	06-Apr-01	24.150	26.644	1.1033	1.10045	0.00285	1.039	1.16189	0.03126
224	13-Apr-01	25.300	28.048	1.1086	1.09949	0.00911	1.03805	1.16094	0.03126
225	20-Apr-01	25.950	28.016	1.0796	1.1056	-0.026	1.04415	1.16704	0.03126
226	27-Apr-01	25.400	27.694	1.0903	1.08359	0.00671	1.02214	1.14503	0.03126
227	04-May-01	26.270	28.402	1.0812	1.09231	-0.01111	1.03086	1.15376	0.03126
228	11-May-01	26.020	28.092	1.0796	1.08165	-0.00205	1.0202	1.1431	0.03126
229	18-May-01	26.320	29.074	1.1046	1.08183	0.02277	1.02038	1.14327	0.03126
230	25-May-01	27.620	29.218	1.0579	1.09952	-0.04162	1.03808	1.16097	0.03126
231	01-Jun-01	28.570	28.378	0.9933	1.06407	-0.07077	1.00262	1.12552	0.03126
232	08-Jun-01	28.550	28.034	0.9819	1.01844	-0.03654	0.95699	1.07988	0.03126
233	15-Jun-01	27.800	28.922	1.0404	1.00357	0.03683	0.94213	1.06502	0.03126
234	22-Jun-01	26.800	26.984	1.0069	1.03929	-0.03239	0.97784	1.10074	0.03126
235	29-Jun-01	26.000	26.330	1.0127	1.01259	0.00011	0.95114	1.07404	0.03126
236	06-Jul-01	25.250	26.855	1.0636	1.02458	0.03902	0.96313	1.08603	0.03126
237	13-Jul-01	25.650	27.110	1.0569	1.05866	-0.00176	0.99722	1.12011	0.03126
238	20-Jul-01	24.400	25.362	1.0394	1.05446	-0.01506	0.99301	1.11591	0.03126
239	27-Jul-01	24.900	26.604	1.0684	1.0479	0.0205	0.98645	1.10934	0.03126
240	03-Aug-01	25.270	27.016	1.0691	1.0689	0.0002	1.00745	1.13035	0.03126
241	10-Aug-01	25.920	27.782	1.0718	1.06719	0.00461	1.00574	1.12864	0.03126
242	17-Aug-01	26.870	27.494	1.0232	1.07304	-0.04984	1.01159	1.13448	0.03126
243	24-Aug-01	25.670	26.998	1.0517	1.03641	0.01529	0.97496	1.09785	0.03126
244	31-Aug-01	26.070	26.928	1.0329	1.0582	-0.0253	0.99676	1.11965	0.03126
245	07-Sep-01	25.670	27.373	1.0663	1.03768	0.02862	0.97623	1.09912	0.03126
246	14-Sep-01	26.870	27.830	1.0357	1.06662	-0.03092	1.00517	1.12807	0.03126

Period in Weeks	Date	Murban Crude Spot Price in USD per Barrel	WTI Futures Prices in USD per Barrel	Basis Ratio	Forecasted Basis Ratio	Residuals	95% Lower Confidence Level	95% Upper Confidence Level	Standard Error of Forecast
247	21-Sep-01	26.770	27.158	1.0145	1.04109	-0.02659	0.97965	1.10254	0.03126
248	28-Sep-01	23.220	22.474	0.9679	1.02939	-0.06149	0.96795	1.09084	0.03126
249	05-Oct-01	21.630	22.634	1.0464	0.99012	0.05628	0.92868	1.05157	0.03126
250	12-Oct-01	21.030	22.660	1.0775	1.04658	0.03092	0.98513	1.10802	0.03126
251	19-Oct-01	20.680	21.848	1.0565	1.06412	-0.00762	1.00267	1.12557	0.03126
252	26-Oct-01	20.530	21.996	1.0714	1.0586	0.0128	0.99716	1.12005	0.03126
253	02-Nov-01	20.030	21.154	1.0561	1.0739	-0.0178	1.01246	1.13535	0.03126
254	09-Nov-01	19.020	20.684	1.0875	1.05962	0.02788	0.99817	1.12106	0.03126
255	16-Nov-01	19.320	19.624	1.0157	1.08527	-0.06957	1.02382	1.14672	0.03126
256	23-Nov-01	17.620	18.610	1.0562	1.02906	0.02714	0.96762	1.09051	0.03126
257	30-Nov-01	18.420	19.090	1.0364	1.06365	-0.02725	1.0022	1.1251	0.03126
258	07-Dec-01	19.180	19.362	1.0095	1.03935	-0.02985	0.9779	1.10079	0.03126
259	14-Dec-01	18.230	18.432	1.0111	1.02429	-0.01319	0.96284	1.08574	0.03126
260	21-Dec-01	18.830	19.456	1.0332	1.02285	0.01035	0.96141	1.0843	0.03126
261	28-Dec-01	19.780	20.860	1.0546	1.03603	0.01857	0.97458	1.09747	0.03126
262	04-Jan-02	19.870	20.710	1.0423	1.05245	-0.01015	0.99101	1.1139	0.03126
263	11-Jan-02	20.660	20.594	0.9968	1.0461	-0.0493	0.98465	1.10754	0.03126
264	18-Jan-02	19.280	18.524	0.9608	1.01449	-0.05369	0.95305	1.07594	0.03126
265	25-Jan-02	19.180	19.383	1.0106	0.98559	0.02501	0.92414	1.04703	0.03126
266	01-Feb-02	19.710	19.714	1.0002	1.01719	-0.01699	0.95574	1.07863	0.03126
267	08-Feb-02	19.780	19.964	1.0093	1.0047	0.0046	0.94325	1.06615	0.03126
268	15-Feb-02	20.430	21.210	1.0382	1.01809	0.02011	0.95664	1.07954	0.03126
269	22-Feb-02	20.070	20.798	1.0363	1.03858	-0.00228	0.97714	1.10003	0.03126
270	01-Mar-02	20.670	21.464	1.0384	1.0384	0	0.97695	1.09984	0.03126
271	08-Mar-02	22.630	23.264	1.028	1.04377	-0.01577	0.98232	1.10522	0.03126
272	15-Mar-02	24.030	24.348	1.0132	1.03567	-0.02247	0.97422	1.09711	0.03126
273	22-Mar-02	24.590	25.170	1.0236	1.02474	-0.00114	0.96329	1.08618	0.03126
274	29-Mar-02	25.020	25.633	1.0245	1.0312	-0.0067	0.96976	1.09265	0.03126
275	05-Apr-02	26.300	26.988	1.0262	1.02996	-0.00376	0.96852	1.09141	0.03126
276	12-Apr-02	25.300	25.390	1.0036	1.03261	-0.02901	0.97117	1.09406	0.03126
277	19-Apr-02	24.500	25.564	1.0434	1.01566	0.02774	0.95421	1.0771	0.03126
278	26-Apr-02	25.760	26.622	1.0335	1.04591	-0.01241	0.98447	1.10736	0.03126
279	03-May-02	26.140	26.894	1.0288	1.03554	-0.00674	0.9741	1.09699	0.03126
280	10-May-02	25.820	27.254	1.0555	1.03719	0.01831	0.97575	1.09864	0.03126
281	17-May-02	26.760	28.404	1.0614	1.05606	0.00534	0.99462	1.11751	0.03126
282	24-May-02	25.970	26.812	1.0324	1.05996	-0.02756	0.99851	1.1214	0.03126
283	31-May-02	25.040	25.253	1.0085	1.04155	-0.03305	0.98011	1.103	0.03126
284	07-Jun-02	24.980	24.968	0.9995	1.02421	-0.02471	0.96276	1.08566	0.03126
285	14-Jun-02	24.790	24.926	1.0055	1.01356	-0.00806	0.95211	1.07501	0.03126
286	21-Jun-02	25.070	25.636	1.0226	1.01494	0.00766	0.95349	1.07639	0.03126
287	28-Jun-02	25.380	26.654	1.0502	1.0267	0.0235	0.96525	1.08814	0.03126
288	05-Jul-02	25.310	26.793	1.0586	1.04837	0.01023	0.98693	1.10982	0.03126
289	12-Jul-02	25.240	26.648	1.0558	1.05702	-0.00122	0.99557	1.11846	0.03126
290	19-Jul-02	26.070	27.620	1.0595	1.05854	0.00096	0.99709	1.11998	0.03126
291	26-Jul-02	25.870	26.618	1.0289	1.06243	-0.03353	1.00098	1.12388	0.03126
292	02-Aug-02	25.520	26.848	1.052	1.03894	0.01306	0.9775	1.10039	0.03126
293	09-Aug-02	25.130	26.756	1.0647	1.05683	0.00787	0.99538	1.11827	0.03126
294	16-Aug-02	25.700	28.460	1.1074	1.06246	0.04494	1.00101	1.1239	0.03126
295	23-Aug-02	26.870	29.332	1.0916	1.09778	-0.00618	1.03633	1.15923	0.03126
296	30-Aug-02	27.110	28.870	1.0649	1.08759	-0.02269	1.02614	1.14904	0.03126
297	06-Sep-02	26.940	28.663	1.064	1.07298	-0.00898	1.01153	1.13443	0.03126
298	13-Sep-02	27.840	29.578	1.0624	1.07018	-0.00778	1.00873	1.13162	0.03126
299	20-Sep-02	27.460	29.468	1.0731	1.06546	0.00764	1.00402	1.12691	0.03126
300	27-Sep-02	28.060	30.614	1.091	1.07343	0.01757	1.01198	1.13488	0.03126
301	04-Oct-02	28.470	30.230	1.0618	1.08677	-0.02497	1.02532	1.14821	0.03126
302	11-Oct-02	27.890	29.362	1.0528	1.06614	-0.01334	1.00469	1.12758	0.03126
303	18-Oct-02	27.650	29.688	1.0737	1.06163	0.01207	1.00018	1.12307	0.03126
304	25-Oct-02	27.000	27.944	1.035	1.07358	-0.03858	1.01213	1.13502	0.03126
305	01-Nov-02	25.540	27.062	1.0596	1.04319	0.01641	0.98174	1.10464	0.03126
306	08-Nov-02	24.560	26.004	1.0588	1.06445	-0.00565	1.003	1.12589	0.03126
307	15-Nov-02	23.440	25.566	1.0907	1.05881	0.03189	0.99737	1.12026	0.03126
308	22-Nov-02	24.070	26.644	1.1069	1.08615	0.02075	1.0247	1.14759	0.03126

Period in Weeks	Date	Murban Crude Spot Price in USD per Barrel	WTI Futures Prices in USD per Barrel	Basis Ratio	Forecasted Basis Ratio	Residuals	95% Lower Confidence Level	95% Upper Confidence Level	Standard Error of Forecast
309	29-Nov-02	25.150	26.467	1.0524	1.09835	-0.04595	1.0369	1.15979	0.03126
310	06-Dec-02	25.180	27.094	1.076	1.06137	0.01463	0.99993	1.12282	0.03126
311	13-Dec-02	25.640	27.758	1.0826	1.08123	0.00137	1.01978	1.14267	0.03126
312	20-Dec-02	27.210	30.300	1.1136	1.07911	0.03449	1.01767	1.14056	0.03126
313	27-Dec-02	28.100	32.233	1.1471	1.10565	0.04145	1.0442	1.1671	0.03126
314	03-Jan-03	28.370	31.875	1.1235	1.13189	-0.00839	1.07045	1.19334	0.03126
315	10-Jan-03	28.290	31.482	1.1128	1.11819	-0.00539	1.05674	1.17963	0.03126
316	17-Jan-03	28.860	33.910	1.175	1.11445	0.06055	1.053	1.1759	0.03126
317	24-Jan-03	30.070	33.248	1.1057	1.15834	-0.05264	1.09689	1.21979	0.03126
318	31-Jan-03	30.520	33.190	1.0875	1.10468	-0.01718	1.04324	1.16613	0.03126
319	07-Feb-03	30.770	33.910	1.102	1.09895	0.00305	1.03751	1.1604	0.03126
320	14-Feb-03	31.510	35.770	1.1352	1.10079	0.03441	1.03934	1.16223	0.03126
321	21-Feb-03	31.700	36.623	1.1553	1.12352	0.03178	1.06207	1.18497	0.03126
322	28-Feb-03	32.090	36.808	1.147	1.14067	0.00633	1.07923	1.20212	0.03126
323	07-Mar-03	31.480	36.848	1.1705	1.1388	0.0317	1.07735	1.20024	0.03126
324	14-Mar-03	31.960	36.642	1.1465	1.15918	-0.01268	1.09773	1.22062	0.03126
325	21-Mar-03	28.490	30.400	1.067	1.13999	-0.07299	1.07855	1.20144	0.03126
326	28-Mar-03	25.810	29.158	1.1297	1.08295	0.04675	1.0215	1.1444	0.03126
327	04-Apr-03	26.050	29.588	1.1358	1.12703	0.00877	1.06559	1.18848	0.03126
328	11-Apr-03	24.870	28.082	1.1292	1.12134	0.00786	1.05989	1.18278	0.03126
329	18-Apr-03	24.870	29.413	1.1827	1.12458	0.05812	1.06314	1.18603	0.03126
330	25-Apr-03	25.830	28.066	1.0866	1.1658	-0.0792	1.10436	1.22725	0.03126
331	02-May-03	24.600	25.646	1.0425	1.09242	-0.04992	1.03097	1.15386	0.03126
332	09-May-03	24.780	27.720	1.1186	1.06592	0.05268	1.00447	1.12737	0.03126
333	16-May-03	25.830	28.580	1.1065	1.11074	-0.00424	1.04929	1.17219	0.03126
334	23-May-03	26.270	29.030	1.1051	1.09596	0.00914	1.03451	1.15741	0.03126
335	30-May-03	26.740	29.148	1.0901	1.10486	-0.01476	1.04341	1.16631	0.03126
336	06-Jun-03	26.690	30.690	1.1499	1.09193	0.05797	1.03049	1.15338	0.03126
337	13-Jun-03	27.270	31.540	1.1566	1.13691	0.01969	1.07547	1.19836	0.03126
338	20-Jun-03	26.680	30.678	1.1499	1.14012	0.00978	1.07868	1.20157	0.03126
339	27-Jun-03	27.140	29.236	1.0772	1.14292	-0.06572	1.08147	1.20436	0.03126
340	04-Jul-03	27.480	30.290	1.1023	1.08884	0.01346	1.02739	1.15029	0.03126
341	11-Jul-03	27.780	30.714	1.1056	1.10679	-0.00119	1.04534	1.16824	0.03126
342	18-Jul-03	28.420	31.462	1.107	1.0998	0.0072	1.03835	1.16125	0.03126
343	25-Jul-03	28.080	30.406	1.0828	1.10416	-0.02136	1.04271	1.1656	0.03126
344	01-Aug-03	27.920	30.776	1.1023	1.0863	0.016	1.02486	1.14775	0.03126
345	08-Aug-03	28.730	32.066	1.1161	1.10118	0.01492	1.03973	1.16262	0.03126
346	15-Aug-03	28.880	31.370	1.0862	1.10847	-0.02227	1.04702	1.16992	0.03126
347	22-Aug-03	28.290	31.252	1.1047	1.08846	0.01624	1.02701	1.1499	0.03126
348	29-Aug-03	28.860	31.558	1.0935	1.10419	-0.01069	1.04274	1.16564	0.03126
349	05-Sep-03	28.030	29.190	1.0414	1.09184	-0.05044	1.03039	1.15329	0.03126
350	12-Sep-03	26.760	28.894	1.0797	1.05487	0.02483	0.99342	1.11632	0.03126
351	19-Sep-03	26.090	27.386	1.0497	1.08225	-0.03255	1.0208	1.14369	0.03126
352	26-Sep-03	25.750	27.756	1.0779	1.05281	0.02509	0.99137	1.11426	0.03126
353	03-Oct-03	26.930	29.446	1.0934	1.07909	0.01431	1.01764	1.14054	0.03126
354	10-Oct-03	28.400	30.734	1.0822	1.08692	-0.00472	1.02548	1.14837	0.03126
355	17-Oct-03	29.840	31.552	1.0574	1.08219	-0.02479	1.02074	1.14364	0.03126
356	24-Oct-03	29.070	30.182	1.0383	1.06546	-0.02716	1.00401	1.1269	0.03126
357	31-Oct-03	28.670	29.194	1.0183	1.04951	-0.03121	0.98806	1.11095	0.03126
358	07-Nov-03	28.340	29.812	1.0519	1.0311	0.0208	0.96966	1.09255	0.03126
359	14-Nov-03	29.580	31.526	1.0658	1.05395	0.01185	0.99251	1.1154	0.03126
360	21-Nov-03	30.130	32.480	1.078	1.0619	0.0161	1.00045	1.12334	0.03126
361	28-Nov-03	30.220	29.973	0.9918	1.07555	-0.08375	1.01411	1.137	0.03126
362	05-Dec-03	29.220	30.764	1.0528	1.01225	0.04055	0.95081	1.0737	0.03126
363	12-Dec-03	29.910	32.126	1.0741	1.05979	0.01431	0.99834	1.12123	0.03126
364	19-Dec-03	30.730	33.230	1.0814	1.0647	0.0167	1.00325	1.12614	0.03126
365	26-Dec-03	30.380	32.227	1.0608	1.07826	-0.01746	1.01681	1.1397	0.03126
366	02-Jan-04	29.870	32.570	1.0904	1.06549	0.02491	1.00405	1.12694	0.03126
367	09-Jan-04	30.600	33.876	1.1071	1.08878	0.01832	1.02734	1.15023	0.03126
368	16-Jan-04	31.390	34.432	1.0969	1.09876	-0.00186	1.03731	1.16021	0.03126
369	23-Jan-04	30.870	35.163	1.1391	1.09496	0.04414	1.03352	1.15641	0.03126
370	30-Jan-04	30.650	33.614	1.0967	1.12903	-0.03233	1.06758	1.19047	0.03126

Period in Weeks	Date	Murban Crude Spot Price in USD per Barrel	WTI Futures Prices in USD per Barrel	Basis Ratio	Forecasted Basis Ratio	Residuals	95% Lower Confidence Level	95% Upper Confidence Level	Standard Error of Forecast
371	06-Feb-04	29.750	33.548	1.1277	1.09573	0.03197	1.03428	1.15717	0.03126
372	13-Feb-04	30.030	33.848	1.1271	1.12461	0.00249	1.06316	1.18605	0.03126
373	20-Feb-04	31.230	35.560	1.1386	1 11865	0.01995	1.05721	1.1801	0.03126
374	27-Feb-04	31.420	35.256	1.1221	1.13141	-0.00931	1.06996	1.19286	0.03126
375	05-Mar-04	32.480	36.644	1.1282	1.11888	0.00932	1.05744	1.18033	0.03126
376	12-Mar-04	32.950	36.384	1.1042	1 12497	-0.02077	1.06352	1.18642	0.03126
377	19-Mar-04	33.320	37.822	1.1351	1.10468	0.03042	1.04323	1.16613	0.03126
378	26-Mar-04	33.720	36.562	1.0843	1.12879	-0.04449	1.06734	1.19023	0.03126
379	02-Apr-04	32.810	35.224	1.0736	1.08731	-0.01371	1.02586	1.14875	0.03126
380	09-Apr-04	32.820	35.660	1.0865	1.08317	0.00333	1.02173	1.14462	0.03126
381	16-Apr-04	34.360	37.416	1.0889	1.08624	0.00266	1.02479	1.14769	0.03126
382	23-Apr-04	34.400	36.784	1.0693	1.08668	-0.01738	1.02523	1.14812	0.03126
383	30-Apr-04	34.950	37.330	1.0681	1.07356	-0.00546	1.01211	1.13501	0.03126
384	07-May-04	35.500	39.212	1.1046	1.07293	0.03167	1.01148	1.13438	0.03126
385	14-May-04	36.530	40.444	1.1071	1.09794	0.00916	1.03649	1.15939	0.03126
386	21-May-04	37.890	40.888	1.0791	1.09974	-0.02064	1.0383	1.16119	0.03126
387	28-May-04	37.150	40.576	1.0922	1.08337	0.00883	1.02193	1.14482	0.03126
388	04-Jun-04	37.530	40.015	1.0662	1.09355	-0.02735	1.0321	1.155	0.03126
389	11-Jun-04	35.830	37.983	1.0601	1.07025	-0.01015	1.00881	1.1317	0.03126
390	18-Jun-04	35.620	37.862	1.0629	1.06731	-0.00441	1.00586	1.12876	0.03126
391	25-Jun-04	35.970	37.758	1.0497	1.066	-0.0163	1.00456	1.12745	0.03126
392	02-Jul-04	34.500	37.216	1.0787	1.05523	0.02347	0.99379	1.11668	0.03126
393	09-Jul-04	36.930	39.755	1.0765	1.07749	-0.00099	1.01605	1.13894	0.03126
394	16-Jul-04	36.960	40.386	1.0927	1.07415	0.01855	1.01271	1.1356	0.03126
395	23-Jul-04	37.240	41.230	1.1071	1.0902	0.0169	1.02875	1.15164	0.03126
396	30-Jul-04	37.760	42.546	1.1267	1.10082	0.02588	1.03938	1.16227	0.03126
397	06-Aug-04	39.740	43.832	1.103	1.11779	-0.01479	1.05634	1.17923	0.03126
398	13-Aug-04	40.890	45.248	1.1066	1.1018	0.0048	1.04036	1.16325	0.03126
399	20-Aug-04	42.510	47.326	1.1133	1.10705	0.00625	1.0456	1.16849	0.03126
400	27-Aug-04	42.300	44.202	1.045	1.10901	-0.06401	1.04756	1.17046	0.03126
401	03-Sep-04	39.160	43.290	1.1055	1.05788	0.04762	0.99643	1.11933	0.03126
402	10-Sep-04	37.960	43.375	1.1427	1.10435	0.03835	1.0429	1.16579	0.03126
403	17-Sep-04	37.570	44.262	1.1781	1.12362	0.05448	1.06217	1.18507	0.03126
404	24-Sep-04	38.280	47.828	1.2494	1.15838	0.09102	1.09693	1.21983	0.03126
405	01-Oct-04	40.260	49.762	1.236	1.21721	0.01879	1.15576	1.27866	0.03126
406	08-Oct-04	42.100	51.800	1.2304	1.21186	0.01854	1.15042	1.27331	0.03126
407	15-Oct-04	42.020	53.896	1.2826	1.21696	0.06564	1.15551	1.2784	0.03126
408	22-Oct-04	41.840	54.304	1.2979	1.25464	0.04326	1.19319	1.31608	0.03126
409	29-Oct-04	41.690	52.970	1.2706	1.26557	0.00503	1.20412	1.32701	0.03126
410	05-Nov-04	41.920	49.812	1.1883	1.25181	-0.06351	1.19037	1.31326	0.03126
411	12-Nov-04	40.240	48.012	1.1931	1.19157	0.00153	1.13012	1.25302	0.03126
412	19-Nov-04	38.230	46.896	1.2267	1.19146	0.03524	1.13001	1.2529	0.03126
413	26-Nov-04	38.980	49.007	1.2572	1.20606	0.05114	1 14462	1.26751	0.03126
414	03-Dec-04	40.240	46.034	1.144	1.22981	-0.08581	1.16836	1.29126	0.03126
415	10-Dec-04	38.010	41.924	1.103	1.14873	-0.04573	1.08728	1.21017	0.03126
416	17-Dec-04	38.720	43.496	1.1233	1.12152	0.00178	1.06008	1.18297	0.03126
417	24-Dec-04	40.730	44.955	1.1037	1.12194	-0.01824	1.06049	1.18338	0.03126
418	31-Dec-04	38.160	42.545	1.1149	1.10179	0.01311	1.04034	1.16323	0.03126
419	07-Jan-05	38.740	44.082	1.1379	1.11288	0.02502	1.05143	1.17432	0.03126
420	14-Jan-05	41.310	46.760	1.1319	1.12771	0.00419	1.06626	1.18916	0.03126
421	21-Jan-05	43.620	47.843	1.0968	1.12469	-0.02789	1.06324	1.18613	0.03126
422	28-Jan-05	44.650	48.650	1.0896	1.10117	-0.01157	1.03972	1.16261	0.03126
423	04-Feb-05	42.970	46.988	1.0935	1.09487	-0.00137	1.03342	1.15632	0.03126
424	11-Feb-05	42.380	46.080	1.0873	1.0932	-0.0059	1.03175	1.15465	0.03126
425	18-Feb-05	43.580	47.784	1.0965	1.08758	0.00892	1.02613	1.14902	0.03126
426	25-Feb-05	45.180	51.300	1.1355	1.09503	0.04047	1.03358	1.15648	0.03126
427	04-Mar-05	47.030	52.716	1.1209	1.12371	-0.00281	1.06226	1.18516	0.03126
428	11-Mar-05	48.790	54.244	1.1118	1.11396	-0.00216	1.05251	1.1754	0.03126
429	18-Mar-05	50.340	55.916	1.1108	1.11217	-0.00137	1.05072	1.17361	0.03126
430	25-Mar-05	51.600	55.325	1.0722	1.10948	-0.03728	1.04803	1.17092	0.03126
431	01-Apr-05	50.900	54.988	1.0803	1.07911	0.00119	1.01767	1.14056	0.03126
432	08-Apr-05	54.870	55.266	1.0072	1.08503	-0.07783	1.02358	1.14647	0.03126

Period in Weeks	Date	Murban Crude Spot Price in USD per Barrel	WTI Futures Prices in USD per Barrel	Basis Ratio	Forecasted Basis Ratio	Residuals	95% Lower Confidence Level	95% Upper Confidence Level	Standard Error of Forecast
433	15-Apr-05	51.870	51.482	0.9925	1.02474	-0.03224	0.96329	1.08618	0.03126
434	22-Apr-05	50.360	52.938	1.0512	1.01455	0.03665	0.9531	1.07599	0.03126
435	29-Apr-05	52.300	52.374	1.0014	1.04929	-0.04789	0.98785	1.11074	0.03126
436	06-May-05	51.180	50.468	0.9861	1.00984	-0.02374	0.9484	1.07129	0.03126
437	13-May-05	50.850	50.352	0.9902	1.00588	-0.01568	0.94444	1.06733	0.03126
438	20-May-05	49.880	47.710	0.9565	1.00242	-0.04592	0.94097	1.06387	0.03126
439	27-May-05	50.590	50.534	0.9989	0.97495	0.02395	0.91351	1.0364	0.03126
440	03-Jun-05	52.670	53.808	1.0216	1.00747	0.01413	0.94602	1.06892	0.03126
441	10-Jun-05	53.890	53.722	0.9969	1.02029	-0.02339	0.95884	1.08173	0.03126
442	17-Jun-05	53.720	56.248	1.0471	1.00723	0.03987	0.94578	1.06867	0.03126
443	24-Jun-05	55.980	59.124	1.0562	1.04809	0.00811	0.98665	1.10954	0.03126
444	30-Jun-05	54.530	58.125	1.0659	1.05183	0.01407	0.99038	1.11327	0.03126