Mercurious Oil Index (MOI)

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Abstract

Indices are very helpful instruments for the tracking and prediction of markets, to measure performance or sentiment and to form a solid basis on which to list futures and options at an exchange or trade them over-the-counter. This paper describes a new oil index, the Mercurious Oil Index (MOI). We will discuss why this index is a reliable global price reference, and why it is superior to and more useful than the existing indices. The MOI can be used as an underlying value for the hedging of (energy) risk through the use of derivatives. The index can additionally provide an underlying instrument for structured products.
Historically the oil markets, in the same way as foreign exchange reserves, are dollar-based; recently however a move towards the euro as currency of denomination (and anchor or reserve currency) has been observed. Participants in the oil market having a national currency other than the dollar risk not only changes in the oil price but also in the currency (dollar). The index is therefore listed in euros.
Along with those of price and currency, the (geo-) political risk is also a key issue to consider. The increasing importance of commodities results in the politicizing and militarizing of energy resources. The price of oil therefore needs to be transparent; however, this is not currently the case. A recognized globally traded oil-index would be useful to obtain greater insight into these developments.

CONTENTS

1. INTRODUCTION

Since the oil crisis of the 1970's, the oil price has been a significant economic indicator. Price fluctuations have a huge impact, on both oil producing and consuming countries. It is remarkable that, despite the relevance and importance of the oil price, there remains no one index that adequately reflects this price.
An important reason for this is that "the" oil price does not exist. The price of oil differs across the world. Dependent partially on quality and partially on location, and also on the risks involved, the price of oil varies by type and region.

Oil is a hot topic, especially since the media inform their public increasingly frequently about the sharp rise in its price. It is often commented that the price of oil has risen from less than 10 US dollars per barrel in 1998 to almost 100 dollars in November 2007 (see figure 1).

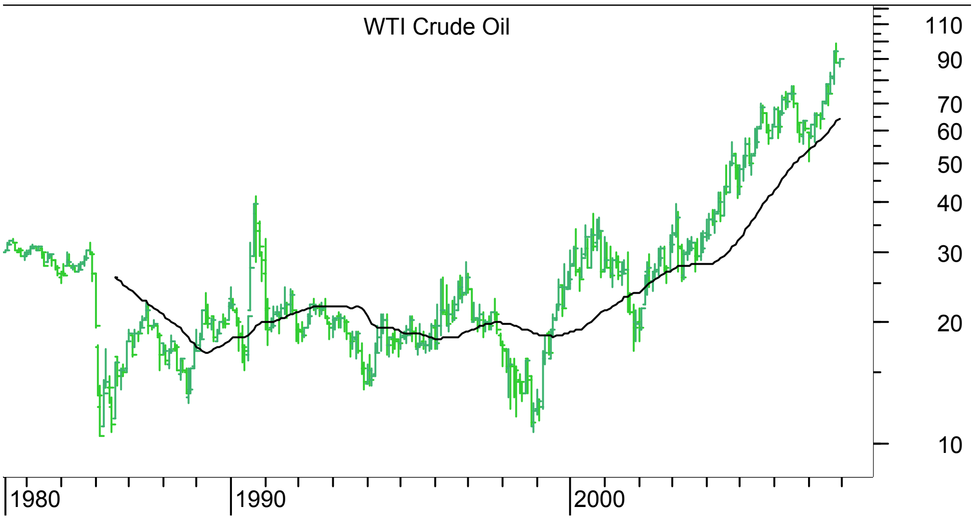


***Figure 1**: Price development of oil (WTI crude)*

However, oil has many facets, and 'the' price of oil therefore does not exist. After all, oil is to be found in many varieties, and each particular type has its own price. Moreover, even two barrels of the same quality and having an identical mix of components, traded at two different locations, will generally achieve different prices. This stems from the fact that oil, being a physical product, is incapable of being digitally transferred in the same way as financial products, such as equity or bonds. The potential price differences of an individual stock listed in two different exchanges will quickly disappear through arbitrage; price differences in oil however cannot be quickly resolved this way. In the first place, movement from A to B is far from instantaneous, but takes a long time; secondly, transport (such as pipelines and vessels) is not available to all (due to limited transport capacity) and especially not always at desirable prices (transport costs have recently shown sharp increases).
The price of oil is basically determined by supply and demand; these two factors however are influenced by a range of fundamentals, such as developments in

demography and wealth, reserves and availability (level of technology), production and production capacity, social stability and governmental policy, geo-political interests and risks (‘*independent energy policy*’ or ‘*energy supply policy*’), transport, the quality of the commodity, currency exchange rates, the weather, seasonality, substitution and emission prices (such as carbon dioxide).
Furthermore, inflation and negative correlation with other asset classes are important issues to take into account when considering oil prices. All these issues are considered more closely in order to more precisely determine a representative global price of oil. Indices are very helpful instruments from this perspective, as will be further demonstrated in this document. A global oil index can be employed as a pricing reference for ‘the’ oil price.

PURPOSE OF THIS DOCUMENT

The purpose of this document is to create a useful and representative global price reference for oil: an oil index. We have called this index the Mercurious oil index (MOI). The development, introduction and use of this index form the subject of this document, but we will also consider other areas of interest to this particular issue.
We are aiming for an oil index that contains a number of oil (related) products. All correlate positively with each other (most to a large extent) and - in many ways in practice - are substitutes to (or equivalents of) each other (to at least some extent). However, ultimately their correlation is less than 1.00 and therefore the prices of these products appear to move to at least some (fractional) extent differently and independently.
Moreover, supply and demand for each product has its own features, or to be more specific, the details of the diverse prices differ. Variances are found between different products, but even for the same products there will be differences over time. The latter reason implies that correlation coefficients will change and reveal their dynamics. Correlation coefficients are usually subject to market dynamics, but in the energy markets in particular fundamentals currently change extensively, so making a well composed index essential.
A single product (component) index will not demonstrate price movement reflective of the entire market. A variety of crudes are therefore gathered as components, but we also took into consideration refinery products. We elected to denominate the index (indices) in euros. No index containing only oil products and refinery products, together with equivalents, and also denominated in euros, currently exists. This makes the MOI a unique oil index.

VALUE OF MOI

This MOI tells us that a price movement from 100.00 to 120.00 means that the price of the basket of oil has gone up by 20%. This reflects an increase of the oil price. The MOI is an indicator for global oil prices (or even for energy prices in general). The sensitivity of the daily operations and activities of companies or other types of entities with respect to the oil (or energy) price has to be determined and can be analyzed in relation to the MOI.

STRUCTURE

The structure of this document is as follows. Section two describes the forces that drive oil price movements, for these price drivers influence supply and demand. In section three we explain the methodology of an index and discuss the requirements for a reliable, representative index. These requirements are necessary for every (financial) index. Since existing indices do not adequately describe oil price development we introduce an alternative index in section 4, the Mercurious Oil Index (MOI). In the following section, section 5, we assess whether and how the new index fits with the requirements of the index as formulated in section 3. After demonstrating the price development of the MOIsr in section 6 we look closely in section 7 at a number of ways in which to use the new index. The final section, section 8, contains a summary and conclusions.

2. THE PRICE DRIVERS OF OIL

Prices of all types of oil are influenced by a variety of fundamentals. These price drivers are described in this section.

TYPES & FORMS *(PRODUCT SPREADS)*
As mentioned, oil exists in many varieties. Most oil found in the Mexican Gulf differs considerably from the majority of oil to be found in the Middle East. ‘Sweetness’ or ‘sourness’ is one distinctive aspect, which reflects the sulfur content, whereas another feature of oil, ‘lightness’ or ‘heaviness’, reflects the API degree of oil, being a measure of how treacly or syrupy it is (see figure 2).

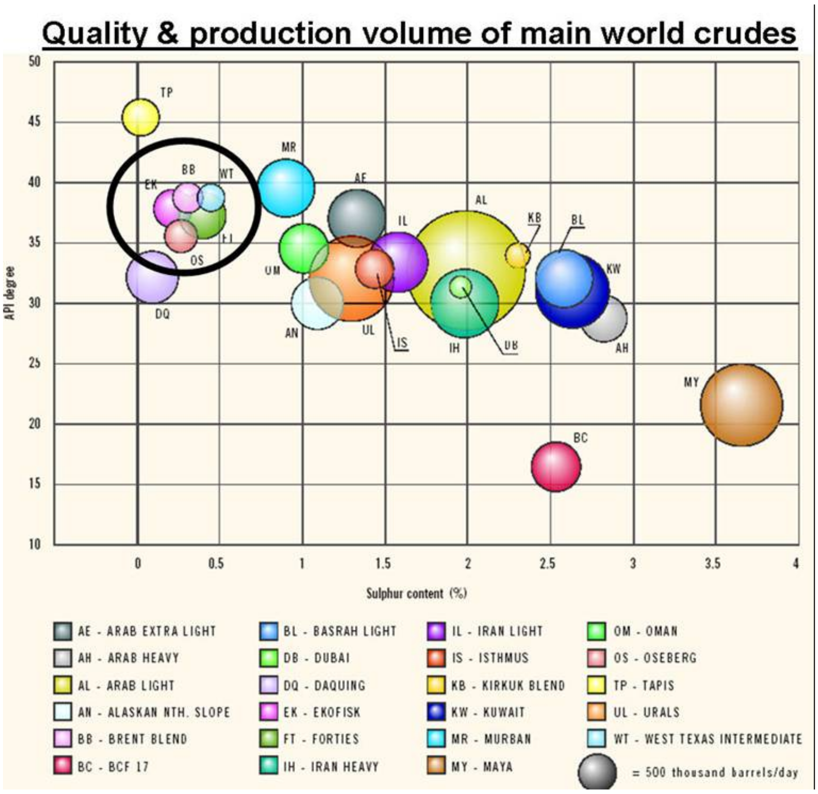


Figure 2: *Quality and production volumes of main world crudes (source: Dubai Mercantile Exchange)*

As a result there are many kinds of oil, all of which need to be refined in their own way. Light, sweet crude is of greater use in production of gasoline, naphtha, propane and butane, than is heavy sour crude, used mainly to produce heavy heating oil, asphalt and bitumen. Accordingly all the different types of crude require their own specific refineries and refining processes. Heavy sour crude needs more refinery processing than does the lightest and sweetest form, meaning that people are unwilling to pay as much for heavy sour crude as for light sweet crude. This results in a situation where the prices of all the different types of oil differ from each other. This means that the price of Brent crude (oil from the North Sea) will most of the time differ from - for instance - Dubai crude (see figure 3). Please be aware that this difference does not remain steady over time, but varies as a result of many factors such as available refining capacity and reserves. The price spread (between two different products) is therefore a dynamic concept.

Figure 3: *Price differential between Brent crude oil and Dubai crude oil (source: Dubai Mercantile Exchange)*

PHYSICALITY & LOCAL SITUATION (supply) (*LOCATIONAL SPREADS*)

From the above it may have become more apparent that 'the' oil price does not exist. Each kind of oil, from each separate well, has its own quality, features and price input variables, which is why each kind of oil has its own price. Additionally, as we have already mentioned, even the price of oil of the same quality (i.e. exactly the same oil) can vary between one place and another. This results from factors such as local scarcity of the crude product, production capacity, refinery capacity and the cost of transportation. These influences all result from local situations and specifics that are not necessary constraints at other locations (either not at all, or at least not at the same time).

The price of heating oil, for instance, can differ between Rotterdam and Singapore, even if they are of the same quality. The price of heating oil in 2007 for the first time in two years rose more quickly than that of kerosene, diesel and gasoline. Demand from power generation plants and from ships is the main reason for this relatively sharp increase. This expensive fuel impacts on the cost of transport, including transport of crude oil. Shipping companies add extra costs on to their invoices.

The sharp rise in heating oil prices can be partially explained by the fact that refineries have become more and more efficient in their use of crude oil. This means they are able to improve the yield of their activities. As a result they are now able to

extract relatively more light oil products, such as gasoline and diesel, which results in a lower supply of heating oil. The prices of heating oil in Rotterdam in 2007 were at times as much as 40 US dollars per metric tonne less than in Singapore ('location spread'). The possibility of profiting from this price difference (arbitrage) has led to transport of heating oil from Rotterdam to Singapore.
Price differences between different locations imply that a regional price basket must contain regional price components; otherwise the index does not fully reflect what it should. Equally, a global index must contain products from all over the world. In other words, when local specifics are taken into account the need for an oil index, having several components (of different qualities and from/in different regions) becomes even more necessary if a global oil price is to be accounted for. A global index must therefore comprise global components, whereas a local index must contain local components.

DEMOGRAPHY (demand)
Globally there is a huge shift occurring in oil production, consumption, transportation and oil flow. The world's population growth is raising concerns amongst economists. Today 6.5 billion people live on this planet, while according to estimates of the United Nations this number will be 9 million in 2050. More people means more (oil) consumption.

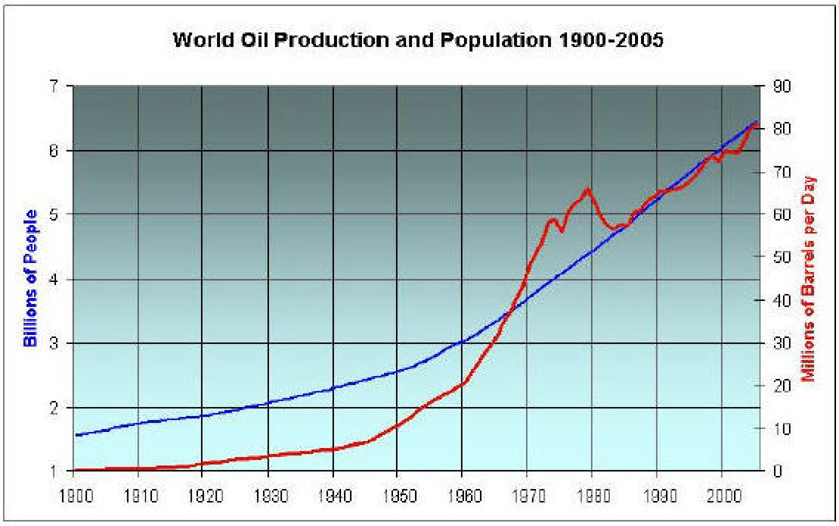


Figure 4: *population and energy consumption*

WEALTH (demand)
Next, the level of income will rise, especially in developing countries such as China and India (together almost 40% of the world's population). There appears to be a clear relation between people's wealth and their use of energy (see figure 5). This means that the oil consumption will also increase accordingly, accelerating the growth in demand for oil.

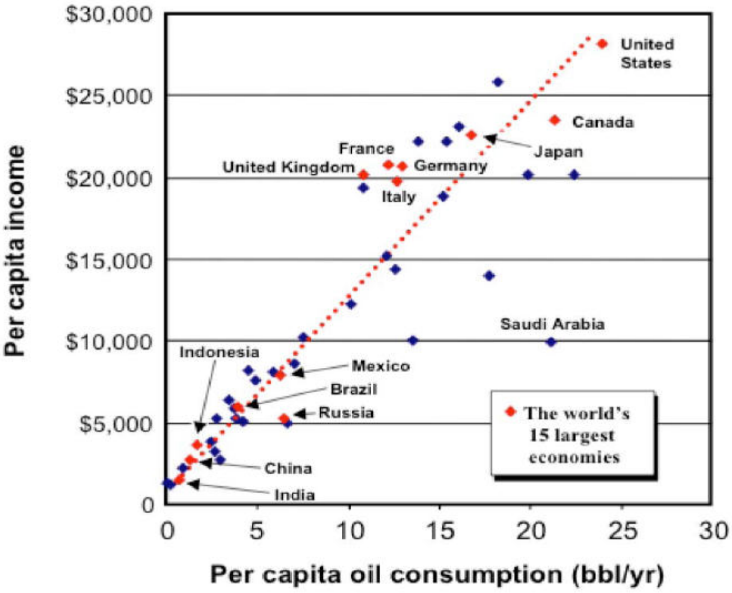


Figure 5: *Per capita income versus per capita oil consumption*

Population growth, especially in India, is raising concerns amongst economists. Within 20 years India's population will reach 1.2 billion. There will be a huge shift in the supply–demand curve for oil in the next ten years.

PRODUCTION (supply)

The current main production locations are the Middle East, Russia and the US (see figure 6).

Saudi Arabia	**9.050.000**
Russia	**9.750.000**
United States of America	**6.937.000**
Iran	**3.750.000**
China	**3.690.000**
Mexico	**3.640.000**
Norway	**2.640.000**
United Arab Emirates	**2.630.000**
Canada	**2.570.000**
Kuwait	**2.510.000**
Venezuela	**2.510.000**
Former Soviet Union (excl. Russia)	**2.380.000**
Nigeria	**2.240.000**
Brazil	**2.190.000**
Iraq	**1.920.000**
Libya	**1.750.000**
United Kingdom	**1.476.000**
Algeria	**1.350.000**
Angola	**1.320.000**
Indonesia	**860.000**
Qatar	**830.000**

Figure 6: *Production of crude oil (in barrels per day) (Source: IEA, October 2006)*

However, the significance of US production is rapidly declining since their reserves are very quickly falling (see figure 7).

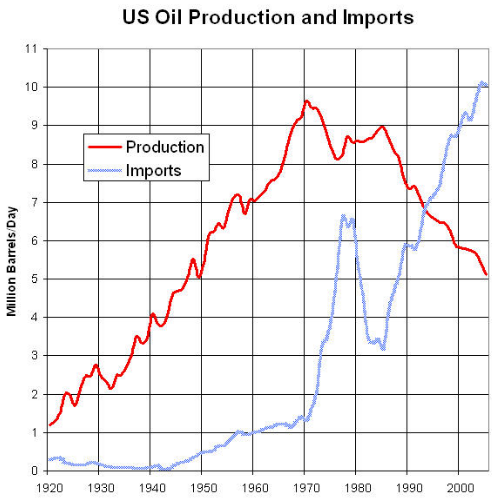


Figure 7: *US oil production and imports*

Globally there is a huge shift occurring in oil production, consumption, transportation and oil flow. Countries in Asia and the Middle East are becoming increasingly hooked on an independent energy (supply) policy. Asia is a source of both demand and import growth (India and China, see figure 8). To ramp up production with heavy sour oil is costly and takes time, while exploration of heavy sour oil fields is underdeveloped and expensive. The reason behind this is the high exploration costs in the 70's, meaning most large sour oilfields don't have a good transport network and are generally situated inland. The price of exploration and refining of sour heavy oil is also greater, and the cost of a pipeline network is very high. There is also terrorism risk, as we see currently in Iraq where inland oilfields are undeveloped, while according to some oil analysts Iraq has the highest oil reserves in the world. The oil infrastructure (transportation) in Iran, Iraq, Russia and Canada is causing concern among oil analysts. In addition the annexation of oil fields in Venezuela and Bolivia is knocking investor confidence. Transparency in the energy markets can help us obtain insight into the development of the future oil demand supply curve.

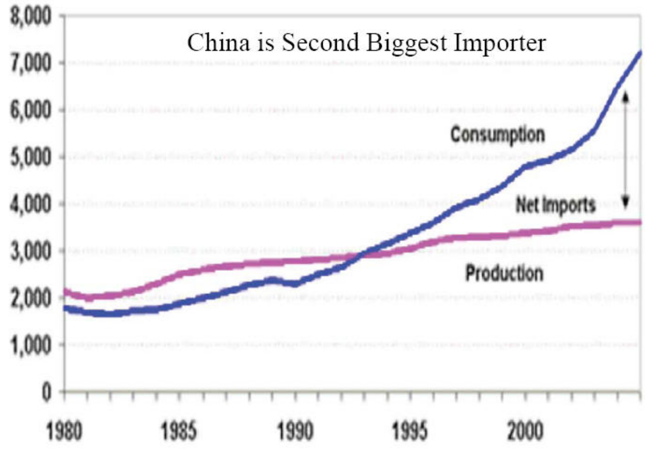


Figure 8: China's oil production and imports

The Middle East, as the global hydrocarbon centre, will see the largest increase in trade, particularly to Asia. About 60% of the world's proven crude oil reserves are in the Middle East, and as reserves in other areas (such as the North Sea and US, see figure 7) continue to decline, this percentage will likely increase.

PEAK OIL-THEORY (supply)

More than 65% of Middle East exports go to Asia and Asian buyers import over 70% of their crude oil from the Middle East. This totals around 12 million barrels per day, as against a current global consumption of around 88 million barrels per day, which is expected to become 120 million barrels within 20 years. However, at current investment rates production capacity can't accommodate this increase. Global supply might even be 40-50 million barrels a day within 20 years. So capacity will be a problem in the future, which adds weight to the search for alternatives (see figure 9).

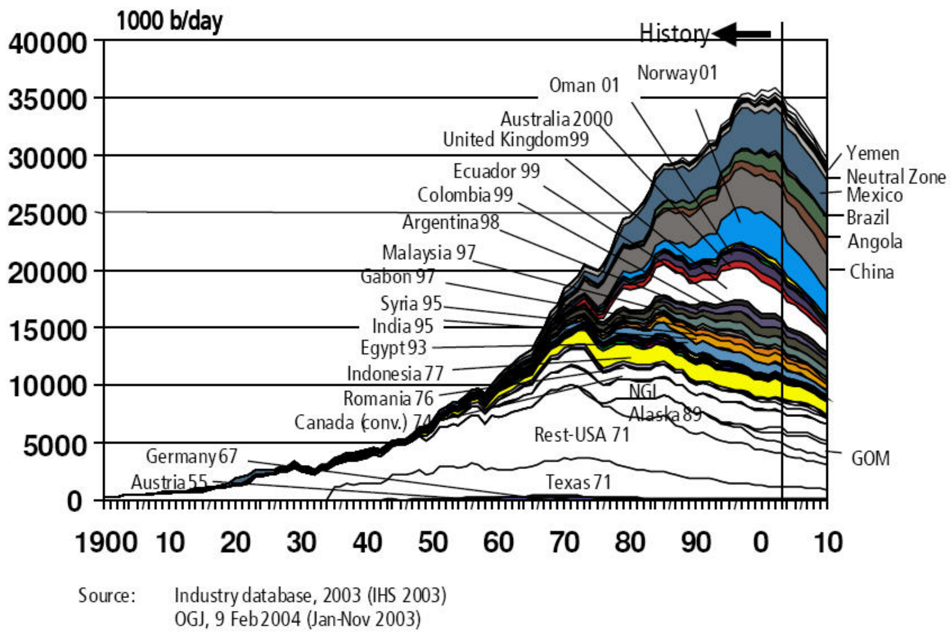


Figure 9: *Peak Oil, the peak in oil production*

If we consider that 10 percent (9 million barrels a day) of world oil supply comes from just one oil-field - Ghawar in Saudi Arabia - than capacity/delivery will become a major problem in the future, especially were the kingdom of Saud to be replaced by another regime. Accordingly political risk is very high in the Mid East and this also influences geographical risk, since the Persian Gulf is important to the transport of oil. War in this region will affect the cost (for insurance) of transportation.

GEO-POLITICS

The situation described above results in a huge shift in the supply-demand curve for oil over the next ten years. Therefore governments are launching (independent) energy supply policies. Further *politicization* and *militarization* of natural resources is observable. Countries such as Venezuela, Bolivia and Russia have forced foreign oil companies to hand over control of main production projects. Saudi Arabia has already had its own fleet of oil tankers for years and the Americans are said to assure their energy supply through military force. The Russians placed a flag at the bottom of the ocean underneath the North Pole, the British have claimed a part of Antarctica and the Japanese and Chinese have argued for years about their border in the East China Sea (see figure 10).

Tension reflects risk, and risk influences price. A risk component may form part of the oil price and this component can increase when situations are likely to deteriorate.

Figure 10: *Geo-political tension in the East China Sea*

SOCIAL STABILITY & SAFETY (supply)
International stability reduces oil production; see figure 11.

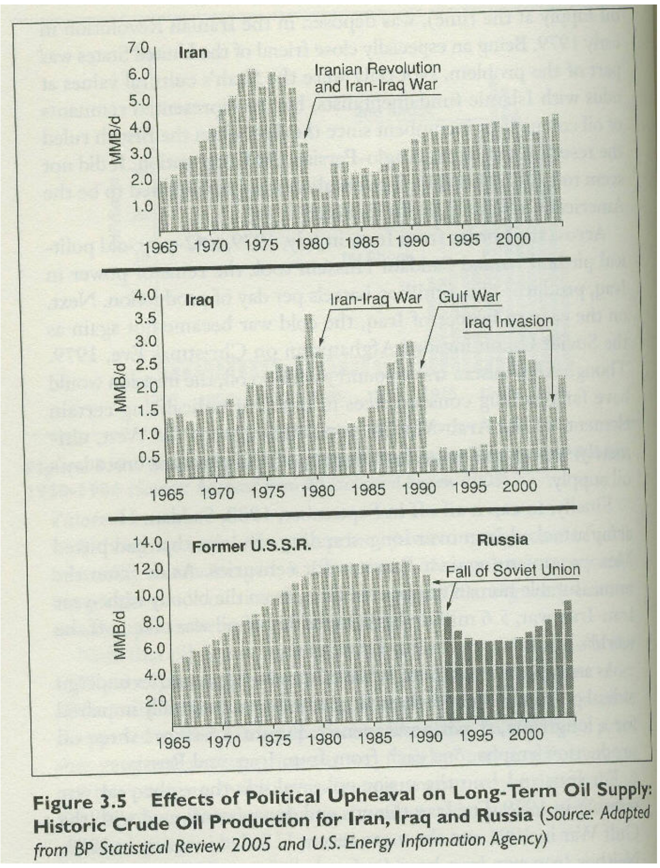


Figure 11: *Effects of political upheaval on long term oil supply (Source: Thousand barrels a second, P. Tertzakian).*

In addition to international stability, social stability and the safety of production processes are also supportive of production. Negative effects on and of the environment: spills from leaking pipelines, oil tanker catastrophes and rigs blown away by hurricanes as well as strikes by personnel, will lower supply.

STATE OWNED OIL COMPANIES

Next, privately owned oil companies become less significant, since state owned oil companies grow at a much faster rate and to a greater extent (see figure 12). This results from the politicization and energy supply policies.

Countries not Companies Control Oil

Saudi Aramco (Saudi Arabia)	302	ExxonMobil	23
National Iranian Oil Co	302	Pertamina (Indonesia)	22
Gazprom (Russia)	198	Lukoil (Russia)	21
Iraqi National Oil Co	136	BP	19
Qatar Petroleum	133	Pemex (Mexico)	19
Kuwait Petroleum Co	109	PetroChina	19
Petroleos de Venezuela	105	Shell	16
Adnoc (Abu Dhabi)	80	Yukos (Russia)	13
Nigerian Natnl Petroleum Co	41	Chevron	12
Sonatrach (Algeria)	38	Petrobras (Brazil)	12
Libya NOC	31	Total (France)	11
Rosneft (Russia)	28	Surgutneftgas (Russia)	9
Petronas (Malaysia)	26		

Figure 12: *Largest companies based on their reserves of oil and oil-equivalents.*

STRATEGIC RESERVES (demand)

Tension often results in rising prices. This happens a lot in politically unstable regions. Geo-political risk is an important factor to take into account when pricing energy derivatives, but is also a difficult factor because this risk cannot really be hedged. Covering exposure due to geo-politics is however a strong desire of those nations that are becoming ever more dependent on exporting countries. Strategic reserves are created to cover oil demand in case of emergency and can therefore be considered as some form of hedge. It must be commented that this 'hedge' or insurance is very costly.

RESERVES (supply)

The principal oil reserves are situated in the Middle East. As a percentage the amount located in the Middle East is in fact increasing, since North American regional reserves are rapidly declining.

Middle East region	**57%**
North America	**18**
South & Central America	**8**
Russia	**7**
Africa	**6**
Asia	**3**
Europe (North sea)	**2**
OPEC	**75%**

Figure 13*: Proven oil reserves, as a percentage of the world's total (source: CNUCED, 2003)*

COST OF PRODUCTION (supply)

It is often said that the oil is running out, but in honesty it is better to state that oil of high quality that is also easy to produce is running out. After all, oil that meets these criteria was the first to be produced. That also meant that some wells were easy to access, and the cost of producing a barrel in this situation is relatively low.
Today, those reserves that satisfy the stated description are declining and people are therefore starting to produce from other types. That means heavy, sour crude is being produced in higher volumes, production in deep ocean waters is more often done and technologically complex, production such as oil extraction from tar sands or oil shale is attracting more attention. Unfortunately the costs of these types of production are higher, with the result that the wholesale price of oil is also rising.

Indonesia	**10.50**
Algeria	**7.80**
Nigeria	**5.75**
Iran	**4.50**
Venezuela	**4.23**
Saudi Arabia	**4.00**
Iraq	**2.50**

Figure 14*:* *Cost of oil production (per barrel, in US dollars) (Het Financieel Dagblad, 23 august 2005)*

ENHANCED RECOVERY (supply)

Improvement of technique will increase the scale of the reserves that can be produced from. Until recently, only 30% of an oil well could have been extracted. By pumping water or gas into the well pressure is maintained at a high level, so more oil can be extracted from the same well. Enhanced recovery methods result in higher recovery rates.

INFRASTRUCTURE & INVESTMENTS

Future supplies of oil will come mainly from the Middle East, because the largest reserves are there. To import oil the infrastructure in many countries needs to be improved, which will require extensive investment. India for instance needs to ramp up refinery capacity for the production of, for example, gasoline, but must also build harbors and oil pipelines. Iran doesn't have refinery capacity, so although the country is rich in oil, they must still import gasoline. Building of a refinery-infrastructure is extraordinary expensive. Although the situation is changing these days, many oil producing countries (even within OPEC) still don't have a decent (mature/sophisticated) financial infrastructure. However, such is important to attract money and confidence in the western world. Exploration for heavy sour oil fields is more expensive than for most of the sweet light crudes so far produced. The oil infrastructure (transportation) in Iran, Iraq, Russia and Canada is raising concerns among oil analysts. In addition the annexation of oil fields in Venezuela and Bolivia is resulting in a lack of confidence amongst insiders. Transparency in the energy markets can help obtain insight into the development of the future oil demand supply curve.

REFINERY CAPACITY (supply) *(CRACK SPREADS)*
Fluctuations in the available refinery capacity influence the price of refined products. In the event of tight available refinery capacity prices of refined products will rise, even when the price of crude has not changed, and vice versa. The price differentials between crude as the basis ingredient (input) and the end product (for instance gasoline) is called the crack spread. The crack spread is therefore a refinery spread. The added value of cracking and refining is reflected by this spread and, since the situation changes over time, the crack spread is also dynamic (the volatility of the crack spread), as can be seen in figure 15.

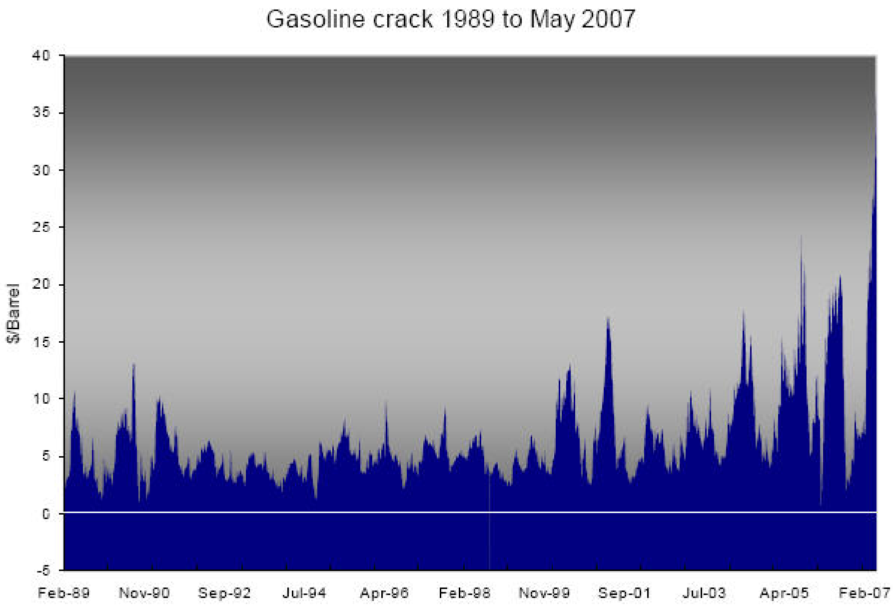


Figure 15: *Crack spread, or refinery spread, between the price of gasoline and the price of crude oil.*

MAINTENANCE & SPARE CAPACITY
Capacity is an important issue in many respects. Much of the time it represents an actual bottleneck and so influences the price. Available capacity changes over time as a result of, for instance, maintenance work and new construction. Since capacity is a local issue, changes in available capacity directly influence prices at affected locations, whereas prices in other areas will be less affected.

Capacities for production, refinery and transport are all showing problems and as a result limit security of supply. Maintenance and spare (production) capacity are other capacity-related issues. Spare capacity has to do with capacity that is available, but not currently in use; this value of course changes over time, since oil companies may or may not decide to use this capacity.
OPEC on occasion elects to change the level of production capacity it employs in order to influence the oil price. However, when only little spare capacity remains, it is no longer possible to bring more on line. Since the price of oil at the end of the nineties was around 10 dollars, investment made in infrastructure, production capacity and refinery installations was low. This has resulted in the current situation of lack of available capacity, which puts pressure on the market and underpins a rising price for oil (products).

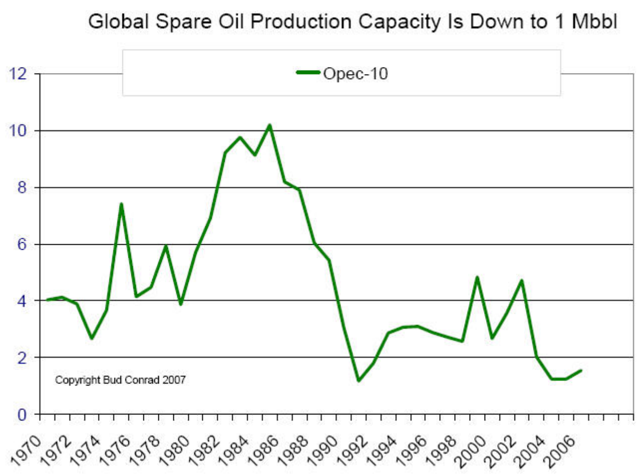


Figure 16: *Global spare capacity*

Maintenance of production processes is on occasion necessary. Maintenance of oil rigs and refineries may take weeks or even months, lowering available production capacity and influencing prices where this capacity is already limited.

ENERGY TRANSITION, SUBSTITUTION & EQUIVALENTS

The demand (need) for oil drives exploration of new oil fields. Production from many of these new sources brings with it high costs (for example the tar sands in Canada) or are located in political unstable countries (Middle East)
Another development to be seen is the production of substitutes, such as oil production from tar sands, or the use of other energy sources (gas or coal). However, while these substitutes can fairly simply be implemented for the generation of electricity, the replacement of oil as an energy source for transport is a much tougher proposition. While substitutes and equivalents can therefore often be used to a large extent, they are certainly not convenient in all cases.
Additionally, the exploration of tar sands in Canada and Venezuela cannot currently deliver as much oil as desired. The quality of this type of oil is also lower than that of oil from the Middle-East. At this time exploration and especially transportation remain major problems for tar sand oil, and in addition the price of exploration is also higher

than for other types of oil. On the other hand however, the higher the price of crude oil, the more reason there is to search for substitution. Even very costly production processes become sufficiently interesting at a certain price level.

INFLATION

The aforementioned rising price level may be defined as inflation, and the rising price of oil is often said to act as a stimulus for inflation. However, the calculations and definitions of 'inflation' vary by country or the specific 'type' of inflation. These definitions are sometimes subject to change, and therefore are dynamic. Additionally the US publishes inflation figures exclusive of energy prices, while some other countries do include these. Note that inflation is defined as a price basket and the components and weightings differ by country, in the same way as all indices differ one from another.
On the other hand, commodities - as an asset class - are considered interesting as investments, because they can be used to hedge against inflation. Further, the price of commodities such as oil must over time be adjusted for inflation. This means that a price of oil of, say, 40 dollars in 1980 is not the same as a price of 40 dollars in 2004.
Many institutional investors invest in commodities such as oil to act as their inflation compensatory factor. The MOI may be used for such a purpose (see page 49, inflation hedging).

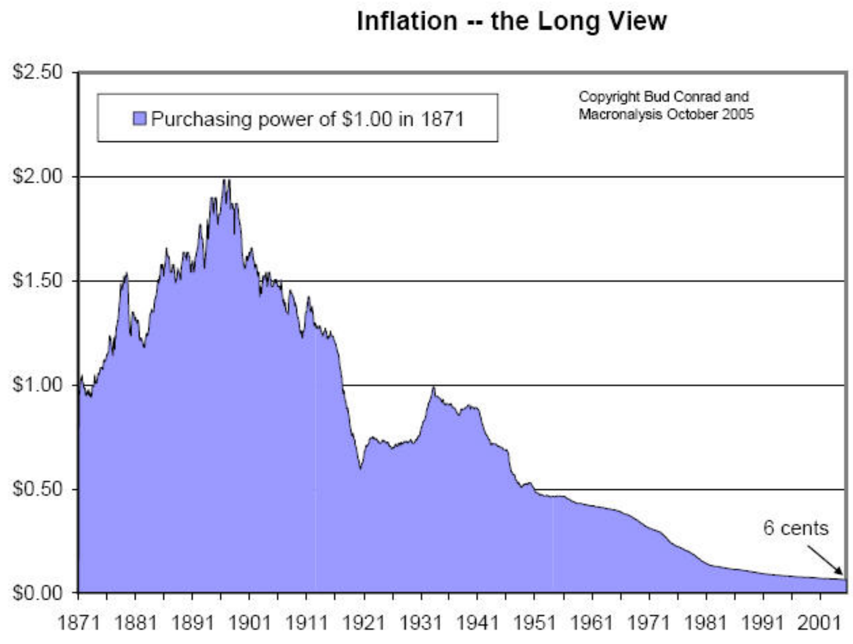


Figure 17: *Inflation*

TAXATION & PRICE SENSITIVITY

Usually, when products increase in price, people tend to search for substitutes. However, in the case of oil, there is in many cases no available substitute (for example in the case of car fuel). Price elasticity is limited, and therefore gasoline prices usually rise when the price of its primary element, crude oil, goes up. However, the impact of a rise in the price of crude and the consequent effect on the price of gasoline varies between countries. Around 60% of the price of gasoline in The Netherlands is made up of taxes. This rate is much lower in the US, which means that while the price of gasoline is lower in the US, it is also more sensitive to fluctuations in the price of crude oil.

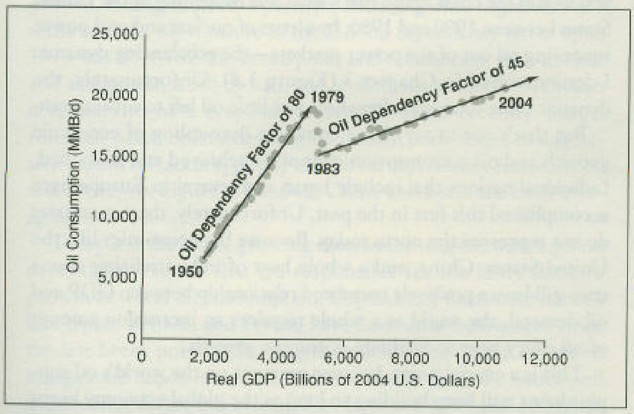


Figure 4.3 U.S. Oil Consumption Cross Plotted Against Real GDP, 1950-2004: Evolution of U.S. Oil Dependency (*Source: Adapted from Bureau of Economic Analysis, U.S. Energy Information Agency and ARC Financial*)

Figure 18: *US oil Consumption cross plotted against real GDP*

Further, it is also important to mention that some countries (and their economies) are more affected by higher oil prices than are others (figures 18, above and 19, below).

	Oil Dependency Factor 1995–2004	2004 GDP[1] $US Billions	2004 Oil Consumption MMB/d
India	94	661	2.6
China	90	1,649	6.7
Thailand	78	163	0.9
Malaysia	72	118	0.5
Taiwan	63	305	0.9
Canada	60	996	2.2
Singapore	48	107	0.7
United States	45	11,733	20.5
Korea	28	681	2.3
Australia	25	618	0.9
France	16	2,018	2.0
Japan	< 0	4,668	5.3
Germany	< 0	2,707	2.6
Russia	< 0	583	2.6
Italy	< 0	1,681	1.9
United Kingdom	< 0	2,126	1.8
World[2]	**29**	**55,655**	**82.5**

1 GDP at current prices in US billions
2 GDP based on purchasing-power-parity (PPP) valuation of country GDP

Figure 4.4 Comparison of Average Oil Dependency Factors: Various Nations (*Source: Adapted from IMF World Economic Outlook Database and BP Statistical Review 2005*)

Figure 19: *Comparison of average Oil dependency Factors: Various Nations*

WEATHER INFLUENCES & SEASONALITY

The weather is another important factor influencing energy prices. During cold periods (winter) in the Western world more energy is consumed to heat houses. This results in a higher demand for products used for heating (gas). In the summer Americans use their cars a lot more than in the remaining periods of the year, celebrating holidays. This so called ‘driver’s season’ results in an increase in gasoline demand. Each year between September and November the Hurricane season brings tropical storms and sometimes hurricanes, which can extensively damage production installations (rigs) and have huge impact on available production capacity.

EMISSION PRICES

Use of fossil energy sources to fuel energy consuming processes results in the emission of polluting gases (see figure 20).

	SO2	NOx	CO2
Natural gas	**0**	**35**	**56.000**
Gas oil	**95**	**50**	**73.000**
Heating Fuel Oil 1%	**500**	**50**	**78.000**
Coal	**640**	**50**	**91.000**

***Figure 20**: Emission of greenhouse gases in grams per gigajoule of fuel (Distrigas, 2007)*

Greenhouse gases produce the greenhouse effect and are the reason for climate change (see figure 21).

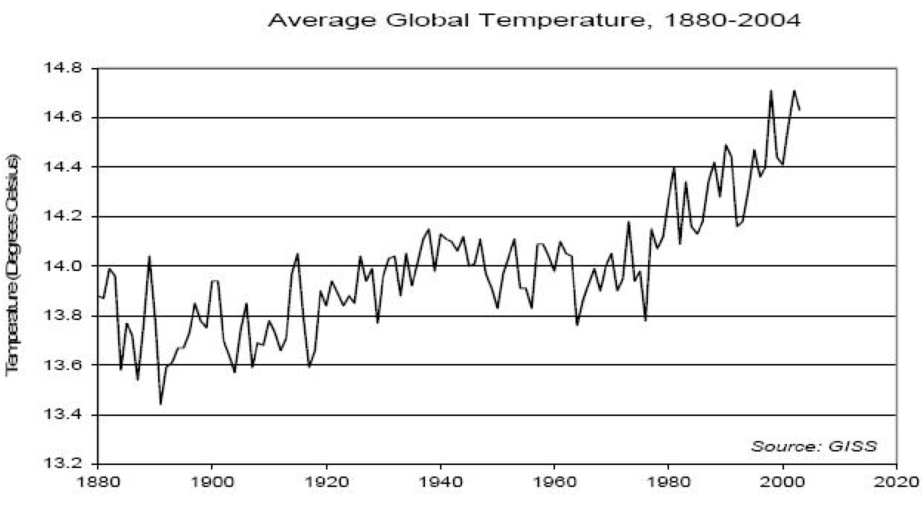


***Figure 21**: Average global temperature, 1880-2004*

The Kyoto protocol strives to lower the emission of greenhouse gases. Based on this protocol countries have got together and introduced emission trading systems. Within these systems a price is put on emissions. Those responsible for emitting greenhouse gases must purchase emission rights, making energy (oil) more expensive. Pricing of emission rights contributes to the rise in energy prices[3], since the extra costs will be incorporated into the selling price to the end user.

CURRENCY OF DENOMINATION

Another important point relates to the currency. The currency of denomination of oil products is important because the price of oil in dollars may rise by a certain percentage, while it remains the same in euros. This will occur when the euro-dollar exchange rate changes by a certain percentage, offsetting the price change.
Additionally, the currency of denomination becomes of greater relevance because more and more countries have recently been responding to the dollar dependency of their trade balance, preferring not to be dependent on the dollar alone. The significance of this issue has accelerated with the decline of the dollar against many other currencies such as the euro, as shown in figure 22.

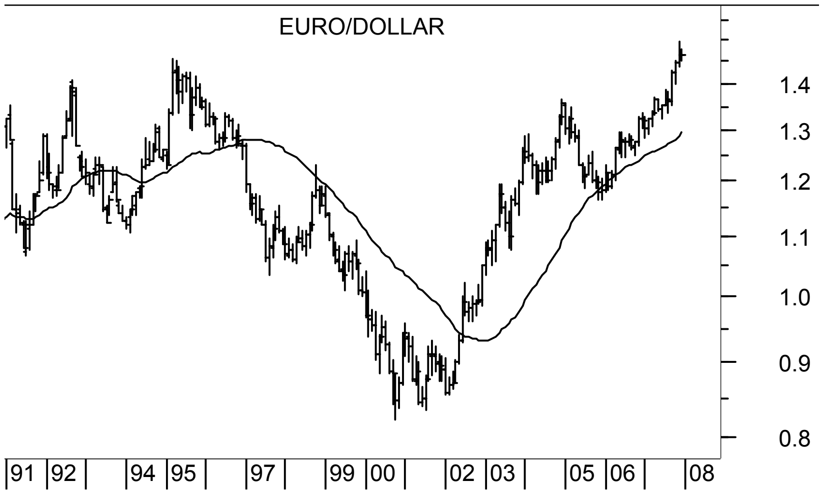


***Figure 22**:* *Exchange rate US Dollar versus Euro, 1990-2007*

The volatility of the dollar has recently been significant. Both dollar-related issues (the dollar-dependency of oil prices and the decline of the dollar exchange rate) lead to a preference for diversifying foreign (currency) reserves in order to decrease the risk to nations. Some countries have already announced - or at least have suggested - that sale of their oil be in euros instead of dollars (e.g. UAE, Iran, Venezuela and Indonesia). Additionally, the Americans have previously promised military support to countries selling their oil in dollars, but for many countries this argument is increasingly becoming irrelevant. As a result the oil market, which has always been dollar-based, may now transform into one that (also) is euro-based. A government, company or organization in, for instance, the euro zone or Middle East is (with respect to oil) exposed to currency risk (dollar exposure) as all main oil futures are (still) denominated in dollars. This underpins the search for a financial instrument (an oil index) based upon another currency, other currencies, or perhaps even a basket of currencies. Entities prefer financial instruments to be denominated in the same currency as that in which their annual report (balance sheet and profit & loss account) is produced.
The currency effect is significant. In fact, the choice of currency influences the trend (and the slope of the chart) of the financial product. Figures 23 & 24 show the

[3] Daskalakis, G., Markellos, R.N., 2007, “Are the European Carbon Markets efficient?”

differences between West Texas Intermediate (WTI) crude oil denominated in dollars and denominated in euros.

Figure 23: *WTI Crude Oil in USD (based on fixed prices) (source: Created by Mercurious, based on data from Bloomberg*

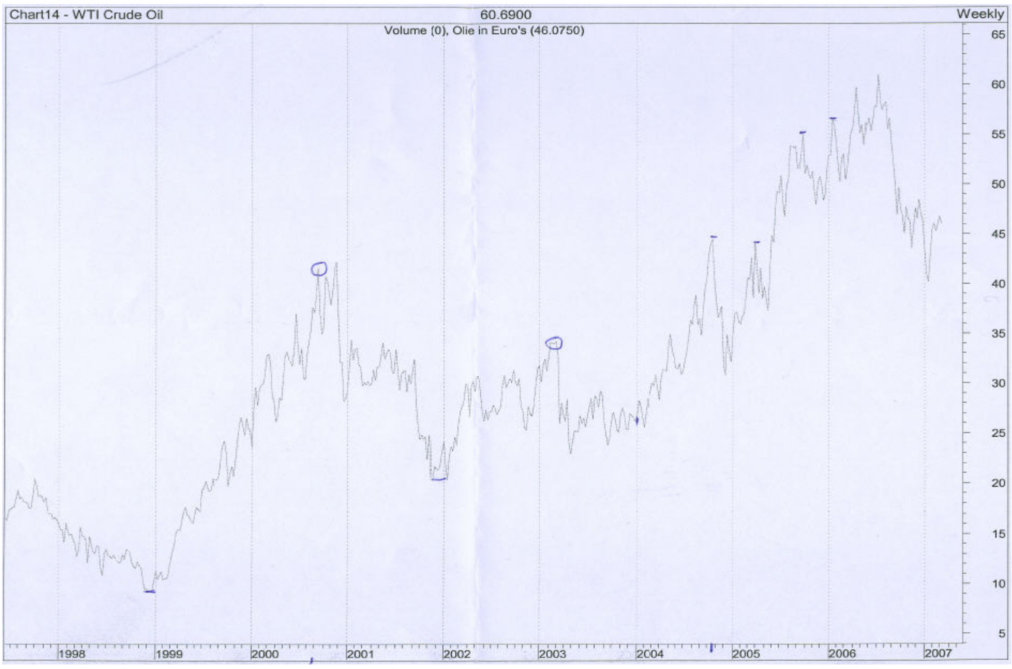


Figure 24: *WTI Crude Oil in Euros (source: Created by Mercurious, based on data from Bloomberg)*

While the dollar-based WTI shows a new high at the beginning of 2003, this is not the case on a euro basis. The same occurs with the results at the end of 2004 and beginning of 2005. The reverse however is true for the highs around September 2005 and the beginning of 2006. It may thus be concluded that differences resulting from denomination are significant. This may also help us in the analysis and prediction of future (price) developments.

3. Indices and requirements for a reliable index

An index is a single value calculated from an array of prices (or of quantities). This results in a price index (or quantity index). Values of the index in successive periods (whether days, weeks, months or years) summarize the level of activity over time or across economic units, such as regions or countries.
A financial index is a collection of financial products and a statistic reflection of the composite value of its components. An index is a tool with which to represent the characteristics of its components, which all have some commonality such as being traded in the same markets or belonging to the same branch. Many indices compiled by news of financial services firms are used to benchmark portfolio performance.
There are several types of indices. A **broad-based index** represents the performance of a whole (product) ***market***, and by proxy, reflects sentiment on the state of the economy.
More specialized indices exist tracking the performance of specific ***sectors*** of the market, and there are additionally the most specific indices reflecting a specific group of financial ***products***.
Based on this, we will formulate within the commodity *market* and energy *sector,* taking oil as a particular *product* (*group*).

Indices are helpful instruments in the financial markets. Development of an oil index is generally desirable since it can be used as a price reference, a pricing mechanism, a benchmark, an indicator of sentiment or of performance, or as a predictor of the market, and has many other applications (as outlined in section 7). Today no representative, specific and widely used global oil index exists.
Benchmarks, and possibly (but not necessarily) an index, can be used to list derivatives or to create structured products having the benchmark as the underlying value. This will generate more trading activity, and will additionally simplify and support the hedging of exposure as the costs of hedging will decline.

REQUIREMENTS
An index must meet a variety of requirements, such as simplicity, the Rule of Chains, path-independency and transparency. The use and quality of an index is dependent on its components, their weightings and its mechanism. Geographical spreading, as well as spreading through the use of more products, can also be relevant or may lead to sub-indices.
To obtain an index suitable for practical use it must (theoretically) meet certain requirements, according to Hendriks (1999):

- Simplicity

The index has to be a function of prices at the time of beginning (start) and at the time of examination (consideration).

- Weightings

  The relative significance of the specific components has to be reflected in the weightings. The weightings must reflect the activity in or the importance of its components and be of an objective view with respect to production.
- Invariance

  Changing the units in which prices are expressed does not change the index.
- Determination

  An index may not be zero when the price of one of its components becomes zero.
- Proportionality

  When all components in the index are multiplied by the same factor, the index will be multiplied by the same factor.
- Identically

  When the components in an index at two different moments in time have exactly the same pricing (quantity), the index - as a result - has to reflect exactly the same pricing (or quantity).
- Currency exchange rate changes

  When all components at a certain moment in time are measured in another currency, it should be possible to determine the index as a value (or figure) in the original currency calculated in another currency.
- Aggregation

  Composed indices have to follow the partial indices after weighting according to the fractions of which the composed index is comprised. Conversely, taking an index as a basis allows separate sub-indices to be constructed out of it.
- Rule of chains

  It should be possible to calculate the value of an index by multiplying two index values with two different starting times.
- Path-independency

  The value of an index should be independent of the pricing at previous moments in time.

Additional requirements:

- Liquidity

  An index must be liquid, which means that it must reflect liquidity. This can be obtained through use of liquid components. This will almost automatically lead to an index that is considered liquid.
- Independency

  For instance, independency of data; it should be of no significance whether monthly or daily data are used in the development of the index.
- Transparency

  The valuation (pricing) of the index's components should be transparent. The greater transparency the more valuable the index.

The efficiency of an index is dependent upon three factors:

1. The number and type of components
2. The ability to adapt to changing market circumstances
3. The method of determination of the value of an index

Measurement of performance may be helpful to set measures, assess and analyze. There are several ways in which to set a performance measure. They can be weighted according to time, money, price, market value, capitalization or market share.

Indices can be either *full weighted*, or *float adjusted weighted*[4].
Considering the composition of indices it is desirable that larger components weigh more in the index than do smaller components. In this respect weightings are needed to compensate and fine-tune. The index must reflect reality as much as possible. Therefore weightings must be determined. With equal weightings each component weighs the same as the others. This automatically avoids the problem of weighting, and assumes that larger components weigh as much as smaller components.

The traditional method of capitalization-weighted indices systematically over-weights overvalued products and under-weights undervalued products, assuming price inefficiency. However, investors cannot observe the true value of a product. They cannot remove inefficiency altogether, but can remove systematic inefficiency that is inherent in capitalization weighted indices. *Equal-weighting* is one method to remove this systematic inefficiency but suffers from high turnover, high volatility, and the requirement to invest potentially large sums in illiquid products. This index can be viewed as a portfolio in which an equal amount is invested in all components of the index. Different performances result in different weightings. At specific moments in time the index may be re-adjusted. In such cases the outperforming components will be partially sold, to buy the underperforming indices.
Un-weighted indices consist for instance of a future of each component. In this case, the weightings of the components are dependent on their prices.
Weighting by fundamental factors avoids the pitfalls of equality while removing the systematic inefficiency of capitalization weighting. It weights products by fundamental factors such as availability (official reserves), production, export or kind/type.
If a product's price gets either too high or too low relative to its fair value, weighting by fundamentals will not reflect this bias. This prevents fundamentally based indices from participating in bubbles and crashes and thus reduces its volatility while delivering a higher return.

CURRENT SITUATION

Single component benchmarks

[4] Float adjusted weightings are corrections for where a part of the float is free to trade and another part is kept away from the markets. This is used for some stock indices.

Currently the most popular oil benchmarks and pricing mechanisms are West Texas Intermediate (WTI, from the US) and Brent (North Sea oil). The largest economies use these instruments and their economic strength is influenced by price changes of these benchmarks. Both are single component indices rather than composed indices having several (or a wide variety) components. They therefore only represent oil prices of a specific type and region and so do not reflect any diversification. Additionally, Brent and WTI represent only a small percentage of the world's crude production and reserves (see figure 2, 6 and 13).

Stock indices

Some indices are referred to as oil indices and consist of oil company stocks. However, such items do not reflect the method of this paper. We clearly focus on oil as a commodity. Oil prices and the prices of oil company stocks do not correlate to a great extent, and over recent years in particular this correlation has reduced further (see figure 25). That means the price of oil can rise while the stock price of an oil company does not. This can easily occur since stock prices are determined by a wide variety of factors, many of which have nothing to do with oil prices.

	SPX	**XOM**	**CL**	**CI**
SPX	**1.00**			
XOM	**0.40**	**1.00**		
CL	**0.37**	**0.08**	**1.00**	
CI	**0.06**	**0.12**	**(0.13)**	**1.00**

Figure 25: *Correlation of several assets and asset classes (SPX = Standard & Poor index, XOM = stock price ExxonMobil, CL = Crude Light, CI = CRB Index) (Mercurious, 1998-2005)*

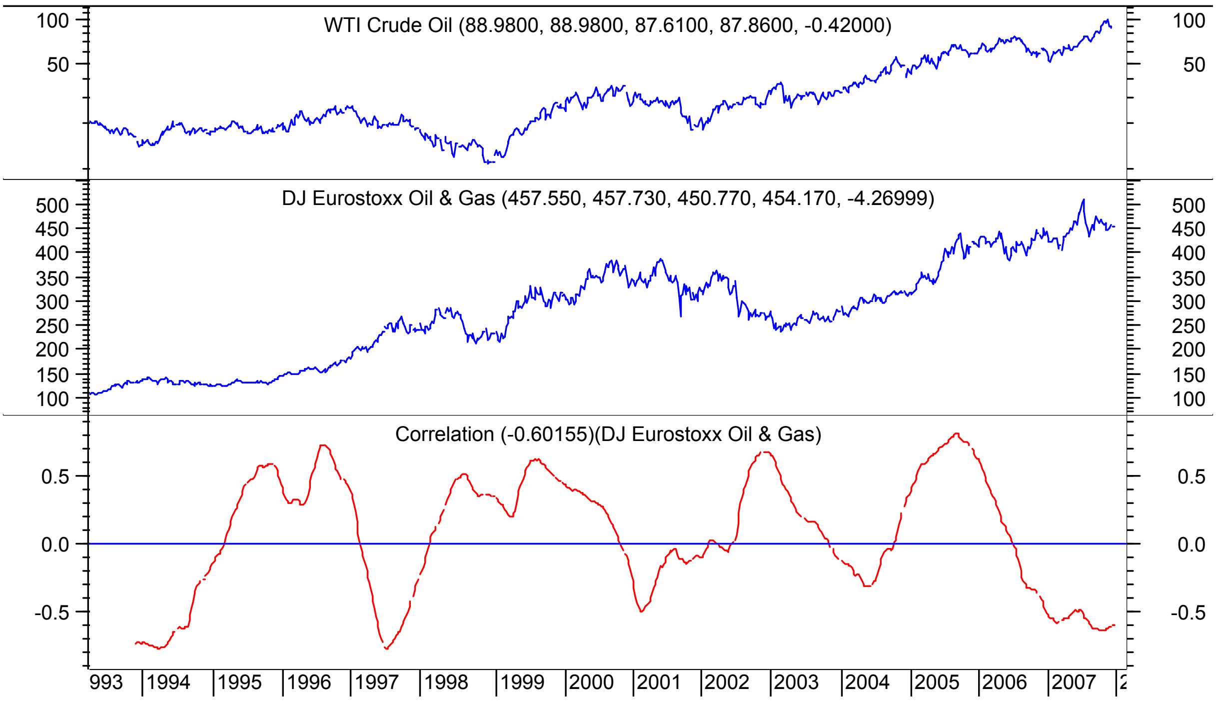


Figure 25 b: *Correlation varies over time (WTI vs. DJ Eurostoxx Oil&Gas index)*

As we can clearly see, the 100 week correlation between European Oil companies and the Oil price moves from positive correlation towards negative correlation. The correlation shows high volatility over time. Over the last two years we have seen a declining correlation in this while the oil price reaches new highs. A change in volatility and a change in correlation is called Contagion-effect (as we have seen recently in the sub prime-crises). The supply-demand cycle for oil is leading to this effect. The price of oil can go up either by lowering output or by a steeper demand curve. This is clearly the case the last three years. India and China are demanding more oil at a time when capacity is limited, while in the sixties and seventies the oil price was more affected by the supply curve.

Commodity indices

Well known indices containing oil or energy components are Standard & Poor's Goldman Sachs Commodity Index (S&P GSCI), the Dow Jones AIG Commodity Index (DJ-AIG CI), the Rogers International Commodity Index (RICI) and the Commodity Research Bureau index (CRB).

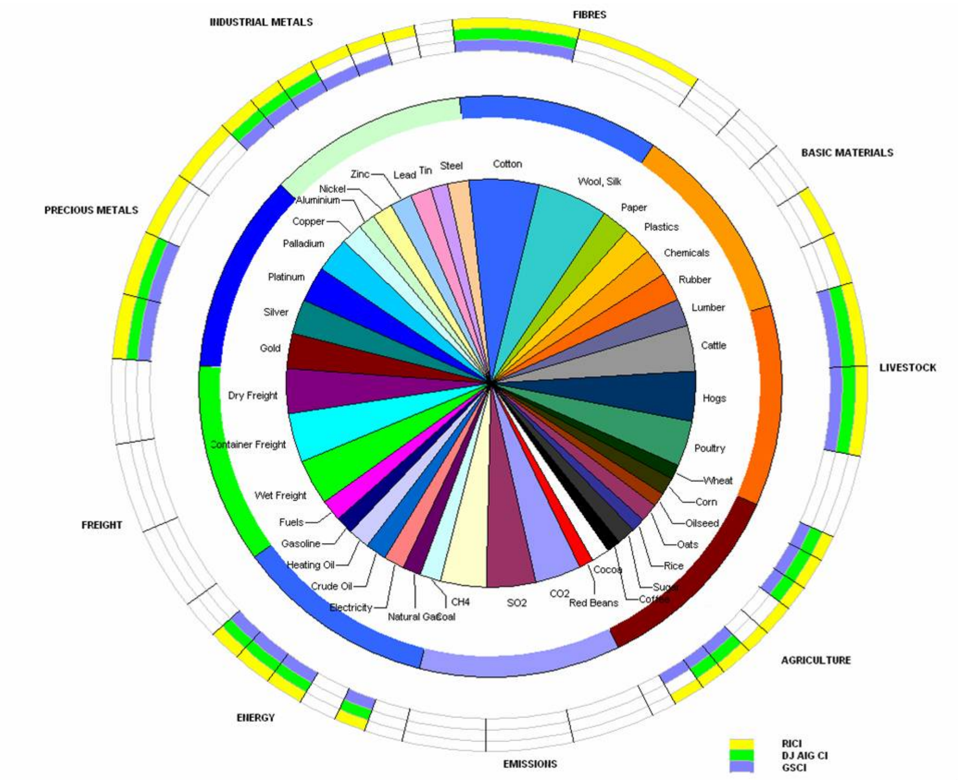


Figure 26: *Commodity indices GSCI, DJ AIG CI and RICI, and the commodities they cover (source: UBS, July 2007)*

Institutional investors invest in commodities because of their negative correlation with other asset classes. By investing in commodities, they diversify their portfolio and reduce the risk to which they are exposed. Further, commodities provide these investors with some protection from inflation.

However, these indices also represent commodities having no connection with oil (or energy in general, see figure 25). Here again then, the availability and quality of these indices as energy indices should be (re)considered. Even though the S&P GSCI comprises a very high level of energy products, it still includes some other commodities.

FUTURE PERSPECTIVE

As there are so many oil (related) products many can be brought together and included in an index to offer a clear view of true market developments. This index would reflect the true market price development, globally if need be, or just for a specific geographical region.

The need for a reliable index is becoming increasingly important. Global oil consumption is rising (see figure 27) and therefore the global oil trade is also set to grow.

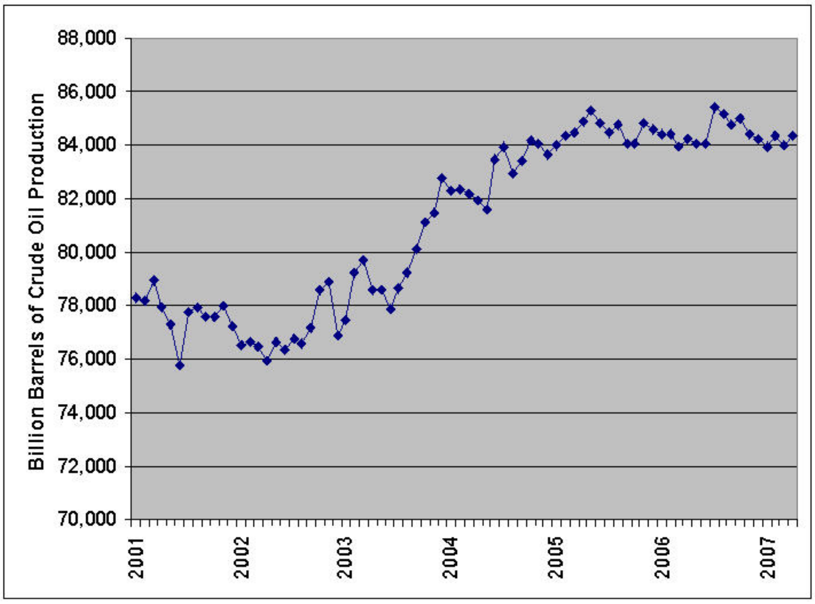


Figure 27: *Global crude production*

NEGATIVE CORRELATION

Oil will continue to play a crucial role in the global energy mix. Increased demand from transportation and industry are the key drivers (over 80%). In addition sovereign wealth funds and institutional investors opted to raise the stake of commodities in their portfolios. This was particularly true of the latter group because commodities provide a negative correlation with other asset classes. The Dutch pension fund PGGM calculated (in 1999 in their ALM study) that commodities correlate negatively with equities at 0.43, private equity at 0.23 and fixed income at 0.29, and positively with price inflation at 0.07 and wage inflation 0.30. Therefore, investments in commodities diversify an investment portfolio (and decrease its risk). All together, oil can be viewed as a very important asset class.

Many institutional investors concluded after research that equity and bonds (representing the main portions of their portfolio) show the highest negative price correlation with energy products (out of all commodities), while the addition of other commodities, such as metals, and aim for[5] hedges against inflation. Such reasoning supports the need for a new (particularly) oil-based index, and investors can use the MOI more effectively for this purpose. Since the S&P GSCI is around 70% dependent on energy or oil related products (the exact figure of course being dependent on the prices and therefore dynamics of the market), many institutional investors chose the S&P GSCI as the most important benchmark on which to project their commodity investments. The negative correlation of commodities, like oil, can be seen also in figure 28.

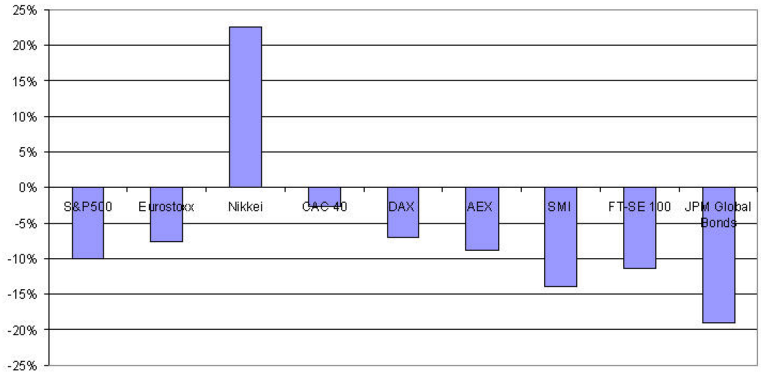


Figure 28: *Historical correlation between GSCI Total Return and other assets (source: UBS / Bloomberg; used data: July 1995 - July 2005, 3-month rolling returns*

A GLOBAL OIL PRICE INDEX

We constructed MOI because single component indices, oil company stocks and commodity indices are not representative as oil price indicators, as stated above.

A global oil index must represent more than just one product, for oil has many faces. The components of MOI are several (grades of) crude, each having a different geographical source. Refinery products, substitutes and equivalents are also included as valuable additions since, after all, specific energy forms may on occasion be replaced by other products (oil or non-oil) that bear (and can transfer) energy. The prices of oil, oil products and their substitutes (proxies) therefore correlate. With respect to substitutes or equivalents we considered gas, coal and bio-fuels.

Note:

The creation of fuel from corn or grain (first generation bio-fuel) through extraction processes causes other problems. One major issue with bio-energy is that of desertization, since a lot of groundwater is used to produce corn, wheat and oats. Water is already a major factor in oil exploration today. Shortages of water (irrigation) and the high cost of food products hit developing countries hardest as we have seen recently in Mexico with the so called 'Tortilla crises'. Since corn is used to feed animals, the price of meat also goes up and therefore fuels inflation. (Bio-) ethanol as a gasoline additive doesn't provide equivalent fuel efficiency in comparison with pure gasoline.

[5] Editor: this sentence is definitely meaningless as it stands but I can't see what it's trying to say to re-phrase…

*Ethanol cannot deliver the energy we need; to do so the entire continent of South-America would need to be filled with sugar cane to meet the energy demand. Governments in Europe aren't subsidizing ethanol, but have opted instead for bio-diesel produced from seed. In the US and Brazil the governments are backing ethanol. This is why water will be an important "asset" in the future. The words '*food*', '*feed*' and '*fuel*' summarize the ongoing struggle.*

PRICE TRANSPARENCY

Neither of the most widely used benchmarks, Brent and WTI, represent heavy, sour crude. The aforementioned products are therefore imperfect as a basis for managing (hedging) heavy, sour crude price risk. Despite this situation, both Brent and WTI continue to be used as the pricing reference for a majority of the world's oil transactions. Further, most of the global oil trade is done bilaterally (Over-The-Counter, OTC) whereas indices usually reflect the other part of the market, the non-bilateral part. Most indices are based on future prices rather than spot prices, since spot price information is hard to gather. Sometimes closing prices are published but these form rather a poor input for a (real time) continuously updated (and possibly traded) index. The lack of availability of prices results in a lack of (price) transparency. The lack of transparency hinders price discovery. In particular the prior lack of transparent (heavy) sour crude benchmarks has hindered Middle East oil price discovery. Price differentials between sweet and sour crudes can be volatile (see figure 3). The only alternative is to list exchange-traded sour crude futures, such as the Dubai Mercantile Exchange (DME) which has been up since June 1st, 2007.
OTC price assessment is more complex and less transparent than publicly available prices of exchange traded products such as futures. Exchange transactions resolve the problem for they are highly visible to the entire market, providing price discovery while preserving anonymity.
Most current price reporting mechanisms do not capture all (exchange and OTC) trades. It is therefore hard to assess the true market price and particularly the forward curve (see section 4). The provision of a liquid benchmark for Middle East sour crude contributes to the resolution of this issue. In the same respect Qatar wishes to open an exchange listing Liquefied Natural Gas (LNG) futures in order to have a transparent price indicator for this type of gas.
Fortunately the number of transactions since the opening of DME has been significant, since limited liquidity makes the market susceptible to manipulation. The solution to this is to eliminate the ability to manipulate the benchmark, through increased liquidity and regulatory oversight. Information in the energy markets is in many cases scarce and unreliable, as is supported by figure 29. Transparency is therefore very much appreciated.

Declared reserves with suspicious increases (in billion of barrels) *Colin Campbell, SunWorld, 80-95*							
Year	Abu Dhabi	Dubai	Iran	Iraq	Kuwait	Saudi Arabia	Venezuela
1980	28.00	1.40	58.00	31.00	65.40	163.35	17.87
1981	29.00	1.40	57.50	30.00	65.90	165.00	17.95
1982	30.60	1.27	57.00	29.70	64.48	164.60	20.30
1983	30.51	1.44	55.31	41.00	64.23	162.40	21.50
1984	30.40	1.44	51.00	43.00	63.90	166.00	24.85
1985	30.50	1.44	48.50	44.50	90.00	169.00	25.85
1986	31.00	1.40	47.88	44.11	89.77	168.80	25.59
1987	31.00	1.35	48.80	47.10	91.92	166.57	25.00
1988	92.21	4.00	92.85	100.00	91.92	166.98	56.30
1989	92.20	4.00	92.85	100.00	91.92	169.97	58.08
1990	92.20	4.00	93.00	100.00	95.00	258.00	59.00
1991	92.20	4.00	93.00	100.00	94.00	258.00	59.00
1992	92.20	4.00	93.00	100,00	94,00	258.00	62.70
2004	92.20	4.00	132.00	115.00	99.00	259.00	78.00

Figure 29: *Declared reserves having suspicious increases (source: Colin Campbell, SunWorld, 80-95)*

4. Description of the Mercurious Oil Index (MOI)

In this section we describe the Mercurious Oil Index. That means we will take a look at its components and weightings, as well as its mechanism and procedures.

COMPONENTS

A useful, reliable, representative, global oil index must consist of a wide variety of components, which can be divided into groups. With MOI we focus on an index that consists of several groups, which could even be considered as sub-indices:

- Crude oil components:
  - Brent (ICE Brent Crude futures, ICE)
  - WTI (West Texas Intermediate, NYMEX)
  - Oman Crude Oil (OQ futures contract, DME)
  - Ural oil (RE, Russian Export Blend Crude Oil, CME Globex)

- Refinery products:
  - Heating oil (HO, CME Globex)
  - Heating oil (Heating Oil futures, ICE)
  - Gasoline (petrol) (RBOB, New York Harbor RBOB Gasoline, CME Globex)
  - Gas oil (Gasoil futures, ICE)
  - Propane (PN, CME Globex)
  - Fuel Oil (Fujeirah 380cst fuel oil contract, DGCX)
  - Fuel Oil (Singapore 380 cst Fuel Oil, HZ, CME Globex)
  - Diesel (New York Harbor Ultra Low Sulfur Diesel, NYMEX)

- Equivalents, or energy-related products:
  - Coal (Richards Bay Coal futures, ICE)
  - Coal (Rotterdam Coal futures, ICE)
  - Coal (NYMEX)

- Natural Gas (NG, Henry Hub, NYMEX)
- Natural Gas (SAP, OCM platform, APX Group)
- Natural Gas (UK Natural Gas futures, ICE)
- Emissions (ECX CFI futures, ICE)

All groups in fact consist of a few products and can therefore be considered as sub-indices. The Mercurious Crude Index (**MCI**), consists of four crudes (WTI from the US, Brent from Europe, Dubai-Oman from the Middle East and Ural oil from Russia), whereas the Mercurious Refined products Index (**MRI**) consists of eight refinery products and the Mercurious Equivalents Index (**MEI**) of seven products (besides emissions, three are related to natural gas and three to coal). The combination of those sub-indices leads to the overall oil index (MOI).
A variety of components is required because a single component index shows price movement that does not reflect the entire market. The MOI is therefore a diverse index which ensures it totally reflects the market. Equivalents are also included since their prices are highly correlated to crude oil.

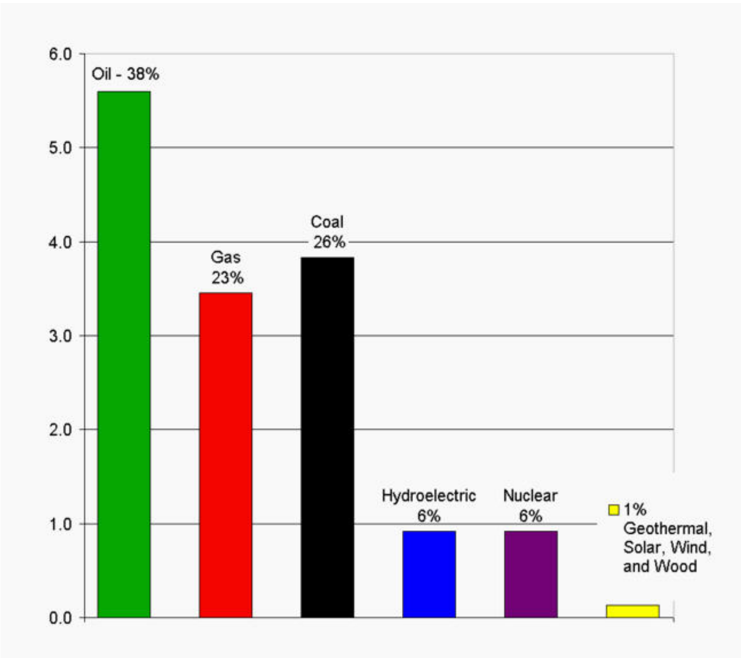


***Figure 30**: Energy sources*

It may eventually even be desirable to add the Mercurious Bio-energy Index (**MBI**) (or even a renewables index), but we consider this at this stage to be too early. Beforehand these markets must become more liquid and significant:

- Bio-energy:
  - Bio-ethanol itself, and its two main ingredients:
    - Ethanol (ICE)
    - Sugar
    - Corn

- Bio-diesel ingredients, such as:
  - Palm oil
  - Soy oil

We denominate this index in euros (MOI€), but of course this index could equally be denominated in dollars (MOI$). Both indices may of course be used, either for scientific research (historical data) or for practical application (current or future data).

SPOT PRICES vs. FUTURE PRICES

Now that the choice has been made as to what kinds of products will be used as components, we must also elect what particular prices of these products are to be used. The choice was between spot prices or future prices. Both have significant pros and cons, and once the decision is made between spot prices and future prices it must then be decided which of the many to use.

Spot prices are mostly unavailable, especially on a continuous basis. An index containing spot prices would however result in an index that best reflects the 'real' market price. As stated previously, these prices are not unfortunately easy to collect; we would otherwise have proposed building an index consisting of the bunker prices for (physical) oil bunkering of the four major harbors, which are based in four different time zones: Singapore, Fujeirah, Rotterdam and Houston. Bunker prices differ from place to place, with the price being highly influenced by the cost of transport. This also means that a global index must preferably be created which has regional viability. Unfortunately the prices cannot be as easily retrieved from the market as can the publicly available future prices of (exchange) listed products.

The same incidentally is also true for an OPEC index, being a price basket of the oil prices of the OPEC countries, of which the spot prices of its components are also subject to little transparency.

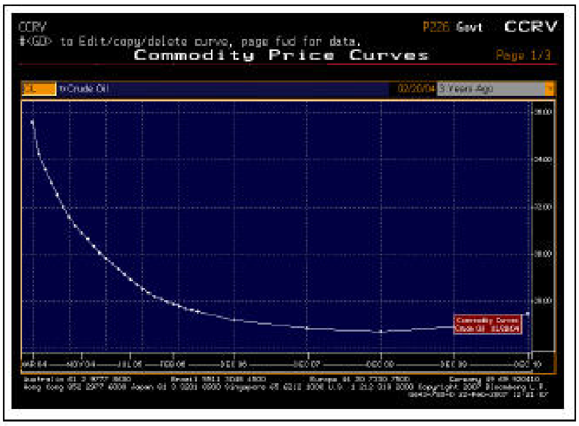
CONTANGO & BACKWARDATION

When using future prices the market may be in either contango or backwardation. A market being in contango means that the spot price is lower than the future price. By contrast, a market is in backwardation when the spot price is higher than the future price.

When an index is constructed using futures, its price is determined by future prices. Before the futures expire, positions must be rolled over to a future having a longer maturity. Depending on whether the market is in contango or backwardation, the process of rolling over the position results in either a positive or negative result ('*roll return*'). Negative roll returns, or at least the possibility of these returns, is a serious disadvantage of the use of future prices instead of spot prices. In the latter case '*spot return*' only is measured. This needs to be taken into consideration when indices are used or compared to other indices.

A forward curve is a graphical reflection of future prices versus different maturities. These curves reflect market circumstances (and are therefore only valid) at specific times and are subject to the dynamics of the financial markets (see figure 31).

Backwardation:
Crude Oil Curve February 2004



Contango:
Crude Oil Curve February 2007

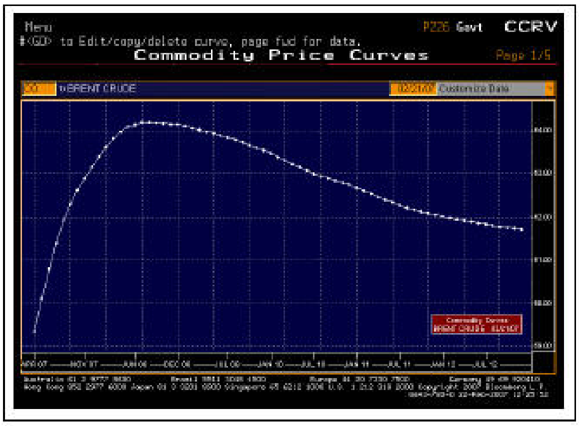


***Figure 31**: Dynamics of forward curves*

WEIGHTINGS

Looking at commodity indices, GSCI and DJ AIG CI both base their weightings on world production averages (and open interest for DJ AIG CI). RICI's components are weighted according to global consumption. We would mention that, depending on the function of the index, it may be preferable to have an oil index weighted by exports, or even by proven reserves (see figure 13). In order to do so, all components must be measured in the same pricing units. However, oil for instance is measured in dollars per barrel, while gas is priced in dollars per billion cubic meters, BTU, therms, or MegaWattHours (MWh).

We opted at this stage of development to weight the sub-indices (MCI, MRI, MEI) as equal parts in the MOI. Within each sub-index every component has an equal weighting. That means in case of four crudes they all weight for 25% in the MCI and for 8.3% (33% of 25%) in the MOI.

ROLL-OVER PROCEDURE

Except for the APX Group natural gas contract (spot prices) we chose to start with futures having a maturity of three months. These will be rolled over to the next futures, again of three months, two weeks before expiration of the portfolio futures.

RE-ADJUSTMENTS

The composition of the index is reassessed at January 1st of each year. A special board is committed to verify and judge on a discretionary basis the addition and/or removal of components for the index.

REGIONAL IMPACT

As developed above, we can conclude that creation of MOI is already possible today and so can therefore already have practical application. It can already be listed, since all its components are traded at exchanges. This provides transparent data to retrieve for index calculations, allowing the index to be measured as from now.

There are of course more ways to construct an oil index. We may prefer to use more spot prices, or the price of the individual crudes of all OPEC nations, as the most important input. Unfortunately these figures are insufficiently transparent and additionally can be retrieved only once daily, making real-time pricing impossible.

Energy prices in general, and more specifically oil prices, are dependent upon the quality of the different products, transport costs, storage costs, insurance costs, political risk, equivalents or substitutes, carbon prices and market access. Therefore each separate product has its local price. The location of the product is critical.
In this respect Henry Hub prices are usually used for global Natural Gas prices, since (amongst other reasons) it is the most liquid market in the world. However, this still only reflects local (US) prices. This means that a representative and reliable global oil index should contain a variety of components, otherwise things such as performance measurement cannot be executed effectively and cannot even be considered.
Implementing coal (steaming or coking coal) into the index also raises many questions. What exactly should be used? The price of coal in Rotterdam/Antwerp, or Mumbai prices (the former Indian city of Bombay)? The choice is important because these can differ widely due to differing costs of transport, storage and labor.
Additionally, should you wish to use the index for energy prices in general, you must be aware of the fact that globally most electricity is generated from coal-fired power plants. However, for historical reasons (the huge Groningen gas field) the Netherlands uses mostly gas-fired power plants. The Netherlands has one of the best organized gas-pipeline networks in the world and will play an important role in European gas logistics in the near future. France generates power mainly from nuclear power plants. However, the worldwide uranium shortages will curtail future developments. As we can see, the very specific geographical factors are significant to the creation and use of an index.

5. RESEARCH

Further, besides the aim of creating an oil index that can be listed, we are also seeking an oil index that may be used for scientific research since we wish to prove the added value of this in practice. Accordingly, an index can also be created for scientific purposes. For research through empirical testing such as by mathematical calculations (e.g. historical correlation coefficients), data are needed over a significant period of time. This implies the need for transparent, available prices. In this respect it is simple to use historical future prices since they can be quite easily retrieved from information systems. However, there are a few factors that need to be taken into account. The first is the use of future prices, in that it may be more convenient to use spot prices instead. Unfortunately, these historical spot prices are hard to locate (retrieve) because the oil business is mostly a bilateral (OTC) business environment, with poor price transparency. Exchange traded futures offer a solution to this, but a second issue then appears; the poor availability of future prices for all components is not really supportive. Most futures have been exchange traded for only a few years, and we are thus faced with a lack of accessible data.

We took a closer look at some of the components with the purpose of ***scientific research*** and created MOI**sr** which consists of Brent crude, light sweet crude, heating oil and natural gas.

Both Brent crude and Crude[6] oil, both being crudes, are highly correlated between each other. Correlation with other crudes (WTI, Oman-Dubai and Ural oil) is also high, thus Brent and light sweet crude do (to a great extent) represent crudes in general.
Heating oil is a refined product of oil and accordingly reflects (to a great extent) other refined products, allowing the correlation between refined products and crudes to be demonstrated. Refined products differ from crude oil with respect to their pricing. They face high geographical risk, and recently crack spreads diverged, meaning that the former price relationship between crudes and refined product has changed significantly. Accordingly these independent price developments of the refined products category need also to be represented in the global oil price index.
Refinery capacity is of great importance in areas where there is shortage of knowledge and capital. The Middle East has recently been in a better financial position than in the past (mainly due to the oil trade), but they still lack a great deal of highly skilled (technical) knowledge.
Natural gas analogously reflects (to a great extent) oil-equivalents. The price correlation with oil substitutes and equivalents is high, and the impact on the market of these is also therefore covered by the inclusion of natural gas. Gas is considered as a substitute for oil because in some processes oil may be substituted for gas. Gas is also produced during the production of oil, which is another reason for their linkage. After all, the main oil companies do also produce gas. This does not however apply to the same extent as regards coal, although both coal and oil are used in electricity generation so are in that respect also substitutes. A large part of electricity generation capacity in Europe remains coal-based, although gas is also used. This also results in a positive price correlation.
Further, gas delivery is commonly arranged through long-term contracts. Usually, both parties will agree that gas pricing is to be dependent on the oil price. In Europe the price of Brent oil is the most commonly used benchmark for gas pricing (although more and more participants are searching for a gas-to-gas market). So far price correlation between oil and gas is high, which all helps to justify the inclusion of substitutes and equivalents in the MOI.
Remember however, that the aforementioned correlations may in practice also become (temporarily/occasionally) negative, especially in times of stress events. War or other catastrophes have huge impacts. The Hurricane season will be important to Florida, but not to Alaska. The supply-demand cycle for gas therefore will be totally different between these two areas. Equally, geographical/seasonality risk is high in Florida (the summer-effect and hurricane-season) and low in Alaska (winter-effect) while environmental risk will be high in Alaska. Thus the local price of gas will be different. In Europe the day length will be an important factor for Sweden since gas consumption will depend on this. In Greece however the holiday season will bring many tourists to the country, resulting in much higher energy demand than in the off-season. This results in additional risk for electricity companies that have long term contracts for electricity supply. Climate change will therefore also be important!

[6] Editor: is there something missing here?

It is essential to include crudes, refined oil products and substitutes and/or equivalents in the index, for each has its own features with respect to volatility. In general the globalization of (energy) markets will lead to a decline of the volatility of MOI, for political risk is priced in(to) volatility. We could also consider whether MOI may be a means of pricing political risk (VMOI, analogous to VIX). Where the diversification of the components is significant, a risk premium will be included in the index (very useful for option pricing).
More specifically, we can see that crude oil products have the lowest volatility (see table 32). Refined products show significantly higher standard deviation (volatility) since they are more sophisticated products and so are more susceptible to fundamental factors (such as seasonality).
The cost of carry will also be important; this is influenced by the volatility of the interest rate yield curve, as dollar-based European refineries face interest rate risk based on US dollars.
Last but not least, gas has the highest volatility, due also to its fundamentals. The gas market is much more consumer driven and influenced by seasonality than is that for crudes, and geographical issues present an even bigger problem for gas than for oil. The price of natural gas (NG) is highly influenced by local (American) fundamentals - incidents such as the Enron-scandal, extreme low temperatures and the 2005 hurricane season had a greater impact on natural gas than on the other three components.

RISK FACTORS
The price of oil can be very volatile due to uncertainty in the global supply-demand cycle, and uncertainty means risk. We can divide this risk into several categories: Political, Currency, Seasonality, Population, Cartel, Geographical, Liquidity, Tourism, Credit, Interest rate, Refinery, Capacity, Environmental, and Transportation (cargo). Some of the risk factors affect the supply curve and others the demand curve. Most of the world's oil fields have to deal with at least some of these risk parameters. This increases the need for greater transparency regarding the oil price. Here again, a recognized global oil index would be useful to obtain more insight in the development of the oil price.

With respect to risk it is also very interesting to note that the volatility (the standard deviation that reflects risk) of the oil price in the two currencies differs significantly (see figure 32 & 33).

	SD in euros	SD in dollars	Difference in basis points
Crude oil	9.96	9.64	32
Brent	10.07	9.86	21
Heating oil	11.68	11.53	15
Natural gas	18.98	18.74	24
			92
			92/ √4 = 46

Figure 32: *Standard deviation (SD) per component in euros and dollars (1999-2006, Mercurious)*

The SD per component in euros appears higher than that in dollars. This conclusion is not in line with our initial expectations; we expected euro exposure to be lower,

since the dollar is more driven by events and the US more influenced by consumer behavior, with the result that the FED is more compelled to change interest rates than is the ECB. This should result in a more volatile dollar in comparison with the euro.
Please note that long term correlation coefficients are not the same (and cannot be easily compared) as short term correlation coefficients.

	Correlation	Skew	Kurtosis
Crude oil	**0.955732**	**-0.062947**	**0.557977**
Brent	**0.964979**	**0.140008**	**0.404563**
Heating oil	**0.974118**	**0.262545**	**2.498118**
Natural gas	**0.990236**	**0.165290**	**0.297100**

Figure 33: *Correlation, skew and kurtosis per component (1999-2006, Mercurious)*

A difference between dollar and euro volatility implies a difference in risk between those two currencies. The risk profile of a dollar-based financial instrument appears different to that of a euro-based instrument.
This implies that currency risk forms part of political risk. Political risk also includes, or at least is strongly linked to, transport risk. This is especially the case in Iraq where the largest explored oilfields are situated inland. The risk of sabotage to the oil pipeline is high. In Iran the cost of transportation is high because the oil pipeline infrastructure is poor, and there are a lot of small oilfields inland. The cost of transportation will be high due to the credit risk of the Iranian government. This is also the case with, for instance, Nigeria, Russia and Bolivia. All the implications of geo-politics must be considered when oil prices are being analyzed or used for indices.

By researching these four categories, we believe we have covered all primary related products (or product categories). Of course, extension of the index using other products would appear to more accurately cover reality. However, obtaining figures for (for instance) WTI, Dubai-Oman oil, gas oil and gasoline is difficult, since publicly listed prices are not available for the entire period 1999-2006.
The figures we used reflect the period 1999-2006. We selected this specific period for several reasons. The main one is the fact that January 1999 reflects the introduction of the euro. Further, eight years reflects a full business cycle; a business cycle of eight years is commonly used in equity markets and is supported by both quantitative and fundamental analysts. Eight years globally reflects a period of 4 years of uptrend and 4 years of downtrend, which is of interest because in this respect the index may be compared to the performance of other asset classes, such as for example stock. This shows a specific insight into the period 1999-2006, which reflects an oil market that fell until 2000 (the stock market went up), and rose thereafter (the stock market fell from 2000 until 2003; and rose from 2003-2007). Consequently, a variety of several market types (bull-bear developments) is involved and three reference periods are available to analyze.
Prices of oil and commodities in general fell from 1980 until 2000. During this timeframe the equity and bond markets rose. After 2000, when the bear market began for equity markets, the main bull market started for commodities. This again reflects the fact that commodities provide a vehicle for diversification since correlations with other asset-classes are negative.

The figures we used for MOI_{sr} are based on monthly prices (the close on the last Friday of each month). This results in (8 years X 12 months X 5 components) 480 values. The results and especially the conclusions based on these values must match with the results and conclusions based on weekly or daily values.
For research purposes we decided to use monthly rather than daily values; other applications may be for hedging or trading. As far as hedging is concerned professional market participants have no interest in day trading, or in a benchmark based on daily data, since they hedge on a monthly or longer basis. Accordingly, professionals employ a hedging platform in which their interest is in rolling-over their positions once a month. From that perspective it is apparent that economic viability is best achieved by ignoring movements on a daily basis.
With respect to its application for trading purposes, as a pricing reference at an exchange the index should be based on daily values; even basing it on real-time values must be of benefit.

For this specific paper we chose to start with equal weightings. The price movements of one component will - in the long run - be reflected in the price developments of the other products. This means that the prices of the components are highly correlated, which automatically removes the primary need for weightings.
As regards the equal weightings we also elected to begin (at T_0) with each of the 4 components at 25%

The value of the index on January 1st, 1999 is 100.00. To be more precise, the value of MOI_{sr} is 100 as at January 30, 1999, for this is the date of the first value (the close of the first month).

MOI is calculated by this formula[7]:

$$I_t = \sum_{i=1}^{n} K_{i,t}$$

Where:

I_t = Value (price) of the index at time t

$K_{i,t}$ = Value (price) of component i at time t

n = Number of components in the index

Next, the MOI_{sr} is calculated in euros. Although the US are the main consumer of oil, the dollar may not be considered the main currency to denominate the price of oil.

[7]Editor: Shouldn't the formula make reference to the weighting? Less of an issue here as all are equal, but I think this will still yield a value 4 x greater than it should?

Primarily, the US is a net importer. This means that they buy (a lot) more oil than they export (or produce). This supports the view that the dollar should be accorded considerably less importance than it first appears. Secondly, for European or other nations, use of the euro (or another – local – currency) would be preferable due to of global (geopolitical) developments. Russian oil, as well as Middle East crude, is gaining market share and the economic balance (relative importance) is tending more toward those regions. Russia has very strong political influence, and is therefore gaining momentum. Political risk, and the credit risk associated with it, is however high for Russia. Ural oil is expensive because Russia has no extensive oil pipeline network.
China and other Asian countries are gaining in importance as importers of Middle East crude oil, which places pressure on flows to Europe and the US. Europe is increasing imports from Russia (for both gas and oil). Rotterdam appears to be the principal distributor of Russian oil in Europe, and this major port (which is euro-based) will then strengthen its role as a key global player in energy.
Further, the US is in political conflict with many oil producing countries (for instance Iran and Venezuela), much more so than are European countries. This leads to geo-political effects, for instance extra (high) volatility in the dollar. Investors try to avoid volatility, for volatility reflects risk.
Additionally, the price of money should be considered. Dollar interest is higher than the euro interest rate. Inflation in the US is more influenced and determined by consumers than it is in Europe, which leads automatically to more cyclic patterns and higher volatility.
With respect to commodities (energy), next to the costs of transport, the costs of carry are very important. Interest rates and their development are essential to analysis of these markets. Inter-market analysis is very relevant, and yield curves can provide relevant information.
All of these factors result in the euro taking a more important social and economical role, and more responsibility.

6. The MOI and the requirements for an index

To obtain an index that is suitable for practical use it must (theoretically) meet certain requirements. Those requirements were stated in section 3 of this paper and we will discuss how the MOI (as described in section 4) does meet these criteria. We also refer occasionally to MOI_{sr} (in *italic*) to explain the probable impact for MOI.

- Simplicity

  The MOI is a function of prices over time, *just as MOI_{sr} began at January 1st, 1999 and ended at December 31st, 2006*.
- Weightings

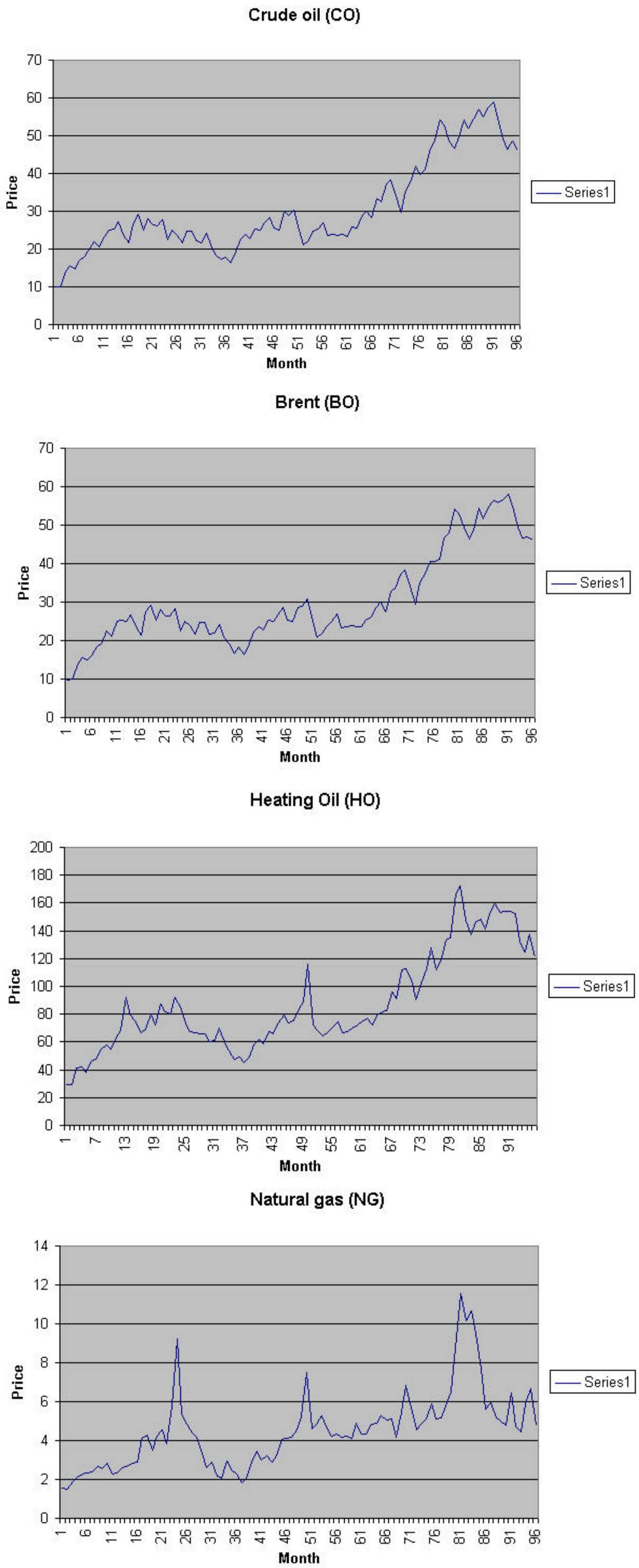
  The relative significance of specific components is not currently reflected in the weightings, since the method uses equal weightings per sub-index and within each sub-index per component. The weightings of

MOI therefore reflect neither the activity in nor the importance of its components, and are an objective view regarding the production.
With MOIsr we also chose not to re-adjust the weightings over time. This implies that the price developments of the components do influence the weightings.
We also decided to leave the weightings for the whole period 1999-2006 as they were at the outset (25% per component), since they show a fairly steady pattern over the entire period (see figure 34).

	CO	BO	HO	NG
Jan 1999	25.00	25.00	25.00	25.00
Dec 1999	27.91	29.24	26.29	16.56
Dec 2000	16.82	17.28	21.87	44.03
Dec 2001	26.06	27.75	24.69	21.51
Dec 2002	25.68	25.28	24.11	24.91
Dec 2003	22.92	23.30	23.73	30.05
Dec 2004	24.83	25.22	25.83	24.11
Dec 2005	23.66	23.82	23.73	28.78
Dec 2006	27.86	28.67	25.04	18.42

Table 34: *Weightings (%) of components at the end of each year (1999-2006)*

Mean reversion occurs in the long run, as is usually the case with correlated assets. Over brief periods however, for natural gas in particular (and especially towards the end of the year), high variation is shown.
It may have been possible to re-adjust the weightings to maintain a 25% stake throughout. Another possibility would be to have re-adjusted the weightings back to 25% (adaptation) after a certain period, for example each year at the 1st of January, or perhaps as soon as a certain limit is reached. Additionally, if desirable, the highest weighting of a component could be maximized to a certain percentage, for instance 35%. When the weightings were calculated at the end of each year and the conclusion drawn that the weightings did not reach this limit, this would support the choice for 'no re-adjustments'. Of course, exceptional patterns must be taken into account before deciding to adjust the weightings. In this case, mean reversion meant there was no need for re-adjustments.
It seems to be of interest to have components that do not move in exactly the same ways (see figure 35), as this leads to the desirable diversification of the index.
Natural gas is very volatile, but does seem to follow the price of oil over the long run. The correlation between all four components is high and this justifies their presence in the index.



<u>Figure 35</u>: *Development of the individual components of MOI: CO, BO, HO and NG (1999-2006) (source: Created by Mercurious, based on data from Bloomberg)*

- Invariance

  Changing the uniformity (or unit) in which prices are expressed does not change the MOI.
- Determination

  Theoretically, the MOI will not be zero when the price of one of its components becomes zero, since the value of the index is the result of adding the different components to each other. In practice, the prices of the different components are highly correlated. The underlying products may be viewed as substitutes. Accordingly the price of one of these components going to zero, without the others moving that way, appears impossible.
- Proportionality

  When all components of the MOI are multiplied by the same factor, the index will be multiplied by the same factor.
- Identity

  When the components in the MOI at two different moments in time have exactly the same time, the index - as a result - reflects exactly the same value; this is particularly the case as we chose not to (continually) re-adjust the weightings.
- Currency exchange rate changes

  When all components at a certain moment in time are measured in another currency, the index should be able to be determined as a value in the original currency calculated in another currency.
- Aggregation

  Composed indices have to follow the partial indices after weighting with the fractions of which the composed index is comprised. The other way around, taking MOI as a starting point we constructed sub-indices, each containing several components (products).
- Rule of chains

  Taking January 1st ,1999 = 100, MOI_{sr} would be 150 at January 1st, 2002. Taking January 1st, 2002 = 100 the index would be 140 at December 31st, 2006. Taking January 1st ,1999 = 100 MOI_{sr} would be 210 (150 times 140%) at December 31st, 2006. By analogy, the rule applies for MOI.
- Path-independency

  The value of the MOI depends to at least some degree on the pricing at previous moments in time for the correlation of all individual components.

  Prices of the individual components show high correlation, except in cases of stress (Enron, hurricane season). In such cases the price of natural gas (compared to the prices of crudes) is even more volatile than usual. The power market (electricity) will be under pressure (having a strong relationship with gas).

Additional requirements:

- Liquidity

  An index must be liquid and it must reflect liquidity. This can be obtained by using liquid components. This will almost automatically lead to a liquid index. The components used in the MOI are very liquid.

- Independency

  For instance independency of data; it should be of no matter whether monthly or daily data are used for the development of the index. Regardless of the data used, the outcome of MOI will be the same.
  Daily values would provide a lot of excessive price movements. Monthly data are not influenced by intra-day swings.

- Transparency

  Within the MOI both the components and their pricing are transparent. Therefore we consider MOI transparent.
  However, even more importantly, volatility is transparent. Volatility in energy markets is three to four times greater than that in equity markets. The search for transparency within the derivatives markets is therefore very relevant. With transparency in volatility, market parties do not need to contact a broker to check the volatility in the market, but can extract it themselves directly from the market.
  Additionally, the fair value of volatility can be analyzed. For instance, what is the difference between historical volatility and the (current) implied volatility? Large differentials may provide crucial information or even arbitrage opportunities when this difference becomes too great.

The efficiency of an index is dependent upon three factors:

1. The number and type of components.

   The MOI consists of 17 components (whereas MOI_{sr} has 4). We consider this to be significant, and all three main categories are represented: crudes, refined products and substitutes or equivalents. All are oil or oil-related. Additionally, their prices are highly correlated.
   Ideally, we would have liked to have included more products and introduced a better geographical spread, but lack of data forces us to do differently. With luck the future will bring more possibilities.

2. The ability to adapt to changing market circumstances.

   The MOI can adapt to changing market circumstances in several ways. Firstly, components can be changed for others, or their numbers can be extended or reduced (at January 1st, see section 4). Secondly, their individual prices are determined independently in several markets. Therefore, the value of the MOI is subject to 'free' market forces.

3. The method to determine the value of an index.

   The method of determination of the value of the MOI is based on equal weightings at the outset. This is the most basic method and must be considered a very simple approach. To fine-tune the efficiency of the index weightings could be added. In this particular case we concluded that there is no need to do so.

Based on the above factors the MOI is an effective (oil) index, and moreover is much more useful as an indicator of oil price development than the currently widely used Brent benchmark or the GSCI-index (see figure 36).

	Brent	GSCI	MOI
Number of components	1	24	17
Oil related	100%	>25% non-energy	100%
Underlyings	Spot & future	Futures	Futures (1 spot price)
Roll-mechanism	3rd Friday of month	Day 5-9	1st Friday
Geographical spread	No	Mainly US based	Yes
Currency	USD	USD	EUR
Weighted	No	Yes	No

Figure 36: *Comparison of Brent, GSCI and MOI*

7. Price development of the MOI

Development of the MOI$_{sr}$ reflects the performance of the index (see figure 37). This can for instance be compared with other financial instruments, or just to its components.

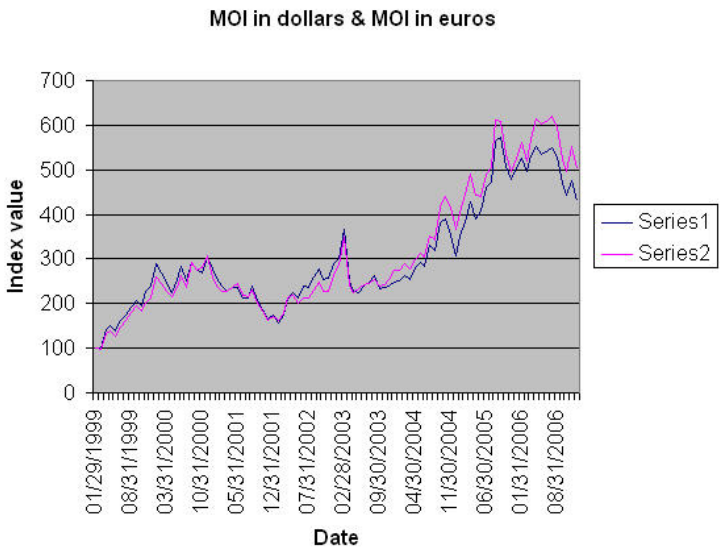


Figure 37: *MOIsr in dollars (series 1) and MOIsr in euros (series 2) (1999-2006) (source: Created by Mercurious, based on data from Bloomberg*

A Sharp ratio could be created for both the separate components and the index. The Sharpe ratio (yield divided by SD) defines how the performance of the benchmark

compares to that of its components (individually measured): How great was the risk involved to realize what return? The Sharpe ratio of an index should be higher than that of its components since an index has a lower standard deviation. Hedge fund managers use the Calmar ratio and Sortino ratio to give insight into downward risk.
Tracking errors may be used to compare the results with other asset classes. An index will have a lower standard deviation than its components and therefore a lower tracking error.

Input data are retrieved from Bloomberg. Prices of crude oil, natural gas and heating oil are Nymex prices, whereas Brent oil prices represent ICE prices. All are monthly closing prices.
The euro has been an official currency for payment since January 1st, 2002. However, its official introduction was January 1st, 1999. Therefore, data could be derived from that period of time.
We had to choose between the length of period we wished to research (8 years reflects a full business cycle) and the number of components of MOI_{sr} (we choose 4), because listings of some products, such as unleaded gasoline futures, were introduced only in January 2006. This is the reason for the lack of transparent prices. For our research however, we need data and therefore transparency.
We could have opted for more products, but we would then have needed to research only a very brief period, of about two years. The significance of the results in such a case is no longer guaranteed, and conclusions and statements would have been hard to draw.

It is interesting in this respect to consider the fact that the crack spread (the price differential between a type of crude and its refined products) has changed lately. Due to volatility in the USD yield curve, the high cost of transportation, and capacity problems in the US refinery industry, refined products have been very volatile and quite far removed from their median over the last period. The correlation with crude oil seems to have altered somewhat (lowered).

	CO	BO	HO	NG	∑
1-1-1999					
In euros	**9.98**	**9.66**	**29.18**	**1.56**	**50.38**
In dollars	**11.35**	**10.98**	**33.16**	**1.77**	**57.26**
31-12-2006					
In euros	**46.10** ***(462%)***	**46.05** ***(477%)***	**121.06** ***(415%)***	**4.77** ***(306%)***	**217.98*(433%)***
In dollars	**60.86** ***(536%)***	**60.79** ***(554%)***	**159.79** ***(482%)***	**6.29** ***(355%)***	**287.73*(502%)***

Whereas:
CO = Crude oil
BO = Brent crude
HO = Heating oil
NG = Natural gas

Current weightings:

CO	50.38 : 9.98 =	5.0480961
BO	50.38 : 9.66 =	5.2153209
HO	50.38 : 29.18 =	1.7265250
NG	50.38 : 1.56 =	32.2948710

Convert to equal weightings of 25% each:

				Weighting in euros:
CO	100% : 5,0480961 = 19.81%	→	25% : 19.81% =	**1.262**
BO	100% : 5.2153209 = 19.17%	→	25% : 19.17% =	**1.300**
HO	100% : 1.7265250 = 57.92%	→	25% : 57.92% =	**0.432**
NG	100% : 32.294871 = 3.10%	→	25% : 3.10% =	**8.065**

***Figure 38**:* *Prices of MOI's components*

The data (shown in figure 32, 33 and 38) shows an additional risk with the index being based in euros. The difference between the indices based in dollars and in euros is significant. It is not however too great, so we may still conclude that the euro-based oil index is useful. For hedging purposes in particular the extra risk in euros is easily offset by the decline in the cost of hedging. Hedging is concerned with dealings involving transaction costs, brokerage and administration fees, clearing and settlement costs, as well as slippage.
Hedging the dollar-euro exposure can be achieved through buying (cash) dollars and selling short (cash) euros, or vice versa. Such hedges, which are performed by brokers, cost at most ten basis points, inclusive of all costs. The costs of hedging currency risk are very low because the currency markets are very mature and liquid and so competitive.
Additionally the euro/dollar price is very subject to trends (see figure 22), which may be a reason to hedge quite thoroughly.
It is interesting in this respect to mention that the euro was initially weak (following its introduction) and has grown strong over the last years. The reason may be that the advantages of a single currency in Europe (the euro) have only recently come to fruition. Countries like Spain and Italy are demonstrating the benefits of being united in one Europe with a single currency. This is important to review in the near future. The euro will gain interest as safe haven.

8. Application of the MOI

The goal of developing a new oil index is to increase transparency, stimulate pricing and decrease volatility risk. Globalization is becoming more effective and as a result correlation between prices of different oil products will increase. However, there is still a long way to go, so energy markets will remain inefficient from an informational perspective for a considerable time. The existence of cartels (such as OPEC) confirms this inefficiency.
Within the energy markets MOI may be employed as a standard for the oil markets, a benchmark with which to measure performance and/or as an underlying value with respect to derivatives.
The MOI can form part of all kinds of investment concepts. It can be involved with the analysis of market sentiment, as a prediction instrument for investment strategy or market portfolio, as a measure of economic conditions, or as the basis for scientific research.

Sentiment
The oil market can be analyzed by means of the MOI and compared to other markets, related or not. Analysts can also describe the market as bullish or bearish.
Additionally, the volatility of MOI (V_{MOI}) can be a measure comparable to the V_{IX} or V_{DAX} used for the stock markets. A sentiment indicator regarding oil could be very helpful.

It may even be used as a hedging instrument against political risk. Stress situations such as regional tension, or even war, may force most asset classes down, but energy prices usually rise.

Measuring performance
Portfolio managers' financial reward is usually through bonuses based on their performance. This performance is relative, and so must therefore be compared to something that can be viewed as representative of the market. To achieve this the MOI can be used as the benchmark.
Remember however that the correlation can also be negative, especially in times of stress events as we saw in September 2001. The Hurricane season will be important to Florida, but not for Alaska; the supply-demand cycle for gas will then be totally different in these two areas. The local price of gas will also be different. In Europe the day length will be an important factor for Sweden since gas consumption will depend on this. In Greece however the holiday season will bring many tourists to the country, resulting in much higher energy demand than in the off-season.

Market prediction
To predict market developments or future prices investors can for instance employ time-series analysis. Charts of indices are very helpful in supporting these analyses.

Index tracking
The MOI is a well diversified index and can be used to construct an oil portfolio. Investments based on the composition and weightings of this index are described as index tracking. The composition and/or weightings of the portfolio are changed only when the index itself is being changed. Investors using index tracking are committed to the efficient market hypothesis (EMH) which implies that it is impossible to outperform the market.

Measuring economic conditions
The MOI can be used as an indicator for economic conditions and may support macro economic predictions, in particular for those countries which rely heavily on export of oil. These are mostly socially and economically unstable countries.

Market portfolio
The MOI can support the calculation of betas for oil products (for example the index's components, or other oil products). The beta reflects the ratio (relationship) of the yield of an individual product compared to the yield of the MOI.
Additionally, oil correlates negatively with other asset classes such as stock and bonds. A portfolio including oil is therefore more diversified. Risk is lowered and return will be more stable.

Scientific research
During scientific research into market efficiency the MOI can be employed as a well diversified portfolio. The economic valuation and statistic valuation must however tend toward the same direction. Conflict of interest must at all times be avoided.

Underlying value
The MOI can be used as an underlying value for derivatives, structured products or other indirect investments. It can also be used however as both a pricing benchmark and a benchmark to determine implied volatilities for the OTC market, which currently is not transparent and is dominated by only a few players, as was clearly demonstrated by both the Enron and Amaranth debacles. Liquidity plays a major role in stress-events, as nobody knows what the risks are. Liquid listed contracts provide for transparency.
An index and financial instruments based on the MOI provides energy market participants with the opportunity to decrease their exposure, through using those instruments to hedge their portfolio. And, of course, a single hedge through a single instrument is much cheaper than hedging each individual component.
Utilities and energy (oil) companies hedge their portfolios. An interesting point is that (the distribution of returns of) stocks of utilities and energy companies have a very low correlation (about 0.2). Utilities profit from the beginning of the business cycle, whereas oil companies tend to do so more toward the middle or end.

Many transactions in the energy markets are performed physically. The introduction of an oil index may support the exchange listing of financial instruments having this index as the underlying value. If these products are to be subject to cash settlement, credit risk will decrease (towards zero) and the same applies for liquidity risk (since liquidity will rise). This scenario supports allowing the development of oil markets to become more like financial markets. Energy markets and financial markets appear to be becoming more and more integrated.
Within the bond market, the German Bund market is faced with physical delivery. The seller of a futures contract decides - within certain limitations of course - what bonds he is going to deliver. Is this feasible within the oil markets, and is it desirable?
Physical delivery of a basket of several oil components would be faced with the problem of a variety of delivery points. Unfortunately the components can not be delivered at the same spot. For this reason cash settlement would be the best way to handle this product.

Most corporations sell (short) futures (or use other financial instruments) to hedge their risk. For investment purposes however, institutions (for instance pension funds) have to buy (long) futures. Pension funds will increase their investments in commodities (both absolutely and relatively). One reason for doing so is that commodities offer investors low correlation with other asset classes and are therefore very welcome in every investment portfolio aiming for diversification.

For instance, a put option may be bought, where the put contract has the MOI as its underlying value. Additionally, the purchase of this option means that it is no longer necessary to deposit collateral. After all, no margin is required. The cost of hedging will accordingly fall through the implementation of such financial instruments (indirect instruments, like derivatives).
Further, the index contains several components. This means that risk can be hedged by using a single instrument for the entire basket, instead of using instruments for each individual component. This will lower the cost of hedging.
Also, these derivatives do not necessarily have to be settled physically. Cash settlement provides an additional advantage that may support trading, hedging, liquidity and so on.

Inflation hedging
Investments made by means of MOI can also be used as a hedge against inflation (see figure 39). Inflation is calculated by comparing the prices of consumer products over time. Each country or entity employs different baskets, meaning different components and different weightings, which results in a large variety of inflation indices. A lot of these also contain energy products, such as oil, which makes sense since energy represents a significant cost to households and companies.
Inflation erodes the value of money. To compensate investors could invest in MOI, although it must be said that commodities such as metals provide even better hedges against inflation.

***Figure 39*:** *Historical correlation between Goldman Sachs Total Return indices and US PPI (source: UBS / Bloomberg; used data: Jan 1985 - May 2005, 1-month rolling returns*

Price balancing
Users of the infrastructure (pipes, grid) must be in balance. This means input and outtake of energy (gas, electricity or oil) must be equal, apart from a small tolerance level. Exceeding certain limits means that the user of the infrastructure will receive a financial penalty.
Transmission System Operators (TSOs) use indices from energy exchanges to price imbalances. In the Dutch gas market for instance the Amsterdam Power Exchange (APX) provides an index that is used by Gas Transport Services (GTS) as a pricing mechanism to settle the imbalance. In the world of oil pipelines there is also the need for balance.

Additional issues
Two primary additional remarks concerning the previous paragraphs have to be made. The first is that the MOI can be used as a benchmark for energy. Secondly, the composition of the MOI can be changed or extended so that it better reflects the oil price.

An index can serve as a benchmark. Current benchmarks in the oil business are West Texas Intermediate (WTI) and Brent crudes. Unfortunately these reflect only a small part of the world's crudes. Both WTI and Brent oil are sweet crudes, with no heavy component. However, most oil is found in the Middle East where the crudes are - on average - sour and tend to be heavier than those mentioned before. This is the reason why when Dubai Mercantile Exchange (DME) opened its doors it listed a new benchmark. They began on June 1st, 2007, listing Oman-backed futures. Oman-Dubai oil is used in the OTC markets and is the leading indicator for Middle East oil. This type of oil also forms a component of MOI. In future other products may be added to the MOI, but the products must first be listed before they can provide transparent prices.

Another way to optimize an oil index is the method of using major products, such as OPEC oil. OPEC accounts for 40% of global oil production, and has about 65% of the world's proven oil reserves.
Using the bunker prices of all twelve current OPEC members would produce an OPEC basket. This index, or an index including these values, will reflect the price of oil much better (more accurately) than just the price of WTI. Unfortunately, the prices are not easy to gather. Figures regarding oil, such as production and sometimes prices, are not made public or - at least - cannot be sufficiently trusted.

Ethical and environmental indices are very popular today. To meet the requirements of our current society and of the market we could extend our index with some additional products.
The use of energy, energy products and energy related products is shifting, because of the problems with nature and the changing climate. This transition leads to the use of other products.
Oil has many varieties in both form (sweet or sour; heavy or light) and substitution (gas, coal, durables or renewables). These products are often calculated in (oil) equivalents. Currently, the techniques and technology to use other materials are becoming increasingly significant. Bio-energy is energy created from soy oil, palm oil, grain (including corn), sugar (cane), waste, or other natural (agro or human) materials. The prices of these products correlate to some extent (and within certain ranges) with the price of crude oil. Therefore, it may be wise to extend the MOI to embody these products as well. This would reflect the price of energy in an interesting way.
To achieve that described, it is necessary to add commodities that act as substitutes for fossil energy. Grain, wheat, oats, corn, sugar can all be used to produce bio-ethanol (bio-energy).
This paper could in that respect even initiate the development of sub-indices (such as the bio-energy commodity index) to analyze or map business cycles.

Analogous to, or in accordance with, the suggestions made above, another currency could be used to limit or reduce exposure. We aimed for a euro denominated index, but this could equally have been another currency. A basket of currencies would resolve the difficulty of selecting one and would address this issue globally.

9. Summary & Conclusions

This scientific paper described the development of an oil index. The Mercurious oil index (MOI) meets all the requirements sufficiently well to validate its sustainability. In fact, it is a very useful tool, for it contains several components. All of them show different price development patterns and are influenced by different fundamentals. The MOI is therefore well diversified within its product group (oil). Additionally, within such a product group, the products (components of the index) have high correlations. The MOI reflects crudes, refinery products and equivalents or substitutes.

The MOI can be used to reduce or hedge energy risk, to measure performance, to indicate sentiment and volatility, to predict the market and to support tracking. MOI can be used as an underlying value for options and futures that could be listed or structured products that can be created.
Prices of oil, gas and electricity are highly correlated. Energy exchanges or companies can therefore use MOI as their index, or at least as a pricing reference.

We also looked at the differences between listing MOI in dollars and in euros. The difference between both standard deviations implies a small difference in currency risk. Market participants try to avoid any significant risk and will search for suitable hedges for their exposure.
The difference in cost between hedging through a dollar-based and a euro-based index is relatively small. This appears to validate the existence of this index in euros (MOI) and it's potential exploitation.

As a result of globalization hedging is becoming both easier and cheaper. Participants using the MOI can fairly easily achieve a reduction in both risk and costs.

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